2.11 Meteorology and Air Quality

2.11.1 Climate

The SQN site is in the eastern Tennessee portion of the southern Appalachian region, which is dominated much of the year by the Azores-Bermuda anticyclonic circulation represented in the annual normal sea level pressure distribution. This circulation over the southeastern United States is most pronounced in the fall and is accompanied by extended periods of fair weather and widespread atmospheric stagnation. In winter, the normal circulation pattern becomes more varied as the eastward-moving migratory high and low pressure systems associated with the mid-latitude westerly current bring alternating cold and warm air masses into the area with resultant changes in wind direction, wind speed, atmospheric stability, precipitation, and other meteorological elements. In summer, the migratory systems are less frequent and less intense, and the area is under the dominance of the western edge of the Azores-Bermuda anticyclone with a warm, moist air influx from the Atlantic Ocean and the Gulf of Mexico. (TVA 2011p, Section 2.3.1.2)

The terrain features of the region have some effect on the general climate. With the mountain ridge and valley terrain aligned northeast-southwest over eastern Tennessee, there is a definite bimodal upvalley-downvalley wind flow in the lower atmosphere at an elevation of 500 to 1,000 feet during much of the year. A detectable lake breeze circulation resulting from discontinuities in differential surface heating between land and water is not expected because of the relatively narrow width of the Tennessee River as it flows southwestward through the valley area. (TVA 2011p, Section 2.3.1.2)

Using National Climatic Data Center (NCDC) data for Chattanooga, Tennessee, the all-time highest temperature was 106ºF recorded on July 28, 1952, while the all-time lowest temperature was recorded as -10ºF on January 21, 1985. Monthly average temperatures range from 31°F in January to 90°F in July. During the year, the typical number of days with temperatures at or below 32°F is 58, while the typical number of days with temperatures at or above 90°F is 48. The highest rainfall in a 24-hour period was recorded in Chattanooga, Tennessee, measuring 7.61 inches March 29–30, 1886. The most rain in a single year measured 73.70 inches in 1994, while the average annual precipitation for Chattanooga is 54.50 inches for the period 1971–2000. (NWS 2010)

Winds at the site are relatively light with the most prevalent wind direction being from the north-northeast. Winds from the northeast and southwest quadrants are more frequent than winds from the southwest and northwest quadrants. The highest wind speeds come from the southwest. (TVA 2011a, Section 3.16.1.3)

Precipitation patterns near the site show an average of 117 days annually with 0.01 inches or more of precipitation. The average monthly precipitation is 4.81 inches, with the maximum monthly average, 6.76 inches, occurring in March, and the minimum monthly average, 2.86 inches, occurring in October. The extreme monthly maximum and minimum is 16.58 inches in November and 0.09 inches in October, respectively. (TVA 2011p, Section 2.3.2.2)

The highest monthly average rainfall near the site area occurs during the winter and early spring months, with March usually having the greatest amount. The maximum 24-hour rainfall reported near the plant site was 7.56 inches and occurred in the month of August. High precipitation is also observed in July, when air mass thunderstorm activity is common. Minimum precipitation normally occurs during the month of October. (TVA 2011p, Section 2.3.1.3) Onsite precipitation data for the years 1998–2009 indicated the annual average rainfall at SQN was 44.90 inches. Rainfall occurs throughout the year; January and December average 4.53 inches each and are the months with the highest average monthly precipitation. October is the month that averages the least precipitation with 2.33 inches. (TVA 2011a, Appendix F)

No observations of the frequency and intensity of fogs have been made in the site area. However, Chattanooga National Weather Service records indicate that heavy fogs (visibility of 1/4 mile or less) occurred on an average of 36 days annually with a maximum average monthly frequency of 6 days in October and a minimum average monthly frequency of 2 days from February through July. (TVA 2011p, Section 2.3.2.2)

Snowfall does not occur often in the SQN site area. The average annual snowfall is 4.4 inches and occurs mostly December through March. The maximum 24-hour snowfall reported at Chattanooga was 20.0 inches in March 1993; the next highest was 10.2 inches in January 1988. (NWS 2010; TVA 2011p, Section 2.3.2.2)

Wind storms may occur several times a year, particularly during winter, spring, and summer, with winds exceeding 35 miles per hour (mph) and, on occasion, 60 mph. The records show the highest wind speed recorded in Chattanooga, Tennessee, prior to 1950 was 82 mph in March 1947. (TVA 2011p, Section 2.3.1.3) Between 1950 and 2009, the highest wind speed recorded in Chattanooga was 63 mph recorded on June 11, 2009. Records of high winds (> 57.54 mph) and thunderstorms for Hamilton County, Tennessee, for the years 1950–2009 indicated 145 high wind and thunderstorm events taking place during those years (NCDC 2010). High wind may accompany moderate to strong cold frontal passages about 20 to 30 times a year, with the maximum frequency in March and April. (TVA 2011p, Section 2.3.1.3) High wind may also accompany thunderstorms that occur about 56 days a year with a maximum frequency in July.

Severe storm data for the period 1955–1967 show 10 occurrences of hail 0.75 inches or greater in diameter, 20 occurrences of wind storms with speeds of 57.54 mph or greater, and 15 occurrences of tornadoes in the 1-degree latitude-longitude square containing the SQN site. If these severe storm occurrences are assumed to be exclusive of one another, it can be assumed that about 45 severe thunderstorms occurred in the 1-degree square in this 13-year period. The annual occurrence for the square would be about 3.5. A smaller annual occurrence would be expected for the immediate site area, which is much smaller than the 1-degree square for which these statistics apply. (TVA 2011p, Section 2.3.1.3)

The probability of a tornado occurrence at the site is estimated to be about once in 6,000 years (TVA 2011p, Section 1.2.1.3). Statistics show that during the 49-year period 1916–1964, no tornadoes were reported in Hamilton County, where the SQN site is located. During the period 1955–1967, a total of 15 tornadoes were recorded for the 1-degree latitude-longitude square containing the site, for an annual occurrence of 1.15. Using the principles of geometric probability described by H.C.S. Thom, his frequency data for that 1-degree square, and a tornado path size of 0.284 mi^2, the probability of a tornado striking any point in the plant site area is 4.4 x 10^{-5}. (TVA 2011p, Section 2.3.1.3)

During the period January 1, 1950, to March 31, 2012, 27 tornadoes were reported in Hamilton County, Tennessee. The magnitude of these tornadoes was as follows: six F/EF-0, fourteen F/EF-1, three F/EF-2, three F/EF-3 and one F/EF-4 (NWS 2012). The Fujita (F) tornado scale was used prior to February 1, 2007. The Enhanced Fujita (EF) tornado scale was used starting February 1, 2007. Both scales range from 0 to 5. Ten of these 27 tornadoes appeared to have tracks within 10 miles of SQN.

A major portion of these tornadoes occurred on a single day (April 27, 2011) when Hamilton County, Tennessee, was significantly impacted as part of a major tornado outbreak in the southeastern United States. Twelve tornadoes, including one EF-4, struck the county. (NWS 2012) Five of these 12 tornadoes (two EF-0 and three EF-1) appeared to have tracks within 10 miles of SQN.

2.11.2 Air Quality

The Chattanooga Interstate Air Quality Control Region (Georgia-Tennessee) consists of Hamilton County in Tennessee and Bartow, Catoosa, Chattooga, Cherokee, Dade, Fannin, Floyd, Gilmer, Gordon, Haralson, Murray, Paulding, Pickens, Polk, Walker, and Whitfield counties in Georgia [40 CFR 81.42]. Hamilton County, where SQN is located, is a nonattainment area for annual $PM_{2.5}$ (very fine) based on 1997 National Ambient Air Quality Standards (NAAQS) (EPA 2008), but it is in attainment for 24-hour $PM_{2.5}$ based on 2006 NAAQS (EPA 2011b). The closest prevention of significant deterioration (PSD) Class I areas (Figure 2.11-1) are the Sipsey Wilderness Area in Alabama (147 miles), the Cohutta Wilderness Area in Georgia (40 miles), the Great Smoky Mountains National Park (92 miles), and the Joyce Kilmer-Slickrock Wilderness Area (65 miles), located within both Tennessee and North Carolina (EPA 2009).

2.11.3 Greenhouse Gas

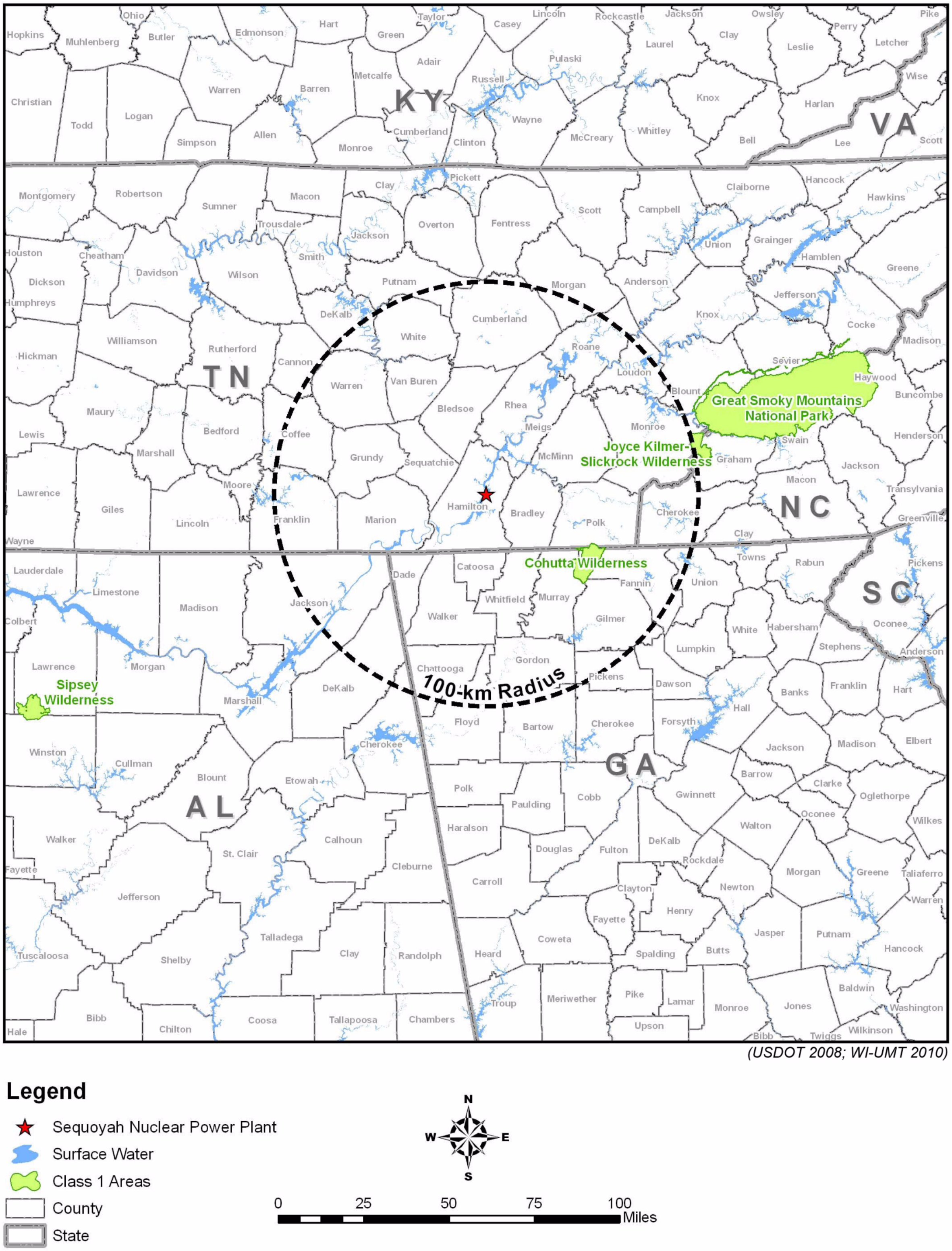
Several studies provide qualitative discussions of the potential for nuclear power to ameliorate greenhouse gas (GHG) emissions (Hagen et al. 2001; IAEA 2000; Keepin 1988; MIT 2003; NEA 2002; NIRS/WISE 2005; and Schneider 2000). While these studies sometimes reference and critique the rationale contained in the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, their conclusions are generally based on other factors such as safety, cost, waste generation, and political acceptability. Therefore, these studies are not directly applicable to the evaluation of the GHG emissions associated with license renewal. (NRC 2010, Section 6.2.1.1)

A number of studies provide technical life-cycle analyses and quantitative estimates of the amount of GHGs generated by nuclear and other power generation technologies (AEA 2006; Andseta et al. 1998; Dones 2007; Fritsche 2006; Fthenakis and Kim 2007; Mortimer 1990; POST 2006; Spadaro et al. 2000; Storm van Leeuwen and Smith 2005; and Weisser 2007).

Comparison of these quantitative studies is difficult because the assumptions and components of the life cycles (i.e., reactor types, energy sources used in mining and processing fuel, capacity factors, fuel quality) included within each study vary widely. Also, these studies are inconsistent in how they define the life cycle: some include plant construction, decommissioning, and resource extraction (uranium ore, fossil fuel), while others include one or two of these activities. Similarly, the scope of these studies is inconsistent with license renewal because license renewal does not include construction or decommissioning. For example, Storm van Leeuwen and Smith present comparisons of GHG emissions from nuclear versus natural gas that incorporate GHG emissions associated with nuclear plant construction and decommissioning in the values used for comparison (Storm van Leeuwen and Smith 2005). License renewal would not involve GHG emissions associated with construction because the facility already exists, nor would it involve additional GHG emissions associated with facility decommissioning, because decommissioning must occur whether the facility license is renewed or not. In many of these studies, the contribution of GHG emissions from facility construction and decommissioning cannot be separated from the other life-cycle GHG emissions that would be associated with license renewal. Therefore, these studies overestimate the GHG emissions that would be attributable to renewal of an operating license. (NRC 2010, Section 6.2.1.2)

The estimates and projections of the carbon footprint of the nuclear power life cycle provided in the various studies vary widely, and considerable debate exists regarding the relative impacts on GHG emissions of nuclear and other electricity-generating technologies. Nevertheless, the studies indicate a consensus that nuclear power produces fewer GHG emissions than fossil fuel-based, electricity-generating technologies. Based on the literature review, life-cycle GHG emissions from the complete nuclear fuel cycle currently range from 2.5 to 55 grams (g) of carbon equivalents per kilowatt hour (Ceq/kWh). The comparable life-cycle GHG emissions from the use of coal range from 264 to 1,250 g Ceq/kWh, and GHG emissions from the use of natural gas range from 120 to 780 g Ceq/kWh. The studies also provided estimates of GHG emissions from five renewable energy sources, based on current technology. These estimates included solar-photovoltaic (17 to 125 g Ceq/kWh); hydroelectric (1 to 64.6 g Ceq/kWh); biomass (8.4 to 99 g Ceq/kWh); wind (2.5 to 30 g Ceq/kWh); and tidal (25 to 50 g Ceq/kWh). The range of these estimates is very wide, but the general conclusion is that the GHG emissions from the nuclear fuel cycle are of the same order of magnitude as those for renewable energy sources. (NRC 2010, Section 6.2.2)

Therefore, GHG emissions associated with renewal of an operating license would be similar to the life-cycle GHG emissions from renewable energy sources and lower than those associated with fossil fuel-based energy sources.



(USDOT 2008; WI-UMT 2010)

Figure 2.11-1
PSD Class I Air Quality Areas

2.12 Historic and Archaeological Resources

Under the National Historic Preservation Act (NHPA) of 1966, as amended [16 USC 470], TVA as a federal agency is required to identify and manage historic properties located on land affected by TVA undertakings.

Prior to taking any action to implement an undertaking, Section 106 of the NHPA [16 USC 470] requires federal agencies to do the following:

- Take into account the effects of an undertaking on historic properties, including any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP).

- Afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertaking.

State historic preservation officers serve as proxies to the ACHP [16 USC 470; 36 CFR Part 800]. The Tennessee Historical Commission (THC) has been consulted by TVA concerning the license renewal application for SQN and any potential effects on historic properties (see Attachment B). Consultation included submission of a Phase 1 cultural resource survey report (McKee et al. 2010) and supplemental 10-mile architectural sensitivity report (Karpynec 2010) documenting the results of record searches and the Phase 1 survey. The investigations were conducted in compliance with Section 106 of the NHPA, as amended, and the implementing regulations contained therein [36 CFR Part 800].

As required by federal regulations [36 CFR Part 800], Native American groups recognized as stakeholders at SQN were consulted by TVA with the opportunity for comment (see Attachment B). TVA has consulted with the following federally recognized Indian tribes regarding properties within the proposed project's area of potential effect (APE) that may be of religious and cultural significance to them and eligible for the NRHP: Cherokee Nation, Eastern Band of Cherokee Indians, United Keetoowah Band of Cherokee Indians in Oklahoma, The Chickasaw Nation, Seminole Tribe of Florida, Muscogee (Creek) Nation of Oklahoma, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Kialegee Tribal Town, Thlopthlocco Tribal Town, Absentee Shawnee Tribe of Oklahoma, Eastern Shawnee Tribe of Oklahoma, and the Shawnee Tribe.

2.12.1 Prehistoric Era

The following discussion is derived from the 2010 Phase I cultural resources survey report contracted for the SQN LRA (McKee et al. 2010), including all references to McKee et al. (2010) and all unreferenced content. All references cited other than McKee et al. (2010) have been independently researched or verified. The survey defined the entire SQN site as the APE.

According to McKee, the vicinity of the SQN property is likely to have been continuously occupied by humans since at least 12,000 years before present (BP). Archaeological records for the Tennessee River valley document four major prehistoric occupational periods with some overlap of cultural markers: Paleo-Indian (12,500 BP–10,000 BP), Archaic (10,000 BP–2,500 BP), Woodland (3,000 BP–1,100 BP), and Mississippian (1,100 BP–400 BP or AD 900–1600).

Prehistoric occupation of the region surrounding the study area has been studied through archaeological research since the late 19th century. The first large-scale excavations in the Guntersville Basin of the Tennessee River occurred in the 1930s by the Works Progress Administration (WPA) and TVA, which provided detailed information on the long prehistoric sequence of the region (Webb and Wilder 1951). In Tennessee, the regional prehistory is understood largely based on intensive investigations in the Normandy Reservoir on the upper Duck River (Faulkner and McCollough 1973, 1974, 1977, 1978, 1982a, 1982b; McCollough and Faulkner 1976, 1978) as well as excavations in the Tellico Reservoir (Chapman 1973, 1975, 1976, 1979, 1994; Davis 1990; Schroedl 1975, 1978). To a lesser extent, various archaeological projects undertaken to fulfill state and federal environmental regulations have also contributed to our understanding of regional settlement patterns. The following discussion draws on these and other sources to provide a basic overview of the prehistoric period.

Paleo-Indian Period

Paleo-Indian adaptation throughout the region was likely characterized by small, highly mobile bands that moved from place to place as preferred resources were depleted and new supplies were sought (Kelly and Todd 1988). During the Early and Middle Paleo-Indian periods, these bands are thought to have practiced generalized hunting and gathering, but concentrated on hunting now extinct megafauna, including mastodon (*Mammut americanum*) and bison (*Bison antiquus*). The exploitation of Late Pleistocene faunal assemblages by the earliest inhabitants in the southeast is attested by the Coates-Hines site (40WM31) in Williamson County, Tennessee, where mastodon remains were discovered in association with Paleo-Indian artifactual material (Breitburg et al. 1996).

South of the project area in Jackson County, Alabama, diagnostic Paleo-Indian artifacts were recovered from Russell Cave (1JA940) during excavations by the Smithsonian Institution and National Park Service (Miller 1957a, 1957b, 1965). Stone tool (lithic) artifacts define the Paleo-Indian diagnostic assemblages and include the typically lanceolate and fluted forms like the Clovis and eastern fluted Gainey and Bull Brook; fluted and unfluted lanceolate forms with modified bases such as Cumberland, Quad, and Parkhill; and typically unfluted, notched, and unnotched lanceolate forms such as the Dalton and Holcombe bifaces.

Two preeminent Paleo-Indian sites in the region, Dust Cave and the Stanfield-Worley bluff shelter, are situated southwest of the current project area along the middle portion of the Tennessee River in Colbert and Lauderdale counties, Alabama. The Stanfield-Worley bluff shelter (1CT125) exhibits nearly 8,000 square feet of shelter floor and cultural material encompassing 8,000 years of aboriginal occupation, and has yielded radiocarbon dates as early as 9640+/-450 BP associated with Paleo-Indian artifacts (DeJarnette et al. 1962). Dust Cave (1LU496), a multi-component habitation cave site near Florence, Alabama, has also yielded a stratified Late Paleo-Indian cultural assemblage dated from 10,500-10,000 BP (Driskell 1994, 1996).

Archaic Period

As the continental glaciers retreated northward, large game species became extinct or migrated north with the retreating tundra and were replaced by modern faunal and floral species. Archaic populations adapted accordingly to rely on smaller mammals, including white-tailed deer, turkey, squirrels, rabbits, and fish. Subsistence strategies also shifted to incorporate seasonal exploitation of vegetal resources such as nuts, berries, seeds, bulbs, and greens.

Intensive exploitation of local resources led to increased population growth throughout the Archaic Period in the southeast and a corresponding reduction in group territory size. Archaic populations gradually became less mobile as villages began to be reoccupied annually. Intensive exploitation of food resources is reflected in substantial quantities of fire-cracked rock on many Archaic sites. This artifact class results from stone boiling techniques using skin bags or wooden bowls prior to the adoption of pottery (Goodyear 1988) and the construction of more prominent, stone-lined, high-heat hearths at repeatedly used campsites.

<u>Early Archaic</u>

Early Archaic populations in northeastern Alabama continued to subsist in ways closely resembling those of earlier Paleo-Indian hunters and foragers. In contrast to Paleo-Indian adaptations, the Early Archaic appears to represent a shift to a more localized subsistence pool based on the seasonal harvest of plant and animal resources. Diagnostic artifacts of the Early Archaic include chipped stone tools with side- and corner-notched hafting elements such as Kirk Corner Notched, Palmer, Plevna, Lost Lake, Pine Tree, and some Big Sandy forms (Cambron and Hulse 1983).

<u>Middle Archaic</u>

The Middle Archaic is generally seen as a difficult time for prehistoric populations, coinciding with the warmer and drier Hypsithermal Interval. Beginning at about 8000 BP, postglacial warming intensified, resulting in a series of environmental changes in parts of the east that influenced cultural developments. Local inhabitants throughout the Midwest and mid-south may have experienced occasional long droughts during this period (Deter-Wolf 2004), given paleo-environmental evidence for such drought (Brackenridge 1984; Klippel and Parmalee 1982).

By the end of the Middle Archaic, there is overwhelming evidence of a complex late Middle Archaic trading/interaction network that likely extended from the Great Lakes to the Gulf Coast. This interaction network is adequately reflected in mortuary objects containing raw materials exotic to the region of final disposition (marine shell beads, non-local chert) and in the widespread occurrence of morphologically similar non-utilitarian artifacts (Deter-Wolf 2004). This phenomenon has been best documented for northern Mississippi by Johnson and Brookes (1989) and Peacock (1988), who describe a string of "Benton phase" sites in the upper

Tombigbee drainage linked by the co-occurrence of such diagnostic markers as Turkey Tails, oversized Bentons, and double-pointed bifaces manufactured from Fort Payne chert.

Late Archaic

During the Late Archaic, modern climatic conditions prevailed throughout North America. This environmental change resulted in increasingly moist conditions throughout the American southeast, and a corresponding boom in local plant and animal life. Prehistoric peoples took advantage of the new, lush conditions while living along major streams where water, plants, and animals were increasingly plentiful.

Evidence of initial plant domestication is reflected in the appearance of cultigens in Late Archaic deposits throughout the southeast. Evidence from sites in Illinois, Kentucky, and Tennessee demonstrates that squash, gourd, and sunflower were well established by 3000 BP (Adovasio and Johnson 1981). Some of the earliest evidence of structural remains in the southeast has been documented for the Late Archaic in the Upper Duck River valley, south of Nashville (Faulkner and McCollough 1974).

South of the project area along the Tennessee River, the Late Archaic period can be divided into two distinct cultural units or phases: the Lauderdale phase and the Bluff Creek phase. The Lauderdale phase represents the classic "Shell Mound Archaic" in this area and may be in need of some refinement or subdivision as new data become available. Along the western Middle Tennessee River, mussel beds provided abundant freshwater invertebrates for exploitation by prehistoric inhabitants. The Lauderdale phase shell mound sites in this vicinity are quite extensive and comprise an organic midden of shell, cultural debris, and human interments accreted over many generations of successive occupation. Jenkins (1974) has suggested that these mound sites were occupied from early spring to early fall, when the local shellfish harvest would be optimum. Jenkins concludes that for the rest of the year, Lauderdale peoples would have moved into the uplands to exploit diverse game animals, plants, and nuts.

The Late Archaic Bluff Creek phase (3200–2500 BP) spans the traditional date of 3000 BP used to divide the Late Archaic from the subsequent Early Woodland period. The Bluff Creek phase is distinguished by fiber-tempered Wheeler series ceramics (ca. 3500–2800 BP) (Futato 1979; Walthall and Jenkins 1976). Ceramics first made their appearance on the Atlantic coastal plain in estuarial settings around 4500 BP. However, it was not until quite later, around 3500–3000 BP, that the Wheeler series made its debut in northern Alabama (Futato 1979; Jenkins 1975; Sassaman 2002).

Woodland Period

The Woodland period in the region is also divided into three sub-periods: Early (3000–2200 BP), Middle (2200–1650 BP), and Late (1650–1100 BP) Woodland. This period has been traditionally linked to sedentism, population growth, and organizational complexity as manifested in the intensive cultivation of crops, establishment of well-defined village settlements, the construction of ceremonial mounds, and the appearance of pottery. However, recent research has proven that all these traditionally Woodland cultural markers have more ancient roots dating back to the

Archaic (see above for discussion of Wheeler ceramics; Fritz 1997; Sassaman 1993, 2002; Saunders et al. 1994). In this respect, the beginnings of the Woodland period in Alabama mark only a gradual transition from subsistence and settlement patterns of the Archaic within a similar deciduous forest environment. However, technological refinement and ideological changes clearly distinguish the Woodland period from its predecessor.

Early Woodland

This initial part of the Woodland period is more of a transitional time from the Late Archaic, as seen in the gradual adoption of ceramics and the shift in subsistence and settlement patterns (Anderson and Mainfort 2002). While a variety of indigenous cultigens had been exploited prior to 3000 BP, the Early Woodland period saw the beginnings of intensive agriculture or horticulture (Watson 1989). Various plants, including goosefoot, maygrass, knotweed, sumpweed, little barley, and sunflower began to be systematically exploited, and in some cases show morphological variations suggesting the beginnings of domestication (Gremillion 1998, 2002).

Middle Woodland

The construction of earthen mounds, which had begun throughout the southeast during the Middle Archaic period, saw rapid increase throughout the Middle Tennessee River valley during the Middle Woodland. South and west of the current project area, the Copena mortuary complex of the Middle Tennessee River valley features the greatest concentration of Middle Woodland burial mounds in the region (Anderson and Mainfort 2002).

Copena represents one of the most widespread Middle Woodland manifestations in the southeast. Webb (1939) first described Copena occupations for the Wheeler Basin. Additional data arise from the Middle Tennessee Valley, where the Copena phase appears around 1800–1400 BP. Copena is no longer regarded as a conventional cultural phase, but rather a social-mortuary pattern shared by local social groups residing in the Middle Tennessee Valley (Cole 1981). Copena sites contain high frequencies of limestone-tempered, plain and carved, paddle-stamped ceramic sherds. Fabric-impressed, cord-marked, brushed, and rocker-stamped ceramics also occur, but less often.

Burial practices for Copena groups include accretional burials in earthen mounds, usually at some distance from the villages. Artifacts interred in Copena burials include copper earspools, bracelets, breastplates, greenstone celts, beads, marine shell cups and beads, and large steatite elbow pipes. Presumably, these finely crafted artifacts were placed with the dead as a means to note their achieved social rank. It is likely that the Copena mortuary cult peaked around 1600 BP (Walthall 1972). By around 1700 BP, the Middle Woodland peoples of northern Alabama became increasingly isolated, as a result of an apparent breakdown in long-distance trade routes. By about 1500 BP, Copena ways had vanished and the populations of northern Alabama were developing local economic adaptations and practicing less stylized burial ceremonialism.

Late Woodland

The Late Woodland period is less well defined in material culture in the region than earlier Woodland occupations (e.g., Walthall 1972). However, recent research has indicated that general Woodland cultural markers (i.e., ceramic production, mound building, and intensive agriculture) continue and even intensify during the Late Woodland (Jefferies 1994; Nassaney and Cobb 1991; Wood and Bowen 1995). Evidence of regional interaction and long distance trade as well as emphasis on burial ceremonialism decreases as cultural groups of this period apparently became more socially isolated. Increased social isolation is also in evidence, as many Late Woodland villages appear to have been fortified. A decrease of ceremonial markers and elite trade goods, however, should not mask the more significant reality of growth in population and agricultural production during this period that led into the Mississippian Period (Nassaney and Cobb 1991). As for technological change, the relatively rapid shift from the larger projectile points of the previous periods to the smaller Madison and Hamilton types is thought to reflect the development of the bow and arrow during the Late Woodland.

Mississippian Period

The Mississippian period has been the subject of much research throughout the southeast. Its cultural manifestations began along the middle course of the Mississippi River between present-day St. Louis, Missouri, and Vicksburg, Mississippi. Mississippian culture underwent major development at the site of Cahokia in the American Bottom and spread primarily along major river systems to all parts of the southeast. From 1000 BP until initial European contact about 400 years ago, Mississippian groups occupied local and regional territories along major rivers including the Tennessee, the Cumberland, and the Forked Deer rivers.

Mississippian populations were substantial and centered in permanent villages that far exceeded those of the Woodland period in size. These villages were primarily supported through the cultivation of maize in fertile alluvial valleys. The Northern Flint variety of maize seems to have been established in the region by around 1200 BP (Buikstra et al. 1988). In addition to maize, Mississippian populations relied on other domesticants, including beans and squash. Domesticated crops were further supplemented with wild foods that contributed to aboriginal diets in the southeast for previous millennia, including wild plants and animals such as nuts, berries, greens, deer, turkey, and aquatic animals.

The Mississippian Period saw a resurgence of shared regional religious icons similar to those manifested during the Middle Woodland. This ideological assemblage is commonly referred to as the "Southeastern Ceremonial Complex" and is defined by a shared body of symbolism, artistic motifs, and artifact types (Waring and Holder 1945). Common motifs include the forked or weeping eye, the hand-eye, the bi-lobed arrow, the cross with a sunburst circle, and representations of anthropomorphic beings. This iconography often appeared on shell gorgets, embossed copper and stone plates, pottery, stone maces, and a variety of other elaborate and specialized artifacts. While the structure of the Southeastern Ceremonial Complex centered on religious iconography and prestige goods, the complex seems to have also served the centralization of political authority in Mississippian cultures.

Status distinctions were also reflected in variation of Mississippian burials. Burials of higher status individuals usually occurred in conical mound earthworks. Distinctive stone box graves of the Middle Cumberland culture are considered regional markers of Mississippian mortuary activity (Dowd 2008; Smith 1992). These graves, lined with slabs of limestone, often include elaborate non-utilitarian funerary furniture and one or multiple human burials. Stone box graves also appear in earth mounds. These were apparently erected by arranging numerous stone box coffins in tiers or layers before piling up dirt to create a mound. Low-status individuals were interred in family cemetery plots near their residences.

2.12.2 Historic Era

The earliest European contact with the general area of what is now Hamilton County consisted of Spanish expeditions in the 16th century. When English explorers arrived in the 17th century, the Cherokee tribe was the dominant native group, with control of an area including eastern Tennessee, western North Carolina, and northern Georgia (Chapman 1985, page 99). American settlers began moving into Cherokee territory in the late 18th century, and Hamilton County was established in 1819. In 1838, the Cherokees were removed from the area by federal troops. An acceleration in white settlement followed.

Following European contact and settlement, the project area was used primarily for timber and agriculture. Early roads through the area connected the first county seat of Hamilton County, Dallas, with Chattanooga and Igou's Ferry, which was located on the SQN site (McKee et al. 2010, page 25). Harrison replaced Dallas as the county seat in 1840, leading to the decline of Dallas.

Igou's Ferry was established by General Samuel Igou on property he owned by the river. The ferry connected roads on the east and west banks. A road near the present-day site still bears the name Igou Ferry Road. General Igou is buried in the Igou Cemetery, still in existence on the SQN site and maintained by TVA (Figure 2.12-1).

During the Civil War, the Union Army guarded the ferry in 1863 and probably used the farmsteads near the crossing for their camp (McKee et al. 2010, page 25). After the war, Dallas declined further, but Igou's Ferry was still in existence and served by a postal route that followed the west bank of the Tennessee River from Chattanooga. According to a 1913 Tennessee Geological Survey map, Igou's Ferry was still operational at that time (McKee et al. 2010, page 27), but by 1936, a TVA survey of the area showed no active ferry.

TVA surveyed the area again in 1937 in preparation for the creation of Chickamauga Reservoir. A second cemetery was documented on the SQN site, identified as the McGill Cemetery #1 (TVA 1938). Sometime before 1983, the 11 graves from this cemetery were relocated to a nearby cemetery associated with the same family group (McKee et al. 2010, pages 27, 38-39).

Chickamauga Reservoir was completed in 1940. The waters of the reservoir covered all lands below the 683-foot contour level, including the site of Igou's Ferry. Most of the former house sites in SQN were not inundated, but property owners were permitted to retain possession and remove buildings for salvage prior to the end of the calendar year of 1939 (TVA 1942, page 232-33).

2.12.3 Cultural Resource Properties

The earliest known documentation of cultural resources on the grounds now occupied by SQN (Figure 2.12-1) was the 1913 recording and testing of site 40HA22 by C. B. Moore (Moore 1915, pages 390-392). Moore described the site as containing a mostly undisturbed mound, 52 feet in diameter and 7.5 feet high, and a light scatter of midden material in the surrounding cultivated field. His excavation into the mound identified nine human burials. The site was revisited in 1936 by Buckner, who reported that the mound was still visible with ceramic fragments on the surface (Buckner 1936).

The 1930s produced pre-inundation surveys and related work for the Chickamauga Reservoir. This work included the recording and testing of site 40HA20, known as the McGill Site (different from McGill Cemetery), also located within the current SQN boundaries (Figure 2.12-1). The results of the testing of 40HA20 are discussed in a compilation on the prehistory of the Chickamauga Reservoir (Lewis and Lewis 1995, pages 295-300), where the site is interpreted as a Late Woodland/Early Mississippian mound complex. Site 40HA20 was first recorded for the Tennessee Division of Archaeology Site Survey Records by Buckner in 1936 (Buckner 1936).

During that same year, 1936, Buckner also recorded the only known archaeological sites located outside, but within 0.5 miles of, the SQN APE. These adjacent sites range from a Late Archaic or later (unknown) period village site with projectile points and ceramics (40HA21) to a Paleo-Indian/Transitional Paleo-Indian open habitation/lithic workshop with projectile points and ground-stone tools (40HA43), both now inundated by Chickamauga Reservoir, to an unknown period burial ground with 8–10 visible stone graves (40HA46), located on the bluff overlooking the Tennessee River (Buckner 1936).

TVA also surveyed the SQN area in 1937 to produce the original property acquisition map for Chickamauga Reservoir (TVA 1937). The map documented public and private roads, structures, fields, orchards, fences, property boundaries, and cemeteries, along with other information, and displayed at least 14 residences and associated structures along with two cemeteries within the current SQN boundaries (McKee et al. 2010, pages 27, 37-38). Additional work by TVA on the two cemeteries soon followed with records of names and locations of burials (TVA 1938; TVA 1940). Following the cemetery reports, no known cultural resource investigations occurred on the SQN grounds until 1973, when they were conducted in association with the original construction of SQN.

Because construction began at SQN early in the development of historic preservation regulations, no comprehensive archaeological survey was conducted on the SQN site prior to construction of the plant. TVA conducted an archaeological survey in 1973, but it was conducted after construction of the plant had begun (Calabrese et al. 1973). Although construction was not yet complete, the emphasis of the 1973 report was that both previously recorded archaeological sites (40HA20 and 40HA22) were destroyed during the construction of SQN prior to the archaeological survey (Calabrese et al. 1973, page 1; McKee et al. 2010, page 37). The 1973 survey located only one intact cemetery (the Igou Cemetery) and remnants suggesting one possible former house.

The past surveys of the area specific to SQN were conducted before the Secretary of the Interior's Historic Preservation Professional Qualification Standards were issued on September 29, 1983 (48 FR 44716). When TVA began developing assessments for continued production at SQN, new cultural resource surveys were done. Two modern surveys were subsequently conducted at SQN. The first was a 2009 Phase 1 survey (Jones and Karpynec 2009) conducted in the preparation of an environmental assessment (EA) for a proposed SQN steam generator replacement project, which included a proposed new barge slip and a storage building. The APE for the 2009 undertaking was limited to three separate locations within SQN for potential direct effects and a 0.5-mile (indirect or visual effect) APE for considering architectural resources. As stated in the EA (TVA 2009a, page 13), the survey confirmed that the APE had been disturbed previously by the construction of SQN. No cultural resources were identified by the survey, and no historic properties were identified within the 0.5-mile viewshed of the proposed actions.

The second modern investigation was a Phase 1 archaeological survey conducted for the entire SQN site in early 2010 in preparation for the LRA (McKee et al. 2010). The APE for the survey was defined as the entire area occupied by SQN (Figure 2.12-1). The APE for architectural field studies included those portions of a 0.5-mile area surrounding the plant facility where a visual link to the plant was unobstructed by topography or vegetation (McKee et al. 2010, page 1). The archaeological investigation focused on shoreline areas and the limited amount of undeveloped land within the APE.

Results of the 2010 Phase 1 archaeological survey confirmed the 1973 findings that sites 40HA20 and 40HA22 were destroyed during plant construction. Figures 2.12-3 and 2.12-4 document construction-related disturbance in the locale of site 40HA20. Figure 2.12-5 documents construction-related disturbance of the area thought to be the location of 40HA22.

A search of THC records also found no previously recorded architectural resources on SQN or within the 0.5-mile visual APE. Previously identified aboveground resources on SQN included the Igou and the McGill cemeteries. During the records investigation, it was determined that for the original SQN construction, the burials at the McGill Cemetery were disinterred and moved to McGill Cemetery #2, across the Tennessee River (see Attachment B).

The 2010 Phase 1 archaeological survey identified one new site (40HA549) and three isolated finds. Site 40HA549 was interpreted as a short-term open habitation represented by three artifacts, including one small quartz flake and two complete Early/Middle Archaic projectile points found in two positive shovel tests. The three isolated finds consisted of separate occurrences of lithic flakes and debitage. TVA determined the site and all three isolated finds ineligible for the NRHP, and the THC concurred by letter dated May 10, 2010.

Two architectural/aboveground resources were also identified (HS-1 and HS-2). HS-1 is a ca. 1930, one-story gable-front house located beyond the APE but within 0.1 miles of the APE boundary and within the 0.5-mile viewshed. HS-2 is the previously investigated Igou Cemetery located in the SQN APE. TVA determined both of these resources ineligible for listing on the

NRHP due to a lack of historic and architectural distinction, and the THC concurred by letter dated May 10, 2010. Archaeological sites within the 0.5-mile radius of SQN are summarized in Table 2.12-1.

The Igou Cemetery (HS-2), which contains about 45 graves, is in the southwestern portion of the APE near the security practice firing range. It is maintained by TVA, and access is only granted by special permission. The cemetery is in no danger of disturbance or destruction from SQN operations, as TVA plans to avoid the cemetery in accordance with the Tennessee laws regarding the treatment of human remains (see Attachment B).

As part of the assessment for the LRA, a supplemental records study and report focused on a 10-mile radius sensitivity analysis for potential visual effects on architectural historic properties. The 10-mile radius was drawn from a point equidistant between the two cooling towers at SQN (Figure 2.12-2). The study considered all previously recorded architectural properties within the radius covering portions of Bradley, Hamilton, and Meigs counties, Tennessee. Architectural information included maps and county architectural survey files housed at the THC in Nashville. (Karpynec 2010)

The study located five NRHP-listed properties (Figure 2.12-2 and Table 2.12-2). The Hiram Douglas House (nominated in 1973); the Brown House (nominated in 1973); the Pleasant L. Matthews House (nominated in 1976); and the Retro School (nominated in 2010) are located in Hamilton County. The fifth, in Meigs County, is the Bradford Rymer Barn (nominated in 1982). For the three properties nominated after SQN operations began, potential adverse effects on the visual integrity of the properties were already determined inconsequential to the nomination. The two resources nominated in 1973 are both located more than 4 miles from SQN, and the view of the cooling towers is blocked by intervening topography. In fact, all five properties are located more than 4 miles from SQN, in valleys where intervening topography blocks the view of SQN.

The 10-mile architectural study also reported buildings of historical interest that have never been assessed as eligible or not eligible for the NRHP, including seven individual buildings, the closest of which is approximately 7.2 miles southeast of SQN, and multiple buildings in the town of Soddy, including the downtown district, approximately 5.8 miles northwest of SQN. However, none of these properties have been determined eligible for the NRHP by the THC, and all are at distances and in topographic positions where visual effects from continued operations at SQN are implausible.

To summarize, the 2010 Phase 1 archaeological survey report for the SQN site identified no significant cultural resources within the SQN APE and recommended that no further investigation of cultural resources is necessary in connection with the LRA and any future undertakings at SQN. The APE for the Phase 1 survey included all land within the SQN site boundary. A site files search of the 6-mile radius in November 2011 confirmed that there are no newly recorded archaeological sites within the SQN APE that were not identified in the 2010 report.

The 10-mile architectural sensitivity study found that no historic properties would receive adverse impacts from continued operation of SQN. In letters dated May 5 and May 20, 2010, TVA received concurrence with the findings and recommendations of the report from the THC (see

Attachment B). A site file update review was subsequently conducted by TRC in December 2011 and no new historic properties were found within the 10-mile radius (Barrett 2011).

No specific properties of religious or cultural significance were identified through tribal consultation. Comments were received from three of the 13 tribes contacted: the Alabama-Coushatta Tribe of Texas, the United Keetoowah Band of Cherokee Indians in Oklahoma, and the Seminole Band of Florida. All concurred with the finding of no effects from continued operation of SQN (see Attachment B).

As a federal agency, TVA is required to assess any future undertakings or inadvertent discoveries under Section 106 [36 CFR Part 800] or Section 110 of the NHPA. These assessments ensure that existing or potentially existing cultural resources are adequately considered, and it assists TVA in meeting state and federal expectations.

Table 2.12-1
Cultural Resources on SQN and Within 0.5-Mile of SQN Boundary

Site[a]	In SQN APE	NRHP
40HA22	Yes	Destroyed/not eligible
40HA20	Yes	Destroyed/not eligible
40HA21	No	Not assessed
40HA43	No	Not assessed
40HA46	No	Not assessed
40HA549	Yes	Not eligible
HS-1	No	Not eligible
HS-2	Yes	Not eligible

(TVA 2011a)

a. All sites are in Hamilton County.

Table 2.12-2
Architectural Historic Properties Within a 10-Mile Radius of SQN

Site	County	Listed NRHP
Hiram Douglas House	Hamilton	Yes
Brown House	Hamilton	Yes
Pleasant L. Matthews House	Hamilton	Yes
Retro School	Hamilton	Yes
Bradford Rymer Barn	Meigs	Yes

(Barrett 2011; Karpynec 2010)

Figure 2.12-1
SQN Site with Area of Potential Effect Shown

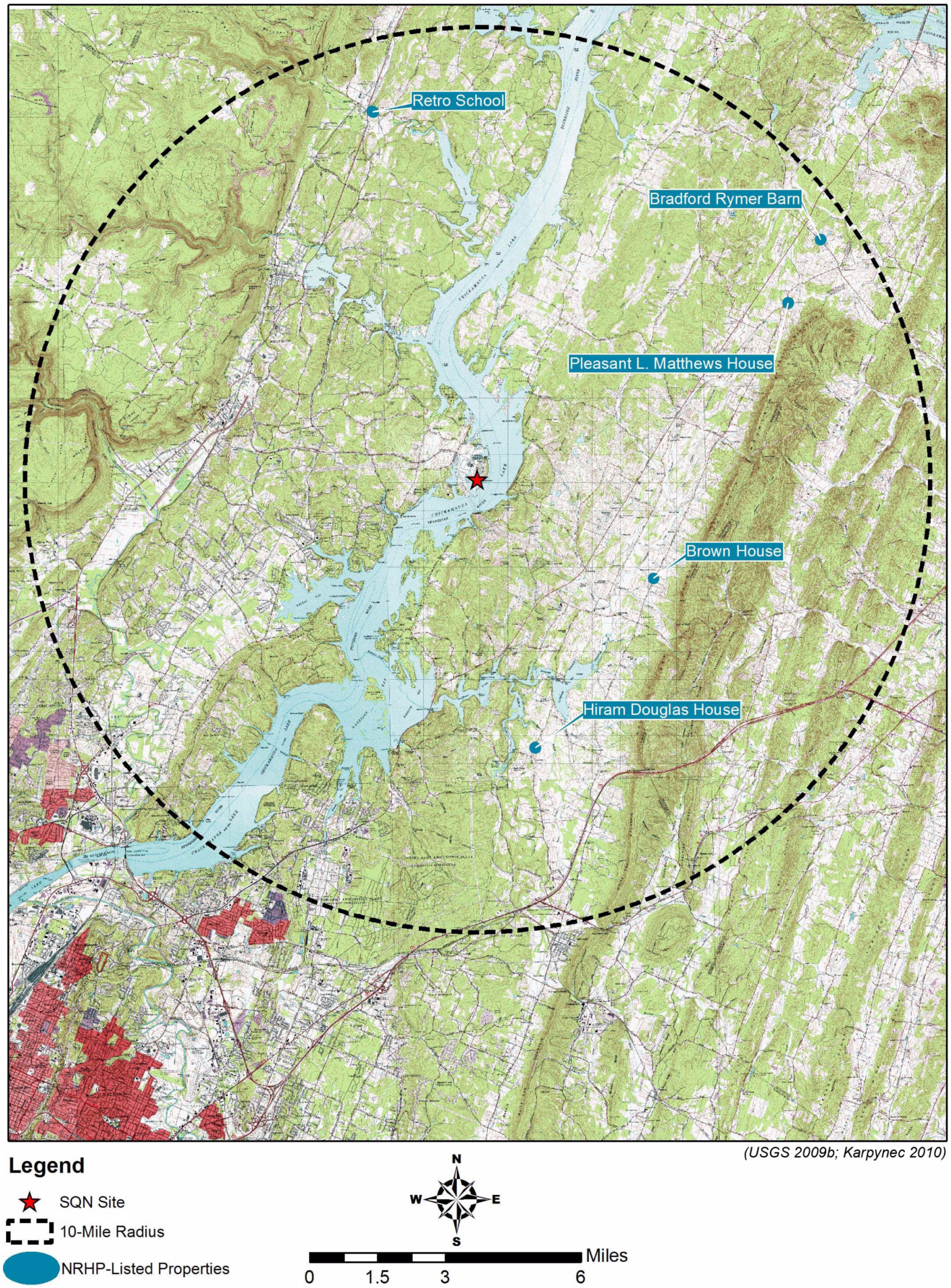


Figure 2.12-2
10-Mile Vicinity for SQN Site with Associated Historical Properties

Figure 2.12-3
Oblique Aerial Photograph Taken During SQN Plant Construction

Locale of Site 40HA20 in left middle distance, behind a line of trees on the far shore of the intake lagoon. View to north. (TVA 2011m)

Figure 2.12-4
Oblique Aerial Photograph Taken During SQN Plant Construction

Locale of Site 40HA20 just above and left of center.
View to north-northeast. (TVA 2011m)

Figure 2.12-5
Oblique Aerial Photograph Taken During SQN Plant Construction ca. 1969

Locale of 40HA22 disturbed by row of TL structures in foreground.
View to north-northwest. (TVA 2011m)

2.13 Related Federal and Non-Federal Projects and Other Actions

The following sections discuss reasonably foreseeable future projects that may contribute to cumulative environmental impacts of license renewal at SQN and the surrounding region.

2.13.1 SQN Projects

As discussed in Section 3.3, no refurbishment activities are planned.

SQN has an ISFSI used to safely store spent fuel in licensed and approved dry cask storage containers on site. This ISFSI is licensed separately from the SQN operating units and would remain in place until the U.S. Department of Energy (DOE) takes possession of the spent fuel and removes it from the site for permanent disposal or processing. Expansion of the onsite spent fuel storage capacity may be required in the future if the DOE does not take responsibility for the permanent storage and disposal of the onsite spent fuel. The impacts associated with this expansion would be assessed under a licensing process separate from that of the SQN operating units.

The SQN plant has also been selected by DOE for purchase of irradiation services. Tritium production at SQN was studied in DOE's environmental impact statement (EIS) for tritium production in a commercial light water reactor (DOE 1999). Tritium production could require the addition of employees (fewer than 10 employees per unit), as well as additional plant modifications. It is expected that irradiated tritium-producing burnable absorber rod (TPBAR) assemblies, nonradioactive waste, and some additional low-level radioactive waste (LLRW) would be transported off site for processing and disposal. (DOE 1999)

To date, SQN has not produced tritium for the DOE; however, on September 28, 2011, DOE announced its intent to prepare a supplemental EIS (SEIS) to update the environmental analyses (76 FR 60017). Four alternatives are expected to be analyzed in DOE's SEIS: the no action alternative (no change from the action identified in the DOE and TVA decision record) and three action alternatives. The three action alternatives would consist of tritium production at WBN only, tritium production at SQN only, and tritium production at both WBN and SQN. TVA will participate as a cooperating agency in the preparation of DOE's SEIS, and the draft SEIS is expected to be published in 2013. DOE's SEIS would consider any cumulative impacts associated with the proposed extension of the SQN operating licenses. Prior to any tritium production at SQN, TVA would need to submit license amendment applications to the NRC.

On May 18, 2011, TVA issued a final EA (TVA 2011n) and finding of no significant impact (FONSI) for the additional use of blended low-enriched uranium (BLEU) at SQN. At SQN, TVA utilizes nuclear fuel derived from commercially available low-enriched uranium (LEU) or weapons-usable highly enriched uranium (HEU) declared surplus to defense needs of the U.S. government. Most of the fuel needs are met with commercial sources of LEU. The HEU is made suitable for nuclear reactor fuel through a process known as "downblending" to produce BLEU. Under an existing agreement, TVA has previously acquired about 33 metric tons of HEU from the DOE, contracted to have it converted to BLEU, and used it as a partial fuel supply at SQN since 2005. TVA testing indicates that HEU-derived fuel performed normally, caused no changes in plant operational parameters, characteristics, or safety, and resulted in no new or additional wastes beyond those occurring with typical operations (75 FR 41850). Under the currently proposed action, TVA would acquire an additional 28 metric tons of HEU from the DOE for downblending to BLEU and subsequent use as reactor fuel at its Browns Ferry Nuclear (BFN) plant and SQN through about 2022. (TVA 2011n)

TVA is coordinating with the DOE on projects regarding other types of nuclear fuel involving the DOE's disposition of nuclear materials pursuant to U.S. nuclear non-proliferation policies. The DOE's National Nuclear Security Administration recently announced its intent to modify the scope of the surplus plutonium disposition (SPD) SEIS to potentially provide alternative methods of disposing of surplus plutonium. The DOE, with TVA as a cooperating agency, is to prepare the SPD SEIS to analyze the potential environmental impacts of the disposal of plutonium. The use of mixed oxide (MOX) fuel in up to five reactors operated by TVA at SQN and BFN would be included in the analysis. Fabricating MOX fuel entails mixing plutonium oxide with depleted uranium oxide, manufacturing the fuel into pellets, and loading the pellets into fuel assemblies for use in nuclear reactors. If the DOE decides to dispose of some surplus plutonium by loading it in nuclear reactors, several decisions would need to be made by the NRC and TVA before MOX fuel is used at SQN and/or BFN. In addition, TVA would need to submit license amendment applications to the NRC. (TVA 2011a)

2.13.2 TVA Projects

TVA has numerous water management projects and facilities in the area as discussed in Section 2.2. In addition, TVA owns and operates numerous electricity generating plants in the Tennessee Valley region. TVA generating plants within a 50-mile radius of SQN include the hydroelectric Raccoon Mountain Pumped-Storage Plant, the fossil fuel Widow's Creek Plant, and WBN. Raccoon Mountain Pumped-Storage Plant (Figure 2.2-2) is in southeast Tennessee on a site that overlooks the Tennessee River near Chattanooga. Widow's Creek fossil plant, with eight generating units, is on Guntersville Reservoir (Figure 2.2-2) on the Tennessee River in northeast Alabama.

WBN is in Rhea County, Tennessee, on 1,700 acres at the northern end of Chickamauga Reservoir, adjacent to the TVA Watts Bar Dam Reservation at TRM 528 on the western shore of Chickamauga Reservoir (approximately 43 river miles upstream from SQN). Unit 1 is operational and Unit 2 is estimated to be completed between September and December 2015. (TVA 2012i)

TVA also has plans for construction of another nuclear unit downstream of SQN. On August 31, 2011, TVA issued a record of decision (ROD) in support of its proposal to complete construction of and to operate a single nuclear unit at the Bellefonte site in Hollywood, Alabama. The unit is Bellefonte Unit 1, a partially completed 1,260-megawatt Babcock and Wilcox (B&W)-designed nuclear unit. The site is a 1,600-acre peninsula in northeastern Alabama, on the western shore of Guntersville Reservoir at TRM 392 (approximately 92 miles downstream of SQN), in Jackson County. Construction activities would resume after fuel is initially loaded at the WBN Unit 2. Commercial operation is expected between 2018 and 2020. (76 FR 53994)

TVA is also studying another site upstream of SQN for nuclear units. TVA signed letters of intent with Babcock & Wilcox and Generation mPower related to the possible development of a project using B&W mPower modular reactors. The B&W-designed reactors are expected to have a capacity in the range of 125-160 megawatts. TVA has identified its Clinch River breeder reactor site in Oak Ridge, Tennessee, more than 80 miles upstream on the Clinch River, which joins the Tennessee River (see Figure 2.2-2), as a potential site for an mPower plant. In late 2010, TVA began studies of the suitability of the Clinch River site, including environmental issues. (TVA 2011o)

TVA also operates three nuclear units at its Browns Ferry Nuclear Plant on the north shore of Wheeler Reservoir (Figure 2.2-2) in northern Alabama.

2.13.3 Other Federal Projects

Section 2.8 discusses land use within Hamilton County, while Table 2.1-1 lists federal lands within a 50-mile radius of SQN. Besides the TVA and DOE projects discussed above, a new navigation lock project has been initiated at Chickamauga Dam at TRM 471 to replace the existing lock. TVA River Operations has a Memorandum of Understanding with USACE, which oversees the design and construction of this project; this agreement ensures that TVA has review rights for this project to ensure that the interests of TVA (including SQN) are protected. The USACE's 2010 project schedule projects completion in 2013 (USACE 2010).

2.13.4 Non-Federal Projects

The vicinity of SQN is primarily residential on the west side of Chickamauga Reservoir and rural on the east side. Much of the residential development is concentrated between the Hixson and Dallas Hills communities and along the reservoir shoreline. More residential development is forecast for the SQN area, but not to the point that population densities will be significant. Contributing to projected development is a provision to install sewage lines in part of the area.

Proposed projects include the potential construction of a Tennessee River toll bridge in north Hamilton County, using the Sequoyah Access Road on the west as the connection from US 27 to the river crossing, with the new bridge and toll road connecting to I-75 on the east side of the river. (TDOT 2011b) This project is in the planning stage and a corridor has been established which shows the general location of the proposed routing across the Tennessee River; however, the exact location of the proposed bridge crossing has not yet been determined. TDOT is currently evaluating the feasibility of undertaking this project as a toll facility. Should TDOT decide to move forward with the project, detailed environmental studies would be conducted, followed by design, permitting, and construction, all in accordance with state and federal regulations. The toll feasibility study currently in progress forecasts a 2021 opening year. (TDOT 2012) TVA is working with TDOT to ensure that the routing of the proposed bridge and toll road will be acceptable to TVA, including nuclear security considerations.

The Chattanooga area has a number of industrial parks including Soddy-Daisy Industrial Park located off Dayton Pike in Soddy-Daisy, which is the closest industrial park to SQN. It consists of 65 acres and is now full (Chattanooga Area Chamber of Commerce 2009). Also, a closer industrial park has been proposed, which would be located between the nuclear plant and Hixson Pike. It would likely house light-manufacturing plants. (TVA 2011p, Section 2.1.4)

Another industrial park in the Chattanooga area is the large industrial park with heavy industry, Enterprise South, which will house heavy industrial facilities. Enterprise South was developed on the site of the Volunteer Army Ammunition Plant. The nearest boundary of the property is about 8 miles from the SQN site (TVA 2011p, Section 2.2.1), south of SQN and on the eastern side of the Tennessee River. Once development is complete, Enterprise South will have 3,000 developable acres. Enterprise South is the home of the Volkswagen Chattanooga Assembly Plant. The plant has had positive economic impacts on the Chattanooga area and has led to additional construction and parts supply contracts awarded to local and state parts suppliers. One of the 161-kV transmission lines from SQN is named the Volkswagen to Chickamauga line. The Volkswagen plant began production in 2011 and employs approximately 2,300 workers (Volkswagen 2011b).

Based on the "Envirofacts Warehouse" online database provided by the EPA, EPA-regulated facilities within approximately 5 miles of SQN can be categorized as follows: (EPA 2011c)

- Six are registered point sources which produce and release air pollutants and are monitored by the Air Facility System (AFS).
- No sites are registered for cleanup as "brownfields" in the assessment, cleanup, and redevelopment exchange system (ACRES) database.
- No sites are registered Superfund sites.
- Two facilities are permitted to discharge wastewater into waterways or rivers.
- Forty-one facilities report hazardous waste management activities.
- Two facilities are registered to store toxic chemicals on site.
- None of the facilities are regulated by the Toxic Substance Control Act.

3.0 THE PROPOSED ACTION

3.1 Description of the Proposed Action

The proposed action is to renew the facility operating licenses for SQN Units 1 and 2, which would preserve the option for TVA to continue to operate SQN to meet TVA's future system generating needs throughout the 20-year license renewal period. For SQN Units 1 and 2 (Facility Operating Licenses DPR-77 and DPR-79), the requested renewals would extend the license expiration dates from midnight September 17, 2020, to midnight September 17, 2040, and from September 15, 2021, to midnight September 15, 2041, respectively.

As discussed in this ER, there are no changes related to license renewal with respect to operation of SQN Units 1 and 2 that would significantly affect the environment during the period of extended operation. In addition, no refurbishment or other construction activities are planned in association with license renewal.

3.2 General Plant Information

The principal structures of SQN consist of two reactor buildings, a turbine building, an auxiliary building, a control building, a service and office building, a diesel generator building, an intake pumping station, ERCW pumping station, two natural draft cooling towers, 161-kV and 500-kV switchyards, a condensing water discharge and diffuser system, and an ISFSI (TVA 2011a, Section 1.1.1). Figure 2.1-1 shows the general features of the facility. Figure 2.1-2 shows the exclusion zone. No residences are permitted within this exclusion zone.

3.2.1 Reactor and Containment Systems

3.2.1.1 Reactor System

SQN utilizes pressurized water reactors (PWRs) in the nuclear steam supply system and a once-through circulating water system supplemented by intermittent operation of the cooling towers that withdraws cooling water from and discharges to Chickamauga Reservoir. Westinghouse Electric Corporation supplied the nuclear steam supply system (TVA 2011p, Section 1.1). Power generation during the license renewal term will consist of SQN Units 1 and 2, with PWRs and turbine generators producing outputs of approximately 2,400 total megawatts electric (MWe) of base load electrical generation. Unit 1 commenced commercial operation in July 1981, and Unit 2 commenced commercial operation in June 1982 (TVA 2011p, Section 1.1).

Fuel for SQN is made of slightly enriched (< 5 percent by weight) uranium dioxide, ceramic cylindrical pellets contained in Zircaloy-4 tubing, which are sealed at the ends to encapsulate the fuel. Based on core design values, SQN operates at an individual rod average fuel burn-up (burn-up is the amount of fuel utilized in the fission process) of no more than 62,000 megawatt-days per metric ton uranium (MWD/MTU), which ensures that peak burn-ups remain within acceptable limits specified in Appendix B to Subpart A of 10 CFR Part 51 (Table B-1). (TVA 2011a, Section 1.1.1)

SQN's Units 1 and 2 are available for the production of tritium in the reactor units. The production of tritium was evaluated in detail by the U.S. Department of Energy (DOE) in its *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE 1999). SQN has not actually produced tritium for the DOE, and TVA would have to amend its OLs before production could commence. There are no plans to do so.

The following modifications have been planned or implemented at SQN to support tritium production:

1. Four rod cluster control assemblies were relocated from core periphery control rod drive mechanism position to provide improved reactivity control.

2. Improved monitoring instrumentation was installed in the waste disposal system.

3. New sampling system was provided in the auxiliary building and shield buildings exhaust vents.

4. Additional grab sampling capability was provided.

5. Tritium-producing burnable absorber rod consolidation equipment in the spent fuel pit cask loading area was installed.

In a tritium production mode, SQN would continue to comply with all federal, state, and local requirements.

3.2.1.2 Containment System

The containment for each reactor consists of a freestanding steel vessel with an ice condenser and separate reinforced concrete shield building. The ice condenser was designed by the Westinghouse Electric Corporation. The freestanding containment vessel was designed by Chicago Bridge & Iron. (TVA 2011p, Section 1.1)

The inherent design of the pressurized water, closed-cycle reactor minimizes the quantities of fission products released to the atmosphere. Three barriers exist between the fission product accumulation and the environment. These are the fuel cladding, the reactor vessel and coolant loops, and the reactor containment. The consequences of a breach of the fuel cladding are greatly reduced by the ability of the uranium dioxide lattice to retain fission products. Escape of fission products through a fuel cladding defect would be contained within the pressure vessel, loops, and auxiliary systems. Breach of these systems or equipment would release the fission products to the reactor containment, where they would be retained. The reactor containment is designed to adequately retain these fission products under the most severe accident conditions. (TVA 2011p, Section 1.2.2.2)

3.2.2 Cooling and Auxiliary Water Systems

3.2.2.1 Condenser Circulating Water System

As shown in Figure 3.2-1, condenser circulating water (CCW) is withdrawn from Chickamauga Reservoir at a combined intake structure and pumping station situated at the end of a trapezoidal intake channel, which leads from an intake embayment (TVA 2011a, Section 1.1.1).

The CCW system provides each turbine generator unit a nominal flow of approximately 535,000 gallons per minute (gpm) to the main condensers and sufficient flow to the raw cooling water (RCW) system for use by auxiliary equipment. The main steam condenser mass flows are based on a maximum temperature rise of 29.5°F for the circulating water through the condensers. (TVA 2011q, Section 1.2) This water flow is of sufficient quantity to condense the steam at an optimum main condenser back pressure and dissipate all rejected heat. The CCW can dissipate a portion of the waste heat directly to the atmosphere by use of the cooling towers in the helper mode when required to meet thermal criteria. The CCW can also provide for dilution and dispersion of routine low-level radioactive liquid wastes. (TVA 2011a, Section 1.1.1)

The CCW system consists of six circulating water pumps, a water intake structure and discharge lines, traveling screens, screen wash pumps, and associated piping, valves, and instrumentation. Each pump has a capacity of 187,000 gpm. The pumps are mounted vertically in the intake structure and discharge into six separate lines and then to two separate conduits with one conduit supplying each unit's main condenser. (TVA 2011a, Section 3.1.4.1)

A floating trash boom is located at the Chickamauga Reservoir shoreline to protect the intake channel from floating debris. An intake skimmer wall also spans the entrance to the embayment. (TVA 2011a, Section 1.1.1) The intake channel extends approximately 1,800 feet from the skimmer wall to the CCW pumping station.

The skimmer wall has a clear opening length of 550 feet and an opening height of 9.7 feet, with the top of the opening at 641 feet above mean sea level (msl), approximately 34 feet below minimum pool elevation of Chickamauga Reservoir. The skimmer wall is designed to allow withdrawal of cooler water from the lower depths of Chickamauga Reservoir. Because of the low elevation of withdrawal, the temperature of the water entering the condensers is normally less than the temperature at the Chickamauga Reservoir surface. (TVA 2011a, Section 1.1.1)

Approximately 250 feet upstream from the discharge diffusers and 1 mile downstream from the intake skimmer wall, an underwater dam exists across the main river channel. The dam is about 90 feet wide and 900 feet long, with the crest at 654 feet above msl. The underwater dam decreases the thickness of any upstream warm water wedge resulting from the thermal discharge from the diffusers. The dam also impounds the cooler water in the lower layer of Chickamauga Reservoir, making this water available to the plant intake. (TVA 2011a, Section 1.1.1)

CCW flows into the intake structure through trash racks designed to catch larger trash such as driftwood, plastic containers, etc. The flow then passes through six traveling screens at an intake velocity of approximately 1.7 feet per second (fps), three screens for each unit (Figure 3.2-1). The traveling screens have 3/8-inch square openings and are designed to trap smaller trash and any larger-sized trash that may have passed through the trash racks. (TVA 2011q, Section 2.1; SQN 2011b) Differential pressure across each traveling screen is monitored by an air bubbler system. When a preset differential pressure of water is reached across the screen, the screen wash pump is started. When a preset pressure is established at the screen wash nozzles, the screen motors are automatically started, and the screens are washed until the pump is manually stopped. (TVA 2011p, Section 10.4.5.2) Each screen will pass a flow of 189,000 gpm at low water depth of 28 feet in the intake channel and the rate of travel of the screens is approximately 10 feet per minute. (TVA 2011q, Section 2.1)

The CCW system is designed to operate in any of three modes: open, helper, or closed. In the open mode, the water bypasses the cooling tower lift pumps and is returned to Chickamauga Reservoir through the diffuser pond and the discharge diffusers.

In the helper mode, the water is pumped into the cooling towers by the lift pumps, then passes through the cooling towers where part of the waste heat is liberated directly to the atmosphere. The cooled water is returned to Chickamauga Reservoir. (TVA 2011p, Section 10.4.5.2) During the helper mode, four lift pumps are designed to deliver approximately 560,000 gpm at a head of 82 feet to each cooling tower (TVA 2011q, Section 1.3). The pumps are in the cooling tower pumping station at the downstream end of the discharge pond. The cooling towers are designed to reject waste heat to the atmosphere, thereby cooling the CCW when river flow/temperatures do not permit direct CCW discharge to the river. (TVA 2011p, Section 10.4.5.2)

The amount of cooling water loss due to evaporation and drift from the cooling towers depends on a number of factors, such as the amount and temperature of flow delivered to the cooling towers and local meteorology. When the plant is operated in helper mode, the net consumption of water for a single day will be larger than the annual average day. For example, when operated under design conditions (a conservative upper-bounding scenario), the net loss of water due to evaporation and drift in the cooling towers is about 45 MGD (70 cfs). In a similar fashion, on a daily basis, the river flow is often lower than the annual average flow. Based on the current operating policy for the TVA reservoir system, the daily average river flow past the SQN site can be as low as 3,000 cfs. However, in practice, the river flow past SQN seldom drops below a daily average of 6,000 cfs. Thus, on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. (TVA 2012j)

In the closed mode, the water is pumped through the cooling towers where the waste heat is liberated directly to the atmosphere and then returned to the intake channel. (TVA 2011p, Section 10.4.5.2) However, it should be noted that although the physical capability exists to operate in the "closed mode," it is not utilized because it would result in significant power derates. Closed-mode testing after plant start-up determined that significant derates would be involved because the cooling tower performance was not sufficient. To improve cooling tower performance, increased cooling tower capacity would likely be required prior to closed-mode operation, from some combination of replacing the fill material, converting from a cross-flow to a counter-flow cooling tower design, installing improved spray nozzles, or possibly adding a third cooling tower. In addition, the individual gates associated with the gate structure between the cooling tower discharge and the diffuser pond would need to be re-installed; the three gates that are kept closed for both the open and helper modes of operation would need to be refurbished; one of the cooling tower lift pumps would need to be replaced; cooling tower lift pump power supply issues would need to be resolved; and the return channel would likely need to be cleaned to prevent carry-over of silt from fouling the condensers. (SQN 2011a)

In addition to the water supplied for CCW, the CCW system supplies water to the plant RCW pumps and raw service water pumps that in turn supply cooling water to nonessential systems, systems not necessary for the safe shutdown of the reactor. RCW can be supplied by gravity head from the river via the condenser intake tunnels in case of complete outage of the CCW pumps. (TVA 2011p, Section 10.4.5.2)

There are currently no structural or operational measures to reduce entrainment and impingement of fish and shellfish associated with the CCW intake structure, largely based on evidence of a lack of adverse environmental impact to the source water body biological community as discussed in Section 2.2. (SQN 2011b)

3.2.2.2 Diffuser Pond

Heated water is discharged from the condenser discharge pond (open mode) or the cooling towers (helper mode) directly into the diffuser pond, from which it is discharged to Chickamauga Reservoir through two diffuser pipes (Figure 3.2-1). The upstream and downstream diffuser pipes are 17 feet and 16 feet in diameter, respectively, and are installed in the approximately 900-foot wide navigation channel. Each diffuser section is 350 feet long and contains 17 two-inch diameter ports per foot of pipe length. (TVA 2011a, Section 1.1.1)

There are two corrugated metal diffuser pipes that extend under the 1,500-foot diked embankment into the river channel. One diffuser is laid to diffuse the water 350 feet across the north side and the other to diffuse the water 350 feet across the south side of the channel. (TVA 2011p, Section 10.4.5.2) Flow rate through the diffuser pipes is controlled by the difference in the diffuser pond and Chickamauga Reservoir water levels. At maximum plant capacity, each diffuser discharges about 1,240 cfs with a driving head of 5.4 feet. (TVA 2011a, Section 1.1.1) When the plant discharges into the pond at a lower rate and the difference between diffuser pond water level and the Chickamauga Reservoir surface elevation drops below 4 feet, a gate automatically closes the downstream diffuser and the diffuser pond is emptied through the upstream diffuser. The upstream diffuser is not gated and will discharge to the river whenever the pond level is greater than the Chickamauga Reservoir level. Approximately 2 to 3 hours would be required to empty the diffuser pond if there are no discharges into the pond.

In summary, the diffusers are designed to provide rapid mixing of the discharged effluent with the river flow. The flow through the diffusers is driven by the elevation head difference between the diffuser pond and the river. Flow is discharged into the diffuser pond via the blowdown line, ERCW system, and CCW system. The diffuser system is composed of two pipes, which are set alongside each other on the river bottom. They extend from the SQN-side bank of the river into the main channel. The main channel begins near the SQN-side bank of the river and is approximately 900 feet wide at SQN Unit 1. Each diffuser pipe has a 350-foot section through which flow is discharged into the river. The downstream diffuser leg discharges across a section 0 to 350 feet from the SQN-side bank of the main channel. The upstream diffuser leg starts at the end of the downstream diffuser leg, and discharges across a section 350 to 700 feet from the SQN-side bank of the main channel. The two diffusers, therefore, provide mixing across nearly the entire main channel width. (TVA 2011p, Section 2.4.12)

3.2.2.3 Thermal Discharge

The NPDES permit specifies the existing mixing zone as an area 750 feet wide, extending 1,500 feet downstream and 275 feet upstream of the diffusers. The depth of the mixing zone measured from the surface varies linearly from the surface 275 feet upstream of the diffusers to the top of the diffuser pipes and extends to the bottom downstream of the diffusers. If the plant is ever operated in closed mode, the mixing zone would also include the area of the intake forebay. (SQN 2011c, page 2) The justification for the mixing zone is based on a physical model study of the discharge diffusers, which examined the thermal effluent over a wide range of plant and river conditions, including reverse flows in Chickamauga Reservoir (TVA 2011a, Section 3.1.3.1).

The NPDES permit for SQN identifies the release of cooling water to the Tennessee River (Chickamauga Reservoir) through the plant discharge diffusers as Outfall 101. Under the current NPDES permit, SQN is limited to a maximum 24-hour average temperature rise of 3°C for April through October, a maximum 24-hour average temperature rise of 5°C for November through March, and a maximum hourly average temperature rate-of-change of 2°C per hour. The water temperature at the downstream end of the diffuser mixing zone is limited to a daily maximum 24-hour average of 30.5°C except in the case when the 24-hour ambient temperature exceeds 29.4°C. In cases when the 24-hour ambient temperature exceeds 29.4°C, the water temperature at the downstream end of the diffuser mixing zone may exceed a daily maximum 24-hour average of 30.5°C provided that the plant is operated in helper mode. But in all situations, the hourly average downstream temperature at the downstream end of the mixing zone shall not exceed 33.9°C. (SQN 2011c, page 3) Helper mode is defined as full operation of one cooling tower and at least three cooling tower lift pumps in service for each operating unit (SQN 2011c, page R-8).

SQN continues to operate under an alternative thermal limitation as allowed under Section 316(a) of the CWA that has been administratively continued with each NPDES permit renewal based on initial studies conducted in the 1980s (SQN 2011c, page R-7) and continued annual monitoring and reporting. The alternative thermal limitation allows for an upstream to downstream rise in temperature as great as 5ºC during the months of November through March (SQN 2011c, page R-8).

3.2.2.4 Essential Raw Cooling Water

The ERCW system is designed as a safety-related system to supply cooling water to various heat loads in both the primary and secondary portions of each unit. Provisions are made to ensure a continuously available flow of cooling water to those systems and components necessary for plant safety during either normal operation or under accident conditions. The ERCW also discharges into the cooling tower return channel and provides a continuous source of blowdown for effluent dilution. (TVA 2011p, Section 9.2.2.1)

The ERCW pumping station is located within the plant intake skimmer structure (Figure 3.2-2) and has direct communication with the main river channel for all Chickamauga Reservoir levels, including loss of the downstream dam. The ERCW station and all equipment therein remain operable during the probable maximum flood. The system also has the ability to remain operational during flood and loss of the downstream dam. (TVA 2011p, Section 9.2.2.2)

The ERCW system consists of eight ERCW pumps (11,000 gpm each), four traveling water screens, four screen wash pumps (270 gpm each), and four strainers located at the ERCW pumping station, and associated piping and valves. The ERCW station draws water directly from Chickamauga Reservoir (TVA 2011p, Section 9.2.2.2; TVA 2011r, Sections 2.2.1 and 2.4). The estimated minimum river flow requirement for the ERCW system is only 45 cfs (TVA 2011r, Section 1.5).

The ERCW supply temperature maximum average is 87ºF (SQN 2007a). Supply water for the ERCW pumps enters the pumping station through each of four traveling water screens at a velocity of < 0.50 cfs directly into a corresponding ERCW pump pit from which two ERCW pumps take suction. (TVA 2011p, Section 9.2.2.2; SQN 2011b) The traveling screens (two ERCW pumps per pit) at the intake pumping station (IPS) are 1/4" mesh designed to remove 3/8" diameter and larger objects. Each screen is designed to pass sufficient water for one train of ERCW. A routine manual backwash of the traveling screens is performed four times per week; however, it may be necessary to run unscheduled backwashes as result of debris accumulation. Debris is deposited into a runoff flume. (TVA 2011r, Section 2.2)

Water is supplied to the auxiliary building from the ERCW pumping station through four independent sectionalized supply headers. During all conditions of operation, the discharge from the various heat exchangers served by the ERCW system goes to a seismically qualified open basin with overflow capability, then flows by gravity to the return channel of the natural draft cooling towers of the CCW system. (TVA 2011p, Section 9.2.2.2)

3.2.3 Radioactive Waste Treatment Processes (Gaseous, Liquid, and Solid)

The site uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a by-product of plant operations. Radioactive materials in liquid and gaseous effluents are reduced to levels as low as reasonably achievable (ALARA) prior to release into the environment. Radionuclides that can be efficiently removed from the liquid and gaseous effluents prior to release are converted to a solid waste form for eventual disposal in a licensed disposal facility with other solid radioactive wastes.

3.2.3.1 Liquid Waste Processing Systems and Effluent Controls

The liquid waste processing system (LWPS) was initially designed to collect and process potentially radioactive wastes for recycle to the reactor coolant system or for release to the environment. The LWPS was, by original design, arranged to recycle as much reactor grade water entering the system as practical. This was implemented by the segregation of equipment drains and waste streams, which prevents the intermixing of liquid wastes. The layout of the LWPS, therefore, consists of two main subsystems designed for collecting and processing reactor grade (tritiated) and non-reactor grade (non-tritiated) water, respectively. (TVA 2011p, Section 11.2.2)

All liquids are now routinely processed as necessary for release to the environment instead of recycling and are no longer maintained segregated based on tritium content during processing. This includes reprocessing the contents of tanks which accumulate wastewater for discharge which may be unsuitable for direct release (e.g., monitor tank to floor drain collector tank for reprocessing via radwaste demineralizer system or similar). Provisions are made to sample and analyze liquids before they are discharged. Based on laboratory analysis, these wastes are either released under controlled conditions via the cooling water system or retained for further processing. (TVA 2011p, Section 11.2.2)

In addition, a system is provided for handling laboratory samples which may be tritiated and may contain chemicals. Capability for handling and storage of spent demineralizer resins is also provided. (TVA 2011p, Section 11.2.2)

The plant LWPS is controlled from a central panel in the auxiliary building and a panel in the main control room. Abnormalities in the system, like a high sump level, for example, actuate an alarm/level switch in the auxiliary building, which annunciates in the control room. All system equipment is located in or near the auxiliary building, except for the reactor coolant drain tank (RCDT) and drain tank pumps and the various reactor building floor and equipment drain sumps and pumps, which are in the containment building. (TVA 2011p, Section 11.2.2)

The radwaste demineralizer system is located and operated in the auxiliary building railroad access bay when the vendor's service is requested (TVA 2011p, Section 11.2.2).

At least two valves must be manually opened to permit the discharge of liquid to the environment. One of these valves is normally locked closed. An automatic control valve trips closed on a high effluent radioactivity level signal. Administrative controls prevent discharge without dilutions. (TVA 2011p, Section 11.2.2)

Parts of the LWPS are shared by the two units. However, as the system serves no emergency function, the safety of either unit is not affected. (TVA 2011p, Section 11.2.2)

3.2.3.1.1 Shared Components

The LWPS consists of one RCDT with two pumps, an auxiliary reactor building floor and equipment drain sump with two pumps, a keyway sump with one pump, and a reactor building floor and equipment drain sump with two pumps inside the containment building of each unit. The following shared equipment is inside the auxiliary building:

- One sump tank and two pumps.

- One tritiated drain collector tank (TDCT) with two pumps and one filter.
- One floor drain collector tank (FDCT) with two pumps and one strainer, monitor tank and two pumps.
- A chemical drain tank and pump.
- Two hot shower drain tanks (HSDT) and pump.
- A spent resin storage tank (SRST).
- A cask decontamination tank with two pumps and two filters.
- Auxiliary building floor and equipment drain sump and two pumps.
- A passive sump.
- A radwaste demineralizer system.
- Associated piping, valves, and instrumentation. (TVA 2011p, Section 11.2.2)

The following shared components are located in the condensate demineralizer building for receiving, processing, and transferring wastes from the regeneration of condensate demineralizers: high crud, low-conductivity tanks, pumps and filters; a neutralizer tank and pumps; and a non-reclaimable waste tank (NRWT) and pumps (TVA 2011p, Section 11.2.2).

Separation of Tritiated and Non-Tritiated Liquids

Waste liquids high in tritium content are routed to the TDCT, while liquids low in tritium content are routed to the FDCT. All tritiated and non-tritiated liquid wastes are processed for discharge to the environment. (TVA 2011p, Section 11.2.2)

Tritiated Water Processing

Tritiated reactor grade water enters the liquid waste disposal system from equipment leaks and drains, valve leak-offs, pump seal leak-offs, tank overflows, and other tritiated and aerated water sources including drain down of the chemical and volume control system (CVCS) holdup tanks, as desired (TVA 2011p, Section 11.2.2). Although the plant is designed to reuse this processed water, due to higher reactor water chemistry standards, water from these sources is processed through the radwaste demineralizer (Rad DI) and then prepared for release via one of two release tanks, either the monitor tank or the cask decontamination collector tank (CDCT) (TVA 2012k).

The equipment provided in this channel consists of a TDCT, pumps, and filter and radwaste demineralizer system. The primary function of the TDCT is to provide sufficient surge capacity for the radwaste processing equipment. (TVA 2011p, Section 11.2.2)

The liquid collected in the TDCT contains boric acid and fission product activity. The liquid can be processed as necessary to remove fission products so the water may be reused in the reactor coolant system or discharged to the environment. (TVA 2011p, Section 11.2.2)

Non-Tritiated Water Processing

Non-tritiated water is sampled and processed as necessary for discharge to Chickamauga Reservoir. Sources include floor drains, equipment drains containing non-tritiated water, certain sample room and radiochemical laboratory drains, hot shower drains, and other non-tritiated sources. The equipment provided in this channel consists of an FDCT, pumps, and strainer, radwaste demineralizer system, HSDT and pump, cask decontamination collector tank and pumps, and monitor tank and pumps. (TVA 2011p, Section 11.2.2)

Liquids entering the FDCT are from small-volume, low-activity sources. If the activity is below permissible discharge levels following analysis to confirm an acceptably low level, the tank contents may be discharged without further treatment other than filtration. Otherwise, tank contents are processed through the radwaste demineralizer system. (TVA 2011p, Section 11.2.2)

The HSDTs normally need no treatment for removal of radioactivity. The inventory of these tanks may be discharged directly to the cooling tower blowdown line via the HSDT strainer or to other tanks in the liquid waste system (TVA 2011p, Section 11.2.2) should sampling determine that treatment is needed prior to discharging.

The liquid waste system is also designed to process blowdown liquid from the steam generators of a unit having a primary-to-secondary leak coincident with significant fuel rod clad defects. The blowdown from the steam generators is passed through the condensate demineralizer or directly to the cooling tower blowdown line. (TVA 2011p, Section 11.2.2)

Radwaste Demineralizer System Processing of Tritiated and Non-Tritiated Waste

Flow from both the tritiated and non-tritiated tanks is routed to the radwaste demineralizer system by use of the waste evaporator and auxiliary waste evaporator feed pumps. Processed water from the system is routed to either the monitor tank or the cask decontamination tank. The contents of these tanks are recycled, reprocessed, or discharged as described in previous sections. The radwaste demineralization system removes soluble and suspended radioactive materials from the waste stream via ion exchange and filtration. Once the resin and filter media are expended, it is processed for disposal. Filters are air dried and placed into containers for disposal. (TVA 2011p, Section 11.2.2)

Laboratory Sample Processing

Laboratory solutions which contain chemicals can be discarded in a separate sink which drains to the chemical drain tank. Low-activity drains from the laboratory, such as flush water, are routed to the floor drain tank. Excess tritiated samples not contaminated by chemicals during analysis can be directed to the TDCT. (TVA 2011p, Section 11.2.2)

Processing of Waste from Regeneration of Condensate Demineralizer

High conductivity chemical regenerate and rinse wastes produced during condensate demineralizer regeneration are routed to the neutralization tank (NT) or, alternately, to the non-reclaimable waste tank (NRWT), where they are collected and neutralized. If the contents of either tank (NT or NRWT) are not radioactive or if the radioactivity level is less than the dischargeable limit, it is transferred to the turbine building sump and subsequently discharged through the low-volume waste treatment pond, or alternately to the cooling tower blowdown line. If the contents of either the NT or NRWT are radioactive, they may be discharged to the cooling tower blowdown line if the radioactivity level is within specification; otherwise, they are processed by the radwaste system. (TVA 2011p, Section 11.2.2)

Low-conductivity wastewater produced during condensate demineralizer regeneration is routed to the high crud tanks (HCT-A and HCT-B), where it is collected and neutralized (if necessary). If the contents of HCTs are not radioactive or if the radioactivity level is within dischargeable limits, they are transferred to the turbine building sump and subsequently discharged through the low-volume waste treatment pond or yard pond, or discharged to the cooling tower blowdown line. If the contents of the HCTs are radioactive, they may be processed through the radwaste system or released via the cooling tower blowdown line. (TVA 2011p, Section 11.2.2)

Spent Resin Processing

Spent ion exchange resin is stored in the SRST. To remove spent resins from the storage tank for packaging, the resin is agitated by bubbling nitrogen through the tank to the vent header. The resin is slurried from the SRST, by nitrogen pressure, to the railroad bay, where it is received in approved liners and dewatered prior to shipment off site or storage in SQN's LLRW on-site storage facility. (TVA 2011p, Section 11.2.2)

3.2.3.1.2 System Summary

Below is a summary of components associated with the liquid waste processing system.

Reactor Coolant Drain Tank and Pumps

The RCDT (one tank per unit) collects reusable clean reactor coolant type water from inside the reactor containment building. Two pumps are set up on a common header to take suction from either the RCDT or the pressurizer relief tank. These pumps can transfer the liquid from the drain tank to the CVCS holdup tanks and transfer water from the refueling canal to the refueling water storage tank. The RCDT is normally vented to the vent header. Because there is oxygen in the refueling water, the tank can be isolated from the vent header and vented locally to the containment sump or containment atmosphere if necessary. (TVA 2011p, Section 11.2.3.1)

Chemical Drain Tank and Pump

The shared chemical drain tank receives radioactive wastes from the radiochemical laboratory drains and from the decontamination room. The pump is provided to transfer tank contents. If activity and chemical contamination are very small and within applicable release limits, tank contents are pumped to the monitor or cask decontamination collector tanks for discharge. Under certain conditions (high activity and no harmful chemicals), the tank contents are pumped to the FDCT using the HSDT's pump. (TVA 2011p, Section 11.2.3.1)

Sump Tank and Pumps

The sump tank collects tritiated liquid wastes from equipment and lower elevation drains, which cannot drain by gravity to the TDCT. Two pumps are furnished to transfer the liquid collected to the TDCT. The tank vents to the building exhaust system. (TVA 2011p, Section 11.2.3.1)

Tritiated Drain Collector Tank and Pumps

The shared tank retains radioactive liquids from the primary plant which contain tritiated water, boric acid, and fission products. The primary function of the tank is to provide sufficient surge capacity for the radwaste processing equipment. Two shared pumps are provided to transfer tank contents to the radwaste demineralizer system. When the radwaste demineralizer system is used to remove soluble and suspended radioactive material, boron is passed through the system and can be discharged to the cooling tower blowdown via the liquid radwaste tanks. (TVA 2011p, Section 11.2.3.1)

Floor Drain Collector Tank and Pumps

The shared tank retains primarily non-reactor grade type fluids and some nonrecyclable reactor grade water from certain drains in the auxiliary building. Following analysis to confirm an acceptable low-activity level, the tank contents can be discharged to the environment without further treatment other than filtration. However, further processing is available through the radwaste demineralizer system should high activity fluids enter the tank. Two shared pumps are provided to transfer the tank contents to the radwaste demineralizer system. (TVA 2011p, Section 11.2.3.1)

Hot Shower Drain Tanks and Pump

The HSDTs collect radioactive wastes from the hot shower drains. A pump is utilized to transfer the liquid for processing or discharge. A recirculation line is provided to permit mixing the contents of the isolated tank before taking samples for activity analysis. If the activity concentration is too high for direct discharge, the waste may be pumped to the floor drain collection tank for further processing. (TVA 2011p, Section 11.2.3.1)

Spent Resin Storage Tank

This tank is supplied for the storage of used demineralizer resins. Resin is held in this tank for decay of short-lived isotopes and periodically removed to preclude the possibility of resin agglomeration. A layer of water is maintained over the resins to prevent degradation due to decay heat. (TVA 2011p, Section 11.2.3.1)

Outdoor Tanks

The two refueling water storage tanks, the two primary makeup water storage tanks, and the two condensate storage tanks have the potential to contain radioactive liquid. Each of the two refueling water storage tanks has redundant high-level alarms actuated by separate level switches. The tanks also have an overflow. (TVA 2011p, Section 11.2.3.1)

The overflow line leads to the pipe tunnel which connects the refueling water storage tank and the primary makeup storage tank with the auxiliary building. Liquid overflowing the tank is discharged onto the floor of the tunnel, from which it flows down a gutter to floor drains at the end of the tunnel adjacent to the auxiliary building. The floor drains are directed to the FDCT of the liquid radwaste system. (TVA 2011p, Section 11.2.3.1)

Each primary makeup water storage tank has a high-level alarm and an overflow. The overflow line discharges into the same pipe tunnel into which the refueling water storage tank overflow discharges. From the tunnel, the liquid drains into the liquid radwaste system. (TVA 2011p, Section 11.2.3.1)

Each condensate storage tank has a high-level alarm and an overflow. The overflow line terminates beside the tanks just above ground level. Liquid overflowing the tanks would be collected in nearby drains and be discharged into the diffuser pond. From the diffuser pond, liquid is discharged via the diffuser. (TVA 2011p, Section 11.2.3.1)

Filters

The filters provided are of two types, the first being a bag type made of felt using polyester, polypropylene, or an equivalent material. Each filter is a once-through design using one to two filters or strainers or a combination of a filter and strainer which are nested one inside of the other. This allows for different combination of filters and/or strainers to obtain acceptable water qualities. The other type of filter is a round cartridge or spun cartridge type construction which relies on a tortuous path to filter particles rather than a carefully controlled absolute hole size. Because of the type of construction, no absolute hole size rating is given. (TVA 2011p, Section 11.2.3.1)

The methods employed to change filters and screens are dependent on activity levels. Filters are valved out of service with a pressure indicator between the isolation valves to assure the valves are not leaking through and the filter is not at system pressure. The filter is drained to the appropriate tank and vented locally. If the radiation level of the filter is low enough, it is changed manually. If activity levels do not permit manual change, the spent filter is removed remotely utilizing temporary shielding to reduce personnel exposure. The spent filter is placed in a shielded drum for removal to the solid waste storage area. A new filter is installed, the housing is reassembled, vent and drain valves are closed, and the new filter is valved into service. Filters are normally changed because of high differential pressure rather than high radiation levels. (TVA 2011p, Section 11.2.3.1)

Floor Drain Collector Tank and Tritiated Drain Collector Tank Discharge Filters

Filters or strainers are provided to remove particulate matter from the tritiated and FDCTs recirculation paths. The vessels are constructed of austenitic stainless steel, and the replaceable filter element is nylon or an equivalent material. (TVA 2011p, Section 11.2.3.1)

Hot Shower Drain Tank Basket Strainer

The HSDT basket strainer is a perforated stainless steel sheet within a stainless steel casing. It is designed to prevent particles from entering the FDCT. (TVA 2011p, Section 11.2.3.1)

Cask Decontamination Collector Tank

The cask decontamination collector tank can receive water used in the decontamination of the spent fuel shipping cask except during dry cask storage operation, wherein the HI-TRAC transfer cask is decontaminated locally on the auxiliary building refueling floor. The cask decontamination collector tank is normally used as one of two available clean release tanks whose contents may be processed as needed for release to the environment. (TVA 2011p, Section 11.2.3.1)

Cask Decontamination Collector Tank Filters

Two filters are provided to remove particulate matter larger than 25 microns from the cask decontamination waste. The vessels are constructed of stainless steel, and the replaceable filter elements are polyester or polypropylene. Both filters are normally bypassed when the CDCT is used as a release tank. (TVA 2011p, Section 11.2.3.1)

Condensate Demineralizer Waste Processing Equipment High Crud Tanks

These tanks collect high crud, low-conductivity waste produced during the backwash phase of condensate demineralizer regeneration. Nonradioactive high crud waste can be routed directly to the turbine building sump or filtered and discharged to the cooling tower blowdown line, provided discharge permit requirements are satisfied. Radioactive high crud waste can be discharged to the cooling tower blowdown line only when the activity is within specified limits. If not within limits, the waste is transferred to the liquid radwaste treatment system for further processing. (TVA 2011p, Section 11.2.3.1)

Bag Filters

Three bag filters are provided upstream of the high crud filter to filter the discharge stream. The vessels are constructed of stainless steel and the replaceable filters' elements are polypropylene.

During normal operating mode, two bag filters are in service. The third filter, which is on standby and isolated, may be placed in service while changing out the clogged filters, one at a time, obviating the need to secure flow through the system. (TVA 2011p, Section 11.2.3.1)

Neutralization Tank

This tank collects spent regenerant chemicals and rinses from condensate demineralizer regeneration (low crud, high-conductivity waste). Sulfuric acid or sodium hydroxide is added to adjust the pH to a value between 6.0 and 9.0. The tank contents are circulated during pH adjustment. After neutralization, tank contents are analyzed for radioactivity. If within limits, they are pumped to the turbine building sump, cooling tower blowdown line, or the liquid radwaste treatment system. (TVA 2011p, Section 11.2.3.1)

Non-Reclaimable Waste Tank

The NRWT receives the same type waste as the neutralization tank. The capability to adjust pH in the tank is provided. The contents of the tank can be routed to the turbine building sump, cooling tower blowdown line, or the liquid radwaste treatment system. (TVA 2011p, Section 11.2.3.1)

Facilities for Venting and Draining

Provisions have been made for venting and draining equipment which may require maintenance during the plant life. Vents and drains are provided either on the components themselves or in the pipelines between the isolation valves. In general, each pipeline and component vent and drain is provided with a valve plus a backup leakage barrier. (TVA 2011p, Section 11.2.3.1)

Radwaste Demineralization System

The radwaste demineralizer system (also referred to as portable demineralizer or Rad DI) is utilized when required to process radioactive liquid waste. The demineralizers and associated equipment are located in the auxiliary building elevation 706 waste packaging area. The radwaste demineralizer system consists of plant-installed equipment and a vendor owned and operated water processing skid, and is utilized as required for efficient radioactive liquid waste processing via ion exchange and filtration. This is accomplished by use of a combination of chemical treatment, filtration, and ion exchange technology. All radwaste demineralizer final effluents produced by the vendor are verified to meet applicable regulatory requirements prior to release, including 10 CFR Part 20 and NRC Regulatory Guide 1.143. (TVA 2011p, Section 11.2.3.1)

3.2.3.1.3 Liquid Effluent Releases

Controls for limiting the release of radiological liquid effluents are described in the ODCM. Controls are based on (1) concentrations of radioactive materials in liquid effluents and projected dose, or (2) dose commitment to a hypothetical member of the public. (SQN 2009b, page 10)

The concentration of radioactive material released in liquid effluents to unrestricted areas is limited to 10 times the effluent concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration is limited to 2 x 10^{-4} microcurie/ml total activity. (SQN 2009b, Section 1.2.1.1)

The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released to unrestricted areas are limited during any calendar quarter to less than or equal to 1.5 millirem (mrem) to the total body and to less than or equal to 5 mrem to any organ, and during any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ. (SQN 2009b, Section 1.2.1.2)

Radioactive liquid wastes are subject to the sampling and analysis program described in the ODCM. The radioactive liquid waste sampling and analysis program specifications provided in the ODCM address the gaseous release type, sampling frequency, minimum analysis frequency, type of activity analysis, and lower limit of detection. (SQN 2009b, Table 2.2-1)

3.2.3.2 Gaseous Waste Processing System and Effluent Controls

The gaseous waste processing system (GWPS) is designed to remove fission product gases from the reactor coolant and permit operation with periodic batch discharges of small quantities of fission gases through the monitored plant vents. This is accomplished by internal recirculation of radioactive gases and holdup in the nine gas decay tanks to reduce the concentration of radioisotopes in the released gases. The offsite exposure to individuals from gaseous effluents released during normal operation of the plant is limited by 10 CFR Part 50 Appendix I and 40 CFR Part 190. (TVA 2011p, Section 11.3.1)

The GWPS consists of two waste-gas compressor packages, nine gas decay tanks, and the associated piping, valves, and instrumentation. The equipment serves both units. Gaseous wastes can be received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown; displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header; purging of some equipment; sampling and gas analyzer operation; and boron recycle process operation (no longer in service). (TVA 2011p, Section 11.3.2)

3.2.3.2.1 Auxiliary Services

The auxiliary services portion of the GWPS consists of an online waste gas analyzer and its instrumentation, valves, and tubing; the nitrogen and hydrogen supply manifolds; and the necessary instrumentation, valves, and piping (TVA 2011p, Section 11.3.2).

The online gas analyzer determines the quantity of oxygen and hydrogen in the waste gas tank that is in service. The volume control tank, pressurizer relief tank, holdup tanks, and SRST may be analyzed by grab sample as plant conditions require. (TVA 2011p, Section 11.3.2)

The nitrogen and hydrogen supply packages are designed to provide a supply of gas to the nuclear steam supply system. Nitrogen supply for the auxiliary and reactor buildings has two headers inside the auxiliary building, each with its own backup supply of high-pressure nitrogen. Alignment is such that both headers are normally supplied by the liquid nitrogen skid located in the east auxiliary building yard. One header is for operation and one is for backup. Twenty-four nitrogen cylinders per bank provide the backup nitrogen supply, or a trailer-mounted nitrogen tank can be connected near the liquid nitrogen skid. (TVA 2011p, Section 11.3.2)

The pressure regulator in the nitrogen backup header is set slightly lower than that in the operating header. When nitrogen from the operating header is exhausted, its discharge pressure falls below the set pressure of the backup header, which comes into service automatically to ensure a continuous supply of nitrogen. An alarm alerts the operator that one header is exhausted. Hydrogen is supplied from two headers up into the reducing station for the auxiliary building, at which point only one header supplies both units' volume control tanks. One serves as the operational header and the other serves as the backup header. (TVA 2011p, Section 11.3.2)

Nitrogen is supplied to the SRST, RCDT, pressurizer relief tank, volume control tank, gas decay tanks and the holdup tanks. Hydrogen is supplied to the volume control tank. (TVA 2011p, Section 11.3.2)

3.2.3.2.2 System Summary

Below is a summary of components associated with the gaseous waste processing system.

Waste Gas Compressors

Two waste gas compressors are provided for continuous or batch removal of gases discharging to the vent header. One unit is supplied for normal operation and is capable of handling the gas from a holdup tank which is receiving letdown flow at the maximum rate. The second unit is provided for backup during peak load conditions, such as degassing the reactor coolant or for service when the first unit is down for maintenance. Operation of either unit can be controlled manually or by vent header pressure. (TVA 2011p, Section 11.3.3.1)

Waste Gas Decay Tanks

Nine tanks are provided to hold radioactive waste gases for decay. This arrangement is adequate for a plant operating with 1 percent fuel defects. Nine tanks are provided so that during normal operation, a minimum of 60 days are available for radioactive decay of gaseous effluents prior to release to the environment. (TVA 2011p, Section 11.3.3.1)

3.2.3.2.3 Gaseous Effluent Releases

Gaseous radioactive effluents are released to the atmosphere through vents on the shield building, auxiliary building, turbine building, and service building (TVA 2011p, Section 11.3.7).

Controls for limiting the release of radiological gaseous effluents are described in the ODCM. The gaseous radwaste system is used to reduce radioactive materials in gaseous effluents before discharge to meet the dose design objectives in 10 CFR Part 50, Appendix I. In addition, the limits in the ODCM are designed to provide reasonable assurance that radioactive material discharged in gaseous effluents would not result in the exposure of a member of the public in an unrestricted area in excess of the limits specified in 10 CFR Part 20, Appendix B. (SQN 2009b, page 10)

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the unrestricted area boundary is limited to less than or equal to 500 mrem/year to the total body and 3,000 mrem/year to the skin for noble gases, and less than or equal to 1,500 mrem/year to any organ for iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days. (SQN 2009b, Section 1.2.2.1)

The air dose due to noble gases released in gaseous effluents to areas at and beyond the unrestricted area boundary is limited to less than or equal to 5 millirad (mrad) for gamma radiation and 10 mrad for beta radiation during any calendar quarter, and less than or equal to 10 mrad for gamma radiation and 20 mrad for beta radiation during any calendar year. (SQN 2009b, Section 1.2.2.2)

The dose to a member of the public from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released to areas at and beyond the unrestricted area boundary is limited to less than or equal to 7.5 mrem to any organ, and less than or equal to 15 mrem to any organ during any calendar year (SQN 2009b, Section 1.2.2.3).

The radioactive gaseous waste sampling and analysis program specifications provided in the ODCM address the gaseous release type, sampling frequency, minimum analysis frequency, type of activity analysis, and lower limit of detection (SQN 2009b, Table 2.2-2).

3.2.3.3 Solid Waste Processing

The resin slurries and solid radwaste produced by SQN Units 1 and 2 are prepared for shipment or temporary onsite storage in compliance with the requirements in 10 CFR Part 61, 10 CFR Part 71, and 49 CFR Parts 170 through 178. Solid wastes are processed by the solid waste system. (TVA 2011p, Section 11.5.1)

Waste inputs are divided into two categories: dry active waste (DAW) and wet active waste (WAW). DAW and WAW inputs are products of the plant operation and maintenance. DAW is further subdivided into compactable and noncompactable wastes. Solid compactable wastes include paper, clothing, rags, mop heads, rubber boots, and plastic. Noncompactable wastes include tools, mop handles, lumber, glassware, pumps, motors, valves, and piping. The WAW is primarily composed of spent resins. Sources for spent resins are the SRST and the radwaste demineralizer system. (TVA 2011p, Section 11.5.2)

3.2.3.3.1 Wet Active Waste Processing

Bulk Resin Processing

When sufficient spent resin is accumulated in the SRST, the appropriate valves necessary to transfer spent resin to the liner filling area in the railroad access bay are opened except for the liner fill valves. The SRST is pressurized with nitrogen. The liner filling valves are opened and the resin is forced into the liner. Primary water used in the transfer is removed from the liner by a dewatering pump to the liquid waste system. The level in the liner is monitored so the resin flow can be stopped when the desired level is reached. During transfer, nitrogen is forced through the spargers in the tank to slurry and level the resin and maintain tank pressure. When the liner is full, the liner filling valves are closed and tank pressure is relieved to the plant waste gas system. The filling valves and transfer line are flushed by pumping primary makeup water through the transfer route to both the liner and the tank. (TVA 2011p, Section 11.5.3.1)

Loading is accomplished with the casks mounted on a truck or trailer bed. The truck or trailer is located in the auxiliary building railroad bay. The cask with disposable liner is filled from the SRST. The spent resins are dewatered to meet the free-standing water limitations at licensed disposal facilities. Flush connections are provided from the primary makeup water system to flush the resin slurry lines. In the event the container were to overflow during the filling process, the initial overflow would be contained in the volume between the cask and liner. In certain cases, spent resins are stabilized (possibly packaged in a high integrity container [HIC] or solidified). Solidification is carried out with an offsite vendor-supplied mobile solidification system. A process control program is utilized to conduct the solidification. (TVA 2011p, Section 11.5.3.1)

The shipping container consists of an inner disposable liner with an outer reusable shield cask. Filter elements are mounted inside the liner and connected to a hose outside the shield to facilitate dewatering operations. The container also has fill and vent connections. (TVA 2011p, Section 11.5.3.1)

Several types of shipping casks may be used. All casks have been licensed pursuant to the general license provisions of paragraph 71.12(b) of 10 CFR Part 71. (TVA 2011p, Section 11.5.3.1)

Radwaste Demineralizer Resin Processing

Spent resins from the radwaste demineralizer system are sluiced to a transportable liner or HIC inside a shipping container within the auxiliary building railroad bay area and dewatered to meet the disposal facilities' free-standing water limitations. The dewatered resins and disposable liners are prepared for shipment or temporary onsite storage. (TVA 2011p, Section 11.5.3.1)

Condensate Polishing Regeneration Resin Processing

Spent resins from the condensate polishing system are transferred directly to a disposal liner (radwaste) or suitable container (nonradwaste) from the condensate polishing system SRST.

The disposal liner or container is adjacent to the condensate polishing system building. After transfer of the resins is complete, the liner or container is dewatered and prepared for shipment or temporary onsite storage. (TVA 2011p, Section 11.5.3.1)

3.2.3.3.2 Dry Active Waste Processing

The waste packaging area is provided for receiving, sorting, and compacting DAW. Bagged and/or boxed DAW collected throughout the plant is brought to the waste packaging area for final packaging into 55-gallon drums or metal boxes. Collected waste may also be sent to a contracted broker/processor for processing, packaging, and/or subsequent disposal. (TVA 2011p, Section 11.5.3.2)

Compactable DAW Processing

Compactable trash—like paper, clothing, rags, and plastic—is collected and compacted or may be transported to a contracted broker/processor for processing, packaging, and/or subsequent disposal (TVA 2011p, Section 11.5.3.2).

Noncompactable DAW Processing

Items such as tools, mop handles, valves, motors, piping, lumber, and some compactables are packaged, sealed, and stored until shipped for offsite disposal. Collected waste may also be sent to a contracted broker/processor for processing, packaging, and/or subsequent disposal. (TVA 2011p, Section 11.5.3.2)

3.2.3.3.3 Miscellaneous Waste Handling

Air and gas filter and prefilter elements and glassware are packaged, sealed, and stored until shipped for offsite disposal or may be transported to a contracted broker/processor for processing, packaging, and/or subsequent disposal. DAW filters are packaged when necessary in HICs. If the radiation levels of containers are high enough to require shielding, the containers are transported in shielded truck trailers or casks similar to those used to transport liners containing bulk quantities of dewatered resins. (TVA 2011p, Section 11.5.3.3)

3.2.3.4 Radwaste Storage—License Renewal Term

LLRW is classified as Class A, Class B, or Class C (minor volumes are classified as greater than Class C). Class A includes both DAW and WAW. Classes B and C are normally WAWs. The majority of LLRW generated would be Class A waste and can be shipped to Oak Ridge, Tennessee, for reduction, packaging, and shipping to a Class A disposal facility such as Energy Solutions LLC in Clive, Utah. Classes B and C wastes constitute a low percentage by volume of the total LLRW and are currently stored in the onsite storage facility at SQN. (TVA 2011a, Section 3.18.1.1)

SQN's onsite storage facility was designed to contain packaged radwaste generated at SQN and WBN Unit 1. Although TVA may decide to transport LLRW from WBN Unit 2 to SQN in the future, long-term plans do not include constructing additional onsite storage facilities to accommodate generated Classes B and C radwaste during the license renewal term.

Based on the draft GEIS, on average, the volume and radioactivity of LLRW generated at a PWR are approximately 10,600 ft^3 and 1,000 Curies per year, respectively. Approximately 95 percent of this waste [by volume] is Class A. (NRC 2009a, Section 3.11.1.1) In comparison, the total current inventory of the SQN onsite storage facility as of August 2012, which has accumulated waste since 2009, is only 895 ft^3 and 689 Curies; therefore, this would be conservatively bounded by that specified in the draft GEIS.

By procedure, the total storage capacity of SQN's onsite storage facility is limited to 88,500 Curies. Therefore, for the 20-year license renewal term, even assuming that TVA decides to transport LLRW from WBN Unit 2 to SQN at similar annual volumes as currently generated at WBN Unit 1, adequate storage capacity for LLRW will be available during the license renewal term.

3.2.3.5 Spent Fuel Storage

SQN maintains an ISFSI on site for temporarily storing spent fuel. The SQN ISFSI is within the existing protected area boundary, southeast of the Unit 2 Reactor Building. The ISFSI storage pad (Figure 2.1-1) consists of eight sections, which is sufficient to store ninety (90) HI-STORM 100 storage systems. In addition to the storage pad, the ISFSI is surrounded by security fencing and monitored by various security systems.

3.2.4 Transportation of Radioactive Materials

SQN radioactive waste shipments are packaged in accordance with NRC and U.S. Department of Transportation (USDOT) requirements specified in 40 CFR Part 71 and Title 49 of the CFR, respectively. The type and quantities of solid radioactive waste generated at and shipped from SQN vary from year to year, depending on plant activities. SQN currently transports radioactive waste to a licensed processing facility in Tennessee such as the Studsvik, Duratek (owned by EnergySolutions), or Race (owned by Studsvik) facilities, where the wastes are further processed prior to being sent to a facility such as EnergySolutions in Clive, Utah.

3.2.5 Radiological Environmental Monitoring Program

The SQN REMP is designed for:

- Analyzing important pathways for anticipated types and quantities of radionuclides released into the environment.
- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.

- Considering the potential radiation exposure to plant and animal life in the environment surrounding SQN.
- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

The SQN REMP was established in 1971 prior to the station becoming operational (1980) to provide data on background radiation and radioactivity normally present in the airborne, direct radiation, waterborne, and ingestion pathways (SQN 2012g, pages 8 and 9). The REMP includes sampling indicator and control locations within a 40-mile radius of the plant (SQN 2012g, Appendix A). The REMP utilizes indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation, and control locations farther away from the site to indicate the presence of only naturally occurring radioactivity. SQN personnel compare indicator results with control and preoperational results to assess any impact operations might have had on the surrounding environment.

3.2.6 Groundwater Protection Monitoring Program

In May 2006, the NEI approved an industry-wide voluntary effort entitled the Groundwater Protection Initiative (GPI) to enhance nuclear power plant operators' management of groundwater protection (NEI 2007). Industry implementation of the GPI identifies actions to improve utilities' management and response to instances where the inadvertent release of radioactive substances may result in detectable levels of plant-related materials in subsurface soils and water. This includes communication of those instances to external stakeholders. Aspects addressed by the initiative include site hydrology and geology, site risk assessment, onsite groundwater monitoring, and remediation. In August 2007, NEI published updated guidance on implementing the GPI known as NEI 07-07, "Industry Ground Water Protection Initiative—Final Guidance Document" (NEI 2007). The goal of the GPI is to reduce any impact on groundwater from the accidental release of licensed material to the environment.

In conjunction with the GPI, SQN performs groundwater monitoring from 19 onsite locations (Well-21, Wells 24–35, GP-7A, GP-7B, GP-10, GP-13, GP-24, and the diffuser pond), as shown in Figure 3.2-3, to monitor for potential radioactive releases via groundwater pathways at the site in accordance with nuclear fleet administrative and site procedures (SQN 2008a; TVA 2008b). Results associated with this program are discussed in Section 9.1.3.7. In addition, current site groundwater conditions were previously described in Section 2.3.6, with associated impacts evaluated in Section 4.0.5.

Elements of the GPI related to site characterization, risk evaluation, groundwater monitoring program, precipitation studies, remediation protocols, voluntary reporting, and briefings to external stakeholders of accidental releases of licensed material to the environment are conducted and implemented in accordance with TVA's fleet groundwater protection program procedure (TVA 2008b).

In addition to the GPI, the Underground Piping and Tanks Integrity Initiative (NEI 09-14) was developed and is being implemented by the industry to proactively manage the reliability of underground piping and tanks with a goal of protecting structural integrity and preventing leaks. SQN initiated compliance with this initiative in accordance with the schedule and program elements cited in NEI 09-14 (Revision 1). SQN has completed the risk ranking of buried piping segments, developed an inspection plan for underground piping and tanks, and is currently implementing inspections in accordance with the schedule outlined in the Underground Piping and Tanks Integrity Initiative.

3.2.7 Meteorological System

The SQN meteorological facility consists of a 91-meter (300-foot) instrumented tower for wind and temperature measurements, a separate 10-meter (33-foot) tower for dewpoint measurements, a ground-based instrument for rainfall measurements, and an environmental data station (EDS), which houses the data collection and recording equipment. A system of lightning and surge protection circuitry with proper grounding is included in the facility design. This facility is approximately 0.74 miles (1.2 kilometers) southwest of the reactor building and about 50 feet (15 meters) above plant grade. (TVA 2011p, Section 2.3.3.1)

3.2.7.1 Instrument Description

A description of the meteorological sensors is as follows (TVA 2011p, Section 2.3.3.1):

- Wind direction and wind speed measurements are obtained at 10, 46, and 91 meters utilizing an ultrasonic wind sensor.
- Temperature measurements are obtained at 10, 46, and 91 meters utilizing a platinum resistance temperature detector with aspirated radiation shield.
- Dewpoint measurements are obtained from a separate 10-meter tower utilizing a capacitive humidity sensor.
- Rainfall measurements are obtained at 1 meter from a tipping bucket rain gauge located approximately 55 feet from the 91-meter tower.

3.2.7.2 Data Acquisition System and Accuracy

The data acquisition system is at the EDS and consists of meteorological sensors, a computer, and various interface devices. These devices send meteorological data to the plant and two different offsite computers. One computer is utilized specifically for Central Emergency Control Center (CECC) emergency preparedness functions. The other is used to relay meteorological data from the EDS to an offsite computer for validation, reporting, and archiving. This meteorological data collection system is designed, and replacement components are chosen, to meet or exceed specifications for accuracy, as specified in NRC Regulatory Guide 1.23, Revision 1. (TVA 2011p, Section 2.3.3.2)

3.2.7.3 Data Recording and Display

Data acquisition is under control of the computer program. The output of each meteorological sensor is scanned periodically, scaled, and the data values stored. The following meteorological sensor outputs are measured every 5 seconds (720 per hour): horizontal wind direction and wind speed, temperature and dewpoint. Rainfall is measured continuously as it occurs. Software data processing routines within the computer accumulate output and perform data calculations to generate 15-minute and hourly averages of wind speed and temperature, 15-minute and hourly vector wind speed and direction, hourly average of dewpoint, hourly horizontal wind direction sigmas, and 15-minute and hourly total precipitation. Subsequently, vector wind speed and direction have been calculated along with arithmetic average wind speed. (TVA 2011p, Section 2.3.3.3)

Selected data each 15 minutes and all data each hour are stored for remote data access. Data sent to the plant computer systems every minute include 10-, 46-, and 91-meter values for wind speed, wind direction, and temperature. (TVA 2011p, Section 2.3.3.3)

Data sent to the CECC computer in Chattanooga every 15 minutes include 91-, 46-, and 10-meter wind direction, wind speed, and temperature values. These data are available from the CECC computer to other TVA and state emergency centers in support of the radiological emergency plan, including the technical support center at SQN. Remote access of meteorological data by the NRC is available through the CECC computer. Data are sent from the EDS to an offsite computer for validation, reporting, and archiving. (TVA 2011p, Section 2.3.3.3)

3.2.7.4 Equipment Servicing, Maintenance, and Calibration

Meteorological equipment at EDS is kept in proper operating condition by staff trained and qualified for necessary tasks. Most equipment is checked, calibrated, or replaced at least every 6 months of service. The methods for maintaining a calibrated status for the components of the meteorological data collection system (sensors, recorders, electronics, DVM, data logger, etc.) include field checks, field calibration, and/or replacement by a laboratory-calibrated component. More frequent calibration intervals for individual components may be conducted, on the basis of the operational history of the component type. (TVA 2011p, Section 2.3.3.4)

3.2.8 Nonradioactive Waste Systems

3.2.8.1 Resource Conservation and Recovery Act Wastes

Nonradioactive hazardous and nonhazardous wastes are collected in central collection areas and managed in accordance with SQN's site procedure (SQN 2008b). The materials are received in various forms and packaged to meet all regulatory requirements prior to final disposition at an offsite facility licensed to receive and manage the material. Listed below is a summary of the types of waste materials generated and managed at SQN.

- Because SQN's hazardous waste generator classification ranges from conditionally exempt small quantity generator to small quantity generator, hazardous wastes routinely make up only a small percentage of the total wastes generated, and typically consist of paints and paint-related materials, spent and off-specification (e.g., shelf-life expired) chemicals, laboratory chemical wastes, and occasional project-specific wastes. Hazardous wastes from SQN are transferred to TVA's permitted hazardous waste storage facility (HWSF) in Muscle Shoals, Alabama, which serves as a central collection point for all TVA-generated hazardous wastes. It is then shipped to an approved licensed facility for disposition (TVA 2011a, Section 3.14). Hazardous waste volumes generated at SQN from 2007 to 2011 are shown in Table 3.2-1.

- Special nonhazardous wastes placed in dumpsters such as asbestos, sandblast grit, alum sludge, resin, and sand from water treatment are transported to a licensed landfill (Rhea County Landfill). Special wastes placed in drums such as oily debris, desiccant, resin, nondestructive examination chemicals, and nonhazardous batteries are transferred to TVA's permitted HWSF where it is then shipped to a licensed facility approved by TVA for disposition. (TVA 2011a, Section 3.14)

- Materials such as universal wastes (batteries and lighting wastes), oil, scrap metal, aluminum cans, plastic bottles, cardboard, paper, and wooden pallets are collected and shipped to licensed recycling facilities approved by TVA. (TVA 2011a, Section 3.14)

- General plant trash, also referred to as municipal solid waste, is collected in dumpsters and transported to a state-licensed regional landfill permitted to accept solid wastes. General trash at SQN typically consists of garbage, paper, plastic, packing materials (metal retaining bands, excelsior, cardboard), leather, rubber, glass, soft drink and food cans, expired animals and fish, floor sweepings, ashes, wood, textiles, and scrap metal. Municipal solid wastes are managed and disposed of in a state-permitted landfill. (TVA 2011a, Section 3.14)

TVA holds a State of Tennessee permit for a construction/demolition landfill (Table 9.1-1) within the confines of the SQN site. This landfill is permitted to accept nonhazardous, nonradioactive solid wastes including scrap lumber, bricks, sandblast grit, crushed metal drums, glass, wiring, non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing steel and similar construction, and demolition wastes from the SQN site. The landfill is approximately 18 acres in size but has not received any waste for at least 10 years. The landfill permit is still active and TDEC inspects the landfill quarterly, but there is currently no need to use the landfill. Instead, construction/demolition wastes are managed and disposed of in an offsite state-permitted landfill. (TVA 2011a, Section 3.14)

SQN is committed to the requirements of the Tennessee Hazardous Waste Reduction Act of 1990, which requires the following:

> Wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste generated should, in order of priority, be reduced at its source, recovered and reused,

> recycled, treated, or disposed of to minimize the present and future threat to human health and the environment. (SQN 2011e, Section I)

Programs that have been implemented at the facility to reduce, to the extent feasible, waste generated, treated, accumulated or disposed are described in SQN's Hazardous Waste Minimization Plan. This plan, which identifies previous waste streams eliminated and current waste streams generated at the facility, is updated annually and used in conjunction with procedures associated with waste management (0-TI-ENV-000-002, Solid, Special, Hazardous, and Mixed Waste Management) and chemical control (0-TI-CEM-260-282.0, Chemistry Chemical Traffic Control, and SPP-5.4, Chemical Traffic Control) to minimize waste generation to the maximum extent practicable. (SQN 2008b; SQN 2009c; TVA 2009e)

3.2.8.2 Wastewater Discharges

Some amount of chemical and biocide wastes are produced from processes used to control the pH in the coolant, scale, and corrosion; to regenerate resins; and to clean and defoul the condenser. These waste liquids are typically combined with cooling water discharges in accordance with the site's NPDES Permit TN0026450. The current SQN NPDES permit authorizes discharges from seven outfalls (five external and two internal). The outfalls and their associated effluent limits are listed in Table 3.2-2.

As shown in Figure 2.1-1 and listed in Table 3.2-2, SQN has constructed several onsite ponds to support plant operations. The yard drainage pond identified as the settling pond (Outfall 118) in the NPDES permit, one of the metal cleaning waste ponds (Outfall 107), and the diffuser pond associated with Outfall 101 are unlined, whereas the low volume waste treatment pond (Outfall 103) is lined. No groundwater monitoring requirements are imposed by the NPDES permit as it relates to the use of these ponds.

Sanitary sewage from all plant locations is collected and pumped off site to the Moccasin Bend publicly owned treatment works (POTW), where it is managed appropriately. Although not a POTW requirement, SQN conducts radiological sampling and monitoring of the sanitary effluent on a monthly basis.

3.2.8.3 Potable Water

The source of fire protection water and potable water for SQN is the Hixson Utility District. Water supplied by this municipal water system is treated off site in accordance with applicable drinking water standards, and no further treatment for potable water usage is performed on site. The wastewater associated with potable water usage is routed to the sanitary drainage system, which is discharged off site to the Moccasin Bend POTW, where it is treated. (TVA 2011a, Section 3.1.4.1)

3.2.8.4 Air Emissions

SQN is classified as a minor air emission source. Although SQN may periodically utilize auxiliary boilers in support of plant operations, or utilize portable generator(s) during outages, nonradioactive gaseous effluents are associated primarily with the testing of emergency generators. To protect Tennessee's ambient air quality standards and ensure that impacts are maintained at minimal levels, TDEC governs the discharge of regulated pollutants by establishing specific conditions in the air permit. Emission sources and conditions established in the various SQN air permits by TDEC are shown in Table 3.2-3.

3.2.8.5 Nonradioactive Spills

The use and storage of chemicals at SQN is controlled in accordance with site and fleet chemical control procedures and site-specific spill prevention plans (SQN 2007a; SQN 2009c; SQN 2012b; TVA 2009e). SQN's spill prevention, control and countermeasures (SPCC) plan also serves as the site hazardous waste contingency plan (SQN 2012b, Section 1.4). In addition, as previously discussed in Section 3.2.8.1, nonradioactive wastes are managed in accordance with SQN's waste management procedure, which contains control measures to prevent spills (SQN 2008b). These procedures and plans are designed to prevent and minimize the potential for a chemical or hazardous waste release to the environment.

3.2.9 Maintenance, Inspection, and Refueling Activities

Various programs and activities currently at the site maintain, inspect, test, and monitor the performance of plant equipment. These programs and activities include, but are not limited to, those implemented to:

- Meet the requirements of 10 CFR Part 50, Appendix B (Quality Assurance), Appendix R (Fire Protection), Appendices G and H, Reactor Vessel Materials.
- Meet the requirements of 10 CFR 50.55a, American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section XI, In-service Inspection and Testing Requirements.
- Meet the requirements of 10 CFR 50.65, the maintenance rule.
- Maintain water chemistry in accordance with Electric Power Research Institute (EPRI) guidelines.

Additional programs include those implemented to meet technical specification surveillance requirements; those implemented in response to NRC generic communications; and various periodic maintenance, testing, and inspection procedures necessary to manage the effects of aging on structures and components. Certain program activities are performed during the operation of the units, while others are performed during scheduled refueling outages.

3.2.10 Power Transmission Systems

3.2.10.1 In-Scope Transmission Lines

TVA is the owner and operator of the transmission lines that were constructed for purposes of connecting SQN to the transmission grid (Figure 3.2-4). SQN Unit 1 is connected into the 500-kV transmission network, and SQN Unit 2 is connected into the 161-kV transmission system. The two systems are interconnected at SQN through a 1,200-megavolt ampere, 500–161-kV intertie transformer bank. (TVA 2011a, Section 1.1.2)

As shown in Table 3.2-4, SQN's 1974 FES identified 12 transmission lines that were constructed specifically for SQN, with an additional line completed in 1977 during the interim period between the SQN FES and initial SQN operations. This additional 500-kV line, identified as Watts Bar #2, was added in part to "harden" the transmission system by increasing the redundancy of the connecting lines and by routing the line away from the existing Watts Bar #1 500-kV line (for storm protection, etc.). Although this line could potentially be considered out of scope, TVA has elected to include it for completeness purposes. (SQN 2011f) These 13 transmission lines (Figure 3.2-4), exit the site property in three major corridors, running south, west, and east before branching out.

Since the 1974 FES was written and SQN began operations, names assigned to the transmission lines have changed. Below is a brief description of these changes. A "loop-in connection line" refers to a segment which connects to the lines but does not represent actual transmission line length.

- The pre-SQN Widows Creek-Charleston 161-kV line built in 1964 was looped to form the SQN-Widows Creek and SQN-Charleston No.1 lines, which have now become the North Hixson to Falling Water to Moccasin and the Harrison Bay Tap to Hopewell to Charleston lines, respectively. The loop-in connection lines were less than 1 mile in length. (SQN 2011f)

- The pre-SQN Watts Bar-Chickamauga 161-kV line was looped to form the SQN-Watts Bar and SQN-Chickamauga No. 1 lines, which have now become the Watts Bar Hydro and the Wolftever to Chickamauga lines, respectively. The loop-in connection lines were less than 4 miles in length. (SQN 2011f)

- The pre-SQN Chickamauga-East Cleveland 161-kV line was looped to form the SQN-Chickamauga No. 2 and SQN-East Cleveland lines, which have now become the Volkswagen to Chickamauga and the North Ooltewah to South Cleveland to East Cleveland lines, respectively. The loop-in connection lines are less than 10 miles in length. (SQN 2011f)

- The Sequoyah-Concord 161-kV line, completed in 1972, was built on ROW land acquired in 1968 for the Concord substation and is now called the Concord line. (SQN 2011f)

- The Sequoyah-Charleston No. 2 161-kV line is now referred to as the Charleston line. (SQN 2011f)

- The pre-SQN Widows Creek-Bull Run 500-kV line traversed SQN property and was looped to form the Sequoyah-Widows Creek and Sequoyah-Bull Run 500-kV transmission lines, which have now become the Widows Creek and the Watts Bar No. 1 lines, respectively. The loop connection lines are less than 1 mile in length. (SQN 2011f)

- The Sequoyah-Georgia State line 500-kV line was completed in 1972 and ran 85 miles to Georgia Power's Bowen Steam Plant. TVA built and owns the line from SQN to the state line (approximately 22 miles). The remainder of the line (approximately 63 miles) was built and is owned and operated by Georgia Power and is therefore not considered within scope. This line has now become the Bradley line. (SQN 2011f)

- The Sequoyah-Franklin 500-kV line, which was initially operated at 161 kV, is now referred to as the Franklin line. Construction of this line was completed in 1975. (SQN 2011f)

3.2.10.2 Vegetation Management Program

3.2.10.2.1 Transmission Line Surveillance Program

On an annual basis, TVA assesses the conditions of the vegetation on and along its ROWs by aerial inspections, periodic field inspections, aerial photography, and information from TVA personnel, property owners, and the general public. Information gathered during these assessments includes the coverage by various vegetation types, the mix of plant species, the observed growth, the seasonal growing conditions, and the density of the tall vegetation. The proximity, height, and growth rate of trees adjacent to the ROW that may be a danger to the line or structures are also evaluated. TVA ROW specialists develop a vegetation reclearing plan that is specific to each line segment and is based on terrain conditions, species mix, growth, and density. (TVA 2010f, Section 1.0)

3.2.10.2.2 Right-of-Way Management Program

TVA uses an integrated vegetation management approach. In farming areas, TVA encourages property owner management of the ROW using low-growing crops. In dissected terrain with rolling hills and interspersed woodlands, TVA uses mechanical mowing to a large extent. When slopes become hazardous to farm tractors and rotary mowers, TVA may use a variety of herbicides specific to the species present with a variety of possible application techniques. When scattered small stands of tall-growing vegetation are present and access along the ROW is difficult or the path to such stands is very long, herbicides may be used. In very steep terrain, in sensitive environmental areas, in extensive wetlands, at stream banks, and in sensitive property owner land use areas, hand clearing may be utilized. (TVA 2010f, Section 2.0)

Mechanical mowers not only cut tall saplings and seedlings on the ROW, they also shatter the stumps and the supporting near-surface root crown. The tendency of resistant species is to resprout from the root crown, and shattered stumps can produce a multistem dense stand in the immediate area. Repeated use of mowers on short cycle reclearing with many original stumps regrowing in the above manner can create a single species thicket or monoculture. With the original large root system and multiple stems, the resistant species can produce regrowth at the rate of 5–10 feet in a year. In years with high rainfall, the growth can reach 12–15 feet in a single year. These dense monoculture stands can become nearly impenetrable for even large tractors. Such stands have low diversity and little wildlife food or nesting potential and become a property owner's concern. Selective herbicide application may be used to control monoculture stands. (TVA 2010f, Section 2.0)

TVA encourages property owners to sign an agreement to manage ROWs on their land for wildlife under the auspices of "Project Habitat," a joint project by TVA, BASF, and wildlife organizations (e.g., National Wild Turkey Federation, Quail Unlimited, and Buckmasters). The property owner maintains the ROW in wildlife food and cover with emphasis on quail, turkey, and deer. A variation used in or adjacent to developing suburban areas is to sign agreements with the developer and residents to plant and maintain wildflowers on the ROW. (TVA 2010f, Section 2.0)

The BMPs governing application of herbicides are contained within *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Transmission Construction and Maintenance Activities* (Bowen et al. 2012). Herbicides can be liquid, granular, or powder; can be applied aerially or by ground equipment; and may be selectively applied or broadcast, depending on the site requirements, species present, and condition of the vegetation. Water quality considerations include measures taken to keep herbicides from reaching streams, whether by direct application or through runoff of or flooding by surface water. "Applicators" must be trained, licensed, and follow manufacturers' label instructions, EPA guidelines, and respective state regulations and laws. (TVA 2010f, Section 3.0)

When herbicides are used, their potential adverse impacts are considered when selecting the compound, formulation, and application method. Herbicides designated "Restricted Use" by EPA require application by or under the supervision of applicators certified by the respective state control board, but TVA does not normally use Restricted Use herbicides. Aerial and ground applications are either done by TVA or contractors in accordance with the following guidelines identified in TVA's BMPs manual (TVA 2010f, Section 3.0):

- Sites to be treated are selected and application directed by appropriate TVA official.
- Aerial application of liquid herbicides is normally not made when surface wind speeds exceed 5 miles per hour, in areas of fog, or during periods of temperature inversion.
- Pellet application is normally not made from the air or on frozen or water-saturated soils.
- Liquid application is not performed when the temperature reaches 95ºF or above.

- Application during unstable, unpredictable, or changing weather patterns is avoided.

- Equipment and techniques used are designed to ensure maximum control of the spray swath with minimum drift.

- Herbicides are not applied to surface water or wetlands unless specifically labeled for aquatic use. Filter and buffer strips are to conform at least to federal and state regulations and any label requirements. The use of aerial or broadcast application of herbicides is not allowed within a streamside management zone (SMZ) (200 feet minimum width) adjacent to perennial streams, ponds, and other water sources. Hand application of certain herbicides labeled for use within SMZs is used only selectively.

- Buffers and filter strips (200 feet minimum width) are maintained next to agricultural crops, gardens, farm animals, orchards, apiaries, horticultural crops, and other valuable vegetation.

- Herbicides are not applied in the following areas or times: (a) in city, state, and national parks or forests or other special areas without written permission and/or required permits; (b) off the ROW; and (c) during rainy periods or during the 48-hour interval prior to rainfall predicted with a 20 percent or greater probability by local forecasters, when soil-active herbicides are used.

The rates of herbicide application utilized are those listed on the EPA-approved label and consistent with utility standard practice throughout the southeast. Herbicides utilized by TVA have been evaluated in extensive studies in support of registration applications and label requirements, and many have been reviewed in the U.S. Forest Service vegetation management environmental impact statements. The result of these reviews has been a consistent finding of limited environmental impact beyond that of control of the target vegetation. All herbicides currently utilized by TVA have been found to be of low environmental toxicity when applied by trained applicators following the label and registration procedures, including prescribed measures, such as buffer zones, to protect threatened and endangered species. (TVA 2010f, Section 3.0)

TVA currently uses primarily low-volume applications of foliar and basal applications of Accord (glyphosate) and Accord (glyphosate) Arsenal (imazapyr) tank mixes. Glyphosate is one of the most widely used herbicidal active ingredients in the world and has been the subject of numerous exhaustive studies and scrutiny to determine its potential impacts on humans, animals, and the environment. (TVA 2010f, Section 3.0)

In summary, TVA utilizes herbicide and mowing on a cyclical plan on the entirety of the transmission lines except for areas that have specific environmental conditions that would prevent it. For the majority of transmission lines, TVA is working towards a mow, spray, spray, mow cycle which helps in reducing the stem count. For example, mowing might occur in the ROW in a given year, and then herbicide application 2–3 years later.

3.2.10.2.3 Environmental Review Process

TVA routinely conducts maintenance activities on transmission lines in the TVA power service area. These activities include, but are not restricted to, ROW reclearing (removal of vegetation), pole replacements, installation of lightning arrestors and counterpoise, and upgrading of existing equipment. Regular maintenance activities are conducted on a cycle of 3–5 years.

Prior to these activities, the transmission line area (including the ROW) is reviewed by technical specialists in the TVA Biological and Cultural Compliance groups to identify any resource issues that may occur along that transmission line. These reviews are conducted on a recurring basis that coincides with the maintenance cycle to ensure the most current information is provided to the organizations conducting maintenance on these transmission lines. Experts in the Biological Compliance group evaluate issues involving sensitive natural resources such as wetlands and protected species. Experts in the Cultural Compliance group evaluate issues involving archaeological and historic sites and structures.

Attachment A contains a summary of the environmental review process TVA utilizes for maintenance and modifications of transmission lines, and presents the results of this process, by subject matter area, for the area within a 6-mile radius of SQN.

3.2.10.2.4 Bird Collisions and Electrocutions

Considerable work has been done in the western United States regarding electrocution hazards for large birds, raptors in particular, on distribution voltage lines, but this is not normally a problem on transmission lines due to the relatively large phase-to-ground and phase-to-phase spacing. All TVA transmission lines terminating at SQN are 161 kV or 500 kV with large phase-to-phase and phase-to-ground spacing. Minimum spacing for TVA transmission line towers is as follows (Attachment A, page 16):

Electrical Separation	161-kV Towers	500-kV Towers
Conductor phase wire spacing	10 feet 5 inches	25 feet
Conductor-to-ground distance	6 feet	12 feet

Due to sensitive protective relaying on TVA power lines, bird electrocutions will normally result in momentary interruptions of line service, all of which are investigated to determine the cause. In the past 5 years, for the entire 16,000 miles of TVA power lines, TVA has averaged approximately 15 momentary service interruptions per year due to electric arcs from bird electrocutions or nests. Raptor or heron nests can be removed as needed for corrective action, but only after the young have fledged. Any removal of nests would require coordination with USDA Wildlife Services, which maintains the appropriate permit from the USFWS for removal of bird nests.

Bird fecal contamination can also result in momentary service interruptions. In the past 5 years, TVA has averaged approximately 20 momentary service interruptions per year due to fecal contamination from roosting birds; most of these involve vultures, but it can also be from herons. Vultures occasionally roost in large numbers on TVA structures in some areas, such as near chicken houses or dump sites. In such cases, installation of "buzzard shields" is the usual corrective action.

All TVA transmission lines are visually inspected twice a year, via either helicopter or foot patrol. The transmission corridor vegetation is also annually inspected by personnel that walk each span of the transmission lines, and vegetation maintenance is performed every 2 to 3 years. TVA environmental compliance personnel also perform frequent field work involving transmission line corridors. During these various transmission corridor activities, bird mortality is only infrequently observed, and there have not been enough instances to consider line and structure collisions as having an impact on avian populations.

3.2.10.2.5 Ozone

Extensive field tests concerning ozone were conducted over a 19-month period during 1971 and 1972 by the Illinois Institute of Technology Research Institute for the Commonwealth Edison Company. These tests were made to determine if measurable quantities of ozone are generated by high-voltage transmission lines. Continuous ozone measurements were made adjacent to a 345-kV switchyard with a high concentration of 345-kV and 128-kV transmission lines and adjacent to a 765-kV line; these were compared with continuous ambient measurements made at locations in the same areas but remote from the transmission lines. From this investigation, it was concluded that high-voltage transmission lines up to 765 kV do not generate ozone measurable above the ambient at ground level adjacent to the lines under tested weather conditions. (Attachment A, pages 14-16) The results of this investigation are also consistent with NRC's conclusion described in the 2009 draft GEIS (NRC 2009a, Section 4.3.1.1)

In view of the design and construction standards employed by TVA in building its transmission facilities, corona discharges are minimal to nonexistent. TVA specifications require that transmission line hardware and electric equipment for operation at 500,000 volts (500 kV) be factory tested to assure corona-free performance up to maximum operating voltage levels. Accordingly, any ozone which could possibly be generated by SQN's in-scope 500-kV transmission lines would be environmentally inconsequential and harmless to vegetation, animals, and humans. (Attachment A, page 16)

Table 3.2-1
SQN Hazardous Waste Generation, 2007–2011

Year	Pounds
2007	550
2008	880
2009	1,063
2010	2,707
2011	3,991

(SQN 2011e; SQN 2012c)

Table 3.2-2
NPDES Permitted Outfalls

Outfall	Description	Parameter	Limit
101	Diffuser discharge	Flow	Report only (monthly average mgd) Report only (daily maximum mgd)
		Ambient temperature	Report only (daily maximum ºC)
		River temperature	Report only (daily maximum ºC)
		Total residual chlorine	0.10 mg/l monthly average 0.10 mg/l daily maximum
		Toxicity testing	43.2% survival
		Temperature (winter)[a]	5ºC daily maximum
		Temperature (summer)[b]	3ºC daily maximum
		Temperature rise (all year)[c]	2ºC daily maximum
		Temperature rise (all year)[d]	30.5ºC daily maximum
103	Low volume waste treatment pond	Flow	Report only (monthly average mgd) Report only (daily maximum mgd)
		Oil and grease	15 mg/l monthly average 20 mg/l daily maximum
		Total suspended solids	30 mg/l monthly average 100 mg/l daily maximum
		pH	6.0–9.0
107	Metal cleaning waste pond	None	None
110[e]	Recycled cooling water	Temperature	38.3ºC daily maximum
		Total residual chlorine	0.10 mg/l daily maximum
116	Condenser circulating water backwash	None	None
117	Essential raw cooling water backwash	None	None

**Table 3.2-2 (Continued)
NPDES Permitted Outfalls**

Outfall	Description	Parameter	Limit
118	Settling pond	Flow	Report only (monthly average mgd) Report only (daily maximum mgd)
		Dissolved oxygen settleable solids	2.0 mg/l minimum 1.0 ml/l daily maximum
		Total suspended solids	100 mg/l daily maximum

(SQN 2011c, Part I)

a. Difference between effluent gross and upstream temperatures November–March (winter).
b. Difference between instream and upstream temperatures April–October (summer).
c. Instream temperature rate of change ºC/hour.
d. Instream temperature ºC.
e. Outfall 101 limitations also apply if used as main discharge point in place of Outfall 101.

Table 3.2-3
Air Permitted Emission Sources

Emission Source	Permit Number	Permit Condition
Unit 1 cooling tower	4150-30600701-01C	Particulate emissions Opacity
Unit 2 cooling tower	4150-30600701-03C	
Insulator saws A and B	4150-30700804-06C	
Carpenter shop	4150-30703099-09C	
Abrasive blasting operations	4150-30900203-10C	
Auxiliary boilers A and B	4150-10200501-08C	Operational run time Fuel sulfur content Fuel usage Opacity
Emergency diesel generators 1A, 1B, 2A, 2B, and blackout diesel generators 1 and 2	4150-20200102-11C	Operational run time Fuel sulfur content Opacity

(SQN 2007c)

Table 3.2-4
SQN Transmission Lines

FES Line Name	Current Line Name	Voltage (kV)	Length (miles)
Sequoyah-Widows Creek	North Hixson to Falling Water to Moccasin	161	22.5
Sequoyah-Charleston No. 1	Harrison Bay Tap to Hopewell to Charleston	161	20.8
Sequoyah-Watts Bar	Watts Bar Hydro	161	38.4
Sequoyah-Chickamauga No. 1	Wolftever to Chickamauga	161	17.1
Sequoyah-Chickamauga No. 2	Volkswagen to Chickamauga	161	19.5
Sequoyah-East Cleveland	North Ooltewah to South Cleveland to East Cleveland	161	29.5
Sequoyah-Concord	Concord	161	18.4
Sequoyah-Charleston No. 2	Charleston	161	20.8
Sequoyah-Widows Creek	Widows Creek	500	49.5
Sequoyah-Bull Run	Watts Bar No. 1	500	34.5
Not applicable[a]	Watts Bar No. 2	500	40.5
Sequoyah–Georgia State Line	Bradley	500	22.0
Sequoyah–Franklin	Franklin	500	63.0

(SQN 2011f; TVA 1974a, Section 2.2; TVA 2011a, Table 1-1; TVA 2012e)

a. Completed in 1977 during the period between the SQN FES and initial SQN operations.

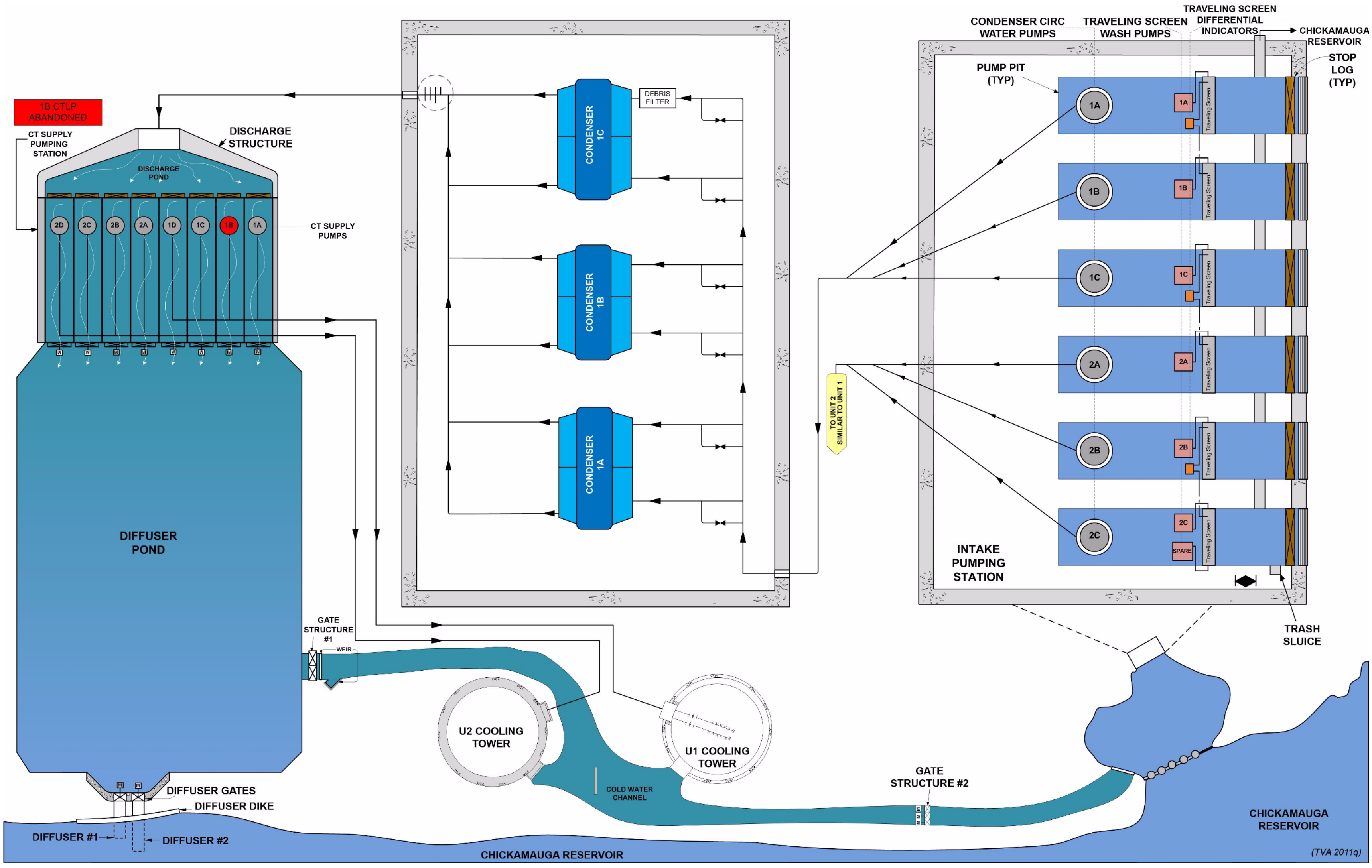


Figure 3.2-1
SQN Cooling Water Intake Structure Flow Path

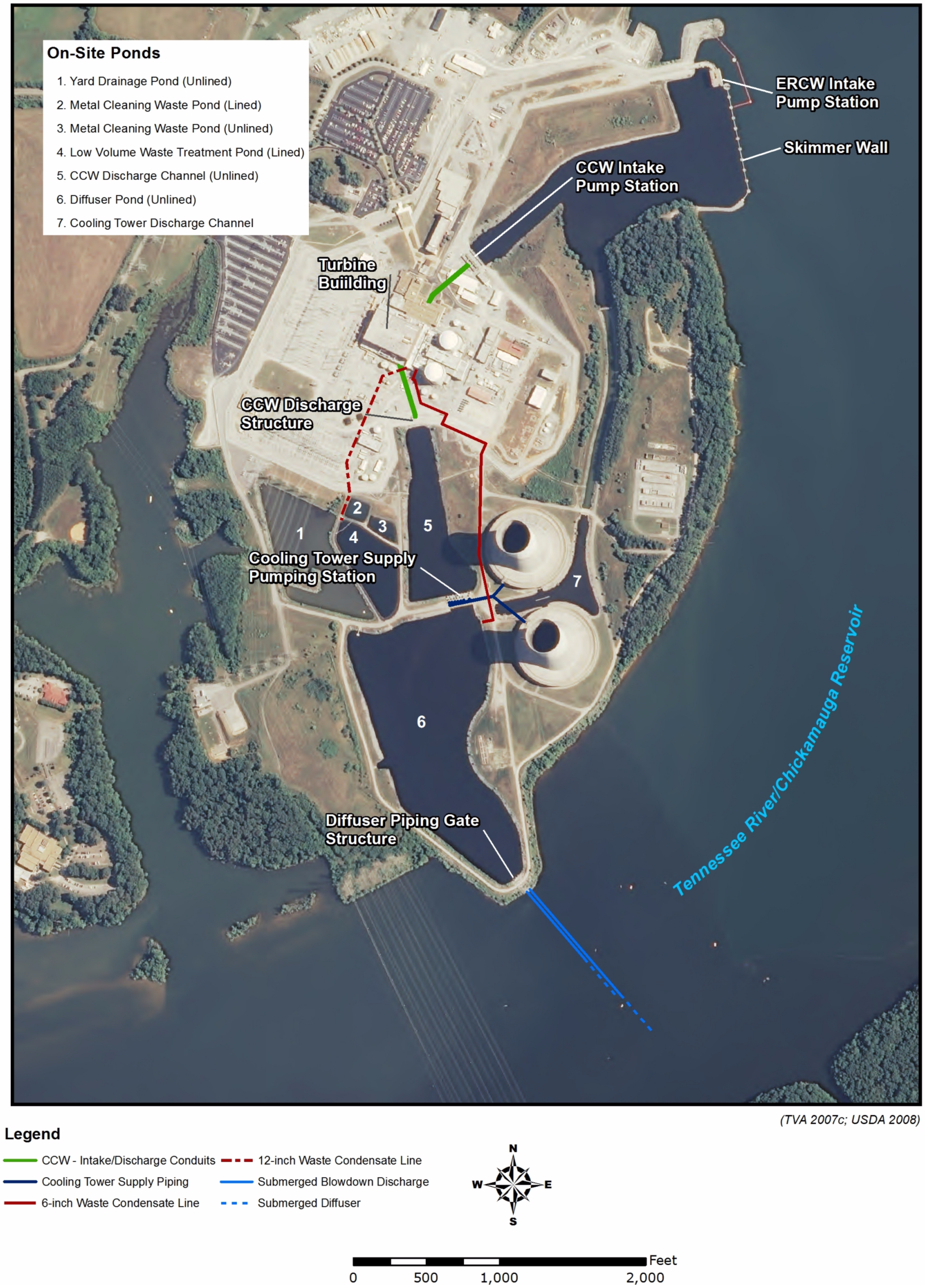


Figure 3.2-2
ERCW Intake Structure

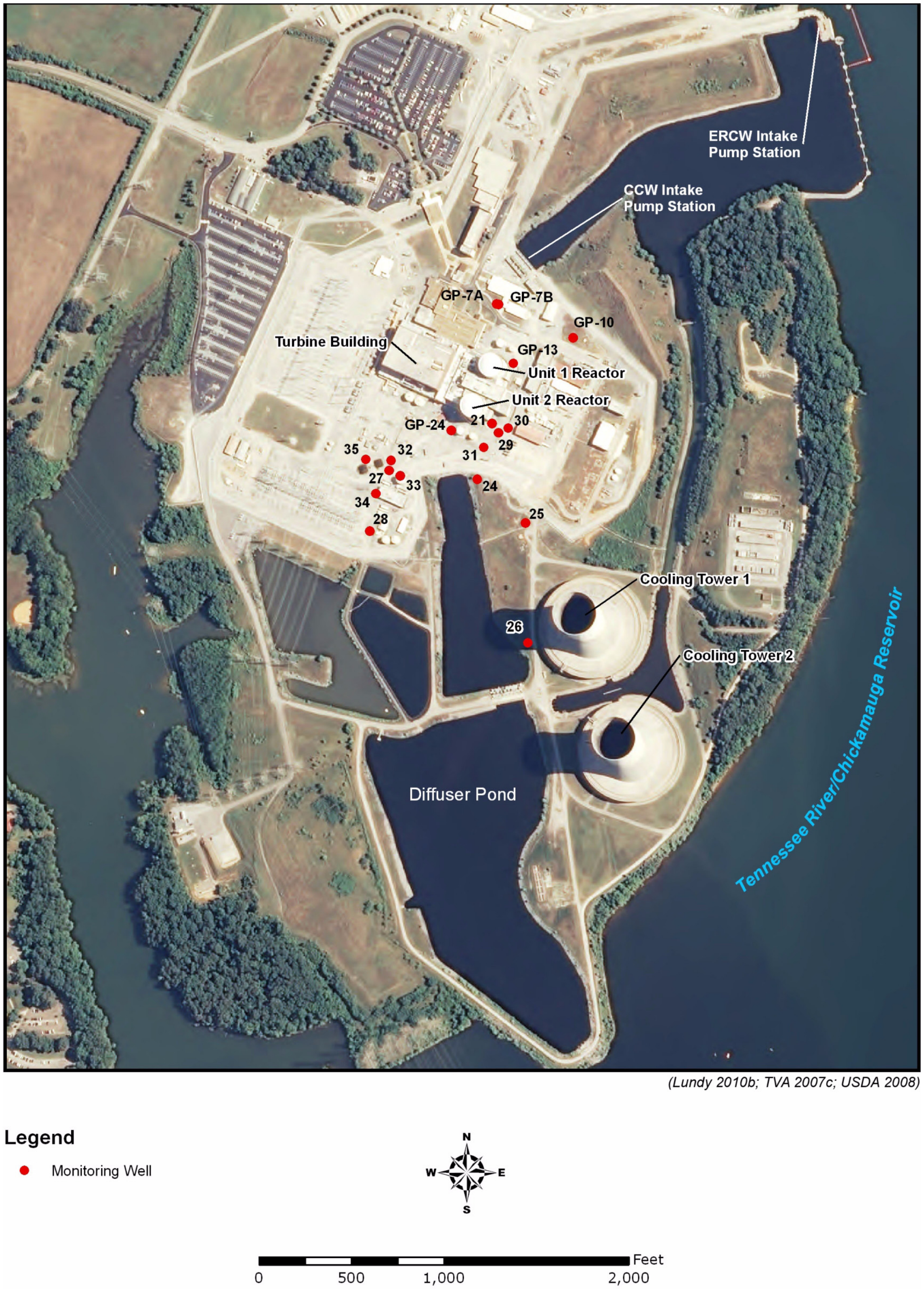


Figure 3.2-3
SQN Monitoring Wells

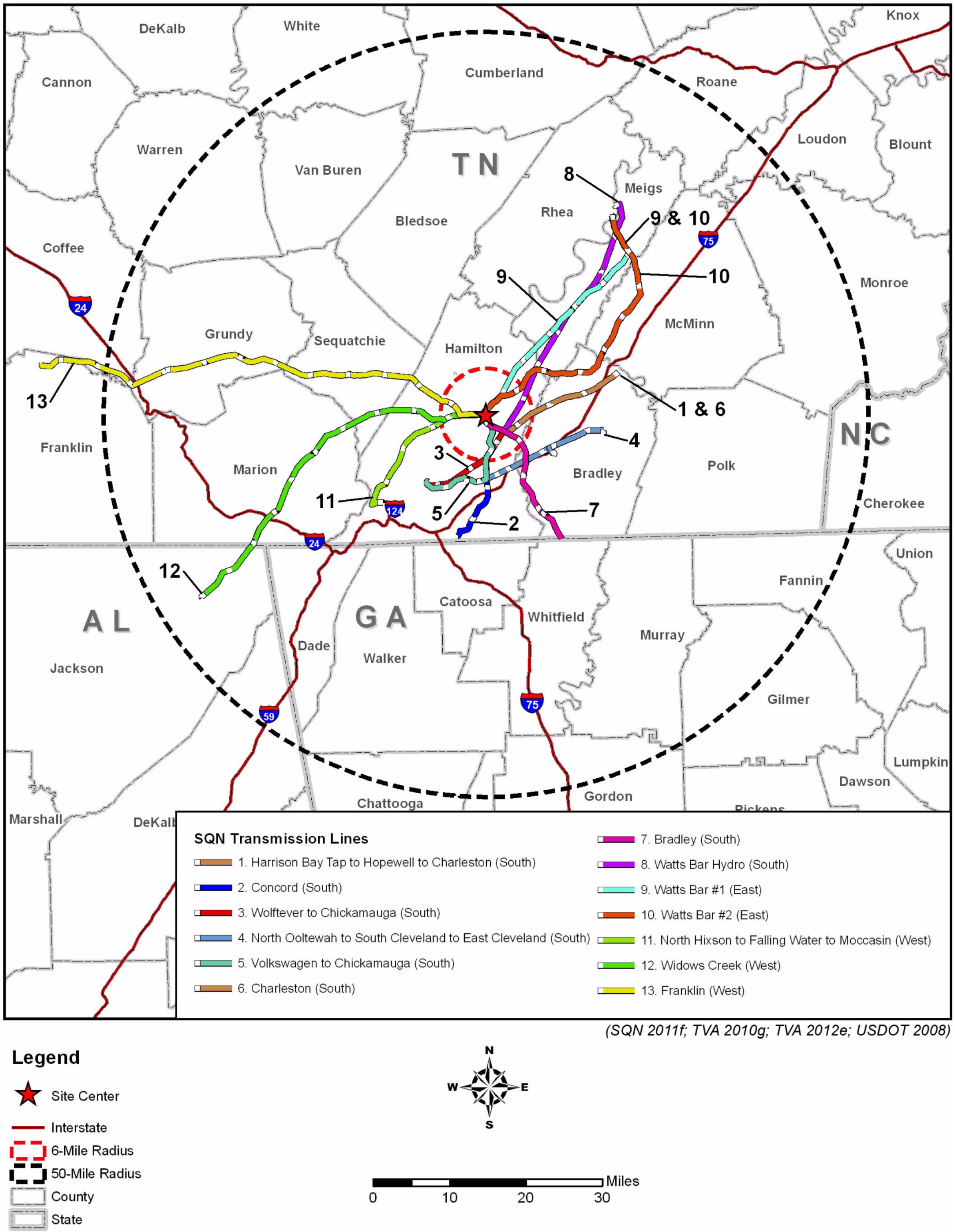


Figure 3.2-4
SQN In-Scope Transmission Lines

3.3 Refurbishment Activities

In accordance with 10 CFR 51.53(c)(2), a license renewal applicant's environmental report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with 10 CFR 54.21 of this chapter. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment.

The objective of the review required by 10 CFR 54.21 is to determine whether the detrimental effects of aging could preclude certain systems, structures, and components from performing in accordance with the current licensing basis during the additional 20 years of operation requested in the LRA.

The evaluation of structures and components as required by 10 CFR 54.21 has been completed and is described in the body of the SQN Units 1 and 2 LRA. This evaluation did not identify the need for refurbishment of structures or components for purposes of license renewal as described in Sections 2.4 and 3.1 of the 1996 Generic Environmental Impact Statement (GEIS), and no such refurbishment activities are planned at this time.

3.4 Programs and Activities for Managing the Effects of Aging

The programs for managing the effects of aging on certain structures and components within the scope of license renewal at the site are described in the body of the LRA (see Appendix B of the SQN Units 1 and 2 LRA). The evaluation of structures and components required by 10 CFR 54.21 identified some new activities necessary to continue operation of the site during the additional 20 years beyond the initial license term. These activities are described in the body of the LRA. The additional inspection activities are, however, consistent with normal plant component inspections and, therefore, are not expected to cause significant environmental impact.

3.5 Employment

The non-outage work force (TVA employees and baseline contractors) at the site consists of approximately 1,141 persons (Table 3.5-1). There are no plans to add additional employees to support plant operations during the extended license renewal period. During refueling outages, which usually last 30–33 days per unit, there are typically on average an additional 750 contractor employees on site (SQN 2010b). Refueling and maintenance outages for SQN Units 1 and 2 are on a staggered 18-month schedule. The number of contractor workers required on site for normal plant outages during the period of extended operation is expected to be consistent with the number of additional workers used for past outages at the site, which is approximately 750 temporary workers.

Table 3.5-1
Employee Residence Information (January 2010)

State, County, and City/Towns[(a)]	TVA Employees Only	TVA Employees and Baseline Contractors[(b)]
TENNESSEE		
Bledsoe County	**11**	**13**
Pikeville	11	
Bradley County	**21**	**23**
Charleston	1	
Cleveland	17	
McDonald	3	
Fentress County	**1**	**1**
Jamestown	1	
Grundy County	**3**	**3**
Coalmont	2	
Gruetli Laager	1	
Hamilton County	**803**	**893**
Birchwood	1	
Harrison	10	
Hixson	217	
Ooltewah	36	
Sale Creek	24	
Signal Mountain	27	
Soddy-Daisy	322	
Chattanooga	166	
Knox County	**1**	**1**
Knoxville	1	
Loudon County	**1**	**1**
Greenback	1	

Table 3.5-1 (Continued)
Employee Residence Information (January 2010)

State, County, and City/Towns[a]	TVA Employees Only	TVA Employees and Baseline Contractors[b]
Marion County	**7**	**8**
Jasper	2	
South Pittsburg	2	
Whitwell	3	
McMinn County	**3**	**3**
Athens	3	
Meigs County	**3**	**3**
Decatur	1	
Georgetown	2	
Monroe County	**1**	**1**
Madisonville	1	
Montgomery County	**7**	**8**
Clarksville	7	
Polk County	**2**	**2**
Benton	1	
Copperhill	1	
Rhea County	**64**	**70**
Dayton	44	
Evensville	3	
Graysville	11	
Spring City	6	
Roane County	**1**	**1**
Rockwood	1	
Sequatchie County	**27**	**30**
Dunlap	27	

**Table 3.5-1 (Continued)
Employee Residence Information (January 2010)**

State, County, and City/Towns[a]	TVA Employees Only	TVA Employees and Baseline Contractors[b]
Sevier County	**1**	**1**
Seymour	1	
Sumner County	**1**	**1**
Castalian Springs	1	
Van Buren County	**2**	**2**
Spencer	2	
GEORGIA		
Catoosa County	**16**	**18**
Ringgold	14	
Fort Oglethorpe	2	
Dade County	**4**	**5**
Rising Fawn	2	
Trenton	1	
Wildwood	1	
Walker County	**23**	**25**
Chickamauga	5	
Flintstone	5	
La Fayette	1	
Lookout Mountain	1	
Rock Spring	1	
Rossville	10	
Whitfield County	**2**	**2**
Cohutta	1	
Dalton	1	

Table 3.5-1 (Continued)
Employee Residence Information (January 2010)

State, County, and City/Towns[a]	TVA Employees Only	TVA Employees and Baseline Contractors[b]
ALABAMA		
Cherokee County	**1**	**1**
Cedar Bluff	1	
DeKalb County	**6**	**7**
Fort Payne	3	
Henagar	2	
Ider	1	
Jackson County	**9**	**10**
Bridgeport	2	
Higdon	1	
Scottsboro	1	
Stevenson	5	
SOUTH CAROLINA		
Darlington County	**1**	**1**
Hartsville	1	
Florence County	**1**	**1**
Florence	1	
FLORIDA		
Polk County	**1**	**1**
Lakeland	1	
ILLINOIS		
McLean County	**1**	**1**
Bloomington	1	
OHIO		
Ross County	**1**	**1**
Chillicothe	1	

Table 3.5-1 (Continued)
Employee Residence Information (January 2010)

State, County, and City/Towns[a]	TVA Employees Only	TVA Employees and Baseline Contractors[b]
VIRGINIA		
Suffolk[c]	1	1
Employee Subtotal	**1,027**	**1,139**
Zip Codes – unable to confirm[d]	2	2
TOTAL	**1,029[b]**	**1,141**

(SQN 2010b)
NOTE: Employee and contractor numbers do not include outage workers.

a. Represents the largest city within the zip code.
b. SQN has approximately 115 baseline contract workers per year in addition to the total number of permanent TVA plant employees. Baseline contractor employee settlement patterns are assumed to follow county settlement patterns indicated by permanent TVA staff.
c. Suffolk is an independent city and not part of any county.
d. Two employee zip codes could not be geographically placed.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

4.0.1 Discussion of GEIS Categories for Environmental Issues

In the 1996 GEIS (NUREG-1437), the NRC identified and analyzed 92 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated the issues as Category 1, Category 2, or NA (not applicable). The NRC designated an issue as Category 1 if the following criteria were met:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

  A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent-fuel disposal).

- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

If the NRC concluded that one or more of the Category 1 criteria could not be met, NRC designated the issue Category 2, which requires plant-specific analysis. The NRC designated two issues as NA, signifying that the categorization and impact definitions do not apply to these issues. NRC rules do not require analyses of Category 1 issues that were resolved using generic findings [10 CFR Part 51, Appendix B, Table B-1] as described in the GEIS (NRC 1996, Section 1.7.2). Therefore, an applicant may reference the GEIS findings for Category 1 issues, absent new and significant information. The 92 issues are listed in Table 1.1-1, along with their NRC-assigned category. Tables 4.0-1 and 4.0-2 present the Category 1 and Category 2 issues, respectively.

4.0.2 Category 1 License Renewal Issues

TVA has determined that, of the 69 specified Category 1 issues, seven are not applicable to the SQN site because they apply to design or operational features that do not exist at the facility. In addition, because SQN does not plan to conduct refurbishment activities, the NRC findings for the seven issues applicable to refurbishment do not apply. The remaining 55 issues are considered applicable to the site. Table 4.0-1 lists each of the 69 Category 1 issues, their applicability to the SQN site, and the applicable GEIS section where these issues were resolved. For issues not applicable to the SQN site, a brief explanation of why they are not applicable is provided. TVA reviewed the NRC findings on the 55 issues considered applicable to the site and identified no new and significant information that would invalidate the findings for the site (Section 5.0). Therefore, TVA adopts by reference the NRC findings for these Category 1 issues.

In addition, although not yet regulatory requirements, TVA also reviewed NRC findings on new Category 1 issues proposed in the amendment to 10 CFR Part 51 (74 FR 38117; NRC 2012) for purposes of completeness rather than to satisfy governing regulatory requirements. Based on TVA's review, there was no new and significant information that would invalidate the findings for the SQN site. These proposed issues are also listed in Table 4.0-1, along with their applicability to the site and the applicable draft GEIS, Revision 1 section. Therefore, TVA adopts by reference the NRC findings for these 13 proposed new Category 1 issues. TVA also addressed the proposed new Category 1 issues in its new and significant process as discussed in Chapter 5.

4.0.3 Category 2 License Renewal Issues

In the 1996 GEIS, the NRC designated 21 issues as Category 2. Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, 4.18, 4.19, 4.20, and 4.21 address these issues, beginning with a statement of the issue. TVA has determined that, of the 21 issues, three are not applicable to the SQN site because they apply to design or operational features that do not exist at the facility; four others do not apply because TVA does not plan to conduct refurbishment activities at SQN. Table 4.0-2 provides a listing of the Category 2 issues, the applicability determination for each one, and the applicable ER section. When the issue does not apply to the SQN site, the section explains the basis.

For the fourteen 1996 GEIS Category 2 issues applicable to the site, the corresponding sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to renewal of the SQN OLs for Units 1 and 2 and, when applicable, discuss potential mitigative alternatives to the extent required. TVA has identified the significance of the impacts associated with each issue as SMALL, MODERATE, or LARGE, consistent with the criteria that the NRC established in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3 as follows:

- SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small.

- MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- LARGE: Environmental effects are clearly noticeable and sufficient to destabilize important attributes of the resource.

In accordance with National Environmental Policy Act (NEPA) practice, TVA considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., small impacts receive less mitigative consideration than large impacts).

4.0.4 "NA" License Renewal Issues

In the 1996 GEIS, NRC determined its categorization and impact-finding definitions did not apply to two issues: electromagnetic fields (chronic effect) and environmental justice. The NRC noted that applicants currently do not need to submit information on chronic effects from electromagnetic fields [10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 5]; thus only acute, not chronic, effects from electromagnetic fields are addressed in this ER. For environmental justice, the NRC does not require information from applicants but noted that the issue would be addressed in individual license renewal reviews [10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 6]. TVA has included environmental justice demographic information in Section 2.6 to assist the NRC in this review and presents an analysis of the issue in Section 4.22.

4.0.5 Proposed New or Expanded Category 2 Issues

As previously discussed in Section 1.1, TVA provided information in this ER concerning those Category 2 issues, either new or with expanded scope, that are currently in the proposed amendment to 10 CFR Part 51 (74 FR 38117; NRC 2012). This information was provided for purposes of completeness and not in order to satisfy governing regulatory requirements. Table 1.1-1 presents these Category 2 issues, their applicability to the site, and the ER section(s) that provide information on the issue. As indicated in Table 1.1-1, the information to address the proposed new or expanded Category 2 issues has been incorporated into various ER sections.

Based on information provided in this ER, TVA has concluded the following regarding associated impacts with these new or expanded Category 2 issues:

- Water Use Conflict (Terrestrial Resources)

As discussed in Section 4.1, there are regulatory controls associated with water withdrawal from the Chickamauga Reservoir. Cooling towers are only utilized when necessary to maintain the limits specified in SQN's NPDES permit, approximately 112 days per year on average. The Tennessee River is considered a low-flow river, as the annual average flow (as measured using flow through Chickamauga Dam) is approximately 32,500 cfs (1.03 x 10^{12} ft^3/year). When operated in the helper mode under design conditions (a conservative upper-bounding scenario), on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. Therefore, impacts are anticipated to be SMALL.

- Water Use Conflict (Aquatic Resources)

As discussed in Section 4.1, there are regulatory controls associated with water withdrawal from the Chickamauga Reservoir. Cooling towers are only utilized when necessary to maintain the limits specified in SQN's NPDES permit, approximately 112 days per year on average. The Tennessee River is considered a low-flow river, as the annual average flow (as measured using flow through Chickamauga Dam) is approximately 32,500 cfs (1.03 x 10^{12} ft^3/year). When operated in the helper mode under design conditions (a conservative upper-bounding scenario), on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. Therefore, impacts are anticipated to be SMALL.

- Radionuclides Released to Groundwater

Tritium has been detected in onsite groundwater, and onsite wells are monitored for tritium levels. One well's monitoring results of 22,922 pCi/l in December 2011 exceeded the EPA drinking water standard for tritium of 20,000 pCi/l, and triggered voluntary reporting requirements (TVA 2012f). Ongoing investigations suggest that inadvertent releases in the past are the sources of tritiated groundwater. Groundwater and surface water level measurements conducted in 2007 confirmed that the intake and discharge channels would ultimately receive tritiated groundwater discharged from the site. Samples from the discharge channel following the groundwater monitoring well having tritium levels that exceeded 20,000 pCi/l had no detectable tritium, and no tritium was detected in sampling of the Tennessee River conducted following the exceedance event. Therefore, no tritiated groundwater has migrated past the site property boundary. The current risk of exposure to radionuclides associated with licensed plant operations to offsite residents is minimal. Therefore, it is concluded that radiological impacts to groundwater during the SQN license renewal term would be SMALL.

- Impacts of Continued Plant Operations on Terrestrial Ecosystems

As discussed in Sections 2.4 and 3.2.10, TVA has existing BMPs in place to ensure that terrestrial resources on the SQN site and associated in-scope transmission line ROWs are protected. No refurbishment activities are planned for renewal of the SQN OLs. Therefore, impacts on terrestrial ecosystems during the SQN license renewal term would be SMALL.

- Minority and Low-income Populations

TVA considered the effects of license renewal on members of the public, including minority and low-income populations (Sections 2.6.2 and 4.22), and determined that minority and low-income populations would not be subject to disproportionate adverse environmental impacts as a result of the renewal of the SQN OLs.

- Cumulative Impacts

TVA considered the potential impacts from SQN continued operation during the license renewal term and other past, present, and future actions for cumulative impacts. TVA concluded that the potential cumulative impacts resulting from SQN operation during the license renewal term (2020 through 2041) would be SMALL for aquatic resources, air quality, and human health, and that SQN's small impacts are not expected to be cumulative with other area projects for water and terrestrial ecology resources. In addition, because TVA does not plan any refurbishment activities at SQN or an increase in the number of workers, the small adverse impacts to socioeconomic resources would continue and make a minimal contribution to cumulative adverse socioeconomic impacts. Beneficial socioeconomic impacts from TVA payments in lieu of taxes and contributions to the local economy by the SQN workforce will continue at current levels.

4.0.6 Format of Category 2 Issue Review

The review and analysis for the specified Category 2 issues (Table 4.0-2), along with the uncategorized issue of environmental justice, are found in Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, 4.18, 4.19, 4.20, 4.21, and 4.22. The format for the review of the issues in the above 22 sections is described below. Section 4.23 addresses cumulative impacts and is formatted to address cumulative impacts by resource area.

- *Issue:* A brief statement of the issue.
- *Description of Issue:* A brief description of the issue.
- *Findings from Table B-1, Appendix B to Subpart A:* The findings for the issue from Table B-1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Appendix B to Subpart A of 10 CFR Part 51.
- *Requirement:* Restatement of the requirement from 10 CFR 51.53(c)(3)(ii).
- *Background:* A background excerpt from the applicable section of the GEIS. The specific section of the GEIS is referenced for the convenience of the reader.
- *Analysis of Environmental Impact:* An analysis of the environmental impact as required by 10 CFR 51.53(c)(3)(ii). The analysis takes into account information provided in the GEIS, Appendix B to Subpart A of 10 CFR Part 51, as well as current specific information.
- *Conclusion:* For issues applicable to the site, the conclusion of the analysis along with the consideration of mitigation alternatives as required by 10 CFR 51.45(c) and 10 CFR 51.53(c)(3)(iii).

Table 4.0-1
Category 1 License Renewal Issues

Issue	Applicability	GEIS Section(s)
1996 GEIS Issues		
Surface Water Quality, Hydrology, and Use (for all plants)		
Impacts of refurbishment on surface water quality	Not applicable; no refurbishment activities planned.	3.4.1
Impacts of refurbishment on surface water use	Not applicable; no refurbishment activities planned.	3.4.1
Altered current patterns at intake and discharge structures	Applicable	4.2.1.2.1, 4.3.2.2, and 4.4.2
Altered salinity gradients	Not applicable; SQN does not discharge to an estuary.	4.2.1.2.2 and 4.4.2
Altered thermal stratification of lakes	Applicable	4.2.1.2.3 and 4.4.2.2
Temperature effects on sediment transport capacity	Applicable	4.2.1.2.3 and 4.4.2.2
Scouring caused by discharged cooling water	Not applicable; SQN's diffuser ports associated with thermal discharges are ~12 feet above the river bed on crushed stone fill (TVA 1974a, Section 2.6).	4.2.1.2.3 and 4.4.2.2
Eutrophication	Applicable	4.2.1.2.3 and 4.4.2.2
Discharge of chlorine or other biocides	Applicable	4.2.1.2.4 and 4.4.2.2
Discharge of sanitary wastes and minor chemical spills	Applicable	4.2.1.2.4 and 4.4.2.2
Discharge of other metals in waste water	Applicable	4.2.1.2.4, 4.3.2.2, and 4.4.2.2
Water use conflicts (plants with once-through cooling systems)	Applicable	4.2.1.3

**Table 4.0-1 (Continued)
Category 1 License Renewal Issues**

Issue	Applicability	GEIS Section(s)
Aquatic Ecology (for all plants)		
Refurbishment	Not applicable; no refurbishment activities planned.	3.5
Accumulation of contaminants in sediments or biota	Applicable	4.2.1.2.4, 4.3.3, 4.4.3, and 4.4.2.2
Entrainment of phytoplankton and zooplankton	Applicable	4.2.2.1.1, 4.3.3, and 4.4.3
Cold shock	Applicable	4.2.2.1.5, 4.3.3, and 4.4.3
Thermal plume barrier to migrating fish	Applicable	4.2.2.1.6 and 4.4.3
Distribution of aquatic organisms	Applicable	4.2.2.1.6 and 4.4.3
Premature emergence of aquatic insects	Applicable	4.2.2.1.7 and 4.4.3
Gas supersaturation (gas bubble disease)	Applicable	4.2.2.1.8 and 4.4.3
Low dissolved oxygen in the discharge	Applicable	4.2.2.1.9, 4.3.3, and 4.4.3
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Applicable	4.2.2.1.10 and 4.4.3
Stimulation of nuisance organisms (e.g., shipworms)	Applicable	4.2.2.1.11 and 4.4.3
Aquatic Ecology (for plants with cooling tower based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages for plants with cooling-tower-based heat dissipation systems	Applicable	4.3.3
Impingement of fish and shellfish for plants with cooling-tower-based heat dissipation systems	Applicable	4.3.3

Table 4.0-1 (Continued)
Category 1 License Renewal Issues

Issue	Applicability	GEIS Section(s)
Heat shock for plants with cooling-tower-based heat dissipation systems	Applicable	4.3.3
Groundwater Use and Quality		
Impacts of refurbishment on groundwater use and quality	Not applicable; no refurbishment activities planned.	3.4.2
Groundwater use conflicts (potable and service water; plants that use less than 100 gpm)	Not applicable; SQN does not use groundwater.	4.8.1.1 and 4.8.1.2
Groundwater quality degradation (Ranney wells)	Not applicable; SQN does not use Ranney wells.	4.8.2.2
Groundwater quality degradation (saltwater intrusion)	Not applicable; SQN is located on a freshwater body.	4.8.2.1
Groundwater quality degradation (cooling ponds in salt marshes)	Not applicable; SQN is located on a freshwater body and does not use cooling ponds.	4.8.3
Terrestrial Resources		
Cooling tower impacts on crops and ornamental vegetation	Applicable	4.3.4
Cooling tower impacts on native plants	Applicable	4.3.5.1
Bird collisions with cooling towers	Applicable	4.3.5.2
Cooling pond impacts on terrestrial resources	Not applicable; SQN does not use cooling ponds.	4.4.4
Power line right-of-way (ROW) management (cutting and herbicide application)	Applicable	4.5.6.1
Bird collisions with power lines	Applicable	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, and livestock)	Applicable	4.5.6.3
Floodplains and wetlands on power line ROW	Applicable	4.5.7

Table 4.0-1 (Continued)
Category 1 License Renewal Issues

Issue	Applicability	GEIS Section(s)
Air Quality		
Air quality effects of transmission lines	Applicable	4.5.2
Land Use		
Onsite land use	Applicable	3.2
Power line ROW land use impacts	Applicable	4.5.3
Human Health		
Radiation exposures to the public during refurbishment	Not applicable; no refurbishment activities planned.	3.8.1
Occupational radiation exposures during refurbishment	Not applicable; no refurbishment activities planned.	3.8.2
Microbiological organisms (occupational health)	Applicable.	4.3.6
Noise	Applicable	4.3.7
Radiation exposures to public (license renewal term)	Applicable	4.6.2
Occupational radiation exposures (license renewal term)	Applicable	4.6.3
Socioeconomics		
Public services: public safety, social services, and tourism and recreation	Applicable	4.7.3, 4.7.3.3, 4.7.3.4, and 4.7.3.6
Public services: education (license renewal term)	Applicable	4.7.3.1
Aesthetic impacts (refurbishment)	Not applicable; no refurbishment activities planned.	3.7.8
Aesthetic impacts (license renewal term)	Applicable	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	Applicable	4.5.8
Postulated Accidents		
Design basis accidents	Applicable	5.3.2 and 5.5.1

Table 4.0-1 (Continued)
Category 1 License Renewal Issues

Issue	Applicability	GEIS Section(s)
Uranium Fuel Cycle and Waste Management		
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	Applicable	6.1, 6.2.1, 6.2.2.1, 6.2.2.3, 6.2.3, 6.2.4, and 6.6
Offsite radiological impacts (collective effects)	Applicable	6.1, 6.2.2.1, 6.2.3, 6.2.4, and 6.6
Offsite radiological impacts (spent fuel and high-level waste disposal)	Applicable	6.1, 6.2.2.1, 6.2.3, 6.2.4, and 6.6
Nonradiological impacts of the uranium fuel cycle	Applicable	6.1, 6.2.2.6, 6.2.2.7, 6.2.2.8, 6.2.2.9, 6.2.3, 6.2.4, and 6.6
Low-level waste storage and disposal	Applicable	6.1, 6.2.2.2, 6.4.2, 6.4.3, 6.4.3.1, 6.4.3.2, 6.4.3.3, 6.4.4, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.4.4, 6.4.4.5, 6.4.4.5.1, 6.4.4.5.2, 6.4.4.5.3, 6.4.4.5.4, 6.4.4.6, and 6.6
Mixed waste storage and disposal	Applicable	6.4.5.1, 6.4.5.2, 6.4.5.3, 6.4.5.4, 6.4.5.5, 6.4.5.6, 6.4.5.6.1, 6.4.5.6.2, 6.4.5.6.3, 6.4.5.6.4, and 6.6

**Table 4.0-1 (Continued)
Category 1 License Renewal Issues**

Issue	Applicability	GEIS Section(s)
Onsite spent fuel	Applicable	6.1, 6.4.6, 6.4.6.1, 6.4.6.2, 6.4.6.3, 6.4.6.4, 6.4.6.5, 6.4.6.6, 6.4.6.7, and 6.6
Nonradiological waste	Applicable	6.1, 6.5, 6.5.1, 6.5.2, 6.5.3, and 6.6
Transportation	Applicable	6.1, 6.3.1, 6.3.2.3, 6.3.3, 6.3.4, 6.6, and Addendum 1
Decommissioning		
Radiation doses	Applicable	7.3.1 and 7.4
Waste management	Applicable	7.3.2 and 7.4
Air quality	Applicable	7.3.3 and 7.4
Water quality	Applicable	7.3.4 and 7.4
Ecological resources	Applicable	7.3.5 and 7.4
Socioeconomic impacts	Applicable	7.3.7 and 7.4
GEIS, Revision 1 (Draft, 2009)		
Impacts of nuclear plants on geology and soils	Applicable	4.4
Effects of dredging on water quality	Applicable	4.5.1.1
Exposure of terrestrial organisms to radionuclides	Applicable	4.6.1.1
Exposure of aquatic organisms to radionuclides	Applicable	4.6.1.2
Effects of dredging on aquatic organisms	Applicable	4.6.1.2
Impacts of transmission line ROW management on aquatic resources	Applicable	4.6.1.2

Table 4.0-1 (Continued)
Category 1 License Renewal Issues

Issue	Applicability	GEIS Section(s)
Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)	Applicable	4.6.1.1
Employment and income, recreation, and tourism	Applicable	4.8.1
Tax revenues	Applicable	4.8.1
Population and housing	Applicable	4.8.1
Human health impact from chemicals	Applicable	4.9.1.1
Physical occupational hazards	Applicable	4.9.1.1
Termination of plant operations and decommissioning	Applicable	4.12.2.1

(74 FR 38117; NRC 1996; NRC 2012)

Table 4.0-2
Category 2 License Renewal Issues

1996 GEIS Issues	Applicability	ER Section(s)
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	Applicable	4.1
Entrainment of fish and shellfish in early life stages (for plants with once-through and cooling pond heat dissipation systems)	Applicable	4.2
Impingement of fish and shellfish (for plants with once-through and cooling pond heat dissipation systems)	Applicable	4.3
Heat shock (for plants with once-through and cooling pond heat dissipation systems)	Applicable	4.4
Groundwater use conflicts (potable, service water, and dewatering; plants that use > 100 gpm)	Not Applicable	4.5
Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	Applicable	4.6
Groundwater use conflicts (Ranney wells)	Not Applicable	4.7
Groundwater quality degradation (cooling ponds at inland sites)	Not Applicable	4.8
Refurbishment impacts to terrestrial resources	Not Applicable	4.9
Threatened or endangered species	Applicable	4.10
Air quality during refurbishment (nonattainment and maintenance areas)	Not Applicable	4.11
Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Applicable	4.12
Electromagnetic fields, acute effects	Applicable	4.13
Housing impacts	Applicable	4.14
Public services: public utilities	Applicable	4.15
Public services: education (refurbishment)	Not Applicable	4.16
Offsite land use (refurbishment)	Not Applicable	4.17
Offsite land use (license renewal term)	Applicable	4.18
Public services: transportation	Applicable	4.19
Historic and archaeological properties	Applicable	4.20
Severe accidents	Applicable	4.21

(NRC 1996)

4.1 Water Use Conflicts

4.1.1 Description of Issue

Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow).

4.1.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See 10 CFR 51.53(c)(3)(ii)(A).

4.1.3 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15 x 10^{12} ft^3/year (9 x 10^{10} m^3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided.

4.1.4 Background

Consultation with regulatory and resource agencies indicates that water use conflicts are already a concern at two closed-cycle nuclear power plants…and may be a problem in the future…. Related to this, the effects of consumptive water use on in-stream and riparian communities could also be small or moderate, depending on the plant . . . . (NRC 1996, Section 4.3.2.1)

4.1.5 Analysis of Environmental Impact

Two factors may cause water-use and water-availability issues to become important for facilities that use cooling towers. First, the relatively small rate of water withdrawal and discharge allow some plants with cooling towers to be located on small rivers that are susceptible to droughts or competing water uses. Second, cooling towers evaporate cooling water, and consumptive water losses may represent a substantial portion of the flow in a small river. SQN's location on the Tennessee River is between two dams which create an impoundment, the Chickamauga Reservoir, through which the river flows. The average flow of the Tennessee River through the Chickamauga Reservoir (as measured using flow through Chickamauga Dam) (Table 4.1-1) is less than the regulatory threshold of 3.15 x 10^{12} ft^3/year (9 x 10^{10} m^3/year). However, TVA does not believe that the concerns of use of cooling towers with a low-flow river apply to SQN Units 1 and 2, because water availability for cooling is not only dependent on flow but also influenced by the volume of water impounded. However, to assist the NRC staff in addressing this issue for license renewal, TVA provides the following information.

4.1.5.1 Hydrology

Site and area hydrology is described in Section 2.2.1.

Consistent with the TVA Act of 1933, Chickamauga Dam and Reservoir are operated for flood protection, navigation, and power production, as well as for improved water quality (dam discharge oxygenation and aeration), aquatic resources, water supply, and recreation. To maintain water depth for navigation, the minimum winter elevation for Chickamauga Reservoir is 675 feet msl. During normal operation, the surface elevation of Chickamauga Reservoir varies from about 676 feet msl in winter to a typical range of 681.5–682.5 feet msl in summer. This variation represents a fluctuation of 6.5 feet msl between winter and summer (TVA 2010h; TVA 2010i). From mid-May to mid-September, TVA may vary the elevation of Chickamauga Reservoir by as much as 1 foot to aid in mosquito population control. During high-flow periods, the top of the normal operating elevation range may be exceeded to regulate flood flows. (TVA 2010i)

Hourly flow rates at Chickamauga Dam and Watts Bar Dam from 1976 through 2011 were recorded by TVA. The average rates of flow at SQN and the two dams were determined based on the 1976–2011 data and are presented in Table 4.1-1, along with the drainage area for each of the three locations.

4.1.5.2 Water Use

The SQN surface water withdrawals within the Chickamauga Reservoir catchment area in 2011 averaged about 1,604 MGD (2,482 cfs), or approximately 8 percent of the average flow (31,100 cfs) of the Tennessee River past the SQN site (Table 4.1-1). Due to evaporation and drift resulting from intermittent operation in helper mode with the cooling towers, the total return flow in 2011 was slightly less, 1,598 MGD (2,473 cfs), again approximately 8 percent of the average river flow. Therefore, the average net consumptive use of water in 2011 was approximately 6 MGD (9 cfs), or about 0.4 percent of the amount withdrawn. (TVA 2012j)

When the plant is operated in helper mode, the net consumption of water for a single day will be larger than the annual average day. For example, when operated under design conditions (a conservative upper-bounding scenario), the net loss of water due to evaporation and drift in the cooling towers is about 45 MGD (70 cfs). In a similar fashion, on a daily basis, the river flow is often lower than the annual average flow. Based on the current operating policy for the TVA reservoir system, the daily average river flow past the SQN site can be as low as 3,000 cfs. However, in practice, the river flow past SQN seldom drops below a daily average of 6,000 cfs. Thus, on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. (TVA 2012j)

In addition, as previously discussed in Section 2.2.1.2, surface water withdrawals from the Chickamauga Reservoir are regulated and impacts are evaluated prior to the issuance of a permit 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. (TVA 2012j)

4.1.5.3 Instream Ecological Uses

Chickamauga Reservoir provides habitat to fish, invertebrates, plankton, and vegetation. As discussed in Section 2.2, TVA has monitored reservoir communities for decades through routine monitoring regimes as well as focused surveys. When reviewing the RBI and RFAI averages from the periods 1994–1999 and 2000–2009, little ecological change is evident. In addition, because SQN is located on a river impoundment and there are no water availability problems in Chickamauga Reservoir, the relatively small consumptive water loss from SQN does not have a significant adverse impact on instream ecological communities.

4.1.6 Conclusion

TVA's *Final Environmental Statement, Sequoyah Units 1 and 2* (TVA 1974a, Section 2.9.2) concluded that the operation of SQN would not result in a water use conflict on this portion of the Tennessee River (Chickamauga Reservoir). During the license renewal term, the operation of SQN will also not result in a water use conflict on Chickamauga Reservoir. As previously discussed, cooling water makeup at SQN is a very small percentage of the overall flow of the Tennessee River through Chickamauga Reservoir. Since the plant became operational in 1981 (Unit 1 on July 1, 1981; Unit 2 on June 1, 1982), water withdrawal has caused no water availability concerns for the lake, no conflicts with other offstream users, and no adverse impacts on riparian or instream ecological communities. This is further supported by the results of TVA's ecological monitoring program discussed in Section 2.2, which shows the plant has had little effect on reservoir ecology.

Therefore, TVA concludes that environmental impacts related to water use conflicts from license renewal would be SMALL.

Table 4.1-1
Drainage Area and Average Flow Rate

Location	Drainage Area [a] (sq mi)	Average Flow Rate[b] (cfs)	Average Flow Rate[b] (ft^3/year)
Watts Bar Dam	17,310	26,200	0.83×10^{12}
SQN	20,650	31,100	0.98×10^{12}
Chickamauga Dam	20,790	32,500	1.03×10^{12}

a. (TVA 2011p, Section 2.4.1.2 and Table 2.4.1-1)
b. (TVA 2012j)

4.2 Entrainment of Fish and Shellfish in Early Life Stages

4.2.1 Description of Issue

Entrainment of fish and shellfish in early life stages (for all plants with once-through and cooling pond heat dissipation systems).

4.2.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. The impacts of entrainment are small at many plants, but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See 10 CFR 51.53(c)(3)(ii)(B).

4.2.3 Requirement [10 CFR 51.53(c)(3)(ii)(B]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations . . . or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from . . . entrainment.

4.2.4 Background

The impacts of fish and shellfish entrainment are small at many plants, but they may be moderate or even large at a few plants with once-through cooling systems. Further, ongoing restoration efforts may increase the numbers of fish susceptible to intake effects during the license renewal period, so that entrainment studies conducted in support of the original license may no longer be valid. (NRC 1996, Section 4.2.2.1.2)

4.2.5 Analysis of Environmental Impact

4.2.5.1 Background

As discussed in Section 3.2, SQN uses once-through cooling both with and without the assistance of cooling towers (open and helper modes). The SQN cooling water intake includes an intake channel that brings water from Chickamauga Reservoir and a CCW pumping station that lies at the end of the channel. A floating trash boom is located at the reservoir shoreline and an intake skimmer wall also spans the entrance to the embayment. The CCW station has six intake openings, each of which is equipped with a trash rack and traveling screens.

As discussed in Section 3.2.2.4, there is also an ERCW intake structure which supplies cooling water to various heat loads in both the primary and secondary portions of each unit. The ERCW system consists of eight ERCW pumps (11,000 gpm each), four traveling water screens, four screen wash pumps (270 gpm each), and four strainers located at the ERCW pumping station.

Supply water for the ERCW pumps enters the pumping station through each of four traveling water screens at a velocity of < 0.50 fps. Because the intake velocity is typically considered best technology available, TVA did not include the ERCW intake structure in this analysis.

Section 2.2 discusses in detail the aquatic resource setting at SQN and the results of TVA-conducted studies and ongoing monitoring of Chickamauga Reservoir, which has a complex and abundant aquatic ecology. TVA monitors aquatic life at multiple sampling points annually to assess the ecological health of Chickamauga Reservoir and discern any adverse impacts that SQN operations may have on aquatic ecology. These annual sampling programs focus on benthic macroinvertebrate and fish populations, the RBI and the RFAI. Section 2.2 discusses the RBI and RFAI programs in more detail and presents annual data in Tables 2.2-6 and 2.2-9, respectively.

For the sampling locations near SQN, some RBI variability is evident from year to year, but no increasing or decreasing trends are apparent, which indicates no significant impacts to aquatic resources from operation of SQN. In comparing the averages from 1994–1999 and 2000–2009, little change is evident, which implies relative stability within the macroinvertebrate community. Trends in RFAI data over time also indicate relative stability by comparing the 1994–1999 average with the 2000–2009 average displayed in Table 2.2-9, thus indicating relative stability within the reservoir.

Section 2.2 also discusses four focused studies undertaken by TVA to address concerns raised by TDEC and TWRA in 1986 which were related to declining numbers of white bass, white crappie, sauger, and channel catfish. These studies indicated that declining numbers were a result of natural causes such as species competition and predation, except that declines in the sauger population were attributed to conditions being less than optimal for reproduction. None of the declines were attributable to SQN's intake structure operations.

SQN operates under an NPDES permit. The initial NDPES permit (TN0026450) was issued by EPA effective January 15, 1979. This permit required TVA to design and implement an operational stage nonradiological monitoring program to evaluate potential intake and discharge effects of SQN on the aquatic environment of Chickamauga Reservoir, to continue through two years of Unit 2 operation. Pursuant to this provision, TVA conducted entrainment monitoring during the operational monitoring period from 1981 through 1985 as discussed in the following section. Subsequently, TVA conducted entrainment monitoring for 12 weeks from April to July 2004. The 2004 study was originally published in 2006 and provided supporting documentation to TDEC for TVA's NPDES permit renewal application. The 2004 entrainment study is also discussed and compared with the earlier entrainment monitoring studies in the following section. Table 2.2-5 presents annual estimated entrainment values for 1981 through 1985, and 2004. At the time the entrainment studies were conducted (1981–2004), only fish eggs and larvae were required to be sampled.

SQN's most recent NPDES permit, TN0026450, became effective on March 1, 2011. Based on 10 CFR 51.53(c)(3)(ii)(B), an assessment of the impact on fish and shellfish resources resulting from entrainment is not required, because it was determined in the 2011 permit that SQN was currently in compliance with 316(b) requirements based on best professional judgment. A copy of the current NDPES permit is provided in Attachment C. Based on previous monitoring, it is anticipated that no additional monitoring will be required by the new regulations pursuant to CWA Section 316(b). CWA Section 316(b) is further discussed in Section 5.1.1.

4.2.5.2 Entrainment Analysis

Freshwater drum eggs were found to be the vast majority of all fish eggs collected (TVA 1986). Oil globules increase the buoyancy of the eggs and increase the possibility of their transport in floodwaters and through river and reservoir systems via natural or controlled flows. Drum eggs float at or near the water surface, but wave action may circulate the eggs deeper, and the eggs often can be found throughout the water column. (Wallus 2006)

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 and to permit comparative entrainment estimates for all taxa throughout the sampling season calculated using both skimmer wall and intake samples (only skimmer wall samples were previously collected). The 1985 data continued to indicate higher entrainment rates for freshwater drum, but also indicated that previous sample methods at the plant transect were underestimating reservoir transport of freshwater drum eggs and larvae past SQN. Continued high densities of freshwater drum eggs observed at the diffuser transect in 1985 reaffirm that significant spawning occurs in the vicinity of, or slightly downstream of SQN, producing eggs and larvae that are not subject to plant entrainment. (TVA 1986)

The 1986 assessment of operational monitoring (TVA 1986) noted that cove rotenone studies indicated a decline in numbers and biomass of young and intermediate-size freshwater drum. The decline of young and intermediate-size freshwater drum was first documented in preoperational monitoring. However, no significant increasing or decreasing trends in adult freshwater drum stocks were identified. Reductions in young and intermediate stocks are not considered ecologically significant unless they are ultimately reflected in reduced stocks of adults. (TVA 1986)

As a result of the assessment, TVA conducted a focused study on freshwater drum in 1986 to assess the impact of the higher entrainment rates on this species. The study involved collecting samples of adult fish and age analysis of the collected freshwater drum. Numbers of freshwater drum captured in each year class were compared to annual estimated entrainment (percentage) of freshwater drum eggs and larvae at SQN during 1981 through 1985. If, during the years of highest entrainment, losses of eggs and larvae significantly impacted survival of the year classes, subsequent age analysis of the population should indicate relatively weak or missing year classes.

Estimated annual entrainment of freshwater drum eggs was highest (41.4 percent) in 1982, and second highest (22.6 percent) in 1983. The year classes produced during these 2 years coincide with the two most abundant age classes collected in 1986, thus contradicting the idea that drum populations may have been harmed by entrainment losses at SQN. Entrainment of freshwater drum larvae at SQN was highest (57.8 percent) in 1983, followed by 1982 (25.6 percent). As observed with freshwater drum eggs, the year classes produced during the 2 years of highest estimated larval entrainment proved to be the most abundant collected in 1986. Therefore, in spite of decreasing trends of young and intermediate stocks of freshwater drum indicated from cove rotenone surveys, the population of adult freshwater drum in Chickamauga Reservoir was found in 1986 to be above normal in terms of age class composition and rate of growth. Thus the results of the 1986 study, along with the results of preoperational and operational monitoring, indicate that the freshwater drum population of Chickamauga Reservoir has not been adversely impacted by the operation of SQN. (TVA 1986)

Sample methods used in the 2004 entrainment study were only slightly different than those used in the original entrainment study. However, ichthyoplankton were identified from the samples collected in both the 1985 and 2004 studies. During 1985, fish eggs from four locations adjacent to SQN were sampled. 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, freshwater drum eggs accounted for 98.8 percent of the total fish eggs collected during all 12 sample periods, demonstrating the extended spawning season for this species. 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 individuals. Shad dominated at 61 percent of the total, followed by sunfish at 17 percent (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 3,465/1,000 m^3 respectively. The abundance of other significant 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) These numbers represent the percentage of eggs and larvae passing by SQN that were removed from the reservoir through entrainment. There are additional fish produced downstream of SQN that were not sampled. Therefore, the actual total percentage of eggs and larvae removed from the reservoir is less than reported here. (TVA 1986)

Hydraulic entrainment refers to the portion of Chickamauga Reservoir diverted into the plant by SQN. Seasonal mean hydraulic entrainment was 12.2 percent in 1985 compared to 24.2 percent in 2004. Higher hydraulic entrainment was likely the result of a lower reservoir flow rate caused by lower than average runoff from rainfall. This also influenced the total entrainment rate of 15.6 percent for larval fish, which was higher than estimated for the years 1981 through 1985. (TVA 2010a)

Densities of fish eggs and larvae in the reservoir near the intake and daily volume of water transported past SQN were compared to daily CCW demand and densities of fish at the intake skimmer wall to estimate percent entrainment. Estimated entrainment of freshwater drum eggs was 11.2 percent in 2004 compared to 16.6 percent in 1985. Drum larval entrainment was estimated at 30.2 percent in 1985 compared to 45.4 percent in 2004. Considering that hydraulic entrainment doubled from 1985 to 2004 due to lower rainfall and subsequent lower inflow to the reservoir, this increased rate of entrainment estimated for drum larvae could be expected.

In May 2004, the TVA Board of Directors approved a new policy for operating the Tennessee River and reservoir system. This policy shifts the focus of TVA reservoir operations from achieving specific summer pool elevations on TVA-managed reservoirs to managing the flow of water through the river 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 that reservoir's dam from drying out. System-wide flow requirements ensure that enough water flows through the river system to meet downstream needs. When water must be released to meet downstream flow requirements, a fair share of water is drawn from each reservoir. System-wide flows are measured at Chickamauga Dam, located near Chattanooga, Tennessee, because this location provides the best indication of the flow for the upper half of the Tennessee River system. (TVA 2012g)

The withdrawal at SQN remains relatively constant, but the apparent hydraulic entrainment of the plant will increase during periods of low flow through the reservoir. Thus, the percent of the hydraulic flow entrained by SQN increases as the reservoir flow decreases, and there may be corresponding increases in fish entrainment.

Historical data led to the conclusion that substantial spawning by freshwater drum occurs in the vicinity of or slightly downstream of SQN, producing eggs and larvae that are not subject to plant entrainment. Even though seasonal larval drum entrainment was abnormally high (45.4 percent) during 2004, it was primarily attributed to a single sample period (May 18, 2004) when the peak density occurred simultaneously with peak hydraulic entrainment (111 percent of river flow during that time period, thus the plant was drawing in the full river flow as well as additional water of the impoundment). These results demonstrate annual variations in the relative abundance and spatial temporal distribution of fish, and fluctuations in reservoir flow are common near SQN. Life history aspects, dynamics of drifting larvae, and fluctuation in reservoir flow past SQN are the primary factors influencing variations observed in the annual entrainment estimates. (TVA 2010a)

4.2.5.3 Category 1 Issue Analysis

Entrainment of phytoplankton and zooplankton is currently a Category 1 issue. However, TVA has elected to address this issue in this analysis.

Because phytoplankton and zooplankton make up the base of the food chain, an assessment of the overall ecological health of the reservoir that indicates a stable and diverse ecological system would indicate that the phytoplankton and zooplankton populations are adequate to support the food chain and not subject to significant adverse impacts from SQN entrainment. As discussed above and in Section 2.2, TVA monitors aquatic life at multiple sampling points annually to assess the ecological health of Chickamauga Reservoir, focusing on benthic macroinvertebrate and fish populations, the RBI, and the RFAI. Both indices indicate stable, healthy ecological communities. Therefore, current SQN operation is not leading to significant adverse impacts to phytoplankton and zooplankton populations, and continuation of operations during the license renewal period would likewise not result in significant adverse impacts to phytoplankton and zooplankton populations from entrainment.

4.2.6 Conclusion

Based on entrainment, RFI, RFAI, and focused, specific studies that have been conducted over the years, there is no indication that SQN operations are adversely impacting the fish community in Chickamauga Reservoir. Instead, studies show that fish populations are healthy and thriving. Because no increase in the amount of cooling water withdrawn is planned during the license renewal period, TVA concludes that the impact due to entrainment of fish and shellfish is SMALL and further mitigation measures are not warranted.

4.3 Impingement of Fish and Shellfish

4.3.1 Description of Issue

Impingement of fish and shellfish (for all plants with once-through and cooling pond heat dissipation systems).

4.3.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See 10 CFR 51.53(c)(3)(ii)(B).

4.3.3 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations . . . or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from. . . impingement . . . .

4.3.4 Background

Aquatic organisms drawn into the intake with the cooling water but too large to pass through the traveling screens may be impinged against the screens.... As with entrainment, operational monitoring and mitigative measures have allayed concerns about population-level effects at most plants, but impingement mortality continues to be an issue at others. Consultation with resource agencies revealed that impingement is a frequent concern at plants using once-through cooling, particularly where restoration of anadromous fish (fish that migrate from the sea to spawn in fresh water) may be affected. The impacts of impingement are small at many plants, but may be moderate or even large at a few plants with once-through cooling systems. (NRC 1996, Section 4.2.2.1.3)

4.3.5 Analysis of Environmental Impact

4.3.5.1 Background

Impingement occurs when fish and other aquatic life are trapped against cooling water intake screens. Sometimes fish are unable to swim against the inflow water velocity and become trapped on the traveling screens. Traveling screens are systematically rotated and washed to remove fish and other debris to prevent clogging of the water flow used to cool the plant condensers. Impingement rates typically increase during the late fall and early winter when fish intolerant of lower water temperatures exhibit die-offs.

Section 3.2.2 of the ER describes the cooling water intake system. Flow passes through six traveling screens at a velocity of approximately 1.7 fps, three for each unit (Figure 3.2-3). The traveling screens have 3/8-inch square openings.

As discussed in Section 3.2.2, there is also an ERCW intake structure which supplies cooling water to various heat loads in both the primary and secondary portions of each unit. The ERCW system consists of eight ERCW pumps (11,000 gpm each), four traveling water screens, four screen wash pumps (270 gpm each), and four strainers located at the ERCW pumping station. Supply water for the ERCW pumps enters the pumping station through each of four traveling water screens at a velocity of < 0.50 fps. Because the intake velocity is typically considered best technology available, TVA did not include the ERCW intake structure in this analysis.

SQN operates under an NPDES permit. The initial NDPES permit (TN0026450) was issued by the EPA effective January 15, 1979. This permit required TVA to design and implement an operational stage nonradiological monitoring program to evaluate potential intake and discharge effects of SQN on the aquatic environment of Chickamauga Reservoir, to continue through 2 years of Unit 2 operation. Pursuant to this provision, TVA conducted impingement monitoring during the operational monitoring period from 1980 through 1985 as discussed in the following section. Subsequently, TVA conducted impingement monitoring in December 2001 to February 2002. The 2001–2002 impingement study is also discussed in the following section.

SQN's most recent NPDES permit, TN0026450, became effective on March 1, 2011. Based on 10 CFR 51.53(c)(3)(ii)(B), an assessment of the impact on fish and shellfish resources resulting from impingement is not required, because it was determined in the 2011 permit that SQN was currently in compliance with 316(b) requirements based on best professional judgment. A copy of the current NDPES permit is provided in Attachment C. Based on previous monitoring, it is anticipated that no additional monitoring will be required by the new regulations pursuant to CWA Section 316(b). CWA Section 316(b) is further discussed in Section 5.1.1.

4.3.5.2 Impingement Analysis

1980–1985 Study

In accordance with SQN's 1979 NPDES permit issued by the EPA, TVA began monitoring impingement rates associated with plant operations to detect impacts to the fish community. In the years monitored (1980–1985), threadfin shad were consistently the most abundant species impinged (generally > 90 percent by number), largely because they have a high fecundity rate, move in large schools, and are intolerant to cold temperatures, often resulting in high mortality rates in winter. In 1985, bluegill, freshwater drum, yellow bass, and skipjack herring each accounted for 5–7 percent of total number of fish impinged. Impingement data during the first 7 months of 1985 were similar to the previous 4 years and confirmed that the low numbers of impinged fish did not constitute an adverse environmental impact to the fish populations in Chickamauga Reservoir. The 1985 data also confirmed the conclusion at the end of 1984 that sufficient impingement monitoring had been done to evaluate the impacts of plant operation and that monitoring could be discontinued. These recommendations were instituted in July 1985 following approval from the EPA. (TVA 1986)

2001–2002 Study

In accordance with SQN's 2001 NPDES permit issued by TDEC, TVA conducted monitoring to evaluate the effects of the operation of SQN's CCW intake on the aquatic community of Chickamauga Reservoir. Impingement samples were collected in the winter of 2001–2002 from the SQN traveling screens when, historically, peak numbers of fish are impinged. Ten impingement samples were collected from the CCW screens between December 19, 2001, and February 25, 2002. The 2001–2002 data presented the worst-case scenario: samples collected in the winter when peak numbers are typically impinged at SQN. Impingement estimates for all species except threadfin shad were low numbers and consistent with the 1981–1985 historical data. Numbers estimated for threadfin shad were similar to historical peaks, and the significant drop in the numbers impinged in February 2002 is consistent with seasonal fluctuations previously reported. The 2001–2002 data showed no changes in SQN operation since the 1981–1985 operational studies that would potentially impact the fish populations in Chickamauga Reservoir. (Kay and Baxter 2002)

2005–2007 Study

In response to the EPA issuance of a 2004 rule for implementing Section 316(b) of the CWA, a rule subsequently suspended in 2007, and in accordance with a proposal for information collection submitted to TDEC in 2005, TVA conducted additional impingement monitoring at SQN to update the impingement database for potential intake effects on fish populations in Chickamauga Reservoir.

Weekly impingement sampling at SQN from January 2005 to January 2007 resulted in collection of 2,889 fish (22 species) during the first year (January 25, 2005–January 23, 2006) and 5,766 fish (21 species) during the second year (January 30, 2006–January 15, 2007). Threadfin shad predominated (91 percent) in the samples, followed by bluegill (3 percent) and freshwater drum (2 percent), while channel catfish, blue catfish, and black crappie each represented but 1 percent each. All other species combined contributed less than 1 percent of the total number of fish collected.

Rate of impingement was highest during November and December during Year 1 (2005–2006), while peak impingement occurred during August, October, and November during Year 2

(2006–2007). Estimated annual impingement was calculated by extrapolating impingement rates from weekly samples. An estimated 20,223 fish were impinged during Year 1 and 40,362 during Year 2 (Table 4.3-1); of these, the majority was threadfin shad. Estimated impingement during Year 2 was more than double the impingement estimate during Year 1 due to collection of greater than two times more threadfin shad during Year 2. (TVA 2007b)

Fish impingement rates at SON during the period 2005–2007 were much lower than that of 1980–1981, but were similar to historical data collected during the period 1982–1985. Threadfin shad continues to be the dominant species impinged during all years sampled and accounted for 91 percent of fish impinged during the 2005–2007 study. (TVA 2007b) Therefore, this study, along with the previous studies discussed above, continues to support no adverse impacts to the fish population as a result of SQN's operations. (TVA 2007b)

<u>Equivalent Adult/Production Foregone Model</u>

In conformance with methods utilized by EPA in its technical development documents in support of the Phase II rule, EPRI identified two models for extrapolating losses of fish eggs, larvae, and juveniles at intake structures to numbers or production of older fish. The equivalent adult (EqA) model quantifies entrainment and impingement losses in terms of the number of fish that would have survived to a given future age. The production foregone (PF) model applies to forage fish species to quantify the loss from entrainment and impingement in terms of potential forage available for consumption by predators. TVA used these models to determine the "biological liability" of the CCW intake structure based on the EPA guidance developed under the suspended 2004 rule. (TVA 2007b)

To determine the impact impingement has on fish populations, models estimating the number of impinged fish which would have been expected to survive to either harvestable size/age or to provide forage for other fish were applied to the number of fish impinged over the study years. This reduced number would be considered the "biological liability" resulting from plant CCW impingement mortality based on the guidance developed for the now-suspended 2004 316(b) rule. Tables 4.3-2 and 4.3-3 present the numbers of fish representing SQN's biological liability over the study years. As shown in these tables, the number of liability fish has been low over the study years; therefore, these results, as well as results from annual monitoring as discussed in Section 2.2, demonstrate that impingement at SQN is not adversely affecting reservoir fish populations. (TVA 2007b)

<u>Summary</u>

Based on the results of previous impingement studies, there is no indication that fish populations in Chickamauga Reservoir are being adversely affected as a result of SQN's operations. To further support these conclusions, effects of impingement on fish communities would also be detected through the RFAI program (Section 2.2). From 1993 to 2010, the RFAI scores upstream (TRM 490.5) and downstream (TRM 482) from SQN have averaged 44 and 41, respectively (Table 2.2-9). Both of these scores are in the GOOD range, indicating that operation of SQN has not adversely impacted the reservoir fish community. As no change in the amount of water withdrawal is planned, no additional impingement impacts are expected at SQN.

4.3.6 Conclusion

TVA has a well-documented history of monitoring the impingement rates at SQN. These data indicate that relatively few fish are impinged when compared to the overall fish population in Chickamauga Reservoir. Therefore, no adverse impact to the reservoir fisheries community is anticipated. This conclusion is further substantiated by reviewing RFAI data from Chickamauga Reservoir. The RFAI data from the period 1993–2010 presented in Section 2.2 show that fish populations both upstream and downstream of SQN are in the GOOD range. Because no increase in the amount of cooling water withdrawn is planned during the license renewal period, TVA concludes that the impact due to impingement of fish and shellfish is SMALL and further mitigation measures are not warranted.

Table 4.3-1
Fish Species and Numbers Collected in Impingement Samples at SQN, 2005–2007

Family	Scientific Name	Common Name	Total # Impinged	
			Year 1[(a)]	Year 2[(b)]
Clupeidae	*Alosa pseudoharengus*	Alewife	10	4
	Dorosoma cepedianum	Gizzard shad	17	25
	Alosa chrysochloris	Skipjack herring	10	10
	Dorosoma petenense	Threadfin shad	2,529	5,373
Cyprinidae	*Pimephales notatus*	Bluntnose minnow	0	2
	Pimephales vigilax	Bullhead minnow	1	3
	Moxostoma spp.	Unidentified redhorse	0	1
	Notropis atherinoides	Emerald shiner	1	0
Ictaluridae	*Ictalurus furcatus*	Blue catfish	25	40
	Ictalurus punctatus	Channel catfish	50	32
	Pylodictis olivaris	Flathead catfish	3	11
	Ameiurus natalis	Yellow bullhead	1	0
Atherinidae	*Labidesthes spp.*	Unidentified silverside	0	1
Moronidae	*Morone saxatilis*	Striped bass	4	0
	Morone chrysops	White bass	2	4
	Morone mississippiensis	Yellow bass	24	10
Centrarchidae	*Lepomis spp.*	Unidentified sunfish	0	1
	Lepomis macrochirus	Bluegill	122	120
	Lepomis auritus	Redbreast sunfish	2	1
	Lepomis microlophus	Redear sunfish	1	0
	Micropterus salmoides	Largemouth bass	5	5
	Micropterus punctulatus	Spotted bass	1	13
	Pomoxis nigromaculatus	Black crappie	0	47
	Pomoxis annularis	White crappie	3	3
Poeciliidae	*Gambusia affinis*	Western mosquitofish	1	0
Percidae	*Sander canadense*	Sauger	1	0
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	76	60
		Total Number of Fish	2,889	5,766
		Total Number of Species	22	21

(TVA 2007b)

a. Year 1 represents sampling during 2005–06 sampling season.
b. Year 2 represents sampling during the 2006–07 sampling season

Table 4.3-2
Total Fish Estimated Impinged by Year at SQN[a] and Numbers Following EqA and PF Models, 2005–2007

	1980–1981	1981–1982	1982–1983	1983–1984	1984–1985	2005–2006	2006–2007
Extrapolated annual number impinged[b]	94,528	81,158	20,685	41,076	27,195	20,223	40,362
Number after EqA and PF reduction	4,851	5,843	2,256	4,162	2,761	1,868	821

(TVA 2007b)

a. Data from the 2001–2002 study are not included in this table, because they represent peak impingement data, for comparison, not an annual estimate, as discussed in Section 4.3.5.2.
b. Based on the standing crop estimates from TVA reservoir monitoring, these annual impingement estimates represent < 0.01 percent of the total standing crop by number.

Table 4.3-3
Percent Composition by Number and After EqA and PF Models Applied of Major Species of Fish Impinged at SQN 1980–1985 and 2005–2007

	1980–1981		1981–1982		1982–1983		1983–1984		1984–1985		2005–2006		2006–2007	
Species Composition	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**	**% by #**	**% After PF & EqA**
Threadfin shad	83	63	72	46	49	25	70	44	65	42	87	59	93	77
Lepomis	8	16	4	7	8	12	9	14	6	12	4	9	2	5
Gizzard shad	4	3	9	6	22	11	2	1	8	5	1	0	0	0
Skipjack herring	0	0	0	0	1	1	3	2	4	3	0	0	0	0
Ictalurids	0	0	0	0	2	7	1	5	1	4	3	15	2	10
Freshwater drum	2	3	8	14	12	19	9	15	6	9	3	6	1	2
Spotted bass	0	0	1	2	0	0	0	0	0	0	0	0	–	1
White crappie	–	3	0	0	1.	2	0	0	0	0	0	0	1	2
Yellow perch	–	3	–	6	1	6	–	4	––	3	0	0	0	0
Yellow/white bass	–	3	3	11	–	6	–	4	–	3	1	6	–	2
Bullhead minnow	0	0	0	0	0	0	0	0	2	1	0	0	0	0
Total	97	94	97	92	98	91	95	94	93	96	99	95	99	99

(TVA 2007b)
– Denotes that a species was not a major species for that year.

4.4 Heat Shock

4.4.1 Description of Issue

Heat Shock (for all plants with once-through and cooling pond heat dissipation systems)

4.4.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See 10 CFR 51.53(c)(3)(ii)(B).

4.4.3 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act . . . 316(a) variance in accordance with 40 CFR Part 125, or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock . . . .

4.4.4 Background

Based on the research literature, monitoring reports, and agency consultations, the potential for thermal discharges to cause thermal discharge effect mortalities is considered small for most plants. However, impacts may be moderate or even large at a few plants with once-through cooling systems. For example, thermal discharges at one plant are considered by the agencies to have damaged the benthic invertebrate and seagrass communities in the effluent mixing zone around the discharge canal; as a result, helper cooling towers have been installed to reduce the discharge temperatures. Conversely, at other plants it may become advantageous to increase the temperature of the discharge in order to reduce the volume of water pumped through the plants and thereby reduce entrainment and impingement effects. Because of continuing concerns about thermal discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions, this is a Category 2 issue for plants with once-through cooling systems. (NRC 1996, Section 4.2.2.1.4)

4.4.5 Analysis of Environmental Impact

SQN possesses a current NPDES permit that demonstrates that the plant meets state water temperature standards, and a current CWA Section 316(a) variance. Therefore, based on 10 CFR 51.53(c)(3)(ii)(B), an assessment of the impact on fish and shellfish resources is not required, and a copy of the NPDES permit is provided in Attachment C. The following sections provide information on the thermal studies conducted in support of the 316(a) variance granted by TDEC, compliance monitoring, as well as background information on the heat dissipation system.

4.4.5.1 Background

Heat Dissipation System

SQN uses once-through cooling both with and without the assistance of cooling towers (helper and open modes, respectively). Once-through cooling is used during the majority of the year; however, during a thermally sensitive period when the water temperature in Chickamauga Reservoir approaches an NPDES permit limit, the plant places the cooling towers into service. Section 3.2.2 discusses the SQN heat dissipation system, providing details for each of the operating modes.

Cooling water is discharged to Chickamauga Reservoir via NPDES-permitted Outfall 101. The outfall includes a two-pipe multiport diffuser on the bottom of the Tennessee River, as detailed in Section 3.2.2. The NPDES permit for Outfall 101 specifies a mixing zone area 750 feet wide, extending 1,500 feet downstream and 275 feet upstream of the diffusers. The permit sets temperature limits for the downstream end of the diffuser mixing zone. The 24-hour downstream temperature shall not exceed 30.5°C (86.9°F), except in cases when the 24-hour ambient temperature exceeds 29.4°C (84.9°F). In these cases, the 24-hour downstream temperature can exceed 30.5°C (86.9°F) in helper mode, but in such situations, the hourly average downstream temperature shall not exceed 33.9°C (93.0°F). The maximum 24-hour average temperature rise is limited to 3.0°C (5.4°F) for April through October, the maximum 24-hour average temperature rise is limited to 5.0°C (9.0°F) for November through March, and the maximum hourly average temperature rate-of-change is limited to 2.0°C (3.6°F)/hour. The November through March limit for the temperature rise was obtained as a result of a 316(a) variance request.

Thermal Studies

Hourly dam releases for winter periods (November through March) over a 13-year period (1976–1989) were used by TVA to run a hydrothermal model to evaluate the instantaneous river flows at SQN and the resulting plant-induced changes in river temperature. Based on the model simulations, SQN would have exceeded the 3°C temperature rise limit 27 percent of the time (on an hourly basis), and a 4°C limit 4 percent of the time during the winter periods between 1976 and 1989. Subsequently, TVA was granted a thermal variance for the Outfall 101 discharge from TDEC's criteria for temperatures under Section 316(a) of the CWA. The variance allows a temperature rise of 5°C (9°F) for the winter operation months, November through March. A thermal monitoring program was designed to determine if the additional heat load to Chickamauga Reservoir would affect fish populations within the reservoir. Field investigations for two operational periods, 1993–1994 and 1994–1995 indicate an increase in water temperature beyond 3°C has occurred only once—on January 1, 1995. (TVA 1995b)

Due to the evolution in understanding the hydrothermal and biological characteristics of Chickamauga Reservoir, as well as the operational aspects of the nuclear plant and the Tennessee River system, modifications of the thermal criteria and monitoring of Outfall 101 have been necessary over the years. The most recent modification, implemented as required by the August 2001 NPDES permit, involved changing the period of averaging for the downstream temperature and temperature rise from hourly to 24 hours. This modification was done because changes in river flow due to hydro-peaking operations were causing unexpected swings in river temperature that could require a near-immediate response by SQN. The hourly averaging placed the plant in situations where thermal violations possibly could not be averted. Previous studies showed that a change from hourly averaging to 24-hour averaging would have no adverse impact on the hydrothermal and biological aspects of Chickamauga Reservoir. However, as part of this change, two special studies were added in the NPDES permit of 2001: one to confirm the adequacy of the ambient temperature measurement, and one to confirm the configuration of the mixing zone (TVA 2009f). TVA also conducted a study to confirm the numerical model used to compute compliance with NDPES temperature limits at the downstream end of the mixing zone (TVA 2009g).

The goal of the ambient temperature study was to determine the major factors contributing to the interaction between main channel and overbank flows, the impacts on water temperatures in the thermal mixing zone, and the optimal location of monitors to record the ambient temperature. The goal of the mixing zone study was to better determine the impact of hydro-peaking operations on the behavior of the thermal plume, and to determine if there is any need to redefine the extent of the mixing zone. As a result of these studies and field observations made during drought conditions in eastern Tennessee, changes were made in the location of the ambient temperature measurement and in the mixing zone compliance model. These changes were needed to account for the local buildup of heat in the river from SQN that occurs at low river flow. The hydrothermal mechanisms responsible for this buildup were not understood prior to conducting the studies. Also, the studies indicated that, on an annual basis, exceedance probabilities show little difference between the duration and frequency of ambient and mixing zone temperatures monitored using 24-hour averaging versus that of hourly averaging. Furthermore, it is very likely that changes in the plant operation to protect the NPDES limits based on 24-hour averaging also attenuate the most extreme hourly average temperature excursions. (TVA 2009f)

The primary method to monitor compliance with the NPDES permit temperature limits for this outfall includes the use of a numerical model that solves a set of governing equations for the flow and temperature of the water in the Outfall 101 mixing zone. The numerical model operates in real time and utilizes a combination of measured and computed values for the temperature, flow, and stage in the river, and the temperature and flow from the SQN discharge diffusers. The numerical model for the SQN effluent discharge study confirmed that the model computes the temperature at the downstream end of the mixing zone with sufficient accuracy for use as the primary method of verifying NPDES permit thermal compliance for Outfall 101. (TVA 2009g)

Impacts of plant operations, including the discharge plume, to four types of fish considered species of special concern in Chickamauga Reservoir were evaluated (TVA 2011a, Section 3.1.3.1). No instances of attraction or avoidance of the thermal plume have been detected for fish species within Chickamauga Reservoir (TVA 1995b). Additionally, relatively constant RBI scores from the period 2000–2009 at the downstream sample point, TRM 482, indicate the thermal plume is not affecting benthic macroinvertebrates downstream of SQN (TVA 2010b).

TVA has studied the sensitivity of the river and power systems to extreme meteorology and climate variations (Miller et al. 1993). In terms of water temperature, the studies evaluated the response to changes in meteorology for a typical mainstream reservoir like Chickamauga Reservoir. The results indicate that based solely on changes in air temperature, the average (April through October) natural water temperature in a mainstream reservoir could increase between 0.3°F and 0.5°F for every 1°F increase in air temperature. (TVA 2011a, Section 3.1.3.1) An assessment of potential climate change in the Tennessee River valley suggests that air temperatures could increase 0.8°C/1.4°F by 2020 and up to 4°C/7.2°F by 2100 (EPRI 2009). An increase in air temperatures of approximately 2°C/3.6°F could occur by the end of the 20-year license renewal period (2041) of SQN. The potential increase in water temperatures in Chickamauga Reservoir could range from 0.5°C/1.0°F to 1.1°C/2.0°F. Such a temperature rise could impact the operation of SQN generating units. The facility would have to utilize helper mode operation more frequently, and, in extreme cases, implement plant derates to maintain compliance with the NPDES permit. (TVA 2011a, Section 3.1.3.1)

4.4.5.2 Thermal Discharge Analysis

NPDES permit monitoring with 24-hour averaging for downstream temperature and temperature rise has been in effect since August 2001, with no evidence of adverse impact to the balanced indigenous population of shellfish, fish, and wildlife in Chickamauga Reservoir. Furthermore, the results of the ambient temperature and mixing zone studies suggest that based on current procedures for monitoring the plant thermal compliance, it is very likely that changes in the plant operation made to protect the NPDES permit limits based on 24-hour averaging (e.g., initiating cooling tower operation) also attenuate the most extreme hourly average temperature excursions based on an hourly average. Therefore, the current NPDES permit recommends that the downstream temperature and temperature rise continue to be based on 24-hour averaging. (TVA 2011a) SQN procedures for monitoring water temperatures and operating the plant have successfully maintained thermal compliance for all instream limits for Outfall 101. For the years 2007–2011, there have been no exceedances of the NPDES water temperature limits at SQN (Section 9.1.3.3.2).

Category 1 Issue Analyses

Although cold shock, thermal plume barrier to migrating fish, distribution of aquatic organisms, and premature emergence of aquatic insects are currently Category 1 issues and do not require further analysis absent new and significant information, TVA has elected to address these issues in this thermal analysis.

Cold shock can occur when organisms acclimated to the elevated temperatures of a thermal plume are abruptly exposed to temperature decreases when the artificial source of heating stops. Such events are most likely to occur during winter. Data collected near the SQN diffuser from gillnets, creel census, and fishermen pressure counts during cold weather (November through March) indicated fish are neither attracted to nor avoid the thermal plume (TVA 1995b). The NRC observed that at plants where this has occurred, fish mortalities usually involved only a few fish and did not result in population-level effects (NRC 1996).

The potential exists for thermal plumes to create a barrier to migrating fishes if the mixing zone covers an extensive cross-sectional area of the receiving water body. 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. These three white bass spawning sites are above SQN so movement of white bass past SQN during and after the spawning migration is apparently not impeded by SQN operations. 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. (TVA 1994) Over half the width of the reservoir at the SQN site is unaffected by the plume, leaving ample room for mobile species to avoid the plume when traveling the length of the reservoir (TVA 1995b).

The impact of SQN thermal discharge on the distribution of aquatic organisms and the premature emergence of aquatic insects can be discerned from the overall health of the ecological community within Chickamauga Reservoir. Over-predation of a species, malnutrition due to various causes including premature emergence of aquatic insects that disrupts the food chain, and other causes that result in an imbalance in the aquatic community would be detected in the annual benthic macroinvertebrate and fish monitoring conducted by TVA. As discussed in Section 2.2, the annual RBI and RFAI scores (Tables 2.2-6 and 2.2-9, respectively) for Chickamauga Reservoir indicate a viable, balanced, and stable indigenous aquatic ecological community in Chickamauga Reservoir in the vicinity of SQN, and show no substantial impacts from current operation of SQN.

4.4.6 Conclusion

SQN operates in compliance with the NDPES permit thermal discharge limits as measured by the temperature monitoring program in place since 2001 with no evidence of significant adverse impact to the balanced indigenous population of shellfish, fish, and wildlife in Chickamauga Reservoir. Furthermore, the determination has been made that shellfish, fish, and wildlife are protected by the current discharge regime (TDEC 2011b). Ecological monitoring from 1993 to present also indicates that a viable balanced indigenous aquatic ecological community is present in Chickamauga Reservoir in the vicinity of SQN, and shows no substantial impacts from current operation of SQN. Therefore, thermal impacts to aquatic species in Chickamauga Reservoir are SMALL and further mitigation measures beyond complying with the NPDES permit are not warranted.

4.5 Groundwater Use Conflicts (Plants Using > 100 gpm of Groundwater)

4.5.1 Description of Issue

Groundwater use conflicts (potable and service water and dewatering: plants that use more than 100 gpm).

4.5.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users. See 10 CFR 51.53(c)(3)(ii)(C).

4.5.3 Requirement [10 CFR 51.53(c)(3)(ii)(C)]

If the applicant's plant . . . pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater use must be provided.

4.5.4 Background

Those nuclear plants that use groundwater may affect the utility of groundwater to neighbors. This impact could occur as a direct effect of pumping groundwater, thereby either lowering the water table and reducing the availability or inducing infiltration of water of lesser quality into the ground. Neighboring groundwater users could also be affected indirectly if construction or operation of the power plant were to disrupt the normal recharge of the groundwater aquifer. The impact to neighboring groundwater users is likely to be most significant at a site where water resources are limited. Groundwater usage impact may be important at those sites where a power plant's usage rate exceeds 0.0063 m^3/s (100 gpm). Lower usage rates are not expected to impact sole source or other aquifers significantly. (NRC 1996, Section 4.8.1)

4.5.5 Analysis of Environmental Impact

SQN does not use any groundwater for its operation. As discussed in Section 2.3, the Hixson Utility District supplies potable water and fire protection water to the SQN plant. Other cooling water and service water systems are supplied from Chickamauga Reservoir. Therefore, this issue is not applicable to the site and further analysis is not required.

4.6 Groundwater Use Conflicts (Plants Using Cooling Towers Withdrawing Make-Up Water from a Small River)

4.6.1 Description of Issue

Groundwater use conflicts (plants using cooling towers withdrawing makeup water from a small river).

4.6.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal. See 10 CFR 51.53(c)(3)(ii)(A).

4.6.3 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), . . . applicant shall . . . provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

4.6.4 Background

Consultation with regulatory and resource agencies indicate the water use conflicts are already a concern at two closed-cycle nuclear power plants . . . and may be a problem in the future . . . . (NRC 1996, Section 4.3.2.1)

4.6.5 Analysis of Environmental Impact

As discussed in Section 4.1.5.1, TVA's operation of the Tennessee River system maintains the Chickamauga Reservoir water levels as part of the entire river system management program. During normal operation, the surface elevation of Chickamauga Reservoir varies from about 676 feet msl in winter to a typical range of 681.5 to 682.5 feet msl in summer. This variation represents a fluctuation of 6.5 feet msl between winter and summer. From mid-May to mid-September, TVA may vary the elevation of Chickamauga Reservoir by as much as 1 foot to aid in mosquito population control. During high-flow periods, the top of the normal operating elevation range may be exceeded to regulate flood flows.

As discussed in Section 2.3, higher surface water levels of Chickamauga Reservoir result in corresponding rises in the groundwater table, and the lateral extent of this effect varies with groundwater hydraulic gradients. Lower surface water levels in Chickamauga Reservoir result in corresponding declines in the water table along the reservoir periphery.

Also as discussed in Section 2.3, there are 22 registered water wells within a 2-mile radius of the SQN site, all of which are considered to be monitoring or low-volume groundwater withdrawals. Therefore, it is anticipated that these wells would be unaffected by surface water levels in Chickamauga Reservoir.

Total offstream surface water use for Chickamauga Reservoir in 2005 had a withdrawal rate of approximately 1,588 MGD and total return flow of approximately 1,715 MGD that resulted in a positive net water consumption of approximately 127 MGD (Bohac 2012b). The reason for the positive net water consumption is that Watts Bar Nuclear Plant withdraws cooling water from Watts Bar Reservoir then discharges to Chickamauga Reservoir. In addition, recent studies indicate an expected decrease in water withdrawals in the Tennessee River valley by 2030 (TVA 2011a, page 3-8).

While the Tennessee River is classified as a low-flow river and SQN uses cooling towers in the helper mode for part of the year when the Tennessee River system is operating at higher levels as discussed in Section 4.1.5.2, the closed-cycle mode is not currently used at SQN because it would result in significant derates. When SQN is in the helper mode, the amount of evaporative losses depends on a number of factors, such as the amount and temperature of flow delivered to the cooling towers and meteorology. When the plant is operated in helper mode, the net consumption of water for a single day will be larger than the annual average day. For example, when operated under design conditions (a conservative upper-bounding scenario), the net loss of water due to evaporation and drift in the cooling towers is about 45 MGD (70 cfs). In a similar fashion, on a daily basis, the river flow is often lower than the annual average flow. Based on the current operating policy for the TVA reservoir system, the daily average river flow past the SQN site can be as low as 3,000 cfs. However, in practice, the river flow past SQN seldom drops below a daily average of 6,000 cfs. Thus, on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. (TVA 2012j)

Because TVA maintains Chickamauga Reservoir water levels at consistent levels during the summer and winter months as part of the entire river system management program, and there is a positive net return of surface water to Chickamauga Reservoir from offstream surface water users, impacts on the alluvial aquifer recharge from the operation of SQN while in the cooling tower helper mode would be SMALL.

Because normal changes in Chickamauga Reservoir levels occur as part of the Tennessee River system operations, which are separate from SQN operations, there is no anticipated impact to onsite wetlands or wetlands within the immediate area during SQN's cooling tower operations. In addition as previously stated, there is a positive net return of surface water to the Chickamauga Reservoir from offstream surface water users, and evaporative losses from cooling tower operations are small as compared to river flow. Therefore, impacts on wetlands from operation of the cooling towers in helper mode are anticipated to be SMALL.

4.6.6 Conclusion

During the license renewal term, the operation of SQN will not result in a water use conflict on alluvial aquifers or wetland areas. As previously discussed, Chickamauga Reservoir levels occur as part of the Tennessee River system operations, there has been a positive net return of surface water to the Chickamauga Reservoir from offstream surface water users, and evaporative losses from cooling tower operations are small as compared to river flow.

Therefore, TVA concludes that environmental impacts related to water use conflicts from license renewal would be SMALL and further mitigation measures beyond existing regulatory control of withdrawal rates, NPDES permitting requirements, and TVA's Chickamauga Reservoir operating procedures are not warranted.

4.7 Groundwater Use Conflicts (Plants Using Ranney Wells)

4.7.1 Description of Issue

Groundwater use conflicts (plants using Ranney wells).

4.7.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Ranney wells can result in potential groundwater depression beyond the site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See 10 CFR 51.53(c)(3)(ii)(C).

4.7.3 Requirement [10 CFR 51.53(c)(3)(ii)(C)]

If the applicant's plant uses Ranney wells . . . , an assessment of the impact of the proposed action on groundwater use must be provided.

4.7.4 Background

The impact of cooling water intake on groundwater at . . . the only plant employing Ranney wells, does not conflict with other groundwater uses in the area. However, conflicts could develop if other uses develop (e.g., additional catfish farms). Because it is not possible to predict whether conflicts will occur . . . or the significance of impacts associated with Ranney well use at other plants (if they were to adopt their use), it is not possible to determine the significance of Ranney well use at this time. (NRC 1996, Section 4.8.1.4)

4.7.5 Analysis of Environmental Impact

The SQN site utilizes cooling and service water taken directly from Chickamauga Reservoir, and does not utilize Ranney wells. Therefore, this issue is not applicable to the site and further analysis is not required.

4.8 Degradation of Groundwater Quality

4.8.1 Description of Issue

Groundwater quality degradation (cooling ponds at inland sites).

4.8.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Sites with closed-cycle cooling ponds may degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See 10 CFR 51.53(c)(3)(ii)(D).

4.8.3 Requirement [10 CFR 51.53(c)(3)(ii)(D)]

If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided.

4.8.4 Background

The extent of groundwater contamination by cooling ponds has not been documented at this time. Offsite groundwater monitoring is not standard practice at these sites, and there are no data with which to characterize the significance of potential offsite groundwater contamination. For those plants with cooling ponds located in a salt marsh . . . , groundwater quality is not a significant concern because groundwater quality beneath salt marshes is too poor for human use. Because continued infiltration into the shallow aquifer will not change its groundwater use category (which is already restricted to industrial uses only) and because potential mitigation measures would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. The impact on groundwater quality for plants with cooling ponds that are not located in salt marshes is a[n] . . . issue. (NRC 1996, Section 4.8.3)

4.8.5 Analysis of Environmental Impact

SQN operates in open and helper modes for cooling purposes as discussed in Section 3.2.2.1 but does not utilize cooling ponds. Although the discharge of the cooling water in open and closed modes passes through the diffuser pond prior to entry into Chickamauga Reservoir, there is no effort to hold the water for cooling purposes. Therefore, this issue is not applicable to the site and further analysis is not required.

4.9 Impacts of Refurbishment on Terrestrial Resources

4.9.1 Description of Issue

Refurbishment impacts—terrestrial resources.

4.9.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See 10 CFR 51.53(c)(3)(ii)(E).

4.9.3 Requirement [10 CFR 51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment and other license renewal related construction activities on important plant and animal habitats.

4.9.4 Background

The significance of lost habitat depends on the importance of the plant or animal community involved. Particularly important habitats are wetlands, riparian habitats, staging or resting areas for large numbers of waterfowl, rookeries, restricted wintering areas for wildlife (e.g., winter deer yards), communal roost sites, strutting or breeding grounds of gallinaceous birds, and areas containing rare plant communities (e.g., Atlantic white cedar swamps). Such habitats are uncommon and unlikely to occur on most plant sites. However, if such resources do occur on plant sites, refurbishment activities should be planned to avoid them to the extent feasible. If no important resource would be affected, the impacts would be considered minor and of small significance. If important resources could be affected by refurbishment activities, the impacts would be potentially significant. (NRC 1996, Section 3.6)

4.9.5 Analysis of Environmental Impact

Section 2.2 discusses the habitats found at SQN and the surrounding vicinity. TVA does not plan to conduct refurbishment activities, so analysis of terrestrial impacts from refurbishment activities is not applicable. Moreover, no construction activities are currently planned for the license renewal term in undisturbed areas, so no terrestrial habitat areas would be converted for SQN facilities. Therefore, continued operations would pose no increased impacts on terrestrial resources. Moreover, as discussed in Section 2.4, there are existing management programs in place associated with operational and maintenance activities to ensure that terrestrial resources on the SQN site and associated in-scope transmission line ROWs are protected.

While no terrestrial ecology impacts would stem from construction or refurbishment activities because none are planned, continued operations could contribute to terrestrial ecology impacts, and the NRC proposed expanding the Category 2 terrestrial ecology impacts issues to include continued operations in its proposed amendment to 10 CFR Part 51 (74 FR 38117; NRC 2012). As discussed in Sections 1.1 and 4.0.5, TVA has elected to provide information in this ER for proposed new or expanded Category 2 issues. Continued operations during the license renewal term would consume water from Chickamauga Reservoir, so TVA reviewed the environmental impact on terrestrial resources from water use. SQN's water consumption during the license renewal term is expected to continue at current rates. Using open-mode cooling operations for the majority of the year, SQN returned 99.6 percent of the water withdrawn for cooling purposes back to the reservoir in 2011 (Section 4.1).

As discussed in Section 3.2.2.1, the physical capability exists to operate SQN Units 1 and 2 in the closed mode, which would consume more water due to evaporation loss from operation of the cooling towers. However, as explained in Section 3.2.2.1, major modifications would be required to implement closed-cycle cooling at SQN, which is not anticipated as discussed in Section 5.1.1.

As the operator of Chickamauga Reservoir and the upstream and downstream dams, TVA can control the level within the reservoir to maintain adequate water resources for SQN and promote a viable ecological community within the reservoir, including riparian communities. TVA is also responsible for permitting water intake structures in the Tennessee River system (TVA 2011s). For each permit request, TVA reviews 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 (TVA 2012a). The permits also require reporting annual water usage. TVA uses these data to track existing water usage and evaluate proposed increases in withdrawals from the Tennessee River system (TVA 2011s). Thus, TVA has the ability to control the amount of water withdrawn and thereby minimize water conflicts between human water demand and the water needs of ecological resources.

In cooperation with the USGS, TVA has published reports trending water use in the Tennessee River valley based on 1995, 2000, and 2005 water use data collected by the USGS. Consumptive water usage in the Tennessee River valley declined from 2000 through 2005 due to the slow growth in water withdrawals and an increase in water returned; consumptive use fell from 649 mgd (5.3 percent) in 2000 to 432 mgd (3.5 percent) in 2005 (Bohac and McCall 2008). This TVA and USGS collaborative report also projects water consumption to continue to fall with an estimated decline in water withdrawals from the Tennessee River of 7 percent by 2030. Data compilation for USGS's 2010 water use report experienced a delayed start, and data availability is not expected until 2014 (USGS 2011e), so a trending and projections report that uses these data would likewise not be available until a later date.

As discussed in Section 2.2, the ecology of Chickamauga Reservoir is dynamic. Water levels fluctuate between seasons and years, which influences habitat quality for all taxa. TVA monitors macroinvertebrates and fish populations annually to characterize trends in populations and factors such as macrophyte abundance or water flow change. Annual monitoring in the reservoir continues to indicate a stable, viable aquatic community, demonstrating that TVA management is effective at preserving ecological resources while ensuring plant water needs are met.

However, as noted in Section 3.3, no refurbishment activities are planned for SQN license renewal. Therefore, this issue is not applicable to the site and no further analysis of impacts from refurbishment is required.

4.10 Threatened or Endangered Species

4.10.1 Description of Issue

Impacts from refurbishment and continued operations on threatened or endangered species.

4.10.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See 10 CFR 51.53(c)(3)(ii)(E).

4.10.3 Requirement of 10 CFR 51.53(c)(3)(ii)(E)

All license renewal applicants shall assess the impact of refurbishment and other license renewal related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act.

4.10.4 Background

The NRC did not reach a conclusion about the significance of potential impacts to threatened and endangered species in the GEIS because (1) the significance of impacts on such species cannot be assessed without site- and project-specific information that will not be available until the time of license renewal and (2) additional species that are threatened with extinction and that may be adversely affected by plant operations may be identified between the present and the time of license renewal. (NRC 1996, Section 3.9)

4.10.5 Analysis of Environmental Impact

4.10.5.1 Refurbishment

As discussed in Section 3.3, SQN has no plans to conduct refurbishment at the site during the license renewal term. Therefore, there would be no refurbishment-related impacts to special-status species and no further analysis is applicable.

4.10.5.2 License Renewal

Section 2.4 addresses critical and important habitats, wetlands, and unique natural areas, and identifies federally and state-listed critical and important habitats. Section 2.5 identifies and discusses threatened or endangered species and state-protected species whose geographic ranges encompass the SQN site and vicinity, including in-scope transmission line ROWs. Federally and state-listed and candidate threatened and endangered species and other state-protected species identified during surveys of SQN and vicinity are identified in Table 2.5-1.

TVA is not aware of any adverse impacts on threatened or endangered species that have been attributed to the site or transmission line operations. Operations and maintenance activities necessary to support license renewal would be limited to previously disturbed areas on site and the in-scope transmission line corridors. No land disturbance outside of previously disturbed areas is anticipated during the license renewal term. In addition, there are no plans to alter plant operations during the license renewal term, and thus no changes which would affect threatened and endangered species that could potentially exist at or pass through SQN facilities considered for license renewal.

As discussed in Section 2.5, there are two state-listed fish species: the highfin carpsucker and the lake sturgeon. Although suitable habitat exists adjacent to the site for the highfin carpsucker, and lake sturgeon may be present adjacent to SQN due to their migratory nature, there are no recorded instances of either species being impinged on the SQN intake structure screens based on impingement studies conducted over previous years. Therefore, there is no associated impact as a result of plant operations.

The USFWS field office in Cookeville, Tennessee, responded that they had no comments (see Attachment D).

As discussed in Section 9.1.3.19, the Magnuson-Stevens Act is not applicable to SQN, because the site is located on a freshwater body and no anadromous fish have migratory ranges within the vicinity of the station; therefore, no impact assessment is needed as it relates to this act.

TVA, as a federal agency, is required to consider the impact of its proposed actions, in this case renewal of the SQN OLs, on the environment. TVA prepared a draft SEIS for renewal of the SQN OLs and published a Notice of Availability for the draft SEIS in the *Federal Register* on November 5, 2010. TVA also specifically notified numerous government agencies and offices within the state of Tennessee and the federal government, including the USFWS and TWRA, regarding the availability of the draft supplemental environmental impact statement (DSEIS) for review and comment. Based on agency and public responses on the SQN DSEIS, no adverse impacts to threatened and endangered species were identified for license renewal.

4.10.6 Conclusion

Although there are four TVA-owned HPAs that provide habitat for the federally listed large-flowered skullcap or the State of Tennessee-protected bald eagle within the vicinity, there are no designated federally or state-listed critical or important habitats for threatened, endangered, or species of special concern on the SQN site, vicinity, or the in-scope transmission line ROWs, as discussed in Section 2.4. However, the continued operation of the site and transmission lines will not adversely impact any federally or state-listed species that may exist on or pass through the SQN facilities considered for license renewal, as discussed above. Therefore, TVA concludes the impacts to threatened or endangered species from license renewal are SMALL, and mitigation measures beyond TVA's existing management programs discussed in Section 2.4 and state and federal regulatory requirements are not warranted.

4.11 <u>Impacts of Refurbishment on Air Quality (Nonattainment Areas)</u>

4.11.1 Description of Issue

Air quality during refurbishment (nonattainment and maintenance areas).

4.11.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be SMALL. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the number of workers expected to be employed during the outage. See 10 CFR 51.53(c)(3)(ii)(F).

4.11.3 Requirement [10 CFR 51.53(c)(3)(ii)(F)]

If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment workforce must be provided in accordance with the Clean Air Act as amended.

4.11.4 Background

Based on EPA's interpretation that mobile emissions from workers' vehicles should generally be considered as indirect emissions in a conformity analysis, a screening analysis was performed which indicated that the emissions from 2,300 vehicles may exceed the thresholds for carbon monoxide, oxides of nitrogen, and volatile organic compounds (the latter two contribute to the formation of ozone) in nonattainment and maintenance areas. In addition, the amount of road dust generated by the vehicles traveling to and from work would exceed the threshold for particulate matter less than 10 micrometers (μm) (PM_{10}) in serious nonattainment areas. However, the assumption of adding 2,300 workers' vehicles to existing traffic forms an upper bound of potential emissions; in reality, some workers would carpool to the refurbishment sites, while others would be driving to other construction sites if the proposed refurbishment activities were not occurring. In addition, EPA suggests there may be some flexibility in the rigor of a conformity analysis, particularly with regard to the specific site, the extent of refurbishment, the pollutants which are in nonattainment, the severity of the nonattainment, the state regulatory agency, and the federal agency's control over workers' vehicles. In summary, vehicle exhaust emissions could be cause for some concern, but a general conclusion about the significance of the potential impact cannot be drawn without considering the compliance status of each site and the number of workers expected to be employed during the outage. (NRC 1996, Section 3.3)

4.11.5 Analysis of Environmental Impact

As discussed in Section 3.2.8.4, the SQN air permit contains conditions established by TDEC to be protective of Tennessee's ambient air quality standards to ensure that operational impacts are maintained at minimal levels. These same ambient air quality standards would regulate any future SQN activities that may involve an increase of air pollutants or change in attainment status.

Although SQN is located within a nonattainment area for annual $PM_{2.5}$ as described in Section 2.11, no refurbishment activities are planned for SQN license renewal, as discussed in Section 3.3. Therefore, this issue is not applicable to the site and further analysis is not required.

4.12 <u>Microbiological Organisms—Public Health</u>

4.12.1 Description of Issue

Microbiological organisms on public health (plants with cooling ponds, lakes, or canal, or discharging to a small river).

4.12.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See 10 CFR 51.53(c)(3)(ii)(G).

4.12.3 Requirement [10 CFR 51.53(c)(3)(ii)(G)]

If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flow rate of less than 3.15 x 10^{12} ft^3/year (9 x 10^{10} m^3/year), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

4.12.4 Background

Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at a given site with current knowledge. Thus, the impacts are not known and are site specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N. fowleri* cannot be determined generically. (NRC 1996, Section 4.3.6)

4.12.5 Analysis of Environmental Impact

Because the average flow in Chickamauga Reservoir is less than 3.15 x 10^{12} ft^3/year, this issue is applicable to SQN. As discussed in Section 4.1.5, consistent with the TVA Act of 1933, Chickamauga Dam and reservoir are operated for flood protection, navigation, and power production, as well as for improved water quality (dam discharge oxygenation and aeration), aquatic resources, water supply, and recreation.

Thermophilic bacteria generally occur at temperatures of 77ºF to 178ºF. Studies suggest that a temperature range of 30ºC to 40ºC (86ºF to 104ºF) is associated with increased occurrence of *Naegleria fowleri* in thermally elevated environments (Huizinga and McLaughlin 1990). *Naegleria* is an amoeba commonly found in warm freshwater and soil. *N. fowleri* is the only species of *Naegleria* that infects people.

Water temperatures in Chickamauga Reservoir have been monitored by TVA recording stations since 1969. The recorded temperatures ranged at TRM 485.7 from about 40ºF in the winter to a typical maximum of 80º–84ºF in the summer with an occasional maximum as high as 88ºF. The temperatures were recorded at elevation 677, which is about 6 feet below the normal summer pool elevation. (TVA 1974a, page 2.6-8) Therefore, ambient river conditions during certain periods of the summer months could potentially support the thermophilic organisms of concern.

During the summer months when ambient temperatures in Chickamauga Reservoir are the warmest, the current SQN NPDES permit specifies that the 24-hour downstream temperature shall not exceed 30.5ºC (86.9ºF), except in cases when the 24-hour ambient temperature exceeds 29.4ºC (84.9ºF). In these cases, the 24-hour downstream temperature can exceed 30.5ºC (86.9ºF) if there are a sufficient number of cooling tower lift pumps in service, but in such situations, the hourly average downstream temperature shall not exceed 33.9ºC (93.0ºF).

As discussed in Section 3.2.2.2, heated water is discharged from the condensers (open mode) or from the cooling towers (helper mode) directly into the diffuser pond, from which it is discharged to Chickamauga Reservoir through two diffuser pipes. The diffusers are designed to provide rapid mixing of the discharged effluent with the river flow. Therefore, it is anticipated that any organisms inhabiting sediments or other substrates on the river bottom or immersed banks that are exposed to temperatures at 86ºF or greater would only be likely in a small zone near the plant due to the mixing characteristics of the discharge.

Though *N. fowleri* commonly occurs, *N. fowleri* infections are very rare. In the 10 years from 2001 to 2010, only 32 infections were reported in the United States (CDC 2011a). A review of the U.S. Centers for Disease Control (CDC) water-borne illnesses reports from 2000 to 2008 did not identify any cases of primary amoebic meningoencephalitis, which is caused by the thermophilic organism *N. fowleri*, occurring in Tennessee (CDC 2004; CDC 2006; CDC 2008; CDC 2011b). Publicly reported cases in more recent years also did not involve cases contracted in Tennessee (Discovery 2011; Post Bulletin 2010).

There are no public swimming beaches less than 3 miles downstream of SQN, and public boating facilities are downstream and on the east bank of the reservoir, across from SQN. Therefore, the potential for exposure to the *N. fowleri* microorganism that could be created as a result of SQN's heated discharge is low.

4.12.6 Conclusion

As discussed above, there have been no recorded *N. fowleri* infections in the SQN vicinity in previous years. Any organisms inhabiting sediments or other substrates on the river bottom or immersed banks that are exposed to SQN's heated discharge would likely be in a small zone near the plant due to the mixing characteristics of the discharge. There are also no public swimming beaches in close proximity downstream from SQN, and public boating facilities are downstream and on the east bank of the reservoir, across from SQN. Therefore, TVA concludes that the impact on public health of microbiological organisms from continued operation of SQN in the license renewal period is SMALL, and further mitigation measures beyond complying with the NPDES permit are not warranted.

4.13 Electromagnetic Fields—Acute Effects

4.13.1 Description of Issue

Electromagnetic fields, acute effects (electric shock).

4.13.2 Findings from Table B-1, Subpart A, Appendix A

SMALL, MODERATE, or LARGE. Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electrical shock potential at the site. See 10 CFR 51.53(c)(3)(ii)(H).

4.13.3 Requirements [10 CFR 51.53(c)(3)(ii)(H)]

If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electric Safety Code (NESC) for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

4.13.4 Background

The transmission lines of concern are those between the plant switchyard and the intertie to the transmission system. With respect to shock safety issues and license renewal, three points must be made:

1. In the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed.

2. Some plants that received OLs with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects.

3. Since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for reevaluation of this issue.

The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear power plants, is of small significance for transmission lines operated in adherence with NESC. Without review of each nuclear plant's transmission line conformance with NESC criteria, it is not possible to determine the significance of the electrical shock potential. (NRC 1996, Sections 4.5.4 and 4.5.4.1)

4.13.5 Analysis of Environmental Impact

4.13.5.1 Background

Objects near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through the object to the ground. The current is called "induced" because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called "capacitively charged." A person standing on the ground and touching a vehicle or a fence receives an electrical shock due to the discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including the following:

- Strength of the electric field which, in turn, depends on the voltage of the transmission line, as well as its height and geometry.
- Size of the object on the ground.
- Extent to which the object is grounded.

In 1977, the NESC adopted a provision that describes an additional criterion to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kV alternating current to ground. The clearance must limit the steady-state induced current to 5 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment were short circuited to ground. By way of comparison, the setting of ground fault circuit interrupters used in residential wiring (special breakers for outside circuits or those with outlets around water pipes) is 4 to 6 mA.

As discussed in Section 3.2.10, TVA owns and operates the transmission lines constructed for purposes of connecting SQN to the transmission system. As shown in Table 3.2-4, there are 13 transmission lines considered in scope for license renewal (Figure 3.2-4). However, because the NESC 5 mA standard excludes 161-kV lines,[1] only the five 500-kV lines were considered in scope for the NESC analysis.

The NESC limits the induced shocks that can occur when a person standing beneath an extra high voltage line touches a large ungrounded metal object such as a truck or farm vehicle. The electric shock potential from induced current of 500-kV transmission lines in the vicinity of SQN was determined in accordance with procedures specified by EPRI. With the exception of a few spans as discussed below, the 500-kV lines were found to be within the 5 mA limits as defined by the NESC.

In 2012, TVA completed a detailed analysis of the current state of compliance with NESC Rule 232 (TVA 2012e). TVA has in recent years obtained an aerial light detection and ranging (LIDAR) survey on all of the 500-kV transmission lines which connect SQN to the grid. Using the results of this survey TVA calculated the potential for induced shock effects for four reference vehicles including utility trailers, SUVs, and large farm machinery. The PLS-CADD (Power Line Systems Software) program was used to analyze the three-dimensional models created from the LIDAR data. All electromagnetic field calculations in PLS-CADD are based on the EPRI Red Book methodology. Of the more than 1,000 spans studied on the subject 500-kV lines, there are nine spans that have insufficient clearance to limit the steady-state current due to electrostatic effects to 5 mA, as presented in the table below:

1. The 161-kV phase-to-phase is within the exclusion value of 98-kV phase-to-ground. The 98-kV alternating current to ground limit was purposely set in the code by the NESC committees to exclude application of the 5 mA rule to 161-kV and lower voltages.

Line	Length	Potential Problem Spans
Widows Creek	49.5 miles	Three spans
Franklin	63.0 miles	Two spans
Bradley	22.0 miles	No problem spans
Watts Bar No. 1	34.5 miles	Two spans
Watts Bar No. 2	40.5 miles	Two spans

TVA has plans to thermally uprate the 500-kV lines listed above to operate at higher conductor temperatures. TVA plans to make the necessary span adjustments to correct the induced current issues concurrent with the construction required to thermally uprate the lines. This work is scheduled to take place from fiscal year 2013 through 2017, prior to the end of the current operational period for SQN. Physical adjustments that could lower the calculated short circuit loads to below 5 mA are as follows:

- Add tower extensions to the existing towers to elevate the 500-kV conductors in the problem spans,
- Replace existing towers with taller towers, or
- Provide shield wires below the 500-kv phase wires in the problem spans.

4.13.6 Conclusion

For all but the nine spans discussed above, the vertical clearances of the transmission lines built to connect SQN to TVA's transmission system have sufficient clearance to limit the steady-state current due to electrostatic effects to 5 mA, should the largest anticipated truck, vehicle, or equipment under the line be short-circuited to ground.

TVA's 500-kV transmission line uprate program has defined projects which will correct these span deficiencies and are in various stages of planning or design. These projects are all scheduled for construction and completion between June 2013 and June 2017. Based on the conservative use of 550-kV maximum nominal voltage, the large truck dimensions used in the calculations, the pre-1977 line construction, and the location of these nine spans in areas of low concern and areas where induced shock would be of a low risk, TVA concludes that the significance of the electrical shock potential at these nine locations is small, and a more aggressive remediation schedule is not warranted.

Because all line spans are projected to be in compliance by the year 2020 prior to the end of SQN's operational period, impacts due to the electrical shock potential for these lines during the license renewal term would be SMALL and do not warrant further mitigation measures beyond TVA's scheduled transmission line uprate program discussed above and TVA's vegetation management program discussed in Section 3.2.10.

4.14 <u>Housing Impacts</u>

4.14.1 Description of Issue

Housing impacts.

4.14.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See 10 CFR 51.53(c)(3)(ii)(I).

4.14.3 Requirement [10 CFR 51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on housing availability . . . within the vicinity of the plant must be provided.

4.14.4 Background

The impacts on housing are considered to be of small significance when a small and not easily discernible change in housing availability occurs, generally as a result of a very small demand increase or a very large housing market. Increases in rental rates or housing values in these areas would be expected to equal or slightly exceed the statewide inflation rate. No extraordinary construction or conversion of housing would occur where small impacts are foreseen.

The impacts on housing are considered to be of moderate significance when there is a discernible, but short-lived, reduction in available housing units because of project-induced in-migration. The impacts on housing are considered to be of large significance when project-related demand for housing units would result in very limited housing availability and would increase rental rates and housing values well above normal inflationary increases in the state.

Moderate and large impacts are possible at sites located in rural and remote areas, at sites located in areas that have experienced extremely slow population growth (and thus slow or no growth in housing), or where growth control measures that limit housing development are in existence or have been recently lifted. (NRC 1996, Section 3.7.2)

Public utility impacts at the case study sites during refurbishment are projected to range from small to moderate. The potentially small to moderate impact . . . is related to water availability (not processing capacity) and would occur only if a water shortage occurs at refurbishment time. (NRC 1996, Section 3.7.4.5)

4.14.5 Analysis of Environmental Impact

Supplement 1 to Regulatory Guide 4.2 provides the following guidance.

Section 4.14.1 states, "If there will be no refurbishment or if refurbishment involves no additional workers then there will be no impact on housing and no further analysis is required."

Section 4.14.2 states, "If additional workers are not anticipated there will be no impact on housing and no further analysis is required."

4.14.5.1 Refurbishment

As discussed in Section 3.3, no refurbishment activities are planned for license renewal at the SQN site. Therefore, housing impacts related to refurbishment are not applicable.

4.14.5.2 License Renewal

As of November 2010, SQN had a staff of approximately 1,141 permanent and contract employees, of which approximately 78 percent reside in Hamilton County (Table 3.5-1). The remaining employees live in the surrounding region and other states. As described in Section 2.6, SQN is located in a high population area. As discussed in Section 2.9, total housing in Hamilton County grew between 2000 and 2010, and overall vacancy rates rose by 1.9 percent during the same period, indicating that more than enough housing was available, even as county population increased. Therefore, adequate housing to accommodate any increase exists in the area. In addition, as discussed in Section 3.5, TVA does not anticipate a need for additional full-time workers during the license renewal period. Therefore, housing would be unaffected as a result of license renewal.

4.14.6 Conclusion

Although Hamilton County has adopted land use planning regulations such as zoning to manage future growth and development, and has a comprehensive land use plan (Section 2.8.2), TVA concludes that the impact on housing from the continued operation of the site would be SMALL and further mitigation is not warranted. This conclusion is based on the following:

- No refurbishment activities are planned for license renewal at the site (Section 3.3).
- Number of housing units in Hamilton County has increased over the years (Section 2.9).
- SQN is located in a high population area, and there is no anticipated increase in employment during the license renewal period (Section 3.5).
- The number of the site employees would continue to be a small percentage of the population in the county during the period of the renewed license (Sections 2.6.1 and 3.5).

4.15 Public Utilities; Public Water Supply Availability

4.15.1 Description of Issue

Public services (public utilities).

4.15.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See 10 CFR 51.53(c)(3)(ii)(I).

4.15.3 Requirement [10 CFR 51.53(c)(3)(ii)(I)]

The applicant shall provide an assessment of the impact of population increases attributable to the proposed project on the public water supply.

4.15.4 Background

Impacts on public utility services are considered small if little or no change occurs in the utility's ability to respond to the level of demand and thus there is no need to add capital facilities. Impacts are considered moderate if overtaxing of facilities during peak demand periods occurs. Impacts are considered large if existing service levels (such as the quality of water and sewage treatment) are substantially degraded and additional capacity is needed to meet ongoing demands for services. (NRC 1996, Section 3.7.4.5)

In general, small to moderate impacts to public utilities were observed as a result of the original construction of the case study plants. While most locales experienced an increase in the level of demand for services, they were able to accommodate this demand without significant disruption. Water service seems to have been the most affected public utility. (NRC 1996, Section 3.7.4.5)

Because the case studies indicate that some public utilities may be overtaxed during peak periods, the impacts to public utilities would be moderate in some cases, although most sites would experience only small impacts. (NRC 1996, Section 3.7.4.5)

4.15.5 Analysis of Environmental Impact

4.15.5.1 Refurbishment

As discussed in Section 3.3, no refurbishment activities are planned for the renewal of the SQN OLs. Therefore, public water supply availability impacts related to refurbishment are not applicable.

4.15.5.2 License Renewal

SQN does not anticipate a need for additional workers during the license renewal period (Section 3.5). Therefore, there will be no impact to public water supply utilities from additional plant workers during the license renewal term.

Both surface water and groundwater withdrawal are water sources for both community and non-community water supply systems in Hamilton County. As shown in Table 2.10-1, public water systems within Hamilton County have sufficient capacity to respond to additional demands. As discussed in Section 3.2.2, SQN withdraws water from Chickamauga Reservoir for cooling purposes. Potable water is supplied by the Hixson Utility District. Because SQN relies on the reservoir for its needs, and only a small portion of potable water from a community water system, water withdrawals and usage at the site would not affect public water resources (Section 2.10.1). In addition, Tennessee regulates by statute the water resources in the state and administers its use through the TDEC permitting program (TDEC 2011c).

4.15.6 Conclusion

Because SQN obtains the majority of the plant's water from Chickamauga Reservoir, public water system availability and capacity near the site will remain unaffected. In addition, no refurbishment activities are planned for renewal of the SQN OL, and no additional workers are needed during the license renewal period. Therefore, impacts to public water supplies will continue to be SMALL during the license renewal period.

4.16 Education Impacts from Refurbishment

4.16.1 Description of Issue

Public services (effects of refurbishment activities upon local educational system).

4.16.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. Most sites would experience impacts of small significance, but larger impacts are possible depending on site- and project-specific factors. See 10 CFR 51.53(c)(3)(ii)(I).

4.16.3 Requirement [10 CFR 51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on . . . public schools (impacts from refurbishment activities only) within the vicinity of the plant must be provided.

4.16.4 Background

Based on the case study analysis of the pressurized water reactor bounding-case work force, refurbishment impacts on education at all plant sites would range from small to large, although most sites will experience only small new impacts to education. Analyses of the work forces associated with the boiling water reactor bounding- and typical-case scenarios conclude that moderate impacts to education could be induced by these smaller work forces, but only at sites that are remotely located and sparsely populated. Because site-specific and project-specific factors determine the significance of impacts to education and the potential value of mitigation measures . . . . (NRC 1996, Section 3.7.4.1)

4.16.5 Analysis of Environmental Impact

As discussed in Section 3.3, no refurbishment activities are planned for the renewal of the SQN OLs. Therefore this issue is not applicable to the site and further analysis is not required.

4.17 Offsite Land Use (Refurbishment)

4.17.1 Description of Issue

Offsite land use (effects of refurbishment activities).

4.17.2 Findings from Table B-1, Appendix B to Subpart A

SMALL or MODERATE. Impacts may be of moderate significance at plants in low population areas. See 10 CFR 51.53(c)(3)(ii)(I).

4.17.3 Requirement [10 CFR 51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on . . . land-use . . . (impacts from refurbishment activities only) within the vicinity of the plant must be provided.

4.17.4 Background

Based on predictions for the case study sites, refurbishment at all nuclear plants is expected to induce small or moderate land-use changes. There will be new impacts; but for almost all plants, refurbishment-related population growth would typically represent a much smaller percentage of the local area's total population than did original construction-related growth. Moderate land-use changes are also possible under the boiling water reactor (BWR) conservative scenario, but only small impacts would be associated with the BWR typical scenario. Because future impacts are expected to range from small to moderate, and because land-use changes could be considered beneficial by some community members and adverse by others . . . . (NRC 1996, Section 3.7.5)

4.17.5 Analysis of Environmental Impact

As discussed in Section 3.3, no refurbishment activities are planned for the renewal of the SQN OLs. Therefore, this issue is not applicable to the site and further analysis is not required.

4.18 Offsite Land Use (License Renewal Term)

4.18.1 Description of Issue

Offsite land use (effects of license renewal).

4.18.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Significant changes in land-use may be associated with population and tax revenue changes resulting from license renewal. See 10 CFR 51.53(c)(3)(ii)(I).

4.18.3 Requirement [10 CFR 51.53(c)(3)(ii)(I)]

An assessment of the impact of the proposed action on . . . land-use . . . within the vicinity of the plant must be provided.

4.18.4 Background

During the license renewal term, new land use impacts could result from plant-related population growth or from the use of tax payments from the plant by local government to provide public services that encourage development. (NRC 1996, Section 4.7.4)

However, as noted in Regulatory Guide 4.2, Section 4.17.2, Table B-1 of 10 CFR Part 51 partially misstates the conclusion reached in Section 4.7.4.2 of NUREG-1437. NUREG-1437, Section 4.7.4.2, concludes that "population-driven land use changes during the license renewal term at all nuclear plants will be small." Regulatory Guide 4.2 further states that "Until Table B-1 is changed, applicants only need cite NUREG-1437 to address population-induced land-use change during the license renewal term." (NRC 2000, Section 4.17.2)

The assessment of new tax-driven, land-use impacts in the GEIS considered the following:

1. The size of the plant's tax payments relative to the community's total revenues.
2. The nature of the community's existing land use pattern.
3. The extent to which the community already has public services in place to support and guide development. (NRC 1996, Section 4.7.4.1)

In general, if the plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land-use changes during the plant's license renewal term would be small, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. If the plant's tax payments were projected to be medium to large relative to the community's total revenue, new tax-driven land-use changes would be moderate. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be large. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development in the past. (NRC 1996, Section 4.7.4.1)

Based on predictions for the case study plants, it is projected that all new population-driven land-use changes during the license renewal term at all nuclear plants will be small, because population growth caused by license renewal will represent a much smaller percentage of the local area's total population than has operations-related growth. In addition, any conflicts between offsite land use and nuclear plant operations are expected to be small. In contrast, it is projected that new tax-driven land-use changes may be moderate at a number of sites and large at some others. Because land-use changes may be perceived by some community members as adverse and by others as beneficial, the staff is unable to assess generically the potential significance of site-specific, offsite land-use impacts. (NRC 1996, Section 4.7.4.2)

4.18.5 Analysis of Environmental Impact

TVA considered the environmental impacts from this issue as it relates to population-driven land-use changes, tax-driven land-use changes, and potential effects on land values.

4.18.5.1 Population-Driven Land-Use Changes

TVA agrees with the GEIS conclusion that new population-driven land-use changes at the site during the license renewal term will be SMALL (NRC 1996, Section 4.7.4.2). TVA does not anticipate that additional workers will be employed at the site during the license renewal period. Therefore, there will be no adverse impact resulting from population-driven land-use changes associated with license renewal.

4.18.5.2 Tax-Driven Land-Use Changes

As discussed in Section 2.7, TVA is exempt from state and federal taxes. Instead, pursuant to the TVA Act, TVA makes in-lieu-of-tax payments each year to states and counties in which TVA conducts power operations or in which TVA has acquired power-producing properties previously subject to state and local taxation. The total amount of these payments is 5 percent of gross revenues from the sale of power during the preceding year, excluding sales or deliveries to other federal agencies and off-system sales with other utilities, with a provision for minimum payments under certain circumstances. The magnitude of the in-lieu-of-tax payments relative to the receiving county's total revenues is not relevant in assessing new tax-driven land-use impacts, because TVA will still be responsible for producing and distributing electricity (and the resulting in-lieu payments) even if the license for SQN is not renewed. Therefore, TVA concludes that impacts would be SMALL, because there would be no tax-driven land-use impacts related to license renewal activities at SQN.

4.18.5.3 Land Value Land-Use Changes

As discussed in the GEIS, land-use changes as a result of a nuclear power plant not having its license renewed could result in SMALL to MODERATE impacts on the surrounding community. With the loss of jobs and taxes and an increase of housing vacancies, and perhaps even population as the former employees left the area to take employment elsewhere, this would have a noticeable effect on the local economy and, in turn, on local land-use values.

SQN has considered the impact of the plant on local property values during the license renewal term. The GEIS concluded that the value of housing units in close proximity to the plant has experienced only SMALL impacts (NRC 1996, Section 4.7.1.3).

Published literature on this subject comes to varying conclusions. The International Association of Assessing Officer (IAAO) guidelines consider the effect of contamination on nearby property values, including the presence of nuclear plants in valuations of property. Actual contamination may depress offsite property values, but the IAAO discusses the established decommissioning funds required for nuclear plants, noting that the value of the nuclear plant site itself is not decreased and that property off site may increase in value due to competing need for land. IAAO also notes that stigma devaluation of property values may be overstated because land value is often not demonstrably affected despite the presence of nearby contaminated sites. (IAAO 2001)

Some studies, which have concluded that the presence of nuclear plants has decreased property values, are based on information derived from opinion polls rather than evidence of actual property values (Pasqualetti and Pijawka 1996). Other studies conclude that the negative impact on land value correlate to whether the property is within visual range of the plant, or correlate to the distance from the nuclear plant (up to 60 miles) (Folland and Hough 2000; Metz et al. 1997). It should be noted that Folland and Hough based their study of negative externality effects on return on investment, rather than direct property values, and attempted to control various variables over broad geographical areas while noting that the geographic and market patterns used as the basis for their study did not necessarily control the individualities and idiosyncrasies of the geographical areas, such as terrain, farmland, farmers, and wholesalers (Folland and Hough 2000). In contrast, several studies have found that the impacts of nuclear plants have been largely positive (Bezdek and Wendling 2006; Clark et al. 1997; Farrell and Hall 2004; Folland and Hough 2000; Metz et al. 1997; NEI 2003; NEI 2004a; NEI 2004b; NEI 2006a; NEI 2006b).

As previously discussed in Section 2.9, the U.S. Census Bureau has not released 2010 updates for median home values for Hamilton County. However, based on 2009 estimates, the Hamilton County median home value increased 57.1 percent since 2000 to $148,800. The causal factors between the valuation of land in Hamilton County and increase in area property values are believed to be related to the growth of the metropolitan area due to employment opportunities and the overall general decline of the agricultural economy in the rural areas (see Section 2.10).

As discussed in Section 2.7, SQN has a significant beneficial tax-driven impact on the State of Tennessee and Hamilton County. Therefore, TVA concludes that impacts would be SMALL to the local community related to license renewal activities at SQN, as there would be no adverse impact from continued operation of SQN.

4.18.6 Conclusion

TVA agrees with the GEIS conclusion that new population-driven land-use changes at the site during the license renewal term would be SMALL.

In addition, the impact to tax-driven land-use changes would be SMALL, because the magnitude of the in-lieu-of-tax payments relative to the receiving county's total revenues is not relevant, as TVA will still be responsible for producing and distributing electricity (and the resulting in-lieu-of-tax payments) even if the license for SQN is not renewed.

4.19 Transportation

4.19.1 Description of Issue

Public services, transportation.

4.19.2 Findings from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Transportation impacts (level of service) of highway traffic generated during the term of the renewed license are generally expected to be of small significance. See 10 CFR 51.53(c)(3)(ii)(J).

4.19.3 Requirement [10 CFR 51.53(c)(3)(ii)(J)]

All applicants shall assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license.

4.19.4 Background

Transportation impacts would continue to be of SMALL significance at all sites during operations and would be of SMALL or MODERATE significance during scheduled refueling and maintenance outages. Because impacts are determined primarily by road conditions existing at the time of the project and cannot be easily forecasted, a site-specific review will be necessary to determine whether impacts are likely to be SMALL or MODERATE and whether mitigation measures may be warranted. (NRC 1996, Section 4.7.3.2)

4.19.5 Analysis of Environmental Impact

4.19.5.1 Refurbishment

As discussed in Section 3.3, no refurbishment activities are planned for the renewal of the SQN OLs. Therefore, transportation impacts related to refurbishment are not applicable.

4.19.5.2 License Renewal

SQN does not anticipate the need for additional workers during the license renewal term (Section 3.5). Therefore, impacts to transportation during the license renewal term would be similar to those experienced during current operations and would be dictated by the workers currently involved in plant operations. As of November 2010, the site employed approximately 1,141 permanent and contract employees during normal plant operations (Section 3.5). In addition, approximately 750 workers may also be present at the facility during refueling outages.

As indicated in Section 2.6.1, SQN is located in a highly populated region of southeastern Tennessee. The vicinity of SQN is bisected by the Tennessee River, with the SQN site located on the west bank of the river. Traffic volumes for the area were obtained from TDOT (Table 2.10-2). As discussed in Section 2.10.2, the largest volume of traffic was recorded on US

Highway 27 west of Sequoyah Access Road. Heavy volumes were also recorded on SR 319-Hixson Pike, south of Sequoyah Access Road, and on Sequoyah Access Road itself, west of SR 319-Hixson Pike.

Section 2.10.2 further discusses the LOS designations for routes serving SQN for workers and shipments. Regulatory Guide 4.2, Supplement 1, "Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses," Section 4.18 states, "LOS A and B are associated with small impacts because operation of individual users is not substantially affected by the presence of other users. At this level, no delays occur and no improvements are needed." As presented in Section 2.10.2.2, Hamilton County has not assigned an LOS designation to the roads that provide access to SQN. However, county reports, maps, and Tennessee annual average daily traffic counts for local roads give no indication that the capacities of access roads to SQN are exceeded by current needs.

Based on available information, Tennessee traffic counts did not include temporary traffic increases due to annual outages at the site. The site generally schedules its outages on a staggered 18-month schedule, and may have an average of approximately 750 temporary workers on site for the duration of the outage. Compensatory measures, such as staggered shift starting and quitting times, are not necessary, but are implemented to facilitate security checkpoint processing. Security personnel are also increased to operate all gatehouse lanes for incoming personnel. This helps ensure that with increased traffic flow during outages, a reasonable level of service will be maintained. Road congestion has not been a particular problem because contractor traffic during outages is routed to a separate parking lot with its own entry gate off Igou Ferry Road. Therefore, traffic patterns around the site would be unaffected by plant operations or outage activities during the license renewal period.

While current transportation needs are being met by the Hamilton County roads that access the site, as described in Section 2.10.2, the county population is expected to increase over time. Hamilton County and Tennessee transportation agencies have developed a planning study that proposes the potential construction of a Tennessee River toll bridge in the northern portion of the county, which could impact the roads that access the SQN site. This project is in the planning stage and a corridor has been established which shows the general location of the proposed routing across the Tennessee River; however, the exact location of the proposed bridge crossing has not yet been determined. Based on current information, however, impacts are anticipated to be SMALL, should the project proceed.

4.19.6 Conclusion

As noted in Section 3.3, no refurbishment activities are planned for SQN license renewal and no expected increases in the total number of employees that will be on site during this same period. Compensating measures, such as staggered shift starting and ending times and access to all gatehouse lanes, are undertaken by SQN to maintain a reasonable level of service during outages. Therefore, impacts on local traffic will be SMALL and will be mitigated by staggering shift times and access to all gatehouse lanes during outages.

4.20 Historic and Archaeological Resources

4.20.1 Description of Issue

Historic and archaeological resources.

4.20.2 Finding from Table B-1, Appendix B to Subpart A

SMALL, MODERATE, or LARGE. Generally plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the NHPA requires the federal agency to consult with the state historic preservation office to determine whether there are properties present that require protection. See 10 CFR 51.53 (c)(3)(ii)(K).

4.20.3 Requirement [10 CFR 51.53(c)(3)(ii)(K)]

All applicants shall assess whether any historic or archaeological properties will be affected by the proposed project.

4.20.4 Background

It is unlikely that moderate or large impacts to historic resources would occur at any site unless new facilities or service roads are constructed or new transmission lines are established. However, the identification of historic resources and determination of possible impacts to them must be done on a site-specific basis through consultation with the state historic preservation office. The site-specific nature of historic resources and the mandatory NHPA consultation process mean that the significance of impacts to historic resources and the appropriate mitigation measures to address those impacts cannot be determined generically. (NRC 1996, Section 3.7.7)

4.20.5 Analysis of Environmental Impact

4.20.5.1 Refurbishment

As discussed in Section 3.3, no refurbishment activities are planned for SQN license renewal. Therefore, historic and archaeological impacts related to refurbishment are not applicable.

4.20.5.2 License Renewal

As noted in Section 2.4, the SQN site includes a mix of barren land, urbanized open space, and low-, medium-, and high-intensity improvements. SQN also comprises other areas such as open water, forests, grasslands, pastures, and wetlands. Approximately 40 percent of the site is developed.

Known cultural resources on the SQN site and within 0.5 mile of the SQN boundaries are presented in Table 2.12-1. The NRHP-listed architectural properties located within a 10-mile radius of SQN are presented in Table 2.12-2. As discussed in Section 2.12, those cultural resources on SQN have been determined not eligible for the NRHP, lacking stylistic or structural elements or characteristics that could meet criteria of eligibility for the NRHP or contribute to the area's sense of historic character. Therefore, impacts to historic properties as a result of renewing the SQN OLs would be SMALL, because no historic properties exist within site boundaries. For archaeological sites outside SQN site boundaries, adverse impacts would only occur as a result of soil-intrusive activities, and TVA has no plans to conduct such soil-intrusive activities at any location outside of the site boundaries under a renewed license. Therefore, impacts to archaeological sites located outside the site property as a result of renewing the SQN OLs would be SMALL.

Five NRHP-listed aboveground historic properties are located within a 10-mile radius of SQN (see Figure 2.12-2). Such architectural properties are susceptible to any substantial force that could degrade their physical or historical integrity. Physical integrity refers to the structural condition (or soundness) of a historic property such as a house, and can be affected by the nearby operation of heavy equipment or by vibrations from the detonation of explosives. Historical integrity is the ability of a property to convey its significance to the public by virtue of its location, design, setting, materials, workmanship, feeling, and association [36 CFR 60.4]. The historical integrity of a property can be adversely impacted by factors such as noise and visual changes in the property such as modern buildings. SQN plant operations and associated transmission lines produce no intense vibrations or other substantial physical forces that would adversely impact historic properties located outside of the site property, and SQN and its associated facilities produce little noise. Furthermore, three of the five listed properties (the Pleasant L. Matthews house, the Retro School, and the Bradford Rymer Barn) were nominated after SQN operations began, such that potential adverse effects on the visual integrity of the property were already determined inconsequential to the nomination. In fact, all five properties are located more than 4 miles from SQN, in valleys where intervening topography blocks the view of SQN, such that visual impacts from continued operations at SQN are implausible. As a result, impacts on the physical and historical integrity of such properties would be SMALL.

Since the original construction and operation of SQN, historical and archaeological resource reviews have been conducted for proposed projects such as replacement of steam generators for Units 1 and 2 and an ISFSI. In all instances, impacts were determined to be SMALL.

As previously discussed, there are no plans for additional construction or plant refurbishments in conjunction with renewal of the SQN OLs. As a federal agency, TVA is required to assess any future undertakings or inadvertent discoveries under Section 106 [36 CFR Part 800] or Section 110 of the NHPA. These assessments ensure that existing or potentially existing cultural resources are adequately considered, and assist TVA in meeting state and federal expectations.

Based on the conclusions and recommendations of the 2010 Phase 1 archaeological survey and concurrence by the THC (see Attachment B), none of the cultural resources identified within the SQN APE are eligible for the NRHP. In addition, no specific properties of special sensitivity or concern were identified through tribal consultation, and all comments received concurred with the finding of no effects (see Attachment B).

4.20.6 Conclusion

No refurbishment activities are planned for renewal of SQN OLs. There are also no plans to alter operations, expand existing facilities, or disturb additional land in support of OL renewals. In addition, as discussed in Section 4.20.5 above, no historic properties such as NRHP-eligible or listed archaeological sites exist within the site boundary, and the five aboveground historical sites are located more than 4 miles from the plant in valleys where intervening topography blocks the view of SQN. Therefore, under renewed licenses, the potential impacts on historic properties from continued operation of SQN would be SMALL, and additional mitigation measures are not warranted.

4.21 Severe Accident Mitigation Alternatives

4.21.1 Description of Issue

Severe accidents.

4.21.2 Finding from Table B-1, Appendix B to Subpart A

SMALL. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See 10 CFR 51.53(c)(3)(ii)(L).

4.21.3 Requirement [10 CFR 51.53(c)(3)(ii)(L)]

If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided.

4.21.4 Background

The staff concluded that the generic analysis summarized in the GEIS applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants. However, not all plants have performed a site-specific analysis of measures that could mitigate severe accidents. Consequently, severe accidents are a Category 2 issue for plants that have not performed a site-specific consideration of severe accident mitigation and submitted that analysis for Commission review (NRC 1996, Section 5.5.2.5)

4.21.5 Analysis of Environmental Impact

This section summarizes the TVA SQN analysis of alternative ways to mitigate the impacts of severe accidents. Attachment E provides a detailed description of the severe accident mitigation alternatives (SAMA) analysis.

The term "accident" refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in the release or a potential for release of radioactive material to the environment. The NRC categorized accidents as "design basis" or "severe." Design basis accidents are those for which the risk is great enough that the NRC requires plant design and construction to prevent unacceptable accident consequences. Severe accidents are those the NRC considers too unlikely to warrant design controls.

In its license renewal rulemaking, the NRC concluded that the unmitigated environmental impacts from severe accidents met its Category 1 criteria. However, the NRC made consideration of mitigation alternatives a Category 2 issue, because not all plants had completed ongoing regulatory programs related to mitigation (e.g., individual plant examinations and accident management). Site-specific information to be presented in the license renewal ER includes the following:

1. Potential SAMAs.

2. Benefits, costs, and net value of implementing potential SAMAs.

3. Sensitivity of analysis to changes in key underlying assumptions.

For the SAMA analysis, TVA used the SQN probabilistic risk assessment (PRA) model output as input to an NRC-approved methodology that calculates economic costs and dose to the public from hypothesized releases from the containment structure to the environment. Using NRC regulatory analysis techniques, TVA calculated the monetary value of the unmitigated severe accident risk for SQN Units 1 and 2. The result represents the monetary value of the base risk of dose to the public and workers, offsite and onsite economic impacts, and replacement power. The value became a cost-benefit screening tool for potential SAMAs. A SAMA whose cost of implementation exceeded the base risk value could be rejected as being not cost-beneficial. The steps of this process are summarized below:

- SQN PRA Model: Use the SQN PRA internal events model as the basis for the analysis.

- Level 3 PRA: Use SQN Level 1 and 2 PRA output and site-specific meteorology, demographic, economic, land use, and emergency response data as input in performing a Level 3 PRA using Version 3.6.0 of Windows interface for MELCOR Accident Consequence Code System, version 2 (MACCS2) (WinMACCS).

- Baseline Risk Monetization: Use the analysis techniques specified in NEI 05-01, Revision A, to calculate the monetary value of the unmitigated SQN Units 1 and 2 severe accident risk. This becomes the maximum averted cost-risk (MACR) that is possible.

- Phase I SAMA Analysis: Identify potential SAMA candidates based on the SQN PRA, individual plant examination (IPE), individual plant examination for external events (IPEEE), and documentation from the industry and the NRC. Screen out Phase I SAMA candidates using the following criteria:

1. Not Applicable: If a proposed SAMA does not apply to the SQN design, it is not retained.

2. Already Implemented: If the SAMA or equivalent was previously implemented, it is not retained.

3. Combined With Another SAMA: If a SAMA is similar in nature and can be combined with another SAMA to develop a more comprehensive or plant-specific SAMA, only the combined SAMA is further evaluated.

4. Excessive Implementation Cost: If the estimated cost of implementation is greater than the modified MACR, the SAMA cannot be cost-beneficial and is screened from further analysis. The MACR is the sum of the maximum averted cost-risks pertaining to the offsite exposure cost, offsite economic cost, onsite exposure cost, onsite cleanup cost, and replacement power cost. The modified MACR is determined by applying an external event risk multiplier to the MACR.

5. Very Low Benefit: If the SAMA is related to a non-risk significant system, which is known to have negligible impact on the risk profile, it is not retained.

6. Implementation in Progress: If plant improvements that address the intent of the SAMA are already in progress, it is not retained.

- Phase II SAMA Analysis: Calculate the risk reduction attributable to each remaining SAMA candidate, in dollars, and compare to its implementation cost to identify the net cost-benefit.

- Sensitivity Analysis: Evaluate how changes in the SAMA analysis assumptions might affect the cost-benefit evaluation.

- Conclusions: Summarize results and identify conclusions.

Using this process, TVA incorporated industry, NRC, and plant-specific information to create a list of 309 SAMAs for consideration. Phase I screening eliminated 262 SAMA candidates from further consideration. The remaining 47 SAMA candidates were evaluated in Phase II. The Phase II analysis identified nine SAMAs that are potentially cost-beneficial for Unit 1 and eight SAMAs that are potentially cost-beneficial for Unit 2. The SAMA candidates are described below.

- SAMA 045 (both Units): Enhance procedural guidance for use of cross-tied component cooling pumps.

- SAMA 070 (both Units): Install accumulators for turbine-driven auxiliary feedwater pump flow control valves.

- SAMA 105 (both Units): Delay containment spray actuation after a large loss-of-coolant accident (LOCA).
- SAMA 106 (both Units): Install automatic containment spray pump header throttle valves.
- SAMA 160 (Unit 1): Implement procedures for temporary heating, ventilation, and air conditioning (HVAC).
- SAMA 215 (both Units): Provide a means to ensure reactor coolant pump (RCP) seal cooling so that RCP seal LOCAs are precluded for station blackout events.
- SAMA 268 (both Units): Perform an evaluation of the component cooling water system/ auxiliary feedwater (CCS/AFW) area cooling requirements.
- SAMA 279 (both Units): Improve internal flooding response procedures and training to improve the response to internal flooding events.
- SAMA 283 (both Units): Initiate frequent awareness training for plant operators/ maintenance/testing staff on important human actions, including dependent (combination) events, for plant risk.

While these results are believed to accurately reflect potential areas for improvement at SQN, TVA notes that this analysis should not necessarily be considered a formal disposition of the proposed changes, as other engineering reviews are necessary to determine the ultimate resolution. TVA will consider the SAMAs using the appropriate design process. None of the SAMAs are related to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

Two sensitivity analyses were conducted to evaluate how the SAMA analysis would change if certain key parameters were changed. The sensitivity analyses include use of a conservative discount rate of 3 percent and an evaluation of risk uncertainty using an uncertainty factor which incorporates the ratio of the 95th percentile value of core damage frequency to the point estimate of core damage frequency. These sensitivity analyses identified additional SAMA candidates for each unit that are potentially cost-beneficial. They are described below.

- SAMA 032 (Unit 2): Add the ability to automatically align emergency core cooling system to recirculation mode upon refueling water storage tank depletion.
- SAMA 088 (both Units): Install nitrogen bottles as backup gas supply for safety relief valves.
- SAMA 160 (Unit 2): Implement procedures for temporary HVAC. This SAMA was potentially cost-beneficial for Unit 1 in the base SAMA analysis.

- SAMA 249 (both units): High volume makeup to the RWST.
- SAMA 275 (both Units): Install spray protection on motor-driven AFW pumps and space coolers.
- SAMA 285 (both Units): Protect important equipment in the turbine building from internal flooding.
- SAMA 286 (both Units): Install flood doors to prevent water propagation in the electric board room.
- SAMA 288 (both Units): Install spray protection on component cooling pumps and space coolers.
- SAMA 289 (both Units): Install backup cooling system for CCS and AFW space coolers.

The sensitivity results are primarily driven by the 95th percentile sensitivity and are, therefore, much more conservative than the baseline SAMA analysis. Implementation of SAMAs 286 and 288 would benefit both units because the proposed modifications impact both Unit 1 and Unit 2 equipment. Therefore, SAMAs 286 and 288 are considered potentially cost-beneficial because the combined Unit 1 and Unit 2 total averted cost risk from the sensitivity analyses is greater than the implementation cost of the SAMAs. This analysis should also not be considered a formal disposition of the proposed changes, as other engineering reviews are necessary to determine the ultimate resolution.

4.21.6 Conclusion

TVA will consider the SAMAs using the appropriate design process. None of the SAMAs are related to adequately managing the effects of aging during the period of extended operation. Therefore, they do not need to be implemented as part of license renewal pursuant to 10 CFR Part 54.

4.22 <u>Environmental Justice</u>

4.22.1 Description of Issue

Environmental justice.

4.22.2 Finding from Table B-1, Appendix B to Subpart A

The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

4.22.3 Requirement

Other than the above-referenced finding, there is no requirement concerning environmental justice in 10 CFR Part 51.

4.22.4 Background

The following background information is from the Regulatory Guide 4.2.

Environmental justice was not reviewed in NUREG-1437. 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 conditions in minority and low-income communities. The NRC Office of Nuclear Reactor Regulation (NRR) is guided in its consideration of environmental justice by Attachment 4, "NRR Procedures for Environmental Justice Reviews," to NRR Office Letter No. 906, Revision 2, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues." NRR Office Letter No. 906 is revised periodically. The environmental justice review involves identifying 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 will be implemented. The NRC staff will perform the environmental justice review to determine whether there will be disproportionately adverse high human health and environmental effects on minority and low-income populations and report the review in its SEIS. The staff's review will be based on information provided in the ER and developed during the staff's site-specific scoping process.

NRR's Office Letter No. 906, Revision 2 contains a procedure for incorporating environmental justice into the licensing process (NRC 2009b). TVA used this process in conducting the review and analysis of this issue.

4.22.5 Analysis of Environmental Impact

The consideration of environmental justice is required to assure that federal programs and activities will not have "disproportionately high and adverse human health or environmental effects . . . on minority populations and low income populations . . . ." TVA's analyses of the Category 2 issues defined in 10 CFR 51.53(c)(3)(ii) determined that environmental impacts from the continued operation of SQN during the license renewal period would either be undetectable or so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

Thus, no disproportionate adverse impact on minority or low-income populations would occur from the proposed action. Based on the review of these issues, no review for environmental justice is necessary. However, TVA presents environmental justice demographic information in Section 2.6.2 of this ER to assist the NRC in its review.

4.22.6 Conclusion

As part of its environmental assessment of this proposed action, TVA has determined that no significant offsite environmental impacts will be created by the renewal of the SQN OLs. This conclusion is supported by the review performed of the Category 2 issues defined in 10 CFR 51.53(c)(3)(ii) presented in this ER.

NRR procedure recognizes that if no significant offsite impacts occur in connection with the proposed action, no member of the public will be substantially affected (NRC 2009a, page C-2). Therefore, there can be no disproportionately high and adverse impacts or effects on minority, low-income, and subsistence populations resulting from the renewal of the SQN OLs.

4.23 Cumulative Impacts

TVA considered potential cumulative impacts in its environmental analysis associated with SQN operations during the license renewal period. For the purposes of this analysis, past actions are those related to the resources at the time of plant licensing and construction, present actions are those related to the resources at the time of current operation of the power plant, and future actions are considered to be those that are reasonably foreseeable through the end of the 20-year license renewal term. The impacts of the proposed action are combined with other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor, but collectively significant, actions taking place over a period of time. Significant cumulative impacts could stem from an impact that may be SMALL by itself but could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. If a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

The impacts discussed in this section are the cumulative impacts of the proposed action plus the impacts of other projects in the area. This analysis considers impacts from SQN and the other projects in the area during the license renewal term, 2020 to 2041 (see Section 1.0). The geographic area considered (i.e., the region of influence) is discussed within each impact area.

Section 2.13 describes other projects at and in the vicinity of SQN. These include an ISFSI and possible expansion, use of SQN by DOE for tritium production, use of BLEU fuel in the SQN reactors, use of MOX in the SQN reactors, TVA projects in the area including other generating plants and water management along the Tennessee River and its tributaries, and existing and planned development in the area. The timing of each of the projects, either their construction, operation, or both, is expected to overlap with SQN operations during the license renewal term.

4.23.1 Cumulative Impacts on Water Resources

4.23.1.1 Surface Water Resources

The region of influence for surface water resources is concentrated in the Chickamauga Reservoir, but also extends downstream with regard to the potential for consumptive water use to impact downstream users. As discussed in Section 4.9, TVA has permitting authority for intake structures and withdrawals, and thereby can minimize water use conflicts; therefore, cumulative impacts from water consumption are not expected. Extended operation of SQN will not result in a water use conflict on Chickamauga Reservoir. Water consumption due to cooling water withdrawals at SQN is a very small percentage of the overall flow of the Tennessee River through Chickamauga Reservoir. During the license renewal term, SQN is expected to consume water from Chickamauga Reservoir at current rates. SQN returned 99.6 percent of the water withdrawn back to the reservoir in 2011 (Section 4.1).

SQN has in place programs to protect the quality of surface water resources. As discussed in Section 2.2, SQN discharges are in accordance with its NPDES permit and associated ecological and biological monitoring of Chickamauga Reservoir, which indicates that SQN operations are not adversely impacting the fish community in Chickamauga Reservoir and show that fish populations are healthy and thriving, which is a measure of existing cumulative water quality impacts. As discussed in Sections 2.4 and 3.2.8.5, SQN has programs in place to protect surface water quality. These programs include SPCC procedures to prevent spills and implement immediate cleanup activities in the event of a spill to protect soils and groundwater, as well as surface water resources.

As discussed in Section 2.13, further development in the area is expected; however, projections for water usage estimate a decline in water withdrawals from the Tennessee River watershed of 7 percent by 2030 (Bohac and McCall 2008). As the operator of Chickamauga Reservoir and upstream and downstream dams, TVA controls the level within the reservoir to maintain adequate water resources. TVA is also responsible for permitting water intake structures in the Tennessee River system. The permits require reporting annual water usage, and TVA uses these data to track existing usage and evaluate proposed increases in withdrawals from the Tennessee River system. (TVA 2011s) The offsite development could lead to discharges to Chickamauga Reservoir that could impact water quality. However, any such discharges including stormwater would be subject to NPDES permit limits designed to be protective of surface water resources, minimizing cumulative impacts.

Therefore, cumulative impacts to surface water are expected to be SMALL.

TVA also considered the potential for impacts to surface water within Chickamauga Reservoir from SQN operations and other projects in combination with climate change. The potential cumulative effects of climate change on a river/impoundment system, whether from natural cycles or related to anthropogenic activities, are not well understood, and hypothetically could result in a variety of environmental alterations that would affect surface water resources such as floods, prolonged drought, and temperature increases (IPCC 2007). Depending on climatic conditions, surface water losses and flooding could potentially affect navigation, power production, and municipal and industrial users, although the magnitude of the impact is uncertain due to unforeseeable events. Therefore, TVA concludes that cumulative impacts to surface water, when combined with the effects of climate change, could range from SMALL to MODERATE.

4.23.1.2 Groundwater Resources

As discussed in Sections 4.5, 4.6, and 4.7, SQN does not use groundwater, so license renewal would not impact the quantity of groundwater resources available for use. Groundwater resources underlying SQN are described in Section 2.3. Section 2.3 also explains the groundwater movement toward Chickamauga Reservoir (northeast and southwest) and the Conasauga-Knox Dolomite Contact, which creates a hydraulic barrier across which only a very small volume of water can migrate. Thus, groundwater resources outside SQN that are drinking water sources are unaffected by SQN operations.

SQN has in place programs to protect the quality of groundwater resources from nonradiological site activities. As discussed in Sections 2.4 and 3.2.8.5, these programs include SPCC procedures to prevent spills and implement immediate cleanup activities in the event of a spill to protect groundwater as well as surface water resources. Using these programs, no groundwater quality impacts are expected, and there would be no cumulative impacts to groundwater resources.

Liquid and gaseous radioactive effluents are monitored as required by the SQN ODCM. Based on monitoring, all effluent releases have been within the concentration and total release limits specified by the ODCM. Projected offsite doses were also within the limits specified by the ODCM, 10 CFR Part 20, 40 CFR Part 190, and Appendix I to 10 CFR Part 50 as discussed in Section 9.1.3.6.2. In addition, as discussed in Section 3.2.5, SQN has an ongoing REMP that includes sampling indicators and control locations within a 40-mile radius of SQN to show any increases or buildup of radioactivity that might occur due to station operation. Groundwater monitoring detects radioactivity from all sources, anthropogenic and naturally occurring, in groundwater samples. Groundwater is sampled from an onsite well and a private well in an area unaffected by SQN. Gamma spectroscopy analysis is performed monthly on a composite sample from the onsite well and quarterly on samples from the offsite well. Analyses are also conducted for gross beta activity and tritium (SQN 2011d). Based on 2011 REMP results, no fission or activation products were detected by gamma analyses in the groundwater samples from the two REMP monitoring locations. Results for tritium were all less than the nominal lower limits of detection, and the gross beta levels were representative of the levels typically found in groundwater.

In addition to the REMP program, TVA has been monitoring tritium levels in various onsite wells for several years. As discussed in Section 4.0, TVA studies indicate that the tritium detected in the groundwater samples are attributable to past inadvertent releases, and that the intake and discharge channel would ultimately receive tritiated groundwater discharged from the site. Monitoring results have been below EPA drinking water standards for tritium with the exception of results for one well in December 2011. Further investigation was triggered by this result. This further investigation undertaken in January 2012 indicated that no tritiated groundwater has migrated past the site property boundary (TVA 2012f).

Given the understanding of groundwater movement underlying the site and the existing groundwater protection and monitoring programs, impacts to groundwater resources from SQN operations are not expected to combine with offsite groundwater impacts. However, the incremental contribution attributable to the continued operation of SQN during the license renewal period would be SMALL should groundwater impacts from SQN combine with those attributable to other actions.

4.23.2 Cumulative Impacts on Aquatic Resources

The region of influence is concentrated in Chickamauga Reservoir, but also extends downstream with regard to the potential for consumptive water use to impact downstream aquatic resources. Section 2.2 describes the existing environmental conditions for aquatic and riparian communities, presenting the results and trends from TVA's ongoing ecological and biological monitoring programs. These monitoring programs present no indication that SQN operations are adversely impacting the fish community in Chickamauga Reservoir and show that fish populations are healthy and thriving, which is a measure of existing cumulative impacts. In addition, the entrainment, impingement, and thermal impacts addressed in Sections 4.2, 4.3, and 4.4, respectively, also determined the impact of SQN operations during an extended license term to be small.

With regard to cumulative impacts occurring during the license renewal term, SQN's existing small impacts could combine with impacts from other future projects. SQN's impacts stem from water consumption, entrainment, and impingement due to the operation of SQN's cooling water intake structures, NPDES-permitted discharges (chemicals, metals, radionuclides, and waste heat), and radiological releases. As for water use conflicts, given TVA's permitting authority for intake structures and withdrawals, cumulative impacts from water consumption are not expected. As discussed in Section 4.9, TVA's permitting process includes an environmental impact review. This review ensures that potential environmental impacts are assessed and appropriate mitigation measures put in place to minimize cumulative impacts from water withdrawals, as well as from the intake structures themselves, which minimizes cumulative impacts specific to entrainment and impingement. The potential future projects at SQN discussed in Section 2.13 would not require changes to the structure and operation of SQN's cooling water system, so cumulative impacts from these onsite projects are not expected.

Offsite projects such as industrial development could potentially lead to discharges to Chickamauga Reservoir. However, any such discharges, including stormwater, would be subject to NPDES permit limits designed to be protective of surface water and aquatic ecology resources, minimizing cumulative impacts. As for cumulative impacts due to radiological releases during normal operations, as discussed in detail in Section 4.23.5, the projected dose from each of the SQN projects and WBN is a small percentage of the allowable regulatory limits. In addition, SQN's REMP (Section 3.2.5), conducted in the vicinity of the plant to measure radiation and radioactive materials from all sources, will continue throughout the license renewal period to ensure there are no cumulative impacts to aquatic resources due to radiological releases from plant operations.

In summary, cumulative impacts to aquatic resources during the license renewal term would be SMALL.

Finally, TVA considered the potential for impacts to aquatic resources within Chickamauga Reservoir from SQN operations and other projects in combination with climate change. As discussed above in Section 4.23.1, the potential cumulative effects of climate change on a river/ impoundment system, whether from natural cycles or related to anthropogenic activities, are not well understood, and hypothetically could result in a variety of environmental alterations that would affect surface water resources and, therefore, affect aquatic resources. Changes due to floods and bank erosion could hypothetically result in effects on wetlands and other shoreline communities. Prolonged drought could hypothetically result in effects on riparian and riverine habitats due to decreased flows that could affect velocity or flood-pulse related spawning triggers, sediment loads and turbidity, and available cover for various species. Water temperature increases could hypothetically affect spawning patterns or success, or influence species distributions when cold-water species move northward while warm-water species become established in new habitats. Changes in turbidity due to sediment load patterns could hypothetically influence the spawning and distribution of exotic or nuisance species. Changes in precipitation patterns could hypothetically have effects on water circulation and alter the nature of sediment and nutrient inputs to the system, which could result in changes to primary production and influence the aquatic food web on many levels. Thus, the extent and magnitude of climate change impacts may hypothetically make this process a contributor to cumulative impacts on the aquatic resources of Chickamauga Reservoir, and these impacts could be MODERATE over the long term.

However, TVA is the operator of Chickamauga Reservoir and the upstream and downstream dams, so TVA can control the level within the reservoir both for flood control and to maintain adequate water levels for SQN and the ecological community, thus minimizing impacts. Cumulative impacts to aquatic resources could range from SMALL to MODERATE.

4.23.3 Cumulative Impacts on Terrestrial Resources

Cumulative impacts to terrestrial resources could stem from land use, noise, air quality, water use conflicts, and ROW vegetative management practices. As indicated in Section 3.3, no refurbishment activities are planned at SQN and furthermore, no construction activities are planned in undisturbed areas for the license renewal term.

No terrestrial habitat areas would be converted for SQN facilities during the renewal term. In addition, as indicated in Section 2.4, any land disturbance activities are reviewed as required by procedure to ensure that the BMPs appropriate for the environment are used to protect terrestrial habitat and wildlife, threatened and endangered species, wetland areas, and water quality. SQN operations resulting in noise and localized air quality impacts from fossil fuel-fired equipment and vehicles will continue, but these impacts are anticipated to be small and not extend beyond the boundaries of SQN. As discussed in Section 2.13, some development is expected in the vicinity of SQN, which could potentially result in adverse impacts to terrestrial resources from land-disturbing activities and land use conversion; however, these impacts would not be cumulative with SQN's operational activities.

As discussed in Section 4.9, a TVA and USGS collaborative report (Bohac and McCall 2008) indicates that cumulative consumption of water from the Tennessee River valley is low (3.5 percent in 2005) and is projected to decline in the coming years, coinciding with the license renewal term. Also, since the plant became operational, water withdrawal has caused no water availability concerns for the Chickamauga Reservoir and no adverse impacts on riparian or instream ecological communities (Section 4.1).

ROW vegetative management practices, an integrated vegetation management approach, are discussed in Section 3.2.10.2.2. These practices are designed to be protective of terrestrial and aquatic resources, and property owners are encouraged to participate. Rural property owners are encouraged to maintain low-growing cover that is compatible with the ROW and supports wildlife, with an emphasis on quail, turkey, and deer, while urban and suburban property owners are encouraged to plant and maintain wildflowers on the ROW. The protective practices and participation of property owners results in the ROW management supporting local land uses and are not expected to adversely affect vegetation characteristics of terrestrial habitats within the ROW or other terrestrial habitats in the vicinity of the transmission lines.

In summary, land use, noise, and air quality impacts are not expected to be cumulative. Impacts from water use conflicts have not been experienced to date and are not projected for the future. ROW vegetative management practices are not expected to adversely affect vegetation characteristics of terrestrial habitats within the ROW or other terrestrial habitats in the vicinity of the transmission lines. Thus, the incremental contribution attributable to the continued operation of SQN during the license renewal period would be SMALL should there be a combining of impacts attributable to other actions resulting in cumulative impacts.

4.23.4 Cumulative Socioeconomic Impacts

The socioeconomic conditions involving population, taxes, housing, local public services, utilities, education, employment, offsite land use, and transportation were presented in Chapter 2. The impacts to housing, local public services/utilities, education, and transportation as measures of socioeconomic indicators were evaluated separately in Sections 4.14, 4.15, 4.16, and 4.19.

As noted in Section 2.7, SQN contributes to the local and state tax base through payments in lieu of taxes, thus contributing to the cumulative revenue base. Continued operation of the plant through the license renewal term would provide a beneficial impact of economic support and tax revenues to Tennessee and the surrounding counties and communities. The revenue benefit from license renewal is expected to remain approximately the same as it is because it is based on electricity sales and property holdings. SQN's contribution is a small percentage of the cumulative revenue base at the state and local levels.

As discussed in Sections 3.3 and 3.5, there are no plans to add workers during the license renewal term or undertake refurbishment. Chapter 2 describes the existing conditions in the region of interest for housing, public services/utilities, education, offsite land use, and transportation that would be expected during the license renewal term. Sections 4.14, 4.15, 4.18, and 4.19 characterize the socioeconomic impacts during license renewal as small. Of the other projects discussed in Section 2.13, the construction workers needed for expansion of the ISFSI and the development projects in the area could coincide with an outage, and thus temporary housing availability could be impacted for a short period of time. However, given the proximity to Chattanooga hotels and motels, the impact to temporary housing availability would be SMALL, but the demand for housing would also have a beneficial economic impact.

Tritium production at SQN would add up to 10 workers per unit (DOE 1999), all of which would seek permanent housing and have a SMALL impact on public utilities/services, education, offsite land use, and transportation infrastructure. However, because SQN has no plans to add workers during the renewal term, the cumulative impact of SQN's existing workforce and the additional 10 workers per unit would essentially be the same as the existing impact, which has already been absorbed into the local community support structure and mitigated by payment in lieu of taxes and worker tax payments.

Overall, cumulative socioeconomic impacts are expected to be SMALL and beneficial.

Information on minority and low-income populations is presented in Section 2.6.2. As discussed in Section 4.22, no disproportionate adverse impact on minority or low-income populations would occur from renewal of the SQN operating licenses. Thus, the proposed action would not contribute to a cumulative disproportionate adverse impact to minority or low-income populations.

As discussed in Section 4.20, impacts to historic aboveground properties or archaeological sites as a result of renewal of the SQN OLs were determined to be SMALL. Therefore, the incremental contribution to a cumulative impact on cultural resources by continued operation of SQN during the license renewal period would be SMALL.

4.23.5 Cumulative Impacts on Air Quality

As discussed in Section 3.2.8.4, SQN is classified as a minor air emission source and, therefore, impacts to air quality associated with the emergency diesel generators, auxiliary boilers, cooling towers, and other insignificant sources would be small. The emergency diesel generators and auxiliary boilers are operated intermittently and in accordance with the conditions outlined in the air permits associated with these sources; therefore, emission impacts from these sources when operated would be localized. The cooling towers are not in service during the majority of the year. The average annual time that the cooling towers were in service from 2006 through 2009 was 112.7 days (TVA 2011a, Section 3.1.3.1). In addition, transportation of workforce personnel causes air pollutants due to the operation of fossil-fueled vehicles. However, TVA does not anticipate an increase in the workforce for the license renewal term, so there would be no increase in the air quality impact due to workers commuting. Therefore, SQN's contribution to cumulative impacts on air quality is expected to be SMALL.

Section 2.11 discusses the air quality for Hamilton County, Tennessee, where SQN is located. Hamilton County is in attainment for the criteria air pollutants with the exceptions of 8-hour ozone and for $PM_{2.5}$. The cumulative impact from past and present actions of SQN along with all the other air pollutant emitters in the county, which includes Chattanooga, is included in this measure of air quality.

As discussed in Section 2.13, the county as a whole is expected to continue to experience development, and infrastructure projects such as the proposed bridge over the Tennessee River in north Hamilton County would increase traffic in the SQN area. Cumulatively, these projects could further degrade the county's air quality. However, the proposed action does not include refurbishment activities (Section 3.3), no additional workers are anticipated for continued operations (Section 3.5), the projects discussed in Section 2.13 would add very minimal additional workers, and the stationary air emission sources on site are operated intermittently. Thus, SQN's contribution to cumulative impacts on air quality is expected to be SMALL and not contribute to a further degradation of air quality.

As discussed in Section 2.11, the GHG emissions associated with renewal of the SQN operating licenses would be similar to the life-cycle GHG emissions from renewable energy sources and lower than those associated with fossil fuel-based energy sources. The impact of GHG emissions is global rather than local or regional. The GHG emissions associated with the renewal of the SQN operating licenses would contribute to global cumulative levels of GHG emissions. The cumulative impact to GHG emissions associated with license renewal would be comparable to the characterization of GHG cumulative impacts due to the operation of other nuclear generating units, which NRC has characterized as noticeable, but not destabilizing (NRC 2011).

The reasonably foreseeable projects described in Section 2.13 could result in cumulative impacts to air quality. However, permitting and licensing requirements and various mitigation measures would likely limit air quality impacts such that they remain below applicable air quality standards. Therefore, the cumulative air quality impacts from the renewal of the SQN OLs and other past, present, and reasonably foreseeable projects would be SMALL.

4.23.6 Cumulative Impacts on Human Health

The potential for SQN operations during an extended license term is discussed in this section. The SQN thermal discharge (Section 4.12), electrical shock hazard of SQN transmission lines (Section 4.13), and SQN radiological releases during normal operations are considered along with other projects in the area for cumulative impacts on public health.

SQN's cooling water is discharged to Chickamauga Reservoir along the Tennessee River. The reservoir extends some 59 miles along the river, from Chickamauga Dam (TRM 471.0) to Watts Bar Dam (TRM 529.9). SQN is in compliance with the thermal limits set by the current NPDES permit. There are no other facilities with thermal discharges in the vicinity of SQN (TVA 2011a, Table 3-3). WBN is approximately 43 miles upstream from SQN. Hence, there would be no cumulative impact due to thermal discharge that could potentially enhance the presence of thermophilic organisms.

Radiological dose limits for protection of the public and workers have been developed by the EPA and NRC to address the cumulative impacts of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within an 80-kilometer (50-mile) radius of SQN was included. As discussed in Section 2.13, there will be two operating nuclear units within a 50-mile radius during the license renewal term: WBN Units 1 and 2. In addition, future projects include expansion of the existing ISFSI at SQN (Section 2.13), and construction and operation of an ISFSI at WBN (TVA 2007d, page 95). Future projects also include the use of BLEU nuclear fuel at SQN, the potential for increased tritium production at WBN, and the potential for tritium production at SQN.

Operating SQN for an additional 20-year period would not cause an increase in annual radioactive effluent releases. The cumulative impact of the additional years of operation would be expected to be SMALL, because all routine releases would be in compliance with federal regulations. Individual doses due to normal liquid and gaseous effluent releases from SQN are less than 1 percent of the applicable limits. The doses are well below the federal regulatory guidelines and standards [Appendix I of 10 CFR Part 50 and 10 CFR Part 20] (TVA 2011a, page 3-162). Doses to the public resulting from the discharge of radioactive effluents from WBN Units 1 and 2 were estimated to be less than 2 percent of the 10 CFR Part 50 Appendix I guidelines (TVA 2007d, page 76).

The contribution to dose from operation of the ISFSI facilities at both the SQN and WBN sites would be negligible, and the radiation dose would be a fraction of the regulatory limit (TVA 2007d, page 99; TVA 2011a, page 3-181).

Radiological exposure to the public from the use of BLEU would be very minor, with no observable impact to public health impacts (TVA 2011n, page 5).

DOE has proposed a change in tritium production in TVA reactors (WBN and SQN) from irradiation of a maximum of 6,000 TPBARs every 18 months to 2,500 TPBARs every 18 months (76 FR 60017). However, prior to any tritium production at SQN, TVA would need to submit license amendment applications to the NRC and receive approval. In its 1999 EIS on tritium production in a commercial light water reactor, DOE assessed the potential impacts of irradiating up to 3,400 TPBARs per reactor unit operating on 18 month fuel cycles, estimating the dose to the total population within 50 miles attributable to irradiation of 3,400 TPBARs to be 1.9 person-rem per year (DOE 1999, page 3-25, 3-27; 76 FR 60017). Since this dose was estimated, operating experience at WBN indicates that the tritium permeation through TPBAR cladding is approximately 3 to 4 times that assumed for the 1999 EIS (76 FR 60017). Even at the increased level of permeation, this level of exposure spread over the entire population surrounding the 50-mile radius of WBN or SQN sites would be less than regulatory limits. The naturally occurring total population dose surrounding SQN inclusive of natural background radiation and other manmade radiation exposure is estimated to be 90 mrem/year for each individual. The annual total body dose due to normal background radiation for a population of 1,060,000 persons currently within a 50-mile radius of SQN is approximately 95,400 person-rem, assuming 90 mrem/year for each individual. (TVA 2011a, page 3-163) Even given the greater tritium permeation, the total population dose increase from tritium production would be a small percentage of the overall radiation exposure experienced by the public from background radiation and exposure from manmade sources such as medical x-rays.

As discussed in Section 2.13, DOE, with TVA as a cooperating agency, is to prepare the surplus plutonium disposition supplemental EIS to analyze the potential environmental impacts of the disposal of plutonium, including the use of MOX fuel as an alternative, at SQN. If the DOE decides to dispose of some surplus plutonium by loading it in nuclear reactors, prior to any use of MOX fuel at SQN, TVA would need to request, and NRC approve, amendments to SQN OL(s). The impacts of this alternative will be assessed for the supplemental EIS and available once the draft supplemental EIS is published. However, the original EIS assessment indicated there would be a small population dose associated with all the action alternatives, and no lethal cancers are expected to occur in the general population attributable to routine operations for any of the alternatives (65 FR 1608).

The projected dose from each of these projects is a small percentage of the allowable limits designed to be conservatively protective of human health. The cumulative dose to the public would remain well below regulatory limits regardless if multiple projects are implemented; however, because the projects involve loading the reactors with varying materials, simultaneous implementation particularly in the same reactor would likely be precluded. The cumulative human health impact would be SMALL.

The REMP discussed in Section 3.2.5 is conducted by TVA in the vicinity of SQN and measures radiation and radioactive materials from all sources; therefore, the monitoring programs measure cumulative radiological impacts. WBN has a similar REMP program as well. The REMP includes sampling indicators and control locations within a 40-mile radius of SQN, utilizing indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation, and control locations farther away from the site to indicate the presence of naturally occurring radioactivity. SQN personnel compare indicator results with control and preoperational results to assess any impact operations might have had on the surrounding environment. The results of the operational REMP are reported annually to the NRC in SQN annual radiological environmental operating reports. The most recent report concluded that exposure to members of the general public which may have been attributable to SQN plant operations is negligible. The radioactivity detected by the REMP is primarily the result of fallout or natural background radiation (SQN 2011d). The REMP would continue to be conducted to ensure there are no cumulative impacts from nuclear operations and to monitor the environment around SQN throughout the license renewal period.

Overall, cumulative impacts on human health are anticipated to be SMALL.

4.23.7 Conclusion

TVA considered the potential impacts from continued operation of SQN during the license renewal term and other past, present, and future actions for cumulative impacts. Based on the various impacts discussed above, TVA's conclusion is the potential cumulative impacts resulting from SQN operation during the license renewal term (2020 to 2041) would be SMALL for surface water, aquatic resources, and human health; however, adverse effects from climate change could result in MODERATE impacts to surface water and aquatic resources. SQN's small impacts are not expected to be cumulative with other area projects for groundwater and terrestrial ecology resources. In addition, because TVA does not plan to perform refurbishment activities at SQN or increase the number of workers, the small adverse impacts to regional air quality would continue and make a small contribution to criteria air pollutant levels. Likewise, the small adverse impacts to socioeconomic resources would continue and make a small contribution to cumulative adverse socioeconomic impacts. SQN beneficial socioeconomic impacts due to payments in lieu of taxes and the participation in the local economy by the SQN workforce will continue at current levels.

5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware. [10 CFR 51.53(c)(3)(iv)]

The NRC has resolved most license renewal environmental issues generically and only requires an applicant to analyze those issues the NRC has not resolved generically. While NRC regulations do not require an applicant's environmental report to contain analyses of the impacts of those Category 1 environmental issues that have been generically resolved [10 CFR 51.53(c)(3)(i)], the regulations do require that an applicant identify any new and significant information of which the applicant is aware. [10 CFR 51.53(c)(3)(iv)]

TVA's review for new and significant information pertaining to Category 1 environmental issues includes development of the final supplemental environmental impact statement (FSEIS) for SQN Units 1 and 2 license renewals (TVA 2011a), public and agency comment solicitation and consideration, and post-FSEIS review of new information as discussed below in Section 5.1.

5.1 New and Significant Information Review

TVA conducted a comprehensive environmental review for continued operation of SQN Units 1 and 2 to support preparation of the FSEIS (TVA 2011a). The FSEIS reviewed the environmental impacts of continuing operation of SQN inclusive of Category 1 issues, and concluded for all resource areas that no new impacts would be forthcoming from license renewal. Any existing impacts would continue to be minor and would neither destabilize nor noticeably alter any important attribute of the resource (TVA 2011a, Table S-1). Information available since the development of the FSEIS is considered new information.

In the course of preparing the FSEIS, TVA performed an analysis to identify the following:

- Information that identifies a significant environmental issue not covered generically in the NRC's generic environmental impact statement (GEIS) and codified in the regulation, or

- Information not covered in the GEIS analyses that leads to an impact finding different from that codified in the regulation.

NRC does not specifically define the term "significant." Accordingly, for the purposes of this review, TVA relied on the definition provided in Council on Environmental Quality (CEQ) regulations [40 CFR 1508.27]. NEPA authorizes CEQ to establish implementing regulations for federal agency use. The NRC requires license renewal applicants to provide the NRC with input, in the form of an environmental report, that the NRC will use to meet NEPA requirements as they apply to license renewal [10 CFR 51.10].

CEQ regulations state that federal agencies should prepare EISs for actions that would significantly affect the environment [40 CFR 1502.3], focus on significant environmental issues [40 CFR 1502.1], and eliminate from detailed study issues that are not significant [40 CFR

1501.7(a)(3)]. CEQ regulations include a lengthy definition of "significantly" that requires consideration of the context of the action and the intensity or severity of the impact(s) [40 CFR 1508.27]. TVA expects that LARGE impacts, as defined by NRC, would be significant.

The FSEIS for SQN license renewal serves as part of a process to ensure that information regarding the environmental impacts of license renewal for SQN not addressed in or available during the GEIS evaluation would be properly reviewed, and to ensure that such new and potentially significant information related to renewal of the licenses for SQN would be identified, reviewed, and assessed.

To support development of the SEIS, TVA published a Notice of Intent to prepare the SEIS in the *Federal Register* on April 12, 2010. The public, state agencies, and several Native American tribes submitted comments, which were considered during development of the draft SEIS. The Notice of Availability for the draft SEIS was published in the *Federal Register* on November 5, 2010. TVA also coordinated an intergovernmental review of the SEIS, sending information to and soliciting the views of numerous government agencies and offices within the state of Tennessee and the federal government. TVA accepted comments on the draft SEIS until December 22, 2010, and held a public open house in Soddy-Daisy, Tennessee, on December 2, 2010. Comments submitted by the public and federal and state agencies were addressed in the FSEIS. A Notice of Availability for the FSEIS was published in the *Federal Register* on July 1, 2011 (76 FR 38650). TVA also accepted comments on the FSEIS as detailed in the Record of Decision published in the *Federal Register* on September 8, 2011 (76 FR 55723). TVA received comments from only nine agencies and individuals, none of which were considered new and significant in the context of 10 CFR 51.53(c)(3)(iv).

Building on the FSEIS review, TVA conducted a review for new information (information that was not available during the development of the SEIS, such as updates to environmental monitoring reports) pertaining to the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, as well as proposed Category 1 issues (74 FR 38117; NRC 2012). This review was performed by personnel familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER. New information was evaluated to determine if it was significant to the GEIS and Revision 1 of the GEIS conclusions with respect to SQN.

In addition to the FSEIS and post-FSEIS review, TVA environmental staff keeps abreast of new and emerging environmental standards from state and federal agencies and participates as a federal agency/owner with environmental concerns pertaining to the Tennessee Valley reservoir system. In this capacity, TVA is routinely in contact with various state and local environmental agencies and organizations.

Nuclear operations staff reviews SQN daily, weekly, and monthly inspections and environmental monitoring reports and, together with the TVA environmental staff, identifies data that potentially indicate environmental concerns. The nuclear operations staff also reviews nuclear industry publications and participates in trade groups to monitor issues relating to SQN. In the course of performing these duties, TVA staff identifies new information and evaluates it for significance in affecting the environmental impacts of SQN.

In addition to the above actions, the TVA operating experience program screens industry-significant documents from the Institute of Nuclear Power Operations (INPO), the NRC, and vendors. If the event or issue is environmentally related, the document would be sent to the environmental group for review and evaluation. Sources of documents screened by the TVA operating experience program include INPO significant operating experience reports, INPO event reports, NRC information notices and Part 21 reports, Westinghouse technical bulletins and nuclear safety advisory letters, General Electric service information letters, rapid industry communication service information letters, and safety communications. Industry events that are not significant (i.e., INPO operating experience reports) are distributed daily via electronic mail to station personnel. The TVA environmental staff would receive these reports for review and conduct an evaluation of the issue if required. Events which have occurred at a TVA nuclear station are shared with the other nuclear sites through an internal operating experience program. As with industry events, any environmental issues would be assigned to the environmental group for review and evaluation.

Therefore, in the course of performing the duties discussed above, TVA staff works cooperatively to identify new information and evaluate it for significance in affecting the environmental impacts of SQN.

As a result of this assessment, TVA is aware of no new and significant information regarding the environmental impacts of license renewal associated with the continued operation of SQN during the license renewal period. Therefore, none of the Category 1 issues require additional analysis. In addition, no comments were received by agencies or individuals that would be considered new and significant information.

The proposed Clean Water Act §316(b) Existing Facilities Rule regulating cooling water intake structures at existing facilities and new units at existing facilities will ultimately establish impingement and entrainment standards. Thus, TVA has elected to provide a brief discussion in Section 5.1.1 regarding this rule in particular, because it concerns impingement and entrainment impacts. However, TVA does not consider this rule to be new and significant information in the context of 10 CFR 51.53(c)(3)(iv), and current plant impacts associated with impingement and entrainment operating in the open (once-through) and helper (once-through with towers) modes are discussed in Sections 4.2 and 4.3.

5.1.1 Clean Water Act Section 316(b)

On April 20, 2011, the EPA released its proposed §316(b) Existing Facilities Rule regulating cooling water intake structures at existing facilities and new units at existing facilities with a design intake flow greater than 2 MGD (76 FR 22174). EPA's rule, as proposed, directs permitting authorities to make separate best technology available (BTA) determinations for impingement mortality and entrainment mortality. For both impingement mortality and entrainment mortality, the proposed rule provides options for compliance with BTA standards, some of which could require continuous closed-cycle cooling year-round.

TVA has carefully reviewed the proposed §316(b) Rule and has concluded the risk of being required to adopt full-time closed-cycle cooling is low, based on the following:

- The reproductive strategy of many fish species in Chickamauga Reservoir, particularly recreationally important game fish species, is such that fish eggs and larvae are largely unavailable for entrainment; that is, these species are largely nest builders rather than pelagic (water column) spawners.

- TVA has conducted long-term monitoring of the fish community in Chickamauga Reservoir and has never documented adverse environmental impact associated with its cooling water intake structures.

- There are no federally threatened or endangered fish species in Chickamauga Reservoir that would be subject to entrainment.

- The permitting authorities' concerns have historically been for hydrothermal impacts of the plant discharge during summer months—a factor the permitting authority must consider under the proposed rule in their site-specific determination of BTA for entrainment. However, SQN has successfully managed hydrothermal discharge issues over the years through strategic operation of its cooling system in helper mode.

- Cost-benefit analysis is a component of the site-specific determination of BTA. TVA does not believe that the benefits of closed-cycle cooling would reasonably justify the significant costs of this technology option. Major modifications would be required to implement closed-cycle cooling at SQN.

- If the permitting authority were to specify BTA for entrainment at SQN, TVA believes that installation of fine-mesh screens may provide a more reasonable and cost-effective alternative to closed-cycle cooling.

- Were closed-cycle operation ultimately specified by the permitting authority, TVA believes seasonal operation (during fish spawning periods) would satisfy requirements, provided SQN continues to operate in helper mode during critical summer months to meet thermal discharge limits.

If any plant modifications were deemed necessary through the site-specific process for evaluating impingement and entrainment reduction technologies and establishing site-specific BTA per the final rule, they would be evaluated and permitted as required at that time. The proposed rule assumed that, on average, impingement modifications would be in place in 2015 and entrainment modifications in 2025.

6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

6.1 License Renewal Impacts

TVA has reviewed the environmental impacts of renewing the operating licenses for SQN and has concluded that all impacts would be SMALL and further mitigation measures beyond those currently existing are not warranted. This ER documents the basis for TVA's conclusion. Chapter 4 incorporates by reference NRC findings for the 55 Category 1 issues that apply to SQN (and for the two uncategorized issues for which the NRC came to no generic conclusion), all of which have environmental impacts that are SMALL. Chapter 4 also incorporates by reference the 13 Category 1 issues that the NRC has proposed in the amendment to 10 CFR Part 51, all of which are applicable to SQN.

The remainder of Chapter 4 analyzes the 21 Category 2 issues, all of which are either not applicable, or have impacts that would be SMALL. Category 2 issues that NRC has proposed in the amendment to 10 CFR Part 51 are also addressed in Chapter 4. TVA identified minority and low-income populations, evaluated potential impacts to these populations alone, and determined that there are no issues that would adversely and disproportionately affect minority or low-income populations.

Table 6.1-1 identifies the environmental impacts that renewal of the operating licenses for SQN would have on resources associated with existing Category 2 issues. Category 2 issues proposed in the amendment to 10 CFR Part 51 are not included in Table 6.1-1. However, Table 1.1-1 of this ER provides a crosswalk to various sections of the ER that address these issues.

6.2 Mitigation

6.2.1 Requirement [10 CFR 51.45(c)]

The report must contain a consideration of alternatives for reducing adverse impacts, as required by §51.45(c), for all Category 2 license renewal issues in Appendix B to Subpart A of this part. No such consideration is required for Category 1 issues in Appendix B to Subpart A of this part. [10 CFR 51.53(c)(3)(iii)]

6.2.2 TVA Response

As discussed in Supplement 1 to Regulatory Guide 4.2, "Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses," when adverse environmental effects are identified, 10 CFR 51.45(c) requires consideration of alternatives available to reduce or avoid these adverse effects.

Furthermore, Supplement 1 states, "Mitigation alternatives are to be considered no matter how small the adverse impact; however, the extent of the consideration should be proportional to the significance of the impact" (NRC 2000, page 4.2-S-5).

As discussed in Section 6.1 and shown in Table 6.1-1, analysis of the Category 2 issues found the impacts to be SMALL for issues applicable to SQN. For these issues, the various permits and programs discussed in Chapter 9 (i.e., NPDES permit, air permit, SPCC program, radioactive effluents monitoring program, groundwater protection program, REMP, cultural resource protection plan, and environmental review programs) that currently mitigate the environmental impacts of plant operations through imposed regulatory control measures are adequate. Therefore, additional mitigation measures are not sufficiently beneficial as to be warranted.

6.3 Unavoidable Adverse Impacts

6.3.1 Requirement [10 CFR 51.45(b)(2)]

The applicant's report shall discuss any adverse environmental effects which cannot be avoided upon implementation of the proposed project.

6.3.2 TVA Response

TVA adopts by reference NRC findings for applicable Category 1 issues, including discussions of any unavoidable adverse impacts. Chapter 4 contains the results of TVA's review and analyses of the Category 2 issues as required by 10 CFR 51.53(c)(3)(ii). These reviews take into account the information that has been provided in the GEIS, Appendix B to Subpart A of 10 CFR Part 51, and information specific to SQN.

An environmental review conducted at the license renewal stage differs from the review conducted in support of a construction permit, because the facility is in existence at the license renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have been avoided, have been mitigated, or have already occurred.

As discussed in Section 3.3, no refurbishment activities are planned for the renewal of the operating licenses for SQN. Therefore, the environmental impacts to be evaluated for license renewal are those associated with continued operation during the renewal term. As presented in Chapter 4, TVA's review and analysis of the 21 Category 2 issues associated with continued operation of SQN identified the following unavoidable adverse impacts, all of which are considered SMALL:

- The majority of the land use at SQN would continue to be designated as industrial until the plant is shut down and decommissioned (decommissioning can take up to 60 years after permanent shutdown of SQN). Uranium mining associated with the nuclear fuel cycle also has offsite land-use implications.

- The ISFSI would remain on the SQN site until the DOE takes possession of the spent fuel. Storage of spent fuel constitutes a long-term commitment of land. Specific plant design features in conjunction with a waste minimization program, employee safety training programs and work procedures, and strict adherence to applicable regulations for storage, treatment, transportation, and ultimate disposal of this waste or reprocessing ensure that the impact is SMALL.

- The SQN site and transmission facilities would continue to exist within the viewscape, but be no more prominent than at present. Therefore, impacts would be SMALL.

- Normal plant operations result in discharge of small amounts of chemicals and radioactive effluents to Chickamauga Reservoir. Compliance with the NPDES permit, water quality standards, the stormwater pollution prevention plan (SWPPP), SPCC plans, and regulatory standards pertaining to radioactive effluents would ensure that impacts remain SMALL.

- Entrainment or impingement results in some loss of fish and other aquatic organisms. However, as discussed in Sections 4.2.5 and 4.3.5, these impacts are SMALL.

- Discharge of cooling water results in a thermal plume in the Chickamauga Reservoir. However, as discussed in Section 4.4.5, these impacts are SMALL.

- Water lost to evaporation represents consumption of water that would not be available for other uses. However, when the plant is operated in helper mode under design conditions (a conservative upper-bounding scenario), on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site. Therefore, the impacts are SMALL.

- Disposal of LLRW and nonradioactive waste represents a long-term commitment of land. Waste minimization programs, employee training programs, and strict adherence to work procedures and applicable regulations ensure that the impact is SMALL.

- Cooling towers emit a plume of water vapor resulting in a limited obstructed view of the sky, causing a shadowing effect on the ground that has a SMALL impact on vegetation.

6.4 Irreversible or Irretrievable Resource Commitments

6.4.1 Requirement [10 CFR 51.45(b)(5)]

The applicant's report shall discuss any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

6.4.2 TVA Response

The term "irreversible" applies to the commitment of environmental resources (e.g., permanent use of land) that cannot by practical means be reversed to restore the environmental resources to their former state. In contrast, the term "irretrievable" applies to the commitment of material resources (e.g., irradiated steel, petroleum) that, once used, cannot by practical means be recycled or restored for other uses.

The continued operation of SQN for the period of extended operation will result in irreversible and irretrievable resource commitments, including the following:

- Uranium in the nuclear fuel consumed in the reactor becomes high-level radioactive waste if the used fuel is not recycled through reprocessing.
- Land required for permanent storage or disposal of spent nuclear fuel, LLRW generated as a result of plant operations, and sanitary waste generated from normal industrial operations.
- Elemental materials that will become radioactive.
- Materials used for the normal industrial operations of SQN that cannot be recovered or recycled or that are consumed or reduced to unrecoverable forms.

Other than the above, there are no refurbishment activities or changes in operation of SQN planned during the period of extended operation that would irreversibly or irretrievably commit significant environmental components of land, water, and air.

However, if SQN ceases operations on or before the expiration of the current operating licenses, the likely power generation alternatives would require a commitment of resources for construction of the replacement plants as well as for fuel to run the plants. Significant resource commitments would also be required for development of transmission capacity.

6.5 Short-Term Use Versus Long-Term Productivity

6.5.1 Requirement [10 CFR 51.45(b)(4)]

The applicant's report shall discuss the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

6.5.2 TVA Response

The current balance between short-term use and long-term productivity of the environment at the site has remained relatively constant since SQN Units 1 and 2 began operating in 1981 and 1982, respectively. The SQN FES and FSEIS both evaluated the relationship between the short-term uses of the environment and the maintenance and enhancement of the long-term productivity associated with the construction and operation of SQN (TVA 1974a, Section 5.0; TVA 2011a, Section 4.2). The period of extended operation will not alter the short-term uses of the environment from the uses previously evaluated in the SQN FES and FSEIS. The period of extended operation will postpone the availability of the site resources (land, air, water) for other uses. Denial of the application to renew the SQN operating licenses would lead to the shutdown of the plant and would alter the balance in a manner that depends on the subsequent uses of the site. For example, the environmental consequences of turning the SQN site into a park or an industrial facility are quite different. However, extending SQN operations would not alter the potential long-term uses of the site that are currently possible.

In summary, there are no refurbishment activities or changes in operation of SQN planned for the period of extended operation that would alter the evaluation of the SQN FES for the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity of these resources.

Table 6.1-1
Environmental Impacts Related to License Renewal at SQN

Issue	ER Section	Environmental Impact
Surface Water Quality, Hydrology, and Use (for all plants)		
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow) [10 CFR 51.53(c)(3)(ii)(A)]	4.1.5	**SMALL.** Cooling towers are not operated year-round; when the plant is operated in helper mode under design conditions (a conservative upper-bounding scenario), on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site; little ecological change is evident based on studies; TVA controls water flow through the Tennessee River system and requires a permit for any permanent surface water withdrawal > 0.05 MGD.
Aquatic Ecology (for all plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish [10 CFR 51.53(c)(3)(ii)(B)]	4.2.5	**SMALL.** Fish community assessments in Chickamauga Reservoir show no substantial impacts as a result of SQN operations; based on the 316(b) evaluation in 2004 and the annual RFAI scores, a viable balanced indigenous fish community is present in Chickamauga Reservoir in the vicinity of SQN.
Impingement of fish and shellfish [10 CFR 51.53(c)(3)(ii)(B)]	4.3.5	**SMALL.** Fish community assessments in Chickamauga Reservoir show no substantial impacts as a result of SQN operations; based on the 316(b) evaluation in 2004 and the annual RFAI scores, a viable balanced indigenous fish community is present in Chickamauga Reservoir in the vicinity of SQN.
Heat shock [10 CFR 51.53(c)(3)(ii)(B)]	4.4.5	**SMALL.** SQN operates within the limitations set forth in the NPDES permit; cooling towers are only operated in helper mode during a portion of the year when required due to Chickamauga Reservoir ambient temperatures and flows; based on the 316(b) evaluation in 2004 and the annual RFAI scores, a viable balanced indigenous fish community is present in Chickamauga Reservoir in the vicinity of SQN.
Groundwater Use and Quality		
Groundwater use conflicts (plants using > 100 gpm of groundwater) [10 CFR 51.53(c)(3)(ii)(C)]	4.5.5	**NONE. Issue is not applicable.** SQN does not withdraw groundwater from the site; potable and fire protection water are provided by Hixson Utility District; all other cooling water and service water systems supplied by the Chickamauga Reservoir.

Table 6.1-1 (Continued)
Environmental Impacts Related to License Renewal at SQN

Issue	ER Section	Environmental Impact
Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river) [10 CFR 51.53(c)(3)(ii)(A)]	4.6.5	**SMALL.** SQN does not use or plan to use the closed-cycle mode for cooling tower operations; when the plant is operated in helper mode under design conditions (a conservative upper-bounding scenario), on a daily average basis, the net consumptive loss due to cooling tower operation is not likely to exceed roughly 1.2 percent of the river flow past the SQN site; Chickamauga Reservoir water levels are increased during the summer months.
Groundwater use conflicts (Ranney Wells) [10 CFR 51.53(c)(3)(ii)(C)]	4.7.5	**NONE. Issue is not applicable.** SQN does not utilize Ranney wells; potable and fire protection water provided by Hixson Utility District; all other cooling water and service water systems supplied from Chickamauga Reservoir.
Degradation of groundwater quality [10 CFR 51.53(c)(3)(ii)(D)]	4.8.5	**NONE. Issue is not applicable.** SQN does not have or utilize cooling ponds.
Terrestrial Resources		
Refurbishment impacts on terrestrial resources [10 CFR 51.53(c)(3)(ii)(E)]	4.9.5	**NONE. Issue is not applicable.** No refurbishment activities are planned.
Threatened or Endangered Species (for all plants)		
Threatened or endangered species [10 CFR 51.53(c)(3)(ii)(E)]	4.10.5	**SMALL.** No major construction or refurbishment activities are planned; no known endangered or threatened species on or adjacent to the SQN site; no essential fish habitat located at the site; future activities would be reviewed and evaluated in accordance with TVA procedures to determine appropriate regulatory/permitting requirements.
Air Quality		
Air quality (nonattainment and maintenance areas) [10 CFR 51.53(c)(3)(ii)(F)]	4.11.5	**NONE. Issue is not applicable.** No refurbishment activities are planned.
Human Health		

Table 6.1-1 (Continued)
Environmental Impacts Related to License Renewal at SQN

Issue	ER Section	Environmental Impact
Microbiological (thermophilic) organisms [10 CFR 51.53(c)(3)(ii)(G)]	4.12.5	**SMALL.** Compliance with the NPDES permit ensures that the temperatures in the Chickamauga Reservoir do not promote survival and reproduction of pathogenic thermophilic microorganisms.
Electromagnetic fields—acute effects [10 CFR 51.53(c)(3)(ii)(H)]	4.13.5	**SMALL.** All transmission lines constructed to connect the plant to the transmission system grid are projected to meet the NESC® recommendations for preventing electric shock from induced currents prior to the end of the current SQN operational period.
Socioeconomics		
Housing impacts [10 CFR 51.53(c)(3)(ii)(I)]	4.14.5	**SMALL.** No refurbishment activities are planned and no additional workers anticipated during the period of extended operation. Therefore, no additional impacts to housing are expected due to continued operation of SQN.
Public utilities: public water supply availability [10 CFR 51.53(c)(3)(ii)(I)]	4.15.5	**SMALL.** No refurbishment activities are planned and no additional workers anticipated during the period of extended operation. Although Hixson Utility District supplies potable water to SQN, Hixson and other major water suppliers in the area have adequate system capacity to meet demand of residential and industrial customers.
Education impacts from refurbishment [10 CFR 51.53(c)(3)(ii)(I)]	4.16.5	**NONE. Issue is not applicable.** No refurbishment activities are planned.
Offsite land use (effects of refurbishment activities) [10 CFR 51.53(c)(3)(ii)(I)]	4.17.5	**NONE. Issue is not applicable.** No refurbishment activities are planned.
Offsite land use (effects of license renewal) [10 CFR 51.53(c)(3)(ii)(I)]	4.18.5	**SMALL.** The area around SQN has pre-established land patterns of development and has public services and regulatory controls in place to support and guide development. No additional workers are anticipated during the period of extended operation.
Local transportation impacts [10 CFR 51.53(c)(3)(ii)(J)]	4.19.5	**SMALL.** No refurbishment activities are planned, no increases in total number of employees during the period of extended operation are expected, and no new impacts to local roads are anticipated.

Table 6.1-1 (Continued)
Environmental Impacts Related to License Renewal at SQN

Issue	ER Section	Environmental Impact
Historic and archaeological properties [10 CFR 51.53(c)(3)(ii)(K)]	4.20.5	**SMALL.** No refurbishment activities are planned; no cultural resources within the SQN area of potential effects are eligible for the NRHP; no adverse effects have been found for existing aboveground historic properties within a 10-mile radius of SQN; TVA administrative procedures ensure protection of these types of resources in the event of inadvertent discovery during excavation activities.
Postulated Accidents		
Severe accident mitigation alternatives [10 CFR 51.53(c)(3)(ii)(L)]	4.21.5	**SMALL.** Potentially cost-effective severe accident mitigation alternatives are not related to adequately managing the effects of aging during period of extended operation.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

NRC regulations require that an applicant's ER discuss alternatives to a proposed action [10 CFR 51.45(b)(3)]. The report is not required to include discussion of need for power or economic costs and benefits of the proposed action or of alternatives to the proposed action, except insofar as such costs and benefits are essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation [10 CFR 51.53(c)(2)].

The applicant's ER is used as a source of information by NRC to prepare a plant-specific EIS for the license renewal. The NRC-prepared EIS would supplement NRC's generic evaluation, NUREG-1437 GEIS. The GEIS assesses the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site. A plant-specific supplement to the GEIS is required for each license renewal application.

In Chapter 8 of the GEIS, the NRC considers the environmental consequences of the no-action alternative (i.e., denying an LRA) and the environmental consequences of the various alternatives for replacing lost generating capacity that would be available to utility and other responsible energy planners. NRC's draft revision of the GEIS (NRC 2009a) also considers these same alternatives inclusive of technological advances and added a renewable alternative, ocean waves and current energy. In addition, several plant-specific SEISs have also included fuel cell technology in the range of alternatives. Although not inclusive, these alternatives are considered by the NRC in the preparation of a plant-specific supplemental EIS. The applicant's ER would serve as one of the sources of information for NRC's plant-specific SEIS and therefore, for completeness, Sections 7.4 and 7.5 address this range of alternatives.

TVA has previously reviewed the range of energy sources to meet its obligation to supply energy to its customers, specifically for replacement of SQN, in its SQN FSEIS and in a system-wide review looking at meeting projected future energy demands in its Integrated Resource Plan (IRP) FEIS (TVA 2011o). TVA drew upon both of these previous reviews to prepare this chapter.

However, not all alternatives would be reasonable alternatives to the proposed action. NRC defined a reasonable alternative as "commercially viable or expected to become so in the near future prior to the expiration of the operating license" and whose generating capacity "must equal the base load capacity previously supplied by the nuclear plant." The IRP FEIS and SQN FSEIS included alternatives deemed reasonable based upon TVA's system-wide generation planning models. In comparison, the range of alternatives evaluated in this review is somewhat different because the alternatives were selected based upon NRC criteria, in order to maintain consistency with the GEIS. Section 7.3 addresses the criteria used by TVA in identifying reasonable alternatives for this ER. Reasonable alternatives could be a combination of alternatives; however, as NRC acknowledges, the possible combinations could be large in number. Therefore, NRC elected to only evaluate individual alternatives rather than combinations of alternatives in its GEIS. TVA has likewise elected to present detailed assessment of reasonable alternatives as individual alternatives rather than in combinations (Section 7.5).

7.1 Proposed Action

The proposed action is to renew the SQN OLs. SQN Units 1 and 2 are PWRs currently rated at 3,455 megawatts thermal each. The purposes for the proposed action are to (1) obtain extended 20-year licenses to operate SQN to help meet the demand for electricity on the TVA system, (2) maximize the use of existing assets on the TVA system, and (3) support TVA's efforts to reduce carbon emissions on its generating system. The review of the environmental impacts required by 10 CFR 51.53(c)(3)(ii) is provided in Chapter 4. Based on this review, TVA concludes that the environmental impacts of renewing the SQN OLs would be SMALL.

7.2 No-Action Alternative

In accordance with Section 8.1 of the GEIS, the "no-action alternative" refers to a scenario in which NRC does not renew the SQN OLs. Unlike the proposed action, denying license renewal does not expressly provide a means of meeting future electric system needs. Because SQN was included in TVA's IRP to meet future system generating needs, a decision by the NRC to not renew the SQN OLs would leave a gap of its approximately 2,400 total MWe energy capacity in TVA's generation plan. For this reason, the no-action alternative is defined as having two components: replacing the generating capacity of SQN with the replacement supply being available during the license renewal term and decommissioning the SQN facility, as described below in Section 7.2.2.

7.2.1 TVA Region of Interest

TVA operates the nation's largest public power system. It provides power to more than nine million people, through 155 distributors of TVA power and 56 directly served customers, in an area encompassing 80,000 square miles, including most of Tennessee and parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia.

Accordingly, the region of interest (ROI) for replacement power is TVA's Tennessee Valley service area, because if the NRC does not renew the operating licenses for SQN, TVA will have to provide replacement power for its customers in this area. When discussing reasonable energy alternatives to SQN license renewals, however, TVA assumes that replacement energy sources can be located somewhere other than the Tennessee Valley if the electricity generated by those out-of-area sources can be efficiently routed into the SQN region of interest. For example, SQN is located within the Southeast Electric Reliability Corporation (SERC) transmission grid. SERC is a nonprofit corporation responsible for promoting and improving the reliability, adequacy, and critical infrastructure of the bulk power supply systems in all or portions of 16 central and southeastern states. Owners, operators, and users of the bulk power system in these states cover an area of approximately 560,000 square miles and comprise what is known as the SERC region.

7.2.2 Decommissioning

The GEIS defines decommissioning as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license (NRC 1996, Section 7.1). NRC-evaluated decommissioning options include immediate decontamination and dismantlement and safe storage of the stabilized and defueled facility for a period of time, followed by additional decontamination and dismantlement. Regardless of the option chosen, decommissioning must be completed within the 60-year period following permanent cessation of operations and permanent removal of fuel. Under the no-action alternative, TVA would continue operating SQN until the existing licenses expire, and then initiate decommissioning activities for both units in accordance with NRC requirements. The GEIS describes decommissioning activities based on an evaluation of an example reactor (the "reference" reactor is the 1,175 MWe Trojan Nuclear Plant at Rainier, Oregon) (NRC 1996, Section 7.1). As each SQN unit operates at an approximate net output of 1,200 MWe, this description is applicable to decommissioning activities that TVA would conduct at SQN for each unit.

As the GEIS notes, NRC has evaluated environmental impacts from decommissioning. NRC-evaluated impacts include occupational and public radiation dose, waste management, air and water quality, and ecological, economic, and socioeconomic impacts. NRC indicated in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities; Supplement 1* (NRC 2002), that the environmental effects of greatest concern (i.e., radiation dose and releases to the environment) are substantially less than the same effects resulting from reactor operations. TVA relies on the NRC conclusions regarding environmental impacts of decommissioning for both units.

TVA notes that decommissioning activities and their impacts are not discriminators between the proposed action and the no-action alternative. SQN will have to be decommissioned eventually regardless of the NRC decision on license renewal; license renewal would only postpone decommissioning for another 20 years. NRC has established in the GEIS that the timing of decommissioning operations does not substantially influence the environmental impacts of decommissioning. TVA relies on NRC findings [10 CFR Part 51, Subpart A, Appendix B, Table B-1] to the effect that delaying decommissioning until after the renewal term would have SMALL environmental impacts. The discriminators between the proposed action and the no-action alternative lie within the choice of generation replacement options to be part of the no-action alternative. Section 7.6 analyzes the impacts from these options.

TVA concludes that decommissioning impacts under the no-action alternative would not be substantially different from those which would occur following license renewal as identified in the GEIS and the decommissioning generic environmental impact statement. These impacts would be temporary and would occur at the same time as the impacts from meeting system generating needs.

7.3 Alternatives Considered Reasonable

In reviewing alternative energy sources, the following criteria were used to determine a reasonable set of alternatives "of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable" (NRC 1996, Section

8.1), for purposes of evaluating the no-action alternative under NEPA requirements and NRC environmental regulations.

- The purpose of the proposed action (license renewal) for TVA is the continued production of approximately 2,400 MWe of energy capacity to continue to meet TVA's system generating needs during the period of SQN's renewed OLs, maximize the use of existing assets, and reduce TVA's carbon footprint. Although alternatives that do not meet these purposes are not considered reasonable by TVA, consistent with NRC's guidance and practice, TVA primarily focused on alternatives capable of achieving 2,400 MWe of energy capacity in this ER irrespective of TVA's other two purposes.

- The annual operating capacity factor of SQN based on a 3-year average from 2008 through 2010 is 96 percent. The capacity factor is targeted to remain near or above this value throughout the plant's operating life.

- The time frame for the replacement power generation is the period of SQN's renewed OLs, which is 2020–2040 for Unit 1 and 2021–2041 for Unit 2. (To allow for a greater field of alternatives to be considered, not just those alternatives that could be permitted, constructed, and connected to the grid by 2020 were considered).

- All necessary federal permits, licenses, approvals, and other entitlements could be obtained. (For example, based on the Phase I 316(b) regulations issued on December 18, 2001, for new facilities that use water withdrawn from rivers, streams, lakes, reservoirs, estuaries, oceans, or other waters of the United States for cooling purposes, TVA excluded alternatives relying on once-through cooling as reasonable alternatives.)

As noted in Section 7.0, TVA previously conducted a review of alternatives to replace SQN in its FSEIS. During the development of the SQN FSEIS, to begin the process of identifying, considering, and narrowing down the alternatives considered to be reasonable, TVA began with the broad range of supply-side and demand-side actions identified in TVA's 2011 IRP. TVA reviewed options that would require new generating capacity, options that would not require new generating capacity, and a combination of those alternatives. (TVA 2011a, Section 2.1) Based on this review, TVA selected new nuclear and natural gas-fired plants as reasonable alternatives to provide adequate generating capacity should the SQN OLs not be renewed. (TVA 2011a, Sections 2.1.1.1 and 2.1.1.2).

Also as noted in Section 7.0, TVA previously conducted a review of projected energy demand and alternatives to meet the energy demands in its IRP. Resource options that TVA considered in the IRP evaluation included existing assets in TVA's current generation portfolio from TVA-owned facilities and power purchases. Options for new generation also included TVA-owned assets and power purchases as well as repowering of current assets. The primary resource options are nuclear, fossil, and renewable generation; energy storage and energy efficiency; and demand response. (TVA 2011t, Section 5.2) Table 7.3-1 shows the recommended planning direction as a result of TVA's IRP evaluation. It should be noted that continued operation of SQN was included in all IRP scenarios.

As stated above, the SQN FSEIS selected new nuclear and natural gas-fired plants as reasonable alternatives to provide adequate generating capacity should the SQN OLs not be renewed. These alternatives were also included in the IRP planning direction. Moreover, both of these alternatives are ones considered in the GEIS.

In addition to these two, the IRP's recommended planning direction for meeting energy demands included demand-side options, generation using renewable energy sources, energy storage, and coal-fired generation using technology to minimize carbon emissions. These alternatives were considered to determine whether, based upon the above criteria, they would provide reasonable alternatives to replace SQN's generating capacity should the OLs not be renewed. Section 7.4.10 discusses demand-side options and the conclusion that this option could not meet the energy capacity of SQN. TVA also developed a deployment schedule for renewable options and wind power, including purchasing wind from outside of the TVA service area. Wind power ranked first within this IRP renewable hierarchy (TVA 2011t, Appendix D). However, as discussed below in Section 7.4.1 of this ER, wind power did not meet the above criteria for continued production of approximately 2,400 MWe of energy capacity due to intermittency. In addition, the IRP selected new pumped storage for storage of lower energy amounts (850 MW) generated by TVA as a planning direction. However, this IRP planning direction does not meet the energy capacity criteria, and new pumped storage, particularly of an even greater capacity, would result in significant construction impacts from creating reservoirs, dams, and diversion of streams into or around the reservoirs that would be required (TVA 2011o, Section 7.3.4).

As discussed above, the IRP's recommended planning direction included coal-fired generation using technology to minimize carbon emissions. Specifically, the IRP's planning direction recommended idling existing coal-fired power plants and consideration of adding either advanced technology coal-fired plants (like integrated-gasification combined cycle [IGCC]) or plants with carbon capture in the 2025+ time frame. In the IRP study, no coal-fired generating alternatives were deemed viable in the 2020–2021 time frame. However, NRC's GEIS states that coal-fired generation capacity is a feasible alternative to nuclear power generating capacity, based on current (and expected) technology and cost factors. Given the NRC's consideration of coal-fired generation as feasible and that this alternative can meet the above criteria, TVA has opted to consider super-critical pulverized coal (SCPC) generation as a reasonable alternative to renewal of the SQN OLs solely for use in this ER. TVA does not include any traditional coal-fired generating alternatives in its ongoing power supply studies, because that technology does not support the goal of developing a cleaner resource portfolio as set out in the agency's strategic plan. There also is significant doubt whether new coal-fired generation without carbon capture can be timely permitted in light of the significant opposition to such generation and EPA's proposal to regulate carbon emissions from new coal plants.

Each of the alternatives considered as reasonable (i.e., meet criteria listed above) for this ER are further discussed below, and a detailed assessment of the impacts of each is presented in Section 7.5. Rationale for exclusion from reasonable alternatives is presented in Section 7.4 for the IRP options discussed above not considered reasonable, along with additional alternatives that NRC has considered in its GEIS and plant-specific SEIS as discussed in Section 7.0.

Super-Critical Pulverized Coal Generation at an Alternate Site (Section 7.5.1)

The SCPC technology TVA has chosen to evaluate is a 2,400 MWe plant using a closed-cycle cooling system with cooling towers at an alternate site, due to the lack of available land within the site boundaries of SQN, with an operating life of 40 years. It is assumed that the plant design would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal (i.e., wet limestone scrubber modules, selective catalytic reduction system, electrostatic precipitators or fabric filter).

Natural Gas-Fired Generation at an Alternate Site (Section 7.5.2)

The natural gas-fired technology TVA has chosen to evaluate is a 2,400 MWe plant using a closed-cycle cooling system with cooling towers at an alternate site, due to the lack of available land within the site boundaries of SQN, with an operating life of 40 years. It is assumed that the plant would be designed to minimize air emissions (i.e., heat recovery steam generators equipped with a selective catalytic reduction system and ammonia vaporizers).

Nuclear Generation at an Alternate Site (Section 7.5.3)

Based on the currently approved advanced reactor design technologies, TVA assumes it would require at least two new units to replace the existing SQN units. Under this alternative, TVA would construct a new nuclear power plant at an alternate site, either a greenfield site or a brownfield site due to the lack of available land within the site boundaries of SQN. It is assumed that the new nuclear power plant would have an initial 40-year license term with the opportunity to renew for an additional 20-year license term.

Table 7.3-1
Recommended Planning Direction

Component	Window of Time	Recommendations
EEDR	2020[a]	Expand contribution of EEDR in the portfolio
Renewable additions	2020[a]	Pursue cost-effective renewable energy
Coal-fired capacity idled	2017	Consider increasing amount of coal capacity idled
Energy storage	2020–2024	Add pumped storage
Nuclear additions	2013–2029	Increase contribution of nuclear generation
Coal additions	2025–2029	Preserve option of generation with carbon capture
Natural gas additions	2012–2029	Utilize natural gas as an intermediate supply source

(TVA 2011t, Figure 8-8)

a. This range includes EEDR savings achieved through 2020. The 2020 range for EEDR and renewable energy does not preclude further investment in these resources during the following decade.

7.4 Alternatives Not Within the Range of Reasonable Alternatives

Although TVA's IRP did not include tidal, ocean thermal, and wave (Section 7.4.7), and fuel cells in its energy planning scenarios, these technologies are being included for consistency with the GEIS, as discussed in Section 7.0.

7.4.1 Wind

Background

Wind power systems produce power intermittently, depending upon when the wind is blowing at sufficient velocity and duration. Despite advances in technology and reliability, capacity factors for wind power systems remain relatively low (30 to 35 percent) compared to the 90 to 95 percent industry average for a base load plant such as a nuclear plant (NWPPC 2000, page 31).

Estimates of the wind resource are expressed in wind power classes ranging from class 1 (low) to class 7 (high), with each class representing a range of mean wind power density or equivalent mean speed at specified heights above the ground. Areas designated class 3 or greater are suitable for most utility-scale wind turbine applications, whereas class 2 areas are marginal for utility-scale applications, but may be suitable for rural applications. Class 1 areas are generally not suitable, although a few locations (e.g., exposed hilltops not shown on the maps) with adequate wind resource for wind turbine applications may exist in some class 1 areas. The degree of certainty with which the wind power class can be specified depends on three factors: the abundance and quality of wind data, the complexity of the terrain, and the geographical variability of the resource. (NREL 2011a)

TVA Region of Interest Wind Resources

Wind generation capacity is low within the overall TVA region, which is rated at class 1 or 2 power ratings. Several ridge crests are the exceptions; TVA is already using wind generation sites such as its Buffalo Mountain, TN, facility (29 MWe). These remote mountain- and ridge-top locations require access roads and power transmission infrastructure at additional cost. Hilly terrain increases the complexity of installation and the overall costs of wind energy due to turbulence. This decreases the usable energy and capacity factor available from the wind. (TVA 2008c, Section 9.2.2.1) Aside from coastal areas and exposed mountains and ridges of the Appalachian Mountains, there is little wind energy potential in the east central region of the United States for current wind turbine applications (Elliott et al. 1987).

According to the state-by-state wind map and resource potential estimates from the DOE's Office of Energy Efficiency and Renewable Energy (EERE), approximately 3,219 MWe of wind power capacity in the seven states (Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia) comprising TVA's region of interest is available at a gross capacity factor of 30 percent or greater, based on a turbine hub height of 80 meters. Most current turbine installations have turbine hub heights between 50 and 80 meters. (NREL 2011b) However, at a turbine height of 100 meters, estimates of the amount of wind capacity in the TVA service area are approximately 5,700 to 7,300 MWe at gross capacity factors greater than 30 percent

(TVA 2011a). Hub heights of 100 meters are technically feasible with current wind turbine technology, and taller turbines can help make wind power more economically feasible in low-wind areas such as the TVA service area. (NREL 2011b)

Interconnected Wind Farms

Proponents of wind power also suggest interconnected regional wind farms could someday provide base load generation. However, this technology has not actually been demonstrated as either feasible or commercially viable for the time frame in question (i.e., 2020 and 2021, when the SQN Units 1 and 2 OLs expire, respectively). The North American Electric Reliability Corporation's (NERC's) 2009 long-term reliability assessment points out that siting new bulk power transmission lines poses unique challenges due to their high visibility, span through multiple states and provinces and, potentially, the amount of coordination and cooperation required among multiple regulating agencies and authorities. Lack of consistent and agreed-upon cost allocation approaches, coupled with public opposition due to land use and property valuation concerns, have, at times, resulted in long delays in transmission construction. When construction is delayed, special operating procedures to maintain bulk power system reliability may be needed.

For example, it took the American Electric Power Company 14 years to obtain siting approval for a 90-mile, 765-kV transmission project, while it required only 2 years to construct it. Therefore, new transmission, including transmission in the DOE's designated "National Interest Electric Transmission Corridors" can be delayed or halted by states, increasing the difficulty to site bulk transmission, including those projects focused on unlocking location-constrained renewable generation. This creates a potential congestion issue and challenges the economic viability of new generation projects. (NERC 2009)

Grid Stability

Wind power may not provide for grid stability; at the least, the variability of wind generation makes grid stability much more complex when unexpected losses of generation occur. Wind generation cannot provide contingency or backup reserve power, and due to the increasing potential for sudden unexpected generation losses as the deployment of wind generation increases, increased backup reserve capacity from conventional generation (i.e., coal, natural gas, or nuclear) will be needed to maintain acceptably consistent power on the grid. (LBNL 2010) This makes it unlikely that wind will provide base load generation within the current SQN license period, or even within the period of extended operation.

Impacts

Even if wind capacity were available in the TVA service area, development of large-scale, land-based wind power facilities is likely not only to be costly, but could have MODERATE to LARGE impacts on aesthetics, cultural resources, land use, and terrestrial ecology. The environmental impacts of a large-scale wind farm are described in the GEIS (NRC 1996, Section 8.3.1) and the draft GEIS Revision 1 (NRC 2009a, Section 4.2.2.3). Much of these impacts would stem from the large construction land-use requirements for large-scale wind farms. Although NRC revised the land-use requirement downward in its draft revision to the GEIS to 0.3 acres per MW, the land required is still characterized as relatively large (NRC 2009a, Section 4.2.2.3).

The construction of roads, transmission lines, and turbine tower supports would result in short-term impacts, such as increases in erosion and sedimentation and decreases in air quality from fugitive dust and equipment emissions. Also, construction in undeveloped areas would have the potential to disturb and impact cultural resources or habitat for sensitive species. During operation, some land near wind turbines could be available for compatible uses such as agriculture. The continuing aesthetic impact would be considerable and there is a potential for bird and bat collisions with turbine blades. Wind farms generate very little waste and pose no human health risk other than from occupational injuries. Although most impacts associated with a single wind farm are SMALL or can be mitigated, some impacts, such as the continuing aesthetic impact and impacts to sensitive habitats, could be LARGE, depending on the location.

Therefore, for reasons discussed above, TVA does not consider wind power a reasonable alternative to renewal of the SQN OLs.

7.4.2 Solar

Generation from solar power is available in two different technologies: concentrating solar power (CSP) and photovoltaic (PV). Due to the low rate of delivery of solar radiation within the TVA service area territory, CSP technologies (i.e., solar thermal plants using parabolic troughs, power tower, etc.) were not considered a reasonable alternative in TVA's analysis. For example, direct solar radiation in Memphis, Tennessee, located in the region of the state where solar radiation is highest, is approximately 4.4 kilowatt hours per square meter per day (kWh/m^2/day), which is below the minimum level of 6.75 kWh/m^2/day required for a viable CSP generating facility. Solar PV can make use of both direct solar radiation and diffuse horizontal radiation, which is one reason PV is technically feasible in more areas of the United States than CSP technologies. (TVA 2011a, Section 2.1.1.4)

The average solar radiation for PV technology was estimated at 4.9 kWh/m2/day, based on the National Renewable Energy Laboratory's (NREL's) solar radiation map for the western portion of the TVA service area. The solar PV capacity factor in the western portion of the TVA service area is calculated at 17 percent, which is equivalent to approximately 4 hours of usable solar radiation available each day. (TVA 2011a, Section 2.1.1.4)

TVA's 2011 combined solar generating capacity is more than 300 kW (TVA 2011u). While the TVA solar PV generation capacity is expected to continue to increase, solar resource limitations make it unreasonable to believe solar energy will offer a reasonable alternative in the region of interest. The best areas for solar power generation are in the southwestern United States (NREL 2011c). For solar power to offer significant potential for SQN's generating capacity replacement, it would have to be imported from the southwest, where concentrating solar power is more reasonable for deployment. For such importation to occur, however, significant upgrade of the national grid would be required, as discussed for wind energy imports from outside the TVA service area. These upgrades would have to meet environmental protection requirements and overcome various permitting and stakeholder objections.

Thus, transmission infrastructure upgrades to allow solar energy to provide a significant portion of TVA's power supply needs is unlikely to be available prior to the expiration of SQN's OLs. Although land use for CSP might be somewhat less than for solar PV, the additional transmission infrastructure environmental impacts and potential impacts on aquatic resources associated with CSP power generation would be significant. Concentrating solar power generation also requires cooling water similar to conventional base load generation from coal and nuclear power. A coal-fired plant uses between 110 and 300 gallons per megawatt-hour; a nuclear plant uses between 500 and 1,100 gallons per megawatt-hour; and a solar parabolic trough plant uses between 760 and 920 gallons per megawatt-hour. (AWR 2008) Therefore, impacts to aquatic resources would be expected to be similar to base load fossil or nuclear power and depend on the site location and type of cooling system employed.

There would also be substantial impacts to other resources (terrestrial habitat, land use, and aesthetic impacts) from construction of solar power generation facilities. As stated in the GEIS, land requirements are high. Based on the land requirements of 14 acres for every 1 MWe generated, approximately 33,600 acres would be required to replace the 2,400 MWe of generating capacity produced by SQN (NRC 1996, Section 8.3.3). Therefore, both types of systems would have LARGE environmental impacts at an alternate site.

PV and CSP generation produces no greenhouse gases during operation. However without energy storage, PV or CSP generation would have to be coupled with generation from fossil plants due to the intermittency of the solar resource. This generation to provide the full complement of the needed energy supply, or to supplement that provided by solar during periods when the solar resource is inadequate to meet energy demands, could be from existing excess capacity, if any, from new fossil generation, energy storage, or delayed decommissioning of existing plants. The use of CSP typically requires cooling water similar to a fossil plant. Therefore, emissions (principally PM_{10}) from CSP would be similar to other thermal power generation sources of equivalent capacity due to the emissions from the cooling towers necessary for the steam cycle. Dependent on location, particulate emissions could create significant impacts, especially for those areas designated as nonattainment or maintenance areas under the Clean Air Act (CAA).

The operating facility would also have considerable aesthetic impact. Solar installations pose no human health risk other than from occupational injuries. The manufacturing process for constructing a large amount of photovoltaic cells would result in waste generation, but this waste generation has not been quantified. Some impacts, such as impacts to sensitive areas, loss of productive land, and the continuing aesthetic impact, could be LARGE, depending on the location.

Therefore, for the reasons discussed above, TVA considers solar energy not a reasonable alternative to renewal of the SQN OLs.

7.4.3 Hydropower

The DOE's Office of EERE study was used to develop an estimate of hydropower resources feasible for development within the TVA service area. The EERE report estimates the annual average power available for development and, if available, how much would be feasible to develop. Available annual average power is based on those sites not located in zones where hydropower development is unlikely, and not co-located with existing hydropower plants. The determination of availability did not consider ownership or control of available sites. Project feasibility criteria included such factors as land use and environmental sensitivities, prior development, site access, and load and transmission proximity. (TVA 2011a, Section 2.1.1.6)

The TVA service area encompasses much of the state of Tennessee and portions of neighboring states. The portion of available annual average hydropower in each state was determined by estimating the number of sites within the TVA service area for that state as compared to the number of sites in the entire state. Based on this approach, the total feasible hydropower capacity is 1,770 MWe. None of the feasible capacity estimated in the TVA service area is categorized as large power (greater than 60 MWe). Seventy percent of the feasible capacity was categorized as small hydro (less than 60 MWe and greater than 2 MWe), and 30 percent was low power resources (less than 2 MWe). Low power resources include conventional technology, ultra-low head and kinetic energy turbines, and micro-hydro power. Compared to nuclear generation, new hydropower has lower capacity factors and more severe environmental impacts. Therefore hydropower development in the TVA service area is not a reasonable alternative to renewal of the SQN OLs. (TVA 2011a, Section 2.1.1.6)

7.4.4 Geothermal

Geothermal has an average capacity factor of 90 percent and can be used for base load power where available. The advantage of geothermal power is the ability to be dispatched with no emissions (TVA 2011a, Section 2.1.1.7). However, as illustrated in Figure 8.4 of the GEIS, geothermal plants would primarily be located in the western continental United States, Alaska, and Hawaii, where geothermal reservoirs are prevalent. This technology is not widely used for base load generation due to the limited geographic availability of the resource and the immature status of the technology. (NRC 1996, Section 8.3.5)

There are also very few accessible geological formations in the Tennessee River Valley, making this an unlikely source for renewable energy in the region. Therefore, geothermal alternatives are not considered reasonable alternatives to renewal of the SQN OLs. (TVA 2011a, Section 2.1.1.7)

7.4.5 Biomass

Biomass power plants use organic matter to generate electricity. It is one of the few renewable power options that can be operated at a relatively high capacity factor (85 percent) and is "dispatchable," meaning that its generation can be planned and scheduled much like a conventional fossil-fueled unit. TVA is performing biomass fuel availability surveys in the region, and a comprehensive study is underway to assess the feasibility of converting one or more coal-burning units to biomass fuel. Biomass generation was a qualifying technology in TVA's request for proposal issued in 2008 for renewable resources. However, few competitive bids sourced from biomass were received. This may suggest doubt in the marketplace about the sustainability of biomass generation in the TVA service area at reliably competitive prices. (TVA 2011a, Section 2.1.1.5)

Agricultural and forest resources provide the most prevalent form of biomass fuel available in the TVA service area. These include agricultural "crop" residues (i.e., by-products of harvest); dedicated energy crops (e.g., switchgrass on Conservation Reserve Program [CRP] lands); forest residues (i.e., waste products from logging operations); and methane gas by-products from livestock manure. Biomass resources, such as primary milling residues (i.e., by-products of commercial mills); secondary milling residues (i.e., by-products of woodworking and furniture shops); urban wood residues (i.e., waste wood products from construction, demolition, and residential); and methane gas by-products from landfills and wastewater treatment facilities are not as prevalent in less densely populated regions such as the TVA service area. Estimates of agricultural residues by state and county were obtained from the USDA's NASS. Dedicated energy crops by state and county were estimated from data obtained from the Farm Service Agency of the USDA. Forest and primary milling residues by state and county were obtained from the U.S. Forest Service Southern Research Station's timber product output reports. Secondary milling residues, urban wood residues, and methane gas amounts by state were obtained from an NREL report and scaled to the area of each state within the TVA service area. (TVA 2011a, Section 2.1.1.5)

The capacity and energy from each of the biomass fuel sources was estimated by assuming the most likely generation technology to be used. A stoker or bubbling fluidized bed technology with a heat rate of 15,000 British thermal unit per kilowatt-hour (BTU/kWh) was assumed for solid fuel. For methane gas as fuel, an internal combustion engine at a heat rate of 12,500 BTU/kWh was assumed. Approximately 2,500 MWe of biomass generation is estimated from agricultural and forest resources. Some 210 MWe of biomass generation is estimated from unutilized primary and secondary mill residues and urban wood residues. Another 60 MWe is estimated from landfill and wastewater treatment methane sources. While there is enough biomass available to produce the required base load capacity, the feasible capacity is much lower. There are substantial environmental impacts from converting all CRP land to energy crops and removing agricultural residue from the cropland. (TVA 2011a, Section 2.1.1.5)

Whether based on agricultural or forest resources, or population-based sources, biomass fuel is dispersed and must be collected and processed for use in biomass generating units. Consequently, the cost of collection system infrastructure and diesel fuel generally limits biomass collection to a 50-mile radius, which in turn limits plant capacity to a maximum of 30–50 MWe. Biomass generating units with required emissions controls provide about the same capacity factor and environmental impacts as a small coal plant. In the context of renewal of the SQN OLs, a biomass-fired plant does not meet the criteria for a reasonable alternative due primarily to impacts on air quality, waste management, and the impacts of biomass fuel collection infrastructure. (TVA 2011a, Section 2.1.1.5)

7.4.6 Oil

In addition to higher emissions of nitrogen oxide (NO_x), carbon dioxide (CO_2), and other pollutants as compared to other alternatives, oil-fired operation is very expensive, which has resulted in a steady decline in its use for electricity generation. Future increases in oil prices are expected to make oil-fired generation increasingly more expensive. In addition, U.S concerns over the security of international oil supplies will further support the move away from oil-fired electricity generation. Therefore, oil-fired generation by itself is not considered a reasonable alternative to renewal of the SQN OLs.

7.4.7 Tidal, Ocean Thermal, and Wave

Technologies to harness electrical power from the ocean are tidal power, ocean thermal energy, and wave power conversion. These technologies are in the early stages of development and not commercially available to replace a large base load generator such as SQN.

Tidal power technologies extract energy from the diurnal flow of tidal currents caused by the gravitational pull of the moon. Unlike wind and wave power, tidal streams offer entirely predictable output. All coastal areas consistently experience two high tides and two low tides over a period of approximately 25 hours. However, because the lunar cycle is longer than a 24-hour day, peak outputs differ by about an hour each day, so tidal energy cannot be guaranteed at times of peak demand. (Feller 2003)

Tidal power technologies consist of tidal turbines and barrages. Tidal turbines, similar in appearance to wind turbines, are mounted on the seabed. They are designed to exploit the higher energy density, but lower velocity, of tidal flows compared to wind. Tidal barrages are similar to hydropower dams in that they are dams with gates and turbines installed along the dam. When the tides produce an adequate difference in the level of the water on opposite sides of the dam, the gates are opened and water is forced through turbines, which turns a generator. For those tidal differences to be harnessed into electricity, the difference in water height between the high and low tides must be at least 16 feet.

There are only about 20 sites on Earth with tidal ranges of this magnitude (DOE 2009, Section 1.3. The only sites with adequate tidal differences within the United States are in Maine and Alaska (CEC 2011). Therefore, tidal resources off the coast of the region of interest do not provide a viable tidal energy resource.

Ocean thermal energy conversion (OTEC) technology capitalizes on the fact that water temperatures decrease with depth. As long as the temperature between the warm surface water and the cold deep water differs by about 36°F, an OTEC system can produce a significant amount of power. The most promising locations for OTEC in North America are Hawaii, the U.S. Virgin Islands, and Puerto Rico. (OPM 2009) Therefore, OTEC technology is not considered a viable energy resource for the region of interest.

Wave energy conversion takes advantage of the kinetic energy in the ocean waves (which are mainly caused by interaction of wind with the surface of the ocean). Wave energy offers an irregular, oscillatory, low-frequency energy source that must be converted to a 60-Hertz frequency before it can be added to the power grid. (CEC 2011) Wave energy resources are best between 30 and 60 degrees latitude in both hemispheres, and the potential tends to be greatest on western coasts (RNP 2007). Offshore technologies that harness the energy of ocean waves and current are in their infancy and have not been used at utility scale (NREL 2008, page 2). Since the late 1990s, new technologies have been introduced to harness the energy of the ocean's waves, currents, and tides. Nearly 100 companies worldwide have joined this effort, but most companies struggle to deploy their first prototypes and not all can be funded from the public sector. A viable strategy to help mature the marine renewable energy industry does not exist (NREL 2008, page 8). Hence, although some technologies may be available in the future, none has yet been demonstrated to be capable of providing the electrical generating capacity needed to replace SQN's generating capacity.

Therefore, TVA believes that tidal, ocean thermal, and wave technologies have not matured sufficiently to provide a viable supply of replacement base load electricity for SQN. As a result, TVA has concluded that, due to cost and production limitations, these technologies are not reasonable alternatives to renewal of the SQN OLs.

7.4.8 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode, passing air over a cathode, and separating the two by an electrolyte. The only by-products are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen. (NRC 2006a, Section 8.2.5.9)

Phosphoric acid fuel cells are generally considered first-generation technology. Higher temperature, second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations. (NRC 2006a, Section 8.2.5.9)

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. Currently, the most widely marketed fuel cells cost about $4,500 per kW of installed capacity. By contrast, a diesel generator costs $800 to $1,500 per kW of installed capacity, and a natural gas turbine can be even less. (NRC 2006a, Section 8.2.5.9)

Therefore, at the present time, fuel cells are not economically or technologically competitive with other alternatives for base load electricity generation. Fuel cells are, consequently, not a reasonable alternative to renewal of the SQN OLs.

7.4.9 Repowering/Uprating Electrical Generating Plants

Repowering electrical generating plants is the process by which utilities update, change the fuel source, or change the technology of existing plants to realize gains in efficiency or output. Power uprates would be a potential alternative source of base load electricity. NRC has approved power uprates for TVA's BFN and WBN since 1998, and TVA is seeking additional uprates for its BFN units. However, power uprates are not sufficient by themselves to generate the capacity and energy provided by the SQN units.

TVA continues to modernize its hydrogeneration, which increases its hydrogeneration capacity by 90 MWe through 2029 as indicated in the IRP. Neither the additional capacity nor additional energy available from hydropower modernization projects is sufficient to provide necessary capacity and energy in the absence of SQN. Also, TVA is considering converting some fossil units to biomass, and studies are underway to support this. Such conversions would change the operational characteristics of converted units, but would not materially address TVA's base load needs. Moreover, TVA is required to retire 15 of its coal-fired units and is considering laying up additional coal-fired units. Retirements and lay-ups increase the need to acquire resources beyond those that might be needed if SQN OLs were not renewed. Therefore, TVA does not consider uprates and other repowering options as reasonable alternatives to renewal of the SQN OLs. (TVA 2011a, Section 2.1.2.2)

7.4.10 Energy Efficiency and Demand Response

As part of the IRP, TVA has developed program initiatives to focus on reducing energy consumption as well as decreasing peak demand. These energy efficiency and demand response (EEDR) program initiatives include the following elements (TVA 2011a, Section 2.1.2.3):

- Residential programs for new site-built and manufactured homes, energyright® home evaluations and in-home energy assessments, heat pump and high-efficiency air conditioning installation and maintenance, and weatherization assistance.
- Commercial and industrial programs providing technical assistance, efficiency advice, incentives, and audits for new and existing facilities.
- Demand response programs for interruptible loads, direct load control, and conservation voltage regulation.

The IRP evaluates several alternatives to the base case EEDR portfolio. The three highest ranked strategies in the IRP include EEDR alternatives that reduce energy needs by up to an additional 8,500 gigawatt hour (GWh) per year above the base case—almost the equivalent of one SQN unit. However, the IRP also shows that the need for power in 2020–2021 is approximately 39,000 GWh, assuming continued operation of SQN, whereas the largest EEDR portfolio has projected energy savings of about 14,500 GWh in that same time frame. Therefore, even with successful implementation of EEDR portfolio as outlined, additional resources would still be required to meet the need for power caused by the shutdown of SQN.

Some of that need could potentially be met by even more EEDR programs, but implementation challenges (i.e., participation rates, maturity of technology, external economic conditions), may reduce the effectiveness of such additional programs. So EEDR, by itself, would likely not be sufficient or reasonable to meet or offset the generating capacity provided by SQN. (TVA 2011a, Section 2.1.2.3)

7.4.11 Delayed Retirement

Figures 7.4-1 and 7.4-2 show the peak load and net system energy requirements forecasts as developed for the IRP. The planning period for the IRP was through 2029, so to arrive at the forecast through 2040, average annual growth through 2029 was assumed to remain constant through 2040. (TVA 2011a, Section 1.3.2)

To ensure enough capacity is available to meet peak demand in most circumstances, including unforeseen contingency, it is necessary to have available additional generating capacity beyond that needed just to meet peak demand. This additional generating capacity, known as "reserve capacity" or "total reserves," must be large enough to cover the loss of the largest single operating unit (contingency reserves), be able to respond to moment-by-moment changes in system load (regulating reserves), and replace contingency resources should they fail (replacement reserves). Total reserves must also be sufficient to cover unplanned unit outages, load forecasting error including abnormal weather, and undelivered purchased capacity, among other uncertainties.

As typical for the utility industry, TVA plans for total reserves of between 12 and 20 percent of total system load. TVA optimizes its mix of generating assets and purchases to meet these standards. For the IRP, required total reserves were set at 15 percent, which coincides with TVA's current planning reserve margin target. Therefore, available generating capacity must be adequate to meet the peak demand shown in Figure 7.4-1, plus 15 percent. (TVA 2011a, Section 1.3.4)

Based on various scenarios evaluated, capacity and generation gaps increase over time, and TVA requires additional capacity and generation to meet forecasted energy needs. EEDR programs could also be used to offset forecasted energy needs. The IRP baseline need for additional generating capacity or EEDR programs is 9,617 MWe and 29,086 GWh of additional generation in 2019, growing to 15,513 MWe and 44,988 GWh in 2029. Under the IRP baseline, SQN is approved for license renewal and continues to operate. If SQN is not approved for license renewal, beginning in 2020 and 2021, the capacity gap grows by an additional 2,400 MWe, and the generation gap grows by approximately 19,000 GWh. (TVA 2011a, Section 1.3.4)

Therefore, because TVA's existing portfolio is needed to meet load growth and peak demand, delayed retirement of other generating units would not provide a reasonable replacement of the power supplied by SQN and would not be a reasonable alternative to renewal of the SQN OLs.

7.4.12 Purchased Power

"Purchased power" is power purchased and transmitted from sources of electric generation that the applicant does not own and that are located elsewhere within the service region, nation, Canada, or Mexico. If power to replace SQN's base load capacity were to be purchased from sources within the United States or a foreign country, the generating technology would likely be one of those described in this ER and in the GEIS (probably coal, natural gas, or nuclear). Purchased power can be a component of a reasonable alternative. There is risk, however, that purchased power will not be delivered. As described in the IRP, TVA must plan total generating reserves to accommodate the potential for undelivered purchased capacity. (TVA 2011a, Section 2.1.2.1) Therefore, TVA does not consider purchasing power to make up for the total generation capacity of SQN as a reasonable alternative to SQN.

In the case of purchased power, the environmental impacts of purchased power would still occur but would be located elsewhere within the region, nation, or another country. The description of the environmental impacts of other technologies in Chapter 8 of the GEIS is representative of the purchased power alternative to renewal of the SQN OLs.

The only environmental unknown is whether new transmission line ROWs would be required. The construction of these lines could have both environmental and aesthetic consequences, particularly if new transmission line ROWs have to be acquired. Therefore, the local environmental impacts from purchased power would be SMALL whenever existing transmission line ROWs are used, and could range from SMALL to LARGE if acquisition of new ROWs is required. The environmental impacts of power generation would depend on the generation technology and location of the generation site and, therefore, are unknown.

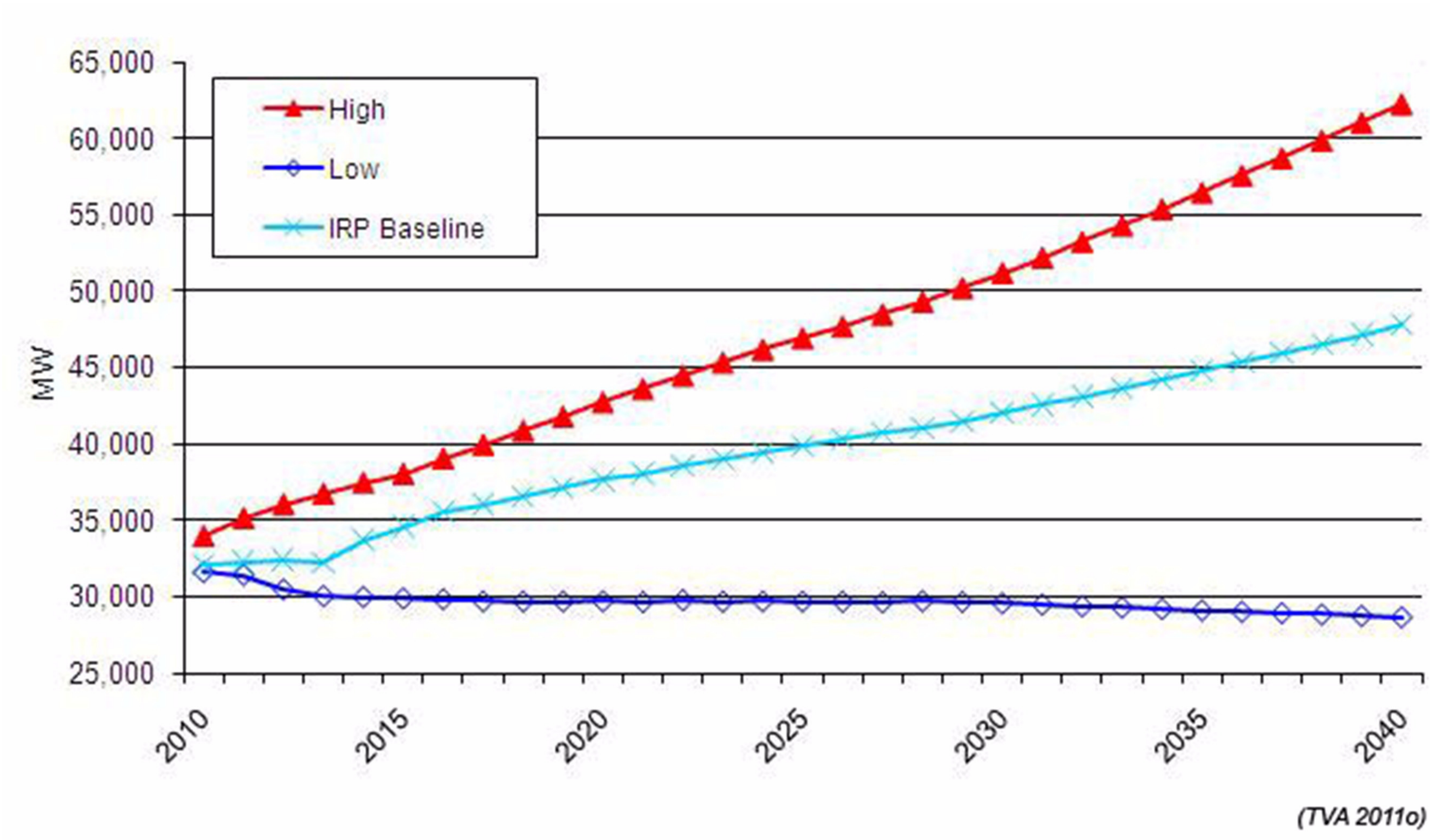


Figure 7.4-1
Peak Load Forecast

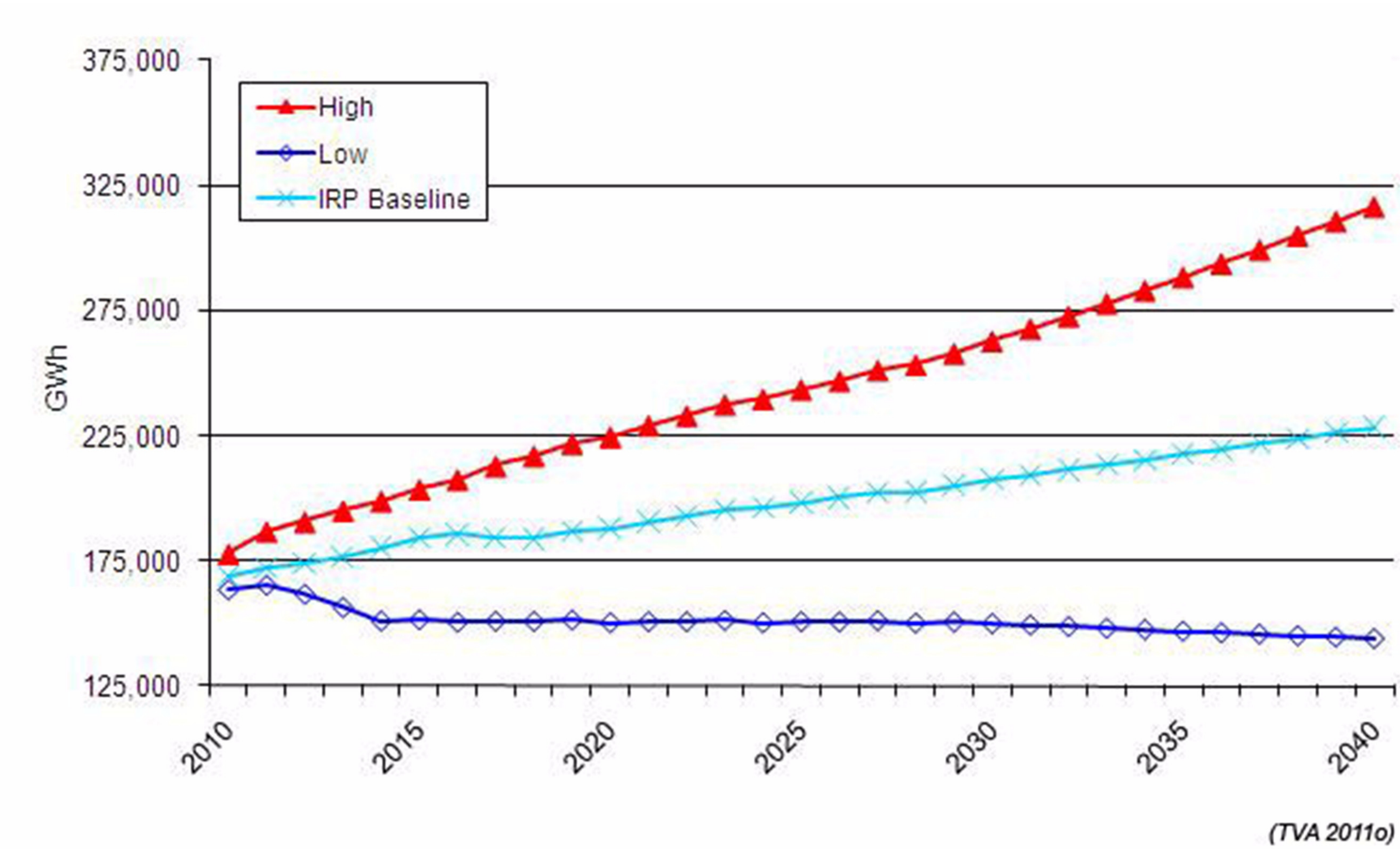


Figure 7.4-2
Energy Forecast

7.5 Environmental Impacts of Reasonable Energy Alternatives

Each of the alternatives considered as reasonable (Section 7.3) is discussed below. The generation alternatives are sized to provide replacement of the approximately 2,400 MWe of power generated by SQN in order to compare the environmental impacts of the alternatives to the "proposed action" which is renewal of the SQN OLs.

7.5.1 Construct and Operate New Super-Critical Pulverized Coal Generating Capacity

TVA has chosen to evaluate the construction and operation of a 2,400 MWe plant using a closed-cycle cooling system with cooling towers at an alternate site with an operating life of 40 years. TVA has assumed a plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal (i.e., wet limestone scrubber modules, selective catalytic reduction system, electrostatic precipitators or fabric filter).

Much of the evaluation in the following discussion focuses on SCPC generation because super-critical steam cycle technology has been used for decades and is becoming the system of choice for new commercial coal-fired plants in many countries. The IGCC plant is being included primarily for comparison purposes, where either data exist as is the case for air emissions, or where impacts are anticipated to be similar to SCPC. However, it should be noted that TVA's most recent 20-year generation resource assessment considered SCPC with carbon capture and storage (CCS) technology and IGCC with CCS. Neither technology is currently considered in that assessment for deployment prior to 2025, and is considered in only a limited number of TVA's resource portfolio scenarios. Thus, TVA's current IRP does not include anticipation of new coal-fired generation within the time prior to expiration of SQN's current OLs. In the discussion that follows, coal-fired plant is thus used in the context of a design chosen by TVA that would minimize air emissions and waste. This evaluation includes, where possible, input from the GEIS that is available to applicants as guidance.

7.5.1.1 Land Use

Based on Table 8.1 of the GEIS, approximately 1.7 acres of land per MWe would be required to construct a coal-fired plant. Therefore, for the 2,400 MWe plant utilized in this analysis, the entire industrial site, inclusive of coal storage and settling ponds, would require approximately 4,080 acres of land. This could amount to a considerable loss of natural habitat or agricultural land for the plant site alone, dependent upon if a greenfield or brownfield site was used, excluding that required for mining and other fuel-cycle impacts. Additional land might also be needed for transmission lines and rail lines, depending on the location of the site relative to the nearest inter-tie connection and rail spur. Depending on the transmission line routing and nearest rail line, these alternatives could result in noticeable land-use impacts.

Land-use changes would also occur off site in an undetermined coal-mining area to supply coal for the plant. In the GEIS, it was estimated that approximately 22 acres of land per MWe would be affected for mining the coal and disposing of the waste to support a coal-fired plant during its operational life (NRC 1996, Section 8.3.9). Therefore, for the 2,400 MWe plant utilized in this analysis, approximately 52,800 acres of land would be needed. Partially offsetting this offsite land use would be the elimination of the need for uranium mining and processing to supply fuel for SQN. In the GEIS, it was estimated that approximately 1 acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (NRC 1996, Section 8.3.12).

Overall, when consideration is given to the extent of land disturbance associated with both power plant site development and coal mining operations, it is concluded that impacts to land use could range from MODERATE to LARGE.

7.5.1.2 Air Quality

Air quality impacts associated with the operation of coal-fired generation are considerably different from those of nuclear power. SCPC and IGCC coal-fired plants emit oxides of sulfur (SO_x), NO_x, particulate matter, and carbon monoxide (CO), all of which are regulated pollutants. Tables 7.5-1 and 7.5-2 present the basic SCPC alternative emission control characteristics and emission estimates. Emission control technology and percent control assumptions were based on alternatives that the EPA has identified as being available for minimizing emissions (EPA 1998). Due to the limited emission data from operational IGCC plants, emissions data only for select parameters are estimated for IGCC for comparison purposes.

TVA estimates the SCPC alternative emissions to be as follows (Table 7.5-2):

- Oxides of sulfur = 10,633 tons per year
- Oxides of nitrogen = 2,104 tons per year
- Carbon monoxide = 2,104 tons per year
- Particulates:
    - PM_f (total filterable particulates) = 667 tons per year
    - PM_{10} (particulates having a diameter of less than 10 microns) = 153 tons per year
- Carbon dioxide = 19.4 million tons per year

In comparison, available emissions data from operational IGCC plants, such as the Wabash River Generating Station in Indiana and the Polk Power Station in Florida, have also indicated significant emissions would occur. Although it is anticipated that IGCC emissions, specifically oxides of nitrogen, will be reduced as the technology is advanced, current emissions from the Wabash plant, the best of the two, are as follows (Ratafia-Brown et al. 2002):

- Sulfur dioxide = 11,166 tons per year
- Oxides of nitrogen = 13,958 tons per year

- Carbon monoxide (expected) = 3,071 tons per year
- Particulates = 1,117 tons per year

It should be noted that the particulate emissions, such as $PM_{2.5}$ and PM_{10}, from the cooling towers, are not included in the above estimates. Although the amount of particulate emissions would be water body specific along with other factors, for PM_{10} comparison purposes the cooling towers at SQN could potentially emit approximately 63 tons/year of PM_{10} if operated year-round (SQN 2007d, Condition 1; SQN 2007e, Condition 1).

The impacts on air quality from SCPC and IGCC generation would vary considerably from those of nuclear generation due to emissions of SO_x, NO_x, CO, particulate matter, and hazardous air pollutants such as mercury. An SCPC or IGCC plant would also have carbon dioxide emissions that could contribute to global warming. (NRC 2006b, Section 8.2.2.1) CCS technology, if successfully deployed, would be expected to reduce the emissions of CO_2, by 90 percent or more, but will not totally eliminate them.

The acid rain requirements of the CAA capped the nation's sulfur dioxide emissions from power plants. TVA would have to obtain sufficient pollution credits either from a set-aside pool, purchases on the open market to cover annual emissions from the plant, or from allowances allocated to other TVA coal-fired units. The market-based allowance system used for sulfur dioxide emissions is not used for NO_x emissions. A new SCPC plant would be subject to the new source performance standard for such plants [40 CFR 60.44Da(d)(1)], which limits the discharge of any gases that contain NO_x (expressed as nitrogen dioxide) to 1.6 pounds/megawatt-hour of gross energy output, based on a 30-day rolling average. (NRC 2006b, Section 8.2.2.1)

A new SCPC plant would also likely need a prevention of significant deterioration permit and an operating permit under the CAA. The plant would need to comply with the new source performance standards for such plants in 40 CFR Part 60 Subpart Da. The standards establish emission limits for particulate matter and opacity [40 CFR 60.42Da], sulfur dioxide [40 CFR 60.43Da], and nitrogen oxide [40 CFR 60.44Da]. (NRC 2006b, Section 8.2.2.1) Under an amendment to these regulations, EPA proposes to set a standard for CO_2 that cannot be met absent use of CCS.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified for criteria pollutants under the CAA [40 CFR 51.307(a)]. Criteria pollutants under the CAA are lead, ozone, particulates, carbon monoxide, nitrogen oxide, and sulfur dioxide. Ambient air quality standards for criteria pollutants are in 40 CFR Part 50. (NRC 2006b, Section 8.2.2.1)

Section 169A of the CAA [42 USC 7491] establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I federal areas when impairment occurs because of air pollution resulting from human activities. In addition, EPA regulations provide that, for each mandatory Class I federal area located within a state, the state must establish goals that provide for reasonable progress toward achieving natural visibility conditions. Reasonable progress goals must provide for an improvement in visibility for those days on which visibility is most impaired over the period of the implementation plan and ensure no degradation in visibility for the least visibility-impaired days over the same period [40 CFR 51.308(d)(1)]. If a new coal-fired power station were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. (NRC 2006b, Section 8.2.2.1)

CO_2 emissions are a major contributor to anthropogenic greenhouse gas emissions, which have been suggested to contribute to climate change. These emissions result from the efficiency of the technologies utilized to produce and deliver the energy and carbon content of the fuel being utilized. Coal-fired electricity generation has the highest emissions rate of CO_2 of the fossil fuel sources, and significantly higher emissions compared to nuclear power generation. As shown in Table 7.5-2, CO_2 emissions are estimated at 209 pounds per million British thermal units (Btu) or 19.4 million tons per year for the SCPC plant, assuming current emissions controls.

The NRC did not quantify coal-fired emissions in the GEIS, but implied that air impacts would be substantial. The NRC noted that adverse human health effects from coal combustion have led to important federal legislation in recent years and that public health risks, such as cancer and emphysema, have been associated with coal combustion and also mentioned global warming and acid rain as potential impacts. TVA concludes that federal legislation and large-scale concerns, such as global warming and acid rain, are indications of concerns about destabilizing important attributes of air resources. However, SO_x emission allowances, NO_x emission offsets, low NO_x burners with overfire air and selective catalytic reduction, fabric filters or electrostatic precipitators, and scrubbers are provided as mitigation measures.

Construction impacts are short term and can be mitigated in many cases. The overall impacts to air quality would be SMALL if there were no existing air quality issues; however, the impacts could be potentially LARGE if the site were in a nonattainment area. The emission impacts during the operational phase of a SCPC or IGCC plant would be noticeable, but insufficient to destabilize air resources (MODERATE).

Overall, it is concluded that collectively, construction and operational impacts on air quality could range from SMALL to LARGE.

7.5.1.3 Groundwater Use and Quality

Depending on the location of the chosen site, groundwater may be used for sanitary, potable water, and cooling at the site. If used for sanitary and potable water, impacts would most likely be SMALL. If used for makeup water and/or cooling water, then impacts could be MODERATE to LARGE. It would not be expected that there would be significant effects on groundwater quality, except during the construction phase due to temporary dewatering and runoff control measures.

Overall, the construction and operational impacts to groundwater use and quality could range from SMALL to LARGE.

7.5.1.4 Surface Water Use and Quality

There is the potential that some erosion and sedimentation may occur during construction; however, construction would be temporary, and the implementation or best management practices should limit any potential short-term impacts to surface water quality.

Cooling water at an alternate site would likely be withdrawn from a surface water body. Water would also be consumed because of evaporation from the cooling towers. Dependent on the volume of water withdrawn for makeup and the source of water, a new plant with a closed-cycle cooling system would increase surface water consumption. Therefore, impacts could be SMALL during normal flows and possibly LARGE during extreme low-flow conditions. Surface water quality impacts would be expected to be SMALL, because they would be controlled under an NPDES permit that would be regulated by the state in which the plant is located.

Runoff from coal storage and waste disposal would be controlled, but some runoff would occur with the potential for water quality impacts. All discharges would be regulated by an NPDES permit, which would contain adequate mitigation measures to ensure SMALL impacts as a result from discharged effluents. Indirectly, water quality could be affected by acids and mercury from air emissions. Some erosion and sedimentation may also occur during construction, but would be mitigated by BMPs pursuant to the site's stormwater permit.

Overall, the construction and operational impacts to surface water use and quality could range from SMALL to LARGE.

7.5.1.5 Aquatic and Terrestrial Ecology

Constructing an SCPC or IGCC plant at an alternate site could alter ecological resources because of the need to convert roughly 4,080 acres (Section 7.5.1.1) of land at the site to industrial use for the plant, inclusive of coal storage and settling ponds. However, some of this land might have been previously disturbed if a brownfield site was chosen for the plant siting. Also as discussed in Section 7.5.1.1, approximately 52,800 acres of land would be needed for coal mining and waste disposal, but partially offsetting this offsite land use would be the elimination of approximately 2,400 acres needed for uranium mining and processing to supply fuel for SQN.

SCPC or IGCC generation at an alternative site would introduce construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. The need to clear land for a transmission line and potentially a rail corridor would increase the scale of terrestrial impacts, resulting in MODERATE to LARGE impacts depending on the length of transmission and rail corridors required.

Use of cooling system makeup water from a nearby surface water body could have adverse impacts on aquatic resources. Depending on the characteristics of the water body used for cooling makeup, these impacts could range from SMALL to MODERATE. There would also be some impact on terrestrial resources associated with the cooling tower drift, and on the body of water from the chemicals used on site, as well as the chemical constituents in the emissions.

Overall, the construction and operational impacts on aquatic and terrestrial ecology are considered SMALL to LARGE.

7.5.1.6 Human Health

SCPC or IGCC power generation introduces worker risk from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal combustion wastes, and public risk from inhalation of stack emissions. Emission impacts can be widespread and health risk is difficult to quantify. The SCPC or IGCC alternative also introduces the risk of coal pile fires and attendant inhalation risk.

The NRC stated in the GEIS that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but the GEIS does not identify the significance of these impacts (NRC 1996, Section 8.3.9). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including the EPA and state agencies, set air emission standards, and requirements based on human health impacts. These agencies also impose site-specific emission limits, as needed to protect human health. EPA has concluded that certain segments of the U.S. population (e.g., developing fetuses and subsistence fish-eating populations) are at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. EPA has recently established standards restricting mercury and other toxic emissions from coal-fired units.

In the absence of more quantitative data, it is concluded that construction and operational impacts from radiological doses and inhaling toxins and particulates are considered to be SMALL.

7.5.1.7 Socioeconomics

The magnitude of socioeconomic impacts would vary at an alternate site depending on the location. Based on Table 8.1 of the GEIS, the peak workforce is estimated to range from 1.2 to 2.5 additional workers per MWe during the construction period. Therefore, for the 2,400 MWe plant utilized in this analysis, the workforce could range from approximately 2,880 to 6,000 workers. Communities around the new site would have to absorb the impacts of a large, temporary workforce (up to approximately 6,000 workers at the peak of construction) and a permanent workforce of approximately 0.25 workers per MWe based on Table 8.2 of the GEIS, or approximately 600 workers for the 2,400 MWe plant utilized in this analysis.

During construction, the communities surrounding the plant site would experience increased demand for rental housing and public services. In addition, the relative economic contributions of construction workers to local business and tax revenues would vary over time. After construction, some local communities may be affected by the loss of construction jobs and associated loss in demand for business services. In addition, the rental housing market could experience increased vacancies and decreased prices. The GEIS states that impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work (NRC 1996, Section 8.3.9). Therefore, socioeconomic impacts from construction could range from SMALL to LARGE based on the location of the plant site.

During the operational phase, the county in which the plant is located would receive tax equivalent payments. Therefore, socioeconomic impacts would be SMALL and potentially beneficial, dependent upon location and economic conditions within the community. However, this would be offset by the SMALL to MODERATE adverse economic impact to the communities surrounding SQN if its OLs are not renewed.

Overall, the construction and operational impacts on socioeconomics could range from SMALL to LARGE.

7.5.1.8 Transportation

During construction, up to potentially 6,000 workers would be commuting daily to the site. In addition to commuting workers, trucks would transport construction materials and equipment to the worksite, increasing the amount of traffic on local roads, while trains or barges may also be used to transport large components to the site. The increase in vehicular traffic on roads would peak during shift changes, resulting in temporary levels of service impacts and potential delays at intersections. Although site-dependent, transportation impacts during construction would likely be MODERATE. Transportation traffic-related impacts would be greatly reduced after construction, but would not disappear during plant operations. The maximum number of plant operating personnel commuting to the site would be approximately 600 workers. At most alternate sites, coal and lime would be delivered by rail, although barge delivery is feasible for a location on navigable waters. Waste disposal would also add to transportation impacts if the disposal location were located off site. Dependent on the delivery method of coal and lime/ limestone to the site, transportation impacts during operations could range from SMALL to MODERATE.

Overall, the construction and operational impacts on transportation could range from SMALL to MODERATE.

7.5.1.9 Aesthetics

During the construction phase, there would be the potential for temporary and minor impacts to visual aesthetics in an area due to the staging of construction materials and site preparation, the introduction of construction cranes, and an increase of dust from additional traffic on local dirt roads. The introduction of tall stacks and cooling towers with the associated plume could potentially have visual impacts at an alternative site, although the impact may be incremental if the site is located in an existing industrialized area. There would also be a visual impact if construction of a new transmission line, barge docking facility, and/or rail spur were needed.

Overall, the construction and operational visual impacts could range from SMALL to MODERATE.

Noise impacts from construction activities are expected to be SMALL for the surrounding communities, and potentially SMALL to MODERATE for the nearest residents. Noise impacts associated with rail delivery of coal and lime/limestone would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail corridor, the short duration of the noise reduces the impact. In a more suburban location, the impacts are considered MODERATE. This is due to the frequency of train transport, the fact that many people are likely to be within hearing distance of the rail route, and the impacts of noise on residents in the vicinity of the facility and the rail line. At a more rural location, the impacts could be SMALL. Noise and light from the plant would be detectable off site.

Overall, the construction and operational impacts on noise could range from SMALL to MODERATE, depending on the characteristics of the alternative site.

7.5.1.10 Historic and Cultural Resources

Before construction at an alternate site, studies would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would be needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). During the operational phase, activities such as trenching, excavation, or ground penetration would most likely be managed under procedures that would be protective of cultural resources, if present.

Depending on the site, construction and operational impacts on historic and cultural resources could range from SMALL to LARGE.

7.5.1.11 Environmental Justice

Although dependent on location, minority and low-income populations could be affected by the construction and operation of a new coal-fired power plant. Potential adverse impacts that might disproportionately impact minority or low-income communities include, for example, pressure on food and housing prices, or increases in road congestion or noise near residential communities. Therefore, impacts on minority and low-income populations from the construction and operation of a coal-fired power plant at an alternate site could range from SMALL to MODERATE.

7.5.1.12 Waste Management

TVA concurs with the GEIS assessment that the coal-fired alternative would generate substantial solid waste, as shown in Table 7.5-3. The SCPC plant would annually consume approximately 8,415,589 tons of coal with an ash content of 7.93 percent. After combustion, 99.8 percent of this ash (approximately 666,021 tons per year) would be collected and disposed of at an onsite or offsite landfill. In addition, approximately 579,530 tons of scrubber waste would be disposed of each year (based on annual calcium hydroxide usage of approximately 195,611 tons). TVA estimates that ash and scrubber waste disposal over a 40-year plant life would require approximately 653 acres. The amount of land needed for final disposal of ash may be less, depending on the availability of local recycling or reuse options for the ash. While only half this waste volume and land use would be attributable to the 20-year license renewal period alternative, the total numbers are pertinent as a cumulative impact.

TVA believes that with proper siting and current waste management and monitoring practices, waste disposal would not destabilize any resources. Some terrestrial habitat would be lost to the waste disposal, which could be significant depending on the occurrence of threatened or endangered species in the area. However, after closure of the waste site and revegetation, the land could potentially be available for other uses. Any impacts would be mitigated as part of the waste disposal permitting process.

Overall, it is concluded that construction and operational impacts associated with waste generation and disposal would be MODERATE.

7.5.2 Construct and Operate New Natural Gas-Fired Generating Capacity

TVA has chosen to evaluate the construction and operation of a combined-cycle 2,400-MWe plant using a closed-cycle cooling system with cooling towers at an alternate site, with an operating life of 40 years. TVA has assumed that the plant would be designed to minimize air emissions to the extent practicable (i.e., heat recovery steam generators equipped with selective catalytic reduction system and ammonia vaporizers).

7.5.2.1 Land Use

In the GEIS, the NRC estimated that 110 acres are needed for a 1,000-MWe natural gas-fired facility (NRC 1996, Section 8.3.10). Assuming 110 acres per 1,000 MWe, the 2,400-MWe plant would require approximately 264 acres. Additional land would also be impacted by construction of transmission lines and natural gas pipelines to serve the plant. The extent of those transmission structures would depend on the characteristics and location of the alternate site. If the plant were constructed on an existing brownfield site near available infrastructure, the amount of land required to be converted to industrial use could be less.

Regardless of where the natural gas-fired plant would be built, additional land would be required for natural gas wells and collection stations. In the GEIS, the NRC estimated that approximately 3,600 acres would be needed for wells, collection stations, and associated pipelines for a 1,000-MWe natural gas-fired plant (NRC 1996, Section 8.3.10). Assuming 3,600 acres per 1,000 MWe, the 2,400-MWe plant would require approximately 8,640 acres. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for SQN. In the GEIS, the staff estimated that approximately 1 acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (NRC 1996, Section 8.3.12). Therefore, approximately 2,400 acres of land would no longer be mined to supply fuel to SQN.

The final location of the site, pipelines, transmission lines, gas wells, compressor stations, and support equipment would determine the overall impacts on land use. Therefore, construction and operational impacts on land use could range from MODERATE to LARGE.

7.5.2.2 Air Quality

Natural gas is a relatively clean-burning fuel. When compared with a coal-fired plant, a natural gas-fired plant would release similar types of emissions, but in lower quantities. (NRC 2006b, Section 8.2.2.2). Table 7.5-4 presents emission estimates associated with the natural gas-fired alternative. With the exception of CO_2, emissions were based on the "Construction Permit Application for John Sevier Fossil Plant Combined Cycle Facility" (TVA 2010j, Table 2-5), and adjusted accordingly for the proposed 2,400 MWe plant. Emissions for CO_2 emissions were based on DOE information for the most recent use of natural gas consumed for electric power generation in the U.S.

A new natural gas-fired power generation plant would likely need a prevention of significant deterioration permit and an operating permit under the CAA. A new combined-cycle, natural gas-fired plant would also be subject to the new source performance standards specified in 40 CFR Part 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, sulfur dioxide, and nitrogen oxides. EPA also has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in areas designated as attainment or unclassified under the CAA. (NRC 2006b, Section 8.2.2.2)

Section 169A of the CAA [42 USC 7491] establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I federal area located within a state, state regulatory agencies must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period [40 CFR 51.308(d)(1)]. If a new natural gas-fired power plant were close to a mandatory Class I area, additional air pollution control requirements could be imposed. (NRC 2006b, Section 8.2.2.2)

TVA estimates the gas-fired alternative emissions to be as follows: (Table 7.5-4)

- Sulfur oxides = 283 tons per year
- Oxides of nitrogen = 1,543 tons per year
- Carbon monoxide = 792 tons per year
- Particulates = 374 tons per year
- Carbon dioxide = 7.9 million tons per year

The combustion turbine portion of the combined-cycle plant would be subject to EPA's national emission standards for hazardous air pollutants for stationary combustion turbines [40 CFR Part 63, Subpart YYYY] if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 10 tons/year or more of any single hazardous air pollutant or 25 tons/year or more of any combination of hazardous air pollutants [40 CFR 63.6085(b)]. (NRC 2006b, Section 8.2.2.2)

A natural gas-fired power plant would also have carbon dioxide emissions that could contribute to global warming. Gas-fired electricity generation emissions of CO_2 are approximately half of those from coal, but still significant. EPA has recently proposed a CO_2 emission standard for gas-fired units.

Construction impacts are short term and can be mitigated in many cases. The overall impacts to air quality would be SMALL if there were no existing air quality issues; however, the impacts could be potentially LARGE if the site were in a nonattainment area. The emission impacts during the operational phase of a natural gas-fired power generation plant would be noticeable, but insufficient to destabilize air resources.

Overall, it is concluded that collectively, construction and operational impacts on air quality could range from SMALL to LARGE.

7.5.2.3 Groundwater Use and Quality

Depending on the location of the chosen site, groundwater may be used for sanitary and potable water at the site. If used for sanitary and potable water, impacts would most likely be SMALL. If used for makeup water and/or cooling water, then impacts could be MODERATE to LARGE. It would not be expected that there would be significant effects on groundwater quality, except during the construction phase due to temporary dewatering and runoff control measures.

Therefore, construction and operational impacts to groundwater use and quality could range from SMALL to LARGE.

7.5.2.4 Surface Water Use and Quality

There is the potential that some erosion and sedimentation may occur during construction; however, construction would be temporary, and the implementation or best management practices should limit any potential impacts to surface water quality. Dependent on the volume of water withdrawn for makeup and the source of water, a new plant with a closed-cycle cooling system would increase surface water consumption. Therefore, impacts could be SMALL during normal flows and possibly LARGE during extreme low-flow conditions. Surface water quality impacts would be expected to be SMALL, because they would be controlled under an NPDES permit that would be regulated by the state in which the plant is located.

Overall, construction and operational impacts on surface water use and quality could range from SMALL to LARGE.

7.5.2.5 Aquatic and Terrestrial Ecology

Constructing a natural gas-fired plant at an alternate site could alter ecological resources because of the need to construct transmission lines, gas pipelines, natural gas wells, and collection stations. (Section 7.5.2.1) Impacts would be dependent on location and the environmental setting of the site, pipelines, meter stations, compressor station, gas wells, collection stations, and the proposed intake and discharge surface water body. It is expected that impacts to terrestrial plants and wildlife species would occur because of the construction of the plant and its associated components. However, alternative analysis, permitting, and avoidance planning may reduce or offset impacts to these resources, but would likely not avoid them altogether. Therefore, overall construction and operational impacts to terrestrial ecology could range from SMALL to LARGE.

Impacts to aquatic ecosystems associated with constructing a new natural gas-fired plant could range from SMALL to LARGE depending upon the physical location of the plant, the location of the intake and discharge structures, and the type of cooling employed by the plant. Any dredging activities would only have SMALL impacts due to USACE permitting conditions and associated best management practices.

Effects of operation to aquatic habitat would depend on the nature of the source water quality. Cooling water discharge is at times warmer than ambient and causes a thermal plume within the receiving waters. Thermal plumes can impede migration of temperature-sensitive aquatic organisms. During winter months, a thermal plume might attract fish, which could increase predation or cause cold shock should the plant cease operation or the fish be chased out of the plume in an attempt to escape predation.

Additionally, discharge can contain contaminants associated with treatment of the intake water or normal plant operation. Depending on the contaminant load within the cooling tower blowdown stream, impacts could range from SMALL to LARGE. However, an NPDES permit would be required prior to discharge and would limit toxic substances entering receiving waters.

Overall, construction and operational impacts to aquatic ecology could range from SMALL to LARGE.

7.5.2.6 Human Health

The GEIS analysis mentions potential gas-fired alternative health risks (cancer and emphysema). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contributes to health risks. As previously discussed in Section 7.5.1.2 for the coal-fired alternative, legislative and regulatory control of the nation's emissions and air quality are protective of human health. Therefore, human health impacts during the construction and operational period would be SMALL; that is, human health effects would be undetectable or would be so minor that they would neither destabilize nor noticeably alter important attributes of the resource.

7.5.2.7 Socioeconomics

Based on Table 8.1 of the GEIS, the peak workforce is estimated to be 1.2 workers per MWe during the construction period. Therefore, for the 2,400 MWe facility utilized in this analysis, the peak workforce could be approximately 2,880 workers. During construction, communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on the local economy and tax base would vary over time.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce may have to move to be closer to the construction site. Therefore, the impact of construction on socioeconomic conditions could range from SMALL to LARGE.

Based on Table 8.2 of the GEIS, the permanent workforce is estimated to be approximately 0.15 workers per MWe. Therefore, for the 2,400 MWe facility utilized in this analysis, the operational workforce would be approximately 360 workers. The plant workforce would most likely permanently relocate within commuter range of the new facility. Impacts would depend to a great extent on the size of the population around the site and the availability of housing and amenities.

During the operational phase, the county in which the plant is located would receive an allocated portion of the tax equivalent payments paid to the state. Therefore, socioeconomic impacts would be SMALL and potentially beneficial dependent upon location and economic conditions within the community. However, this would be offset by the SMALL to MODERATE adverse economic impact to the communities surrounding SQN if its OL is not renewed.

Overall, the construction and operational impacts on socioeconomics could range from SMALL to LARGE.

7.5.2.8 Transportation

Should a new power facility be constructed, the facility could be sited in a manner that would reduce or avoid transportation and traffic impacts. However, mitigation of potential transportation impacts due to the location of a facility may be necessary because of expected increases in construction and operation traffic. This mitigation may include a need for extensive improvements to roadways and intersections (e.g., roadway widening, ramp improvements, and traffic signal installation) on state and local roads. Other mitigation actions could include employee car pooling, staggered shifts, or offsite parking with organized transportation, such as buses, to the site.

Traffic generated as an outcome of construction activities would be temporary and short term. Scheduling for certain construction activities to occur during off-peak hours could also be an option to reduce conflict with normal traffic use on area roads. Traffic related to operation and maintenance at a potential site would utilize any mitigation improvements established during the construction phase.

Overall, construction and operational impacts to transportation could range from SMALL to MODERATE, depending on project and site-specific conditions.

7.5.2.9 Aesthetics

During the construction phase, there would be the potential for temporary and minor impacts to visual aesthetics in an area due to the staging of construction materials and site preparation, the introduction of construction cranes, and an increase of dust from additional traffic on local dirt roads. More permanent impacts to the viewshed during the operation phase could result from the cumulative effects of introducing cooling towers or exhaust stacks to the skyline, water vapor plume release, transmission lines, and visibility of other prominent facility features. The level of impact anticipated during construction and operation could range from SMALL to MODERATE and vary depending upon viewer distance from the site, the abundance of trees, hilly terrain, and mitigation measures used, such as utilizing landscape materials on site, and painting techniques applied to facility structures.

Based on the projected noise levels and the duration of construction activities, noise impacts from construction activities are expected to be SMALL for the surrounding communities, and potentially SMALL to MODERATE for the nearest residents.

The operation of a new natural gas-fired plant would have noise sources similar to other large industrial facilities. Cooling towers, fans, pumps, compressors, boilers, etc. are usually on a smaller scale than nuclear plants, but still produce noise when they are used to support plant operations. Natural gas-fired sites are usually smaller than nuclear facilities, and may be located closer to residences or sensitive receptors due to the smaller area required to separate the site from the public. However, noise levels would still be expected to be within acceptable background noise levels at the nearest residence. Based on the GEIS, noise impacts during the operational period are expected to be SMALL for both the surrounding communities and the nearest residents (NRC 1996, Section 4.3.7).

Overall, the construction and operational impacts on noise could range from SMALL to MODERATE, depending on the characteristics of the alternative site.

7.5.2.10 Historic and Cultural Resources

Before construction at an alternate site, studies would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would be needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). During the operational phase, activities such as trenching, excavation, or ground penetration would most likely be managed under procedures that would be protective of cultural resources, if present.

Depending on the site, construction and operational impacts on historic and cultural resources could range from SMALL to LARGE.

7.5.2.11 Environmental Justice

Although dependent on location, minority and low-income populations could be affected by the construction and operation of a new natural gas-fired power plant. Potential adverse impacts that might disproportionately impact minority or low-income communities include, for example, pressure on food and housing prices and increases in road congestion or noise near residential communities. Therefore, impacts on minority and low-income populations from the construction and operation of a natural gas-fired power plant at an alternate site could range from SMALL to MODERATE.

7.5.2.12 Waste Management

Construction would be similar to that of any large industrial facility. Construction-related debris would be generated during construction activities and removed to an appropriate disposal site, either on site or off. Construction debris includes waste types such as dirt, concrete rubble, metal, wood, paper, oil, and chemicals. All debris would be recycled in an approved and licensed facility or disposed of in an approved and permitted landfill.

There are only small amounts of solid waste products from burning natural gas fuel. Waste generation from gas-fired technology would be minimal. Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste generation would be limited to typical office wastes, waste treatment plant waste, and waste oil. The primary wastewaters generated by the proposed combined-cycle alternative are cooling tower blowdown, clarifier sludge from the raw water treatment system, reverse osmosis reject from the makeup demineralizer plant, and a combination of heat recovery steam generator blowdown and evaporative cooler blowdown to the blowdown sump. Compressor wash water would be collected and disposed off site at an approved wastewater treatment facility.

Overall, construction and operational impacts associated with waste generation and disposal would be SMALL.

7.5.3 Construct and Operate New Nuclear Generating Capacity

Although TVA would evaluate the various available approved reactor technologies and decide which would best meet the TVA mission and goals, for purposes of this evaluation it is assumed that there would be two units with generating capacities similar to the SQN units (1,200 MWe each). The environmental impacts associated with constructing and operating a nuclear power plant at an alternate site using a closed-cycle cooling system are discussed below.

7.5.3.1 Land Use

According to the GEIS, a 1,000 MWe advanced design light water reactor requires approximately 500 to 1,000 acres excluding transmission lines. TVA's existing nuclear plant sites range from about 600 acres (BFN and SQN) to more than 1,500 acres (Watts Bar). TVA would construct two nuclear units on a site approximately 1,000 acres in size. Additional land would be required to support new transmission lines. In addition, it may be necessary to construct a rail spur or barge slip to an alternate site to bring in equipment during construction.

In the GEIS, the NRC staff estimated that approximately 1 acre per MWe would be affected for mining and processing the uranium during the operating life of a new nuclear power plant. Therefore, approximately 2,400 acres would be affected by the uranium mining necessary to refuel a new two-unit nuclear plant.

If a greenfield site were selected for the new facility, it is probable that land-use changes would occur, with the potential for loss of natural habitat and agricultural land. Should the site selected be a brownfield site, the level of impact would vary. There would be no net change in offsite land-use impacts from the mining of uranium fuel, if supplies destined to be used during an SQN license renewal period were redirected for use at a new nuclear facility.

Overall, construction and operational impacts on land use could range from MODERATE to LARGE.

7.5.3.2 Air Quality

Ground-clearing, grading, and excavation activities would raise dust, as would the movement of materials and machinery. Fugitive dust may also rise from cleared areas during windy periods. Exhaust from the vehicles required to transport the construction workforce could also decrease air quality somewhat. However, construction impacts are short term and can be mitigated in many cases. Therefore, overall impacts to air quality would be SMALL if there were no existing air quality issues; however, the impacts could be potentially LARGE if the site were in a nonattainment area.

The air quality impacts during the operational phase would be SMALL because the emission sources would be operated intermittently and emissions would be within federal, state, and local air quality limits. In addition, as discussed in Section 7.6, GHG emissions that would be associated with nuclear are lower than fossil fuel-based energy sources, and similar to the life-cycle GHG emissions from renewable energy sources. Therefore, air quality impacts associated with new nuclear at an alternate site would avoid millions of tons of greenhouse gases that otherwise would be produced by fossil fuel-fired generation.

Overall, it is concluded that construction and operational impacts on air quality could range from SMALL to LARGE.

7.5.3.3 Groundwater Use and Quality

Depending on the hydrology of the chosen site, groundwater may be used for sanitary purposes, potable water, and cooling at the site. If used for sanitary and potable water, impacts would most likely be SMALL. If used for makeup water and/or cooling water, then impacts could be MODERATE to LARGE. During construction, groundwater use would be of a temporary nature and considered minor. Therefore, construction and operational impacts to groundwater use and quality could range from SMALL to LARGE.

7.5.3.4 Surface Water Use and Quality

There is the potential that some erosion and sedimentation may occur during construction; however, construction would be temporary, and the implementation of BMPs should limit any potential short-term impacts to surface water quality. For a replacement reactor located at an alternate site, new intake and discharge structures would need to be constructed to provide water needs for the facility. Dependent on the volume of water withdrawn for makeup and the source of water, a new plant with a closed-cycle cooling system would increase surface water consumption. Therefore, impacts could be SMALL during normal flows and possibly LARGE during extreme low-flow conditions. Surface water quality impacts would be expected to be SMALL, because they would be controlled under an NPDES permit that would be regulated by the state in which the plant is located.

Overall, construction and operational impacts to surface water could range from SMALL to LARGE.

7.5.3.5 Aquatic and Terrestrial Ecology

A new nuclear plant at an alternate greenfield site would result in potentially substantial land-use impacts. In addition to property needed for the new plant, additional land would be needed to support water lines and potential construction of a railroad spur or barge dock to transport equipment during construction and operation. In addition, new transmission lines and associated ROWs would also be required.

Direct impacts would likely occur to terrestrial plants and wildlife as a result of clearing and construction operations. These impacts could include important terrestrial habitats such as:

- Adjacent shorelines of open waters: ponds, lakes, and large bodies of water.
- Forests: hardwood, pine-hardwood, mixed hardwood, etc.
- Open fields: fallow fields, old fields, barren land, etc.
- Wetlands: forested, scrub shrub, emergent, etc.
- Riparian areas along streams.
- Native grass fields: pastures, agriculture, etc.

Impacts to terrestrial plants could be greater than impacts to wildlife, because many wildlife species have the ability to relocate by their own means. Plant communities in the proposed construction footprint would be cleared to accommodate the new plant site, and wildlife would be displaced. Disturbed areas would be revegetated with native and non-invasive flora species to reduce the introduction and spread of exotic invasive plant species associated with ground disturbance and other construction activities. In addition, wildlife species that recolonize the area are expected to be suited for life in and around an industrial/urban environment.

Overall, construction and operational impacts to terrestrial ecology could range from SMALL to LARGE, dependent on the characteristics of the alternate site.

Effects of operation on aquatic habitat would depend on the nature of the source water quality. The source water for cooling in a plant using a closed-cycle cooling system is concentrated up to four times in the cooling tower operations before being discharged as wastewater blowdown, which concentrates the potential impurities already dissolved in the source water. However, the blowdown stream and all wastewater discharges would be regulated by and in compliance with the site-specific NPDES permit.

Impingement and entrainment effects of operation would also be dependent on the quality of the source water and organisms residing within the local habitat. Intake velocities are required to adhere to 316(b) of the CWA [33 USC Section 1326], which minimizes impingement of aquatic organisms. Intake and discharge volumes are lower from plants using a closed-cycle cooling system (as opposed to a once-through system), but the volume of water required increases as the source water quality decreases (as water quality decreases fewer cycles of concentration are possible), which may affect entrainment, impingement, and effects to organisms sensitive to a thermal plume. However, plants that use a closed-cycle cooling system consume more water through evaporation in the cooling towers than plants using a once-through cooling system.

Aquatic organisms susceptible to entrainment are usually planktonic, and thus quite small with limited swimming ability and subject to the motion of the water. The effects of entrainment would depend on local species residing in the source water and the percentage of source water being routed through the plant.

Cooling water discharge is at times warmer than ambient and causes a thermal plume within the receiving waters. Thermal plumes can impede migration of temperature-sensitive aquatic organisms. During winter months, a thermal plume might attract fish, which could increase predation or cause cold shock should the plant cease operation or the fish be chased out of the plume in an attempt to escape predation.

Additionally, discharge can contain contaminants associated with treatment of the intake water or normal plant operation. Depending on the contaminant load within the cooling tower blowdown stream, impacts could range from minor to substantial. However, an NPDES permit would be required prior to discharge and would limit toxic substances entering receiving waters.

Overall, the construction and operational impacts to aquatic ecology could range from SMALL to LARGE depending on the plant design, organisms present, source water, and receiving water.

7.5.3.6 Human Health

Human health impacts for an operating nuclear power plant are identified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Overall, human health impacts of a new nuclear plant at an alternate site are considered SMALL.

7.5.3.7 Socioeconomics

During construction, many of the workers (5,000 peak construction workforce) are likely to temporarily relocate to the area. The communities surrounding the plant site would experience increased demand for rental housing and public services. In addition, the relative economic contributions of construction workers to local business and tax revenues would vary over time. After construction, some local communities may be affected by the loss of construction jobs and associated loss in demand for business services. In addition, the rental housing market could experience increased vacancies and decreased prices. In the GEIS, it is stated that impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work (NRC 1996, Section 8.3.9). Therefore, socioeconomic impacts from construction could range from SMALL to LARGE based on the location of the plant site.

A plant operations workforce would most likely permanently relocate within commuter range of the new facility. During the operational phase, the county in which the plant is located would receive an allocated portion of the tax equivalent payments paid to the state. Therefore, socioeconomic impacts would be SMALL and potentially beneficial dependent upon location and economic conditions within the community.

Overall, the construction and operational impacts on socioeconomics could range from SMALL to LARGE.

7.5.3.8 Transportation

Construction and operation of a new nuclear facility would potentially impact the transportation infrastructure and traffic load on the roadways associated with a site. Should a new power facility be constructed, the facility could be sited in a manner that would reduce or avoid transportation and traffic impacts. However, mitigation of potential transportation impacts due to the location of a facility may be necessary because of expected increases in construction and operation traffic. This mitigation may include a need for extensive improvements to roadways and intersections (e.g., roadway widening, ramp improvements, and traffic signal installation) on state and local roads. Other mitigation actions could include employee car pooling, staggered shifts, or offsite parking with organized transportation, such as buses, to the site.

Traffic generated as an outcome of construction activities would be temporary and short term. Scheduling certain construction activities to occur during off-peak hours could also be an option to reduce conflict with normal traffic use on area roads. Traffic related to operation and maintenance at a potential site would utilize any mitigation improvements established during the construction phase.

Overall, construction and operational impacts on transportation could range from SMALL to MODERATE, depending on site-specific conditions.

7.5.3.9 Aesthetics

During the construction phase, there would be the potential for temporary and minor impacts to visual aesthetics in an area due to the staging of construction materials and site preparation, the introduction of construction cranes, and an increase of dust from additional traffic on local dirt roads. More permanent impacts to the viewshed during the operation phase could result from the cumulative effects of introducing cooling towers to the skyline, water vapor plume release, transmission lines, and visibility of other prominent facility features. The level of impact anticipated during construction and operation could range from SMALL to MODERATE and vary depending upon viewer distance from the site, the abundance of trees, hilly terrain, and mitigation measures used, such as utilizing landscape materials on site, and painting techniques applied to facility structures.

Sources of noise during construction would include bulldozers, draglines, scrapers, haulers to excavate earth and grade, cranes, front loaders, graders, forklifts, man lifts, compressors, backhoes, dump trucks, a pier driller, and portable welding machines. However, due to the anticipated noise levels and the temporary duration of construction activities, impacts are expected to be SMALL for the surrounding communities, and SMALL to MODERATE for the nearest residents.

Noise associated with the operation of a new nuclear plant would include such sources as the cooling tower, switchyard, motors, generators, pumps, and trucks and cars typical of an operating industrial facility. The permanent workforce would also produce traffic noise during their commute to and from work. However, impacts are expected to be SMALL for the surrounding communities and for the nearest residents.

Overall, the construction and operational impacts on noise could range from SMALL to MODERATE, depending on the characteristics of the alternative site.

7.5.3.10 Historic and Cultural Resources

Before construction at an alternate site, studies would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would be needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). During the operational phase, activities such as trenching, excavation, or ground penetration would most likely be managed under procedures that would be protective of cultural resources, if present.

Depending on the site, construction and operational impacts on historic and cultural resources could range from SMALL to LARGE.

7.5.3.11 Environmental Justice

Although dependent on location, minority and low-income populations could be affected by the construction and operation of a new nuclear plant. Potential adverse impacts that might disproportionately impact minority or low-income communities include, for example, pressure on food and housing prices and increased road congestion and noise near residential communities. Therefore, impacts on minority and low-income populations from the construction and operation of a new nuclear power plant at an alternate site could range from SMALL to MODERATE.

7.5.3.12 Waste Management

The waste impacts associated with operation of a nuclear power plant are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. Waste would be generated during the construction and operational period and removed to an appropriate disposal site. Overall, waste impacts of a new nuclear plant at an alternate site are considered SMALL.

Table 7.5-1
Super-Critical Pulverized Coal Alternative Emission Control Characteristics

Characteristic	Basis
Total size = 2,400 MWe	Chosen as comparable to SQN units.
Boiler type = pulverized coal, tangentially fired, dry-bottom, NSPS	Minimizes nitrogen oxide emissions (EPA 1998, Table 1.1-3)
Fuel type = combination bituminous, subbituminous	Typical for coal used in Tennessee (DOE 2010a, Table 4)
Fuel heating average value of bituminous/ subbituminous coal = 11,057 Btu/lb	2009 value for coal used in Tennessee (DOE 2010a, Table 15)
Fuel ash content by weight = 7.93 percent	2009 value for coal used in Tennessee (DOE 2010a, Table 15)
Fuel sulfur content by weight = 1.33 percent	2009 value for coal used in Tennessee (DOE 2010a, Table 15)
Uncontrolled SO_x emission = 38S lb/ton Uncontrolled NO_x emission = 10 lb/ton Uncontrolled CO emission = 0.5 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, new source performance standard (EPA 1998, Table 1.1-3) "S" represents sulfur.
Heat rate = 10,414 Btu/kWh	Average operating heat rate for coal (DOE 2011, Table 5.3)
Capacity factor = 0.85	Typical for newer large coal-fired units
NO_x control = low NO_x burners, overfire air and selective catalytic reduction (95 percent reduction)	Best available and widely demonstrated for minimizing NO_x emissions (EPA 1998, Table 1.1-2)
Particulate material, filterable (PM_f) = 10A lb/ton of ash Particulate material (less than 10 microns) PM_{10} = 2.3A lb/ton of ash	Typical for pulverized coal, tangentially fired, dry-bottom (EPA 1998, Table 1.1-4). "A" represents factor based on fuel ash content by weight.
Particulate control = fabric filters (baghouse: 99.8 percent removal efficiency)	Best available for minimizing particulate emissions (EPA 1998, Table 1.1-6)
SO_x control = Wet scrubber: lime (95 percent removal efficiency)	Best available for minimizing SO_x emissions (EPA 1998, Table 1.1-1)
CO_2 emission: average of bituminous and subbituminous coal = 209 lb/MMBtu	(DOE 2010b)

Table 7.5-2
Air Emissions From Super-Critical Pulverized Coal Alternative

Annual Consumption	Tons
Coal	8,415,589
Oxides of sulfur	10,633
Nitrogen oxides	2,104
Carbon monoxide	2,104
Filterable particulate matter	667
Particulates less than 10 microns in diameter	153
Carbon dioxide	19.4 million tons (assuming 209 lb/CO_2/MMBtu)

(Enercon 2011)

Table 7.5-3
Solid Waste From Super-Critical Pulverized Coal Alternative[a]

Waste	Amount
Annual SO_x generated[b]	223,506 tons
Annual SO_x removed	212,331 tons
Annual ash generated	666,021 tons
Annual lime consumption[c]	195,611 tons
Annual calcium sulfate waste[d]	569,749 tons
Annual scrubber waste[e]	579,530 tons
Total volume of scrubber waste (40-year period)[f]	320,182,320 ft^3
Total volume of ash (40-year period)[g]	532,816,800 ft^3
Total volume of solid waste (40-year period)	852,999,120 ft^3
Waste pile area (40-year period)	653 acres, 30 ft high

(Enercon 2011)

a. Calculations are based on annual coal consumption of 8,415,589 tons per year (Table 7.5-2).
b. Calculations assume 100 percent combustion of coal.
c. Lime consumption is based on total SO_2 generated.
d. Calcium sulfate generation is based on total SO_2 removed.
e. Total scrubber waste includes scrubbing media carryover.
f. Density of calcium sulfate dehydrate is 144.8 lb/ft^3.
g. Density of coal bottom ash is 100 lb/ft^3 (FHWA 2000).

Table 7.5-4
Air Emissions From Natural Gas-Fired Alternative

Emission	Annual Amount
Gas consumption	132,153,360,000 ft^3
Btu input	134,796,427 MMBtu
Oxides of sulfur	283 tons
Nitrogen oxides	1,543 tons
Carbon monoxide	792 tons
Particulate matter[(a)]	374 tons
Carbon dioxide	7.9 million tons (assuming 117 lb CO_2/MMBtu)

(Enercon 2011)

a. Includes cooling tower emissions.

7.6 Proposed Action vs. No Action

The proposed action is to renew the SQN OLs, which would preserve the option for TVA to continue to operate SQN to meet TVA's future system generating needs throughout the 20-year license renewal period. The analysis of the environmental impacts required by 10 CFR 51.53(c)(3)(ii) concluded that environmental impacts from the continued operation of SQN during the license renewal period would either be undetectable or so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

The no-action alternative is the denial of the renewal of the SQN OLs by the NRC. The environmental impacts of the no-action alternative would be the impacts associated with the construction and operation of the type of replacement power utilized. In effect, the net environmental impacts would be transferred from the continued operation of SQN to the environmental impacts associated with the construction and operation of a new generating facility. Therefore, the no-action alternative would have no net environmental benefits.

The environmental impacts associated with the proposed action (the continued operation of SQN) were compared to the environmental impacts from the no-action alternative (the decommissioning of SQN and the construction and operation of other reasonable sources of electric generation). TVA believes this comparison shows that the continued operation of SQN would produce fewer significant environmental impacts than the no-action alternative.

In addition, carbon dioxide emissions are suspected to be a major contributor to anthropogenic GHG emissions, which many scientists believe contribute to climate change. Fossil fuels (coal, natural gas, and petroleum) are the largest energy-related carbon dioxide emissions in the world (EIA 2012). As shown in Table 7.6-1, which includes the amount of CO_2 produced when various fuels are burned to produce electricity, GHG emissions associated with nuclear power are lower than those associated with fossil fuel-based energy sources. In addition, as previously discussed in Section 2.11.3, GHG emissions associated with renewal of an operating license would be similar to the life-cycle GHG emissions from renewable energy sources and lower than those associated with fossil fuel-based energy sources.

Table 7.6-1
Carbon Dioxide Emissions From Electricity Generation

Fuel	Pounds CO_2 per Million Btu
Sub-bituminous coal	213
Bituminous coal	205
Lignite coal	215
#6 fuel oil	174
Natural gas	117
Nuclear	0
Renewable sources	0

(DOE 2010b)

8.0 COMPARISON OF ENVIRONMENTAL IMPACTS

> To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form . . .
>
> —10 CFR 51.45(b)(3) as adopted by 10 CFR 51.53(c)(2).

The proposed action is renewal of the SQN operating licenses, which would preserve the option to continue to operate SQN to meet TVA's future system generating needs throughout the 20-year license renewal period. Chapter 4 analyzes environmental impacts of the proposed action, and Chapter 7 describes potential energy alternatives to the proposed action and analyzes impacts from the alternatives deemed to be reasonable.

Table 8.0-1 summarizes the environmental impacts of the proposed action and the alternatives deemed reasonable, for comparison purposes. Table 8.0-2 provides a more detailed comparison. The environmental impacts compared in Tables 8.0-1 and 8.0-2 are either Category 2 issues that apply to the proposed action or issues that the GEIS identified as major considerations in an alternatives analysis.

As shown in Tables 8.0-1 and 8.0-2, there are no reasonable alternatives superior to that of the continued operation of SQN, providing approximately 2,400 MWe power generation. The continued operation of SQN would create significantly less environmental impact than the construction and operation of new alternative generation capacity. In addition, the continued operation of SQN will have a significant positive economic impact on the communities surrounding the station, such as reduced local unemployment, economic support of surrounding communities, and lower energy costs.

Table 8.0-1
Environmental Impacts Comparison Summary[a]

Impact Area	Proposed Action	No-Action Alternative			
		Decommissioning	Super-Critical Coal-Fired Alternative	Gas-Fired Alternative	New Nuclear
Land use	SMALL	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Air quality	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Groundwater use and quality	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Surface water use and quality	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Aquatic and terrestrial ecology	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Human health	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Transportation	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Historic and cultural resources	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Environmental justice	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Waste management	SMALL	SMALL	MODERATE	SMALL	SMALL

a. Impacts are defined as follows based on 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Table 8.0-2
Environmental Impacts Comparison Detail[(a)]

Land Use	
Proposed action	**SMALL:** No refurbishment activities are planned; no changes in onsite land use are anticipated.
Decommissioning	**SMALL:** Not an impact evaluated in the GEIS; NUREG-0586 determined impacts to be SMALL for onsite activities.
Super-critical pulverized coal alternative	**MODERATE to LARGE:** ~4,080-acre site (includes coal storage yard and settling ponds), with additional land potentially needed for transmission lines and rail line for coal delivery.
Gas-fired alternative	**MODERATE to LARGE:** Up to ~8,640 acres required for gas wells and collection stations; additional land needed for plant and gas pipeline, and potentially transmission lines.
New nuclear alternative	**MODERATE to LARGE:** ~1,000-acre site, with additional land potentially needed for transmission lines and rail spur or barge slip for transporting equipment.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Air Quality	
Proposed action	**SMALL:** No refurbishment activities are planned; emissions primarily associated with testing of emergency generators; beneficial to climate change.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with air quality (decommissioning).
Super-critical pulverized coal alternative	**SMALL to LARGE:** Air quality impacts would be SMALL if no air quality issues exist; impacts could be potentially LARGE if site were in a nonattainment area. Operational emission impacts would be MODERATE. Sulfur oxides = 10,633 tons/year Oxides of nitrogen = 2,104 tons/year Carbon monoxide = 2,104 tons/year Particulate (filterable) = 667 tons/year Particulate (unfilterable) = 153 tons/year Carbon dioxide = 19.4 million tons/year Trace amounts of mercury, arsenic, chromium, beryllium, and selenium
Gas-fired alternative	**SMALL to LARGE:** Air quality impacts would be SMALL if no air quality issues exist; impacts could be potentially LARGE if site were in a nonattainment area. Operational emission impacts would be MODERATE. Sulfur oxides = 283 tons/year Oxides of nitrogen = 1,543 tons/year Carbon monoxide = 792 tons/year Particulates = 374 tons/year Carbon dioxide = 7.9 million tons/year
New nuclear alternative	**SMALL to LARGE:** Air quality impacts would be SMALL if no air quality issues exist; impacts could be potentially LARGE if site were in a nonattainment area. Operational emission impacts would be SMALL because emission sources would be operated intermittently and would be within federal, state, and local air quality limits.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[a]

Groundwater Use and Quality	
Proposed action	**SMALL:** No refurbishment activities are planned; SQN does not withdraw groundwater from the site.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with water quality (decommissioning).
Super-critical pulverized coal alternative	**SMALL to LARGE:** If used for sanitary and potable water, impacts would be SMALL; if used for makeup water and/or cooling water, impacts could be MODERATE to LARGE; no effects on groundwater quality, except during construction due to temporary dewatering and runoff control measures.
Gas-fired alternative	**SMALL to LARGE:** If used for sanitary and potable water, impacts would be SMALL; if used for makeup water and/or cooling water, impacts could be MODERATE to LARGE; no effects on groundwater quality, except during construction due to temporary dewatering and runoff control measures.
New nuclear alternative	**SMALL to LARGE:** If used for sanitary and potable water, impacts would be SMALL; if used for makeup water and/or cooling water, impacts could be MODERATE to LARGE; no effects on groundwater quality, except during construction due to temporary dewatering and runoff control measures.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[a]

Surface Water Use and Quality	
Proposed action	**SMALL:** No refurbishment activities are planned; discharges are regulated by NPDES permit.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with water quality (decommissioning).
Super-critical pulverized coal alternative	**SMALL to LARGE:** Construction impacts would be temporary and managed by using BMPs; dependent on volume of water withdrawn for makeup and the source of water, closed-cycle cooling would result in SMALL impacts during normal flows and possibly LARGE impacts during extreme low-flow conditions due to surface water consumption; discharges to the receiving water during operations would be regulated by an NPDES permit.
Gas-fired alternative	**SMALL to LARGE:** Construction impacts would be temporary and managed by using BMPs; dependent on volume of water withdrawn for makeup and the source of water, closed-cycle cooling would result in SMALL impacts during normal flows and possibly LARGE impacts during extreme low-flow conditions due to surface water consumption; discharges to the receiving water during operations would be regulated by an NPDES permit.
New nuclear alternative	**SMALL to LARGE:** Construction impacts would be temporary and managed by using BMPs; dependent on volume of water withdrawn for makeup and the source of water, closed-cycle cooling would result in SMALL impacts during normal flows and possibly LARGE impacts during extreme low-flow conditions due to surface water consumption; discharges to the receiving water during operations would be regulated by an NPDES permit.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Aquatic and Terrestrial Ecology	
Proposed action	**SMALL:** No refurbishment activities are planned; operates within NPDES permit limits; no substantial impacts to fish population in Chickamauga Reservoir.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with ecological resources (decommissioning).
Super-critical pulverized coal alternative	**SMALL to LARGE:** Impact will depend on ecology of site and the need for additional transmission lines and rail spur.
Gas-fired alternative	**SMALL to LARGE:** Impact dependent on location and environmental setting of the site, pipelines, meter stations, compressor station, gas wells, collection stations, and the proposed intake and discharge surface water body.
New nuclear alternative	**SMALL to LARGE:** Impact will depend on ecology of site and the need for additional transmission lines and rail spur or barge dock.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Human Health	
Proposed action	**SMALL:** Human health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with radiation doses (decommissioning).
Super-critical pulverized coal alternative	**SMALL:** Regulatory controls and oversight would be protective of human health.
Gas-fired alternative	**SMALL:** Regulatory controls and oversight would be protective of human health.
New nuclear alternative	**SMALL:** Human health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Socioeconomics	
Proposed action	**SMALL:** No refurbishment activities are planned; no additional workers are anticipated during the period of extended operation.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with socioeconomics (decommissioning).
Super-critical pulverized coal alternative	**SMALL to LARGE:** Communities would have to absorb impacts of a large, temporary workforce of (up to ~6,000 workers) with impacts at a rural site being LARGE; permanent workforce of ~600 workers would have less impact.
Gas-fired alternative	**SMALL to LARGE:** Communities would have to absorb impacts of temporary workforce of ~2,880 workers with impacts at a rural site being LARGE; permanent workforce of ~360 workers would have less impact.
New nuclear alternative	**SMALL to LARGE:** Communities would have to absorb impacts of a temporary construction workforce with impacts at a rural site being LARGE; permanent operational workforce would have less impact.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Transportation	
Proposed action	**SMALL:** No refurbishment activities are planned; no additional workers are anticipated during the period of extended operation.
Decommissioning	**SMALL:** Not an impact evaluated in the GEIS; NUREG-0586 determined impacts to be SMALL.
Super-critical pulverized coal alternative	**SMALL to MODERATE:** Transportation-related construction and operational impacts would depend on the site and the chosen delivery method for coal and lime/limestone during the operational period.
Gas-fired alternative	**SMALL to MODERATE:** Transportation-related construction and operational impacts would be site dependent.
New nuclear alternative	**SMALL to MODERATE:** Transportation-related construction and operational impacts would be site dependent.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Aesthetics	
Proposed action	**SMALL:** There are no activities planned which would create new impacts to the landscape or area visual resources.
Decommissioning	**SMALL:** Not an impact evaluated in the GEIS; NUREG-0586 determined impacts to be SMALL.
Super-critical pulverized coal alternative	**SMALL to MODERATE:** Impact could be reduced if siting is in an industrial area; impact could be MODERATE if siting is in an undeveloped area; noise impacts would be site dependent.
Gas-fired alternative	**SMALL to MODERATE:** Temporary and minor visual impacts during construction; permanent visual impacts due to prominent facility features during operational period; noise impacts during construction potentially SMALL to MODERATE for nearest residents.
New nuclear alternative	**SMALL to MODERATE:** Temporary and minor visual impacts during construction; permanent visual impacts due to prominent facility features during operational period; noise impacts during construction potentially SMALL to MODERATE for nearest residents.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Historic and Cultural Resources	
Proposed action	**SMALL:** No refurbishment activities are planned; no cultural resources within area of potential effects are eligible for NRHP; TVA procedures ensure protection of these types of resources in the event of inadvertent discovery during excavation activities.
Decommissioning	**SMALL:** Not an impact evaluated in the GEIS; NUREG-0586 determined impacts to be SMALL for activities within operational areas.
Super-critical pulverized coal alternative	**SMALL to LARGE:** Level of impact would be dependent on the site for the plant and supporting infrastructure.
Gas-fired alternative	**SMALL to LARGE:** Level of impact would be dependent on the site for the plant and supporting infrastructure.
New nuclear alternative	**SMALL to LARGE:** Level of impact would be dependent on the site for the plant and supporting infrastructure.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[(a)]

Environmental Justice	
Proposed action	**SMALL:** No significant offsite environmental impacts; no unusual resource dependencies or practices identified.
Decommissioning	**SMALL:** Not an impact evaluated in the GEIS; NUREG-0586 determined impacts with this issue to be site specific.
Super-critical pulverized coal alternative	**SMALL to MODERATE:** Impacts dependent on location; impacts could include pressure on food and housing prices, or increases in road congestion or noise near residential communities.
Gas-fired alternative	**SMALL to MODERATE:** Impacts dependent on location; impacts could include pressure on food and housing prices, or increases in road congestion or noise near residential communities.
New nuclear alternative	**SMALL to MODERATE:** Impacts dependent on location; impacts could include pressure on food and housing prices, or increases in road congestion or noise near residential communities.

Table 8.0-2 (Continued)
Environmental Impacts Comparison Detail[a]

Waste Management	
Proposed action	**SMALL:** Waste impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.
Decommissioning	**SMALL:** Adopting by reference the GEIS conclusion for the Category 1 issue associated with waste management (decommissioning).
Super-critical pulverized coal alternative	**MODERATE:** Total ash and scrubber sludge waste volume would be approximately 1,245,551 tons per year.
Gas-fired alternative	**SMALL:** Only small amounts of solid waste products (i.e., ash); GEIS concluded waste generation would be minimal; waste generation would be limited to typical office wastes.
New nuclear alternative	**SMALL:** During construction, debris would be generated and removed to an appropriate disposal site; waste impacts from an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1.

a. Impacts are defined as follows based on 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

9.0 STATUS OF COMPLIANCE

9.1 Requirement [10 CFR 51.45(d)]

The environmental report shall list all Federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection . . . .

9.1.1 Sequoyah Nuclear Plant Authorizations

Table 9.1-1 provides a summary of authorizations held by SQN for current plant operations. Authorizations in this context include any permits, licenses, approvals, or other entitlements. With the exception of Nationwide Permit 2009-00654, which was related to a specific project associated with the installation of a barge facility unloading ramp which has been completed, these authorizations would continue to be in place as appropriate throughout the period of extended operation, given their respective renewal schedules.

As discussed in Sections 9.1.3.16 and 9.1.3.23 below, TVA, as a federal agency, is required to comply with Section 7 of the ESA, the NHPA, and 36 CFR Part 800 as it relates to renewal of the SQN OLs. Federal and state agencies and tribal organizations that TVA consulted with during the development of the SQN FSEIS to meet these requirements are listed in Table 9.1-2. Therefore, TVA's consultation requirements identified in these Acts and regulation have been fulfilled prior to submittal of this ER.

9.1.2 Status of Compliance

SQN has established control measures in place to ensure compliance with the authorizations listed in Table 9.1-1, including monitoring, reporting, and operating within specified limits. SQN chemistry/environmental personnel are primarily responsible for monitoring and ensuring that the site complies with its environmental permits and applicable regulations. Monitoring and sampling results associated with environmental programs are submitted to appropriate agencies as specified in the permits and/or governing regulations.

9.1.3 Federal, State, and Local Regulatory Standards: Discussion of Compliance

The discussions below include several environmental regulatory programs that are not legally applicable to SQN due to TVA's status as a federal agency. In these situations, the discussions describe SQN's voluntary compliance actions.

9.1.3.1 Notice of Violations

Based on review of records associated with the various environmental programs and permits that SQN is subject to, there has been only one regulatory notice of violation issued to the facility over the previous 5 years (2007–2011) under the listed permits in Table 9.1-1. In 2009, a notice of violation involving the hazardous waste program was issued by TDEC. This violation was related to proper labeling of used oil containers and proper labeling of containers as to their nonhazardous or hazardous characteristics. SQN has addressed and resolved the deficiencies identified by TDEC. (SQN 2009d)

9.1.3.2 Remediation Activities (Nonradiological)

There are no known surface or subsurface areas on site currently contaminated with nonradiological constituents. Therefore, there are no remediation activities or investigations occurring at the SQN site that are subject to any regulatory standards.

However in June 2009, a diesel fuel oil spill associated with an underground storage tank was identified by SQN. Spill remediation efforts, which involved the removal and disposal of approximately 353,240 pounds of diesel fuel-contaminated soil was completed in April 2010. In August 2010, SQN submitted a request for closure and no further action regarding remediation efforts associated with the spill. The TDEC granted closure and considered the contamination case closed. (TDEC 2010e)

9.1.3.3 Clean Water Act

9.1.3.3.1 Water Quality (401) Certification

Federal CWA, Section 401, requires an applicant for a federal license to conduct an activity that might result in a discharge into navigable waters to provide the licensing agency a certification from the state that the discharge will comply with applicable CWA requirements [33 USC 1341].

The NRC indicated in its GEIS that issuance of an NPDES permit implies continued certification by the state (NRC 1996, Section 4.2.1.1). TDEC also concurs that the NPDES permit constitutes certification under Section 401 of the CWA as evident by the language below that has been included in SQN's NPDES Permit TN0026450 (TDEC 2012c).

> This TN-NPDES permit also constitutes the State's certification under Section 401 of the Clean Water Act for the purpose of obtaining any federal license for activities resulting in discharges covered under the TN-NPDES permit.

Therefore, SQN is providing a copy of its NPDES permit in Attachment C as evidence of a state Section 401WQC.

9.1.3.3.2 NPDES Permit

The release of pollutants (chemical and thermal effluent) in wastewaters at the SQN facility is regulated and controlled through NPDES permit TN0026450 issued by TDEC. As discussed in

Section 3.2.8.2, there are seven outfalls (five external and two internal) identified in the NPDES permit. Monitoring results associated with these outfalls are submitted in discharge monitoring reports to TDEC at the frequency specified in the permit. TVA compliance with the NPDES permit over previous years has been excellent. For example, there have been no thermal-related noncompliances over the previous 5 years, and other noncompliances associated with the NPDES permit have been infrequent, with any deviations addressed in accordance with TVA's problem evaluation and corrective action procedures, and reported in accordance with either the conditions outlined in the permit or as recommended by the regulatory agency. Table 9.1-3 provides a summary of SQN noncompliances from 2007 to 2011.

9.1.3.3.3 Biocide Corrosion Treatment Plan

In accordance with Part IV.B. of NPDES Permit No. TN0026450, SQN developed a biocide/corrosion treatment plan that was approved by the TDEC Division of Water Pollution Control on April 27, 2005, for the specific and limited application of raw water treatment chemicals that are necessary to ensure the safe and reliable operation of the plant by controlling fouling, plugging, and pipe wall thinning of the ERCW and RCW systems. These raw water treatment chemicals include oxidizing biocides, non-oxidizing biocides, corrosion inhibiting chemicals (e.g., surfactants and dispersants), and detoxification chemicals. Oxidizing (i.e., chlorination and/or bromination) biocide treatments are used to control microbiologically induced corrosion. Both oxidizing and non-oxidizing biocide treatments are used to control macroinvertebrates (mollusks). Corrosion inhibiting chemicals are used to provide protection for carbon steel piping in RCW systems.

9.1.3.3.4 Stormwater Permit

Stormwater discharges associated with industrial activities at the SQN site are regulated and controlled through Multi-Sector General Stormwater Permit TNR 050015 issued by TDEC. SQN is required under this permit to develop, maintain, and implement an SWPPP that identifies potential sources of pollution that would reasonably be expected to affect the quality of stormwater and identify the practices that will be used to prevent or reduce pollutants in stormwater discharges (SQN 2007b). SQN is in compliance with the terms and conditions of this permit.

9.1.3.3.5 Sanitary Wastewaters

As discussed in Section 3.2.8.2, sanitary sewage from all plant locations is collected and pumped off site to the Moccasin Bend POTW, where it is managed appropriately. Although not a POTW requirement, SQN conducts radiological sampling and monitoring of the sanitary effluent on a monthly basis.

9.1.3.3.6 Spill, Prevention, Control and Countermeasures

SPCC Plan [40 CFR Part 112]

The EPA's oil pollution prevention rule became effective January 10, 1974, and was published under the authority of Section 311(j)(1)(C) of the Federal Water Pollution Control Act. The regulation has been published in 40 CFR Part 112, and facilities subject to the rule must prepare and implement an SPCC plan to prevent any discharge of oil into or upon navigable waters of the United States or adjoining shorelines. SQN is subject to this rule and has a written SPCC plan that identifies and describes the procedures, materials, equipment, and facilities utilized at the station to minimize the frequency and severity of oil spills to meet the requirements of this rule (SQN 2010c).

Reportable Spills [40 CFR Part 110]

SQN is subject to the reporting provisions of 40 CFR Part 110 as it relates to the discharge of oil in such quantities as may be harmful pursuant to Section 311(b)(4) of the Federal Water Pollution Control Act. Any discharges of oil in such quantities that may be harmful to the public health or welfare or the environment must be reported to the National Response Center. From 2007 to 2012, there have been two spill events at SQN that resulted in a notification to the National Response Center.

In May 2009, a track excavator performing work on a steep bank adjacent to the condenser circulating water intake forebay (intake) slid into the intake at the discharge of the cold water return channel, resulting in a slight sheen in the water. It was estimated that less than 1 gallon of oil was spilled, the source being primarily grease and other lubricants used on the exterior of the equipment. The sheen was quickly contained and cleaned using absorbent pads and a biodegradable absorbent. (SQN 2009e)

On May 24, 2012, oil sheen was discovered on the east side of the ERCW building. Environmental personnel verified the presence of oil sheen outside the ERCW intake skimmer wall and determined it was coming from the C-B ERCW traveling water screen gear drive oil drip pan. The oil spill was stopped utilizing an oil boom and absorbent pads. The amount of oil spilled was estimated to be much less than 1 gallon. Offsite agencies were notified in accordance with the SPCC Plan.

9.1.3.3.7 Facility Response Plan [40 CFR Part 112]

SQN is not subject to the facility response plan risk requirements described in 40 CFR 112.20, because the facility does not transfer oil over water to or from vessels and does not store oil in quantities greater than 1 million gallons.

9.1.3.3.8 Section 404 Permit

Approximately 1.3 percent of the SQN site consists of wetlands. For these wetland areas, either an individual or nationwide Section 404 permit would have to be obtained from the USACE prior to performing activities in these areas. SQN currently has a nationwide permit associated with the installation of the barge facility unloading ramp, which has since been completed. SQN complied with the conditions in this permit, and would continue to comply with Section 404 regulatory requirements when appropriate.

9.1.3.4 Safe Drinking Water Act

Because SQN does not have jurisdiction over any public water system in the vicinity of the plant, and does not engage in underground injections or other actions that could endanger drinking water sources, SQN is not subject to the Safe Drinking Water Act. As discussed in Section 3.2.8.3, potable water for SQN is supplied by the Hixson Utility District municipal water system. No further treatment for potable water usage is performed on site.

9.1.3.5 Clean Air Act

9.1.3.5.1 Air Permit

SQN is subject to and complies with permits to operate the cooling towers, insulator saws, carpenter shop, abrasive sandblasters, auxiliary boilers, and emergency diesel generators. Operation of these air emission sources is maintained within the particulate emissions, opacity, operational run times, fuel usage, and sulfur limits established in the station air permit issued by Chattanooga-Hamilton County Air Pollution Control Bureau (CHCAPCB). Reports of the fuel sulfur content associated with the auxiliary boilers, and operational run times associated with the auxiliary boilers and diesel generators are submitted to the CHCAPCB on a semiannual and annual basis, respectively (SQN 2007f; SQN 2007g; SQN 2008c; SQN 2008d; SQN 2008e; SQN 2009f; SQN 2009g; SQN 2009h; SQN 2010d; SQN 2010e; SQN 2011g; SQN 2011h; SQN 2012d; SQN 2012e; SQN 2012l). SQN is considered a minor air emission source under the CAA.

9.1.3.5.2 Chemical Accident Prevention Provisions [40 CFR Part 68]

SQN is not subject to the risk management plan requirements described in 40 CFR Part 68, because the amount of regulated chemicals present on site do not exceed the threshold quantities specified in 40 CFR 68.130.

9.1.3.5.3 Stratospheric Ozone [40 CFR Part 82]

Under Title VI of the CAA, the EPA is responsible for several programs that protect the stratospheric ozone layer. Regulations promulgated by the EPA to protect the ozone layer are in 40 CFR Part 82. Motor vehicle air conditioners and refrigeration appliances are regulated under Sections 608 and 609 of the CAA. A number of service practices, refrigerant reclamation, technician certification, and other requirements are covered by these programs. SQN is in compliance with Section 608 of the CAA as amended in 1990 and the implementing regulations codified in 40 CFR Part 82. The program to manage stationary refrigeration appliances at SQN is described in TVA's fleet procedure (SQN 2010f; TVA 2010k). Because motor vehicle air conditioners are not serviced on site, Section 609 of the CAA is not applicable.

9.1.3.6 Atomic Energy Act

9.1.3.6.1 Radioactive Waste

As a generator of both LLRW and spent fuel, SQN is subject to and complies with provisions and requirements of the Low-Level Radioactive Waste Policy Amendment Act of 1985 and the Nuclear Waste Policy Act of 1982, as subsequently amended.

SQN also complies with TDEC requirements for shipping radioactive material within Tennessee to a disposal/processing facility licensed by the state of Tennessee to receive such material.

9.1.3.6.2 Liquid and Gaseous Effluent Monitoring Program

Liquid and gaseous radioactive effluents are monitored as required by the SQN ODCM (SQN 2009b, Sections 1/2.2.1 and 1/2.2.2). Based on monitoring conducted over the previous 5 years (2007–2011), all effluent releases were within the concentration and total release limits specified by the ODCM. Projected offsite doses were also within the limits specified by the ODCM, 10 CFR Part 20, 40 CFR Part 190, and Appendix I to 10 CFR Part 50. (SQN 2008f; SQN 2009i; SQN 2010g; SQN 2011i; SQN 2012f) In summary, releases were generally consistent from year to year, allowing for variations based on plant operation, the number of refueling outages, and the scope of routine maintenance work performed. No adverse trend was observed.

9.1.3.6.3 Radiological Environmental Monitoring Program

The airborne, direct radiation, waterborne, and ingestion pathways are monitored as required by the SQN ODCM (SQN 2009b, Section 1/2.3). Based on monitoring conducted over the previous 5 years (2007–2011), review of data has shown no unusual trends and no significant or measurable radiological impact from SQN operations (SQN 2008g; SQN 2009a; SQN 2010a; SQN 2011d; SQN 2012g).

9.1.3.7 NEI Industry Initiative

Onsite groundwater sampling has occurred since the late 1970s and has been expanded since then to incorporate additional well sampling. While no plant-related tritium has been detected in offsite REMP monitoring wells, tritium has been detected in onsite wells over the previous 5 years in the Conasauga Formation which underlies the site (SQN 2008f; SQN 2009i; SQN 2010g; SQN 2011i; SQN 2012f).

Current results suggest that the sources of tritiated groundwater are primarily associated with past inadvertent releases (TVA 2007c, Section 5.2). As discussed in Section 2.3.6, tritium is currently being detected in four shallow wells and one new deep well. Tritium concentrations in the shallow wells are remaining flat or trending downward, while the new well showed a concentration slightly above EPA's drinking water standard limit for tritium. Groundwater and surface water level measurements conducted in 2007 confirmed that the intake and discharge channel would ultimately receive tritiated groundwater discharged from the site, where it would then be diluted in the channels and subsequently the Tennessee River (TVA 2007c, Section 5.3).

Therefore, offsite groundwater supplies would be unaffected. No active remediation has been recommended for the site, and more importantly, the current risk of exposure to radionuclides associated with licensed plant operations to offsite residents is minimal.

9.1.3.8 Resource Conservation and Recovery Act

9.1.3.8.1 Nonradioactive Wastes

As a generator of hazardous and nonhazardous wastes, SQN is subject to and complies with the Resource Conservation and Recovery Act (RCRA) and specific TDEC regulations contained in Chapters 1200-01-07 (Solid Waste Processing and Disposal) and 1200-01-11 (Hazardous Waste Management). As discussed in Section 3.2.8.1, SQN's generator status ranges from conditionally exempt small quantity generator to small quantity generator; therefore hazardous wastes routinely make up only a small percentage of the total wastes generated. As a generator of hazardous wastes, SQN maintains a hazardous waste generator identification number (Table 9.1-1) and reports hazardous wastes generated at the site to TDEC on an annual basis, along with the submittal of hazardous waste generator fees (SQN 2008h; SQN 2009j; SQN 2010h; SQN 2011j; SQN 2012h).

Reportable Spills [40 CFR Part 262]

SQN is subject to the reporting provisions of 40 CFR 262.34(d)(5)(iv)(C) as it relates to a fire, explosion, or other release of hazardous waste, which could threaten human health outside the facility boundary or when the facility has knowledge that a spill has reached surface water. Any such events must be reported to the National Response Center. There have been no releases at SQN that have triggered this notification requirement over the previous 5 years (2007–2011).

9.1.3.8.2 Mixed Wastes

Mixed wastes consisting of lead shielding and paint contaminated with lead are periodically generated at the SQN site. Radioactive materials are regulated by the NRC under the Atomic Energy Act of 1954, and hazardous wastes are regulated by the EPA under the RCRA of 1976. SQN is in compliance with these requirements.

9.1.3.8.3 Underground Storage Tanks

SQN has five embedded underground diesel fuel oil storage tank assemblies encased in the respective structures' concrete foundations. Each assembly consists of four interconnected tanks with a combined capacity of 68,000 gallons (17,000 gallons/tank). In accordance with TDEC's underground storage tank program regulations 0400-18-01, SQN is subject to and complies with the petroleum release response, remediation, and risk management requirements.

Reportable Spills [40 CFR Part 280]

SQN is subject to the reporting provisions of TDEC regulation 0400-18-01-.06 as it relates to discovering a release of a regulated substance at the underground storage site or in the surrounding area. Any such events must be reported to TDEC. There has been one release at SQN that has triggered this notification requirement over the previous 5 years (2007–2011) as discussed in Section 9.1.3.2.

9.1.3.9 Tennessee Hazardous Waste Reduction Action of 1990

As a generator of hazardous waste, SQN must develop and maintain a waste minimization plan for the facility and update the plan annually as required by the Tennessee Hazardous Waste Reduction Act of 1990 (SQN 2008i; SQN 2009k; SQN 2010i; SQN 2011e; SQN 2012i). SQN is in compliance with these requirements.

9.1.3.10 Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act requires that "restricted use" pesticide (inclusive of herbicides) may only be applied by certified applicators or persons working under the direct supervision of a certified applicator [40 CFR Part 171]. Pesticide and herbicide usage does occur periodically at the SQN site. Pesticides are hand applied, while herbicides may either be hand or mechanically applied. Because only certified personnel conduct pesticide/herbicide applications on site, SQN is in compliance with the requirements of this act.

9.1.3.11 Toxic Substances Control Act

The Toxic Substances Control Act of 1976 regulates PCBs [40 CFR Part 761] and asbestos [40 CFR Part 763], both of which are present at SQN. PCBs are present in some transformers, while asbestos-containing materials are typically present in gaskets, insulation, and flooring. SQN is in compliance with the PCB and asbestos regulations applicable to the facility. As a note, based on the reporting of asbestos removal activities associated with the Annual Asbestos Removal Permit A123008 (Table 9.1-1), there has only been one friable asbestos removal activity that has occurred over the previous 5 years (SQN 2009l).

9.1.3.12 Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (HMTA) does not apply to transportation of hazardous materials by SQN when it is carried out by government personnel in government vehicles for a governmental purpose. Such transportation is not "in commerce." However, SQN complies with applicable pre-transportation requirements by private contractors, and voluntarily complies with USDOT regulations under the HMTA on vehicle signage, container labeling, and manifests when transporting hazardous materials over public highways.

9.1.3.13 Emergency Planning and Community Right-to-Know Act (EPCRA)

9.1.3.13.1 Section 312 Reporting [40 CFR Part 370]

SQN submits an emergency and hazardous chemical inventory report (Tier II) to the local emergency planning commission, the state emergency response commission, and the local fire department. This report which typically includes, but is not limited to, chemicals such as boric acid, carbon dioxide, chlorodifluoromethane, diesel fuel, ethylene glycol, gasoline, hydrazine, insulating oil, lead, lubricating oil, nitrogen, PCBs, sand blasting media, sodium hydroxide, sodium tetraborate, and sulfuric acid, is submitted to these agencies annually (SQN 2008j; SQN 2009m; SQN 2010j; SQN 2011k; SQN 2012j).

9.1.3.13.2 Section 313 Reporting [40 CFR Part 372]

Although EPCRA does not apply to federal agencies and Section 313 of EPCRA is not applicable to nuclear plants, SQN submits reports each year on the amounts of chemicals that the facility releases into the environment or transfers off site as wastes if the threshold reporting quantity for that particular chemical is met or exceeded. Based on Section 313 threshold reporting quantities, only two chemicals (hydrazine and lead) have been reported in previous years. (SQN 2008k; SQN 2009n; SQN 2010k; SQN 2011l; SQN 2012k)

9.1.3.14 Comprehensive Environmental Response, Compensation, and Liability Act

SQN is subject to the hazardous substance release and reporting provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as subsequently amended. Any release of reportable quantities of substances listed as hazardous to the environment requires a report to the National Response Center and TDEC, and subsequent written follow-up. There have been no CERCLA-reportable spills at the SQN site over the previous 5 years (2007–2011).

9.1.3.15 Migratory Bird Treaty Act

Although there are no activities at SQN currently affecting migratory birds, the station would comply with the requirements of this act, as appropriate.

9.1.3.16 Endangered Species Act

TVA recognizes that Section 7 of the ESA requires the NRC to review actions they undertake or support (such as issuing permits and licenses) to determine whether they may jeopardize the continued existence of an endangered species or their habitats. However, TVA as a federal agency was also required under Section 7 of the ESA to perform this same review as a result of renewal of the SQN OLs. TVA's review is documented in Section 3.7 of the SQN FSEIS. It was determined that there would be no impacts to threatened or endangered species, because there are no known endangered or threatened species on or adjacent to the SQN site.

9.1.3.17 Bald and Golden Eagle Protection Act

Although bald eagles are present in the vicinity of SQN, there are no activities at the site that trigger requirements for TVA associated with this act.

9.1.3.18 Coastal Zone Management Act

SQN is not subject to the Federal Coastal Zone Management Act [16 USC 1451 et seq.], as the facility is not located in a designated coastal zone area.

9.1.3.19 Magnuson-Stevens Fishery Conservation and Management Act

Because SQN is located on a freshwater body and no anadromous fish have migratory ranges within the vicinity of the station, the consultation requirements of Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the National Marine Fisheries Service Sustainable Fisheries Act of 1996, are not required.

9.1.3.20 Marine Mammal Protection Act

SQN is not subject to the Marine Mammal Protection Act because the facility is located on a freshwater reservoir.

9.1.3.21 Farmland Protection Policy Act

SQN is subject to the Farmland Protection Policy Act, which directs federal agencies to identify and take into account the adverse effects of federal programs on the preservation of farmland. As a federal agency, TVA is not subject to state or local zoning requirements. Because SQN structures associated with license renewal already exist, there would be no impacts to prime farmland associated with license renewal as already determined in Section 1.4.3 of the SQN FSEIS. Therefore, no action relative to the Farmland Protection Policy Act is required.

9.1.3.22 Floodplain Management (Executive Order 11988)

The 100-year floodplain for the Tennessee River is the area below elevation 687 feet msl at TRM 484.5. The 500-year floodplain for the Tennessee River is the area below elevation 688.5 feet msl at TRM 484.5. The TVA flood risk profile (FRP) elevation on the Tennessee River is elevation 689 feet msl at TRM 484.5. The FRP is used to control flood damageable development for TVA projects, and residential and commercial development on TVA lands. Hamilton County, Tennessee, has adopted the 100-year flood as the basis for local floodplain regulations, and any new or future development would be consistent with these regulations (TVA 2011a, Section 3.3.1).

For a "critical action," facilities must be protected to the 500-year flood elevation where there is no practicable alternative. A "critical action" is defined in the Water Resources Council's *Floodplain Management Guidelines for Implementing Executive Order 11988* as any activities for which even a slight chance of flooding would be too great (43 FR 6030). One of the criteria used in determining if an activity is a critical action is whether essential and irreplaceable records, utilities, and/or emergency services would be lost or become inoperable if flooded. Some SQN facilities fall under the classification of a "critical action"; as such, facilities must be protected to the 500-year flood elevation where there is no practicable alternative. However, TVA would require that critical facilities must be protected to the FRP elevation, which is higher than the 500-year flood elevation. Based on this criterion, all facilities that would force the shutdown or curtailment of power generation, if flooded, would either be located above or flood-proofed to the FRP elevation (elevation 689 feet msl at TRM 484.5). Many of the support facilities that would not impact power generation, if flooded, would only be subject to evaluation using the 100-year flood (elevation 687 feet msl at TRM 484.5). (TVA 2011a, Section 3.3.1).

Therefore, no identification of preferable options or determination of "no practicable alternative" per EO 11988 is required.

9.1.3.23 National Historic Preservation Act

TVA recognizes that Section 106 of the NHPA requires the NRC to take into account the effects of the agency's undertaking (including issuance of a license) on properties included in or eligible for the NRHP and, prior to approval of an undertaking, to afford the ACHP a reasonable opportunity to comment on the undertaking. However, TVA as a federal agency was also required under the NHPA to perform the same actions for renewal of the SQN OLs. TVA was also required by federal regulations [36 CFR Part 800] to consult with Native American groups (Table 9.1-2) recognized as stakeholders with the opportunity for comment.

Based on TVA's evaluation and consultations that are documented in Section 3.10.1 of the SQN FSEIS, it was determined that no further investigation of cultural resources on the SQN area of potential effect is necessary in connection with license renewal and any future undertakings at the site. In addition, no specific properties of religious or cultural significance were identified through tribal consultation.

9.1.3.24 Federal Aviation Act

Coordination with the Federal Aviation Administration (FAA) is required when it becomes necessary to ensure that the highest structures associated with the project do not impair the safety of aviation. Submission of a letter of notification (with accompanying maps and project description) to the FAA would result in a written response from the FAA certifying that no hazard exists or recommending project changes and/or the installation of warning devices such as lighting.

The site elevation is dominated by the two 459-foot high cooling towers equipped with an FAA lighting system. In addition, there is a 300-foot meteorological tower equipped with an FAA lighting system. There are no plans at this time to build any new structures during the license renewal period; therefore, no new notifications to the FAA are required.

9.1.3.25 Occupational Safety and Health Act

The federal Occupational Safety and Health Administration (OSHA) governs the occupational safety and health of construction workers and operational staff. As a federal agency, TVA is not directly subject to regulation from OSHA; however, TVA and its contractors comply with OSHA's substantive requirements, as these are incorporated in TVA's occupational health and safety practices.

9.1.3.26 Soddy-Daisy Ordinances

SQN is not subject to any Soddy-Daisy zoning or noise-related ordinances.

9.1.4 Environmental Reviews

TVA has procedural controls (TVA 2010l) in place that require:

- Environmental reviews to be conducted of proposed programs, projects, or actions that could impact the environment.

- Potential environmental impacts of its activities be assessed, decisions made based on an understanding of those impacts, and action taken to protect, restore, and enhance the environment, as appropriate.

These control measures ensure that activities at SQN comply with NEPA, TVA's implementing regulations, CEQ regulations, and other environmental laws, regulations, and executive orders. (TVA 2010l)

9.2 Requirement [10 CFR 51.45(d)]

The discussion of alternatives in the report shall include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements.

9.2.1 Alternatives

The SCPC, natural gas-fired, and new nuclear alternatives discussed in Chapter 7 could likely be constructed and operated to comply with all applicable environmental quality standards and requirements. However, increasingly stringent air quality protection requirements could make the construction of a large fossil-fueled plant infeasible in certain regional locations.

Table 9.1-1
SQN Authorizations—Current Operations

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-30600701-01C	July 17, 2017	Operation of Unit 1 cooling tower.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-30600701-03C	July 17, 2017	Operation of Unit 2 cooling tower.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-30700804-06C	July 17, 2017	Operation of insulation saws A and B.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-10200501-08C	July 17, 2017	Operation of auxiliary boilers A and B.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-30703099-09C	July 17, 2017	Operation of carpenter shop.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-30900203-10C	July 17, 2017	Operation of abrasive blasting operation.
CHCAPCB	Chapter 4, Article I, Section 4-8	Air Permit	4150-20200102-11C	July 17, 2017	Operation of emergency generators 1A, 1B, 2A, and 2B and generators 1 and 2.
CHCAPCB	Chapter 4, Article I, Section 4-8	Asbestos Permit	3034	December 31, 2013	Asbestos removal for individual, non-scheduled renovations.
NRC	Atomic Energy Act,10 CFR Part 50	SQN Unit 1 License to Operate	DPR-77	September 17, 2020	Operation of SQN Unit 1.
NRC	Atomic Energy Act,10 CFR Part 50	SQN Unit 2 License to Operate	DPR-79	September 15, 2021	Operation of SQN Unit 2.
TDEC	Federal Water Pollution Control Act Section 402	NPDES Permit	TN0026450	October 31, 2013	Discharge of wastewaters to waters of the State.

Table 9.1-1 (Continued)
SQN Authorizations—Current Operations

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
TDEC	Federal Water Pollution Control Act Section 402	Stormwater Multi-Sector General Permit	TNR 050015	September 29, 2013	Discharge of stormwater to waters of the State.
TDEC	Chapter 1200-01-11, Hazardous Waste Management	Hazardous Waste Generator Identification Number	TN5640020504	None	Hazardous waste generation and shipments.
TDEC	Chapter 1200-01-07, Solid Waste Processing and Disposal	Solid Waste	DML 331050021	None	Disposal of construction and demolition waste in inert landfill.
TDEC	Tennessee Department of Environment and Conservation Regulations	SQN Radioactive Waste License for Delivery	T-TN002-L13	December 31, 2013	Shipment of radioactive material to a Tennessee disposal/processing facility.
USACE	Federal Water Pollution Control Act Section 404	Nationwide Permit	2009-00654	August 16, 2014	Installation of a barge facility unloading ramp.

CHCAPCB: Chattanooga-Hamilton County Air Pollution Control Bureau
TDEC: Tennessee Department of Environment and Conservation
NRC: U.S. Nuclear Regulatory Commission
USACE: U.S. Army of Corps Engineers

Table 9.1-2
Reviews Related to Endangered Species and National Historic Preservation Acts

Agency	Authority	Response
U.S. Department of the Interior (U.S. Fish and Wildlife Service)	Endangered Species Act Section 7 [16 USC 1636]	No adverse impacts identified as a result of SQN license renewal.
Tennessee Historical Commission	National Historic Preservation Act Section 106	No adverse impacts identified as a result of SQN license renewal.
Cherokee Nation	National Historic Preservation Act Section 106	No comments received.
Eastern Band of Cherokee Indians	National Historic Preservation Act Section 106	No comments received.
The Chickasaw Nation	National Historic Preservation Act Section 106	No comments received.
Kialegee Tribal Town	National Historic Preservation Act Section 106	No comments received.
Thlopthlocco Tribal Town	National Historic Preservation Act Section 106	No comments received.
Shawnee Tribe	National Historic Preservation Act Section 106	No comments received.
Seminole Tribe of Florida	National Historic Preservation Act Section 106	No adverse impacts identified as a result of SQN license renewal.
United Keetoowah Band of Cherokee Indians in Oklahoma	National Historic Preservation Act Section 106	No adverse impacts identified as a result of SQN license renewal.
Muscogee (Creek) Nation of Oklahoma	National Historic Preservation Act Section 106	No comments received.
Absentee Shawnee Tribe of Oklahoma	National Historic Preservation Act Section 106	No comments received.
Eastern Shawnee Tribe of Oklahoma	National Historic Preservation Act Section 106	No comments received.
Alabama-Coushatta Tribe of Texas	National Historic Preservation Act Section 106	No adverse impacts identified as a result of SQN license renewal.

(TVA 2011a, Appendices C and D)

Table 9.1-3
SQN NPDES Permit Noncompliances 2007–2011

NPDES Outfall	Noncompliance Issue	Date
103 (low volume waste treatment pond)	pH exceedance	July 2009
N/A	Missed molluscicide sample	October 2009
N/A	Towerbrom 960 release	August 2010
103 (low volume waste treatment pond)	pH exceedance	October 2010
N/A	Diffuser pond overflow	July 2011

(Howard 2011; SQN 2010l; SQN 2011m)

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