2.4.2 Aquatic Ecology

The construction and operation of two or more small modular reactors (SMRs) on the Clinch River Nuclear (CRN) Site has the potential to affect aquatic resources within the Lower Clinch River watershed. Potentially affected aquatic resources include reservoirs, ponds, and streams on and in the vicinity of the CRN Site. Wetlands and riparian habitats are discussed in conjunction with terrestrial ecology in Subsection 2.4.1. This subsection describes the ecological characteristics of the aquatic resources potentially affected by the Clinch River (CR) SMR Project.

2.4.2.1 Aquatic Habitats

The CRN Site is located between approximately Clinch River mile (CRM) 14.5 and CRM 19 (Reference 2.4.2-1). The proposed location of the condenser cooling water intake is at approximately CRM 17.9, and the proposed location of the cooling water discharge is near CRM15.5. These locations are shown in Figure 2.1-3.

Tennessee Valley Authority's (TVA's) Watts Bar Dam was built in 1942 at Tennessee River mile (TRM) 529.9 to create the Watts Bar Reservoir. This dam effectively impounded the portion of the Clinch River that flows past the CRN Site; accordingly, this reach of the Clinch River is considered part of Watts Bar Reservoir. (Reference 2.4.2-2) TVA's Melton Hill Dam, which was completed in 1963, is 5.2 miles (mi) upstream of the proposed cooling water intake structure for the CRN Site. Although Melton Hill Reservoir is a run-of-river reservoir that does not hold water long-term, this dam also affects water flow rates past the CRN Site. Releases from Fort Loudoun Dam and Watts Bar Dam downstream also can influence water velocity adjacent to the CRN Site. (Reference 2.4.2-3)

The aquatic habitats with the potential to be affected by the CR SMR Project include the Clinch River arm of the Watts Bar Reservoir, Melton Hill Reservoir, and streams and ponds on the CRN Site. Watts Bar Reservoir would be directly affected by water withdrawals and discharges. Melton Hill Reservoir may be affected indirectly through changes in water management associated with downstream withdrawals for the CR SMR Project. Ponds and streams on or near the CRN Site may be directly affected if they are located within areas required for construction or operation of two or more SMRs. The ecological characteristics of these potentially affected water bodies are described below.

2.4.2.1.1 Clinch River Arm of the Watts Bar Reservoir

TVA assesses the ecological health of its reservoirs through periodic sampling conducted historically under its Vital Signs Monitoring Program and currently under ongoing ecological health and compliance monitoring programs. The programs use multi-metric evaluation techniques to assess trends in aquatic resources and overall conditions in the reservoirs. These monitoring activities focus on:

- Physical and chemical characteristics of the water
- Physical and chemical characteristics of the sediment
- Fish community sampling
- Benthic macroinvertebrate community sampling (Reference 2.4.2-4)

TVA monitors four locations on the Watts Bar Reservoir, usually on a 2-year (yr) cycle. Monitoring occurred in even-numbered years beginning in 1994, with an additional monitoring event in 2009. The four monitoring locations were: the forebay area of deep water near the dam, the middle part of the reservoir, and the riverine areas at the extreme upper ends of the reservoir in the Tennessee River and the Clinch River, called the Tennessee and Clinch inflow locations. (Reference 2.4.2-5) The Clinch inflow location is at CRM 22 below Melton Hill Dam. To obtain seasonal data specifically from the reach of the Watts Bar Reservoir adjacent to the CRN Site, TVA initiated additional studies in 2011 to characterize baseline conditions of the aquatic habitats and communities in the reservoir immediately upstream and downstream of the CRN Site (Reference 2.4.2-6).

Physical and Chemical Characteristics

The physical and chemical characteristics of the water body affect the aquatic habitats and ecological communities present in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site. These characteristics are discussed in more detail in Subsection 2.3.3. Water quality and sediment quality parameters were measured in 2011, 2012, and 2013 as part of the preapplication monitoring study of aquatic habitats of the Watts Bar Reservoir in the area of the CRN Site. Water quality samples were taken at CRMs 18.5, 19.7, and 22.0 (upstream), and at CRM 15.5 (downstream). The sample analyses included metals, radionuclides (gross alpha, gross beta, radium-226, and radium-228), nutrients (Kjeldahl nitrogen, nitrate plus nitrite-nitrogen, ammonia-nitrogen, total phosphorus, and orthophosphate), total organic carbon (TOC), alkalinity, hardness, water clarity (turbidity and suspended solids), dissolved solids, and other constituents. Additionally, parameters such as water temperature, dissolved oxygen (DO), conductivity, and pH were measured. (Reference 2.4.2-7) Surface water sample results for the Clinch River arm of the Watts Bar Reservoir upstream and downstream of the CRN Site indicate that TDEC’s most stringent numeric water quality criteria are being met. In addition, the results of stormwater sampling indicate that site runoff would not have a significant impact on water quality. (Reference 2.4.2-7)

Water quality in the vicinity of the CRN Site is influenced by Melton Hill Dam and Norris Dam and the water quality of the inflow to Melton Hill Reservoir. Consistent with the geology of the area, water of the Clinch River arm of Watts Bar Reservoir was slightly alkaline, moderately hard, and well buffered. Nutrient concentrations were relatively high for nitrogen and moderate to low for phosphorus. The low phosphorus levels could limit phytoplankton growth and abundance. Maximum water temperatures in summer, near 72 degrees Fahrenheit (°F) in June and July, were well below the State of Tennessee maximum temperature criterion of 86.9°F.

The water column tended to be well mixed, though appreciable vertical gradients in oxygen were observed in July. DO concentrations often varied spatially about 1.0 to 1.5 milligrams per liter (mg/L). Several water quality parameters varied seasonally in response to variations in rainfall and runoff as well as processes in the reservoir related to dam operations. Concentrations of metals in water were below maximum concentrations established by the State of Tennessee for protection of aquatic life. (Reference 2.4.2-6) As discussed in Subsection 2.3.1.1.2.7, daily thermal gradients were documented to occur during summer due to surficial warming during the hottest time of the day. However, the warmer surface water was then either flushed out by daily dam releases from Melton Hill Dam, or its heat dissipated with nighttime atmospheric cooling.

Physical and chemical characteristics of the Clinch River arm of Watts Bar Reservoir resulting from historical human activities in the area have affected aquatic habitats and ecological communities. The hydrological characteristics of the Clinch River arm of the Watts Bar Reservoir near of the CRN Site were changed by the construction of Norris Dam on the Clinch River in 1936, Watts Bar Dam on the Tennessee River in 1942, and Melton Hill Dam on the Clinch River in 1963. (Reference 2.4.2-4) Dams create impoundments that can alter water quality, resulting in effects such as excessive nutrient levels, accumulation of sediment, and growth of aquatic plants. The altered flow pattern can change the physical character of the channel morphology and substrate composition. These changes affect the types of habitats present and the chemical characteristics of the water. Dams also impede the movement of aquatic organisms and reduce the likelihood of reproductive dispersal. These dam-induced mechanisms change the composition of the ecological communities present. (Reference 2.4.2-8) The Clinch River arm of Watts Bar Reservoir also has been affected by the historical release of pollutants. For example, contaminants released from the Oak Ridge National Laboratory (ORNL) have resulted in sediment toxicity issues between White Oak Creek (at CRM 21, upstream of the CRN Site) and Watts Bar Dam (TRM 530) that may have contributed to mussel declines in this area. (Reference 2.4.2-4)

In addition to water quality, sediment quality was assessed at three locations (CRMs 15.5, 18.5, and 22.0) during the 2011 surveys. Sediment samples were analyzed for pesticides, polychlorinated biphenyls (PCBs), and metals. Metals concentrations were below U.S. Environmental Protection Agency (EPA) Region 4 ecological screening levels for sediment, and pesticides and PCBs were not detected in the sediment samples collected near the CRN Site. Sediments at these locations contained lower metals concentrations than typically found in more lacustrine environments within TVA reservoirs. Substrate composition was characterized at eight downstream transects and eight upstream transects. Sand was the dominant substrate downstream, followed by cobble, silt, and gravel. Clay was the dominant substrate upstream, followed by gravel, cobble, and bedrock. (Reference 2.4.2-6)

Although contaminants were not detected in sediments near the CRN Site, the Division of Water Pollution Control of the Tennessee Department of Environment and Conservation (TDEC) has issued fish consumption advisories for Watts Bar Reservoir due to PCBs and for Melton Hill Reservoir due to PCBs and chlordane. These fish consumption advisories were issued because these contaminants were detected in sediments in other areas of these reservoirs. (Reference 2.4.2-6)

Biological Communities

Since 1990 TVA has systematically monitored the aquatic biological communities in its reservoirs as part of the former Vital Signs Monitoring Program and its ongoing ecological health and compliance monitoring programs. The Clinch River inflow area of Watts Bar Reservoir upstream of the CRN Site has been monitored under this program. (Reference 2.4.2-4) To obtain additional data specifically from the reach of Watts Bar Reservoir adjacent to the CRN Site, TVA initiated additional studies in 2011 to characterize the aquatic communities occurring in the reservoir immediately upstream and downstream of the CRN Site. These 2011 studies were designed to evaluate the diversity, abundance, and condition of resident fish, benthic macroinvertebrate, and plankton communities in the vicinity of the CRN Site in order to establish baseline conditions existing prior to construction and operation of two or more SMRs. During these studies of aquatic habitat, submerged aquatic vegetation (macrophytes) was not observed at either of the study locations. (Reference 2.4.2-6)

Fish Community

Fish communities are used to evaluate ecological conditions because of their importance in the aquatic food web and because fish life cycles are long enough to integrate conditions over time. Impoundments have affected the characteristics of the fish community in the Clinch River arm of Watts Bar Reservoir (Reference 2.4.2-6). The cool water of Melton Hill Reservoir is released to Watts Bar Reservoir at CRM 23.1, approximately 4.1 mi upstream of the CRN Site. Although the water warms with distance below the Melton Hill Dam, its relatively cooler temperatures may limit fish species diversity and abundance downstream (Reference 2.4.2-6). To characterize the fish community currently present in the reach of Watts Bar Reservoir adjacent to the CRN Site, TVA implemented fisheries studies there in 2011. In conjunction with the Vital Signs Monitoring Program, TVA previously developed a fisheries monitoring tool, the Reservoir Fish Assemblage Index (RFAI) (Reference 2.4.2-4). The RFAI was thoroughly tested on TVA reservoirs and other reservoirs and published in peer-reviewed literature. The RFAI was used in the 2011 aquatic habitat study to characterize the fish community in the vicinity of the CRN Site. (Reference 2.4.2-6)

Fish Community Characterization

To characterize the fish community in the Clinch River arm of Watts Bar Reservoir at the CRN Site, TVA selected two fish sampling locations: one located downstream of the CRN Site between CRMs 14 and 16 (referred to as location CRM 15.0), and one located upstream of the CRN Site between CRMs 18 and 19.8 (referred to as location CRM 18.5). Sampling by electrofishing and gill netting was conducted in February, May, July, and October of 2011 to document seasonal variation in fish community composition. The fish collected were identified by species, counted, and examined for anomalies such as disease, deformations, parasites, or hybridization. The resulting data were analyzed using RFAI methodology. (Reference 2.4.2-6)

The RFAI uses 12 fish community metrics from four general categories: Species Richness (numbers of species) and Composition; Trophic Composition; Abundance; and Fish Health. Individual species can be utilized for more than one metric. Together, these 12 metrics provide a balanced evaluation of fish community integrity. (Reference 2.4.2-6) The 12 metrics, grouped by category, are summarized below:

- Species Richness and Composition
  - Total number of indigenous species (greater than 29 required for highest score): Greater numbers of indigenous species are considered representative of a healthier aquatic ecosystem. As conditions degrade, numbers of species in an area decline.
  - Number of centrarchid species (greater than four required for highest score): Sunfish species (excluding black basses) are invertivores, and a high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.
  - Number of benthic invertivore species (greater than seven required for highest score): Due to the special dietary requirements of this species group and the limitations of their food source in degraded environments, numbers of benthic invertivore species increase with better environmental quality.
  - Number of intolerant species (greater than four required for highest score): A group composed of species that are particularly intolerant of physical, chemical, and thermal habitat degradation. Higher numbers of intolerant species suggest the presence of fewer environmental stressors.
  - Percentage of tolerant individuals (less than 31 percent of electrofishing samples and less than 16 percent of gill net samples required for highest score): This metric signifies poorer water quality with increasing percentages of individuals tolerant of degraded conditions.
  - Percent dominance by one species (less than 20 percent of electrofishing samples and less than 14 percent of gill net samples required for highest score): Ecological quality is considered reduced if one species inordinately dominates the resident fish community.
  - Percentage of non-indigenous species (less than 3 percent of electrofishing samples and less than 5 percent of gill net samples required for highest score): This metric is based on the assumption that non-indigenous species reduce the quality of resident fish communities.
  - Number of top carnivore species (greater than seven required for highest score): Higher diversity of piscivores is indicative of the availability of forage species and the presence of suitable habitat.

- Trophic Composition
  - Percentage of individuals as top carnivores (greater than 11 percent of electrofishing samples and greater than 52 percent of gill net samples required for highest score): This metric is a measure of the functional aspect of top carnivores that feed on lower trophic levels.
  - Percentage of individuals as omnivores (less than 22 percent of electrofishing samples and less than 23 percent of gill net samples required for highest score): Omnivores are less sensitive to environmental stresses due to their ability to vary their diets. As trophic links are disrupted due to degraded conditions, specialist species such as insectivores decline while opportunistic, omnivorous species increase in relative abundance.
- Abundance
  - Average number per run (number of individuals) (greater than 210 from electrofishing samples and greater than 24 from gill net samples required for highest score): This metric is based on the assumption that high-quality fish assemblages support large numbers of individuals.
- Fish Health
  - Percentage of individuals with anomalies (less than 2 percent of gill net and electrofishing samples required for highest score): Occurrences of diseases, lesions, tumors, external parasites, deformities, blindness, and natural hybridization are noted. A higher percentage of individuals exhibiting such conditions can indicate poor environmental conditions. (Reference 2.4.2-6)

The fish species collected from the Clinch River arm of Watts Bar Reservoir in the 2011 study are listed in Table 2.4.2-1. The trophic level for each species is shown, indigenous species are identified, and those species designated as tolerant and intolerant also are identified. The RFAI scores for each location in each season and the associated ecological health ratings for the fish community are summarized in Table 2.4.2-2.

The overall RFAI scores resulted in an ecological health rating for the fish community of “fair” for each season at the downstream location. The ecological health rating for the fish community at the upstream location was “fair” for winter, summer, and autumn, and “good” for spring. These scores are similar to other assessment locations on the Clinch River downstream of Melton Hill Dam. (Reference 2.4.2-6)

Overall RFAI ratings for each season for the downstream and upstream sampling locations were similar. RFAI scores during each of the four seasons differed by four points or less between the two sampling sites. RFAI scores have an intrinsic variability of plus or minus three points. This variability comes from various sources, including:

- Annual variations in air temperature and stream flow

- Variations in pollutant loadings from nonpoint sources
- Changes in habitat, such as extent and density of aquatic vegetation
- Natural population cycles and movements of the species being measured

In addition, nearly any practical measurement, lethal or non-lethal, of a biological community is a sample rather than a measurement of the entire population. This variability due to methods must be considered when comparing scores between sampling locations. (Reference 2.4.2-6)

Both sampling locations received low scores for the metric “average number per run” for both electrofishing and gill net samples each season. Cool water temperatures from Norris Dam releases upstream may limit overall productivity, thus reducing abundance of some species in this portion of the Clinch River arm of Watts Bar Reservoir. Although catch rates were low, species diversity was relatively high at both locations. Averages of 33 (28 indigenous) and 36 species (31 indigenous) were collected at the downstream and upstream locations, respectively. Distinct differences in trophic guild composition of the fish community were evident between locations during each season. The upstream location contained higher proportions of omnivores and fewer proportions of insectivores than the downstream location in each season. Proportions of top carnivores were higher at the upstream location during spring but were similar at the two locations during other seasons. The downstream location had a much higher proportion of benthic invertivores during autumn. (Reference 2.4.2-6)

Thermally sensitive species were defined as those having an upper lethal limit of water temperatures greater than or equal to 90°F. Thermally sensitive species collected in the 2011 sampling are identified in Table 2.4.2-1. On average, two thermally sensitive species were present during all four seasons at both sampling locations. All fish species collected were considered Representative Important Species because they were used to obtain an overall RFAI score. Representative Important Species are defined by the EPA as those species that are representative in terms of their biological requirements of a balanced, indigenous community of fish, shellfish, and wildlife in the body of water into which a discharge is released. (Reference 2.4.2-6)

<u>Fish Eggs and Larvae</u>

Also in 2011, TVA investigated fish eggs and larvae in Watts Bar Reservoir at the CRN Site to assess the temporal occurrence, abundance, and species composition of ichthyoplankton in that part of the reservoir. Samples were collected adjacent to the CRN Site at an upstream location at CRM 18 and a downstream location at CRM 15.5. Eight samples were collected from each location at the following frequencies: once in February 2011, weekly from March through August 2011, and once a month from September 2011 through January 2012. (Reference 2.4.2-3) The sampling frequency was selected to capture seasonal spawning activity of fishes. Thus, sampling was performed weekly during March through August when the majority of spawning occurs and monthly from September through February when little to no spawning occurs. Each sampling event included the collection of eight samples (four day and four night) along a transect at each location. The four day and four night samples were collected along the transects at mid-channel full stratum, mid-channel bottom only, right descending bank, and left descending bank. The species abundance data also were used with sample volume data to calculate species-specific densities of fish eggs and larvae in the water column. (Reference 2.4.2-3)

The total numbers of fish eggs and larvae collected at the upstream and downstream locations and the percentage composition of the samples represented by each taxon are summarized in Table 2.4.2-3. The taxa identified in the samples are organized in the table by family. The families represented in the egg and larvae samples and the principal species identified from each family include the following (Percidae and Polyodontidae constitute less than 1 percent of the total eggs or larvae collected):

- Atherinopsidae (silversides, predominantly Mississippi silversides)
- Catostomidae (buffalofishes, carpsuckers, redhorses)
- Centrarchidae (crappie, sunfishes)
- Clupeidae (gizzard shad, threadfin shad, unidentifiable clupeids, skipjack herring)
- Cyprinidae (common carp, minnows of genus *Pimephales*)
- Moronidae (temperate basses)
- Percidae (darters, yellow perch, walleye)
- Polyodontidae (paddlefish)
- Sciaenidae (freshwater drum) (Reference 2.4.2-3)

A total of 7814 fish eggs were collected at both locations. The families represented, in order of frequency, were:

- Sciaenid (freshwater drum) eggs (53.6 percent)
- Clupeid eggs (23.4 percent)
- Moronid eggs (14.3 percent)
- Unidentifiable eggs (8.7 percent)
- Percid eggs (less than 1 percent) (Reference 2.4.2-3)

A total of 3949 larval fish were collected, representing nine families. Larvae were more abundant downstream than upstream, mainly due to a high number of catostomid larvae downstream. The dominant larval taxon at both transects was the clupeids (67.4 percent). The other taxa contributing at least 1 percent of the total composition were:

- Catostomids (11.7 percent)

- Moronids (10.2 percent)
- Centrarchids (5.6 percent)
- Atherinopsids (1.8 percent)
- Sciaenids/freshwater drum (1.3 percent)
- Cyprinids (1.3 percent) (Reference 2.4.2-3)

A single larval paddlefish was collected at the upstream location (CRM 18) during the survey. The paddlefish is highly valued for its eggs, and the paddlefish fishery throughout the Tennessee Valley has been of special concern and is closely monitored and regulated. This larva is significant in that it indicates that at least some minimal spawning is occurring in the Clinch River arm of the Watts Bar Reservoir in the tailwater below Melton Hill Dam. (Reference 2.4.2-3)

Benthic Macroinvertebrate Community

TVA assessed benthic macroinvertebrate communities of its reservoirs using the Reservoir Benthic Index (RBI) methodology. RBI is a metric used to assess relative conditions at selected locations within TVA reservoirs across the reservoir system. This index does not provide an absolute measure of aquatic community health as compared to an unimpounded river. Therefore, an RBI score of "excellent" does not necessarily equate to an excellent benthic community, rather it indicates an excellent condition of the benthic community as compared to other, similar, reservoir-influenced sites within the TVA reservoir system. Because benthic macroinvertebrates are relatively immobile, negative effects on aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities than in fish communities. Accordingly, RBI data are used to supplement RFAI results to provide a more thorough characterization of aquatic communities. (Reference 2.4.2-6)

The RBI methodology was used in the 2011 aquatic habitat assessment of the CRN Site. Benthic macroinvertebrate communities were sampled along transects with a Peterson or Ponar dredge downstream (CRM 15.0) and upstream (CRM 18.8) of the CRN Site during spring, summer, and autumn of 2011. RBI metrics were scored using evaluation criteria for lab-processed samples collected in the “inflow” reservoir zone. In addition to dredge sampling, during the autumn sampling event, shoreline benthic samples were collected with a kick-net and from rocks along the shoreline at both sites to obtain additional species richness and density data. (Reference 2.4.2-6)

Benthic community results were evaluated using seven metrics for assessing community characteristics. Results for each metric were assigned a rating of 1 (poor), 3 (good), or 5 (excellent), depending on how they scored based on reference conditions developed for Tennessee River reservoir inflow sample sites. The ratings for the seven metrics were then summed to produce a benthic score for each sample site. Potential benthic scores ranged from

7 to 35. Ecological health ratings were then assigned based on the scores using the following scale:

- 7 to 12 = "Very Poor"
- 13 to 18 = "Poor"
- 19 to 23 = "Fair"
- 24 to 29 = "Good"
- 30 to 35 = "Excellent"

The individual metric ratings and overall RBI scores for the downstream and upstream locations based on the 2011 dredge samples are summarized in Table 2.4.2-4. (Reference 2.4.2-6) The individual metrics are summarized below:

- Average number of taxa (greater than 8.3 required for highest score): This metric is calculated by averaging the total number of taxa present in each sample at a site. Higher numbers of taxa (taxa richness) usually indicate better conditions than lower numbers of taxa. (Reference 2.4.2-6)
- Proportion of samples with long-lived organisms (greater than 0.8 required for highest score): This is a presence/absence metric that is assigned based on the proportion of samples collected at a given location containing at least one long-lived organism (e.g., *Corbicula* greater than 10 millimeters (mm), *Hexagenia* greater than 10 mm, mussels, snails). The presence of long-lived organisms is indicative of conditions that allow long-term survival. (Reference 2.4.2-6)
- Average number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa (greater than 1.9 required for highest score): This metric is calculated by averaging the number of EPT taxa present in each sample at a site. Higher diversity (i.e., a higher average number) of EPT taxa indicates good water quality and better habitat conditions. (Reference 2.4.2-6)
- Percentage as oligochaetes (less than 12.0 percent required for highest score): This metric is calculated by averaging the percentage of oligochaetes in each sample at a site. Oligochaetes are considered tolerant organisms, so a higher percentage indicates poor water quality. (Reference 2.4.2-6)
- Percentage as dominant taxa (less than 73.1 percent required for highest score): This metric is calculated by selecting the two most abundant taxa in a sample, summing the number of individuals in those two taxa, dividing that sum by the total number of individuals in the sample, and multiplying that number by 100 to obtain a percentage. The percentages for each of the 10 samples collected from each location are then averaged. Often, the most abundant taxa differ among the 10 samples at a site. This method for calculating the percentage allows more discretion to identify imbalances at a site than developing an average for a single dominant taxon for all samples at a location. This metric is used as an

evenness indicator. Dominance of one or two taxa indicates poor conditions. (Reference 2.4.2-6)

- Average density excluding chironomids and oligochaetes (density greater than 609.9 required for highest score): This metric is calculated using a two step process. First, the number of organisms in each sample excluding chironomids and oligochaetes is summed to obtain the density without chironomids and oligochaetes. Then an average of these densities for the 10 samples at a site is calculated. This metric examines the community by excluding taxa that often dominate under adverse conditions. A higher abundance of non-chironomids and non-oligochaetes indicates good water quality conditions. (Reference 2.4.2-6)
- Proportion of samples containing no organisms (no empty samples required for highest score): This metric is the proportion of samples at a site that have no organisms present. Empty samples, or "zero samples," indicate living conditions unsuitable to support aquatic life (e.g., due to toxicity or unsuitable substrate). (Reference 2.4.2-6)

The shorelines also were sampled for benthic invertebrates in autumn of 2011. Invertebrate samples were collected from submerged rocks at the upstream location. However, there was not sufficient rock substrate present at the downstream location to collect a sample. Therefore, a kick net was used to collect the sample from the downstream location. The differences in sampling techniques and habitat sampled limit direct comparisons of the results from these two locations. At the downstream location, chironomids and oligochaetes were the dominant taxa. At the upstream location, zebra mussels (*Dreissena polymorpha*), dipterans, hydrobiid snails, and oligochaetes were dominant. Mean densities (organisms/ square meter [m^2]) were about 2 to 3 times higher at the upstream location than at the downstream location, but taxa richness values were similar downstream and upstream. (Reference 2.4.2-6)

Overall, the RBI scores calculated for samples collected from both the upstream and downstream locations during spring, summer, and autumn of 2011 were high. The ecological health rating for the downstream location was "good" in spring and autumn and "excellent" in summer. The ecological health rating for the upstream location was "good" in spring and "excellent" in summer and autumn. The downstream location received the lowest score (1) in only two metrics, the average number of EPT taxa in spring and the average percentage of oligochaetes in autumn. The upstream location received a score of 1 only in the average number of EPT taxa metric in spring. All other metrics were 3 or 5. Taxa richness was higher in samples from the upstream location than in samples from the downstream location during each of the seasons. Mean densities were higher in autumn than in spring or summer at both locations, due to high densities of zebra mussels. The most abundant species collected at either location in spring and summer was the snail *Amnicola limosa*. The Chironomidae family was particularly diverse, with more than 55 distinct species, and was the second most abundant taxon collected at either location during each of the seasons. In the shoreline samples, taxa richness was similar at the upstream and downstream locations. Very few taxa were present in shoreline samples that were not encountered in dredge samples. Overall, these data depict an ecologically healthy benthic macroinvertebrate community in the reservoir both upstream and downstream of the CRN Site. The presence of high densities of zebra mussels upstream and downstream of the CRN Site is of concern because it indicates a potential for biofouling issues. (Reference 2.4.2-6)

In addition to its 2011 RBI assessment of the benthic macroinvertebrate community and the aquatic habitat assessment at the CRN Site, TVA also conducted an evaluation in 2011 that focused on the freshwater mollusk community of the reservoir adjacent to the CRN Site. Both qualitative and semi-quantitative sampling methods were used to characterize the composition, density, and distribution of species within the mollusk community between CRM 15.0 and CRM 19.0. Bank-to-bank survey transects were spaced approximately 300 meters (m) apart and additional transects were placed about 50 m upstream and downstream of the anticipated locations of the discharge and intake structures near CRM 16.0 and CRM 17.9, respectively. Thus, a total of 25 transects were sampled using semi-quantitative methods. In addition, qualitative sampling consisted of 1-hour (hr) timed searches at each of five sites: the discharge site, the intake site, and three sites in areas with the most suitable mollusk habitat, as determined based on data from the semi-quantitative sampling. The report documenting the details of the mollusk survey methods and results is provided in Appendix B of the TVA Technical Report: *Clinch River Small Modular Reactor Site – Evaluation of Aquatic Habitats and Protected Aquatic Animals*. (Reference 2.4.2-4)

The survey collected 74 live mussels from the following six species:

- Pimpleback (*Quadrula pustulosa*) (71.6 percent of the mussels collected)
- Fragile papershell (*Leptodea fragilis*) (17.6 percent of the mussels collected)
- Purple wartyback (*Cyclonaias tuberculata*) (less than 5 percent of the mussels collected)
- Pink heelsplitter (*Potamilus alatus*) (less than 5 percent of the mussels collected)
- Giant floater (*Pyganodon grandis*) (less than 5 percent of the mussels collected)
- Elephant ear (*Elliptio crassidens*) (less than 5 percent of the mussels collected) (Reference 2.4.2-4)

None of these species are federally listed as threatened or endangered. However, relic (nonliving) specimens of four mussel species federally listed as endangered were collected:

- Dromedary pearlymussel (*Dromus dromas*)
- Fanshell (*Cyprogenia stegaria*)
- Rabbitsfoot (*Quadrula cylindrica*)
- Spectaclecase (*Cumberlandia monodonta*)(Reference 2.4.2-4)

The presence of these relic specimens indicates that these species once resided in the Clinch River arm of the Watts Bar Reservoir near the CRN Site. Other relic mussel shells also were collected, including those of the following species:

- Black sandshell (*Ligumia recta*)
- Butterfly (*Ellipsaria lineolata*)
- Fluted kidneyshell (*Ptychobranchus fasciolaris*)
- Longsolid (*Fusconaia subrotunda*)
- Mucket (*Actinonaias ligamentina*)
- Ohio pigtoe (*Pleurobema cordatum*)
- Pocketbook (*Lampsilis ovata*)
- Pyramid pigtoe (*Pleurobema rubrum*)
- Round hickorynut (*Obovaria subrotunda*) (Reference 2.4.2-4)

The only snail species collected was the silty hornsnail (*Pleurocera canaliculata*), which is common within the Tennessee River basin (Reference 2.4.2-4).

Mean mussel density (semi-quantitative sampling) was 0.02 mussels/m^2 and the mean catch rate (qualitative sampling) was 4.2 mussels per hour. The mussels did not appear to be distributed in a particular pattern, but they were most abundant upstream at transects 2 and 3 near CRM 19 and downstream around transect 21 at CRM 16. Substrates where mussels were encountered during the survey contained mixtures of cobble, gravel, and sand, but in numerous areas with this substrate type mussels were less abundant or absent. Unsuitable substrates included bedrock and heavily silted areas, which were located along the banks of the river. (Reference 2.4.2-4)

The survey concluded that the mussel community at the CRN Site is in poor condition. Evaluation of the 2011 mollusk and habitat survey in conjunction with historical surveys near the CRN Site indicated that habitat conditions to support mussels are generally inadequate, despite improvements in reservoir releases from Melton Hill Dam and Watts Bar Dam that began in 1991. In previous studies in the Clinch River arm of the Watts Bar Reservoir in the vicinity of the CRN Site, 16 mussel species were found in 1918, 10 species were found in 1982, 15 species were found in 1991, and six species were found in 1994. Comparing the 2011 mussel survey results to the 1982 survey results and accounting for sampling effort, the decline in numbers was estimated to be approximately 60 percent. In addition, no evidence of recent mussel reproduction was found in the 2011 survey, because no juvenile mussels were found and individuals 15 yr old or older were common. (Reference 2.4.2-4)

Plankton Community

The plankton component of the aquatic ecosystem is made up of drifting organisms, including algae (phytoplankton), protists, metazoans and larvae (zooplankton), and bacteria and archaea (bacterioplankton). These organisms form the bottom of the trophic food chain upon which the other levels depend. (Reference 2.4.2-9) During 2011, TVA surveyed both phytoplankton and zooplankton while characterizing the aquatic communities at the CRN Site. Plankton samples were collected at the same time as the water chemistry samples, monthly from March through December 2011. (Reference 2.4.2-6)

Phytoplankton

For each sample, chlorophyll a concentrations were determined and a fraction of the algal community was identified and counted until the standard error for mean abundance was less than 10 percent. Basic statistics were calculated, including cell densities, biovolume, and mean abundance. Chlorophyll a concentrations were low in all samples, ranging from less than 1.0 to 5.0 micrograms per liter (μg/L). In approximately 40 percent of the samples, concentrations were undetectable, and only two samples contained greater than 2 μg/L. These low concentrations indicate that phytoplankton growth was very limited at the CRN Site. Turbulence causing light limitation was the most likely factor influencing growth. Occasional higher concentrations upstream were attributed to releases from the Melton Hill Reservoir, which is less turbulent. (Reference 2.4.2-6)

A total of 81 phytoplankton taxa were collected during the 2011 survey. The taxa collected were:

- Chlorophytes (32 taxa)
- Bacillariophytes (17 taxa)
- Cyanophytes (16 taxa)
- Chrysophytes (eight taxa)
- Euglenophytes (three taxa)
- Pyrrophytes (three taxa)
- Cryptophytes (two taxa)

The phytoplankton was numerically dominated by cyanophytes, which represented 90 to 99 percent of the samples at all locations and sampling times. The other algal groups consistently represented less than 2 percent of the assemblage each. Chrysophytes and cryptophytes represented approximately 1 percent of the assemblage, and euglenophytes and pyrrophytes were below 1 percent. (Reference 2.4.2-6)

Phytoplankton population size estimates ranged from 3600 to 52,000 cells per milliliter (cells/mL). Variability among locations and dates was accounted for by the abundance of cyanophytes due to their overall dominance. Other algal groups showed the same trend. Highest abundances were present at CRM 22, followed by CRM 15.5; lowest abundances were present at CRM 18.5. Higher abundance upstream may be due to releases from Melton Hill Reservoir. Abundance trended downward generally in the autumn, due to factors including seasonal declines in water temperature, light levels, and nutrients. (Reference 2.4.2-6)

Phytoplankton biovolume varied from 23,000 to 920,000 cubic micrometers per milliliter ($\mu m^3/mL$), with a maximum in spring. The sample with maximum biovolume contained the diatom *Melosira*, which represented 60 percent of the total. This species is usually found in reservoirs rather than in flowing waters. Diatoms dominated biovolume in most months. Although the cyanophytes dominated numerical abundance, they contributed an average of only approximately 7 percent of the total biovolume due to their small individual size. Euglenophytes and pyrrophytes often include large-celled phytoplankton. Therefore, a few individuals can contribute considerable biovolume. The pyrrophytes *Glenodinium, Gymnodinium*, and *Peridinium* contributed up to 65 percent of total biovolume when present. (Reference 2.4.2-6)

Phytoplankton populations in the area of the CRN Site were characterized by low abundance and appeared to result mainly from phytoplankton populations generated within Melton Hill Reservoir and transported downstream. Based on chlorophyll results, phytoplankton productivity in the sampled reach was very limited. Phytoplankton populations were essentially in a senescent phase. Productivity was likely light-limited due to turbulence within the water column. (Reference 2.4.2-6)

Similar temporal patterns in the structure of the phytoplankton communities were evident among the sampling locations, though many phytoplankton taxa occurred at various times and locations. Quantitative characteristics (total and group cell densities) often varied substantially. Overall, cyanophytes were dominant numerically throughout the 10-month study period, and bacillariophytes (diatoms) were typically dominant in terms of biovolume. Although no definitive spatial trends were evident, there was a general pattern of higher population densities at the most upstream site from March through August. These higher densities likely are related to entrainment of phytoplankton in releases from Melton Hill Dam and the proximity of the most upstream location to the dam. This pattern was not evident after August, when phytoplankton densities were substantially lower at all sampling locations due to increased flow and the interrelated effects of seasonal changes. (Reference 2.4.2-6)

Zooplankton

Eighteen zooplankton taxa were collected during the 2011 survey. The most diverse group was the cladocerans (eight taxa), followed by the rotifers (seven taxa) and copepods (three taxa). More copepod taxa may have been collected, but identification past the level of order was not possible. The three taxa identified were *Diaptomus* sp., *Tropocyclops prasinus* and *Cyclops* sp. Overall taxa richness varied between four and eight taxa. Individual samples consisted of one to seven taxa. Only seven of the taxa were collected in all three sites in one sample period. Seven taxa were represented in only one sample. *Bosmina longirostrus* was the most common species, present in 63 percent of the samples. Other common taxa were *Daphnia lumholtzi* and *Asplanchna brightwellii*. Cyclopoid copepods were present in 70 percent of the samples. Calanoid copepods were in 43 percent of the samples. (Reference 2.4.2-6)

Zooplankton abundance was generally low, although variable, ranging from 34 to 12,790 individuals. Seasonally, densities rose through spring, peaked in July, then declined through December. Copepods were numerically dominant in April at all locations. Rotifers, including *Asplanchna brightwellii* and *Conochilus unicornis*, were dominant in May. Zooplankton density in May was highest at the farthest upstream location (CRM 22). All populations reached their highest levels in June. During this peak, the cladocerans were the dominant taxonomic group. Common species included *Daphnia lumholtzi*, *Daphnia pulicaria*, *Diaphanosoma leuchtenbergianum, Bosmina longirostris*, and *Chydorus sphaericus*. *Daphnia lumholtzi* was the only taxon collected from the CRM 18.5 sampling location in June. Populations were low in abundance from August to December, generally with less than 500 organisms per cubic meter. The lowest densities occurred in October and November, when samples contained high numbers of rotifers in the family Notommatidae. (Reference 2.4.2-6)

Biomass of the zooplankton community ranged from 1 to 42,300 micrograms dry weight per cubic meter. Most samples were characterized as low or sparse in biomass, with exceptions during peak densities in June and July. The clodocerans were the largest organisms and contributed the most to biomass estimates, followed by the copepods and rotifers. Biomass was highest in mid-summer and lowest in late autumn. The relative biomass of individual taxa was highly variable, in part due to succession within the assemblage, but also because of low abundance and diversity overall. (Reference 2.4.2-6)

Zooplankton assemblages in the vicinity of the CRN Site were characterized by low abundance and diversity throughout the 10-month sampling period. High turbulence and advection within the sampling reach likely limited zooplankton populations and affected their distribution. Zooplankton assemblages often showed a notable degree of spatial heterogeneity in terms of both species composition and total abundance, but no systematic differences were evident. Conversely, similar temporal patterns were evident among sites due to seasonal succession within the zooplankton communities and the proximity of the locations sampled. At each sampling location, copepods were the dominant taxonomic group in early spring (March and April). Rotifers were the dominant taxonomic group in May. Peak zooplankton abundance and biomass occurred during June and/or July and were dominated by Cladocera. These peaks were associated with warmer water temperatures and generally low flow. Abundance and biomass were extremely sparse throughout the remainder of the year, with no ecologically significant differences evident among sites. (Reference 2.4.2-6)

2.4.2.1.2 Melton Hill Reservoir

Melton Hill Dam is operated primarily for the purposes of navigation and hydroelectricity generation. As discussed in Subsection 2.3.1.1.2.4, the main source of water for the Clinch River arm of the Watts Bar Reservoir at the CRN Site is the release from Melton Hill Dam.

Releases from Melton Hill Dam range from no discharge to the maximum turbine capacity of about 21,000 cubic feet per second (cfs) to 23,000 cfs. Intervals of 12 to 22 hr with no releases are common. For the period 2004 through 2013, the overall average release was approximately 4670 cfs. Approximately 80 percent of the total annual inflow to Melton Hill Reservoir is discharged from Norris Dam. Because the water is discharged from deep within Norris Reservoir, water temperatures in the lower half of the water column of the Melton Hill forebay often remain cold (54 to 66°F) from early spring until late autumn. (Reference 2.4.2-6) Melton Hill Reservoir exhibits a temperature gradient from north to south, which is influenced by the coal-fired Bull Run Fossil Plant that discharges warm water at approximately CRM 77. In January of 2000, surface water temperatures in Melton Hill Reservoir were 46.4°F at CRM 65, 68°F at CRM 77, 55.4°F at CRM 44, and 46.4°F at CRM 32. (Reference 2.4.2-10)

TVA monitors the ecological health of Melton Hill Reservoir at three locations: the forebay near the dam, the mid-reservoir, and the inflow at the upper end of the reservoir. TVA assesses the ecological health of the reservoir using measurements of DO, chlorophyll, fish and benthic macroinvertebrate communities, and sediment quality. Monitoring usually is performed on a 2-yr cycle, and the most recent ecological health ratings for Melton Hill Reservoir are based on monitoring in 2012. (Reference 2.4.2-11)

Physical and Chemical Characteristics

Based on ecological health monitoring data for DO, the mid-reservoir has been rated “good” during every year of monitoring. DO typically also has been rated “good” in the forebay, except that it was rated “fair” in the forebay in 2000, 2001, and 2008 and “poor” in 2012 due to extended periods with low-flow conditions. (Reference 2.4.2-11) TVA valley-wide monitoring data from 2011 collected from the forebay (CRM 24.0) above Melton Hill Dam and the tailrace (CRM 23.1) below the dam indicated that DO in the forebay ranged from a depth-averaged concentration of 6.2 mg/L in June to 11.2 mg/L in March. DO concentrations in the tailrace ranged from 6.5 mg/L in June to 9.7 mg/L in May. (Reference 2.4.2-6)

In 2012 sediments at the forebay location were rated “fair” due to slightly elevated levels of arsenic. The mid-reservoir location was rated “good” because no PCBs or pesticides were detected and no metals concentrations were elevated in the sediment samples in 2012. However, chlordane, PCBs, arsenic, and copper have been detected at elevated levels in sediment samples in some previous years. (Reference 2.4.2-11) Sediments collected in Melton Hill Reservoir in 2011 contained PCBs (Aroclor 1242). TDEC has issued fish consumption advisories for the reservoir due to PCBs and chlordane. (Reference 2.4.2-6)

Biological Communities

TVA’s reservoir monitoring program measures ecological health based on three biological indicators: chlorophyll, fish, and bottom life. Chlorophyll concentrations in Melton Hill Reservoir historically have been measured at the forebay and mid-reservoir locations. Ratings for 2012 were “fair” at the forebay and “good” at the mid-reservoir locations. Since 1998, chlorophyll ratings at the forebay location have fluctuated between “fair” and “poor.” Ratings at mid-reservoir have varied through time with no clear trend. Reservoir flows play a role in the yearly fluctuations because lower flows allow more time for the algal community to expand. (Reference 2.4.2-11) In 2011, chlorophyll a concentrations at the forebay location ranged from 6 to 19 μg/L and averaged 11.8 μg/L (Reference 2.4.2-6).

The fish assemblage in 2012 was rated “good” at the forebay, “fair” at mid-reservoir, and “poor” at the inflow location. This was consistent with previous ratings, which reflected a fish assemblage at each location characterized by a lower abundance of fish and higher proportions of tolerant species than would be expected. In 2012, as in most previous years, higher diversity at the forebay and mid-reservoir resulted in higher ratings at those locations (Reference 2.4.2-11)

The benthic community was rated “fair” at the forebay and mid-reservoir and “poor” at the inflow in 2012. Most of the organisms collected were considered tolerant of poor conditions. Historically, ratings were “fair” to “poor” at the forebay and “poor” at the inflow. Ratings have recently improved due to an increase in less tolerant species. (Reference 2.4.2-11)

2.4.2.1.3 Streams and Ponds on the CRN Site and the Barge/Traffic Area

During several visits to the CRN Site and adjacent Grassy Creek Habitat Protection Area (HPA) in April and May 2011, October 2013, and October 2014, TVA mapped the locations of waterbodies within the survey area using a global positioning system (GPS). Also in 2014, TVA performed a survey of waterbodies in the Barge/Traffic Area between the CRN Site entrance and Tennessee State Highway (TN) 58. Surveys were conducted on the portions of the Barge/Traffic Area (101-ac) with the highest potential for disturbance that had not been previously surveyed. All streams documented in the surveyed areas, with the exception of the Clinch River arm of the Watts Bar Reservoir and associated backwaters, are first-order, unnamed tributaries of the reservoir. (Reference 2.4.2-4) Perennial streams have a well-defined channel, flowing water throughout the year under normal weather conditions, and support aquatic organisms. Intermittent streams have a well-defined channel, flowing water during wet seasons but not the entire year, and support aquatic organisms during periods when water is present. Intermittent streams flow in response to major rainfall events or as long as ground water is abundant. (Reference 2.4.2-12) The streams were determined to be perennial or intermittent based on the geomorphology of the channel, hydrologic characteristics, and the presence of visually observable aquatic fauna. Ephemeral streams/wet-weather conveyances (WWCs) flow diffusely over depressions, usually not in a well-defined channel, and only for short periods in response to major rainfall events. Flow in WWCs is not driven by ground water sources, and aquatic organisms are not present. (Reference 2.4.2-12)

Other than the Clinch River arm of the Watts Bar Reservoir and associated backwaters, TVA identified four perennial streams on the CRN Site and two perennial streams in the Barge/Traffic Area. One additional stream identified on the CRN Site and four additional streams in the Barge/Traffic Area were determined to be intermittent. Six ponds were identified on the CRN

Site, all of which were determined to be man-made and four of which were originally created as stormwater retention ponds. Two ponds were identified in the Barge/Traffic Area. Descriptions of these streams and ponds are included in Table 2.4.2-5, and their locations are shown in Figure 2.4.1-2. (Reference 2.4.2-4)

Table 2.4.2-5 also includes the streamside management zone (SMZ) categories determined for the onsite streams and ponds. An SMZ consists of a stream and an adjacent management area of variable width where management practices are modified to protect water quality. They are intended to “filter sediment and nutrients from overland runoff, allow water to soak into the ground, protect stream banks and lakeshores, provide shade for streams and improve the aesthetics of forestry operations.” Perennial streams and intermittent streams with a well-defined channel and water flow 40 to 90 percent of the time require SMZs. The SMZs should be at least 50 feet (ft) wide, with increasing width depending on the percent slope of the adjacent land. WWCs do not require SMZs but would be protected by established Best Management Practices (BMPs) to the extent practical. (Reference 2.4.2-12) Based on the SMZ categories determined for the streams and ponds on the CRN Site, all but one are Category A and require a 50-ft SMZ, and one stream is Category B and requires a 100-ft SMZ. Stream S06 was designated as Category B to provide more protection to the spring from which it originates. (Reference 2.4.2-4).

In addition to the perennial and intermittent streams on the CRN Site and the Barge/Traffic Area, the TVA survey identified the WWCs shown in Figure 2.4.1-2 (Reference 2.4.2-4). The WWCs on the CRN Site and the Barge/Traffic Area are listed in Table 2.4.2-5 and each is identified as natural or constructed.

A Hydrologic Determination Field Data Sheet, which is a form developed by the Tennessee Division of Water Pollution Control, was completed for each watercourse. The data sheets, which include scores for and descriptions of the onsite water bodies evaluated, are provided in Appendix A of the TVA report *Clinch River Small Modular Reactor and Barge/Traffic Site – Evaluation of Aquatic Habitats and Protected Aquatic Animals Technical Report*. (Reference 2.4.2-4)

In March 2015, biological surveys were conducted on seven of the streams previously delineated on the CRN Site and the Barge/Traffic Area that were considered to have the greatest potential to support aquatic communities. Four of those streams are perennial and three are intermittent. An additional perennial stream located north of the CRN Site, Grassy Creek, also was sampled due to its proximity and habitat likely to support fish and crayfish. The streams were sampled using timed searches with a backpack electrofishing unit and a seine. All available habitat types were sampled in each stream (e.g., pool, riffle, run). On the CRN Site, the three streams sampled were perennial streams S01, S05, and S06 (Figure 2.4.1-2). The entire length of stream S01 (approximately 925 ft) was sampled, and no fish were collected. A few crayfish were observed but were too small for identification. In stream S05, one fish (a banded sculpin) and one crayfish were collected. No fish or crayfish were collected in stream S06. In the Barge/Traffic Area, one crayfish was identified in intermittent stream S09, and no fish or crayfish were collected in the other three streams sampled (S07, S08, and S12) (Figure 2.4.1-2). Thus, only one fish was collected or observed in any of the streams on the CRN Site or the Barge/Traffic Area, and stable habitat supportive of a viable fish community was not observed in these streams. In Grassy Creek, 70 individuals of nine fish species were collected. Of the aquatic species documented in any of the streams sampled, none were federally or state-listed. (Reference 2.4.2-13)

2.4.2.1.4 Aquatic Habitats in Offsite Transmission Line ROWs

In addition to Watts Bar Reservoir and the streams and ponds on the CRN Site and Barge/Traffic Area, potentially affected aquatic habitats also could include offsite streams that intersect the 500-kV transmission line right-of-way (ROW) east of the CRN Site. Installation of a 69-kV underground transmission line is planned within the 5-mi segment of the existing ROW that extends east from the CRN Site to the Bethel Valley substation. Installation of the proposed underground transmission line potentially could affect aquatic organisms within streams crossed by the 69-kV line.

Three streams that cross the ROW are designated as aquatically sensitive areas (Figure 2.4.1-3). Ish Creek is an aquatic natural area that crosses the ROW approximately 0.5 mi from the CRN Site. Northwest Tributary is an aquatic reference area consisting of three small streams, two of which cross the ROW approximately 2 to 2.5 mi from the CRN Site. There are no recorded occurrences of federally or state-listed aquatic species within this ROW. The Tennessee dace, a fish designated by the state as in need of management, has been recorded in Ish Creek approximately 0.25 mi downstream of this ROW. Up to three additional streams also would be crossed: Streams S03 and/or S06 on the CRN Site near the northeastern boundary (Figure 2.4.1-2), and a small stream that crosses the ROW slightly southwest of the Bethel Valley substation.

As discussed in Subsections 2.2.3, 2.4.1.6, and 3.7.3.8, the transmission system structures within ROWs outside the CRN Site (other than the 69-kV underground line) would require modification by uprating, reconductoring, or rebuilding activities, but additional ROWs would not be developed. The lines that include segments or structures that may need to be modified are overlaid on a map of regional land cover types in Figure 2.2-7. Based on TVA’s Natural Heritage database, the aquatic resources that potentially occur within the ROWs of the lines that may be modified are identified in Table 2.4.1-7. These resources include designated critical habitats for two endangered mussel species (one line segment to be uprated crosses over a riverine habitat unit for each species). Aquatic habitats within these existing ROWs would not be affected by these activities because of the limited potential for impacts associated with the types of activities to be performed and the use of BMPs to prevent or minimize erosion and sedimentation.

2.4.2.2 Important Aquatic Habitats

U.S. Nuclear Regulatory Commission (NRC) guidance (NUREG 1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*) identifies important aquatic habitats as follows:

- Wildlife sanctuaries, refuges, and preserves
- Habitats identified by the State Natural Heritage Program, the U. S. Fish and Wildlife Service (USFWS), or the National Marine Fisheries Service as unique, rare, or of priority for protection
- Wetlands, floodplains, or other resources protected by federal regulations or executive orders or by state regulations
- Critical habitats designated by the USFWS to protect listed species

Wetlands are discussed in Subsection 2.4.1, Terrestrial Ecology, and floodplains are discussed in Section 2.3, Water.

A 2015 report by TVA assessed natural areas on, adjacent to, and within 3 mi of the CRN Site. These areas are described in Subsection 2.4.1.3 and shown in Figure 2.4.1-3. Those that encompass notable aquatic habitats near the CRN Site include the Grassy Creek HPA, the eight aquatic natural areas and seven aquatic reference areas within the Oak Ridge Reservation (ORR), and the New Zion Unit Proposed State Natural Area (SNA). The Grassy Creek HPA adjoins the north end of the CRN Site and includes 265 acres (ac) intended to provide a buffer for sensitive habitat surrounding Grassy Creek and the Grassy Creek embayment of Watts Bar Reservoir. Within the ORR, the Ish Creek aquatic natural area (ANA1 on Figure 2.4.1-3) is located east of the CRN Site and within approximately 0.25 mi of the Site Boundary at its closest point. The New Zion Unit Proposed SNA is immediately east of the CRN Site and includes wetlands and the Raccoon Creek embayment of Watts Bar Reservoir. (Reference 2.4.2-14; Reference 2.4.2-15)

2.4.2.3 Important Aquatic Species

According to NUREG-1555, important species may include:

- Rare species, including:
  - Species federally listed as threatened or endangered
  - Species that are proposed for federal listing
  - Species that are candidates for federal listing
  - Species that are state-listed as threatened, endangered, or a species of concern
- Commercially or recreationally valuable species

- Species that are essential to the maintenance and survival of rare or commercially or recreationally valuable species
- Species that are critical to the structure and function of the local ecosystem
- Species that may serve as biological indicators to monitor the effects of the proposed facility on the environment
- Nuisance species that could cause problems for facility operations

Aquatic species that are important with regard to the CRN Site are discussed below. In conjunction with agency coordination regarding listed species, TVA sent letters to the USFWS and TDEC in September 2016 requesting their concurrence with the listed species identified as important species for the site. These letters are included in Appendix A. Information provided in the consultation responses from USFWS and TDEC will be incorporated when received, and the responses will be included in Appendix A.

2.4.2.3.1 Federally Listed Species

Species with federal listing status (currently listed, proposed for listing, or candidates for listing) and recorded occurrences in Roane County, Tennessee are identified in Table 2.4.2-6. There are 13 aquatic, federally-listed, threatened or endangered species and one candidate species with documented occurrences in Roane County, Tennessee. These include 12 freshwater mussels that are listed as endangered, one fish that is listed as threatened, and an aquatic cave salamander that is a candidate for listing. Eight of these federally endangered mussel species have Natural Heritage element occurrence rankings of “historical” (last recorded occurrence in the county greater than 25 yr old) or “considered extirpated” (no longer occurs in this portion of its former range). The species with only historical records of occurrence are:

- Spectaclecase
- Fanshell
- Fine-rayed pigtoe
- Alabama lampmussel
- Ring pink
- Orangefoot pimpleback
- Purple bean (Reference 2.4.2-4)

The turgid blossom pearlymussel is considered extirpated. Because these eight historical or extirpated species have not been detected in many decades, including the 2011 mollusk survey at the CRN Site, and habitat conditions in this area appear to remain unsuitable for mollusks, TVA has determined that these species either do not occur or occur at extremely low (undetectable) levels near the CRN Site. (Reference 2.4.2-4) Accordingly, these eight mussels are not considered to have the potential to be affected by the CR SMR Project and are not addressed further.

The federally listed aquatic species potentially occurring in Roane County and ranked as extant (recorded occurrence less than or equal to 25 yr old) in the region are discussed below. Although these species historically have occurred or potentially could occur in the vicinity of the CRN Site, recent surveys, including a survey performed by TVA in 2011, did not detect any aquatic federally listed species in the Clinch River arm of the Watts Bar Reservoir. (Reference 2.4.2-4)

Pink mucket (Lampsilis abrupta)

The pink mucket mussel was historically found in 25 river systems in the Tennessee, Cumberland, and Ohio River drainages, including the Clinch River. A recovery plan was prepared by the USFWS in 1985. At that time, the pink mucket was known to exist in 16 rivers throughout these drainages. Reasons for the decline of this species include impoundment, siltation, and pollution. The pink mucket is usually found in medium to large rivers greater than 20 m wide in moderate to fast flowing water. (Reference 2.4.2-16) However, individuals occasionally become established in small to medium sized tributaries of large rivers. The pink mucket inhabits rocky bottoms with swift current, usually in less than 3 ft of water. It appears to be tolerant of reservoir conditions with some flow. (Reference 2.4.2-4) The pink mucket has an elliptical shell approximately 105 mm long, 82 mm high, and 61 mm wide at full size. The surface of the shell is smooth except for the growth rings. Reproduction is similar to the other freshwater mussels. Females collect broadcast sperm and larvae (glochidia) temporarily attach to a fish host for dispersal. (Reference 2.4.2-16) The pink mucket spawns from August to September and releases larvae the following year between May and July. Fish hosts of the larval stage include largemouth bass, smallmouth bass, spotted bass, and walleye. (Reference 2.4.2-4)

The pink mucket mussel is federally listed as endangered and is listed by the State of Tennessee as endangered (Reference 2.4.2-4). The recovery plan for this species states that, as of 1985, individuals had recently been found downstream of the Melton Hill Dam (Reference 2.4.2-16). A live pink mucket was collected in 1984 slightly upstream of the CRN Site at CRM 19.1. However, the 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the pink mucket. (Reference 2.4.2-4)

Sheepnose (Plethobasus cyphyus)

The sheepnose is a medium-sized mussel, generally reaching less than 5 inches (in.) long. The shell is elongated and ovate with thick solid valves. The anterior is rounded and the posterior is bluntly pointed. The outer surface has a row of large, broad, tubercular swellings in the center. The sheepnose is light yellow to yellowish brown in color with slightly darker growth arrest ridges. The interior of the shell is white, pinkish, or cream colored with iridescence at the posterior. The details of the life history of the sheepnose are unknown. The sheepnose is thought to reach sexual maturity at a few years of age and spawns in early summer. The sheepnose is believed to be a short-term brooder that releases glochidia in masses. (Reference 2.4.2-17) The fish host has been identified as the sauger (Reference 2.4.2-4). Recent laboratory studies also have shown that successful metamorphosis can be obtained on fathead minnow (*Pimephales promelas*), creek chub (*Semotilus atrromaculatus*), central stoneroller (*Campostoma anomalum*), and brook stickleback (*Culaea inconstans*) (Reference 2.4.2-17).

The sheepnose mussel is federally listed as endangered, but is not listed by the State of Tennessee (Reference 2.4.2-4). The sheepnose is found in large streams in shallow shoals with moderate to swift currents. Substrates inhabited include sand, gravel, mud, cobble, and boulders. Historically, the sheepnose occurred in at least 76 streams and rivers in the Mississippi, Ohio, and Tennessee River basins across 14 states. The sheepnose is currently known to exist in 25 streams and rivers in the same 14 states, including the Clinch River. Individuals have been recorded in the Clinch River as recently as 2006. (Reference 2.4.2-17) A living sheepnose was collected in 1994 at CRM 21.4 (Reference 2.4.2-4). Habitat destruction and degradation are the reasons for the decline of this species. No critical habitat has been designated for the sheepnose. (Reference 2.4.2-17) The 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the sheepnose (Reference 2.4.2-4).

Rough rabbitsfoot (Quadrula cylindrica strigillata)

The rough rabbitsfoot is a medium-sized mussel reaching up to 5 in. long (Reference 2.4.2-18). The rough rabbitsfoot has a yellow to greenish shell covered in green rays and blotches. The interior of the shell is silvery to white and iridescent. The rough rabbitsfoot is found in a range of waterbodies, from small headwater streams to large rivers in moderate to swift current. Substrates inhabited include silt, sand, gravel, and cobble. The rough rabbitsfoot spawns from May through June. (Reference 2.4.2-19) The rough rabbitsfoot is a short-term brooder, and the fish hosts for its glochidia include the whitetail shiner (*Cyprinella galactura*), spotfin shiner (*C. spiloptera*), and bigeye chub (*Hybopsis amblops*) (Reference 2.4.2-18).

The rough rabbitsfoot is federally listed as endangered, and is listed by the State of Tennessee as endangered (Reference 2.4.2-20). The rough rabbitsfoot is endemic to the Tennessee River system and was historically found in the Clinch River above Norris Reservoir. The rough rabbitsfoot currently is found only in three streams and rivers in Tennessee and Virginia, including the Clinch River. Reasons for the decline of this species are habitat destruction and deterioration as a result of human activities. (Reference 2.4.2-19) Critical habitat has been designated for the rough rabbitsfoot in the Clinch River in Hancock County in Tennessee and Scott, Russell, and Tazewell Counties in Virginia (Reference 2.4.2-21). The 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the rough rabbitsfoot (Reference 2.4.2-4).

Spotfin chub (Erimonax monachus)

The spotfin chub is a small fish reaching a maximum length of 92 mm. The spotfin chub is dusky green above the lateral line and silver on the lower sides, bordered by gold and green stripes. There is no speckling on the body, but there is a distinct caudal fin spot. The sexes are dimorphic, with males having longer dorsal, anal, and pelvic fins. (Reference 2.4.2-22) The spotfin chub inhabits clear upland rivers in swift currents over boulder substrates. Spawning occurs from May through August (Reference 2.4.2-4).

The spotfin chub is federally listed as threatened, and is listed by the State of Tennessee as threatened (Reference 2.4.2-4). The spotfin chub existed historically in 24 streams in the upper and middle Tennessee River system. The spotfin chub is now found in only four rivers. (Reference 2.4.2-23) The historical range included the Clinch River, and a single specimen was collected in 1893 in the area now occupied by the Norris Reservoir. Reasons for the decline of this species include habitat destruction by impoundment, channelization, pollution, turbidity or siltation, temperature changes, and possible over-collecting and interspecific competition. Critical habitat has been designated for the spotfin chub in North Carolina and Virginia and in Cumberland, Fentress, and Morgan Counties in Tennessee. (Reference 2.4.2-22) The spotfin chub has been observed and collected in the City of Oak Ridge and could be present on the ORR (Reference 2.4.2-24). An individual was found in East Poplar Creek in 2002 during an ORNL stream sampling event (Reference 2.4.2-25). Although it has been recorded in Roane County, the spotfin chub is extremely unlikely to occur in the Clinch River arm of the Watts Bar Reservoir due to the unsuitable habitat conditions present in the reservoir (Reference 2.4.2-4).

Berry Cave salamander (Gyrinophilus gulolineatus)

The Berry Cave salamander is aquatic and an obligate cave dweller. The Berry Cave salamander reaches a maximum length of 136 mm and has a broad head with a truncated and spatulate snout and very small eyes. The gills are long and pink with purplish flecks. The tail is laterally compressed and has a fin that extends up the back. Adults typically are mottled dark brown, and juveniles are lighter in color. Unpigmented sensory pores are present on the head and along the sides of the body. (Reference 2.4.2-26) The Berry Cave salamander usually retains some larval characteristics as an adult, but it can metamorphose and lose these characteristics. Generally, cave salamanders become sexually mature without complete metamorphosis into the adult stage. Very little is known of its breeding habits or life span. The habitat of the Berry Cave salamander is subterranean waters in the Appalachian Valley and Ridge Province in East Tennessee. The Berry Cave salamander requires cave habitats with an inflow of organic detritus and aquatic prey. (Reference 2.4.2-27)

The Berry Cave salamander is a candidate for federal listing as endangered or threatened by the USFWS, and is listed by the State of Tennessee as threatened (Reference 2.4.2-20). Ongoing threats to the species include lye leaching from quarrying activities, urban development, water quality degradation, and genetic hybridization with other salamander species (Reference 2.4.2-28). Water quality issues that threaten the species include pesticide use, agricultural runoff, roadway runoff, and siltation due to forestry operations (Reference 2.4.2-27). The known locations of the Berry Cave salamander are in the Upper Tennessee River and Clinch River drainages. The Berry Cave population is in Roane County, Tennessee (Reference 2.4.2-28). Berry Cave is located approximately 9 mi south of the CRN Site and a few hundred yards west of Watts Bar Reservoir. None of the caves in which the Berry Cave salamander is known to occur are located on or adjacent to the CRN Site (Reference 2.4.2-26).

2.4.2.3.2 State-Listed Species

Seventeen aquatic species with a state listing or other state protected status have recorded occurrences in Roane County (Table 2.4.2-6). These include two amphibians, five fish, nine mussels, and one plant that are state-listed as threatened or endangered, are deemed in need of management, or are of special concern. Eleven of these species also are federally listed. In Subsection 2.4.2.3.1, these federally listed species either were identified for evaluation or were eliminated from further evaluation because they are not considered to have the potential to be affected by the CR SMR Project due to their extirpation or historical absence from the area. The remaining aquatic species that have a state listing or other protective status include one amphibian, four fish, and one plant. None of these species were observed during biological surveys of aquatic habitats performed at the CRN Site in March 2015. These species are briefly discussed below.

Hellbender (Cryptobranchus alleganiensis)

The hellbender has been designated by TDEC as in need of management (Reference 2.4.2-20). The hellbender is a completely aquatic, large salamander that can reach a length of up to 29 in. The hellbender is brown to grayish in color with irregular dark blotches. The body is flattened horizontally, and the tail is flattened vertically. The hellbender has four short legs with four toes on the front feet and five toes on the rear feet. Along the body, between the front and hind legs, are skin folds that are used in respiration. Larval hellbenders have external gills, but at 18 months of age, a metamorphosis results in the loss of these gills. Hellbender breeding season occurs between September and early November. Males dig shallow depressions under a rock or log in which females deposit two long strings of eggs, which are fertilized by the male as they are laid. The males brood the eggs in the nest for 2 to 4 months. Hellbenders become sexually mature at 5 to 7 yr and can live up to 30 yr. Lack of suitable large objects has been proposed as a population-limiting factor for the hellbender. The hellbender usually is found in medium to large streams and rivers with fast-flowing water and rocky substrates. (Reference 2.4.2-29) Hellbenders have been found in the tail waters below Melton Hill dam upstream of the CRN Site. The Clinch River arm of the Watts Bar Reservoir potentially provides habitat suitable for the hellbender, including large rocks and logs for breeding sites, but the hellbender has not been documented near the CRN Site. (Reference 2.4.2-30) The last known record of the hellbender in the Clinch River arm of the Watts Bar Reservoir was a collection in the Melton Hill dam tailwaters in 1989. This species has not been reported from the Clinch River since then and is assumed to no longer be present. (Reference 2.4.2-31)

Blue sucker (Cycleptus elongatus)

The blue sucker is listed as threatened by TDEC (Reference 2.4.2-4). The blue sucker is a fish which is olive-blue or slate-olive on its back and sides with a lighter bluish-white ventral coloring. Its lips are white and its fins are dark blue-gray to black. The blue sucker reaches a maximum of 825 mm in length. Spawning occurs in April through May in deep riffles with substrates of cobble and bedrock. The blue sucker reaches sexual maturity at ages 3 through 5 yr and can live up to 22 yr. (Reference 2.4.2-32) The blue sucker is found in deep pools of large, free-flowing rivers with swift currents (Reference 2.4.2-4). Characteristic habitats have very swift flow and cobble or bedrock substrates. Juveniles are found in shallower and less turbulent areas. (Reference 2.4.2-32) Blue sucker populations have declined drastically due to the effects on large rivers from impoundments and increased siltation (Reference 2.4.2-4). The blue sucker is extremely unlikely to occur in the Clinch River arm of the Watts Bar Reservoir due to the unsuitable habitat conditions present in the reservoir.

Flame chub (Hemitremia flammea)

The flame chub has been designated by TDEC as in need of management (Reference 2.4.2-4). The flame chub is a small minnow that reaches a maximum length of approximately 3 in. The flame chub has a distinct caudal spot and a dark lateral stripe bordered above by a pale gold area. Sexually active males are bright scarlet to orange ventrally and retain some of this coloring throughout the year. Spawning occurs from late January to June. The flame chub can live for up to 2 yr. Spawning has been reported in flooded agricultural fields and pastures. The flame chub inhabits springs, spring-fed streams, and shallow seepage waters in locations where gravel and aquatic vegetation are present. (Reference 2.4.2-33) Populations have declined with the continued alteration of spring habitats (Reference 2.4.2-4). The flame chub is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area, which lack suitable habitat conditions.

Tangerine darter (Percina aurantiaca)

The tangerine darter has been designated by TDEC as in need of management (Reference 2.4.2-4). The tangerine darter is a fish that reaches a maximum length of 7 in. Males have an orangish red to tangerine color on the lower sides and ventral area, while females are yellow in this area. A black stripe extends from head to tail, and small black dots above this stripe are unique to the species. Male dorsal fins are dusky orange and female dorsal fins are yellow. Males reach sexual maturity after 1 yr and females reach sexual maturity after 2 yr. Spawning occurs in May through July in gravel-bottomed riffles. Eggs and sperm are released onto the gravel bed with no brooding or nesting. (Reference 2.4.2-34) The tangerine darter inhabits clearer reaches of moderate to large headwater tributaries of the upper Tennessee River drainage and is most abundant in smaller tributaries. Preferred habitats most of the year are deeper riffles and runs with substrates of bedrock, boulders, and large rubble, but in winter, deeper pools are used. (Reference 2.4.2-4) The tangerine darter potentially could occur in some sections of Grassy Creek. It is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area due to the unsuitable habitat conditions.

Tennessee dace (Chrosomus tennesseensis)

The Tennessee dace has been designated by TDEC as in need of management (Reference 2.4.2-4). The Tennessee dace is a small minnow reaching a maximum length of approximately 2 in. The Tennessee dace is found in pools in spring-fed headwaters and small creeks, typically 1 to 2 m wide with substrates of gravel, sand, and silt (Reference 2.4.2-35). The Tennessee dace typically inhabits shallow pools in association with undercut banks and debris in small, low-gradient, woodland tributaries of the upper Tennessee River drainage. The Tennessee dace spawns from April through July. (Reference 2.4.2-4) The Tennessee dace has been observed on the ORR and potentially could occur in some sections of Grassy Creek (Reference 2.4.2-24). It is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area due to the unsuitable habitat conditions.

Nutall's waterweed (Elodea nutallii)

Nuttall's waterweed has been designated by TDEC as a species of special concern (Reference 2.4.2-20). Nuttall's waterweed is a submerged, aquatic, perennial plant with stems growing up to 40 in. long. The stems are branched, and the white flowers float on top of the water. Male and female flowers grow on separate plants. (Reference 2.4.2-36) Nuttall's waterweed reproduces sexually with seeds during June, July, and August. The male flowers break off the plant and split open, spreading the pollen on the water's surface. Pollination occurs when the pollen comes in contact with a female flower. Nuttall's waterweed also can reproduce vegetatively by fragmentation of the stem, which is the most common method. (Reference 2.4.2-37) The leaves are linear to lance-like, bright green, and do not have stalks. The edges are folded, and there are two to three leaves per whorl. Nuttall's waterweed generally is found in still water growing in fine sediment. (Reference 2.4.2-36) Nuttall's waterweed prefers quiet waters of lakes or streams and typically is found in calcareous (hard) water (Reference 2.4.2-37).

2.4.2.3.3 Species of Commercial or Recreational Value

TVA and state fisheries agencies developed a Sport Fishing Index that was used until 2008 to provide an indication of the quality of sport fishing for individual species in TVA reservoirs (Reference 2.4.2-38). Sportfish surveys were performed in the spring, but not every reservoir was sampled each year (Reference 2.4.2-39). TVA discontinued the spring sport fish survey after 2014 (Reference 2.4.2-40). The Sport Fishing Index scores for each reservoir and species were based on population measures (the number of fish and the size and health of individual fish) and information about angler use of the reservoir and their success (the number of anglers fishing for a particular type of fish and the number of that type that they actually catch). The Sport Fishing Index score for a given species could range from 60 (excellent) to 20 (very poor).(Reference 2.4.2-38) For Watts Bar Reservoir, the most recent sport fish survey statistics available are from 2014, but the most recently calculated Sport Fishing Index score available is from 2008. The 2008 Sport Fishing Index scores for Watts Bar Reservoir indicate that scores for black basses, smallmouth bass, striped bass, white bass, crappie, white crappie, and channel catfish were below the 2008 average across the TVA region and the scores for black crappie, largemouth bass, and spotted bass were above the average. (Reference 2.4.2-39; Reference 2.4.2-38; Reference 2.4.2-41)

To characterize the fish community in the Clinch River arm of the Watts Bar Reservoir, TVA selected two fish sampling locations, one upstream and one downstream of the CRN Site. Sampling by electrofishing and gill netting was conducted in February, May, July, and October of 2011 to document seasonal variation in fish community composition. An average of 14 commercially valuable and 22 recreationally valuable fish species were collected at the downstream location during 2011 and an average of 15 commercially valuable and 24 recreationally valuable species were collected at the upstream location. The commercially and recreationally valuable fish species collected are identified in Table 2.4.2-1. Commercially valuable species are defined as those that can be legally harvested by commercial fishing methods for sale as meat, roe, or bait. Recreationally valuable species are those species that are commonly sought by anglers or bowfishers or are used for bait. (Reference 2.4.2-6) As discussed in Subsection 2.4.2.1.1, fish consumption advisories have been posted by TDEC on Watts Bar Reservoir in the vicinity of the CRN Site warning that, due to the levels of contaminants (PCBs) in their tissues, consumption of catfish and sauger should be limited to about two meals per month and striped bass should not be eaten (Reference 2.4.2-42).

For Melton Hill Reservoir, the 2008 Sport Fishing Index scores for black basses, largemouth bass, smallmouth bass, spotted bass, crappie, black crappie, white crappie, and sauger were below the 2008 average across the TVA region, while the scores for channel catfish and striped bass were above the average (Reference 2.4.2-39). Melton Hill Reservoir is popular for sportfishing for species that include muskellunge, striped bass, hybrid striped bass, white crappie, largemouth bass, and skipjack herring. In 2008, there was an advisory against the consumption of catfish from the reservoir due to PCB levels. Muskellunge are stocked annually in Melton Hill Reservoir by the Tennessee Wildlife Resources Agency. (Reference 2.4.2-43)

2.4.2.3.4 Nuisance Species

Aquatic invasive species are non-native species that are likely to cause economic and/or environmental harm. Other terms for these types of species are nuisance, alien, non-indigenous, exotic, or undesirable species. (Reference 2.4.2-44) Within the Tennessee Valley, TVA has identified seven invasive species that constitute the greatest threat to rare native species or the balance of the aquatic community in general. These seven species are:

- Common carp (*Cyprinus carpio*)
- Grass carp (*Ctenopharyndogon idella*)
- Alewife (*Alosa pseudoharengus*)
- Blueback herring (*Alosa aestivalis*)

- Rusty crayfish (*Orconectes rusticus*)
- Asiatic clam
- Zebra mussel (Reference 2.4.2-45)

The Kentucky River crayfish (*Orconectes juvenilis*) is an invasive, non-native species that is very similar to the rusty crayfish, and until recently *Orconectes juvenilis* was considered to be the same species as *Orconectes rusticus* (Reference 2.4.2-46). The Asiatic clam and zebra mussel were found in the 2011 sampling by TVA in the Clinch River arm of the Watts Bar Reservoir (Reference 2.4.2-6). The Asiatic clam and zebra mussel potentially are the most problematic of these nuisance species because they contribute to biofouling of water intake systems (Reference 2.4.2-44). TVA has a monitoring and eradication program for these species at generating facilities, including the use of chemical and heated-water treatments. Nuisance species can cause other problems as well, including negative effects on fishing and musseling, and they can contribute to the decline of native species through competition or predation (Reference 2.4.2-44).

Federal regulations regarding invasive species include Executive Order 13112 – Invasive Species, which requires federal agencies to:

- Prevent the introduction of invasive species
- Detect and respond rapidly to control populations of such species in a cost-effective and environmentally sound manner
- Monitor invasive species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded

The nuisance species that occur in the vicinity and have the greatest potential to affect the CR SMR Project, the Asiatic clam and zebra mussel, are briefly described below.

Asiatic Clam (Corbicula fluminea)

The Asiatic clam is a small, filter-feeding bivalve with a maximum size of 1.5 in. The outer surface is light yellow to dark brown or black and the interior is white to light purple. The Asiatic clam is hermaphroditic and capable of self-fertilization and does not require a host fish for successful development. Larvae are brooded in the gills, and individuals can release up to 70,000 juveniles per yr. The Asiatic clam is native to China, Korea, and southeast Russia. The Asiatic clam was first collected in Washington State in 1938. The Asiatic clam is currently distributed across 38 states and the District of Columbia, including almost every river and reservoir in Tennessee. It is hypothesized that the Asiatic clam entered the country as a food item used by Chinese immigrants. Currently, the Asiatic clam is spread by human activities such as accidental bait bucket introductions and aquaculture species, and intentional introductions by people that eat them. The Asiatic clam causes environmental harm by competing for habitat and food with native bivalves. The Asiatic clam causes economic harm by biofouling water intakes of power plants and industrial and municipal water supplies. (Reference 2.4.2-44)

Zebra Mussel (Dreissena polymorpha)

The zebra mussel is a small mussel reaching a maximum size of 1.5 in. The outer shell can be cream colored without banding but is usually striped with parallel brown or black bands. The inside surface is bluish white. The zebra mussel attaches to hard surfaces using byssal threads. The zebra mussel spawns in spring or summer at water temperatures of 14 to 16ºC (57 to 60ºF). The zebra mussel is a broadcast spawner, with the eggs fertilized in the water column. Larvae hatch within 3 to 5 days and do not require a fish host for successful development. The zebra mussel is native to the Black, Caspian, and Azov Seas and was first discovered in the United States in Lake St. Claire in 1988. The zebra mussel is thought to have arrived in the ballast of a commercial cargo ship and later spread by passive drifting of the larvae and adults attachment to boats and other water gear. By 1990 the zebra mussel was found in all of the Great Lakes, and by 1991 the zebra mussel had invaded the Illinois and Hudson Rivers. In 1994 the zebra mussel was reported in 19 states, and by 2002 the zebra mussel had invaded 23 states. (Reference 2.4.2-44)

The zebra mussel causes harm by biofouling intake pipes of power plants and industrial and municipal water supplies. Biofouling by the zebra mussel can be so intense that is has sunk navigational buoys and deteriorated dock pilings. The zebra mussel also competes with native bivalves for habitat and food. After its arrival in the Great Lakes, the biomass of plankton was significantly reduced. Zebra mussels also settle on native mussel species, which can cause death by interfering with normal valve operation, causing shell deformity, smothering siphons, competing for food, impairing movement, and depositing metabolic waste into underlying mussels. (Reference 2.4.2-44) During the mollusk survey by TVA at the CRN Site in 2011, biologists noted an abundance of zebra mussels throughout that reach of the reservoir. Only three of the other mussel species found were not infested with zebra mussels. Zebra mussels were particularly abundant in areas with solid and stable substrates, and were especially dense on bedrock. (Reference 2.4.2-47)

2.4.2.4 References

Reference 2.4.2-1. Watts Bar - Clinch Watershed Team, Final Watts Bar Reservoir Land Management Plan, Panel 4; Alternative B "Preferred", January 23, 2009.

Reference 2.4.2-2. Tennessee Valley Authority, Watts Bar Reservoir, Website: http://www.tva.gov/sites/wattsbarres.htm, 2013.

Reference 2.4.2-3. Tennessee Valley Authority, "Temporal Occurrence, Composition, Abundance and Estimated Entrainment of Fish Eggs and Larvae at the Proposed Clinch River Small Modular Reactor Site," Tennessee Valley Authority Biological and Water Resources, Knoxville, TN, 2012.

Reference 2.4.2-4. Howard, Charles S., Henderson, Andrew R., and Phillips, Craig L., "Clinch River Small Modular Reactor and Barge/Traffic Site Evaluation of Aquatic Habitats and Protected Aquatic Animals Technical Report - Revision 5," Tennessee Valley Authority, December 22, 2015.

Reference 2.4.2-5. Tennessee Valley Authority, Watts Bar Reservoir Ecological Health Rating - 1994-2012, Website: http://www.tva.com/environment/ecohealth/wattsbar.htm, 2015.

Reference 2.4.2-6. Tennessee Valley Authority, "Biological Monitoring to Characterize the Aquatic Community near the Site of the Proposed Clinch River Small Modular Reactor 2011," Tennessee Valley Authority Biological and Water Resources, Chattanooga, Tennessee, January, 2013.

Reference 2.4.2-7. Tennessee Valley Authority, "Surface Water Quality Report," March 16, 2015.

Reference 2.4.2-8. Michigan Department of Natural Resources, Michigan Department of Natural Resources, Dams, Website: http://www.michigan.gov/dnr/0,4570,7-153-10370_30909_43606-154930--,00.html, 2013.

Reference 2.4.2-9. Weis, J., Plankton, Website: http://www.eoearth.org/view/article/155259/, 2013.

Reference 2.4.2-10. Cole, Aaron J., Seasonal Distribution and Thermal Ecology of Muskellunge in Melton Hill Lake, Tennessee, Tennessee Technological University, December, 2011.

Reference 2.4.2-11. Tennessee Valley Authority, Melton Hill Reservoir Ecological Health Rating - 1994-2012, Website: http://www.tva.gov/environment/ecohealth/meltonhill.htm, 2015.

Reference 2.4.2-12. Tennessee Department of Agriculture, "Guide To Forestry Best Management Practices in Tennessee," Division of Forestry, 2003.

Reference 2.4.2-13. Henderson, Andrew R. and Phillips, Craig L., "Clinch River Small Modular Reactor and Barge/Traffic Site Stream Survey Report - Revision 3," Tennessee Valley Authority, December 22, 2015.

Reference 2.4.2-14. Pilarski-Hall, Kim, "Clinch River Small Modular Reactor Site - Technical Report Natural Areas (Managed Areas & Sites) - Revision 2," Tennessee Valley Authority, November 19, 2015.

Reference 2.4.2-15. Baranski, Michael J., "Aquatic Natural Areas Analysis and Evaluation, Oak Ridge Reservation," ORNL/TM-2011/13, Oak Ridge National Laboratory, April, 2011.

Reference 2.4.2-16. U.S. Fish and Wildlife Service, "Recovery Plan Pink Mucket Pearly Mussel Lampsilis orbiculata," January 24, 1985.

Reference 2.4.2-17. U.S. Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Sheepnose and Spectaclecase Mussels Throughout Their Range," 77(49): 14914-14949, Federal Register, March 13, 2012.

Reference 2.4.2-18. Natureserve, Quadrula cylindrica strigillata - Rough Rabbitsfoot, Website: http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Quadrula+cylindrica+strigillata, October, 2012.

Reference 2.4.2-19. U.S. Fish and Wildlife Service, "Recovery Plan for Cumberland Elktoe, Oyster Mussel, Cumberlandian Combshell, Purple Bean, and Rough Rabbitsfoot," U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia, May 4, 2004.

Reference 2.4.2-20. Tennessee Department of Environment and Conservation, Rare Species by County - Listing for Roane County, TN, Website: http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9014:3:6699189149038::::: 2015.

Reference 2.4.2-21. U.S. Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Five Endangered Mussels in the Tennessee and Cumberland River Basins," 69(168): 53136-53180, Federal Register, August 31, 2004.

Reference 2.4.2-22. U.S. Fish and Wildlife Service, "Recovery Plan Spotfin Chub Hybopsis monacha," November 21, 1983.

Reference 2.4.2-23. U.S. Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants; Establishment of Nonessential Experimental Population Status for 15 Freshwater Mussels, 1 Freshwater Snail, and 5 Fishes in the Lower French Broad River and in the Lower Holston River, Tennessee," 72(177): 52434-52461, Federal Register, September 13, 2007.

Reference 2.4.2-24. Oak Ridge National Laboratory, Y-12 National Security Complex, and URS/CH2M Oak Ridge LLC, "Oak Ridge Reservation Annual Site Environmental Report for 2011," DOE/ORO/2418, U.S. Department of Energy, U.S. Department of Energy, September, 2012.

Reference 2.4.2-25. Gaynor, Shawn, Asheville Global Report, Endangered Species of the Southern US: The Spotfin Chub, No. 247, Website: http://archives.theglobalreport.org/issues/247/environment.html, October, 2003.

Reference 2.4.2-26. Niemiller, M. L. and Miller, B. T., "Amphibia: Caudata: Plethodontidae: Gyrinophilus gulolineatus," Catalogue of American Amphibians and Reptiles, 2010.

Reference 2.4.2-27. U.S. Fish and Wildlife Service, "U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form," October 31, 2012.

Reference 2.4.2-28. U.S. Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants; Review of Native Species That Are Candidates for Listing as Endangered or Threatened; Annual Notice of Findings on Resubmitted Petitions; Annual Description of Progress on Listing Actions," 77(225): 69994-70060, Federal Register, November 21, 2012.

Reference 2.4.2-29. Eakes, Ron, Alabama Department of Conservation and Natural Resources, Hellbender, Website: http://outdooralabama.com/watchable-wildlife/what/Amphibians/Salamanders/hellbender.cfm, May, 2005.

Reference 2.4.2-30. LeGrand, Holly, "Terrestrial Animal Survey Report - TVA Clinch River Site - 11/4/2013," Tennessee Valley Authority, November 4, 2013.

Reference 2.4.2-31. LeGrand, Holly, Hamrick, Elizabeth B., and Baxter, Jr. J. T., "Clinch River Small Modular Reactor Site - Terrestrial Animal Survey Report - Revision 7," Tennessee Valley Authority, November 20, 2015.

Reference 2.4.2-32. Hendrickson, Dean A. and Cohen, Adam E., Texas Natural History Collection, a Division of Texas Natural Science Center, University of Texas at Austin, Fishes of Texas Project and Online Database, Cycleptus elongatus, Blue Sucker, Website: http://www.fishesoftexas.org/taxon/cycleptus-elongatus, 2012.

Reference 2.4.2-33. Natureserve, Hemitremia flammea - Flame Chub, Website: http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Hemitremia+flammea, October, 2012.

Reference 2.4.2-34. Watson, Brian T. and Fraley, Steve, North Carolina Wildlife Resources Commission, Percina aurantiaca - Tangerine Darter, Website: http://www.ncwildlife.org/Portals/0/Fishing/documents/tdarter.pdf, June 25, 2013.

Reference 2.4.2-35. Natureserve, Chrosomus tennesseensis - Tennessee Dace, Website: http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=105508&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=105508&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=105508, October, 2012.

Reference 2.4.2-36. University of Wisconsin, Elodea nuttallii, Website: http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=ELONUT, 2012.

Reference 2.4.2-37. Rook, Earl J. S., Elodea nuttallii, Website: http://www.rook.org/earl/bwca/nature/aquatics/elodeanut.html, February 26, 2004.

Reference 2.4.2-38. Tennessee Valley Authority, Sportfish Index Ratings, Website: http://www.tva.com/environment/water/sportfish.htm#29, May 19, 2015.

Reference 2.4.2-39. Tennessee Valley Authority, Spring Sportfish Survey Results, Website: http://www.tva.gov/environment/water/catchtables.htm#29, May 19, 2015.

Reference 2.4.2-40. Tennessee Valley Authority, Spring Sport Fish Survey, Website: http://www.tva.com/environment/water/catchfaq.htm, 2015.

Reference 2.4.2-41. Tennessee Valley Authority, Spring Sportfish Survey Results, Website: http://www.tva.com/environment/water/catchtables.htm, 2013.

Reference 2.4.2-42. AECOM, "Final Clinch River Site Land Use and Recreation Technical Report - Revision 2," Greenville, SC, Tennessee Valley Authority, October, 2014.

Reference 2.4.2-43. Tennessee Wildlife Resources Agency, Melton Hill Reservoir - General Information, Website: http://www.tnfish.org/ReservoirLakeInformation_TWRA/TWRA_MeltonHillReservoirInformation.htm, June, 2011.

Reference 2.4.2-44. Tennessee Wildlife Resources Agency, "Tennessee Aquatic Nuisance Species Management Plan," February, 2008.

Reference 2.4.2-45. Tennessee Valley Authority, "Reservoir Operations Study - Final Programmatic EIS, Section 4.11 Invasive Plants and Animals," May 1, 2004.

Reference 2.4.2-46. Taylor, Christopher A., "Systematic Studies of the Orconectes Juvenilis Complex (Decapoda:Cambaridae), With Descriptions of Two New Species," Journal of Crustacean Biology 20(1): 132-152, March 24, 1999.

Reference 2.4.2-47. Third Rock Consultants, LLC, "Evaluation of Freshwater Mollusk and Habitat, Clinch River CRM 15.0-19.0, Roane County, Tennessee," October 27, 2011.

Table 2.4.2-1 (Sheet 1 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Atherinopsidae							
Brook silverside	*Labidesthes sicculus*	IN	X	INT	-	X	-
Mississippi silverside	*Menidia audens*	IN	-	-	-	X	X
Catostomidae							
Black buffalo	*Ictiobus niger*	OM	X	-	-	X	-
Black redhorse	*Moxostoma duquesnei*	BI	X	INT	-	-	-
Golden redhorse	*Moxostoma erythrurum*	BI	X	-	-	X	-
Northern hogsucker	*Hypentelium nigricans*	BI	X	INT	-	-	-
Quillback	*Carpiodes cyprinus*	OM	X	-	-	X	-
River carpsucker	*Carpiodes carpio*	OM	X	TOL	-	X	-
Silver redhorse	*Moxostoma anisurum*	BI	X	-	-	X	-
Smallmouth buffalo	*Ictiobus bubalus*	OM	X	-	-	X	-
Smallmouth redhorse	*Moxostoma breviceps*	BI	X	-	-	-	-
Spotted sucker	*Minytrema melanops*	BI	X	INT	X	X	-
White sucker	*Catostomus commersoni*	OM	X	TOL	X	X	-
Centrarchidae							
Black crappie	*Pomoxis nigromaculatus*	TC	X	-	-	-	X
Bluegill	*Lepomis macrochirus*	IN	X	TOL	-	-	X
Green sunfish	*Lepomis cyanellus*	IN	X	TOL	-	-	X
Hybrid sunfish	Hybrid *Lepomis* sp.	IN	X	-	-	-	X
Largemouth bass	*Micropterus salmoides*	TC	X	TOL	-	-	X
Redbreast sunfish	*Lepomis auritus*	IN	-	TOL	-	-	X
Redear sunfish	*Lepomis microlophus*	IN	X	-	-	-	X
Rock bass	*Ambloplites rupestris*	TC	X	INT	-	-	X
Smallmouth bass	*Micropterus dolomieu*	TC	X	INT	-	-	X

Table 2.4.2-1 (Sheet 2 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Spotted bass	*Micropterus punctulatus*	TC	X	-	-	-	X
Warmouth	*Lepomis gulosus*	IN	X	-	-	-	X
White crappie	*Pomoxis annularis*	TC	X	TOL	-	-	X
Clupeidae							
Gizzard shad	*Dorosoma cepedianum*	OM	X	TOL	-	X	X
Hybrid shad	Hybrid *Dorosoma*	OM	X	-	-	-	X
Skipjack herring	*Alosa chrysochloris*	TC	X	INT	-	X	X
Threadfin shad	*Dorosoma petenense*	PK	X	-	-	X	X
Cottidae							
Banded sculpin	*Cottus carolinae*	IN	X	-	-	-	-
Cyprinidae							
Bluntnose minnow	*Pimephales notatus*	OM	X	TOL	-	-	-
Bullhead minnow	*Pimephales vigilax*	IN	X	-	-	-	-
Common carp	*Cyprinus carpio*	OM	-	TOL	-	X	X
Fathead minnow	*Pimephales promelas*	OM	-	TOL	-	X	X
Golden shiner	*Notemigonus crysoleucas*	OM	X	TOL	-	X	X
Largescale stoneroller	*Campostoma oligolepis*	HB	X	-	-	-	X
Spotfin shiner	*Cyprinella spiloptera*	IN	X	TOL	-	-	-
Esocidae							
Muskellunge	*Esox masquinongy*	TC	-	INT	-	-	X
Ictaluridae							
Blue catfish	*Ictalurus furcatus*	OM	X	-	-	X	X
Channel catfish	*Ictalurus punctatus*	OM	X	-	-	X	X
Flathead catfish	*Pylodictis olivaris*	TC	X	-	-	X	X

Table 2.4.2-1 (Sheet 3 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Lepisosteidae							
Longnose gar	*Lepisosteus osseus*	TC	X	TOL	-	X	-
Spotted gar	*Lepisosteus oculatus*	TC	X	-	-	X	-
Moronidae							
Hybrid striped bass	Hybrid *Morone*	TC	-	-	-	-	X
Striped bass	*Morone saxatilis*	TC	-	-	-	-	X
White bass	*Morone chrysops*	TC	X	-	-	-	X
Yellow bass	*Morone mississippiensis*	TC	X	-	-	X	X
Percidae							
Dusky darter	*Percina sciera*	IN	X	-	-	-	-
Greenside darter	*Etheostoma blennioides*	SP	X	-	X	-	-
Logperch	*Percina caprodes*	BI	X	-	X	-	-
Sauger	*Sander canadensis*	TC	X	-	-	-	X
Saugeye	Hybrid *Sander*	TC	X	-	-	-	X
Snubnose darter	*Etheostoma simoterum*	SP	X	-	-	-	-
Walleye	*Sander vitreus*	TC	X	-	-	-	X
Yellow perch	*Perca flavescens*	IN	-	-	-	-	X
Poeciliidae							
Western mosquitofish	*Gambusia affinis*	IN	X	TOL	-	-	-
Sciaenidae							
Freshwater drum	*Aplodinotus grunniens*	BI	X	-	-	X	X

[1] Species listed by family in alphabetical order by common name
[2] Trophic level: BI = benthic invertivore, HB = herbivore, IN = insectivore, OM = omnivore, PK = planktivore, SP = specialized insectivore, TC = top carnivore
[3] Tolerance: INT = intolerant species, TOL = tolerant species
Source: (Reference 2.4.2-6)

Table 2.4.2-2
Summary of Reservoir Fish Assemblage Index (RFAI) Scores and Ecological Health Ratings

	Seasonal RFAI Scores Calculated from 2011 Fish Community Data							
	February		May		July		October	
Metrics	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**
Species Richness and Composition								
No. of indigenous species	3	3	3	5	5	5	3	5
No. of centrarchid species	5	5	3	5	5	3	5	5
No. of benthic invertivore species	3	3	3	3	3	5	3	3
No. of intolerant species	3	3	5	5	5	5	5	5
Percent tolerant individuals	4	3	4	3	3	2	4	3
Percent dominance by one species	2	2	3	3	3	2	2	3
Percent non-indigenous species	1	1	2	1	1	1	3	1
No. of top carnivore species	5	3	3	5	5	5	3	5
Trophic Composition								
Percent top carnivores	3	3	3	4	2	3	1	2
Percent omnivores	5	3	4	4	2	1	3	2
Fish Abundance and Health								
Average no. per run	2	2	2	2	2	2	1	1
Percent anomalies	2	5	3	2	3	3	4	5
Overall RFAI Score	38	36	38	42	39	37	37	40
Ecological Health Rating	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair

Notes:
Sampling locations within the Clinch River arm of Watts Bar Reservoir:
Downstream at CRM 15.0, upstream at CRM 18.5
Assignment of ecological health ratings based on RFAI Scores:
12 to 21 = very poor   22 to 31 = poor   32 to 40 = fair   41 to 50 = good   51 to 60 = excellent
Source: (Reference 2.4.2-6)

Table 2.4.2-3 (Sheet 1 of 2)
Numbers and Percent Composition of Fish Eggs and Larvae Collected in Ichthyoplankton Samples from Upstream (CRM 18.0) and Downstream (CRM 15.5) of the CRN Site – February 2011 through January 2012

Taxon	Upstream (CRM 18.0)		Downstream (CRM 15.5)		Total	
	Total Numbers	**Percent Comp. (%)**	**Total Numbers**	**Percent Comp. (%)**	**Total Numbers**	**Percent Comp. (%)**
FISH EGGS						
Sciaenidae	**3839**	**64.2**	**353**	**19.2**	**4192**	**53.6**
Aplodinotus grunniens (freshwater drum) eggs	3839	64.2	353	19.2	4192	53.6
Clupeidae	**1109**	**18.5**	**718**	**39.1**	**1827**	**23.4**
Clupeid (not skipjack herring) eggs	1108	18.5	609	33.2	1717	22.0
Alosa chrysochloris (skipjack herring)	1	T	109	5.9	110	1.4
Moronidae	**699**	**11.7**	**415**	**22.6**	**1114**	**14.3**
Morone (not *M. saxatilis*)	699	11.7	415	22.6	1114	14.3
Unidentifiable fish eggs	**331**	**5.5**	**349**	**19.1**	**680**	**8.7**
Percidae	**1**	**T**	**-**	**-**	**1**	**T**
Walleye egg	1	T	-	-	1	T
Total	**5979**	**100**	**1835**	**100**	**7814**	**100**
FISH LARVAE						
Clupeidae	**1253**	**76.2**	**1407**	**61.1**	**2660**	**67.4**
Clupeid spp.	1223	74.3	1399	60.7	2622	66.3
Dorosoma spp. (shad)	8	0.5	-	-	8	0.2
Dorosoma cepedianum (gizzard shad)	10	0.6	4	0.2	14	0.4
Dorosoma petenense (threadfin shad)	1	0.1	-	-	1	T
Alosa chrysochloris (skipjack herring)	11	0.7	4	0.2	15	0.4
Catostomidae	**14**	**0.9**	**448**	**19.4**	**462**	**11.7**
Ictiobinae (buffalofishes or carpsuckers)	13	0.8	448	19.4	461	11.7
Moxostoma spp. (redhorse)	1	0.1	-	-	1	T
Moronidae	**206**	**12.5**	**197**	**8.6**	**403**	**10.2**
Moronid spp.	5	0.3	13	0.6	18	0.5
Moronid (not *M. saxatilis*)	201	12.2	184	8.0	385	9.7

Table 2.4.2-3 (Sheet 2 of 2)
Numbers and Percent Composition of Fish Eggs and Larvae Collected in Ichthyoplankton Samples from Upstream (CRM 18.0) and Downstream (CRM 15.5) of the CRN Site – February 2011 through January 2012

Taxon	Upstream (CRM 18.0)		Downstream (CRM 15.5)		Total	
	Total Numbers	Percent Comp. (%)	Total Numbers	Percent Comp. (%)	Total Numbers	Percent Comp. (%)
Centrarchidae	**104**	**6.3**	**116**	**5.0**	**220**	**5.6**
Lepomis spp. (sunfish)	97	5.9	103	4.5	200	5.1
Pomoxis spp. (crappie)	7	0.4	13	0.6	20	0.5
Atherinopsidae	**20**	**1.2**	**52**	**2.3**	**72**	**1.8**
Atherinopsid spp.	3	0.2	1	T	4	0.1
Menidia audens (Mississippi silverside)	17	1.0	51	2.2	68	1.7
Sciaenidae	**17**	**1.0**	**36**	**1.6**	**53**	**1.3**
Aplodinotus grunniens (freshwater drum)	17	1.0	36	1.6	53	1.3
Cyprinidae	**21**	**1.3**	**32**	**1.4**	**53**	**1.3**
Cyprinus carpio (common carp)	21	1.3	31	1.3	52	1.3
Cyprinid spp. (*Pimephales* group)	-	-	1	T	1	T
Percidae	**5**	**0.3**	**9**	**0.4**	**14**	**0.4**
Etheostoma spp.	1	0.1	-	-	1	T
Perca flavescens (yellow perch)	-	-	1	T	1	T
Percina spp. (*Etheostoma* type)	3	0.2	8	0.3	11	0.3
Percina spp. (*P. caprodes* type)	1	0.1	-	-	1	T
Polyodontidae	**1**	**0.1**	**-**	**-**	**1**	**T**
Polyodon spathula (paddlefish)	1	0.1	-	-	1	T
Unidentifiable fish larvae	**4**	**0.2**	**7**	**0.3**	**11**	**0.3**
Total	**1645**	**100.0**	**2304**	**100.0**	**3949**	**100.0**

Notes:
Comp. = composition
CRM = Clinch River mile
Spp. = species
T = trace (< 0.1%)
- = not present

Source: (Reference 2.4.2-3)

Table 2.4.2-4
Summary of Overall Reservoir Benthic Index (RBI) Scores and Ecological Health Ratings

	Seasonal RBI Scores Calculated from 2011 Data					
	May		July		October	
Metric	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream
Average number of taxa	5	5	5	5	5	5
Proportion of samples with long-lived organisms	5	3	5	5	3	5
Average number of EPT taxa	1	1	3	3	3	5
Percentage as oligochaetes	3	5	5	3	1	5
Percentage as dominant taxa	3	3	3	5	3	3
Average density excluding chironomids and oligochaetes	5	5	5	5	5	5
Proportion of samples containing no organisms	5	5	5	5	5	5
Benthic Index Score	27	27	31	31	25	33
Ecological Health Rating	Good	Good	Excellent	Excellent	Good	Excellent

Notes:
Sampling locations within the Clinch River arm of Watts Bar Reservoir:
Downstream at CRM 15.0, upstream at CRM 18.8
Assignment of ecological health ratings based on RBI Scores:
7 to 12 = very poor   13 to 18 = poor   19 to 23 = fair   24 to 29 = good   30 to 35 = excellent
Source: (Reference 2.4.2-6)

Table 2.4.2-5 (Sheet 1 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
		Ponds		
CRN Site				
P01	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P02	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P03	Pond	Category A (50 ft)	Unnamed	Small dug out pond
P04	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P05	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P06	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
Barge/Traffic Area				
P07	Pond	Category A (50 ft)	Unnamed	Small pond connected to backwater of the reservoir
P08	Pond	Category A (50 ft)	Unnamed	Large pond
		Streams		
CRN Site				
S01	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Small channel being fed by pond and spring; flows through wetland.
S02	Perennial	Category A (50 ft)	Clinch River	Watts Bar Reservoir
S03	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Channel 2 ft wide by 1 ft deep.
S04	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Deep channel flowing out from beaver dam to reservoir.
S05	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Channel with clay substrate; flows through wetland.
S06	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Spring with small spring/run channel.

Table 2.4.2-5 (Sheet 2 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
CRN Site (continued)				
C01	WWC	NA	Unnamed	Natural
C02	WWC	NA	Unnamed	Constructed
C03	WWC	NA	Unnamed	Natural
C04	WWC	NA	Unnamed	Natural
C05	WWC	NA	Unnamed	Natural
C06	WWC	NA	Unnamed	Natural
C07	WWC	NA	Unnamed	Natural
C08	WWC	NA	Unnamed	Natural
C09	WWC	NA	Unnamed	Natural
C10	WWC	NA	Unnamed	Natural
C11	WWC	NA	Unnamed	Natural
C12	WWC	NA	Unnamed	Natural
C13	WWC	NA	Unnamed	Constructed
C14	WWC	NA	Unnamed	Natural
C15	WWC	NA	Unnamed	Constructed
C16	WWC	NA	Unnamed	Natural
C17	WWC	NA	Unnamed	Natural
C18	WWC	NA	Unnamed	Natural
C19	WWC	NA	Unnamed	Natural
Barge/Traffic Area				
S07	Perennial	Category B (100 ft)	Unnamed tributary to reservoir	Small channel with gravel/silt substrate; flooding at time of survey.
S08	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Channel 3 ft wide by 3 ft deep with gravel/silt/clay substrate; originates from seep area.
S09	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	First order stream with 3 ft wide by 2 ft deep channel and substrate of gravel with some cobble.

Table 2.4.2-5 (Sheet 3 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
Barge/Traffic Area (continued)				
S10	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Small stream that scored below TDEC threshold but was elevated due to water flow and wetland plants within the channel.
S11	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Small channel with bedrock/silt substrate.
S12	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Small stream that has been impounded by beaver activity.
C20	WWC	NA	Unnamed	Natural
C21	WWC	NA	Unnamed	Natural
C22	WWC	NA	Unnamed	Natural
C23	WWC	NA	Unnamed	Natural
C24	WWC	NA	Unnamed	Natural
C25	WWC	NA	Unnamed	Natural
C26	WWC	NA	Unnamed	Natural
C27	WWC	NA	Unnamed	Constructed
C28	WWC	NA	Unnamed	Natural
C29	WWC	NA	Unnamed	Natural
C30	WWC	NA	Unnamed	Natural
C31	WWC	NA	Unnamed	Natural
C32	WWC	NA	Unnamed	Natural
C33	WWC	NA	Unnamed	Natural
C34	WWC	NA	Unnamed	Natural

Notes:
WWC ephemeral streams/wet-weather conveyance
NA Streamside management zones are not applicable to WWCs

Source: (Reference 2.4.2-4)

Table 2.4.2-6
Aquatic Species with Federal or State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name	Common Name	Federal Status	State Status
AMPHIBIANS			
Cryptobranchus alleganiensis	hellbender	–	NMGT
Gyrinophilus gulolineatus	Berry Cave salamander	C	T
FISH			
Chrosomus tennesseensis	Tennessee dace	–	NMGT
Cycleptus elongatus	blue sucker	–	T
Erimonax monachus	spotfin chub	T	T
Hemitremia flammea	flame chub	–	NMGT
Percina aurantiaca	tangerine darter	–	NMGT
MUSSELS			
Cumberlandia monodonta	spectaclecase	E	Rare (not listed)
Cyprogenia stegaria	fanshell	E	E
Epioblasma turgidula	turgid blossom pearlymussel	E	Extirpated
Fusconaia cor	shiny pigtoe	E	E
Fusconaia cuneolus	finerayed pigtoe	E	E
Lampsilis abrupta	pink mucket	E	E
Lampsilis virescens	Alabama lampmussel	E	E
Obovaria retusa	ring pink	E	E
Plethobasus cooperianus	orangefoot pimpleback	E	E
Plethobasus cyphyus	sheepnose	E	Rare (not listed)
Pleurobema rubrum	pyramid pigtoe	–	Rare (not listed)
Quadrula cylindrica strigillata	rough rabbitsfoot	E	E
Villosa perpurpurea	purple bean	E	E
SNAILS			
Io fluvialis	spiny riversnail	–	Rare (not listed)
Lithasia geniculata	ornate rocksnail	–	Rare (not listed)
VASCULAR PLANTS			
Elodea nutallii	Nutall's waterweed	–	S

Notes:
Federal status definitions: E = Endangered; T = Threatened; C = Candidate for listing

State status definitions: E = Endangered; T = Threatened; NMGT = In need of management (nongame wildlife); S = Special concern (plants)

Natural Heritage Element Occurrence Rank:
All species shown are ranked as extant (record ≤ 25 yr old) except the following mussels:
Considered extirpated –Turgid blossom pearlymussel
Historical record > 25 yr old – Spectaclecase, fanshell, finerayed pigtoe, Alabama lampmussel, ring pink, orangefoot pimpleback, and purple bean.

Source: (Reference 2.4.2-20; Reference 2.4.2-4)