2.2 Aquatic and Riparian Ecological Communities

SQN is located in Hamilton County, Tennessee, on the western shore of Chickamauga Reservoir at TRM 484.5 (Figure 2.1-2). An impoundment of the Tennessee River, Chickamauga Reservoir extends approximately 59 river miles: from Chickamauga Dam in southeast Tennessee at TRM 471 upstream to Watts Bar Dam in southern Tennessee at TRM 529.9. The reservoir has a drainage area of 20,790 square miles, a shoreline length of 784 miles, a volume of 628,000 acre-feet, and a surface water area of 35,400 acres at normal maximum pool elevation of 682.5 feet mean sea level (msl). The reservoir ranges from 700 feet to 1.7 miles wide. (TVA 1974a) Average flow of the Tennessee River at the Chickamauga Dam is approximately 32,500 cubic feet per second (cfs) (1.03×10^{12} ft^3/year) (TVA 2012j). TVA's WBN is also located on Chickamauga Reservoir, approximately 31 miles north-northwest of SQN. (TVA 2011p, Section 2.1.1)

2.2.1 Physical and Chemical Environment

The Tennessee River system, managed by the TVA, is a network of dams and reservoirs that generates power, reduces flooding, provides recreational opportunities, and boosts the regional and national economies. The Tennessee River system has approximately 11,000 miles 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 2011c)

The headwaters of the Tennessee River Basin watershed originate in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia. (TVA 2011c) The Tennessee River and its tributaries drain a total of 40,648 square miles (Table 2.2-1), which makes it the largest tributary of the Ohio River. In its course, the river flows through portions of Virginia, North Carolina, Tennessee, Alabama, Georgia, Mississippi, and Kentucky. The 850 miles of the main stem Tennessee River begin at the junction of the Holston and French Broad rivers above Knoxville, Tennessee. The river weaves a U-shaped course, flowing southwest from Knoxville into northern Alabama, where it makes a great bend, running west before turning north to flow across western Tennessee and Kentucky. The mouth is at the Ohio River near Paducah, Kentucky. (USGS 2011a)

Tributaries to the Tennessee River include the Hiwassee, Little Tennessee, Clinch, Flint, Elk, Duck, Big Sandy, and Clark rivers. The mean annual discharge of the Tennessee River near Paducah, Kentucky, is 65,600 cfs. (USGS 2011a)

2.2.1.1 Hydrologic Setting

The Tennessee River Basin watershed is subdivided by the U.S. Geological Survey (USGS) into 32 hydrologic units (USGS 2011b), each identified by a hydrologic unit code (HUC) (Table 2.2-1 and Figure 2.2-1). The SQN site lies on the western side of the Chickamauga Reservoir within the Middle Tennessee-Chickamauga Watershed (USGS HUC 06020001). Surrounding the Middle Tennessee-Chickamauga Watershed are the Guntersville, Sequatchie, Watts Bar Lake, and Hiwassee watersheds (Figure 2.2-1).

The USGS divides the Tennessee River Basin into the Upper Tennessee River Basin and the Lower Tennessee River Basin. The boundary between these sub-basins is TRM 465 on the main stem of the Tennessee River at Chattanooga, Tennessee. The Lower Tennessee River Basin includes portions of Tennessee, Georgia, Alabama, Mississippi, and Kentucky that drain to the Tennessee River and its tributaries between TRM 465 and the confluence with the Ohio River at Paducah, Kentucky. (USGS 2000b)

The Upper Tennessee River Basin encompasses approximately 21,390 square miles and includes the entire drainage area of the Tennessee River and its tributaries upstream from the USGS gauging station at Chattanooga, Tennessee. The study area includes parts of four states: Tennessee, 11,500 square miles; North Carolina, 5,480 square miles; Virginia, 3,130 square miles; and Georgia, 1,280 square miles. Parts of three physiographic provinces (Cumberland Plateau, Valley and Ridge, and Blue Ridge) compose the Upper Tennessee River Basin. Elevations range from 621 feet msl at Chattanooga to 6,684 feet msl at Mount Mitchell, which is located just northeast of Asheville, North Carolina, and is the highest point in the eastern United States. The Upper Tennessee River Basin contains some of the most rugged terrain in the eastern United States, including the Great Smoky Mountains range. (USGS 2011c)

The Lower Tennessee River Basin includes 14 of the 32 major hydrologic units that compose the Tennessee River Basin watershed. Seven of these units represent 37 percent of the basin area and make up the drainage areas for five tributaries to the Tennessee River: the Elk (two units), Duck (two units), Sequatchie, and Buffalo rivers, and Bear Creek. The remaining units represent 63 percent of the basin and correspond to direct drainage in the main stem of the Tennessee River, or to groupings of minor tributaries to the main stem. No individual tributary drains more than 600 square miles or 3 percent of the Lower Tennessee River Basin. (USGS 2000b)

The natural character of the Tennessee River was substantially changed in the 20th century. From 1920 through the 1960s, dams were constructed along the river's main stem and tributaries. Other alterations include the Tennessee-Tombigbee Waterway, which entailed the merger of the Tennessee River with the Mobile River to create a navigational route to the Gulf of Mexico. (USGS 2011a)

The Tennessee River basin is known for the abundance and diversity of freshwater fish, crayfish, aquatic insects, and mollusks within its waters. It is one of the most diverse rivers in North America, supporting approximately 240 different fish species. The only other rivers that come close are the Mobile (236 species), the Cumberland (186 species), the Roanoke (82 species), and the Conasauga (78 species). (USGS 2011a)

In addition, the Tennessee River hosts the most diverse collection of mollusk fauna in North America. Approximately 102 species of freshwater mussels have been recorded in the Tennessee River basin with the majority of such fauna confined to the Clinch and Duck rivers. The U.S. Fish and Wildlife Service (USFWS) lists 51 aquatic species (fish and mollusks) in the entire Tennessee River basin as threatened or endangered, none of which are found immediately adjacent to, or downstream of, the SQN. (USGS 2011a)

2.2.1.2 Tennessee River Controls

The TVA owns or operates 49 dams and reservoirs in the main stem Tennessee and Cumberland watersheds, including nine dams and the Raccoon Mountain pumped storage facility on the Tennessee River (Table 2.2-2 and Figure 2.2-2) (TVA 2011d). TVA operates the Tennessee River system to provide year-round navigation, flood-damage reduction, power generation, improved water quality (dam discharge oxygenation and aeration), water supply, recreation, and economic growth (Bohac and McCall 2008).

System-wide flows are measured at Chickamauga Dam, located near Chattanooga, Tennessee, because this location provides the best indication of flow for the upper half of the Tennessee River system. The Tennessee River is well regulated with minimal changes in water levels. Based on TVA control measures, frequency of flooding is not a concern. If the total volume of water flowing into Chickamauga Reservoir is less than what is needed to meet system-wide flow requirements, additional water is released from upstream reservoirs to augment the natural inflows (a function of rainfall and runoff), resulting in some drawdown of these projects (TVA 2011e).

In May 2004, the TVA Board of Directors approved a new policy for operating the Tennessee River and reservoir system. The new policy specifies flow requirements for individual reservoirs and for the system as a whole. Reservoir-specific flow requirements keep the riverbed below a given reservoir's dam from drying out. System-wide flow requirements provide sufficient water flow through the river system to meet downstream needs (TVA 2011e). Based on the amount of water stored in these reservoirs, in relation to TVA's minimum operations guide shown in Figure 2.2-3, TVA releases enough water to provide the weekly average minimum flows at Chickamauga Dam.

Section 26a of the TVA Act also requires facilities that will have permanent surface water withdrawals to obtain a Section 26a permit before any construction activities commence. The amount of water that a facility may withdraw under this permit is dependent upon many factors, including need, low-flow conditions, aquatic habitat, and other environmental conditions. All 26a water-intake permit applications must include a documented need for the requested volume of water. TVA reviews these requests and evaluates its associated environmental impacts to determine the appropriate volume of water that can be withdrawn, taking into account factors such as operation of the river system and impact on the river environment. Water withdrawal permit holders are required to report annual usage as a condition of their permits, except for small residential irrigation users who are exempt from reporting requirements. These data are used in tracking existing withdrawals and evaluating proposed increases in withdrawals from the Tennessee River system. (TVA 2012a)

2.2.1.3 Ecological and Riparian Habitats

Riparian zone disturbance falls into two main categories: hydrologic modifications that indirectly impact riparian communities through changes in stream morphology and hydrologic processes, and habitat alterations that result in direct modification of riparian communities through land clearing or disturbance. These are generally associated with construction activities or river modifications, such as dam building.

There are no refurbishment activities or plant operational changes associated with SQN license renewal. Current plant water withdrawal and discharges would remain the same during the license renewal period and would be regulated by the SQN National Pollutant Discharge Elimination System (NPDES) permit, which would assure continued compliance with applicable water quality standards and criteria.

2.2.1.4 Tennessee River Restoration Efforts

Current fish restoration projects on Chickamauga Reservoir include operational support to improve downstream water quality as well as reducing the deleterious efforts of reservoir thermal stratification on water quality and biota. Restoration projects were reported in areas within the upper reaches of some tributaries to the Tennessee River including efforts to repatriate the lake sturgeon (*Acipenser fulvescens*) near the headwaters of the Tennessee River (Huddleston 2006). Some of these fish have been known to migrate into and through Chickamauga Reservoir.

2.2.1.5 Water Quality

The State of Tennessee has designated the reach (river segment of a specific length) of the Tennessee River in the vicinity of SQN for domestic and industrial water supply, fish and aquatic life, recreation, livestock watering, irrigation, and navigation use classifications.

The State of Tennessee also assesses the water quality of streams and (biannually) develops a draft 303(d) list for impaired waterbodies. Under Section 303(d) of the 1972 Clean Water Act (CWA), states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that do not meet water quality standards. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop total maximum daily loads (TMDLs) for these waters.

Chickamauga Reservoir is not listed on the TDEC 2008 or 2010 303(d) lists for impaired waters. However, nine listed impaired waters discharge to the Chickamauga Reservoir and are identified on both 303(d) lists (TDEC 2008; TDEC 2010a). Table 2.2-3 and Figure 2.2-4 present the relative location of each impaired water to SQN (EPA 2011a; USACE 2011) and impairment information from the proposed final version 2010 303(d) list for impaired tributaries to the Chickamauga Reservoir.

The CWA requires that Congress receive a biennial accounting of the water quality for each state. The Tennessee Water Quality Control Act also requires a report on water quality. The TDEC, Division of Water Pollution Control, has primary responsibility for assessment and reporting of the quality of surface waters. Chickamauga Reservoir and the Hiwassee River (tributary) were fully supportive according to the most recent 305(b) report submitted in 2010. The Watts Bar Reservoir (upstream) is considered impaired due to polychlorinated biphenyls (PCB) accumulation in fish tissue. The Nickajack Reservoir (downstream) is only partially supportive due to PCBs (TDEC 2010b). PCBs are present in sediments due to historic industrial and military releases.

2.2.1.6 TVA Ecological Monitoring

TVA has conducted its vital signs monitoring program on Chickamauga Reservoir in alternate years since 1994. The vital signs program uses five metrics to evaluate the ecological health of TVA reservoirs: chlorophyll concentration, fish community health, bottom life, sediment contamination, and dissolved oxygen. Values of good, fair, or poor are assigned to each metric. Scores from monitoring sites in the deep, still area near the Chickamauga Dam (forebay, TRM 472.3), mid-reservoir (TRM 490.5), the Hiwassee River embayment (Hiwassee River mile [HiRM] 8.5), and at the upstream end of the reservoir (inflow, TRM 518 and 527.4) are combined for a summary score. The data from these sites characterize Chickamauga Reservoir's biological conditions and water quality near the SQN site. (TVA 2012b)

Based on the metric evaluation, the overall ecological health condition of Chickamauga Reservoir rated fair in 2011 (Table 2.2-4). The lower rating in 2011 was due to the fact that the fish and sediment quality indicators concurrently rated at the low end of their historic range or lower than in other years. Chickamauga's ecological health scores were good in previous years that were monitored, except for 2007 when Chickamauga rated fair. In 2007, three indicators (dissolved oxygen [DO], chlorophyll, and bottom life) were either at the low end of their historic range or lower than in previous years. The lower ratings were largely due to low reservoir flows in 2007, which was the driest year in 118 years of record. Ecological health scores tend to be lower in most Tennessee River reservoirs during years with low flows, because chlorophyll concentrations are typically higher and DO levels are lower. (TVA 2012b)

In 2011, the five individual metrics scored good or fair at all sites except for chlorophyll in the forebay and mid-reservoir stations, which rated poor (Table 2.2-4). These metrics are briefly explained in the paragraphs that follow. (TVA 2012b)

1. DO levels in 2011 rated good at all locations monitored. DO levels typically rate good at all monitoring locations (Table 2.2-4) except during extremely dry, low-flow years such as 2007, which can result in the development of low DO near the bottom and fair ratings. (TVA 2012b)

2. Chlorophyll ratings have fluctuated between good, fair, and poor at each location, generally in response to reservoir flow conditions. Annual average concentrations indicate a trend of increasing chlorophyll concentrations at the forebay and mid-reservoir, with lower concentrations at the Hiwassee River embayment monitoring location. Elevated concentrations of chlorophyll in the majority of the samples collected at the forebay and mid-reservoir monitoring locations gave those locations a poor rating, while chlorophyll concentrations at the Hiwassee River embayment monitoring location have consistently rated good. (TVA 2012b)

3. Fish health (i.e., fish community) rated at the high end of the fair range at all monitoring locations. The fish community typically rates good or at the high end of

the fair range. In 2011, the numbers of individuals and variety of species collected were slightly fewer than expected, and a greater proportion of those were tolerant individuals. Also, the predominance of three species (bluegill, gizzard shad, and non-native inland silversides) contributed significantly to the lower ratings at these sites. (TVA 2012b)

4. Bottom life rated good at the inflow and fair at the three other monitoring locations. Ratings typically vary between good and fair at each location. However, bottom life scored at the low end of the fair range at the mid-reservoir in 2011, lower than in previous years. The lower scores for bottom life in 2007 and 2011 were likely due in part to the low dissolved oxygen conditions that developed along the reservoir bottom. (TVA 2012b)

5. Sediment quality rated fair at all monitoring locations. PCBs were detected at each location, and arsenic concentrations were slightly higher than expected background levels at the forebay and mid-reservoir. Elevated concentrations of PCBs, chlordane, and selected metals, generally zinc and copper, have been detected in sediment samples from the forebay and Hiwassee embayment monitoring locations in some previous years. Arsenic also was above background levels in samples collected at the forebay in 2001. These metals (arsenic, copper, and zinc) are common in the sediments, and concentrations are generally near (slightly above or below) suggested background concentrations. (TVA 2012b)

2.2.1.7 Fish Consumption Advisories

No fish consumption advisories exist for Chickamauga Reservoir. (TWRA 2012a)

2.2.2 Plankton Communities

Plankton communities are composed of both microscopic and macroscopic algae (phytoplankton) and animals (zooplankton as well as bacteria and various larval forms of free-living and sessile organisms). Similar to terrestrial vascular plants, planktonic algae use energy from the sun and elemental nutrients in the water to transform carbon dioxide into the organic material of their cells and in the process they produce the oxygen needed by the entire aquatic community. These organisms provide the basis for the food web of aquatic systems and are the principal food of most of the zooplankton and some fish species.

Phytoplankton consist of the assemblage of small plants having no or very limited powers of locomotion; therefore, they are more or less subject to distribution by water movements. Most algae do not float because their density is greater than water. They do, however, possess various mechanisms to alter their buoyancy, which is crucial due to their dependence on sunlight for photosynthesis. (Wetzel 1983)

On an ecological level, phytoplankton act as the primary producers that provide energy to the system. Non-photosynthetic organisms such as zooplankton, insects, and small fish consume phytoplankton. Higher-level predators such as insectivorous and piscivorous fish are then sustained by the system.

An outstanding feature of phytoplanktonic communities is the coexistence of a number of algal species. In some cases, one species is found in much greater abundance than others; more often, two or more algal species are co-dominant in the phytoplanktonic assemblage. Among the dominant species, subdominant species are usually also identified. (Wetzel 1983) Species dominance may change on a seasonal basis.

Cyanobacteria (blue-green algae), chlorophyta (green algae), chrysophyta (golden-brown algae), cryptophyta, euglenoids and dynoflagellates are common to freshwater systems (Wetzel 1983). In 1986, phytoplankton was sampled in Chickamauga Reservoir at five locations between TRMs 472.8 and 490.5. Cell densities ranged from 2–4 million/liter in May and 1–3 million/liter in August. In both sampling months, chlorophyta (32 species), chrysophyta (16 species) and cyanophyta (5 species) were the dominant divisions followed by euglenophyta (3 species), phrrhophyta (4 species), and cryptophyta (1 species).

Freshwater zooplankton are dominated by four major groups of animals: protozoa, rotifers, and two subclasses of crustaceans, the cladocerans and copepods (Wetzel 1983).

Zooplankton was measured at the same locations as phytoplankton in 1986. Cell densities in May ranged from 75,000–300,000/cubic meter (m^3). In August, cell densities ranged from 100,000–200,000/m^3. Cladocera (13 species), copepoda (11 species) and rotifera (28 species) were identified. Copepods were dominant at all sampling sites in May but in August, rotifers were dominant.

Generally, plankton densities in Chickamauga Reservoir increase from upstream to downstream under normal flow regimes (TVA 1990a). However, occasionally reduced cell counts occur at the diffuser location. This is thought to be a result of the mixing of the plankton-rich upper water strata and plankton-poor lower stratum caused by the diffuser action in warmer months where stratification is evident in the reservoir, rather than a true reduction in plankton cells (TVA 1989).

The plankton community also includes ichthyoplankton, which are the eggs and larvae of fish found mainly in the upper reaches of the water column. The eggs are passive and drift with the water currents. Most fish larvae have a temporary free-floating stage prior to developing the ability to swim effectively. Eggs of some fish species (e.g., mooneye [*Hiodon tergisus*]; striped bass [*Morone saxatilis*]; and drum [*Aplodinotus grunniens*]) float possibly as a dispersal mechanism and to improve the survival rate of the larvae. Other fish eggs (e.g., buffalo [*Ictiobus spp*.]; gar [*Lepisosteus spp*.]; and redhorse [*Moxostoma spp*.]) are demersal (i.e., suspended on or attached on the bottom), and some (sunfish [*Lepomis spp*.]; black basses [*Micropterus spp*.]; and crappies [*Pomoxis spp*.]) are attached to various substrates. The free-floating eggs are more susceptible to entrainment because they are subject to the currents.

TVA conducted entrainment monitoring during the operational period from 1981 through 1985. Subsequently, TVA conducted entrainment monitoring for 12 weeks from April through July 2004.

Annual estimated entrainment values are presented for the years 1981 through 1985 and 2004 in Table 2.2-5.

Fish eggs from four locations adjacent to SQN were sampled in 1985. A total of 35,257 eggs were collected in 685 samples. Freshwater drum eggs accounted for 99.5 percent of the total (TVA 1986). In 2004, samples were taken at five stations along a transect perpendicular to river flow just upstream of the plant intake channel at TRM 485. Freshwater drum eggs accounted for 98.8 percent of the total fish eggs collected during all 12 sample periods. Average seasonal densities for drum eggs were 549 and 652/1,000 m^3 in the intake and reservoir samples, respectively. The estimated total transport of fish eggs (primarily drum eggs) past SQN during 12 weekly sample periods between April 20 and July 12, 2004, was 5.4 billion. (TVA 2010a)

Fish larvae collected in 1985 from 685 samples near SQN totaled 121,370. Shad (*Dorosoma spp*.) dominated at 61 percent of the total number of individuals sampled, followed by sunfish at 17 percent. The entrainment data for 1981 through 1984 indicated low entrainment rates of fish larvae for all species other than freshwater drum. TVA recommended a sampling regime for 1985 designed to further evaluate the relatively high entrainment estimates for freshwater drum. The 1985 data continued to indicate higher entrainment rates for freshwater drum, but also indicated that previous sampling methods at the plant transect underestimated reservoir transport of freshwater drum eggs and larvae past SQN. (TVA 1986)

The estimated total transport of fish larvae past SQN during the 12 sampling events from April through July in 2004 was 9.8 billion. Clupeid (shad) larvae accounted for 87.9 percent of this total and were entrained at a rate of 15.4 percent of the total passing the plant. The overall estimated rate of entrainment for total fish larvae was 15.6 percent, driven by clupeids as the most dominant taxon. Average seasonal densities of clupeids in the intake versus reservoir samples were 2,249 and 3,465/1,000m^3 respectively. The abundance of other taxa of larval fish collected during the 12 weekly sample periods was Morone (5.5 percent), freshwater drum (3.2 percent), and centrarchids (3.1 percent). (TVA 2010a)

2.2.3 Macroinvertebrate Communities

Macroinvertebrates (small animals without backbones that can be seen with the naked eye) are an important component of the aquatic environment. Macroinvertebrates include aquatic insects, crustaceans, worms, clams, and mollusks, and they are typically found within all strata of the water column, especially in association with the bottom, banks, and aquatic vegetation. Macroinvertebrates provide a food source for many fish species while concurrently influencing macronutrient levels through foraging.

Freshwater macroinvertebrate habitat includes aquatic vegetation, river, and reservoir substrates. The availability of food, nature of the sediment, and current flow constitute the primary factors determining the benthic macroinvertebrate distribution patterns. Food is usually the ultimate determinant of macroinvertebrate distribution and abundance. The majority of macroinvertebrates are nonselective feeders taking in a wide range of food substances of acceptable particle dimensions. Presence and absence data can provide information regarding macroinvertebrate habitat quality. Many species are sensitive to pollution, and macroinvertebrate populations respond quickly (both positively and negatively) to changes in water quality.

Some invertebrates have a relatively long and usually complex life cycle of a year or more, and their presence or absence helps describe environmental conditions over a period of time. Because most have limited mobility and are not subject to rapid migrations, they serve as natural monitors of water quality. (TVA 2006) Biomass of aquatic insects is relatively constant if food supplies of similar nutritional content are supplied. Biomass turnover is controlled primarily by water temperature and is governed by the positive relation between temperature, food availability, feeding rate, and respiration. (Wetzel 1983)

Historically, the number and density of macroinvertebrates identified near SQN have been lower than other sampling locations within Chickamauga Reservoir. Substrate data near SQN indicate the silt-to-sand ratio within the substrate near SQN is far reduced from the silt-to-sand ratio measured at other sample locations and would not support as diverse a benthic community. (TVA 1986) Similarly freshwater mussel populations near SQN are in low numbers and densities.

Benthic macroinvertebrate populations are assessed using the reservoir benthic index (RBI) methodology, which is based on seven community metrics. Combining several endpoints into one measurement captures the intricacies of a community more effectively than listing the results of each metric independently. The seven metrics used in calculating the RBI (TVA 2010b) for sample locations in Chickamauga Reservoir are as follows:

1. Taxa richness: This metric is calculated by averaging the total number of taxa present in each sample at a site. Taxa generally means Family or Order level because samples are processed in the field. For chironomids, taxa refers to obviously different organisms (i.e., separated by body size, head capsule size and shape, color, etc.). An increase in taxa richness indicates better conditions than low taxa richness.

2. EPT: This metric is calculated by averaging the number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa present in each sample at a site. Higher diversity of these taxa indicates good water quality and other habitat conditions in streams. A similar use is incorporated here despite expected lower numbers of these organisms in reservoirs than in streams.

3. Long-lived organisms: This is a presence/absence metric, which is evaluated based on the proportion of samples with at least one long-lived organism (Corbicula, Hexagenia, mussels, and snails) present. The presence of long-lived taxa is indicative of conditions which allow long-term survival.

4. Percentage as Oligochaetes: This metric is calculated by averaging the percentage of oligochaetes in each sample at a site. Oligochaetes are considered tolerant organisms so a higher proportion indicates poor water quality.

5. Percentage as dominant taxa: 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 animals in the sample, and converting to a percentage for that sample. The percentage was then averaged for the 10 samples at each site. Often, the most abundant taxa differed among the 10 samples at a site. This allows more discretion to identify imbalances at a site than developing an average for a single dominant taxon for all samples at a site. This metric is used as an evenness indicator. Dominance of one or two taxa indicates poor conditions.

6. Density excluding Chironomids and Oligochaetes: This metric is calculated by first summing the number of organisms excluding chironomids and oligochaetes present in each sample and then averaging these densities for the 10 samples at a site. This metric examines the community excluding taxa which often dominate under adverse conditions. A higher abundance of non-chironomids and oligochaetes indicates good water quality conditions.

7. Zero-samples (Proportion of samples with no organisms present): This metric is the proportion of samples at a site which have no organisms present. "Zero-samples" indicate living conditions unsuitable to support aquatic life (i.e., toxicity, unsuitable substrate, etc.). Any site having one empty sample was assigned a score of 3, and any site with two or more empty samples received a score of 1. Sites with no empty samples were assigned a score of 5.

Because benthic macroinvertebrates are relatively immobile, adverse local impacts to aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities in comparison to fish communities. (TVA 2011f) In Chickamauga Reservoir, RBI data are collected annually from established sites. Supplemental data collected from additional sites near SQN are used in conjunction with RBI results to provide an understanding of reservoir conditions over time and determine the effects of various perturbations (e.g., drought conditions or SQN discharge).

The six sites sampled for benthic macroinvertebrates include two inflow sites at TRM 527.4 and 518.0, one transition site at TRM 490.5 (SQN upstream site), two forebay sites at TRM 482.0 (SQN downstream site), and TRM 472.3 and HiRM 8.5. Average RBI scores from 1994 to 2010 in Chickamauga Reservoir were good except for the site at the HiRM, which scored an average of 22 (fair), aided by one very low RBI score in 2007 (Table 2.2-6). The year 2007 was a low-flow year for Chickamauga Reservoir due to local drought conditions. DO levels dropped in the reservoir, which likely had a negative impact on the benthic macroinvertebrate communities, thereby contributing to the low RBI score. (TVA 2011f)

Benthic macroinvertebrate data collected during 2008 from TRM 490.5 upstream of SQN and 482.0 forebay downstream of SQN revealed an RBI score of 17 (poor) and 25 (good), respectively. The downstream site was similar to past sampling events; however, the upstream site was uncharacteristically low in 2007 and 2008. The upstream sampling site also received lower RBI scores from 2000 to 2002, but returned with an "excellent" score from 2003 to 2005.

(TVA 2011f) This likely represents natural variation in benthic communities, not a decline related to SQN operation, and may have been due to the drought in 2007.

RBI variability over time is higher than reservoir fish assemblage index (RFAI) variability, likely due to the sampling protocol and relative immobility of macroinvertebrates when compared to fish. When sampling for macroinvertebrates, often habitats with high invertebrate concentrations are adjacent to areas of low concentration, which leads to increased variability with regard to invertebrate concentration among samples. (TVA 2005) For the sampling locations near SQN, some RBI variability is evident from year to year, but no increasing or decreasing trends are apparent. In comparing the averages from 1994–1999 and 2000–2009, little change is evident, which implies relative stability within the macroinvertebrate community. Macroinvertebrate populations from 2008 and 2009 are presented in Table 2.2-7. (TVA 2010b, Table 14)

Mollusk Population

As a subset of macroinvertebrates, mollusk populations have been studied throughout the Tennessee River system since the early 20th century. In 1918, Ortmann documented the freshwater mussel fauna of the upper Tennessee River and concluded that it was the most prolific region in the world for this fauna (Ortmann 1918). Scruggs and Isom reported the dramatic decline of mussels in the river system, including the reach between Chickamauga Dam (TRM 471.0) upstream to Watts Bar Dam (TRM 529.9), citing loss of habitat from impoundment, overharvesting, and water quality degradation as causes (Scruggs 1960; Isom 1969). Isom concluded that suitable habitat for mussels within Chickamauga Reservoir only occurred for 29 miles downstream of Watts Bar Dam with effects of impoundment (e.g., sediment accumulation) as a continuing problem.

TVA's final environmental statement (FES) for SQN (TVA 1974a) recognized the presence of freshwater mussels (Family: Unionidae) and an active mussel harvest practice within Chickamauga Reservoir during TVA's initial environmental review of the facility. However, it reported that mussel harvesting activity and a state mussel sanctuary both occurred quite some distance from SQN (i.e., between 24 and 40 miles upstream of SQN in the tailwaters of Watts Bar Dam). In 1978, TVA conducted a widespread survey of the main stem Tennessee River using scuba diving to document the status of freshwater mussels and snails throughout portions of reservoirs between Kentucky Dam and Fort Loudon Dam (TVA 1979); survey efforts in Chickamauga Reservoir included only a 15-mile reach downstream of Watts Bar Dam (i.e., TRM 514.2–529.0). TVA collected 21 species at sites between TRM 520.0–521.0 and TRM 526.5–528.1, which included the now federally listed endangered pink mucket (*Lampsilis abrupta*) and dromedary pearly mussel (*Dromus dromas*) at community frequencies of 0.4 and 0.2 percent or less, respectively (TVA 1979).

Ahlstedt and McDonough reported preoperational mussel monitoring data (1982–1993) from near the WBN facility at TRM 528, which documented the persistence of the endangered pink mucket but an overall reduction in species and recruitment for most mussel species near WBN prior to operation (Ahlstedt and McDonough 1996). In September 2010, TVA surveyed mollusks (mussels and snails) and habitat at three sites that had been surveyed for mussels prior to operation (1983–1994) and after operations (1996–1997) started at WBN (Third Rock 2010a). This 2010 survey associated with WBN recorded a total of 17 species, including one, old individual each of the federally endangered pink mucket and the proposed endangered sheepnose mussel (*Plethobasus cyphyus*). Mean mussel density in 2010 was 1.2 mussels/square meter (m^2), and mean catch per hour was 86.1 mussels/hour (Third Rock 2010a). Thus, measures of mussel abundance and species richness in 2010 were very similar to those measured near WBN just before and after its operations began (1992–1997).

In summer 2010 (June 28–July 2 and July 5–9), TVA conducted a survey of the Tennessee River near SQN (Third Rock 2010b) to document the existing mollusk community (unionid mussels, aquatic snails, and zebra mussel infestation) and habitat conditions in areas that may be affected by plant operations and areas outside the range of potential effects from SQN. TVA studied four sites in the Tennessee River adjacent to SQN in areas that may be affected by plant operations as well as four sites in areas that would not be affected by potential impacts from SQN. Areas most likely to be affected by SQN operations include the water intake and associated skimmer wall, coolant water diffusers and associated mixing zone, and a submersed dam in the historical river channel downstream of the intake site used to help retain colder deep water near the plant intake.

The survey showed that all sites near SQN support relatively low-diversity, low-abundance mussel and snail communities. The study found a total of 280 mussels representing 10 species and 281 snails representing four species. No federally listed mussel or snail species were collected (live or dead) during the study. Mean mussel density among all sites was 0.05 mussels/m^2 from semi-quantitative samples and 0.18 mussels/m^2 from quantitative samples. The highest mussel density of any site was 1.8 mussels/m^2 for any semi-quantitative sample and 0.30 mussels/m^2 for quantitative samples. (Third Rock 2010b)

Mussel species richness and density in the SQN study area are very low compared to other areas of the Tennessee River that still support viable mussel communities (since impoundment), particularly those with listed species like pink mucket. In areas of the main stem river that still retain quality mussel habitat, species richness typically exceeds 15 species and can exceed 25 species. Mussel densities in these areas are usually two orders of magnitude greater than that observed near SQN (Dinkins 2008; LEC 2008; MCD 2006; Third Rock 2010c). Another indication that the area near SQN does not provide suitable habitat to many mussel species was the lack of apparent recruitment (e.g., very few young individuals) and overall lack of generally suitable substrate conditions throughout the study area (Third Rock 2010b).

Mussels would be expected to experience better habitat conditions in the area of Chickamauga Reservoir immediately below Watts Bar Dam due to the flowing water which would prevent sediments from being deposited, as pointed out by Isom (Isom 1969). However, lower in the reservoir, sedimentation would make the habitat less desirable for mussels, likely a reason that contributes to lower mussel populations near SQN.

In addition to mussels, aquatic snails are also an important ecological component of the Tennessee River system and are considered a highly imperiled taxonomic group within the southeastern United States. Data from TVA's RBI monitoring efforts during the period 2001–2009 indicated aquatic snails are commonly found in Chickamauga Reservoir near SQN (TRM 490.5 and 482.0) at densities averaging 27.7 snails/m^2 (range = 0.0–106.7 snails/m^2) among both sites over the 9-year monitoring period. No federally or state-listed snail species have been collected at the monitoring sites since the start of monitoring in 2001; however, the RBI monitoring efforts were not meant to fully characterize snail or macroinvertebrate communities but rather to provide general indications of benthic community health. Few snail taxa have been collected to date from the monitoring sites near SQN. In 2010, TVA's evaluation of the mollusk community near its WBN facility (TRM 528.0) upstream from SQN found only two species of snails, which occurred at mean site densities ranging from 0.03 to 0.43 snails/m^2 (Third Rock 2010a).

The summer 2010 survey of the Tennessee River near SQN found low densities of snails near SQN. Overall mean snail density was 0.2 snails/m^2 from semi-quantitative samples and 1.39 snails/m^2 from quantitative samples. The highest sample densities for snails were 2.90 snails/m^2 (semi-quantitative) and 0.40 snails/m^2 (quantitative) at Sites 5 and 6, respectively (Third Rock 2010b, Table 3). Like the pattern observed for mussels, general snail abundance was greatest at Sites 5, 6, and 7, which were sites closest to the SQN mixing zone. Because snail habitat (preferably larger rock particles such as cobble, boulder, and bedrock) was sparse throughout the study area, it is not surprising that snail densities were very low at all the sites. Information on snail density is obscure within the Tennessee River main stem, but in comparison to TVA's monitoring sites at TRM 482.0 and 490.5 where densities averaged 36.3 and 19.1 snails/m^2, respectively, it appears that habitat throughout the SQN study area tends to be poor for snails.

A 2011 search of TVA's Natural Heritage Database (TVA 2011b) indicated no records of state or federally listed aquatic snails within 10 miles of SQN.

2.2.4 Vascular Aquatic Plants

The complex morphology of aquatic macrophytes creates a diversity of microhabitats for colonizing organisms (from algae and invertebrates to zooplankton to benthic macroinvertebrates to young and/or small fishes, as well as adult fish of some species) and provides refuge from predators. Macrophytes also modify the physical environment by directly or indirectly affecting the chemical composition, nutrient cycles, and biological features of the ecosystem. (TVA 1993a)

Rooted submersed aquatic macrophytic vegetation was not abundant near the SQN site until the establishment of Eurasian watermilfoil (*Myriophyllum spicatum*) in 1961. Milfoil is an exotic plant that was introduced from an aquarium into Watts Bar Reservoir, the next reservoir upstream, circa 1953. From its establishment in Chickamauga Reservoir until the mid-1970s, milfoil was the only abundant submersed aquatic macrophyte within the reservoir. (TVA 1993a)

While milfoil coverage expanded in most main stem Tennessee River reservoirs between 1970 and 1985, spinyleaf naiad (*Najas minor*), another exotic species, became the dominant species of vegetation in Chickamauga Reservoir in 1982. It continued to be more abundant than milfoil until 1989 when there was a major decline in naiad coverage. Annual coverage of spinyleaf naiad (in combination with southern naiad, *N. guadalupensis*) and milfoil have fluctuated greatly over time. Hydrilla (*Hydrilla verticillata*) was found in Chickamauga Reservoir in 1988; since that time, populations of this exotic species have fluctuated but covered increasing areas of the reservoir (TVA 1993a; TVA 2007a)

As milfoil coverage expanded and colonized shallow water habitat along developed shorelines, TVA designated priority areas for herbicide treatment. In addition to the application of herbicides such as 2,4-D to control milfoil and Aquathol K to control naiads, other management techniques in use include drawdowns and reservoir surcharge. Milfoil is vulnerable to winter drawdowns because it is a perennial and its exposed root masses are subjected to lethal winter temperatures. (TVA 1993a)

Vascular plant coverage largely due to milfoil and spinyleaf naiad in Chickamauga Reservoir appears to be negatively correlated to water flow levels in the Tennessee River. From 1970 to 1975, aquatic macrophyte coverage in Chickamauga Reservoir was less than 100 hectares (ha). Macrophyte coverage increased greatly from 1976 to 1981 to nearly 2,200 ha. Approximately 2,800 ha of coverage existed during the period 1982–1988, which coincided with several drought years. Increased flows and associated factors (such as scouring and turbidity) during 1989 and 1990 caused a decrease in vegetation to approximately 1,400 and 869 ha, respectively. This pattern continued in the 1991 and 1992 seasons when coverage dropped to 275 and 155 ha, respectively. (TVA 1993a) By 2007, there were about 1,400 acres of aquatic vegetation in Chickamauga Reservoir. This area varies on an annual basis depending on flow through the reservoir. (TVA 2007a)

Aquatic macrophytes have varied in abundance since Chickamauga Reservoir was impounded. As the type, location, and coverage of aquatic plants has changed through time, so have the impacts on the biota within the reservoir. Changes in the coverage of aquatic macrophytes has influenced the abundance of some fish species. (TVA 1990b)

2.2.5 Fish Communities

Community Impacts

In general, reservoir fish communities are different from those found in the river prior to impoundment due to the significant habitat alterations associated with impounding a river. Table 2.2-8 provides a list of fish species in the vicinity of SQN.

Three flow regimes are common in reservoirs created by impounding rivers. Inflow sections are generally riverine in nature. Transitional zones are located mid-reservoir where water velocity decreases due to increased cross-sectional area. Suspended materials begin to settle, and water clarity increases. (TVA 2006) Algal productivity also increases in the transitional zone due to increased water clarity and reduced mixing, which allows the algae to remain in the photic zone. The forebay area is where water velocity is diminished, primary production declines, and water depth increases. (TVA 2005)

Differences are expected in the fish community along the longitudinal gradient with a more riverine community expected at the upper end of inflow of a reservoir and a more lacustrine (similar to a lake) community expected in the pool near the dam. Other factors to consider in evaluating biotic communities in reservoirs include reservoir operation characteristics such as water depth, water clarity, nutrient input, fluctuation, drawdown, retention time, stratification, bottom anoxia, substrate type, and stability.

Water flow has been negatively correlated with macrophyte concentration in Chickamauga Reservoir. Macrophyte density affects fish communities. Certain fish species become more abundant with increased vegetation coverage. Golden shiner (*Notemigonus crysoleucas*), warmouth (*Lepomis gulosus*), bluegill (*L. macrochirus*), redear sunfish (*L. microlophus*), brook silverside (L*abidesthes sicculus*), yellow bass (*Morone mississippiensis*), black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*) are mid-water insectivores, which benefit from an increased invertebrate forage base and protective habitat provided by aquatic vegetation. As the forage base for piscivorous species shifts from shad to small sunfish during periods of heavy vegetation coverage, numbers of largemouth bass (*Micropterous salmoides*), an ambush predator, increase. (TVA 1993a)

Other fish species decline in abundance as macrophytes increase. Most of them are open-water, benthic insectivores/omnivores whose feeding habitat in shallow, silted overbanks becomes colonized with vegetation. Species in this category are carp (*Cyprinis carpio*), smallmouth buffalo (*Ictiobus bubalus*), spotted sucker (*Minytrema melanops*), channel catfish, (*Ictalurus punctatus*), and freshwater drum. Decline of piscivorous adult white crappie (*P. annularis*) has been attributed to habitat alterations associated with increased macrophyte coverage. (TVA 1993a)

Community Studies

Fish communities are used to evaluate ecological conditions because of their role in the aquatic food web, and because fish life cycles are long enough to integrate conditions over time. Twelve metrics are scored and summed to determine an overall RFAI score for each sample collection site. (TVA 2011f)

The 12 metrics that constitute the RFAI are as follows:

Species Richness and Composition

1. Total number of species: Greater numbers of species are considered representative of healthier aquatic ecosystems. As conditions degrade, numbers of species at a site decline.

2. Number of centrarchid species: Sunfish (excluding black basses) are invertivores, and high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.

3. Number of benthic invertivore species: Due to the special dietary requirement of this group of species and the limitations of their food source in degraded environments, numbers of invertivores increase with better environmental quality.

4. Number of intolerant species: This group is made up of species that are particularly intolerant of habitat degradation. Higher densities of intolerant individuals represent better environmental quality.

5. Percentage of tolerant individuals (excluding young-of-year): This metric signifies poorer quality with increasing proportions of individuals tolerant of degraded conditions.

6. Percentage dominance by one species: Ecological quality is considered reduced if one species dominates the resident fish community.

7. Percentage of non-native species: This metric is based on the assumption that non-native species reduce the quality of resident fish communities.

8. Number of top carnivore species: Higher diversity of piscivores is indicative of better quality environment.

Trophic Composition

9. Percent of individuals as top carnivores: This metric is a measure of the functional aspect of top carnivores which feed on major planktivore populations.

10. Percentage of individuals as omnivores: 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

11. Average number per run (number of individuals): This metric is based on the assumption that high quality fish assemblages support large numbers of individuals.

Fish Health

12. Percentage individuals with anomalies: Incidence of diseases, lesions, tumors, external parasites, deformities, blindness, and natural hybridization are noted for all fish measured, with higher incidence indicating poor environmental conditions. (TVA 2006)

The RFAI scores have an intrinsic variability that stems from several sources, including annual variations in air temperature and stream flow; variations in nonpoint source pollutant loadings;

changes in habitat, such as the extent and density of aquatic vegetation; and natural population cycles and movements of the species being measured. (TVA 2011f)

TVA has conducted the RFAI program in Chickamauga Reservoir since 1993. Traditionally, RFAI data in Chickamauga Reservoir are collected from four sites: Chickamauga Reservoir inflow site (TRM 529.0); the transition site (TRM 490.5), which also acts as the SQN upstream site; the forebay site (TRM 472.3); and the Hiwassee River embayment site, HiRM 8.5, to provide information on the health of the fish community throughout the reservoir. (TVA 2006) In 1999, a site was added at TRM 482.0 downstream of SQN to discern possible effects to the fish community from SQN discharge over time (TVA 2009b).

SQN is physically positioned where reservoir characteristics shift from the transitional zone to the forebay. Therefore, the site upstream of SQN is scored with transition criteria, and the downstream site is scored using forebay criteria. This complicates comparisons of the RFAI scores because the best comparisons can only be made between sites located in the same reservoir zone (i.e., transition to transition). The physical and chemical composition of the forebay is different than that of the transition zone; consequently, inherent differences exist among the aquatic communities (e.g., species diversity and overall productivity are often higher in a transition zone than in a forebay zone). However, the RFAI is particularly useful in identifying changes at each site over time.

The average RFAI scores at these five sites over all sampling years have remained in the "good" range (Table 2.2-9). The inflow and upstream sites have an average score of 45 and 44 (good), respectively. The downstream and Hiwassee River Embayment sites have an average score of 41 and 42 (good), and the forebay site averages a score of 43 (good). Averages from 1993 to 1999 are similar to those from 2000 to 2010, indicating stability over time. (TVA 2011f)

During 2008, the upstream site scored 10 points lower than the previous year while the downstream score remained the same. This was the only site in Chickamauga Reservoir that exhibited a decrease in the RFAI score. In 2009, the upstream site rebounded, scoring an RFAI of 41 (good). Differences greater than six points can be expected simply due to method variation, and changes of this magnitude with a similar rebound have occurred in previous years. (TVA 2011f)

Interpretations of fish community changes are complex and multifaceted. Fish communities in reservoirs are subjected to highly variable water conditions (e.g., rate of spring warming, discharges, turbidity, water level fluctuation) that affect planktonic food chains, spawning times and success, early survival of different fish species, and interspecific competition between early life stages of fish species (TVA 1993a). RFAI score anomalies are expected in such a dynamic system.

As previously mentioned, TVA has been studying fish populations in Chickamauga Reservoir for decades using a variety of methods such as cove rotenone (using a toxicant to aid in the collection of all fish in a cove), gill netting, creel surveys, and electrofishing. At times, routine surveys that indicated a changing fish population would trigger a focused study to determine reasons behind the population shifts. For example, declining numbers of white bass (*Morone* *chrysops*), white crappie, sauger (*Stizostedion canadense*), and channel catfish, based on cove rotenone samples and harvest rates based on creel surveys, prompted the Tennessee Department of Health and Environment and the Tennessee Wildlife Resources Agency (TWRA) to express concern regarding these populations in 1986 (TVA 1990b; TVA 1991; TVA 1994; TVA 1995a). Cove rotenones notoriously underestimate adult white bass, and the decline in white crappie populations was attributed earlier to increases in milfoil. TVA conducted four focused studies as a result of the concerns addressed by the State of Tennessee. The results of the four studies follow.

White bass provide year-round fishing on most Tennessee River reservoirs. They are early spring spawners (March–April), and mature adults congregate and run up tributary streams and into tail waters to spawn. White bass are known to traverse the Tennessee River system. Larval fish and egg studies indicate three primary spawning areas in Chickamauga Reservoir: the Hiwassee River, Sewee Creek, and Hunter Shoals. However, yellow bass appear to spawn in greater numbers in the same areas and likely compete for food and habitat. (TVA 1994) These three white bass spawning sites are upstream of SQN so that movement of white bass past SQN during and after the spawning migration is apparently not impeded by SQN operation. Several white bass were recaptured below Chickamauga Reservoir indicating that these fish move freely throughout the Tennessee River system. Recapture of tagged white bass by fishermen in the vicinity of SQN did not indicate an attraction that would result in overharvest or a significant disruption of adult migration to the spawning areas.

White crappie populations were investigated in Chickamauga Reservoir from 1986 through 1989 in response to cove rotenone and creel data indicating a decline in the population. White crappie predominantly spawn in large embayments and smaller tributaries throughout the reservoir. The multi-year investigation revealed good survival through the early juvenile stage but high mortality in their second summer as determined by aging otoliths (a structure in the inner ear of fish). Mortality of young crappie appeared to be correlated to an increase in aquatic vegetation, increased numbers of yearling sunfish, yearling largemouth bass, adult largemouth bass, and gizzard shad. Drought years from 1985 to 1988 caused decreased flow through the reservoir, which enabled aquatic vegetation to increase and effectively changed the habitat to that less suitable for white crappie populations. Incidentally, changes that were unfavorable for white crappie proliferation had a positive effect on black crappie populations. (TVA 1990b)

Population estimates of sauger in Chickamauga Reservoir declined progressively from 1986 to 1990. Sauger are considered a cool-water fish and migrate throughout the reservoir system (TVA 1994) to spawn at Hunter Shoals (TRMs 521–522) (TVA 1995a), which is approximately 35 miles upstream of SQN. A thermal variance was approved for SQN in 1993 that raised the maximum instantaneous temperature increase from 3ºC to 5ºC from November through March (TVA 1995a). The sauger population was at a low density in 1993 prior to implementation of the thermal variance. In 1994, after the variance was implemented in November 1993, the resident sauger population was estimated at its highest level since 1986. No attraction to, or avoidance of, the SQN diffuser area was documented for fishermen or sauger based on a SQN creel survey and tags returned during 1993 and 1994. Critical factors determining reproductive success of sauger in Chickamauga Reservoir are an instantaneous minimum water flow of 8,000 cfs in the reservoir and a gradually increasing water temperature during the spawning period. When flow conditions are unsuitable for natural reproduction, stocking of fingerlings into the reservoir is an effective means of producing a viable year class. (TVA 1995a)

Channel catfish in Chickamauga Reservoir are important to both commercial and sport fisheries. Analysis of historical and recent data collected using a variety of sample methods failed to reveal any trends in steadily declining adult channel catfish densities in Chickamauga Reservoir from 1970 to 1990 (TVA 1991). Sport fishing data indicate the total number of channel catfish estimated harvested in 1989 (27,107 fish) was second only to the number harvested during 1976, and estimated biomass in 1989 (23,700 kilograms [kg]) was the highest for the period. In 2008 and 2009, the estimated harvest of channel catfish was 67,755 and 38,180 fish, respectively (Black 2009; Black 2010). This indicates that since SQN began operations, channel catfish populations have increased, and channel catfish populations in Chickamauga Reservoir are healthy.

Cove rotenone surveys revealed no significant trend in numbers or biomass of adult channel catfish after analysis of data from 1970 through 1990; however, both numbers and biomass of intermediate size and numbers of young-of-year channel catfish have shown a significant decreasing trend since 1970. Due to the relatively late spawning time for channel catfish and the normal variability of cove rotenone samples, it would not be expected that there would be a relationship between cove rotenone data and the results of other gear types. Total number of channel catfish of all sizes increased in 1988 to the second highest number collected since 1970. Gill net sampling in the period 1986–1990, which employed similar gear and methods during roughly the same time period each year, resulted in catch rates that again did not indicate declining abundance of channel catfish in upper Chickamauga Reservoir. (TVA 1991)

Trends in RFAI data over time indicate relative stability according to mean RFAI scores (Table 2.2-8). As previously mentioned, fish communities are complex and multifaceted, and RFAI scores can change substantially from year to year. When RFAI scores indicate a possible trend, focused surveys are performed to determine probable causes of changes in the reservoir and appropriate mitigation. Analysis over time reveals increasing or decreasing trends are not apparent within the data, as evident by comparing the 1994–1999 average with the 2000–2009 average displayed in Table 2.2-8, thus indicating relative stability within the reservoir and effectiveness in TVA management.

Impingement Studies

TVA has conducted three impingement studies: 1980 through 1985, a short winter study during the period 2001–2002, and a 2-year study from 2005 through 2007, which was in response to EPA's 2004 proposed 316(b) rule. In the years monitored, threadfin shad were consistently the most abundant species impinged (Kay and Baxter 2002; TVA 1986; TVA 2007b). This is due to their high rate of reproduction, their tendency to form large schools, and their intolerance of low water temperatures.

Impingement samples were used to estimate the total number of fish impinged by SQN. Estimates for the 1980–1985 and 2005–2007 studies are presented in Table 2.2-10. The 2001–

2002 impingement study was conducted in winter, which is when, historically, peak numbers of fish are impinged at SQN. Ten impingement samples were collected from the condenser circulating water (CCW) screens between December 19, 2001, and February 25, 2002, with a total of 13,570 fish collected. The data confirmed the seasonal fluctuations previously reported. The 2001–2002 data also confirmed the 1980–1985 conclusion that the low numbers of impinged fish are not affecting the fish community, which is reflected in the RFAI discussion above. The 2005–2007 study confirmed that the vast majority (91 percent) of fish impinged were threadfin shad. The loss of these impinged fish was insignificant to the reservoir populations. The 1999 cove rotenone samples (TVA 2000) averaged about 6,404 threadfin shad and 16,168 fish per acre in the reservoir.

Recreational and Commercially Important Fish Species

Chickamauga Reservoir maintains a thriving recreational fishery. Sport fish are sampled annually by TVA to measure abundance and size classes for commonly targeted species identified in Table 2.2-11. In 2011, more than 75 percent of the sport fish sampled were of harvestable size. (TVA 2011g)

Commercial fishing also takes place in Chickamauga Reservoir. Gear types allowed on the reservoir are trotlines, slat baskets, hoop nets, fyke nets, trap nets, pound nets, trammel nets, gill nets, seines, cast nets, and turtle traps. Hoop nets, fyke nets, trap nets, and pound nets with a mesh size of 1 inch or smaller on the square may only be used during the months of October, November, December, January, February, March, and April. Fish species harvested for commercial purposes are listed in Table 2.2-11. (TWRA 2011a)

Commercial harvest of rough fish in Chickamauga Reservoir from April to December 1977 was estimated to be 23.1 kg/ha with smallmouth buffalo as the dominant species in the catch. (Heitman and Van Den Avyle 1979) It was also reported that standing crops of commercially valuable smallmouth buffalo had decreased while the standing crop of the less valuable carp had significantly increased.

Federally Listed Aquatic and Riparian Species

Aquatic species currently protected under the Endangered Species Act (ESA), including candidate species, include two mussel species, the dromedary pearly mussel and the pink mucket (Table 2.5-1).

A more detailed discussion of federally listed threatened and endangered species is provided in Section 2.5.

State-Protected Aquatic and Riparian Species

Aquatic and terrestrial (riparian) species designated as endangered, threatened, or of special concern by TDEC include four birds, one fish, and two mussels (Table 2.5-1): Appalachian Bewick's wren (*Thryomanes bewickii atlus*), bald eagle (*Haliaeetus leucocephalus*), Bachman's sparrow (*Aimophila aestivalis*), great egret (*Ardea alba*), highfin carpsucker (*Carpiodes velifer*), dromedary pearly mussel, and the pink mucket.

A more detailed discussion of species designated as endangered, threatened, or of special concern by TDEC is provided in Section 2.5.

Heat or Cold Shock Events

Heat or cold shock to reservoir inhabitants is a site-specific impact dependent on characteristics of the discharge stream and receiving waters. Data for hourly dam releases for the 13 winter periods were used to run a finite-difference, unsteady flow model to evaluate the instantaneous river flows at SQN. Based on this simulated computer model, SQN would have exceeded the 3ºC temperature rise limit 27 percent of the time (on an hourly basis) and a 4ºC limit 4 percent of the time from November through March between 1976 and 1989. However, based on 1993–1994 and 1994–1995 SQN operational data during the field investigations, a water temperature rise of more than 3ºC occurred only once on January 1, 1995. (TVA 1995b)

White bass, white crappie, sauger, and channel catfish have been considered important species in Chickamauga Reservoir due largely to their significance as a sport fish and various levels of population decline in the 1980s (TVA 1990b; TVA 1991; TVA 1994; TVA 1995b). Plant operations including the discharge plume were evaluated for all four species. No instances of attraction or avoidance of the thermal plume were detected for fish species within Chickamauga Reservoir (TVA 1990b; TVA 1991; TVA 1994; TVA 1995b). Additionally, relatively constant RBI scores from 2000 to 2010 at TRM 482.0 indicate the thermal plume is not affecting benthic macroinvertebrates downriver of SQN (TVA 2011f).

Summary

Ecology of Chickamauga Reservoir is dynamic. Water levels fluctuate between seasons and years, which influences habitat quality for all taxa. During periods of lower flow, macrophytes are more abundant than periods of high flow, which alters vertebrate and invertebrate populations. TVA monitors macroinvertebrates and fish populations annually to characterize trends in populations as factors such as macrophyte abundance or water flow change. Macroinvertebrates are monitored using the RBI, and the RFAI is used for characterization of fish populations.

The comparison of RBI and RFAI variability is complicated because the indices measure different types of organisms. RBI variability over time is higher than RFAI variability likely due to the sampling protocol and relative immobility of macroinvertebrates when compared to fish. When sampling for macroinvertebrates, often habitat with high invertebrate concentrations are adjacent to areas of low concentration, which leads to increased variability with regard to invertebrate concentration among samples. (TVA 2005) For the sampling locations near SQN, some RBI variability is evident from year to year, but no increasing or decreasing trends are apparent. In comparing the averages from the periods 1994–1999 and 2000–2009, little change is evident, which implies relative stability within the macroinvertebrate community.

The RFAI data trends indicate relative stability through time. While fish communities are multifaceted and complex, the stability in the RFAI scores indicate that SQN is not having a significant impact on the associated reservoir fisheries.

Table 2.2-1
USGS Hydrologic Units and Surface Area for Region 06: Tennessee River Basin

Hydrologic Unit Code	Watershed Name	Surface Area (square miles)	State(s)	Flow Gradient to SQN
Subregion 0601: Upper Tennessee				
06010101	North Fork Holston	708	TN, VA	Upstream
06010102	South Fork Holston	1,170	TN, VA	Upstream
06010103	Watauga	870	NC, TN	Upstream
06010104	Holston	990	TN	Upstream
06010105	Upper French Broad	1,870	NC, TN	Upstream
06010106	Pigeon	679	NC, TN	Upstream
06010107	Lower French Broad	792	TN	Upstream
06010108	Nolichucky	1,740	NC, TN	Upstream
06010201	Watts Bar Lake	1,340	TN	Upstream
06010202	Upper Little Tennessee	839	GA, NC	Upstream
06010203	Tuckasegee	731	NC	Upstream
06010204	Lower Little Tennessee	1,050	NC, TN	Upstream
06010205	Upper Clinch	1,970	TN, VA	Upstream
06010206	Powell	939	TN, VA	Upstream
06010207	Lower Clinch	620	TN	Upstream
06010208	Emory	866	TN	Upstream
Subregion 0602: Middle Tennessee-Hiwassee				
06020001	Middle Tennessee-Chickamauga	1,870	AL, GA, TN	Both
06020002	Hiwassee	2,060	GA, NC, TN	Downstream
06020003	Ocoee	648	GA, NC, TN	Downstream
06020004	Sequatchie	586	TN	Downstream
Subregion 0603: Middle Tennessee-Elk				
06030001	Guntersville Lake	1,990	AL, GA, TN	Downstream
06030002	Wheeler Lake	2,890	AL, TN	Downstream

Table 2.2-1 (Continued)
USGS Hydrologic Units and Surface Area for Region 06: Tennessee River Basin

Hydrologic Unit Code	Watershed Name	Surface Area (square miles)	State(s)	Flow Gradient to SQN
06030003	Upper Elk	1,270	AL, TN	Downstream
06030004	Lower Elk	950	AL, TN	Downstream
06030005	Pickwick Lake	2,270	AL, TN, MS	Downstream
06030006	Bear	930	AL	Downstream
Subregion 0604: Lower Tennessee				
06040001	Lower Tennessee-Beech	2,080	MS, TN	Downstream
06040002	Upper Duck	1,160	TN	Downstream
06040003	Lower Duck	1,540	TN	Downstream
06040004	Buffalo	731	TN	Downstream
06040005	Kentucky Lake	1,810	KY, TN	Downstream
06040006	Lower Tennessee	689	KY, TN	Downstream
	Total Area	**40,648**		

(USGS 2011b)

Table 2.2-2
Tennessee River Dams

Dam	Location	River Mile	Year Completed
Fort Loudoun	Knoxville, TN	602.3	1943
Watts Bar	Spring City, TN	529.9	1942
Chickamauga	Chattanooga, TN	471.0	1940
Raccoon Mountain (pumped storage facility)	Chattanooga, TN	444.5	1978
Nickajack	Marion County, TN	424.7	1967
Guntersville	Guntersville, AL	349.0	1939
Wheeler	Decatur, AL	274.9	1936
Wilson	Florence, TN	259.4	1924
Pickwick Landing	Hardin County, TN	206.8	1938
Kentucky	Gilbertsville, KY	22.0	1944

(TVA 2011d)

Table 2.2-3
TDEC Final 303(d) List of Impaired Tributaries to Chickamauga Reservoir

Waterbody ID[(a)]	Confluence (TRM)[(b)]	Impacted Waterbody	County	Miles/Acres Impaired	Cause/TMDL	Priority	Pollutant Source	Comments
Upstream to SQN (TRM 487)								
TN06010201 001–1000	529.9	Watts Bar Reservoir	Rhea Roane Meigs	34,075 acres	PCB	NA	Contaminated sediments.	Fishing advisory due to PCBs. Category 4a. EPA approved a PCB TMDL for the known pollutant.
TN06020001 049–1000	504.5	Little Richland Creek	Rhea	20.4 miles	Alteration in streamside or littoral vegetative cover	M	Urbanized high-density area channelization.	Stream is Category 5. (One or more uses impaired.)
					Physical substrate habitat alterations	M		
					Loss of biological integrity due to siltation	M		

Table 2.2-3 (Continued)
TDEC Final 303(d) List of Impaired Tributaries to Chickamauga Reservoir

Waterbody ID[a]	Confluence (TRM)[b]	Impacted Waterbody	County	Miles/Acres Impaired	Cause/TMDL	Priority	Pollutant Source	Comments
TN06020002 001–2000	499	Hiwassee River Embayment of the Chickamauga Reservoir	Meigs McMinn Bradley	3,130 acres	Mercury	L	Atmospheric deposition industrial point source.	Fishing advisory due to mercury in largemouth bass. Category 5. Assistance requested for atmospheric deposition TMDLs.
TN06020001 057–0200	495 (Sale Creek)	Roaring Creek	Rhea	5.3 miles	Physical substrate habitat alteration	H	Channelization .	In addition to channelization, some illegal rock harvesting in this stream. Category 5.
TN06020001 062–1000	489.8	Possum Creek	Hamilton Bledsoe	13.2 miles	pH	H	Abandoned mining channelization.	In addition to channelization, some illegal rock harvesting in this stream. Category 5. (One or more uses impaired.)
					Iron	H		
					Physical substrate habitat alteration.	M		
Downstream to SQN (TRM 487)								
TN06020001 497–1000	480.5	Unnamed Tributary To Chickamauga Reservoir	Hamilton	3.5 miles	Biological integrity loss due to undetermined cause.	M	Undetermined source.	Near Daisy Dallas Road. Category 5.

Table 2.2-3 (Continued)
TDEC Final 303(d) List of Impaired Tributaries to Chickamauga Reservoir

Waterbody ID[a]	Confluence (TRM)[b]	Impacted Waterbody	County	Miles/Acres Impaired	Cause/TMDL	Priority	Pollutant Source	Comments
TN06020001 029–1000	478 (Harrison Bay)	Long Savannah Creek	Hamilton	15 miles	Escherichia coli.	H	Pasture grazing.	Stream is Category 5. (One or more uses impaired.)
TN06020001 889–1000	478 (Harrison Bay)	Wolftever Creek	Hamilton	11.1 miles	Escherichia coli.	H	Discharges from MS4 area.	Stream is Category 5. (One or more uses impaired.)
TN06020001 880–1000	478 (Harrison Bay)	Rogers Branch	Hamilton	10.4 miles	Escherichia coli.	H	Discharges from MS4 area.	Stream is Category 5. (One or more uses impaired.)

a. (TDEC 2010a)
b. (USACE 2011)
NA: Not applicable
L: Low TMDL priority
M: Moderate TMDL priority

Table 2.2-4
Ecological Health Indicators for Chickamauga Reservoir, 2011

Monitoring Locations	Dissolved Oxygen	Chlorophyll	Fish	Bottom Life	Sediment
Forebay	Good	Poor	Fair	Fair	Fair
Mid-Reservoir	Good	Poor	Fair	Fair	Fair
Hiwassee River Embayment	Good	Good	Fair	Fair	Fair
Inflow	-----[(a)]	-----[(a)]	Good	Good	-----[(a)]

(TVA 2012b)

a. Not measured at inflow station.

Table 2.2-5
Seasonal Mean Hydraulic Entrainment and Entrainment Percentages of Total Fish Eggs and Larvae Passing SQN Entrained 1981 to 1985 and 2004

	1981	1982	1983	1984	1985	2004
Seasonal Mean Hydraulic Entrainment						
Entrainment Percentage of Total Water Passing SQN	13.4[(a)]	12.6[(a)]	5.7[(a)]	5.7[(a)]	12.2[(a)]	24.2[(b)]
Entrained Fish Eggs[(b)] (Percentage Passing SQN)						
Freshwater Drum Eggs	6.7	41.4	22.6	9.7	16.6	11.2
Entrained Larvae[(b)] (Percentage by Taxon Passing SQN)						
Clupeidae	2.1	1.5	2.7	1.8	1.1	15.4
Cyprinidae	4.3	4.2	5.9	2.3	3.1	72.6[(c)]
Catostomidae	0.0	0.0	6.1	2.6	0.0	0.0
Ictaluridae	8.4	7.7	9.1	45.9[(c)]	27.8	0.0
Moronidae	1.7	2.7	4.8	2.2	2.5	5.0
Centrarchidae	1.0	1.8	1.1	0.6	0.7	24.2
Percidae	3.6	1.6	10.7	1.6	3.5	0.0
Sciaenidae	5.5	25.6	57.8	22.7	30.2	45.4
Entrainment Percentage of Total Fish Larvae Passing SQN	**2.3**	**2.2**	**4.7**	**2.3**	**2.6**	**15.6**

a. (TVA 1986)
b. (TVA 2010a)
c. While the number of Cyprinids and Ictalurids passing SQN was low, the percentage of these taxa that was entrained was higher than for other taxa.

Table 2.2-6
Summary of RBI Scores in Chickamauga Reservoir, 1994–2010

Year	Inflow TRM 527.4	Inflow TRM 518.0	Transition SQN Upstream TRM 490.5	Forebay SQN Downstream TRM 482.0	Forebay TRM 472.3	Hiwassee River Embayment HiRM 8.5
1994	----	19	33	----	31	17
1995	----	31	29	----	27	27
1997	----	25	31	----	29	25
1999	----	21	31	----	25	21
1994–1999 Average	***----***	***24***	***31***	***----***	***28***	***23***
2000	----	23	23	23	27	----
2001	29	29	25	31	27	21
2002	27	23	25	29	21	----
2003	33	27	31	29	27	31
2004	35	35	31	33	29	----
2005	31	29	31	31	27	25
2006	----	33	27	31	29	----
2007	23	25	21	25	19	13
2008	23	----	17	25	25	----
2009	23	31	27	23	23	19
2010	21	----	23	29	----	----
2000–2010 Average	***27***	***28***	***26***	***28***	***25***	***22***
Average All Years	**27**	**27**	**27**	**28**	**26**	**22**

(TVA 2011f)
RBI scores: 7–12 (very poor), 13–18 (poor) 19–23 (fair), 24–29 (good), 30–35 (excellent)

Table 2.2-7
Comparison of Average Mean Density per Square Meter of Benthic Taxa Collected at Upstream and Downstream Sites Near SQN, Chickamauga Reservoir, Autumn 2008 and Autumn 2009

	2009		2008	
Taxa	**Downstream TRM 482**	**Upstream TRM 490.5**	**Downstream TRM 482**	**Upstream TRM 490.5**
Tubellaria				
Tricladida				
Planariidae			5	-----
Oligocheata				
Oligochaetes	15	18	133	93
Hirudinea	-----	7	35	3
Crustacea				
Amphipoda	-----	-----	57	12
Isopoda	-----	-----	-----	-----
Insecta				
Ephemeroptera				
Mayflies other than Hexagenia	-----	3	-----	-----
Ephemeridae				
Hexagenia (≤ 10 mm)	2	2	8	—
Hexagenia (> 10 mm)	37	18	7	2
Trichoptera				
Caddisflies	-----	-----	15	-----
Chironomidae				
Chironomids	164	285	238	352

Table 2.2-7 (Continued)
Comparison of Average Mean Density per Square Meter of Benthic Taxa Collected at Upstream and Downstream Sites Near SQN, Chickamauga Reservoir, Autumn 2008 and Autumn 2009

	2009		**2008**	
Taxa	**Downstream TRM 482**	**Upstream TRM 490.5**	**Downstream TRM 482**	**Upstream TRM 490.5**
Gastropoda				
Snails	13	5	17	3
Bivalvia				
Unionoida				
Unionoidae				
Mussels	2	-----	2	-----
Veneroida				
Corbiculidae				
Corbicula (≤ 10 mm)	40	5	48	2
Corbicula (> 10 mm)	11	12	13	-----
Sphaeriidae				
Fingernail clams	26	27	8	20
Dreissenidae				
Dreissena polymorpha	9	3	8	-----
Density of Organisms per meter^2	**348**	**296**	**507**	**711**
Number of Samples	**10**	**10**	**10**	**10**
Total Area Sampled (meter^2)	**0.6**	**0.6**	**0.6**	**0.6**

(TVA 2010b)

Table 2.2-8
Fish Species in the Vicinity of SQN

Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*
Largemouth bass	*Micropterus salmoides*
Rock bass	*Ambloplites rupestris*
Smallmouth bass	*Micropterus dolomieu*
Spotted bass	*Micropterus punctulatus*
Striped bass	*Morone saxatilis*
White bass	*Morone chrysops*
Yellow bass	*Morone mississippiensis*
Bluegill	*Lepomis macrochirus*
Bigmouth buffalo	*Ictiobus cyprinellus*
Black buffalo	*Ictiobus niger*
Smallmouth buffalo	*Ictiobus bubalus*
Black bullhead	*Ameiurus melas*
Brown bullhead	*Ictalurus Ameiurus nebulosus*
Yellow bullhead	*Ictalurus Ameiurus natalis*
Common carp	*Cyprinus carpio*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictis olivaris*
Silver chub	*Macrhybopis storeriana*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Mud darter	*Etheostoma asprigene*
Orangethroat darter	*Etheostoma spectabile*
Rainbow darter	*Etheostoma caeruleum*
Stripetail darter	*Etheostoma kennicotti*
Freshwater drum	*Aplodinotus grunniens*
Longnose gar	*Lepisosteus osseus*
Shortnose gar	*Lepisosteus platostomus*
Spotted gar	*Lepisosteus oculatus*
Goldfish	*Carassius auratus*

Table 2.2-8 (Continued)
Fish Species in the Vicinity of SQN

Common Name	Scientific Name
Skipjack herring	*Alosa chrysochloris*
Killifish	Fundulidae
Chestnut lamprey	*Icthyomyzon castaneus*
Bluntnose minnow	*Pimephales notatus*
Bullhead minnow	*Pimephales vigilax*
Fathead minnow	*Pimephales promelas*
Pugnose minnow	*Opsopoeodus emiliae*
Blackstripe topminnow	*Fundulus notatus*
Blackspotted topminnow	*Fundulus olivaceus*
Mooneye	*Hiodon tergisus*
Mosquitofish	*Gambusia affinis*
Paddlefish	*Polyodon spathula*
Yellow Perch	*Perca flavescens*
Logperch	*Percina caprodes*
Quillback	*Carpiodes cyprinus*
Black redhorse	*Moxostoma duquesnei*
Golden redhorse	*Moxostoma erythrurum*
River redhorse	*Moxostoma carinatum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Silver redhorse	*Moxostoma anisurum*
Sauger	*Sander canadensis*
Gizzard shad	*Dorosoma cepedianum*
Threadfin shad	*Dorosoma petenense*
Common shiner	*Luxilus cornutus*
Emerald shiner	*Notropis atherinoides*
Ghost shiner	*Notropis buchanani*
Golden shiner	*Notemigonus crysoleucas*
Mimic shiner	*Notropis volucellus*
Spotfin shiner	*Cyprinella spiloptera*
Steelcolor shiner	*Cyprinella whipplei*
Striped shiner	*Luxilus chrysocephalus*

Table 2.2-8 (Continued)
Fish Species in the Vicinity of SQN

Common Name	Scientific Name
Whitetail shiner	*Cyprinella galactura*
Brook silverside	*Labidesthes sicculus*
Inland silverside	*Menidia beryllina*
Central stoneroller	*Campostoma anomalum*
Lake sturgeon	*Acipenser fulvescens*
River carpsucker	*Carpiodes carpio*
Northern Hog sucker	*Hypentelium nigricans*
Spotted sucker	*Minytrema melanops*
White sucker	*Catostomus commersoni*
Green sunfish	*Lepomis cyanellus*
Longear sunfish	*Lepomis megaolotis*
Orangespotted sunfish	*Lepomis humilis*
Redbreast sunfish	*Lepomis auritus*
Redear sunfish	*Lepomis microlophus*
Walleye	*Sander vitreus*
Warmouth	*Lepomis gulosus*

(Nelson et al. 2004; TVA 1984; TVA 2000; TVA 2009b)

Table 2.2-9
Summary of RFAI Scores in Chickamauga Reservoir, 1993–2010

Year	Inflow TRM 529.0	Transition SQN Upstream TRM 490.5	Forebay SQN Downstream TRM 482.0	Forebay TRM 472.3	Hiwassee River Embayment HiRM 8.5
1993	52	51	----	43	46
1994	52	40	----	44	39
1995	48	48	----	47	39
1996	42	44	47	----	----
1997	44	39	----	40	40
1999	42	45	41	45	43
1993–1999 Average	***47***	***45***	***44***	***44***	***41***
2000	44	46	48	45	43
2001	46	45	46	48	47
2002	48	51	43	46	-
2003	48	42	45	43	36
2004	42	49	41	43	42
2005	42	46	39	46	45
2006	42	47	35	43	----
2007	42	44	38	41	41
2008	44	34	38	41	----

Table 2.2-9 (Continued)
Summary of RFAI Scores in Chickamauga Reservoir, 1993–2010

Year	Inflow TRM 529.0	Transition SQN Upstream TRM 490.5	Forebay SQN Downstream TRM 482.0	Forebay TRM 472.3	Hiwassee River Embayment HiRM 8.5
2009	44	41	37	34	42
2010	44	39	39	40	----
2000–2010 Average	***44***	***44***	***41***	***43***	***42***
Average All Years	**45**	**44**	**41**	**43**	**42**

(TVA 2011f)
RFAI scores: 12–21 (very poor), 22–31 (poor) 32–40 (fair), 41–50 (good), 51–60 (excellent)

Table 2.2-10
Total Fish Estimated Impinged by Year at SQN

	1980–1981	1981–1982	1982–1983	1983–1984	1984–1985	2005–2006	2006–2007
Extrapolated Annual Number Impinged[a]	94,528	81,158	20,685	41,076	27,195	20,223	40,362

(TVA 2007b)

a. Based on the standing crop estimates from TVA reservoir monitoring, these annual estimates represent < 0.01 percent of the total standing crop by number.

Table 2.2-11
Recreational and Commercially Important Fish Species

Common Name	Scientific Name
Recreational Species	
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomieu*
Spotted bass	*Micropterus punctulatus*
Black crappie	*Pomoxis nigromaculatus*
White crappie	*Pomoxis annularis*
Commercial Species	
Yellow bass	*Morone mississippiensis*
Bowfin	*Amia calva*
Bigmouth buffalo	*Ictiobus cyprinellus*
Black buffalo	*Ictiobus niger*
Smallmouth buffalo	*Ictiobus bubalus*
Black bullhead	*Ameiurus melas*
Brown bullhead	*Ameiurus nebulosus*
Yellow bullhead	*Ameiurus natalis*
Bighead carp	*Hypophthalmichthys nobilis*
Common carp	*Cyprinus carpio*
Grass carp	*Ctenopharyngodon idella*
Silver carp	*Hypophthalmichthys molitrix*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictis olivaris*
Freshwater drum	*Aplodinotus grunniens*
Longnose gar	*Lepisosteus osseus*
Shortnose gar	*Lepisosteus platostomus*
Spotted gar	*Lepisosteus oculatus*
Paddlefish	*Polyodon spathula*
Quillback	*Carpiodes cyprinus*
Golden redhorse	*Moxostoma erythrurum*
Silver redhorse	*Moxostoma anisurum*
River carpsucker	*Carpiodes carpio*

Table 2.2-11 (Continued)
Recreational and Commercially Important Fish Species

Common Name	Scientific Name
Spotted sucker	*Minytrema melanops*
White sucker	*Catostomus commersoni*

(TVA 2011g; TWRA 2011a)

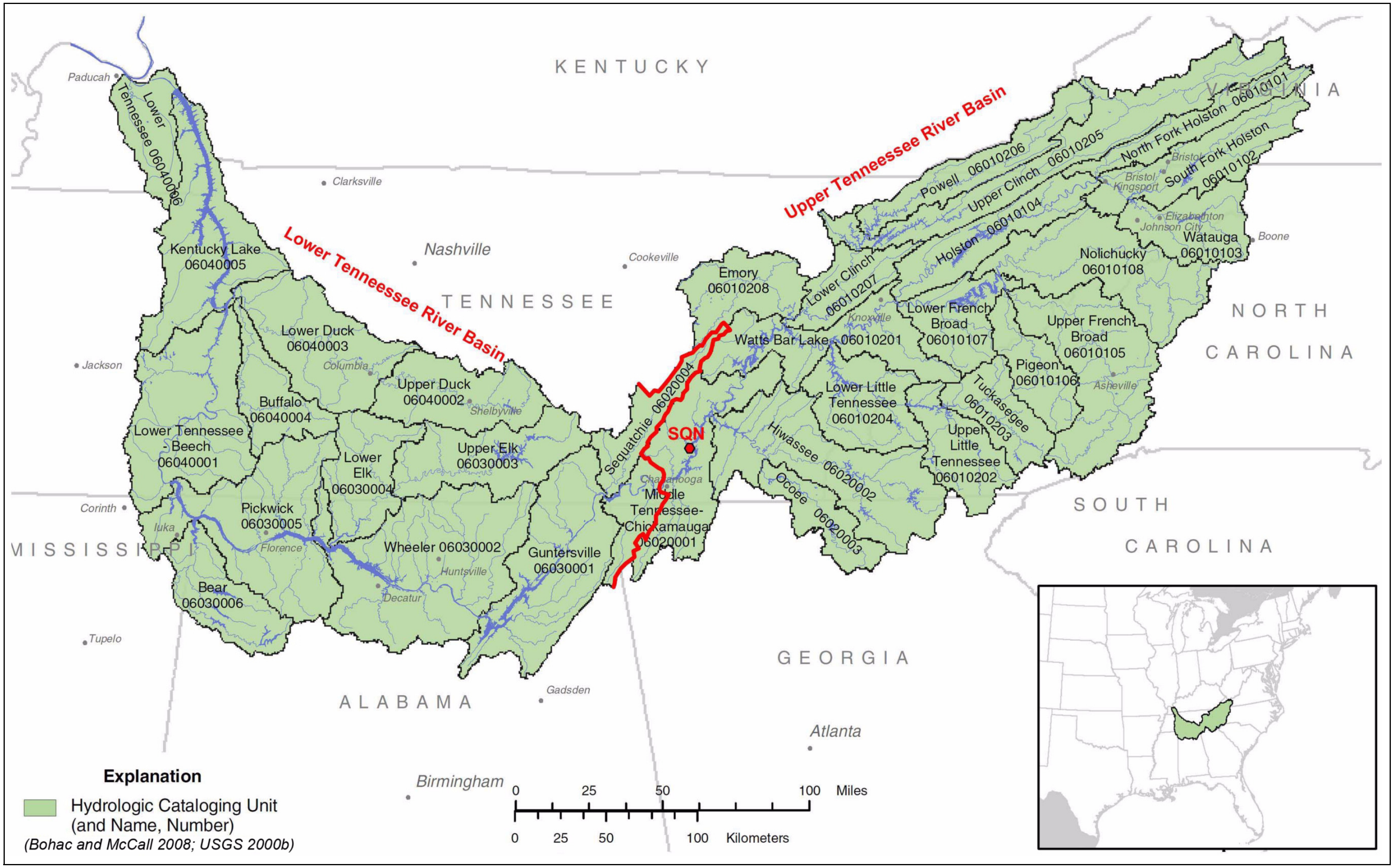
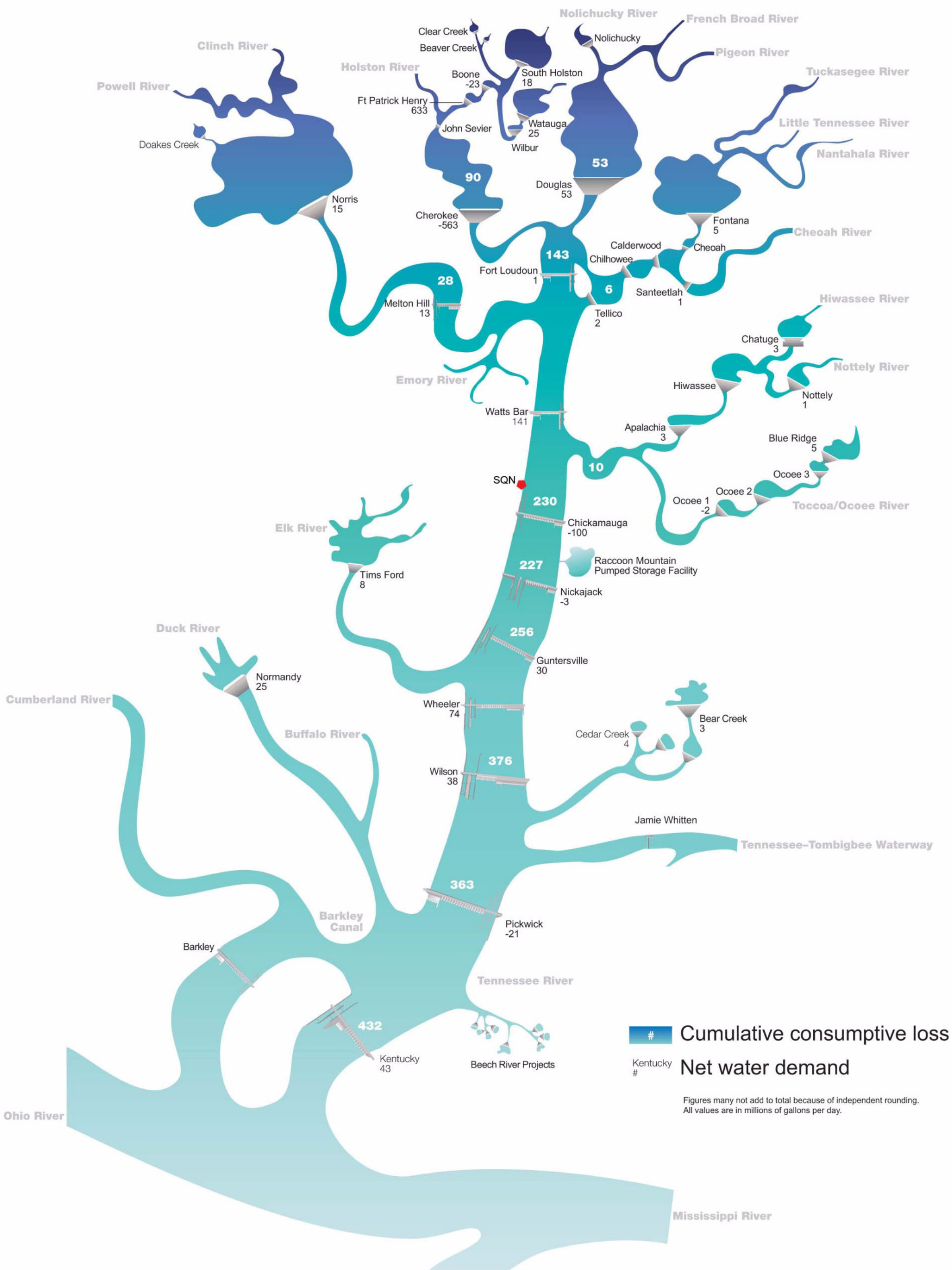
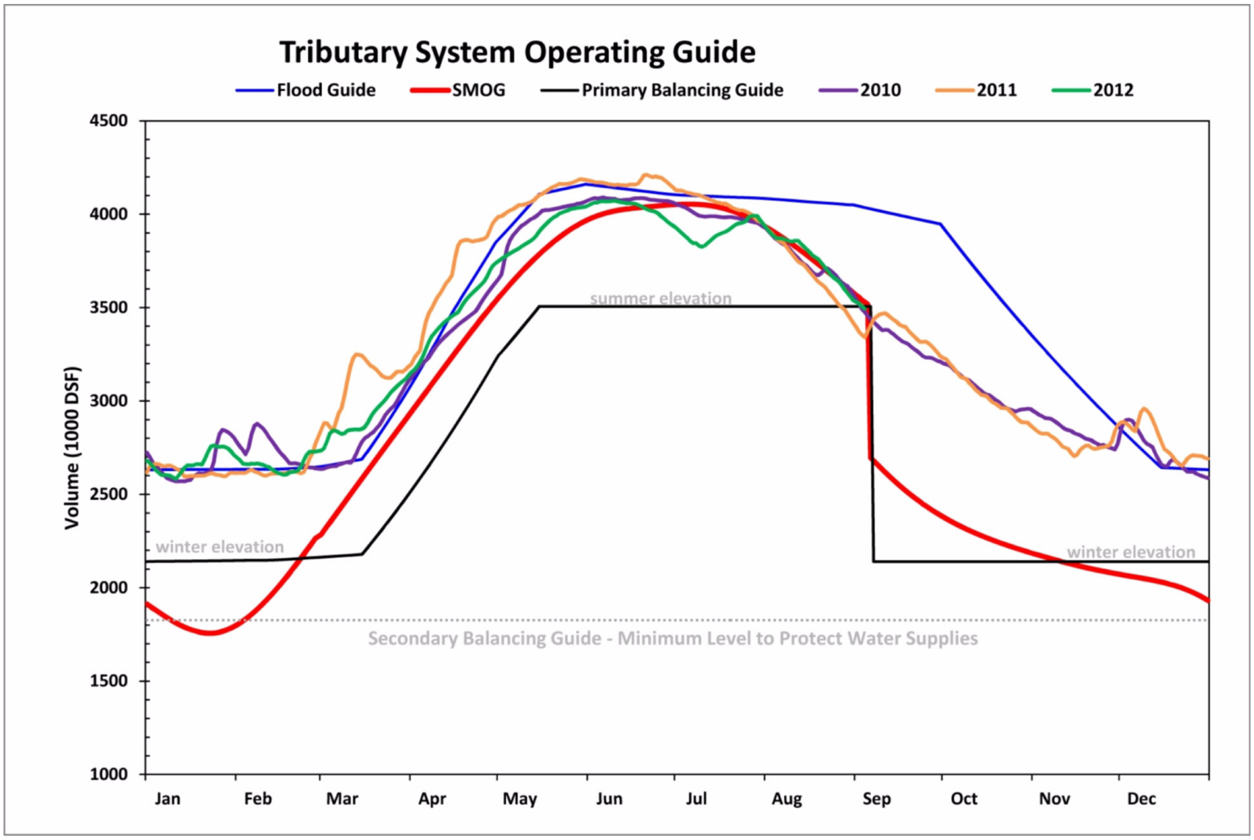


Figure 2.2-1
Tennessee River Watershed Basin



(Bohac and McCall 2008)

Figure 2.2-2
TVA Dams and Reservoirs



SMOG: system minimum operating guide (TVA 2012h)

System Flow Requirements (June 1–Labor Day)

Weekly average minimum flow at Chickamauga Dam (cubic feet per second)

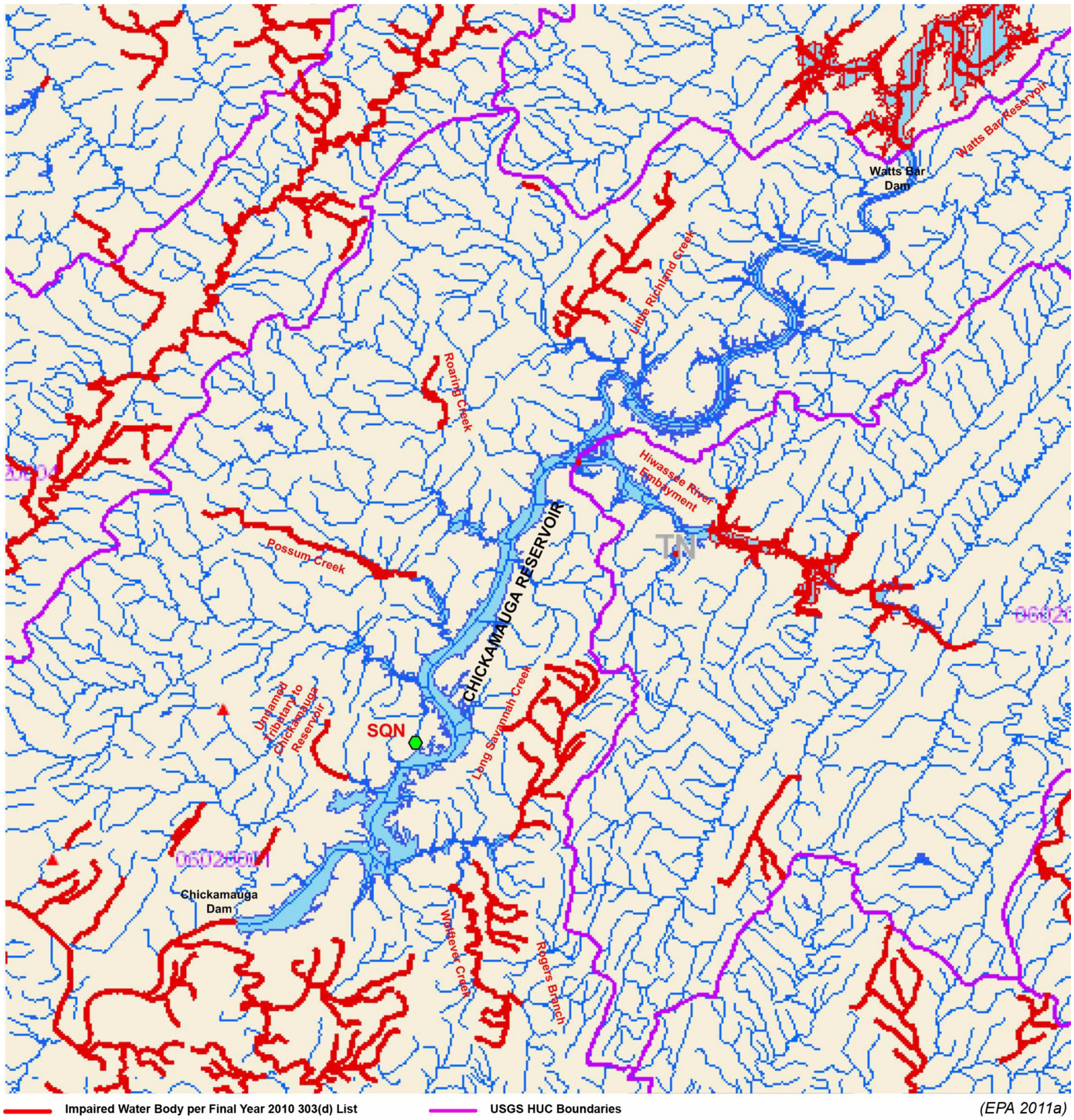
	June 1–July 31	Aug. 1–Labor Day
If the volume of water stored in tributary reservoirs is BELOW the minimum operations guide.	13,000 CFS	25,000 CFS
If the volume of water stored in tributary reservoirs is ABOVE the minimum operations guide.	Increases from 14,000 CFS the first week of June to 25,000 CFS the last week in July	29,000 CFS

Bi-weekly average minimum flow at Kentucky Dam (cubic feet per second)

	June 1–July 31	Aug. 1–Labor Day
Kentucky flow requirement can drive minimum flows when conditions are dry below Chickamauga Dam.	18,000 CFS* at Kentucky Dam	18,000 CFS* at Kentucky Dam

*May increase up to 25,000 CFS for navigation.

Figure 2.2-3
TVA Reservoir Water Release and System Flow Requirements (2010–August 2012)



(EPA 2011a)

Figure 2.2-4
Impaired Waters Discharging to Chickamauga Reservoir

2.3 Groundwater Resources

2.3.1 Geology

2.3.1.1 Regional Geology

The SQN site is situated on a peninsula extending from the western bank into Chickamauga Reservoir between TRMs 484 and 485. The majority of the plant site resides at a grade elevation of 705 feet msl. Elsewhere, terrain is rolling with the highest elevation of about 775 feet msl being encountered southeast of the plant site at the top of Locust Hill (TVA 2007c, page 30). To the west, the land is a broad, rolling plain with general elevations between 800 and 900 feet msl until the terrain rapidly rises up the Cumberland Plateau to approximately 1,600 feet msl on the western side of Soddy-Daisy, approximately 5 miles west of the SQN site.

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 that extend from Alabama and Georgia to New York. In the eastern part of Tennessee, it is underlain by rocks that are primarily Cambrian and Ordovician in age. Minor Silurian, Devonian, and Mississippian rocks also are present in the province. Soluble carbonate rocks and some easily eroded shales underlie the valleys in the province, and more erosion-resistant siltstone, sandstone, and some cherty dolomite underlie ridges.

The arrangement of the northeast-trending valleys and ridges and the broad expanse of the Cambrian and the Ordovician rocks in eastern Tennessee 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 as shown in Figure 2.3-1. The result of the faulting is that geologic formations can be repeated several times across the faults; for example, the carbonate-rock aquifers in the Chickamauga, the Knox, and the Conasauga groups are repeated across the thrust faults shown in Figure 2.3-1. 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 valleys and ridges on the present land surface. (USGS 1995)

2.3.1.2 Site Geology

The Conasauga Formation of Middle Cambrian age underlies SQN, providing the foundation bedrock of the plant (Figure 2.3-2). Unconsolidated alluvial, terrace, and residual deposits mantle the Conasauga Formation at the site. More recent alluvial deposits that were associated with the floodplain of the Tennessee River are now covered by Chickamauga Reservoir (TVA 2007c, page 32).

The Conasauga Formation at the site is composed of several hundred feet of interbedded limestone and shale in varying proportions. The shale, where fresh and unweathered, is dark gray, banded, and somewhat fissile in character. The limestone is predominantly light gray, medium-grained to coarse crystalline to oolitic, with many shaly partings. A statistical analysis of the cores obtained from the site indicates a ratio of 56 percent shale to 44 percent limestone. Farther to the southeast and higher in the geologic section, the amount of limestone increases in exposures along the shore of Chickamauga Reservoir. (TVA 2007c, page 32)

Cavities and solution openings are not a major problem in the site foundation. Most solution openings are restricted to the upper few feet of bedrock near the overburden/bedrock interface. The insolubility of interbedded shale in deeper bedrock functions as a lithologic control to the development of large solution openings. However, small solution openings and partings may exist at greater depths within the bedrock along faults and joints, especially along synclinal zones. (TVA 2007c, page 32)

Alluvium within the area of the main plant site was removed during construction, and only residual soils remain. In the plant area not mantled by terrace deposits, the Conasauga is overlain by varying thicknesses of residual silt and clay derived from weathering of the underlying shale and limestone. The residual soils are primarily silts and clays grading downward into saprolitic shale of the Conasauga Formation. In a few localized areas, weathered shale is exposed at the ground surface. However, in most exploratory drilling, the residuum depths ranged from 3 to 34 feet. Grain size analyses show that soils across the site range from fat clay residual material to sand and gravel terrace deposits. (TVA 2007c, pages 32 and 37)

2.3.2 Regional Groundwater

SQN lies within the Valley and Ridge aquifer system with the principal aquifers consisting of carbonate rocks that are Cambrian, Ordovician, and Mississippian in age (Figure 2.3-3). These aquifers, which are typically present in valleys and rarely present on broad dissected ridges, underlie more than one-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 (USGS 1995).

2.3.3 Local Groundwater

The peninsula on which SQN is located is underlain by the Conasauga Formation, a poor water-bearing formation. About 2,000 feet northwest of the plant site, the trace of the Kingston fault separates the Conasauga Shale from a wide belt of Knox Dolomite. The Knox Dolomite is a major water-bearing formation of eastern Tennessee. Based on a comprehensive examination of bedrock coreholes, groundwater in the Conasauga Formation occurs in small openings along fractures and bedding planes. These openings rapidly decrease in size with depth, and few exist below 300 feet. Groundwater in the Knox Dolomite occurs in solution-enlarged openings formed along fractures and bedding planes, and also in locally thick cherty clay overburden. (TVA 2011p, Section 2.4.13.1)

There is no distinct aquifer in the Conasauga Formation at the SQN site (TVA 1974a, pages 1.2-5 and 1.2-6). The source of groundwater below the SQN site is derived from incipient infiltration of precipitation (TVA 2007c, page 43). Within overburden soils at the site, groundwater movement is generally downward. Local areas of natural lateral flow likely occur near some streams, topographic lows, and where extensive root systems exist. Groundwater movement might also occur in the vicinity of pipelines associated with plant systems due to preferential groundwater flow paths created by the permeable fill placed around the pipelines during their installation. (TVA 2007c, page 43) Groundwater is first encountered at the site 10–25 feet below ground surface (bgs) based on recent groundwater depth measurements. (TVA 2009c)

Groundwater movement is expected to occur mainly along the strike of bedrock, to the northeast and southwest, into Chickamauga Reservoir (TVA 2007c, page 43). Based on previous analysis, the permeability across strike in the Conasauga Shale is extremely low, and nearly all water movement is in a southwest to northeast direction, along the strike. The Conasauga-Knox Dolomite Contact is a hydraulic barrier across which only a very small volume of water could migrate in the event large groundwater withdrawals were made from the adjacent Knox. Although some water can cross this boundary, the permeability normal to strike in the Conasauga is too low to allow development of an extensive cone of depression. (TVA 2011p, Section 2.4.13.2)

Groundwater also discharges from overburden soils into the reservoir, site drainage channels (i.e., discharge channel), and surface water impoundments (i.e., diffuser pond). Higher surface water levels of Chickamauga Reservoir (April–October) result in corresponding rises in the groundwater table, and the lateral extent of this effect varies with groundwater hydraulic gradients. Lower surface water levels of Chickamauga Reservoir (November–March) result in corresponding declines in the water table along the reservoir periphery. (TVA 2007c, page 43)

Preconstruction boring logs collected by TVA suggest that groundwater transmissivity across the strike in the Conasauga Formation is extremely low. The computed mean time of groundwater travel from SQN to Chickamauga Reservoir is 303 days. Local variations in hydraulic conductivity within the shallow bedrock are primarily controlled by geologic structure and stratigraphy. Shale beds and clay seams provide lithologic restrictions to the vertical movement of groundwater. The Conasauga/Knox contact northwest of the plant has been described as a hydraulic boundary; however, no field testing has been conducted to verify this assumption. The Conasauga Formation porosity is estimated to be about 3 percent based upon results of exploratory drilling. (TVA 2007c, page 44)

2.3.4 Groundwater Quality

Groundwater quality at SQN has been monitored over the years to obtain background concentrations, to examine the effect of onsite disposal practices, and in response to specific incidents. Monitored parameters include radionuclides and organics. SQN participates in the Nuclear Energy Institute (NEI) groundwater protection initiative (GPI) NEI 07-07 (NEI 2007) to monitor inadvertent releases of radioactive substances that may result in low but detectable levels of plant-related materials in the groundwater as discussed in Section 3.2.6.

SQN does not utilize onsite groundwater for plant or potable water purposes and no public or private water supply wells were found that withdraw water from the Conasauga formation underlying the SQN property. As the Conasauga is not considered a reliable drinking water aquifer, little groundwater quality information is available. One sample analysis for onsite groundwater quality parameters was reported in conjunction with the investigation and remediation of a historic fuel oil spill (TVA 1993b); however, the results show the groundwater quality of the Conasauga formation beneath the site is generally good.

Groundwater quality within the surrounding Valley and Ridge aquifer units is somewhat variable, dependent on the formation, but generally is satisfactory for municipal supplies and other purposes. Most of the water in the upper parts of the aquifers is not greatly mineralized and is suitable for most uses.

For public water supplies listed in Table 2.10-1 that utilize groundwater, the quality of the water is generally good; however, EPA records show several of the community water supply systems have violations due to total coliform and halomethanes, primarily from groundwater supplies under the influence of surface water bodies.

2.3.5 Groundwater Use

As stated in Section 2.3.3, the Conasauga Formation underlying the site is a poor water-bearing formation. Water supply wells are normally located within the more productive carbonate aquifers within the Valley and Ridge Province, such as the nearby Knox Dolomite.

There are no groundwater supply wells on the SQN site. TVA contracts with the Hixson Utility District to supply potable water (TVA 2011p, Section 9.4.2.1) and fire protection water (TVA 2011h; TVA 2011p, Section 9.4.2.1) to the SQN plant. Other cooling water and service water systems are supplied from Chickamauga Reservoir. Potable water for the residential area around SQN is also provided by Hixson Utility District (CHCRPA 2005a). Hixson Utility District uses groundwater supply wells from the Cave Springs area located approximately 8 miles southwest of SQN near State Highway 27 (TVA 2007c, page 54).

Registered groundwater withdrawals for municipal, industrial, and irrigation uses within Hamilton County are listed in Table 2.3-1. Hamilton County registered groundwater usage in 2010–2011 totaled 15.46 million gallons per day (MGD), consisting of public supply (10.97 MGD), industrial (4.05 MGD), and irrigation (0.44 MGD). Hamilton County is the second largest user of groundwater in the Tennessee Valley (Bohac and McCall 2008).

There is a declining trend in groundwater withdrawal in the Tennessee Valley. As a result, it is assumed that any increases in future water demands would be met from surface water sources. Public supply systems, which use groundwater as a source, are slowly transitioning to surface water sources as treatment plants are upgraded or systems are consolidating to meet higher demand and new drinking water regulations. Therefore, it is likely that groundwater withdrawal would continue to decline. (Bohac and McCall 2008)

Based on the results of an Environmental Data Resources (EDR) GeoCheck® search, no water wells were identified within a 1-mile radius (from the plant center point) of the site (EDR 2011). The nearest registered well is a private well completed in 1964; however, it is on the opposite side of Chickamauga Reservoir and is not influenced by nor can it influence the site. The nearest registered well with the potential for site influence is a private well, completed in 1984, measured at approximately 1.2 miles north-northwest from the SQN center point.

According to the EDR report, there are 22 registered water wells within a 2-mile radius of the SQN center point (Figure 2.3-4). However, only two are not separated from the site by the Chickamauga Reservoir and, therefore, are the only two wells that could reasonably be considered to be within the influence of the plant (EDR 2011). Both are residential wells and are considered to be low-volume groundwater withdrawals and, therefore, based on distance and low groundwater volume extractions, would not be considered to have a potential influence on the groundwater beneath the SQN site.

2.3.6 Site Groundwater Conditions

During quarterly testing, tritium is being detected around the SQN Unit 1 refueling water storage tank and in an area south-southeast of the SQN Unit 2 Reactor Building. Results suggest that the sources of tritiated groundwater are primarily associated with past inadvertent releases of liquids containing radioisotopes, which have since been stopped. In general, the highest tritium concentrations in the shallow groundwater are associated with two distinct areas north and south of Units 1 and 2. The extent of the tritium plume has been bounded horizontally by sampling locations. (TVA 2007c, page 79) During quarterly testing, tritium is being detected in four shallow monitoring wells associated with these areas, with concentrations remaining flat or trending downward (TVA 2009c). In addition, tritium was detected at a concentration of ~23,000 picocuries per liter (pCi/L) in December 2011 in one of the two new deep wells that were installed in October 2011 to characterize the vertical plume.

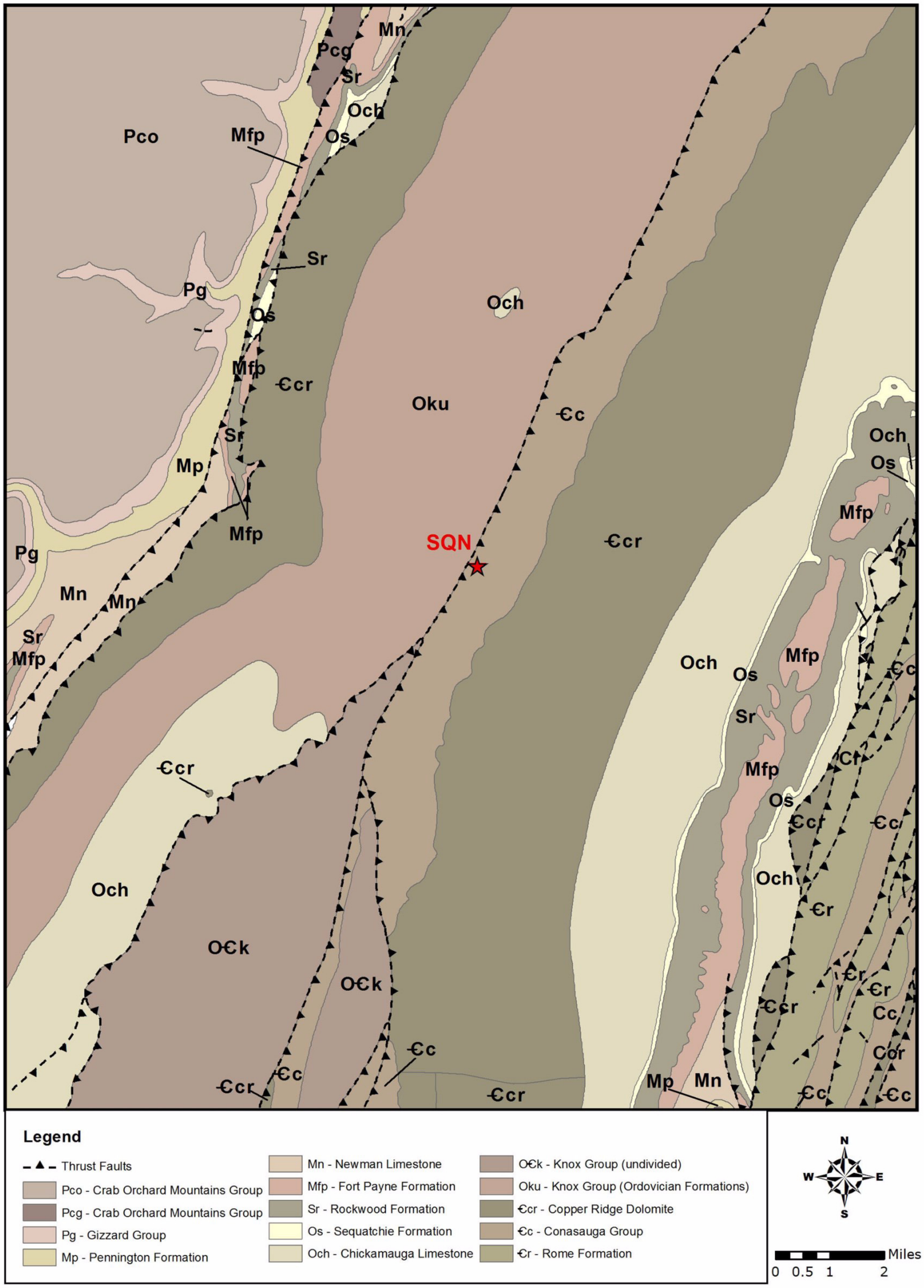
No active remediation has been recommended for the site due to the limited extent of tritium concentrations in groundwater, low exposure and dose risks, and negligible potential for offsite groundwater migration. In addition, groundwater and surface water level measurements confirm that the intake and discharge channels would ultimately receive tritiated groundwater discharged from the site. (TVA 2007c, pages 81-82)

In compliance with industry guidelines for groundwater protection initiatives, SQN conducts a hydrogeologic evaluation review every 5 years. This review updates the predominant groundwater flow characteristics and gradients in a three-dimensional graphic representation of the subsurface based on current site configuration and environmental factors, including complexities in stratigraphy such as bedrock, clay lenses, geologic materials, or aquifers that may have the potential to affect contaminant flow. SQN also performs groundwater monitoring in conjunction with the industry groundwater program initiative to monitor for potential radioactive releases via groundwater pathways at the site as discussed in Section 3.2.6.

Table 2.3-1
Registered Groundwater Withdrawal Locations in Hamilton County, Tennessee

Name	Distance from SQN (approx. miles)[a]	Withdrawal Type	Average Annual Withdrawal (MGD)	Year (Reference)
Akzo Nobel Surface Chemistry, LLC	13.31	Industry	2.928	2010 (Bohac 2012a)
Black Creek Club	22.53	Irrigation	0.296	2010 (Bohac 2012a)
Chattanooga Golf and Country Club	15.8	Irrigation	0.072	2010 (Bohac 2012a)
Chattem Chemical	19.85	Industry	0.752	2010 (Bohac 2012a)
Coca-Cola Bottling Company, Inc.	12.97	Industry	0.111	2010 (Bohac 2012a)
Coca-Cola Bottling Company, Inc.	12.97	Industry	0.184	2010 (Bohac 2012a)
Eagle Bluff Golf Club	7.00	Irrigation	0.014	2010 (Bohac 2012a)
Geo Specialty Chemicals	17.59	Industry	0.023	2010 (Bohac 2012a)
Hampton Creek Golf Club	6.08	Irrigation	0.06	2010 (TDEC 2012a)
Hixson Utility District	8.11	Municipal	5.14	2011 (TDEC 2012a)
Hixson Utility District	5.15	Municipal	2.73	2011 (TDEC 2012a)
Sale Creek Utility District	10.51	Municipal	0.17	2011 (TDEC 2012a)
Savannah Valley Utility District	6.60	Municipal	1.06	2011 (TDEC 2012a)
Savannah Valley Utility District	3.64	Municipal	0.00	2011 (TDEC 2012a)
Savannah Valley Utility District	4.78	Municipal	1.38	2011 (TDEC 2012a)
Top Flight	17.68	Industry	0.048	2010 (Bohac 2012a)
Union Fork-Bakewell Utility District	8.53	Municipal	0.49	2011 (TDEC 2012a)
Walden Ridge Utility District	10.18	Municipal	0.00[b]	2011 (TDEC 2012a)

a. (TVA 2011i)
b. Groundwater wells are present but not in use. The Walden Ridge Utility District currently purchases surface water (TDEC 2012a).



(USGS 2011d)

Figure 2.3-1
Regional Geologic Map

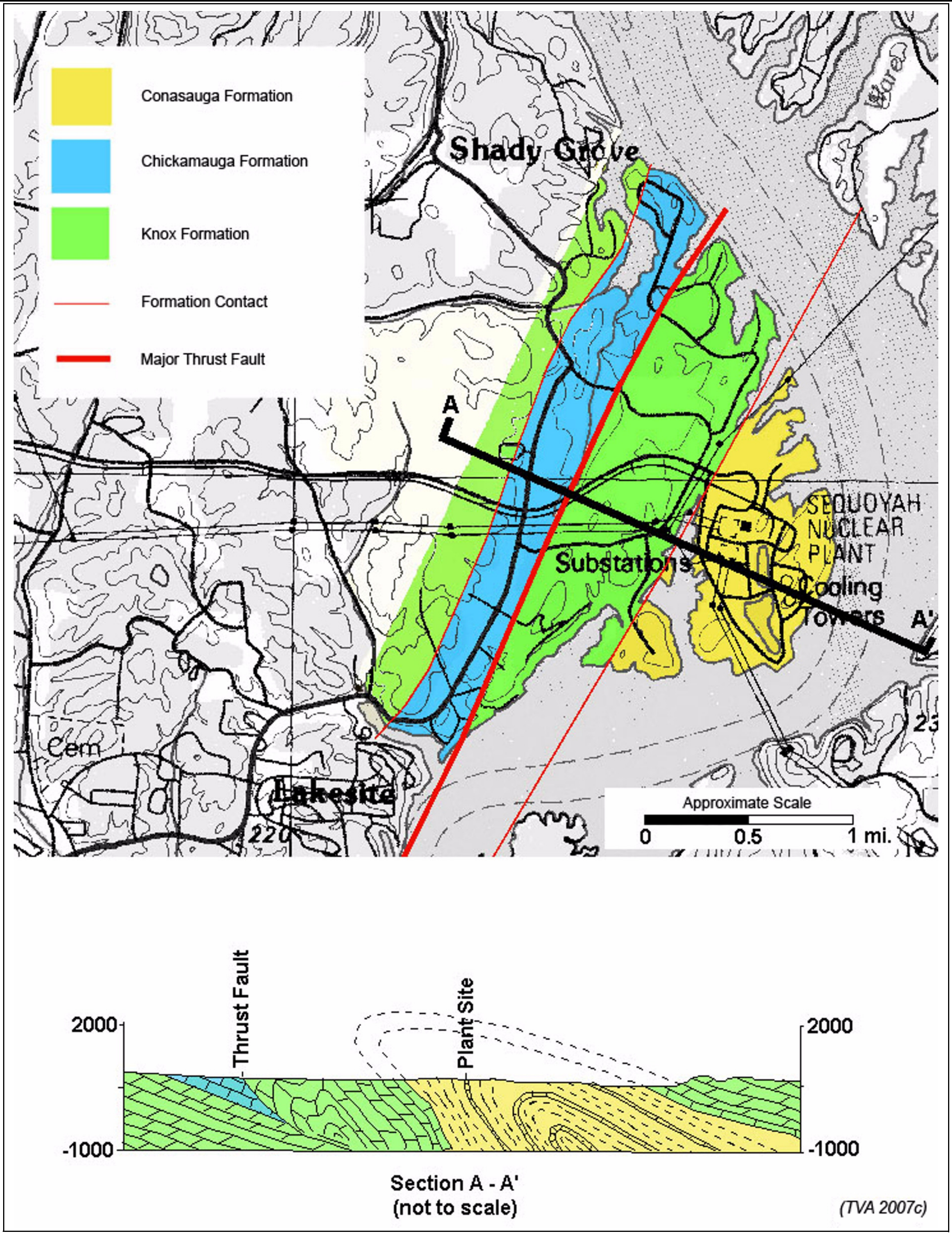


Figure 2.3-2
Site Geologic Map

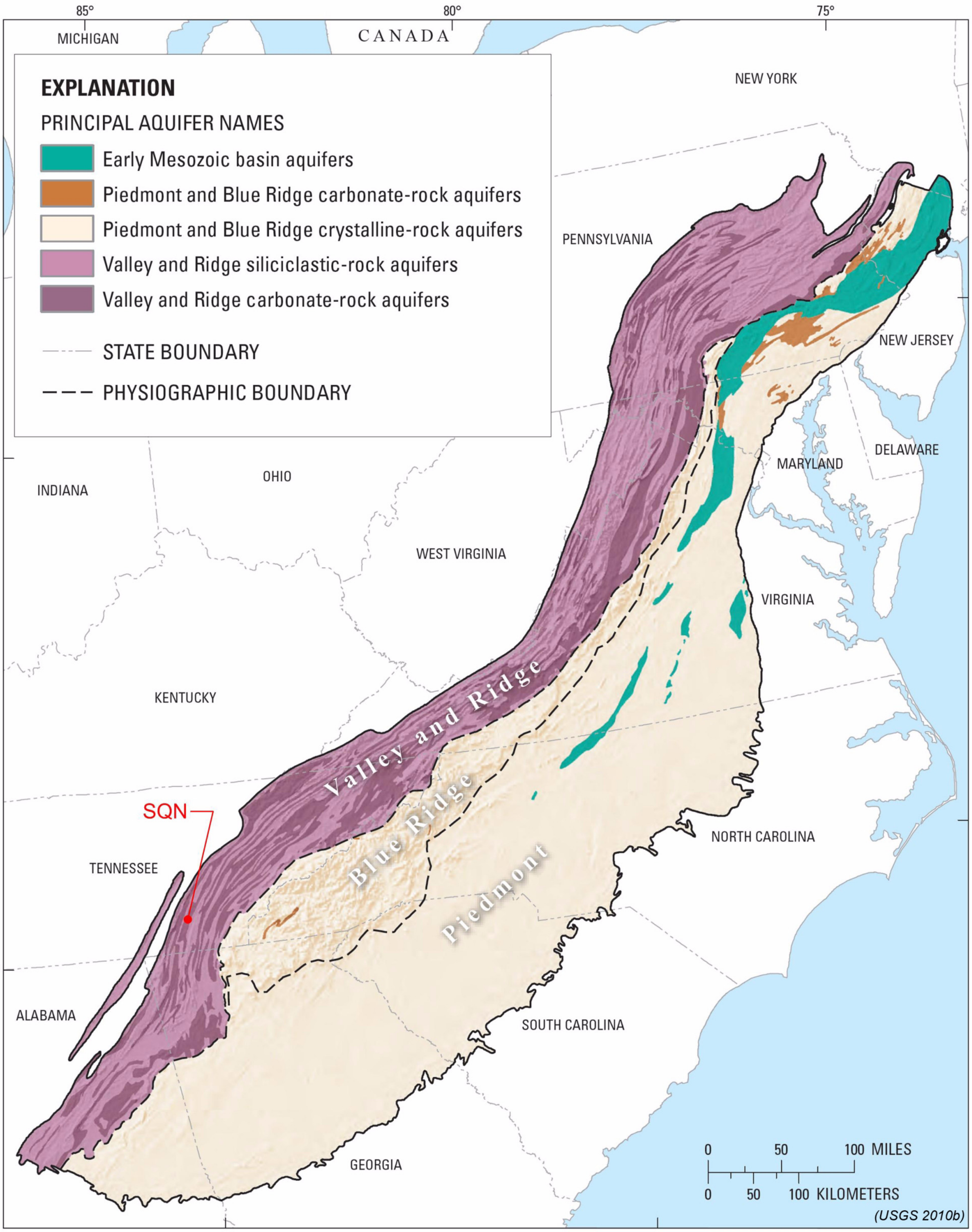


Figure 2.3-3
Regional Aquifers

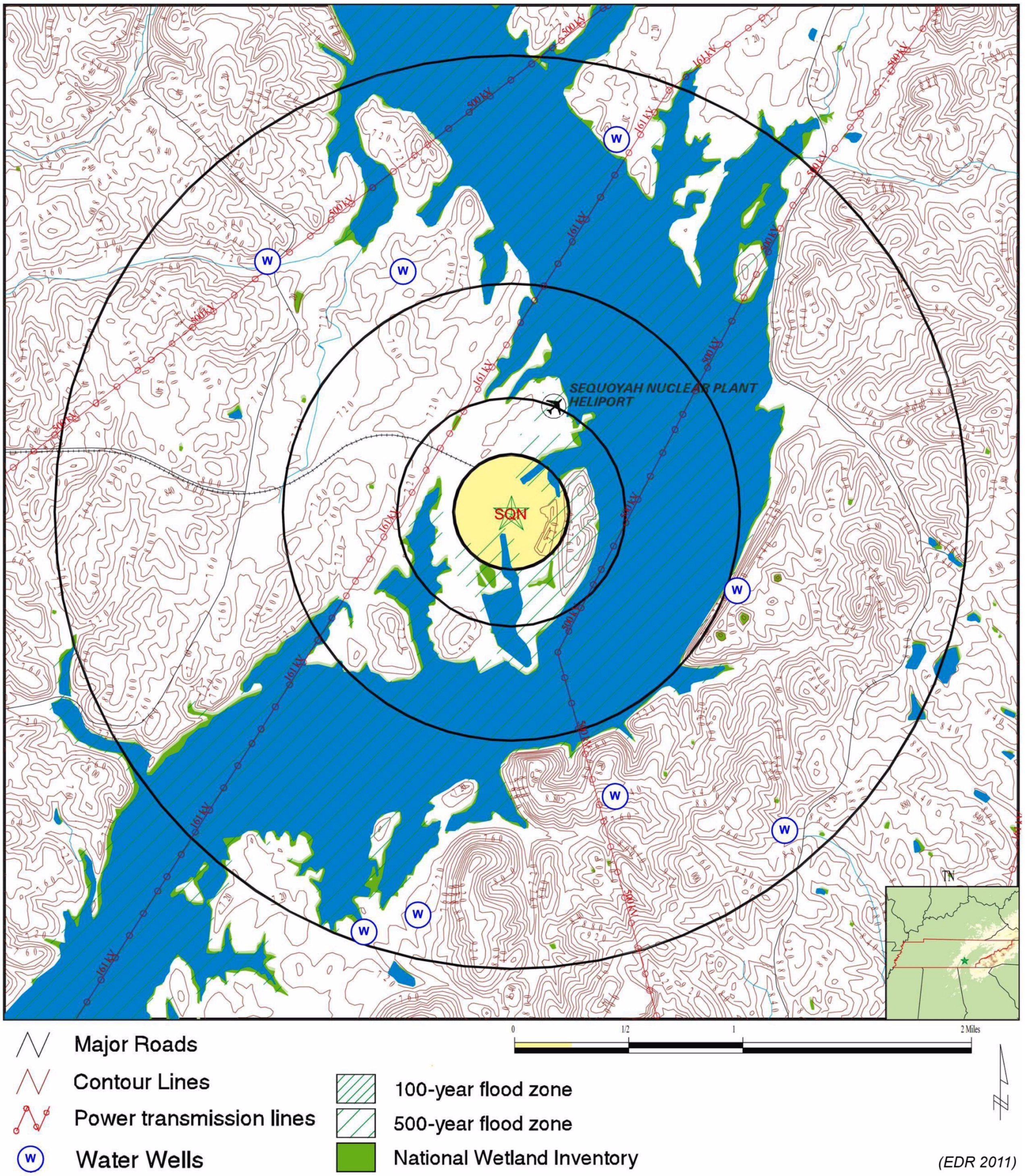


Figure 2.3-4
Registered Water Wells Within a 2-Mile Radius of SQN

2.4 Critical and Important Terrestrial Habitats

SQN lies within the Ridge and Valley ecoregion, also known as the Great Valley of East Tennessee. Ecoregions are areas of land or water within an ecosystem that contain a geographically distinct collection of environmental resources (e.g., species, natural communities, environmental conditions). Many state agencies use ecoregions to establish geographically specific environmental standards such as chemical and biological water quality standards. The Ridge and Valley ecoregion is a relatively low-lying region between the Blue Ridge Mountains to the east and the Cumberland Plateau on the west. As a result of extreme folding and faulting events, the roughly parallel ridges and valleys come in a variety of widths, heights, and geologic materials, including limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble. Springs and caves are numerous. Present-day forests cover about 50 percent of the region. The ecoregion has great aquatic habitat diversity in Tennessee and supports a diverse fish fauna rivaled only by that of the Highland Rim ecoregion. (Griffith et al.1997)

2.4.1 Site Ecology

The SQN site is divided into two peninsulas by the Chickamauga Reservoir shoreline. The larger peninsula contains the plant and is mostly developed. A small strip of forested habitat adjacent to the water's edge is apparent. Grass fields surround the various plant components. The smaller of the two peninsulas contains little development and the remainder of the peninsula is covered by a mix of evergreen and deciduous forest habitat.

Approximately 39 percent of the SQN site is developed and includes a mix of barren land (rocks, sand, and clay) (30.51 percent); developed open space (2.43 percent); and low-, medium-, and high-intensity improvements (6.34 percent). Approximately 24 percent of the SQN site remains forested, while almost 17 percent of the site is herbaceous grassland. The rest is open water (almost 8 percent); scrub/shrub (approximately 9 percent); pasture (approximately 2 percent), and wetlands (approximately 1 percent) (see Table 2.4-1). Figure 2.4-1 shows the land cover pattern on the SQN site.

Vegetation at the SQN site and in the general vicinity has been continuously disturbed via decades of agricultural activities and land development (e.g., residential, light commercial, infrastructure, farming, etc.). Construction of the SQN plant converted approximately 525 acres of mixed hardwood forest, pine forest, pasture, and old field into buildings, parking lots, landscaped areas, and other industrial uses. In addition, approximately 2,700 acres of mixed-hardwood forest, hardwood forest, pine forest, pasture, etc. were converted into transmission line rights-of-way (ROWs) (TVA 1974a, page 2.2-3).

Terrestrial plant communities were assessed during the initial environmental review for the construction of SQN Units 1 and 2; however, TVA's 1974 FES for SQN did not specify the onsite methodology for ecological surveys (e.g., aerial data, plots, transects, or cursory paths) (TVA 1974a, Appendix C). It is assumed that onsite surveys were completed for the tract, and additional data were extracted from a 1969 Bradley-Hamilton County survey (TVA 1974a, page 1.2-19). Prior to construction of SQN, the peninsula on which the facility is currently located was 93 percent forested (54 percent pine, 32 percent pine-hardwood, 7 percent hardwood). The remaining 7 percent included pasture (3 percent), old field (2 percent), and ROWs (2 percent) (TVA 1974a, Appendix C, Table C-1).

Dominant evergreen tree species included shortleaf pine (*Pinus echinata*) and Virginia pine (*P. virginiana*). Other tree species included oaks (*Quercus spp*.), hickories (*Carya spp*.), beeches (*Fagus spp*.), and other local ridge and valley deciduous species. Field surveys on adjacent property identified the following dominant tree species: white oak (*Q. alba*), post oak (*Q. stellata*), black oak (*Q. velutina*), southern red oak (*Q. falcata*), shagbark hickory (*C. ovata*), mockernut hickory (*C. tomentosa*), yellow poplar (*Liriodendron tulipifera*), and American beech (*F. grandifolia*). (TVA 1974a, Appendix C, page C-1)

During the January 2010 SQN site walkdown, general plant populations were identified that include herbaceous vegetation along fence rows and roadsides, and various unnamed lawn and weedy species. There are also wooded areas adjacent to Chickamauga Reservoir, around the training center, west of the ponds, along the reservoir between the intake channel and cooling towers, northwest of the old steam generator storage facility, and in the northern portion of the SQN property. Common tree species identified during the January 2010 SQN site walkdown included short leaf pine and Virginia pine. Other common plants include Japanese honeysuckle (*Lonicera japonica*), trumpet creeper (*Campsis radicans*), various unnamed lawn species, and weedy species such as crab grass (*Digitaria spp*.). Plant communities on site are representative of hardy species that survive well in an industrial facility setting. (TVA 2011a, Section 3.6.1.1)

The terrestrial flora at SQN also includes invasive plant species in habitat such as forest, grasslands, and pastures. Terrestrial species such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle, Japanese stilt grass (*Microstegium vimineum*), multiflora rose (*Rosa multiflora*), and Chinese bush clover or sericea lespedeza (*Lespedeza cuneata*) occur in small populations within these SQN environments and in surrounding areas as well. SQN's native flora has been altered extensively by previous disturbance. All of these species have the potential to affect native plant communities adversely because of their potential to spread rapidly and displace native flora (TVA 2009a, Section 3.7).

2.4.1.1 Wetlands

Wetlands are areas inundated or saturated with surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetlands are regulated under Sections 404 and 401 of the CWA and addressed under Executive Order (EO) 11990. To conduct certain activities in the "Waters of the U.S." that may affect wetlands, authorization under a Section 404 permit from the U.S. Army Corps of Engineers (USACE) is required. Section 401 gives states the authority to certify whether activities permitted under Section 404 are in accordance with state water quality standards. The TDEC is responsible for Section 401 water quality certifications in Tennessee. EO 11990 requires all federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities.

The determination of wetlands within the SQN boundary is based on the SQN land cover map (Figure 2.4-1) and the National Wetland Inventory (NWI) map (Figure 2.4-2). Table 2.4-1 (derived from Figure 2.4-1) indicates approximately 1 percent of the site is composed of woody wetlands. Emergent herbaceous wetlands do not exist on site. Areas labeled as woody wetlands on Figure 2.4-1 border the Chickamauga Reservoir. Additionally, a single, 0.88-acre wetland classified as PSS1C (palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded) is located on the north side of the plant (Figure 2.4-2).

NWI maps list most of the aquatic habitat within or adjacent to SQN as wetland acreage. Onsite ponds are designated PUBHx (palustrine, unconsolidated bottom, permanently flooded, excavated) classification as defined using the Cowardin method of classification (Cowardin et al. 1979). Four wetland types exist along the Chickamauga Reservoir shoreline adjacent to the SQN site, including:

- L2AB3Fh: lacustrine, littoral, aquatic bed, rooted vascular, semi-permanently flooded, impounded.
- L2AB3Hh: lacustrine, littoral, aquatic bed, rooted vascular, permanently flooded, impounded.
- L2UBHh: lacustrine, littoral, unconsolidated bottom, permanently flooded, impounded.
- L1UBHh: lacustrine, limnetic, aquatic bed, rooted vascular, permanently flooded, impounded.

Seasonal water level fluctuation in Chickamauga Reservoir is substantial enough to sustain wetland areas along the shore.

Within a 6-mile radius of SQN, 621 water bodies were identified by the NWI. However, the NWI also identifies water bodies that would not be considered wetlands. Of the 621 identified water bodies, 595 were identified as freshwater ponds, lakes, or rivers. Of the remaining 26 water bodies, 21 were labeled freshwater forested/shrub wetlands, four were identified as freshwater emergent wetlands, and one water body, approximately 1.2 acres in size, was labeled "other."

Water bodies identified as wetlands by the NWI (Figure 2.4-3, light blue areas) are associated primarily with Chickamauga Reservoir or its tributaries. Additional freshwater ponds, rivers, and lakes (blue-green areas) appear throughout the 6-mile radius.

2.4.1.2 Common Wildlife

Terrestrial habitats of SQN offer suitable habitat to a variety of wildlife species; however, due to the small amount of available habitat, the site is particularly adapted to animals that thrive in urban and semi-urban environments. Chickamauga Reservoir's shorelines are used extensively by a variety of waterfowl and wading bird species. Habitats in the vicinity are used by many species of mammals, birds, amphibians, and reptiles. Table 2.4-2 presents common wildlife identified at SQN and adjacent areas, and not only lists species discussed in the section but includes other species that may typically be present. Threatened or endangered species are addressed in Section 2.5.

Flooded areas in and around the SQN site provide habitat for beavers (*Castor canadensis*) and common amphibians such as the American toad (*Bufo americanus*) and Fowler's toad (*Bufo fowleri*). The shoreline areas along Chickamauga Reservoir provide suitable habitat for wading birds such as great blue herons (*Ardea herodias*) and gulls (*Larus spp*); however, some shoreline areas have eroded and are covered in riprap, preventing the shoreline from providing suitable habitat to some terrestrial wildlife species or changing the wildlife species that might live there (TVA 2009a, Section 3.7).

During the January 2010 SQN site visit, a heron rookery was identified along the eastern shoreline of SQN near the intake structure in the Chickamauga Reservoir. Approximately 15 to 20 herons were observed nesting in pine trees. Five additional heron colonies occur within 3 miles of SQN. (TVA 2011a, Section 3.6.1.2)

Bald eagle and osprey (*Pandion haliaetus*) nests have been also been identified in the vicinity of SQN.

Tennessee is part of the Mississippi flyway, and waterfowl are attracted to Chickamauga Reservoir. High numbers of mallards (*Anas platyrhynchos*), American black ducks (*A. rubripes*), gadwalls (*A. strepera*), hooded mergansers (*Lophodytes cucullatus*), and Canada geese (*Branta canadensis*) have been identified on the reservoir. Sandhill cranes (*Grus canadensis*) rely heavily on Chickamauga Reservoir habitat during winter months (National Audubon Society 2011a). The USFWS is in the early stages of establishing a whooping crane (*G. americana*) population in the eastern United States. These birds will use the same migration corridor as sandhill cranes. This effort is in the early stages of development, and it is doubtful that whooping cranes would be found at the site at this time. Wetlands within the reservoir attract species such as wood ducks (*Aix sponsa*) and green-winged teal (*Anas crecca*), as well as small birds such as marsh wrens (*Cistothorus palustris*) and sedge wrens (*C. platensis*). (National Audubon Society 2011b)

The TVA reservoir system provides benefits to wildlife resources in the Tennessee River valley. During annual reservoir drawdowns, thousands of acres of mudflats are exposed, which provide habitat for migrating shorebirds and waterfowl. As mudflats are exposed, a complex community of invertebrates develops in moist soils along the receding reservoir edge, creating an important source of food for shorebirds and waterfowl. As the drawdown continues, plant communities develop on upper portions of mudflats, providing an important source of food and cover for waterfowl during fall and winter months. Mudflats also provide important stopover and overwintering sites for migratory shorebirds. (Henry 2011a)

As part of a multi-agency group, TVA initiated a 5-year study (2004–2009) of shorebirds in the Tennessee River valley that included Chickamauga Reservoir, an important location for migrating and overwintering shorebirds. Although shorebirds begin migrating through the Tennessee River valley in late July, the greatest number of shorebirds on the reservoir will be found in the fall. During the 5-year study, 10,200 shore birds were observed during 526 surveys on Chickamauga Reservoir. Killdeer (*Charadrius vociferus*) was the most abundant species found in the study. However, in the study, prime shorebird habitat on Chickamauga Reservoir was found to be located north of SQN with only one site, Savannah Bay (175 acres), found in Hamilton County. (Henry 2011a) Shorebird habitat at the SQN site would be considered marginal, and the study did not reveal that SQN operations were impacting shorebirds.

Soddy Mountain is approximately 6.7 miles northwest of SQN and is the premiere established hawk-watching location in Tennessee. This site is the only hawk lookout in Tennessee that has ever been monitored for the entire migratory seasons in both spring and fall. Prior to the establishment of this lookout, many Tennessee lookouts were monitored mostly in September. Soddy Mountain was monitored during the period 1993–2005 for the fall hawk migration that occurs from September through early December. Spring hawk migration monitoring has been less frequent and occurs from February through April.

Fall hawk counts were conducted during the period 1993–2005. In this 13-year period, 17 species of raptors totaling 46,102 individuals were counted in 3,257.2 hours of hawk watching. In the period 2001–2005, 15 species of raptors totaling 20,431 individuals were observed in 1,373.7 hours of hawk watching for an average of 4,086 raptors in 274.7 hours of hawk watching. The broad-winged hawk (*Buteo platypterus*) was the most common raptor observed in the 13-year period, with 26,920 individuals (58.4 percent of total). In the period 2001–2005, broad-winged hawks totaled 14,260 individuals (69.8 percent of total). The top five raptors counted were broad-winged hawks, turkey vultures (*Cathartes aura*), red-tailed hawks (*B. jamaicensis*), sharp-shinned hawks (*Accipiter striatus*), and black vultures (*Coragyps atratus*).

Spring hawk counts were conducted in 1998 and during the period 2001–2003. In these four years, 14 species of raptors totaling 2,303 individuals were counted during 261.1 hours of hawk watching, with broad-winged hawks being the most common with 1,459 individuals (63.4 percent of total). The top five species were broad-winged hawks, turkey vultures, red-tailed hawks, ospreys, and sharp-shinned hawks. The three most numerous species were the same as in the fall. (National Audubon Society 2011c)

Based on review of records for the previous years (2007–2011), there have been no recorded instances of onsite bird deaths.

According to the TVA Natural Heritage Database (TVA 2011b), three caves are located within 6 miles of SQN. Posey Cave, Havens Cave, and Harrison Bluff Cave are all within Hamilton County and located within 2.3 miles, 5.9 miles, and 5.95 miles of SQN, respectively. Most caves in the area are formed through the dissolution of limestone by acidic groundwater. When caves are common, this forms what is known as karst topography. Caves accommodate a variety of ecosystems and typically provide an important habitat for many species of wildlife (USFWS 2010a). Although the TVA Natural Heritage Database identified these caves, the database does not include any species associated with the caves (TVA 2011b). However, caves in Hamilton

County have been historically associated with the Tennessee cave salamander (*Gyrinophilus palleucus*). This species may move through underground waterways and should be considered in any review of caves located in Hamilton County.

2.4.1.3 Terrestrial Monitoring Programs

Other than the ongoing terrestrial monitoring associated with the site's radiological environmental monitoring program (REMP) described in the SQN Offsite Dose Calculation Manual (ODCM), TVA only conducts ecological monitoring of terrestrial resources on an as-needed basis, as discussed below, to support environmental reviews of proposed projects.

Area nests of important avian species have been identified and their locations noted by TVA. Along Chickamauga Reservoir, several bald eagle nests and six heron rookeries have been identified within 6 miles of SQN. Nests are monitored annually for activity. However, numbers of these large birds are low, and calculating descriptive statistics would not divulge any information beyond nest quantification and determination of activity on an annual basis.

TVA's Natural Heritage Resource program also maintains a list of species currently considered to be either rare nationally or rare in a particular state. The national or federal list of threatened and endangered species is overseen by the USFWS, and updates to this list are made by either notification from the local field office of the USFWS or through notices in the *Federal Register*. In addition, the TVA Heritage Resource program receives annually, from each of the seven states in the TVA power service area or in the Tennessee Valley watershed, a list of species considered to be rare or in need of protection in that particular state. Through this process, TVA Heritage Resources is able to maintain an updated list of rare species for the Tennessee Valley.

TVA Biological Compliance also updates, adds, or deletes occurrence records of rare species on a daily basis as new information becomes available. TVA's Heritage program also twice annually exchanges data with the seven state heritage programs and the USFWS so that all programs mutually benefit from the data, and TVA can maintain the most up-to-date database of known locations of rare species possible.

2.4.1.4 Site Management Programs

As discussed in Section 9.1.3.3, the site area is managed in accordance with the USACE Section 404 permitting process; SQN's NPDES Permit TN0026450; Multi-Sector General Stormwater Permit TNR 050015 issued by the TDEC; and Spill Prevention, Control, and Countermeasure (SPCC) Plan, as appropriate. In addition, as discussed in Section 9.1.4, any land disturbance activities are reviewed as required by procedure to ensure that best management practices (BMPs) appropriate for the environment are used to protect terrestrial habitat and wildlife, threatened and endangered species, wetland areas, and water quality.

2.4.2 Transmission Line Ecology

Habitats in the transmission ROWs within a 6-mile radius of SQN are typical of those found within the 6-mile radius of SQN. The ROW habitats are composed primarily of pasture/hay

(27.7 percent), shrub/scrub (19.7 percent), deciduous forest (17.6 percent), and grasslands/ herbaceous (8.6 percent) (Table 2.4-3).

2.4.2.1 Transmission Line Management Programs

The TVA Energy Delivery (ED) organization routinely conducts maintenance activities on transmission lines in the TVA power service area. These activities include ROW clearing, pole and crossarm replacements, installation of lightning arrestors and counterpoise, and upgrading of existing equipment. Regular vegetation maintenance activities are conducted on a 3–5 year cycle. Prior to maintenance activities, the transmission line area, including ROWs, is reviewed by technical specialists in the TVA Biological and Cultural Compliance groups to identify any natural resource issues that may occur along the line. If potential for endangered species habitation exists, site reconnaissance follows the desktop review. Because information is qualitative rather than quantitative, descriptive statistics are not calculated. (Attachment A)

The TVA Regional Natural Heritage database contains occurrence records for protected plants, animals, caves, heronries, eagle nests, and natural areas for the entire TVA power service area. The TVA Natural Heritage database is dynamic, with updates and additions taking place throughout the year from state and federal agencies. Only credible records are included in the database, and the sources include the results of field surveys by TVA biologists, publications, museum and herbarium specimens, unpublished reports from biologists outside TVA, *Federal Register* notices, data exchanges with the seven state heritage programs overlapped by TVA's coverage area, and data exchanges with five offices of the USFWS. (Attachment A)

Wetland information is maintained by TVA Biological and Cultural Compliance group and includes NWI wetland maps for the service area. All records of listed plants or animals, caves, wetlands, or natural areas that are potentially present in the ROWs are taken into consideration when conducting transmission line reviews. (Attachment A)

If potential impacts of maintenance activities to listed plants or animals are identified, field surveys may be conducted to document presence of the species in the ROWs, especially if the proposed actions would result in habitat disturbance. In many cases, heritage specialists assume the species is present and work with staff to avoid or mitigate impacts to listed species. (Attachment A)

Although restrictions are determined on a case-by-case basis, common restrictions include hand clearing or backpack herbicide applications to reduce impacts to streams and aquatic species. Restrictions have also been placed on the time of year in which maintenance activities can be conducted to avoid impacts to migratory bat species. (Attachment A)

2.4.3 State-Listed Critical or Important Habitats

Natural areas include managed areas, sites, ecologically significant sites, the U.S. National Park Service's (NPS's) Nationwide Rivers Inventory (NRI), and the National Wild and Scenic Rivers system (NW&SR). Managed areas typically have an owner or management entity (e.g., TVA, TWRA, municipalities), but they may or may not have an onsite staff or developed facilities. No known natural areas are located within or adjacent to SQN. However, within a 6-mile radius of the site, there are seven natural areas: a TVA-owned forest, four TVA habitat protection areas (HPAs), a state wildlife management area, and a state park. (TVA 2011a; TVA 2012c)

- Chigger Point TVA HPA is located across Chickamauga Reservoir from SQN, approximately 1.0 miles to the east. This natural area comprises approximately 15 acres of steeply wooded shoreline, with a population of large-flowered skullcap (*Scutellaria montana*).

- Friendship Forest is located approximately 1.3 miles northeast of and across Chickamauga Reservoir from SQN. This 680-acre tract is owned by TVA and was leased to the University of Tennessee as a forestry experiment station for 53 years until 2002.

- Harrison Bay State Park is located approximately 1.4 miles south of SQN across the Tennessee River. This 1,200-acre area includes approximately 40 miles of shoreline on Chickamauga Reservoir and was originally developed as a TVA recreation demonstration area in the 1930s, but it is now part of the Tennessee State Parks system and is managed by TDEC. The park contains large wooded areas and also has occurrences of state-listed endangered tall larkspur (*Delphinium exaltatum*).

- Soddy Creek TVA HPA is located approximately 2.1 miles northwest of SQN. This tract contains approximately 36 acres, which occupies more than 1 mile of very steep shoreline and provides habitat for bald eagles. Many species of water birds occupy the nearby shallow waters and mudflats during fall and winter months.

- Chickamauga State Wildlife Management Area is a 4,000-acre area made up of several individual units that provide wildlife habitat, and it is managed for small and large game by TWRA. A portion of the wildlife management area is located within a 6-mile radius of SQN, approximately 2.3 miles northwest of SQN.

- Ware Branch Bend TVA HPA is located approximately 2.6 miles northwest of SQN. This natural area contains approximately 42 acres of steep, rocky shoreline, which provides habitat for large-flowered skullcap and bald eagles.

- Murphy Hill TVA HPA is located approximately 4.7 miles northeast of SQN and comprises approximately 194 acres. This area, featuring a steep bluff that runs along the river front, has a large population of large-flowered skullcap and provides roosting for wintering bald eagles.

TVA owns the transmission lines that originate at SQN and leave the site. Several in-scope transmission lines cross two natural areas within a 6-mile radius of SQN. Watts Bar No. 1 and Watts Bar No. 2 transmission lines extend generally northeast from SQN across Chickamauga Reservoir and cross Friendship Forest. The Concord, Wolftever to Chickamauga, North Ooltewah to South Cleveland to East Cleveland, and Volkswagen to Chickamauga transmission lines extend to the south-southeast and cross Harrison Bay State Park.

Based on TVA's review, there are no state-listed critical or important habitats on the SQN site or within a 6-mile radius.

2.4.4 Federally Listed Critical or Important Habitats

As addressed in Section 2.5, federally listed threatened or endangered species are potentially present within the vicinity of SQN. To determine if critical or important habitats are listed in the vicinity of SQN, the U.S. NPS NRI and the NW&SR database were searched, in addition to the USFWS's critical habitat portal.

The NW&SR was created by Congress in 1968 [Public Law 90-542; 16 U.S.C. 1271 et seq.] to protect certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Section 5(d) of the NW&SR Act [16 U.S.C. 1271–1287] requires that "all planning for the use and development of water and related land resources, consideration shall be given by all federal agencies involved to potential national wild, scenic and recreational river areas" (NW&SR 2010). In partial fulfillment of the NW&SR Act-Section 5(d), the NPS has also compiled and maintains the NRI, which is a register of river segments that potentially qualify as national wild, scenic, or recreational river areas. The NRI also qualifies as a comprehensive plan under Section 10(a)(2)(A) of the Federal Power Act (NPS 2010b).

In the SQN vicinity, no streams are included on the NRI or the NW&SR database (NW&SR 2010; NPS 2010b). Additionally, no critical habitat was identified in Hamilton County by the USFWS. No in-scope SQN transmission lines within a 6-mile radius of SQN cross any federally listed critical habitats.

Table 2.4-1
SQN Land Cover

Category	Site Percentage
Open water	7.79
Developed: Open space	2.43
Developed: Low intensity	2.75
Developed: Medium intensity	2.04
Developed: High intensity	1.55
Barren Land (rock/sand/clay)	30.51
Forest: Deciduous	6.73
Forest: Evergreen	10.18
Forest: Mixed	6.69
Scrub/shrub	9.30
Grassland/herbaceous	16.88
Pasture/hay	1.83
Wetlands: Woody	1.30
TOTAL	**100**

(USDA 2001)

Table 2.4-2
SQN and Adjacent Areas Wildlife

Common Name	Scientific Name	Species Type
American toad	*Bufo americanus*	Amphibian
Cave salamander	*Gyrinophilus palleucus*	Amphibian
Fowler's toad	*Bufo fowleri*	Amphibian
Northern cricket frog	*Acris crepitans*	Amphibian
Upland chorus frog	*Pseudacris feriarum*	Amphibian
American crow	*Corvus brachyrhynchos*	Bird
American robin	*Turdus migratorius*	Bird
Bald eagle	*Haliaeetus leucocephalus*	Bird
Black duck	*Anas rubripes*	Bird
Black vulture	*Coragyps atratus*	Bird
Broad-winged hawk	*Buteo platypterus*	Bird
Canada goose	*Branta canadensis*	Bird
Eastern bluebird	*Sialia sialis*	Bird
Gadwall	*Anas strepera*	Bird
Great blue heron	*Ardea herodias*	Bird
Green-winged teal	*Anas crecca*	Bird
Gull	*Larus spp.*	Bird
Hooded merganser	*Lophodytes cucullatus*	Bird
Killdeer	*Charadrius vociferus*	Bird
Mallard	*Anas platyrhynchos*	Bird
Marsh wren	*Cistothorus palustris*	Bird
Northern cardinal	*Cardinalis cardinalis*	Bird
Osprey	*Pandion haliaetus*	Bird
Red-tailed hawk	*Buteo jamaicensis*	Bird
Sandhill crane	*Grus canadensis*	Bird
Sedge wren	*Cistothorus platensis*	Bird

Table 2.4-2 (Continued)
SQN and Adjacent Areas Wildlife

Common Name	Scientific Name	Species Type
Sharp-shinned hawk	*Accipiter striatus*	Bird
Tree swallow	*Tachycineta bicolor*	Bird
Turkey	*Meleagris gallopavo*	Bird
Turkey vulture	*Cathartes aura*	Bird
Whooping crane	*Grus americana*	Bird
Wood duck	*Aix sponsa*	Bird
Coyote	*Canis latrans*	Mammal
Eastern cottontail	*Sylvilagus floridanus*	Mammal
Eastern mole	*Scalopus aquaticus*	Mammal
Hispid cotton rat	*Sigmodon hispidus*	Mammal
Least shrew	*Cryptotis parva*	Mammal
North American beaver	*Castor canadensis*	Mammal
Striped skunk	*Mephitis mephitis*	Mammal
Virginia opossum	*Didelphis virginiana*	Mammal
White-tailed deer	*Odocoileus virginianus*	Mammal
Black racer	*Coluber constrictor*	Reptile
Eastern garter snake	*Thamnophis sirtalis*	Reptile
Rat snake	*Pantherophis*	Reptile

(National Audubon Society 2011a; National Audubon Society 2011b; National Audubon Society 2011c; TVA 2009a; TWRA 2012b; USFWS 2010a)

Table 2.4-3
SQN Vicinity and Transmission Line ROW Land Use

Land Cover Classification	6-Mile Radius		Transmission Line ROWs (within 6-mile radius)	
	Acres	Percent	Acres	Percent
Open water	9,662.40	13.35	55.64	3.8
Developed: Open space	6,064.66	8.38	93.77	6.41
Developed: Low intensity	3,158.53	4.36	32.59	2.23
Developed: Medium intensity	326.91	0.45	6.43	0.44
Developed: High intensity	84.06	0.12	2.44	0.17
Barren land (rock/sand/clay)	473.90	0.65	27.27	1.86
Forest: Deciduous	21,764.15	30.07	257.81	17.62
Forest: Evergreen	4,760.15	6.58	32.81	2.24
Forest: Mixed	6,919.73	9.56	98.64	6.74
Shrub/scrub	2,317.70	3.2	288.40	19.71
Grassland/herbaceous	2,316.36	3.2	125.25	8.56
Pasture/hay	13,156.52	18.18	405.44	27.71
Cultivated crops	911.56	1.26	33.03	2.26
Wetlands: Woody	417.64	0.58	3.55	0.24
Wetlands: Emergent herbaceous	48.04	0.07	0	0
Total	**72,382**	**100**	**1,463**	**100**

(MRLC 2006)

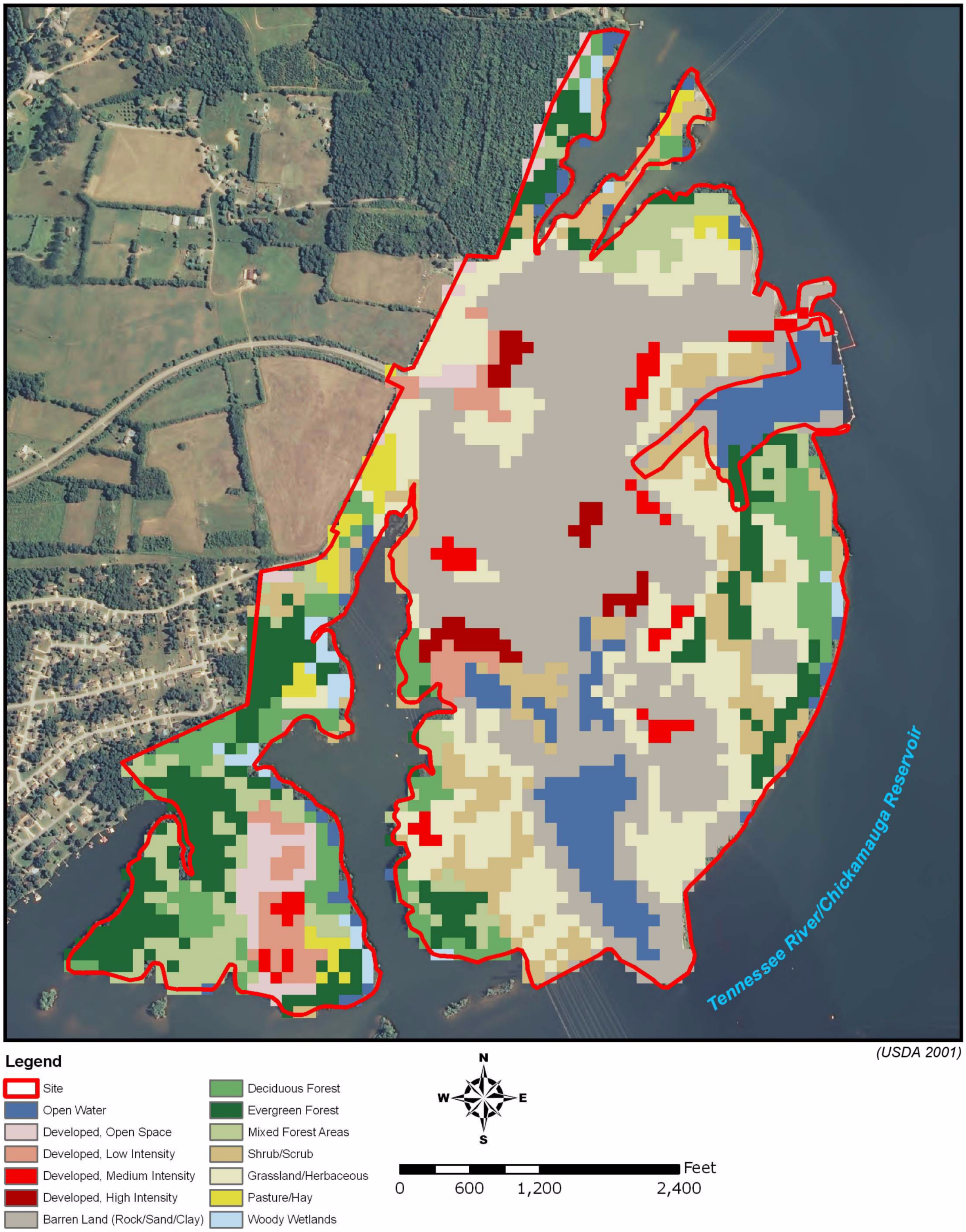


Figure 2.4-1
SQN Land Cover

Figure 2.4-2
SQN National Wetlands Inventory

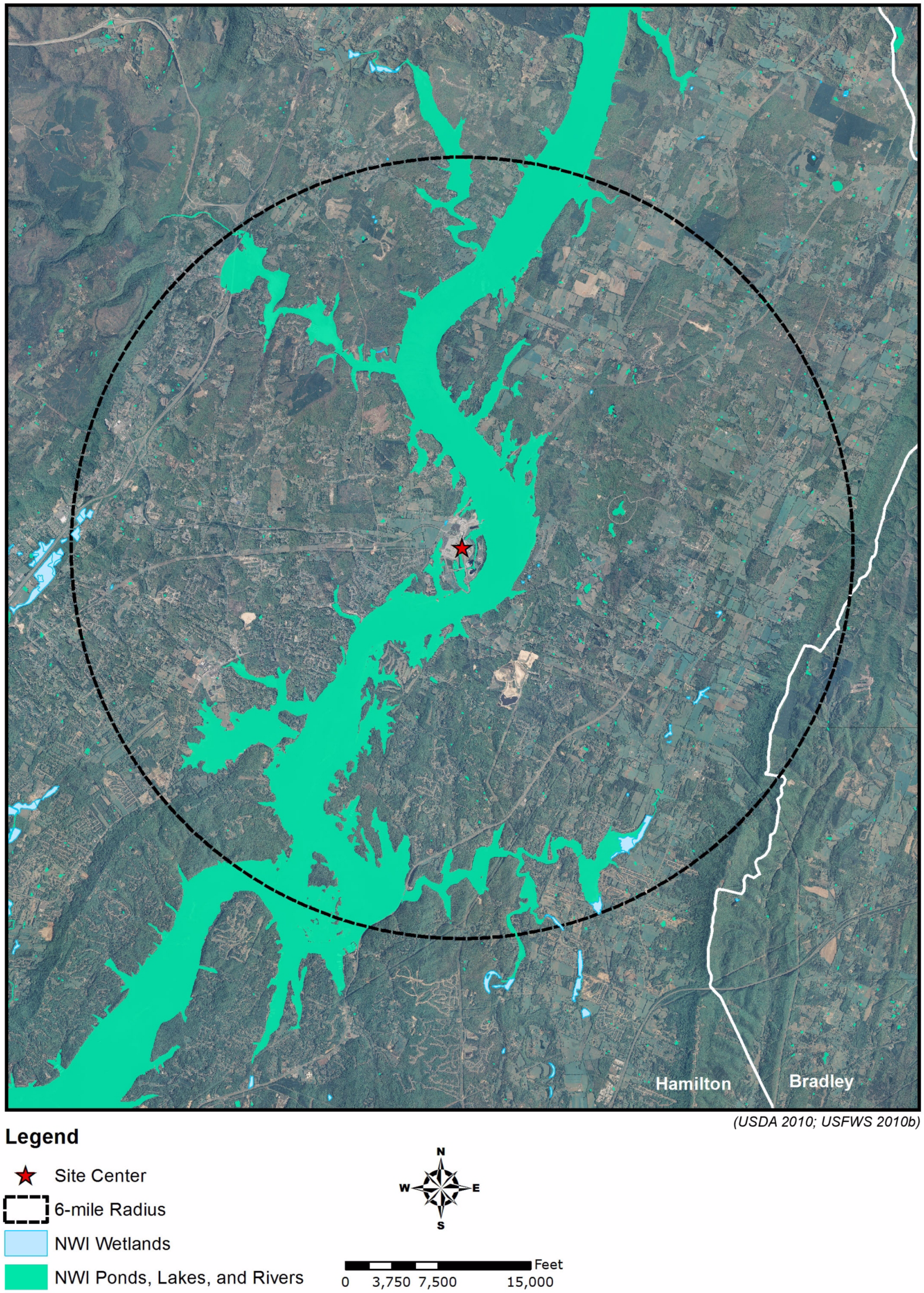


Figure 2.4-3
National Wetlands Inventory Within the Vicinity of SQN

2.5 Threatened or Endangered Species

TVA, as well as each of the seven states in the TVA region, maintains copies of the lists of federally and state-listed endangered, threatened, or otherwise protected species. TVA also records where those species have been encountered in its 201-county power service area and stores this occurrence information in its Natural Heritage Database, which uses a common format and compatible storage systems to facilitate sharing data among agencies. (TVA 2004a, page 4.13-2) TVA's Biological Compliance group conducts biannual data exchanges with the state heritage programs in each of the seven states that fall within TVA's power service area to update the occurrence records of state-listed plant and animal species and natural areas. In addition, biannual data exchanges with five USFWS field offices within TVA's power service area, as well as weekly notices in the *Federal Register*, provide TVA's Biological Compliance group with updates to occurrence records of federally protected species. (Attachment A) The TDEC and TVA also collaborate on a dual natural heritage inventory list and share information on species such as occurrences, rarity, surveys, etc.

2.5.1 Federally Listed Species

As shown in Table 2.5-1 and discussed in greater detail below, species currently protected under the ESA with geographic ranges potentially including the SQN vicinity and/or transmission line ROWs include one plant and two mussels. These three species are large-flowered skullcap, dromedary pearlymussel, and pink mucket mussel. None of these species has been recorded as present on or adjacent to (abutting) the SQN site based on TVA's query of the Natural Heritage Database. (TVA 2011b)

Large-Flowered Skullcap

The large-flowered skullcap is a perennial herb with solitary, erect, square stems usually from 12 to 20 inches tall. It is typically found on rocky, dry slopes, ravines, and stream bottom forests in the ridges, valleys, and Cumberland Plateau of northwestern Georgia (Dade, Floyd, Chattooga, Gordon, Catoosa, and Walker counties) and adjacent southeastern Tennessee (Hamilton, Marion, and Sequatchie counties). (USFWS 2002)

Large-flowered skullcap has not been identified on site, but large-flowered skullcap plants have been identified at 16 locations within a 6-mile radius of SQN. The species has not been recorded as occurring within transmission line ROWs; however, some portions of the in-scope ROWs have suitable habitat for the species.

Dromedary Pearlymussel

Dromedary pearlymussels are medium-sized (reaching up to 90 millimeters [mm] in length) freshwater mussels with a yellowish-green shell with two sets of broken green rays. The life span of individuals of this species is greater than 50 years. Like other freshwater mussels, the dromedary pearlymussel feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton. The diet of dromedary pearlymussel glochidia, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted). (USFWS 2001)

The dromedary pearlymussel inhabits small to medium, low turbidity, high to moderate gradient streams. The species is commonly found near riffles on sand and gravel substrates with stable rubble. Though commonly associated with shallow, high-velocity riffles and shoals, individuals have been found in deeper (up to 18 feet in depth), slower waters. (USFWS 2001)

Many of the historic populations of the dromedary pearlymussel were apparently lost when the river sections they inhabited were impounded (USFWS 2001). One individual was identified in the late 1970s approximately 3 miles from SQN (TVA 2011b). The Chickamauga Reservoir habitat adjacent to SQN is not suitable to sustain a breeding population of dromedary mussels due to the impoundment of the Tennessee River (Third Rock 2010b).

Only three reproducing populations of dromedary pearlymussel are believed to be present in the Powell and Clinch rivers (USFWS 2001). Therefore, they are not likely to be identified along transmission line routes crossing water bodies.

Pink Mucket Mussel

Pink mucket mussels are a rounded to slightly elongated mussel. The posterior end is bluntly pointed in males. Females are shorter and may be nearly square. They are 3–5 inches long. (MDC 2011a)

The shell is thick, inflated, and smooth. Growth-rest lines produce ridges and dark-stained grooves. The outer layer of the shell is yellowish-brown to chestnut-colored in mature individuals. Broad, faint, green rays may cover the shell, but are usually absent from adult shells. (MDC 2011a)

This mussel is found in mud and sand, and in shallow riffles and shoals swept free of silt in major rivers and tributaries. It buries itself in sand or gravel, with only the edge of its shell and its feeding siphons exposed. (USFWS 1997)

In the early 1960s, pink mucket mussels were identified approximately 5.5 miles from SQN (TVA 2011b). Due to the river impoundment, habitat in Chickamauga Reservoir adjacent to SQN is not suitable to sustain breeding populations of mussels; however, relic populations could potentially be present within the vicinity (Third Rock 2010b). The species has not been recorded as occurring within transmission line ROWs; however, suitable habitat may occur in the portions of the in-scope ROWs that cross large free-flowing streams or rivers.

2.5.2 State-Protected Species

As shown in Table 2.5-1, TDEC has designated six species as endangered, two as threatened, and five as species of special concern (two of which are commercially exploited). An additional three species are deemed in need of management. These 16 species are gibbous panic grass (*Sacciolepis striata*), pink lady's slipper (*Cypripedium acaule*), ovate-leaved arrowhead

(*Sagittaria platyphylla*), fragrant bedstraw (*Galium uniflorum*), tall larkspur, American ginseng (*Panax quinquefolius*), large-flowered skullcap, southern prairie dock (*Silphium pinnatifidum*), Appalachian Bewick's wren, bald eagle, Bachman's sparrow, great egret, highfin carpsucker, lake sturgeon, dromedary pearlymussel, and pink mucket. (TDEC 2011a).

TVA's query of the Natural Heritage Database determined that the database did not have any recorded sightings of these 16 species on or adjacent to SQN (TVA 2011b); however, as discussed below, bald eagles have been spotted in close proximity to SQN and can be assumed to have flown over and adjacent to the site.

Below is a discussion of species not already discussed above in Section 2.5.1, as it relates to their potential for being present on the SQN site, within a 6-mile radius of SQN, and/or within transmission line ROWs.

Gibbous Panic Grass

Gibbous panic grass is a grass-like plant that grows in a wetland environment. It is currently distributed through the southeast, including Tennessee. (USDA 2011a) No habitat is present on site for gibbous panic grass. However, gibbous panic grass was identified within a 6-mile radius of SQN in 1985 (TVA 2011b), and TVA found gibbous panic grass adjacent to a project approximately 13 miles northeast of SQN in 2004 (TVA 2004b). If transmission lines cross wetland habitat, gibbous panic grass potentially could be present.

Pink Lady's Slipper

Pink lady's slipper belongs to the orchid family and displays a large pink flower between May and July. To survive and reproduce, pink lady's slipper interacts with a fungus in the soil from the *Rhizoctonia* genus. Generally, orchid seeds do not have food supplies inside them like most other seeds. Pink lady's slipper seeds require threads of the fungus to break open the seed and attach to it. The fungus will pass food and nutrients on to the pink lady's slipper seed. When the lady's slipper plant is older and producing most of its own nutrients, the fungus extracts nutrients from the orchid roots. (USDA 2011b)

Pink lady's slippers also require bees for pollination. Attracted by the flower's bright color and sweet scent, bees are lured into the flower pouch through the front slit. Once inside, the bees find no reward, and discover that they are trapped, with only one point of escape. Inside the pouch, there are hairs that lead to a pair of exit openings, one beneath each pollen mass. The bee must pass under the stigma, so if it bears any pollen from a visit to another flower, it will be deposited before picking up a fresh load on the way out. (USDA 2011b)

Pink lady's slipper lives in a variety of habitats, growing in mixed hardwood coniferous forests of pine and hemlock on rocky/mossy slopes, and in semi-open spaces or in deep humus and acidic but well-drained soil under birch and other deciduous trees of eastern U.S. forests. (USDA 2011b)

No pink lady's slippers have been identified on or adjacent to the SQN site, or within a 6-mile radius of SQN (TVA 2011b). Because pink lady's slipper grows in forests, it is not likely to be found along transmission line ROWs.

Ovate-Leaved Arrowhead

Ovate-leaved arrowhead is a rhizomatous aquatic plant that can reach heights up to approximately 5 feet. It has fleshy rhizomes submerged below the water surface, while leaves are held above the surface by rigid stems. There are two kinds of leaves: emergent leaves that are linear to ovate, tapering abruptly to a point with stems that are triangular in cross-section and winged towards the base; and submerged leaves that are strap-shaped. The white or sometimes pink flowers are found in clusters of three-flowered whorls at the end of the flower stem. (ISSG 2006)

Ovate-leaved arrowhead has not been identified on the SQN site or within a 6-mile radius of SQN; however, it was identified in Hamilton County in 1980 (TVA 2011b).

Fragrant Bedstraw

Fragrant bedstraw is a plant (perennial forb) with the *Galium* genus. Although *Galium spp*. are widespread throughout the southeastern United States, fragrant bedstraw is critically imperiled in the state of Tennessee. (NatureServe 2012) It was identified in Hamilton County in 1997, but not on site or within a 6-mile radius of SQN (TVA 2011b). Because habitat requirements for this species are not well defined, it is possible that it may be present along transmission line ROWs.

Tall Larkspur

Tall larkspur is an herbaceous perennial member of the buttercup family (*Ranunculaceae*) (PNHP 2012). Stems are slender, and leaves are wedge-shaped and pale beneath. Flowers are purple, pale blue, or lavender. (NatureServe 2011a)

Larkspurs have distinctive flowers with four blue petals and one sepal elongated into a slender spur, which gives the plant its name. The leaves are deeply lobed into irregular segments. Tall larkspur blooms in late summer and grows 2–6 feet high, while dwarf larkspur, which blooms in early spring, grows only 8–30 inches high. (PNHP 2012)

Natural habitats occupied by larkspur include rich woods (and edges of woods), rocky slopes, semi-open woodlands, glades, and prairie openings. The species is tolerant of a limited amount of disturbance and is also periodically found along disturbed road cuts, roadside ditches, old fields, power line corridors, and wooded fence rows. The substrate of occupied habitat is typically dry and rocky, consisting of limestone or other calcareous rock. The species occurs on a variety of slope exposures (south-, southwest-, west-, north- and northwest-facing). Exposures may be steep, receiving full sun or partial shade. (NatureServe 2011a)

In Tennessee, habitat consists primarily of Ridge and Valley cedar barrens on thin cherty loam over limestone (dolomite). Other occupied sites include oak-cedar woods, mixed pine-cedar woodlands, and disturbed areas (e.g., roadsides and pastures), mimicking barrens habitat. The elevation range of known locations is from 679 to 984 feet above msl (207 to 300 meters [m]). (NatureServe 2011a)

Tall larkspur has not been identified on site although habitat potentially may be present. It was identified within a 6-mile radius of SQN in 1939. (TVA 2011b) Habitat also is potentially likely present along transmission line ROWs.

American Ginseng

American ginseng is an herbaceous, perennial plant with bright red fruits and palmate, serrated leaves. It is found primarily in rich, cool, and moist, but not extremely wet, woods under a closed canopy. It is especially prevalent on slopes or ravines and often over a limestone or marble parent material on soil with a good humus component. Forests where American ginseng is found are typically hardwood dominated or mixed. Occasionally plants occur in rocky woods, among swampy hardwoods, or at the edges of dense woods. (NatureServe 2011b).

American ginseng has not been identified on site, nor is suitable habitat available on the SQN site. In 2007, it was identified within Hamilton County, but not within a 6-mile radius of SQN (TVA 2011b). Because transmission line ROWs are usually open areas, suitable habitat would not be available for American ginseng.

Southern Prairie Dock

Southern prairie dock (also known as tansy rosinweed) is a tall plant. From a clump of large, oval, basal leaves emerges a smooth leafless stalk that branches out at the top. These bear loose clusters of flowers 3 inches wide that bloom from July through September. Southern prairie dock is found in full sun and can grow in average to poor soil. It propagates from fresh seeds in the fall. It is shorter and less hairy than *S. laciniatum* with which it is sometimes confused. The genus gets the common name rosinweed because of the large amounts of resin exuded from injured parts of the plant. (Izel Plants 2012) Prairie dock has not been identified on site, but was observed within a 6-mile radius of SQN in 2011. Prairie dock has not been identified in the ROWs within a 6-mile radius of SQN. (TVA 2011b)

Appalachian Bewick's Wren

Appalachian Bewick's wren is a subspecies of the more common Bewick's wren. This subspecies once ranged northeast to New York and Ontario, but is now limited to a few relic populations in the Ohio and Tennessee River valleys. Competition with house wrens is thought to be a major factor in the Bewick's wren's decline, but direct evidence for long-term competitive exclusion is not proven. (National Geographic Society 2006)

Wrens generally have a long, mobile tail; attenuated body shape; and active demeanor that imparts a lean look. Adult plumage is variable, but all subspecies are gray-brown to rufous-brown above and gray-white below. A white-tipped tail has black bands. Juvenile plumage is subtly paler than adult plumage. (National Geographic Society 2006)

In Tennessee, Bewick's wrens are found mainly on rural farms with brushy hedgerows and old buildings. They nest in cavities located in old buildings, junk cars, bird houses, or in a brush pile. (TWRA 2011b)

Appalachian Bewick's wrens were identified in Hamilton County in 1908, but the species has been in decline (TVA 2011b). In 2010, only four Bewick's wrens were identified in Tennessee, in Rutherford County (TWRA 2011b). Habitat is not available on site. Shrub habitat may potentially be available on transmission line ROWs; however, it is unlikely this species would be identified in Hamilton County.

Bald Eagle

Adult bald eagles are unmistakable, with a white head and white tail. The body is dark brown, and the bill, eyes, legs, and feet are yellow. The legs are unfeathered. In flight, the wings are long and broad and held flat while soaring. Bald eagles do not reach adult plumage until they are 5 years old. Immature plumages vary greatly with age but include a mix of dark brown and white scattered throughout the plumage. During the first 4 years the bill is blackish, becoming light at the base, and the eyes are brown, while legs and feet are yellow, like adults. Adult pairs breed in forested areas near large bodies of water. Bald eagles winter on reservoirs and large rivers in Tennessee. (TWRA 2011c)

The size and distribution of the bald eagle population in Tennessee before the continent-wide population crash in the 1950s to mid-1970s is unknown. However, there were no known successful bald eagle nests found in the state between 1961 and 1983. Efforts, coordinated by TWRA, to restore Tennessee's eagle population began in 1980 and continued until 2003, and young eagles were reintroduced at several locations in the state. The first successful bald eagle nest was discovered near Cross Creeks National Wildlife Refuge (NWR) in the spring of 1983. There are more than 100 nesting pairs of bald eagles in Tennessee today, and most of these birds remain in the state year-round. Individuals from more northern breeding populations migrate to Tennessee for the winter, arriving in late October, and peak numbers of 300 to 500 individuals occur from late January to mid-February. (TWRA 2011c)

Two records for nesting bald eagles occur with a 6-mile radius of SQN (TVA 2011b). Neither of these documented nests occurs on or in close proximity to associated transmission lines. Multiple eagles have been spotted using the area on occasion. Nesting habitat likely is not available on site, and bald eagles have not been known to nest on the SQN site.

Bachman's Sparrow

With a stout bill and a long, rounded tail, Bachman's sparrow is a fairly large sparrow. It measures 5–6 inches long, with a 7.2-inch wingspan, and weighs up to 0.8 ounces. The upper parts present a complex pattern of gray streaks alternating with rusty-brown streaks, marked with black. The rump is gray and the upper tail dark brown. The crown, hind neck, and a stripe extending behind the eye are streaked with dark brown and rufous. The eyebrow is light gray, as are the face, throat, and chest. The belly is whitish, and the underparts are unstreaked. The eye is dark brown, the bill gray, and the legs dull yellow. (National Audubon Society 2011d)

Bachman's sparrow primarily occupies open pine woods with a grassy floor, but can sometimes use oak-palmetto scrub and open spaces in transition to forest (replanted clearcuts, power line cuts, and abandoned fields). Important understory components include grasses (wiregrass, panic grass, little blue stem, broom sedge), palmetto, leaf litter, and open ground. Frequent and brief natural fire maintains this habitat best. Even fairly small patches (7–140 acres) of suitable habitat may be occupied. (National Audubon Society 2011d)

Two Bachman's sparrows were identified within a 6-mile radius of SQN in 1969 (TVA 2011b). Habitat on site is not suitable for Bachman's sparrows, but they do use habitat in the transmission line ROWs.

Great Egret

This large, long-necked, long-legged wading bird is pure white with a yellow bill and dark legs and feet. In breeding, plumage adults have longish plumes descending from their tails. They typically fly with their neck pulled back in an S-curve. Males and females look the same. (TWRA 2011d)

Great egret habitat includes lakeshores, large marshes, rivers, ponds, and rarely grassy fields near water. They nest in colonies with other herons and egrets, mainly in west Tennessee, but small numbers are found in colonies in middle and east Tennessee. (TWRA 2011d)

A nest was identified within a 6-mile radius of SQN in 1991 (TVA 2011b). Herons nest communally, and egrets and herons do nest together on the SQN site. Great egrets would not be drawn to transmission line ROWs, but if transmission lines crossed a water body, egrets potentially may be present in the ROW.

Highfin Carpsucker

Highfin carpsuckers live in rivers, oxbows, sloughs, and ponds over sand or gravel bottom. Average length of a highfin carpsucker is about 8.3 inches. They are generally in rivers where current is moderate to swift, or in quiet water adjacent to river channels. Little is known about the biology of this fish; however, gravid carpsuckers migrate in large numbers to shallow areas and to overflow ponds of streams to spawn. They may spawn over riffles. Juvenile and adults are herbivores and invertivores, feeding on the bottom of the water body. (NatureServe 2011c)

One individual was identified within a 6-mile radius of SQN in 1994 during a survey in Chickamauga Reservoir approximately 5.75 miles from SQN (TVA 2011b). Although this species has not been observed adjacent to SQN, suitable habitat does exist adjacent to the site.

Lake Sturgeon

Lake sturgeon were reintroduced into the headwaters of the Tennessee River system in 2000. While these introductions were made in the headwater areas, the sturgeon have moved freely throughout the system and have been reported in Chickamauga Reservoir. Improved water quality due to reduced pollutants and the implementation of the TVA reservoir releases improvement/lake improvement plan have allowed this species to be re-established in its native range. (Huddleston 2006)

Lake sturgeon prefer the bottoms of large, clean rivers and lakes and are listed as endangered in Tennessee. (TDEC 2011a) They have a long, streamlined, shark-like body; long bony snout; and rows of sharp, bony, armored plates called scutes. A sucker-type mouth is under the long bony snout. Lake sturgeon have short, rounded snouts compared to those of other sturgeon species. Also, the four barbels dangling in front of the mouth of a lake sturgeon are smooth rather than fringed or serrated. Young lake sturgeon are mottled light and dark brown, while adults are solid dark brown or slate-colored with white belly. These fish may be as long as 8 feet and weigh up to 300 pounds. (MDC 2011b)

Lake sturgeon can live to be 150 years old and become mature at 15–20 years of age. Females spawn once every 3–5 years. This slow reproductive rate makes sturgeon vulnerable to overharvest. They are extremely migratory fish and travel hundreds of miles each year on spawning migrations. Spawning peaks in the first half of May. (MDC 2011b)

Due to the migratory nature of this species, it is likely that individuals may be present adjacent to the SQN site; however, they are not likely to spawn there (Huddleston 2006). None have been identified within a 6-mile radius of SQN (TVA 2011b).

Table 2.5-1
Endangered, Threatened, and Other Species of Concern in the SQN Geographic Area

Common Name	Scientific Name	Federal Status	Tennessee Status	On SQN Site	Within a 6-Mile Radius	Transmission ROWs (within a 6-Mile radius of SQN)
Plants						
American ginseng	*Panax quinquefolius*	—	S-C	No	No	No
Fragrant bedstraw	*Galium uniflorum*	—	S	No	No	No
Gibbous panic grass	*Sacciolepis striata*	—	S	No	Yes	No
Large-flowered skullcap	*Scutellaria montana*	LT	T	No	Yes	No
Ovate-leaved arrowhead	*Sagittaria platyphylla*	—	S	No	No	No
Pink lady's slipper	*Cypripedium acaule*	—	S-C	No	No	No
Southern prairie dock	*Silphium pinnatifidum*	—	T	No	Yes	No
Tall larkspur	*Delphinium exaltatum*	—	E	No	Yes	No
Birds						
Appalachian Bewick's wren	*Thryomanes bewickii atlus*	—	E	No	No	No
Bachman's sparrow	*Aimophila aestivalis*	—	E	No	Yes	No
Bald eagle	*Haliaeetus leucocephalus*	DM	D	Yes[a]	Yes	No
Great egret	*Ardea alba*	—	D	No	Yes	No

Table 2.5-1 (Continued)
Endangered, Threatened, and Other Species of Concern in the SQN Geographic Area

Common Name	Scientific Name	Federal Status	Tennessee Status	On SQN Site	Within a 6-Mile Radius	Transmission ROWs (within a 6-Mile radius of SQN)
Fish						
Highfin carpsucker	*Carpiodes velifer*	—	D	No	Yes	No
Lake sturgeon	*Acopenser fulvescens*	—	E	No	No[(b)]	No
Mussels						
Dromedary pearlymussel	*Dromus dromas*	LE	E	No	Yes	No
Pink mucket	*Lampsilis abrupta*	LE	E	No	Yes	No

(TVA 2011b; TDEC 2010c; TDEC 2010d; TDEC 2011a)

— = No status under the federal Endangered Species Act.

Federal Status Abbreviations: LE = Listed Endangered; LT = Listed Threatened; C = candidate; DM = Delisted, recovered, and being monitored

State Status Abbreviations: E = Endangered; T = Threatened; D = Deemed in need of management; S = Special concern; S-C = Special concern-Commercially exploited

a. Bald eagles have been spotted in close proximity to SQN and can be assumed as having flown over and adjacent to the site.
b. Lake sturgeon was reintroduced into the headwaters of the Tennessee River system in 2000 and have been reported in Chickamauga Reservoir.

2.6 Regional Demography

2.6.1 Regional Population

NUREG-1437 GEIS presents a population characterization method based on two factors: "sparseness" and "proximity" (NRC 1996, Section C.1.4). "Sparseness" measures population density and city size within 20 miles of a site and categorizes the demographic information as follows.

Demographic Categories Based on Sparseness

		Category
Most sparse	1.	Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles.
	2.	40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles.
	3.	60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles.
Least sparse	4.	Greater than or equal to 120 persons per square mile within 20 miles.

(NRC 1996)

"Proximity" measures population density and city size within 50 miles and categorizes the demographic information as follows.

Demographic Categories Based on Proximity

		Category
Not close proximity	1.	No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles.
	2.	No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles.
	3.	One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles.
Close proximity	4.	Greater than or equal to 190 persons per square mile within 50 miles.

(NRC 1996)

The GEIS then uses the following matrix to rank the population in the vicinity of the plant as low, medium, or high.

GEIS Sparseness and Proximity Matrix

		Proximity			
		1	**2**	**3**	**4**
Sparseness	**1**	1.1	1.2	1.3	1.4
	2	2.1	2.2	2.3	2.4
	3	3.1	3.2	3.3	3.4
	4	4.1	4.2	4.3	4.4

Low Population Area

Medium Population Area

High Population Area

(NRC 1996)

The 2010 census population and TIGER/Line data from the U.S. Census Bureau (USCB) were used to determine demographic characteristics in the vicinity of the site. The data were processed at the state, county, and census block levels using Environmental Systems Research Institute (ESRI) ArcView® geographic information system (GIS) (ESRI 2005). Census data include people living in group quarters such as institutionalized and non-institutionalized populations. Examples of institutional populations living in group quarters are correctional institutions (i.e., prisons, jails, and detention centers), nursing homes, mental (psychiatric) hospitals, hospitals or wards for the chronically ill, and juvenile institutions. Examples of non-institutional populations living in group quarters are group homes, college dormitories, military quarters, soup kitchens, shelters for abused women (shelters against domestic violence or family crisis centers), and shelters for children who are runaways, neglected, or without conventional housing.

The 2010 census data indicate that approximately 472,684 people live within a 20-mile radius of the site, which equates to a population density of 376 persons per square mile (ESRI 2005). According to the GEIS sparseness index, the site is classified as Category 4, least sparse, with greater than or equal to 120 persons per square mile within 20 miles.

The 2010 census data indicate that approximately 1,080,361 people live within a 50-mile radius of the site, which equates to a population density of 138 persons per square mile. Chattanooga, Tennessee, lies within 50 miles of the site and has a population greater than 100,000 residents (Table 2.6-1). According to the GEIS proximity index, the site is classified as Category 3, one or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles. (ESRI 2005)

According to the GEIS sparseness and proximity matrix, the combination of "sparseness" Category 4 and "proximity" Category 3 results in the conclusion that the site is located in a "high" population area.

The area within the region (50-mile radius of the site) totally or partially includes 32 counties from four states (Alabama, Georgia, North Carolina, and Tennessee) (see Table 2.6-2). According to the 2010 census, the permanent population (not including transient populations) of the entire 32 counties was approximately 1,658,222 (Table 2.6-2). (USCB 2010d) By 2041, the end of the proposed license renewal period, the permanent population (not including transient populations) of the entire 32 counties is projected to be approximately 2,251,162. Based on 2010–2041 population projections, an annual growth rate of approximately 0.99 percent is anticipated for the permanent population in these 32 counties that are wholly or partially located within the 50-mile region.

The total population (including transient populations) of the entire 32 counties, which are totally or partially included in the 50-mile region, is projected to be approximately 2,417,217. The total population (including transient populations) in the 50-mile region only is projected to be 1,608,773 in 2041. (AHLA 2011; ATD 2010a; ATD 2010b; CGCA 2010; GAOPB 2010; GDED 2009; GDED 2010; NCDOC 2009; NCDOC 2010a; NCDOC 2010b; NCOSBM 2011a; NCOSBM 2011b; NCOSBM 2011c; NCOSBM 2011d; TDTD 2010; UACB 2001; UACB 2012; UT-CBER 2011)

The latest county-level permanent population projections were obtained from the following sources:

- Alabama county population from 2000 to 2010, and projections for the period 2015 to 2040 from the University of Alabama Center for Business and Economic Research (UACB 2012).

- The Georgia 2030 population projections for the period 2010 to 2030 from the State of Georgia Governor's Office of Planning and Budget (GAOPB 2010).

- Projected annual county population totals for the period 2010 to 2031 from the North Carolina Office of State Budget and Management (NCOSBM 2011b; NCOSBM 2011c; NCOSBM 2011d).

- Population projections for the State of Tennessee for the period 2015 to 2040 from the Tennessee Advisory Commission on Intergovernmental Relations, but developed by the University of Tennessee Center for Business and Economic Research (UT-CBER 2011).

Tennessee and North Carolina projection data were based on the 2010 census counts, while projection data for Alabama and Georgia were based on the 2000 census counts. According to state agencies, the 2010 census-based projections for Alabama and Georgia are currently in progress and not available. County-level permanent population values for the counties included in the region are shown in Table 2.6-2. Transient data for Alabama, Georgia, North Carolina, and Tennessee were obtained from state and national sources (AHLA 2011; ATD 2010a; ATD 2010b; CGCA 2010; GDED 2009; GDED 2010; NCDOC 2009; NCDOC 2010a; NCDOC 2010b; TDTD 2010).

SQN is located in rural Hamilton County. The population of Hamilton County, Tennessee, as reported in the 2010 census was 336,463 (USCB 2010d). Based on Tennessee's projected data set, Hamilton County's projected population for 2041 is expected to be 343,156 (UT-CBER 2011). The average projected annual growth rate for this period is 0.06 percent.

Estimated projected populations and average annual growth rates for the 11 counties included within the 20-mile radius of the site are shown in Table 2.6-3 (UT-CBER 2011; GAOPB 2010). All of the counties, with the exception of Hamilton and Marion counties, Tennessee, are expected to grow at rates greater than 0.5 percent annually.

The cities and towns with boundaries falling totally or partially within the 50-mile region are listed in Table 2.6-1. The nearest town to SQN with a census-reported population is Lakesite. Its population was reported at 1,826 residents (USCB 2010e). The closest city, Soddy-Daisy, had a 2010 population of 12,714 residents (Table 2.6-1) (USDOT 2008; USCB 2010e). Three cities within the 50-mile region have a population greater than 25,000: Chattanooga, Tennessee (18 miles); Cleveland, Tennessee (13 miles); and Dalton, Georgia (32 miles). These cities have a 2010 population of 167,674; 41,285; and 33,128 residents, respectively (Table 2.6-1).

2.6.2 Minority and Low-Income Populations

2.6.2.1 Background

The NRC performs environmental justice analyses utilizing a 50-mile radius around the plant as the environmental "impact area." The four states included within the 50-mile radius compose the "geographic area." Two approaches are used to establish the comparative criteria defined in the guidance. The first approach used each state individually to define the comparative criteria. The regional blocks for each state were evaluated separately using four sets of criteria. The second approach used a combined geographic area comprising the four states. The regional blocks were evaluated using a single set of criteria based on all four states. Both approaches were used to assess the minority and low-income population criteria.

NRC guidance suggests using the most recent USCB decennial census data. However, low-income data are collected separately from the decennial census and are available in 5-year averages. The 2009 (low-income) and 2010 (minority) census population data and TIGER/Line data for Alabama, Georgia, North Carolina, and Tennessee were obtained from the USCB website and processed using ESRI ArcView® GIS software. Census population data were used to identify the minority and low-income populations within a 50-mile radius of SQN.

Environmental justice evaluations for minority and low-income populations are based on the use of U.S. Census blocks for minority populations and block groups for low-income populations. Blocks are the finest resolution of data available in the census data hierarchy, and block groups are used for low-income populations because block data are not publicly available for personal income data.

Regarding environmental justice, EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, issued on February 11, 1994, is designed to focus the attention of federal agencies on the human health and environmental effects of their programs, policies, and activities on minority and low-income communities (59 FR 7629). While TVA is not subject to this EO, it evaluates potential environmental justice impacts as a matter of policy (TVA 1997; TVA 2010c; TVA 2011a). The environmental justice review involves identifying potential offsite environmental impacts, their geographic locations, minority and low-income populations that may be affected, the significance of such effects, and whether they are disproportionately high and adverse compared to the population at large within the geographic area, and if so, what mitigative measures are available, and which would be implemented.

Regarding population resource dependencies or practices, TVA's REMP monitors pathway receptors associated with the consumption of groundwater, local food, fish, and wildlife occurring in the vicinity of SQN.

2.6.2.2 Minority Populations

NRC procedural guidance categorizes minority populations as American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Black or African American, other, two or more races, the aggregate of all minority races, Hispanic or Latino ethnicity, and the aggregate of all minority races and Hispanic ethnicity (NRC 2009b, page C-5). The guidance indicates that a minority population is considered present if either of the following conditions exists:

1. The minority population in the census block exceeds 50 percent.

2. The minority population percentage is more than 20 percentage points greater in the census block than the minority percentage of the geographic area chosen for the comparative analysis.

To establish minimum thresholds for each minority category, the non-white minority population total for each state was divided by the total population in the state. This process was repeated with the combined four-state total minority population and four-state total population. As described in the second criterion, 20 percent was added to the minority percentage values for each geographic area. The lower of the two NRC conditions for a minority population was selected as defining a minority area (i.e., census block minority population exceeds 50 percent, or minority population is more than 20 percent greater than the minority population of the geographic area, state, or four-state area). Any census block with a percentage that exceeded this value was considered to be a minority population. Minority percentages for Alabama, Georgia, North Carolina, Tennessee, and the four-state area, along with corresponding thresholds, are shown in Table 2.6-4.

A minority category of "All Races Combined" is created when the populations of all the 2010 U.S. Census minority categories are summed. The 2010 "All Races Combined" category, when compared to the total population, indicates 32.41 percent of the population in the four states combined is minorities. The minority population percentages for Alabama, Georgia, North Carolina, and Tennessee are 31.47, 40.26, 31.53, and 22.44 percent, respectively (Table 2.6-4). (USCB 2010f; USCB 2010g) Using the second criterion listed above for identification of the presence of a minority population, when Alabama is used as the geographic area, any census block group with a combined minority population equal to or greater than 51.47 percent would be considered to be a minority population. Because 51.47 percent exceeds the criterion of 50 percent, the first criterion (50 percent) would be used. The other states are evaluated in a similar manner. When the four-state area is used as the geographic area, any census block with a combined minority population exceeding 50 percent would be considered a minority population area.

Because Hispanic is not considered a race by the USCB, Hispanics are already represented in the census-defined race categories. Because Hispanics can be represented in any race category, some white Hispanics not otherwise considered minorities become classified as a minority when categorized in the "All Races Combined plus Hispanics" category. Also, Hispanics of non-white racial background are included in both the racial group and the Hispanic group, and thereby counted twice. The "All Race Combined plus Hispanics" category, however, results in the greatest chance of consideration of populations within a block group to be classified as minority.

The number of census blocks contributing to the minority population count was evaluated using the criteria shown in Table 2.6-4 and summarized in Table 2.6-5. The results of the evaluation are census blocks flagged as having a minority population(s). The resulting maps (Figures 2.6-1, 2.6-2, 2.6-3, 2.6-4, 2.6-5, 2.6-6, 2.6-7, 2.6-8, 2.6-9, 2.6-10, 2.6-11, 2.6-12, 2.6-13, 2.6-14, 2.6-15, 2.6-16, 2.6-17, and 2.6-18) depict the location of minority population census blocks flagged accordingly for each race or aggregate category.

The percentage of census blocks exceeding the "All Races Combined" minority population criterion was 6.18 percent when a four-state geographic area was used and 5.74 percent when each individual state was used as the geographic area. For the "All Races Combined plus Hispanic" category, 8.20 percent of the census blocks contained a minority population, and 8.08 percent of the blocks contained minority populations when each individual state was used. The minority population values of the blocks were significantly reduced when races were analyzed individually. (USCB 2010f)

The identified minority population closest to SQN is approximately 1.1 miles away in Census Block 470650101012006. This census block contained a total of three people, with three people counted in the "Other" category, and 3 people counted in the "Hispanic" category. The majority of the blocks within the 6-mile vicinity had populations ranging from 1 to 24 individuals. This is consistent with single families or a few families living in a relative close proximity. The only exception to this that met the minority criteria within the vicinity was Block 470650103062043, which had 53 individuals. The distribution of identified minority blocks is relatively even and random outside of urban clusters. Inside Chattanooga, Tennessee, and Dalton, Georgia, there are more incidents of clustering minority blocks. Smaller cities show similar patterns, but to a lesser extent.

There are no Native American Indian reservations within the 50-mile region of SQN.

2.6.2.3 Low-Income Populations

NRC guidance defines "low-income" using USCB statistical poverty thresholds (NRC 2009b, page C-5). As addressed above with minority populations, two alternative geographic areas (Alabama, Georgia, North Carolina, and Tennessee individually and all four states combined) were used in this analysis.

The guidance indicates that a low-income population is considered present if either of the two following conditions exists:

1. The low-income population in the census block group exceeds 50 percent.

2. The percentage of households below the poverty level in a block group is significantly greater (typically at least 20 percentage points) than the low-income population percentage of the geographic area chosen for the comparative analysis (i.e., individual state and four-state combined average).

The latest data, provided in block group geography, corresponding to the low-income population are available from the USCB in the 2005–2009 American Community Survey. To establish minimum thresholds for low-income category, the population with an income below the poverty level for each state was divided by the total population for whom poverty status is determined in the state. This process was repeated with the combined four-state total population with an income below the poverty level and four-state total population for whom poverty status is determined. As described in the second criterion, 20 percent was added to the minority percentage values for each geographic area. None of the geographic areas described in the first criterion exceeded 50 percent.

When the 2005–2009 census data category "income in the past 12 months below poverty level" is compared to "total population for whom poverty status is determined," 15.5 percent of the population in the four states combined has an income below poverty level. The populations of Alabama, Georgia, North Carolina, and Tennessee have 36.8, 35.0, 35.1, and 36.1 percent of their populations below poverty level, respectively (Table 2.6-6). (USCB 2010h)

For example, when Alabama is used as the geographic area, any census block group within the region with a low-income population equal to or greater than 36.8 percent of the total block group population would be considered a "low-income population." Using the appropriate criteria for each individual state, 77 of the total 766 census block groups (10.1 percent) have low-income population percentages which meet or exceed the percentages in Table 2.6-6. These census block groups are illustrated in Figure 2.6-19. (USCB 2010h; USCB 2010i)

When the four-state combined area is used as the geographic area, any census block group within the 50-mile region with low-income populations equal to or greater than 35.5 percent of the total block group population would be considered a "low-income population." Using these criteria, 78 of the 766 census block groups (10.2 percent) were identified within a 50-mile radius of the site, as shown in Figure 2.6-20. (USCB 2010h; USCB 2010i)

The closest low-income population is approximately 10.9 miles away and located inside the city of Chattanooga, Tennessee. It is U.S. Census Block Group 47065104334. All of the low-income population block groups are located in or near cities. (USCB 2010h; USCB 2010i)

Table 2.6-1
2010 Population of Cities and Towns Within the 50-Mile Region

State and City/Town	County	2000 Census Population[(a)]	2010 Census Population[(b)]	Direction	Distance to SQN (Miles)[(c)]
Alabama					
Ider	DeKalb	664	723	SW	49
Bridgeport	Jackson	2,728	2,418	WSW	40
Stevenson	Jackson	1,770	2,046	WSW	49
Georgia					
Fort Oglethorpe	Catoosa	6,940	9,263	SSW	21
Ringgold	Catoosa	2,422	3,580	S	21
Trion	Chattooga	1,993	1,827	SSW	49
Trenton	Dade	1,942	2,301	SW	34
McCaysville	Fannin	1,071	1,056	ESE	44
Resaca	Gordon	815	544	SSE	45
Chatsworth	Murray	3,531	4,299	SSE	37
Eton	Murray	319	910	SE	33
Chickamauga	Walker	2,245	3,101	SSW	27
LaFayette	Walker	6,702	7,121	SSW	38
Lookout Mountain	Walker	1,617	1,602	SW	23
Rossville	Walker	3,511	4,105	SSW	20
Cohutta	Whitfield	582	661	SSE	20
Dalton	Whitfield	27,912	33,128	SSE	32
Tunnel Hill	Whitfield	1,209	856	S	27
Varnell	Whitfield	1,491	1,744	SSE	23
Tennessee					
Pikeville	Bledsoe	1,781	1,608	NNW	27
Charleston	Bradley	630	651	ENE	19
Cleveland	Bradley	37,192	41,285	ESE	13
Crab Orchard	Cumberland	838	752	NNE	49

Table 2.6-1 (Continued)
2010 Population of Cities and Towns Within the 50-Mile Region

State and City/Town	County	2000 Census Population[(a)]	2010 Census Population[(b)]	Direction	Distance to SQN (Miles)[(c)]
Crossville	Cumberland	8,981	10,795	N	50
Altamont	Grundy	1,136	1,045	WNW	38
Beersheba Springs	Grundy	553	477	WNW	36
Coalmont	Grundy	948	841	WNW	35
Gruetli-Laager	Grundy	1,867	1,813	WNW	31
Monteagle	Grundy	1,238	1,192	W	42
Palmer	Grundy	726	672	WNW	28
Tracy City	Grundy	1,679	1,481	W	37
Chattanooga	Hamilton	155,554	167,674	SW	18
Collegedale	Hamilton	6,514	8,282	SSE	12
East Ridge	Hamilton	20,640	20,979	SSW	17
Lakesite	Hamilton	1,845	1,826	WSW	2
Lookout Mountain	Hamilton	2,000	1,832	SW	22
Red Bank	Hamilton	12,418	11,651	SW	14
Ridgeside	Hamilton	389	390	SSW	16
Signal Mountain	Hamilton	7,429	7,554	WSW	16
Soddy-Daisy	Hamilton	11,530	12,714	W	6
Walden	Hamilton	1,960	1,898	WSW	13
Philadelphia	Loudon	533	656	NE	50
Jasper	Marion	3,214	3,279	WSW	32
Kimball	Marion	1,312	1,395	WSW	35
New Hope	Marion	1,043	1,082	WSW	36
Orme	Marion	124	126	WSW	43
Powells Crossroads	Marion	1,286	1,322	W	22
South Pittsburg	Marion	3,295	2,992	WSW	38
Whitwell	Marion	1,660	1,699	W	24

Table 2.6-1 (Continued)
2010 Population of Cities and Towns Within the 50-Mile Region

State and City/Town	County	2000 Census Population[(a)]	2010 Census Population[(b)]	Direction	Distance to SQN (Miles)[(c)]
Athens	McMinn	13,220	13,458	ENE	32
Calhoun	McMinn	496	490	ENE	20
Englewood	McMinn	1,590	1,532	ENE	37
Etowah	McMinn	3,663	3,490	ENE	33
Niota	McMinn	781	719	NE	37
Decatur	Meigs	1,395	1,598	NE	26
Madisonville	Monroe	3,939	4,577	ENE	46
Sweetwater	Monroe	5,586	5,764	NE	44
Tellico Plains	Monroe	859	880	ENE	46
Benton	Polk	1,138	1,385	E	25
Copperhill	Polk	511	354	ESE	44
Ducktown	Polk	427	475	ESE	42
Dayton	Rhea	6180	7191	NNE	19
Graysville	Rhea	1,411	1,502	N	15
Spring City	Rhea	2,025	1,981	NNE	35
Rockwood	Roane	5,774	5,562	NNE	50
Dunlap	Sequatchie	4,173	4,815	WNW	20
Spencer	Van Buren	1,713	1,601	NNW	42
McMinnville	Warren	12,749	13,605	NW	50
Viola	Warren	129	131	WNW	48
Doyle	White	525	537	NNW	49

a. (USCB 2000a)
b. (USCB 2010e)
c. Distance measurements are approximate and based on the SQN center point and NTAD city center data.

Table 2.6-2
County-Level Permanent Population
(32 Counties Totally or Partially Within the 50-Mile Region of SQN)

State and County	2000 Census Population[a]	2010 Census Population[b]	2041 Projected Permanent Population[c]
Alabama (Two Counties)	**118,378**	**124,336**	**145,401**
DeKalb	64,452	71,109	92,174
Jackson	53,926	53,227	53,227
Georgia (10 Counties)	**452,913**	**521,050**	**875,943**
Catoosa	53,282	63,942	131,379
Chattooga	25,470	26,015	39,120
Dade	15,154	16,633	24,789
Fannin	19,798	23,682	38,789
Floyd	90,565	96,317	130,478
Gilmer	23,456	28,292	69,208
Gordon	44,104	55,186	96,040
Murray	36,506	39,628	95,791
Walker	61,053	68,756	89,753
Whitfield	83,525	102,599	160,596
North Carolina (One County)	**24,298**	**27,444**	**38,161**
Cherokee	24,298	27,444	38,161
Tennessee (19 Counties)	**897,186**	**985,392**	**1,191,657**
Bledsoe	12,367	12,876	15,752
Bradley	87,965	98,963	135,635
Coffee	48,014	52,796	60,848
Cumberland	46,802	56,053	86,031
Franklin	39,270	41,052	43,262
Grundy[d]	14,332	13,703	13,703
Hamilton	307,896	336,463	343,156[e]

**Table 2.6-2 (Continued)
County-Level Permanent Population
(32 Counties Totally or Partially Within the 50-Mile Region of SQN)**

State and County	2000 Census Population[(a)]	2010 Census Population[(b)]	2041 Projected Permanent Population[(c)]
Loudon	39,086	48,556	81,494
Marion	27,776	28,237	30,369
McMinn	49,015	52,266	66,973
Meigs	11,086	11,753	16,578
Monroe	38,961	44,519	71,745
Polk	16,050	16,825	17,124
Rhea	28,400	31,809	43,188
Roane	51,910	54,181	61,106
Sequatchie	11,370	14,112	23,638
Van Buren	5,508	5,548	6,462
Warren	38,276	39,839	39,875
White	23,102	25,841	34,718
Overall Total	**1,492,775**	**1,658,222**	**2,251,162**

a. (USCB 2000b; County Population, 2000 Census)
b. (USCB 2010d; County Population, 2010 Census)
c. (UACB 2001; UACB 2012; GAOPB 2010; NCOSBM 2011a; NCOSBM 2011b; NCOSBM 2011c; NCOSBM 2011d; UT-CBER 2011)
d. The 2010 population values were held constant for counties with projected negative population growth.
e. The Chattanooga-Hamilton County/North Georgia Transportation Planning Organization (CHNGTPO) projects that the 2040 population will be 411,494 (CHCRPA 2012).

Table 2.6-3
Projected County Populations and Average Annual Growth Rates 2010–2041
(Counties Within a 20-Mile Radius of SQN)

			2010	2015	2020	2025	2030	2035	2041
Tennessee	Bledsoe County	Population	12,876	13,181	13,613	14,088	14,568	15,073	15,752
		Average Annual Growth %		0.47	0.65	0.69	0.67	0.68	0.74
	Bradley County	Population	98,963	103,094	108,820	115,227	121,571	127,858	135,635
		Average Annual Growth %		0.82	1.09	1.15	1.08	1.01	0.99
	Hamilton County	Population	336,463	337,929	340,104	341,846	342,606	343,077	343,156
		Average Annual Growth %		0.09	0.13	0.1	0.04	0.03	0
	Marion County	Population	28,237	28,590	29,009	29,401	29,719	29,996	30,369
		Average Annual Growth %		0.25	0.29	0.27	0.22	0.19	0.21
	McMinn County	Population	52,266	53,885	56,093	58,540	61,010	63,581	66,973
		Average Annual Growth %		0.61	0.81	0.86	0.83	0.83	0.87
	Meigs County	Population	11,753	12,248	13,007	13,852	14,644	15,430	16,578
		Average Annual Growth %		0.83	1.21	1.27	1.12	1.05	1.2
	Rhea County	Population	31,809	33,076	34,836	36,775	38,715	40,694	43,188
		Average Annual Growth %		0.78	1.04	1.09	1.03	1	1
	Sequatchie County	Population	14,112	15,105	16,554	18,191	19,836	21,498	23,638
		Average Annual Growth %		1.37	1.85	1.9	1.75	1.62	1.59

Table 2.6-3 (Continued)
Projected County Populations and Average Annual Growth Rates 2010–2041
(Counties Within a 20-Mile Radius of SQN)

			2010	2015	2020	2025	2030	2035	2041
Georgia	**Catoosa County**	**Population**	63,942	74,174	83,222	93,176	104,242	116,017	131,379
		Average Annual Growth %		3.01	2.33	2.29	2.27	2.16	2.09
	Walker County	**Population**	68,756	69,994	73,835	77,810	81,254	85,200	89,753
		Average Annual Growth %		0.36	1.07	1.05	0.87	0.95	0.87
	Whitfield County	**Population**	102,599	105,163	114,157	123,979	134,561	145,926	160,596
		Average Annual Growth %		0.49	1.65	1.66	1.65	1.63	1.61

(USCB 2010d; GAOPB 2010; UT-CBER 2011)

Note: Projected population values are based on the population projection growth trends for the years reported by the states.

Table 2.6-4
Minority Populations Evaluated Against Criterion

Minority Population	Alabama (2010 Pop. 4,779,736)			Georgia (2010 Pop. 9,687,653)			North Carolina (2010 Pop. 9,535,483)			Tennessee (2010 Pop. 6,346,105)			Four State Area (2010 Pop. 30,348,977)		
	Count	%	Criterion	Count	%	Criterion	Count	%	Criterion	Count	%	Criterion	Count	%	Criterion
Black	1,251,311	26.18	46.18	2,950,435	30.46	50	2,048,628	21.48	41.48	1,057,315	16.66	36.66	7,307,689	24.08	44.08
American Indian/ Alaska Native	28,218	0.59	20.59	32,151	0.33	20.33	122,110	1.28	21.28	19,994	0.32	20.32	202,473	0.67	20.67
Asian	53,595	1.12	21.12	314,467	3.25	23.25	208,962	2.19	22.19	91,242	1.44	21.44	668,266	2.2	22.2
Native Hawaiian/ other Pacific Islander	3,057	0.06	20.06	6,799	0.07	20.07	6,604	0.07	20.07	3,642	0.06	20.06	20,102	0.07	20.07
Two or More Races	71,251	1.49	21.49	207,489	2.14	22.14	206,199	2.16	22.16	110,009	1.73	21.73	594,948	1.96	21.96
Other	96,910	2.03	22.03	388,872	4.01	24.01	414,030	4.34	24.34	141,955	2.24	22.24	1,041,767	3.43	23.43
All Races Combined	1,504,342	31.47	50	3,900,213	40.26	50	3,006,533	31.53	50	1,424,157	22.44	42.44	9,835,245	32.41	50
Hispanic	185,602	3.88	23.88	853,689	8.81	28.81	800,120	8.39	28.39	290,059	4.57	24.57	2,129,470	7.02	27.02
All Races Combined + Hispanic	1,689,944	35.36	50	4,753,902	49.07	50	3,806,653	39.92	50	1,714,216	27.01	47.01	11,964,715	39.42	50

(USCB 2010f; USCB 2010g)

Table 2.6-5
Minority Census Block Counts Within the 50-Mile Region

	Four-State Combined Method		Individual State Method	
	Number of Blocks with Identified Racial Category	% of Blocks within 50 miles	Number of Blocks with Identified Racial Category	% of Blocks within 50 miles
Black	1,737	3.8	1,592	3.48
American Indian/Alaska Native	122	0.27	122	0.27
Asian	204	0.45	204	0.45
Native Hawaiian/ Other Pacific Islander	31	0.07	31	0.07
Two or More Races Combined	610	1.33	608	1.33
Other	974	2.13	977	2.14
All Races Combined	2,825	6.18	2,622	5.74
Hispanic	1,672	3.66	1,636	3.58
All Races Combined + Hispanic	3,748	8.2	3,693	8.08

(USCB 2010d)

Table 2.6-6
Low Income Population Criteria Using Two Geographic Areas

Geographic Area	Total Population	Number of Persons Below Poverty Level	Percentage of Persons Below Poverty Level	Percentage of Low-Income Criterion
Alabama	4,512,909	757,833	16.8	36.8
Georgia	9,228,265	1,384,518	15.0	35.0
North Carolina	8,768,580	1,320,816	15.1	35.1
Tennessee	6,001,130	967,189	16.1	36.1
Four-State Area	28,510,884	4,430,356	15.5	35.5

(USCB 2010i)

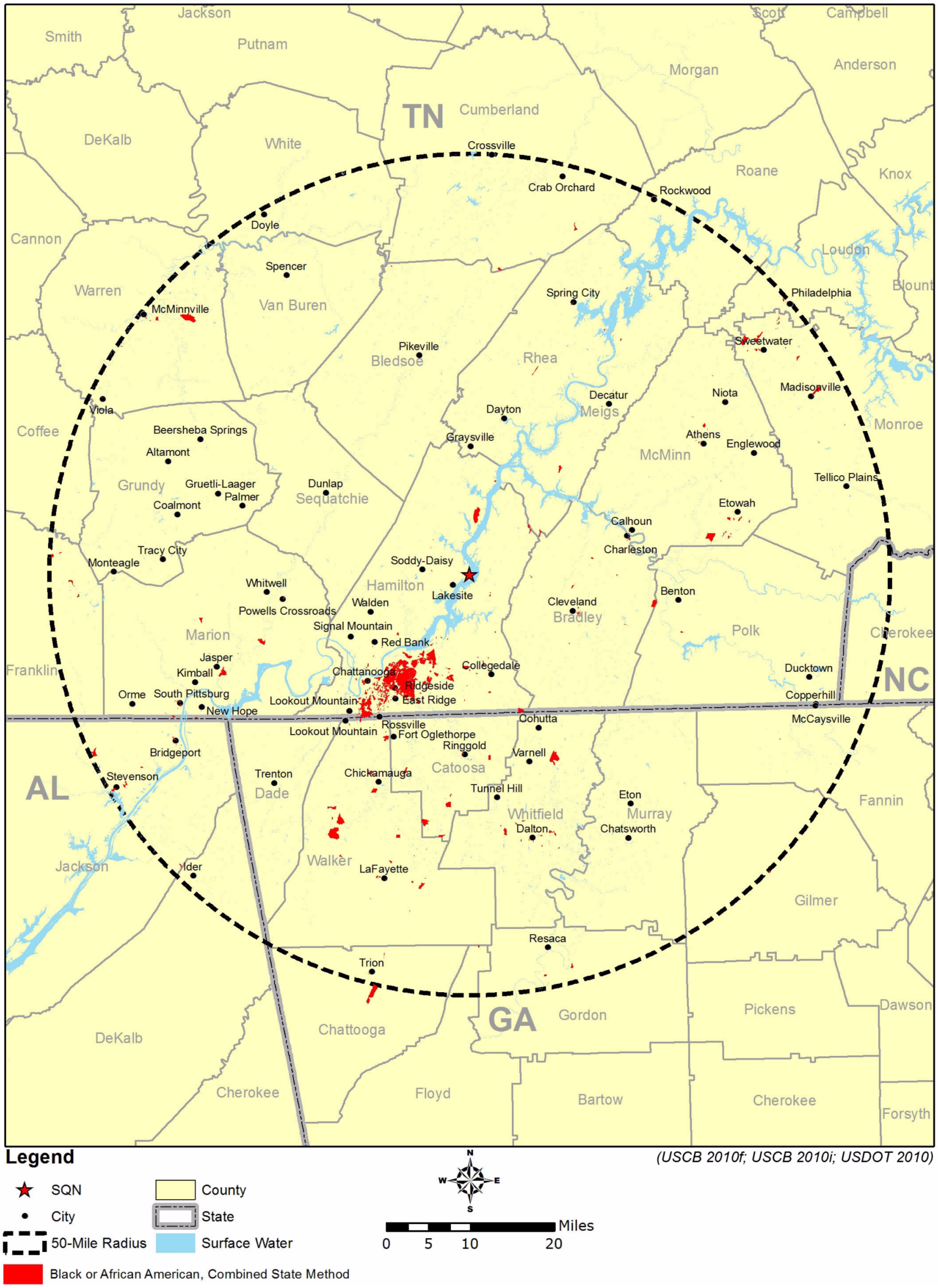


Figure 2.6-1
Black or African American Populations, Combined State Method

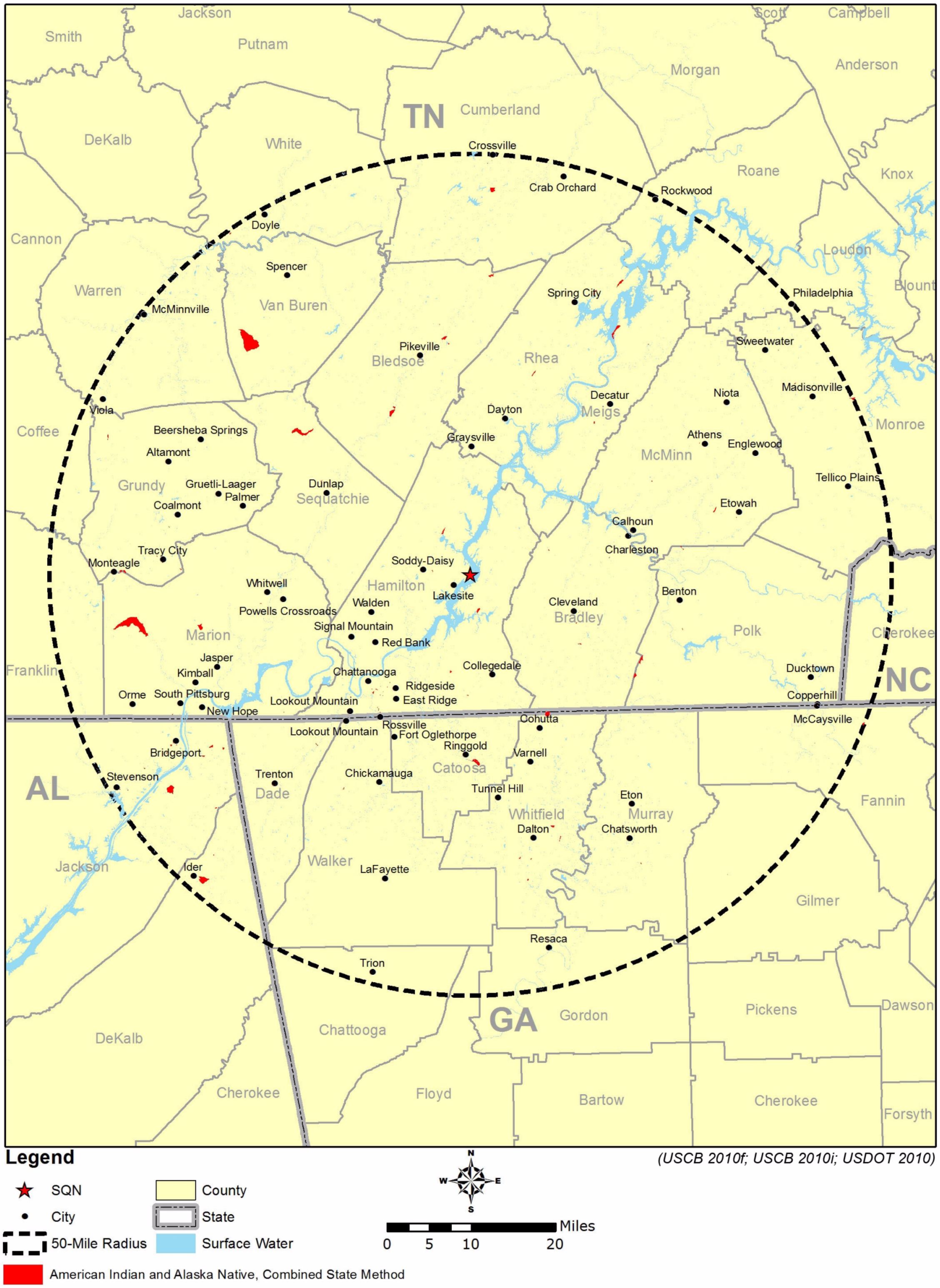


Figure 2.6-2
American Indian and Alaska Native Populations, Combined State Method

(USCB 2010f; USCB 2010i; USDOT 2010)

Figure 2.6-3
Asian Populations, Combined State Method