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WATTS BAR NUCLEAR PLANT

BIOLOGICAL ASSESSMENT

Tennessee Valley Authority
Nuclear Regulatory Commission

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INTRODUCTION

The Tennessee Valley Authority (TVA) is a regional resource development agency of the United States. Among its activities are the generation and transmission of electric energy. TVA is responsible for providing electricity to parts of seven states, an area inhabited by almost eight million people.

In 1971, TVA proposed to build and operate Watts Bar Nuclear Plant (WBN) to help meet an increasing demand for electricity. WBN is a two-unit plant, located on the Tennessee River just downstream from Watts Bar Dam. TVA issued a final environmental impact statement (EIS) in 1972 that evaluated the potential environmental impacts of constructing and operating WBN. That EIS mentioned the bald eagle as a relatively common visitor to the WBN area and addressed potential impacts on freshwater mussel species. Endangered and threatened species were not discussed as they would be today because the Endangered Species Act (ESA) was not passed and signed into law until 1973.

The Nuclear Regulatory Commission (NRC) is the Federal agency which licenses and regulates commercial nuclear power plants in this country, including those operated by TVA. In 1978, NRC issued a final environmental statement (FES) that evaluated the potential environmental impacts of completing and operating WBN. That FES addressed the bald eagle and two endangered freshwater mussel species (Lampsilis orbiculata and Dromus dromas). Bald eagles had been seen in the area and both mussel species were known to occur approximately seven miles downstream from WBN. NRC concluded that operation of WBN would not effect these species.

Completion and operation of WBN has taken longer than anticipated. Since the release of the TVA EIS and the NRC FES, the U.S. Fish and Wildlife Service (FWS) has added species to the lists of endangered and threatened wildlife and plants and some previously listed species have been found in the vicinity of WBN. Today, seven endangered or threatened animal species are now known to exist near WBN.

This biological assessment has been prepared to support joint TVA and NRC discussions with FWS on the WBN project. The assessment presents a description of pertinent project components, summarizes information about the seven listed species known to occur in the vicinity of WBN, and describes the potential impacts of plant operation on these species. The assessment also includes references to a number of monitoring and research reports. The discussions and impact determinations presented in this assessment are based upon information contained in the reports and other documents listed as references.

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PROJECT DESCRIPTION

Watts Bar Nuclear Plant (WBN) is located on the west (right) bank of Chickamauga Reservoir near Tennessee River Mile (TRM) 528. This two-unit nuclear generating plant is designed for an electrical output of about 2540 megawatts (MWe). WBN is situated approximately two miles downstream of Watts Bar Dam (TRM 529.9) and one mile downstream of the four-unit Watts Bar Fossil Plant (WBF), also located on the west bank of Chickamauga Reservoir (TRM 529). WBF was placed in cold standby condition on March 29, 1983. Figure 1 shows the locations of these TVA facilities along the river.

Construction of all major exterior facilities at WBN was completed during the 1970s. Unit 1 is now essentially complete, and TVA expects to initiate commercial generation at this unit in the summer of 1995. Unit 2 is approximately 65 percent complete, and its completion is being reevaluated as part of an integrated resource planning process being conducted by TVA.

WBN will be operated in a closed cycle cooling mode, using one natural draft cooling tower for heat dissipation per nuclear unit. Makeup water and other water supply requirements will be obtained from an intake channel and pumping station now in place at TRM 528.0. Blowdown from the cooling towers will be discharged through a multiport diffuser now in place in the river channel at TRM 527.8 (Outfall 101). These intake and discharge structures are indicated on Figure 1.

The intake channel has a cross section area of approximately 155 m^2 (1650 ft^2) at Chickamauga Reservoir winter pool elevation 206 m (675 ft) mean sea level, and 293 m^2 (3159 ft^2) at summer pool elevation 208 m (682.5 ft). Corresponding average velocities into

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the intake channel are 0.03 m/s (0.1 ft/s) and 0.016 m/s (0.05 ft/s). Maximum intake pumping flowrate will be approximately 4.0 m^3/s (143 cfs). This pumping flowrate represents about 0.7 percent of the long-term average flow past the plant (736 m^3/s or 26,300 cfs).

Blowdown is discharged directly to the diffuser or into a holding pond for later release through the diffuser. As required by the National Pollutant Discharge Elimination System (NPDES) permit for this site, discharges will be stored in the holding pond when releases from Watts Bar Dam are less than 98 m^3/s (3500 cfs). In emergency situations, overflow from this pond would be discharged to the river using a drainway with a mouth at TRM 527.2 (Outfall 102). Blowdown from the cooling towers will be discharged at a rate of between 1.3 and 2.4 m^3/s (45 and 85 cfs). Releases for normal two-unit operation will be 2.4 m^3/s (85 cfs), approximately 0.6 percent of the long-term average flow.

The diffuser system consists of two pipes extending into the main river channel. The downstream pipe segment extends 90 m (300 ft) into the channel with a 50 m (160 ft) long, 1.3 m (4.5 ft) diameter diffuser section located in the deepest portion of the river channel. The upstream pipe segment extends 140 m (450 ft) with a 25 m (80 ft) long, 1.0 m (3 ft) diameter diffuser section beginning where the downstream diffuser section ends. The diffuser sections are half buried in the river bottom with two rows of 2.5 cm (1 in) diameter ports at 7.5 cm (0.25 ft) spacing oriented at 45° in the downstream direction. The exit jet velocity will vary depending on operational mode, from 2 to 5 m/s (6 to 16 ft/s). The expected discharge temperature depends on cooling tower performance and varies from 17°C (63°F) in January to 35°C (95°F) in July.

All WBN point source discharges and storm water runoff points are required to comply with conditions established in the NPDES permit for

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the site (Tennessee Water Pollution Control, 1993). The current permit also requires substantial chemical and toxicity monitoring of WBN discharges.

Liquids potentially containing radioactive wastes are collected and processed before being released to the Tennessee River. Provisions are made to sample and analyze fluids for batch releases before they are discharged. Based on laboratory analyses, these wastes are either released under controlled conditions via the cooling tower blowdcwn or retained for further processing. Under plant procedures, radioactive releases may be discharged from the plant through the cooling tower blowdown. Additional releases could occur from the discharge of low level radioactive liquid effluents from the turbine building station sump to the yard holding pond via the low volume waste treatment pond. Such a release would occur only in the unlikely event of a primary to secondary leak. Releases from the liquid waste processing system are controlled by NRC regulations and discharged in accordance with the NPDES permit.

A variety of chemicals are used for different purposes at WBN. The potential sources and quantities of these chemicals are controlled by a site Chemical Traffic Control Program. Table 1 lists the chemicals being used at WBN and the anticipated quantities of their resulting end products. All chemical discharges at WBN are controlled by the NPDES permit.

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LISTED SPECIES

Information collected in recent years indicates that one threatened fish (snail darter, Percina tanasi) and four endangered freshwater mussels (fanshell, Cyprogenia stegaria; dromedary pearly mussel, Dromus dromas; pink mucket, Lampsilis orbiculata; and rough pigtoe, Pleurobema plenum) occur in the Tennessee River and tributary streams near WBN. Two endangered terrestrial species (bald eagle, Haliaeetus leucocephalus; and gray bat, Myotis grisescens) also are known to occur in the vicinity of this site.

Since 1973, TVA aquatic biologists have conducted substantial mussel field work in the Tennessee River downstream from Watts Bar Dam, primarily associated with preoperational monitoring for WBN. Starting in 1983, TVA has monitored the status of mussel stocks in three areas of relatively high density ("mussel beds") located just upstream, just downstream, and several miles downstream from the WBN discharges (TVA, 1986; Ahlstedt, 1989; 1991; 1994).

Native mussel resources are now known to occur in various concentrations throughout the Watts Bar tailwater. Since 1978, a total of 31 freshwater mussel species has been reported from this tailwater. The most abundant species are the elephantear (Elliptio crassidens), Ohio pigtoe (Pleurobema cordatum), and pimpleback (Quadrula pustulosa). The results of several recent studies (primarily TVA, 1986; and Ahlstedt, 1994) indicate that very few mussel species have reproduced successfully in this river reach during the last 30 or more years. The causes of this reproductive failure are unknown.

Recent mussel surveys in the Watts Bar tailwater provide information about the local distribution of the four endangered mussel species (Table 2). The dromedary pearly mussel (Dromus dromas), listed as endangered in 1976 (FWS, 1976), is the most uncommon of these species. Only four specimens of this species have been collected from this river reach -- three in 1978 and one in 1983 (Gooch et al., 1979; TVA, 1986). No other specimens have been found in subsequent surveys (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). All four specimens were encountered on Hunter Shoals, between River Miles 520 and 521 (approximately 7.6 miles downstream from the WBN site). Surviving populations of this mussel species occur in the Cumberland River in middle Tennessee and in the Clinch and Powell Rivers in northeast Tennessee and southwest Virginia (FWS, 1984a).

The fanshell (Cyprogenia stegaria) and rough pigtoe (Pleurobema plenum) were both found consistently in very low numbers (1 to 3 per year) in the Watts Bar tailwater between 1983 and 1985 (TVA, 1986); however, neither species has been encountered during any subsequent survey (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Both species were found more consistently on Hunter Shoals but a few specimens of each species also were found between River Miles 528 and 529. Reproducing populations of the fanshell persist in the Green River, central Kentucky; the Licking River, eastern Kentucky; and the Clinch River, northeast Tennessee and southwest Virginia (FWS, 1991). The rough pigtoe persists in the Green and Barren Rivers, central Kentucky; the Cumberland River, central Tennessee; and the Clinch River, northeast Tennessee and southwest Virginia (FWS, 1984b). The rough pigtoe was added to the list of endangered species in 1976 (FWS, 1976) but the fanshell was not added to that list until 1990 (FWS, 1990).

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The pink mucket (Lampsilis orbiculata) was listed as endangered in 1976 (FWS, 1976). At least a few specimens of this species have been found during each mussel survey conducted in the Watts Bar tailwater since 1978 (Gooch et al., 1979; TVA, 1986; Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Representatives of this species have been found on all three beds involved in the preoperational monitoring program as well as upstream toward the dam and at intermediate sites. In terms of relative abundance, the pink mucket consistently accounts for 0.3 to 0.7 percent of the mussel community encountered. Besides the Watts Bar tailwater, the pink mucket is known to exist at scattered locations from the Kanawha River, West Virginia, west to the Osage and Meramec Rivers, Missouri, south to the Black River, Arkansas, and east to the Tennessee and Cumberland Rivers in Tennessee. The most upstream site in the Tennessee River watershed where this species has been found is the Clinch River, northeast Tennessee (FWS, 1985).

So far as is known, each of these endangered mussel species has similar feeding and reproductive requirements. Adult members of these species live embedded in cobble or gravel river bottoms where water currents prevent excessive silt accumulation. They feed by filtering small food particles (detritus, algae, etc.) out of the water. Reproduction involves a stage when the larvae (glochidia) must become temporary parasites on specific fish species in order to complete their development. The required "fish hosts" are unknown for all of these species but the pink mucket (sauger, Stizostedion canadense and freshwater drum, Aplodinotus grunniens - FWS, 1985). Members of these species may live for 40 years or more.

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The only other federally-protected aquatic species known to occur near WBN is the snail darter (Percina tanasi). This small fish was listed as endangered in 1975 (FWS, 1975) based on the assessment that its natural habitat would be destroyed by impoundment. In 1976, two snail darters were observed at Tennessee River Mile 515 and, in 1981, snail darters were discovered in Sewee Creek, a small stream which enters the Tennessee River at River Mile 524.6 (FWS, 1983). This is now one of six known snail darter populations, all of which occur in direct tributaries to the Tennessee River. The core of each population apparently exists in the smaller stream but young snail darters routinely drift down into the river during their first year of life. As the name implies, these fish eat primarily snails, but aquatic insects also contribute to their diet. The snail darter was reclassified to threatened status in 1984 (FWS, 1984c) based on the increased number of populations and continued threats to their continued existence.

As indicated above, only two federally-protected terrestrial species are known to occur near WBN. In 1972, when bald eagles (Haliaeetus leucocephalus) were described as fairly common visitors to Watts Bar and Chickamauga Reservoirs, the wintering population in this area was probably no more than 6 to 8 birds. Since 1972, the Watts Bar/Chickamauga bald eagle population has increased substantially to about 30 birds (Tennessee Wildlife Resources Agency unpublished data), as has been the case elsewhere across the range. The first bald eagle nesting observed in the Watts Bar/Chickamauga area was in 1994, when a pair built and, then, abandoned a nest about 6 kilometers (4 miles) south-southwest of the WBN site (Hatcher 1994; R. M. Hatcher, Tennessee Wildlife Resources Agency, personal communication).

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Bald eagles living south of the 40th parallel were listed as endangered in 1967 (under the Endangered Species Protection Act of 1966) because of declines resulting from pesticide poisoning, habitat loss, and shooting. Recovery Plan objectives for this species in the southeastern states (FWS, 1984d; 1989) include a goal of 15 occupied breeding territories in Tennessee. Now that many rangewide eagle recovery objectives have been met, the FWS has recently proposed to reclassify most of the eagle population in the lower 48 states from endangered to threatened status (FWS, 1994). If adopted, this reclassification would apply to bald eagles living in Tennessee.

Bald eagles feed primarily on fish which are either caught live or found dead. They also eat a variety of other vertebrates, especially waterfowl. Nests are usually built in large trees near the edge of a woodland within 3 kilometers (2 miles) of water. When not nesting, bald eagles usually roost on wooded slopes near water (FWS, 1989).

Gray bats (Myotis grisescens) occur throughout most of the limestone karst areas of the United States south and east of Missouri, southern Illinois, and southern Indiana (FWS, 1982). These bats roost in caves throughout the year and feed on adult aquatic insects primarily over water. Gray bats often travel 20 kilometers or more from their roost caves to feeding sites. The species was listed as endangered in 1976 because of population declines due mostly to habitat loss and human disturbance of caves (FWS, 1982).

The nearest cave in which gray bats have been found is located about 6 kilometers (4 miles) downstream from WBN. This cave is visited by male bats during the summer. The cave also receives heavy human

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visitation, which probably prevents its regular occupancy by bats (Harvey and Pride, 1986). Three other caves regularly occupied by gray bats occur between 15 and 30 kilometers (10 and 20 miles) from WBN. No significant change in the bat population of these caves has occurred in recent years. Bats from these caves probably forage over the reservoir adjacent to and downstream from WBN.

No other listed endangered or threatened terrestrial species are known to occur regularly in the WBN area. The 1972 TVA EIS mentioned five other terrestrial animals, now listed as endangered, which once occurred in east Tennessee and might be found near WBN. Three of these species (red-cockaded woodpecker, Picoides borealis; Bachman's warbler, Vermivora bachmanni; and Kirtland's warbler, Dendroica kirtlandii) have never been observed near WBN. The other two species (peregrine falcon, Falco peregrinus; and Indiana bat, Myotis sodalis) migrate or range through the general vicinity of Watts Bar and Chickamauga Reservoirs but are not known to occur regularly near WBN. Several plant species which have been listed as endangered or threatened in recent years also are known to occur in east Tennessee; however, none of them have been found during plant surveys in the vicinity of WBN.

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IMPACT ASSESSMENT

Construction Impacts

Construction of the intake channel, discharge diffuser, and other in-water facilities at WBN, as well as major exterior land-based facilities such as transmission lines, have been completed. No additional major exterior construction is proposed, and no new construction effects on endangered or threatened species are anticipated.

Operational Impacts

Operational impacts to listed aquatic species could occur through the release of radioactive, thermal, or chemical discharges to the river. Such releases could affect bald eagles and gray bats if prey species were affected. A variety of studies have been conducted to evaluate the risk of adverse environmental impacts from these discharges, the results of which are presented in the following paragraphs.

Radioactive Impacts. While there are no current radioactive releases from WBN, the potential for eventual releases of radioactive materials from the plant have been estimated at various times. Table 3 compares the estimated annual WBN liquid radioactive releases and resulting doses presented in the TVA EIS, the WBN FSAR (Amendment 77), the NRC FES, and recent data from the TVA Sequoyah Nuclear Plant (as submitted in the Semi-Annual Radioactive Effluent Reports). Data from Sequoyah are relevant because that plant uses essentially the same radioactive waste system design as WBN and the two systems are expected to operate in much the same manner. The Sequoyah monitoring period

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chosen for this comparison most closely represents expected operation of the WBN liquid radwaste system (i.e., the use of demineralizers versus evaporators to treat liquid radwaste).

The following conclusions can be drawn from this comparison: 1) the WBN FSAR estimates, even though based on very conservative (worst-case) assumptions, continue to meet the NRC dose guidelines given in 10 CFR Part 50, Appendix I; and 2) recent Sequoyah operational data for liquid effluents indicate that actual releases and resulting dose estimates to the public are a small fraction of the Appendix I guidelines (averaging 2 percent or less).

The radiological monitoring TVA conducts around both Sequoyah and Watts Bar nuclear plants also provides some specific information on radioactivity levels in fish and Asiatic clams. Data collected in 1993 (TVA, 1994a; 1994b) indicate that concentrations of Cesium-137 and Strontium-90 found in fish were essentially equivalent upstream and downstream from Sequoyah, suggesting fallout or other upstream sources. Only naturally occurring radioisotopes were identified in the Asiatic clams.

Based on these conclusions, TVA and NRC have determined that the doses to the public resulting from the discharge of radioactive effluents from WBN will be less than two percent of the NRC guidelines given in 10 CFR 50, Appendix I. Nothing in the estimates or existing plant monitoring data suggest any radioactive impact on mollusks, fish, or species which might prey on them.

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Thermal Impacts. The NPDES permit establishes monitoring requirements and/or limits for the WBN discharges into the Tennessee River. The NPDES permit required that TVA conduct temperature modeling studies to determine the appropriate daily average discharge temperature limit from the diffuser (Outfall 101) and emergency overflow (Outfall 102). These studies were completed and a report submitted to the State of Tennessee in December 1993 (Lee et al., 1993). Modeling results presented in that report indicated that the maximum WBN diffuser discharge temperature (under hot weather conditions) could be as much as 36.3°C (97.3°F). At the downstream end of the mixing zone, the model results predicted a maximum river temperature (also under hot weather conditions) of 28.1°C (82.6°F) and a maximum temperature rise (under cold weather conditions with low dam releases) of 1.0 C° (1.8 F°). Average downstream river temperatures are predicted to be lower than 25°C (77°F) and the average temperature rise is predicted to be less than 0.2 C° (0.3 F°). The size of the mixing zones used in these model studies were 75 x 75 m (240 x 240 ft) of full river depth for the discharge diffuser and 300 x 900 m (1000 x 3000 ft) largely on the surface for the emergency overflow.

Upper temperature limits are not known for any of the endangered mussel species or the snail darter; however, water temperature data (presented in Lee et al., 1993) indicate that releases from Watts Bar Dam have exceeded 27°C (80°F) relatively often during the last 15 years. Temperature data from several locations in the Tennessee River system which support diverse mussel and fish communities (Poppe and Fehring, 1986) include a number of recorded maximum temperatures above 32°C (88°F).

Based on this information, TVA and NRC have concluded that thermal discharges from WBN will not impact endangered mussels, the snail darter, or prey of the bald eagle or gray bat. Average and maximum temperature increases at the downstream ends of the mixing zones will be only very slightly different from existing conditions in the river and well within the range of temperatures these species encounter naturally. The possible maximum temperature of the discharge, which would occur rarely, would exist only in a small part of the mixing zones and would rise in the water column away from the habitat of these bottom-dwelling species.

Chemical Impacts. The NPDES permit also controls the discharge of chemicals from WBN. However, it is possible that listed species living in or near the discharge mixing zone could be affected by levels of some plant effluents which could otherwise be allowed under typical NPDES permit limits. This would include such chemicals as molluscicides that are used to control Asiatic clams and, potentially, zebra mussels at WBN. TVA has been aware of this potential impact for some time and has been working with the State of Tennessee to better determine safe discharge concentrations of these chemicals.

Monthly chronic toxicity tests were conducted over a year-long period when chemicals were being used by WBN (Table 4). These tests did not identify toxicity in undiluted Outfall 101 effluent based on response of either daphnids (Ceriodaphnia dubia) or fathead minnows (Pimaphales promelas). Both species are standard NPDES toxicity biomonitoring organisms.

In addition, two studies have been conducted to evaluate the potential impact of chemical use by WBN on the paper pondshell, Anodonta imbecillis, as a representative freshwater mussel. An initial study,

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conducted in 1991 jointly by the TVA Toxicity Testing Laboratory and Presbyterian College, Clinton, South Carolina, evaluated toxic responses of daphnids and 8-10 day old juvenile freshwater mussels to WBN Outfall 101 effluent that was spiked with chemicals used at WBN. Daphnid survival during 48-hour tests was reduced in treatments containing DGH/QUAT, the active ingredients in a molluscicide being used to control Asiatic clams at WBN. In contrast, juvenile mussels were not affected by any treatment during 9-day tests. A repeat of the study using WBN effluent spiked with DGH/QUAT alone showed toxicity to daphnids but not to fathead minnows.

A second study was conducted by TVA and two laboratories under contract with the Tennessee Wildlife Resources Agency (EMPE, Nashville, Tennessee, and Presbyterian College). This 1994 study evaluated the impact of synthetic water spiked with DGH/QUAT on non-target species [daphnids, fathead minnows, Anodonta imbecillis, Elliptio arctata (another freshwater mussel), and Brachionus calyciflorus (a rotifer)]. Results were similar to the spiked effluent test in that daphnids were the most sensitive organisms tested (Table 5). The 96-hour LC_{50} for daphnids was 0.07 mg/L (whole product), compared with the 9-day LC_{50} for A. imbecillis of 0.14 mg/L without silt and 1.07 mg/L with silt present (silt is a detoxifying agent used for DGH/QUAT). The 9-day LC_{50} for E. arctata was 8.74 mg/L with silt present. In this experiment, the more sensitive mussel species (A. imbecillis) was 15 times less sensitive than daphnids to DGH/QUAT under conditions comparable to those which would occur in the river (i.e., when silt was included in the test).

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These monitoring and experimental data indicate that undiluted WBN effluent would not affect mussel species in the diffuser mixing zone. In addition, the large dilution which occurs as the discharge mixes with river water and the detoxifying effect of silt suspended in the river and on mussel beds provide an additional margin of safety to mussels and fish, including endangered and threatened species, outside of the mixing zone. Although the sensitivity of the mussel and fish species tested have not been compared with the sensitivity of listed species, the order of magnitude greater sensitivity of daphnids compared to the fish and mussel species tested indicates the whole effluent toxicity biomonitoring requirement at WBN (using daphnids as a test organism) will provide an ample margin of safety for listed species occurring both near and downstream from the WBN discharges.

To further ensure that plant operations have minimal adverse effects on mussel populations, TVA will continue to monitor area mussel beds and perform toxicity tests. If adverse effects are detected, steps will be taken to eliminate the effects, including altering plant chemical uses.

Chemical discharges from WBN also are unlikely to have any effect on bald eagles or gray bats. The toxicity testing data indicate that no prey for either of these species are likely to be affected by the levels of chemicals released into the river.

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SUMMARY

All major construction activities at the Tennessee Valley Authority (TVA) Watts Bar Nuclear Plant (WBN) have been completed for some time. TVA is now preparing for the plant to shift into an operational mode.

Six current endangered species and one threatened species are now known to exist in the general vicinity of WBN. Five of these species are aquatic (four endangered freshwater mussels and the snail darter, a threatened fish); the other two (bald eagle and gray bat, both endangered) are terrestrial. Regional bald eagle and snail darter populations are increasing, while the gray bat population in this part of its range appears to be relatively stable. All four endangered mussel species found in the Tennessee River adjacent to WBN have been represented by relatively few, old individuals. They and most other mussel species present in this area apparently have not reproduced successfully in this river reach during the last 30 or more years.

WBN operational impacts to endangered or threatened aquatic species could occur through the release of radioactive, thermal, and/or chemical discharges to the river. Bald eagles and gray bats could be affected if the fish or aquatic insects they prey upon were impacted. Conservative estimates of potential radioactive discharges from WBN, along with monitoring data from the similar, operating Sequoyah Nuclear Plant (40 river miles downstream), indicate that estimated radioactive discharges from WBN would have no impacts to mollusks, fish, or species which prey on them.

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Thermal and chemical discharges from WBN are controlled by a National Pollutant Discharge Elimination System (NPDES) permit. Most discharges would enter the river through a diffuser located in the river channel; emergency discharges would enter via a drainway along the shore. Modeling studies indicate the average temperature rise at the downstream edge of the diffuser or emergency mixing zone would be less than 0.2°C (0.3°F). The maximum predicted temperature rise (under cold weather conditions) would be 1.0°C (1.8°F). These temperature increases would not impact endangered or threatened species living in the river or species which prey on aquatic life.

A number of chemicals are used at WBN, including molluscicides to prevent fouling by Asiatic clams. Test results have shown that undiluted WBN effluent was not toxic to standard toxicity testing animals in any of 12 successive monthly tests. Targeted experiments indicated that a standard toxicity testing animal (the daphnid, Ceriodaphnia dubia) is much more sensitive to the active ingredients in the molluscicide used at WBN than a fish or two species of juvenile freshwater mussels. When silt is present (a natural condition in the river), this daphnid is 15 times more sensitive to the molluscicide than the fish or mussels tested. The NPDES permit for WBN requires periodic whole effluent toxicity testing using daphnids as a test organism. This requirement will provide a very conservative way to insure that endangered mussel species and the snail darter are not impacted by these discharges. No chemical impacts would affect prey of the bald eagle or gray bat.

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Considered as a whole, operation of WBN is not likely to affect individuals or populations of any endangered or threatened species. While releases of radioactive, thermal, and chemical discharges have the potential to impact these species, those impacts will not occur ar WBN. Estimates and sister-plant monitoring data indicate no impacts from radioactive discharges, increases in water temperature will be minor and within natural fluctuations, and chemical discharges, which have been shown to be non-toxic, will continue to be tested using aquatic species more sensitive than fish or freshwater mussels.

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__________. 1994. Endangered and Threatened Wildlife and Plants; Reclassify the bald eagle from endangered to threatened in most of the lower 48 states. Proposed Rule. Federal Register, 59(132):35584-35594.

WMC2542R

Table 1
SUMMARY OF ADDED CHEMICALS AND RESULTING END PRODUCTS
Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup water filter plant	Alum $Al_2(SO_4)_3 \cdot 18H_2O$	35,743	(78,800)	$Al(OH)_3$[b]	7,489	(16,510)	20	(45)
					SO_4^{2-}	13,880	(30,600)	38	(84)
					Settled Solids[b,c]	32,114	(70,800)	88	(194)
2	Makeup water demineralizer	Sulfuric Acid H_2SO_4 (93% solution)	104,780	(231,000)	SO_4^{2-} (Neutral pH)	98,430	(217,000)	270	(595)
		Sodium Hydroxide NaOH (50% solution)	195,498	(431,000)	Na^+ (Neutral pH)	56,245	(124,000)	154	(340)
	Natural Minerals Removed by Demineralizers	Sodium Na^+	4,590	(10,120)	Na^+	4,590	(10,120)	13	(28)
		Chloride Cl^-	8,936	(10,700)	Cl	8,936	(10,700)	75	(54)
		Sulfate SO_4^{2-}	9,866	(21,750)	SO_4^{2-}	8,866	(21,750)	27	(60)
		Total Dissolved Solids	53,298	(117,500)	Dissolved Solids	53,297	(117,500)	146	(322)
3	Secondary Steam System	Sulfuric Acid	267,665	(590,100)	SO_4^{2-} (Neutral pH)	262,176	(578,000)	717	(1580)
	Condensate Polishing								
	Demineralizers	Sodium Hydroxide NaOH	160,665	(353,500)	Na^+ (Neutral pH)	92,197	(203,260)	254	(560)
	Ionized Soluble Species	Carbonates (CO_3^{2-})	11,521	(25,400)	CO_3^{2-}	11,521	(25,400)	32	(70)
	Removed by Demineralizers	Metallic Salts	d	d		d	d	d	d
		Ethanolamine	44,019	97,820	$EtONH_2^+$	44,019	97,820	121	(268)
		Boric Acid	45,000	100,000	H_3BO_3	45,000	100,000	122	(273)

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Tab[illegible] 1
(Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
4	Auxiliary Steam	Ammonia NH_3	1.4	(3)[e]	NH_3	1.4	(3)	<.05	(<0.1)
		Hydrazine $H_2N_2H_2$	4.5	(10)[f]	NH_3	4.5	(10)	<.05	(<0.1)
5	Condenser Circulating Water Systems	<<Copper (corrosion product only)[h]			Cu	2,812	(6,200)	8	(17)
		<<Nickel (corrosion product only)[h]			Ni	313	(690)	0.9	(1.9)
6	Raw Cooling Water[g]	Pyrophosphate	34,088	(75,752)	$H_2PO_4^{-}$	34,088	(75,752)	93	(207)
		Organic Co-Polymer Dispersant	7,953	(17,673)	N/A	7,953	(17,673)	22	(48)
		Zinc Sulfate	18,182	(40,405)	Zn^{2+}	7,340	(16,312)	20	(45)
					SO_4^{2-}	10,841	(24,092)	30	(66)
		Coppertrol	261	(581)	Benzotriazole	261	(581)	22	(48)
		Clamtrol	1,386	(3,080)	DGH	69	(154)	14	(31)
					Quat	110	(246)	22	(49)
		Bromo-Chloro-Hydantoin	3,611	(8,024)	HOCl	1,264	(2,808)	3.5	(7.69)
					HOBR	2,347	(5,216)	6.4	(14.3)
7	Raw Service Water[g]	Pyrophosphate	3,787	(8,417)	$H_2PO_4^{-}$	3,787	(8,417)	10	(23)
		Organic Co-Polymer Dispersant	883	(1,964)	N/A	883	(1,964)	2.4	(5.4)
		Zinc Sulfate	2,020	(4,489)	Zn^{2+}	815	(1,812)	2.3	(5.0)
					SO_4^{2-}	1,204	(2,677)	3.3	(7.3)
		Coppertrol	29	(65)	Benzotriazole	29	(65)	2.4	(5.3)
		Clamtrol	154	(342)	DGH	8	(17)	1.5	(3.4)
					Quat	12	(27)	2.5	(5.5)
		Bromo-Chloro-Hydantoin	401	(891)	HOCl	140	(312)	0.4	(0.9)
					HOBR	260	(579)	0.7	(1.6)

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Table 1
(Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
8	Essential Raw Cooling[g] Water	Pyrophosphate	151,011	(335,581)	$H_2PO_4^{1-}$	151,011	(335,581)	413	(919)
		Organic Co-Polymer Dispersant	35,231	(78,291)	N/A	35,231	(78,291)	97	(215)
		Zinc Sulfate	80,547	(178,994)	Zn^{2+}	32,518	(72,262)	89	(198)
					SO_4^{2-}	48,028	(106,728)	131	(292)
		Coppertrol	1,158	(2,574)	Benzotriazole	1,158	(2,574)	96	(214)
		Clamtrol	6,139	(13,644)	DGH	307	(682)	61	(136)
					QUAT	490	(1,091)	98	(218)
		Bromo-Chloro-Hydantoin	15,996	(35,546)	HOCl	5,598	(12,439)	15	(34)
					HOBR	10,398	(23,107)	28	(63)

a Items 1, 2, 4, 5, 6, 7, and 8 are based on 365 days/year operation at rated capacity. Item 3 based on 292 days/year operation at rated capacity.

b Precipitated material that will make up the water treatment sludge on a day weight basis. Ultimately put in landfill. No discharge.

c Estimates based on maximum suspended solids data observed at TRM 529.9.

d The quantities of ionized soluble species continuously removed by the condensate demineralizers are predicated upon a primary to secondary leak rate or a condenser tube leak. These constituents will be discharged in the form of neutral salts of sodium, oxides of iron, or suspended solids. High crud filters will treat the backwash waste prior to discharge.

e Ammonia will be added as needed to maintain pH of 9.0 in the system.

f Hydrazine will be added as needed as a DO scavenger. Hydrazine conservatively assumed to decompose to ammonia.

g Based on chemical feed rates at maximum cooling water usage and treatment schedule.

h Although copper and nickel will not be added to the system, the values shown represent high estimates of corrosion losses. Actual losses are expected to be immeasurable.

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Table 2. Recent endangered mussel records from Watts Bar Dam tailwater. Entries include the total number of each species found during each survey, the River Mile intervals from which they came, and the number found there (if more than one).

Year	*Dromus dromas* dromedary		*Cyprogenia stegaria (=irrorata)* fanshell		*Pleurobema plenum* rough pigtoe		*Lampsilis abrupta (=orbiculata)* pink mucket	
	No.	River Mi.	No.	River Mi.	No.	River Mi.	No.	River Mi.
1978 (random survey)	**3**	520(3)	**4**	520 521(2) 524	**[NR]**		**19**	516 518 520(5) 521(5) 525 527 528(5)
1983	**1**	520	**3**	520 528(2)	**2**	520(2)	**10**	520(2) 526 528(7)
1984			**1**	520	**2**	520(2)	**8**	520 526(3) 528(4)
1985			**1**	520	**1**	528	**8**	520(2) 528(6)
1986							**8**	520(4) 526 528(3)
1988							**12**	526(2) 528(10)
1990							**4**	526 528(3)
1990 (lock survey)							**6**	528(2) 529(4)
1991 (Mead survey)							**2**	525(2)
1992							**6**	526(2) 528(4)

NR - species may have been present but was not recognized.

Table 3. Comparison of estimated annual liquid radioactive releases from Watts Bar Nuclear Plant (WBN) and actual releases from Sequoyah Nuclear Plant (SQN).

	WBN EIS (Table 2.4-2)	WBN FSAR (Table 11.2-7 & Table 11.2-11)	WBN FES (Table 3.3 & Table 5.9)	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
Tritium Released	1.46E+02 Ci	5.2E+03 Ci	1.04E+03 Ci	8.7E+02 Ci	
Activity Released	3.2E-01 Ci	2.2E+01 Ci	4.4E-01 Ci	4.8E-01 Ci	10 Ci
Total Body Dose	1.7E-02 mrem	1.1E+00 mrem	2.0E-01 mrem	8.0E-02 mrem	3 mrem
Maximum Organ Dose	5.5E-02 mrem	1.3E+00 mrem	1.9E-01 mrem	1.0E-01 mrem	10 mrem

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Table 4

SUMMARY OF TOXICITY BIOMONITORING RESULTS FOR WATTS BAR NUCLEAR PLANT

January 1991 - March 1994

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
Jan. 11-18, 1991					Initial baseline test of Outfall 101. Isco composite 24-h samples.
Outfall 101*	*Pimephales promelas*	TR[†]	Not toxic, s & g[§]	100, 50	
	Ceriodaphnia dubia	TR	Not toxic, s & r[§]	100, 50, 25	
	Selenastrum capricornutum	TR	Not toxic, g[§]	100, 50, 25	
Apr. 9-21, 1991 Outfall 101*					Test conducted during discharge of ice melt water w/ 2,000 ppm sodium tetraborate (20 gpm). Boron concentration range = 0.22-2.20 mg/L. Also effluent spiked with 9.0 ppm boron (nominal concentration). Isco composite 24-h samples.
	Pimephales promelas	TR	Not toxic, s & g	100, 30, 9, 2.7	9.0 ppm boron not toxic (12-d embryo-larval test).
	Ceriodaphnia dubia	TR	Not toxic, s & r	100, 30, 9, 2.7	9.0 ppm boron toxic (reproduction only)
	Selenastrum capricornutum	TR	Toxic (NOEC = 9%), g	100, 30, 9, 2.7	*Intake source of toxicity*; 9.0 mg B/L was not toxic.
Jul. 31- Aug. 9, 1991 Outfall 101*					Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of: A. TVA06[#], TVA07[#], Betz 30K[#] (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Copper-Trol[#] (treatments 5 & 6) C. TVA06, TVA07, Betz 30K, Clam-Trol[#] (treatments 7 & 8) Treatments 5-8 were exposed to Copper-Trol & Clam-Trol only during the initial 24 hours of testing.
	Ceriodaphnia dubia	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatments 7 & 8 Chronic toxicity of treatments 5 (s) and 3 (r)	See Study Comments	100% mortality in 24-h for treatments 7 & 8. Only high concentrations of A & B affected.

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Table 4
(Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
(Cont.)	*Anodonta imbecillis* (Juvenile freshwater mussels, Paper Pondshell, 8-9 days old post transformation, 9-day test exposure)	WBN Intake/ Outfall 101	Not toxic, s	See Study Comments	9-day survival in ranged from 89% (reference) to 98% (treatment 7). All treatments contained ~ 600-800 mg silt/L (dry weight).
Sept. 19-26, 1991 Outfall 101*					Follow up study that Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of : A. TVA06, TVA07, Betz 30K (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Clam-Trol (5 & 6) Treatments 5 & 6 were exposed to CT-1 only during the initial 24 hours of testing.
	Pimephales promelas	WBN Intake/ Outfall 101	Not toxic, s, g	See Study Comments	
	Ceriodaphnia dubia	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatment 5 and chronic (6-day) toxicity of treatment 6 (s)	See Study Comments	CT-1 toxic at both high and low concentrations tested. No other toxicity observed.
Apr. 9-16, 1992					Second baseline evaluation of Outfall 101 alone and spiked w/ Copper-Trol® for the algal test.
Outfall 101*	*Pimephales promelas*	WBN Intake	Toxic (NOEC < 50%), s	100 & 50	*Intake source of toxicity;*
	Ceriodaphnia dubia	WBN Intake	Not toxic, s, r	100, 75, 50, 25	
	Selenastrum capricornutum	WBN Intake	Toxic (NOEC = 50%; IC25 = 63%), g 100%-spiked Outfall 101 not toxic, g	100, 75, 50, 25 Also, with Copper-Trol®-spiked & trsted @ 100, 30, 9	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:83 minimum for the study).

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Table 4
(Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
June 25-July 2, 1992					Third baseline assessment of Outfall 101.
Outfall 101*	*Pimephales promelas*	WBN Intake	Not toxic, s, g	100, 50	
	Ceriodaphnia dubia	WBN Intake	Not toxic, s, r	100, 75, 50, 25	
	Selenastrum capricornutum	WBN Intake	Toxic (NOEC = 75%), g	100, 75, 50, 25	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:117 minimum for the study).
Oct. 15-22, 1992					First operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 12.5	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 12.5	
Nov. 18-25, 1992					Second operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:404 minimum for the study).
Dec. 16-23, 1992					Third operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jan. 15-22, 1993					Fourth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	

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Table 4
(Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
Feb. 11-18, 1993					Fifth operational assessment during injection of anti fouling chemicals.
<u>Outfall 101</u>*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:831 minimum for the study).
Mar. 19-26, 1993					Sixth operational assessment during injection of anti fouling chemicals.
<u>Outfall 101</u>*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Apr. 16-23, 1993					Seventh operational assessment during injection of anti fouling chemicals.
<u>Outfall 101</u>*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
May 12-19, 1993					Eighth operational assessment during injection of anti fouling chemicals.
<u>Outfall 101</u>*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Intake/TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:159 minimum for the study).
Jun. 9-16, 1993					Ninth operational assessment during injection of anti fouling chemicals.
<u>Outfall 101</u>*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	

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Table 4
(Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
(Cont.)	*Ceriodaphnia dubia*	Intake/ Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jul. 15-22, 1993					Tenth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Aug. 19-26, 1993					Eleventh operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Synthetic water	Toxic (NOEC = 1.1%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:424 minimum for the study).
Sep. 25-Oct. 2, 1993					Twelfth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	Growth reduction in 25% & 50% treatments but not in undiluted Outfall 101.
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Feb. 2-9, 1994					First semi-annual compliance monitoring of Outfalls 101 and 112 under renewed NPDES permit TN0020168.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 9.8, 7.8, 2.9, 2.3	
	Ceriodaphnia dubia	Synthetic water	Toxic (NOEC = 9.8%), r	100, 9.8, 7.8, 2.9, 2.3	*Permit limit not exceeded.*
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), s	100, 80, 50, 25, 12.5	*Permit limit exceeded.*

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Table 4
(Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
(Cont.)	*Ceriodaphnia dubia*	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Feb. 18-25, 1994					Repeat test of Outfall 112 due to fish toxicity exceeding permit limit.
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), g	100, 80, 50, 25, 12.5	*Permit limit exceeded* (based on 0.1 µg of fish weight in 100% Outfall 112 treatment).
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Mar. 23-30, 1994					Repeat test due to fish toxicity exceeding permit limit in the previous test.
Outfall 112*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 80, 50, 25, 12.5	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	

Test types: 3-brood *Ceriodaphnia dubia* chronic test (EPA protocol), 7-day *Pimephales promelas* chronic test (EPA protocol), 9-day *Anodonta imbecillis* acute test (TVA protocol).

*Outfall 101 = Diffuser pipe at TRM 527.9; Outfall 112 = Runoff holding pond to unnamed tributary to Yellow Creek

†TR = Non-toxic dilution water collected from outdoor channels at TVA's Toxicity Testing Laboratory, Wheeler Reservoir once-through water pumped from upstream of the Browns Ferry Nuclear Plant (TRM 293).

§s = survival (fish, daphnids, & mussels), g = growth (fish & algae), r = reproduction (daphnids).

#Chemical additives:

TVA06 = HPS-1 copolymer dispersant
TVA07 = zinc sulfate
Betz 30K = tetra potassium pyro phosphate
Copper-Trol = tolyltriazole
Clam-Trol = CT-1 (DGH/QUAT).

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Table 5
DGH/QUAT TOXICITY TO NON-TARGET ORGANISMS

Product (mg/L)	TOXICITY IN LABORATORY WATER WITHOUT SILT				TOXICITY WITH SILT PRESENT†		
	C. dubia *3-brood test*	*P. promelas* 7-day test	*A. imbecillis* 9-day test	*B. calyciflorus.* *24-hour test*	*A. imbecillis* 9-day test	*A. imbecillis* 9-day test	*E. arctata* *9-day test*
	EMPE* (Survival)	**EMPE*** (Survival)	**TVA*** (Survival)	**TVA*** (Survival)	**TVA*** (Survival)	**PC*** (Survival)	**PC*** (Survival)
Control	NOEC-r (100%)	(100%)	(97.5%)	(100%)	(97.6%)	(97.6%)	(97.5%)
0.05	NOEC-s (100%)						
0.07	96-h LC_{50}						
0.10	(0%)	NOEC-s,g (100%)	(67.5%)	(100%)	(95%)	(87.8%)	(97.5%)
0.12			9-d EC_{50}				
0.14			9-d LC_{50}				
0.20	(0%)						
0.40	(0%)	(85%)	(0%)	(100%)	(97.5%)	(82.5%)	(100%)
0.67		96-h LC_{50}					
0.80	(0%)						
0.96					9-d EC_{50}		
1.07					9-d LC_{50}		
1.60	(0%)	(0%)	(0%)	(60%)	(25%)	(90%)	(97.5%)
1.80§				24-h LC_{50}			
2.85						9-d LC_{50}	
3.20				(0%)			
6.40		(0%)	(0%)	(0%)	(0%)	(0%)	(97.5%)
8.74							9-d LC_{50}
12.80		(0%)	(0%)		(0%)	(0%)	(0%)
26.00					(0%)	(0%)	(0%)

*Testing conducted by EMPE, Inc., Nashville, Tennessee; Tennessee Valley Authority (TVA), Water Management; and Presbyterian College (PC), Clinton, South Carolina. Species tested were < 24-h old *Ceriodaphnia dubia* (daphnids), *Pimephales promelas* (fathead minnows), and *Brachionus calyciflorus* (rotifers), and 8-9 day old *Anodonta imbecillis* and *Elliptio arctata* (freshwater mussels).

†Silt provided by TVA from non-toxic reference site. Include in test at 600-800 mg dry wt./L.

§Graphically determined.

[ ] = Concentration tested.   [ ] = Toxicity test endpoint.

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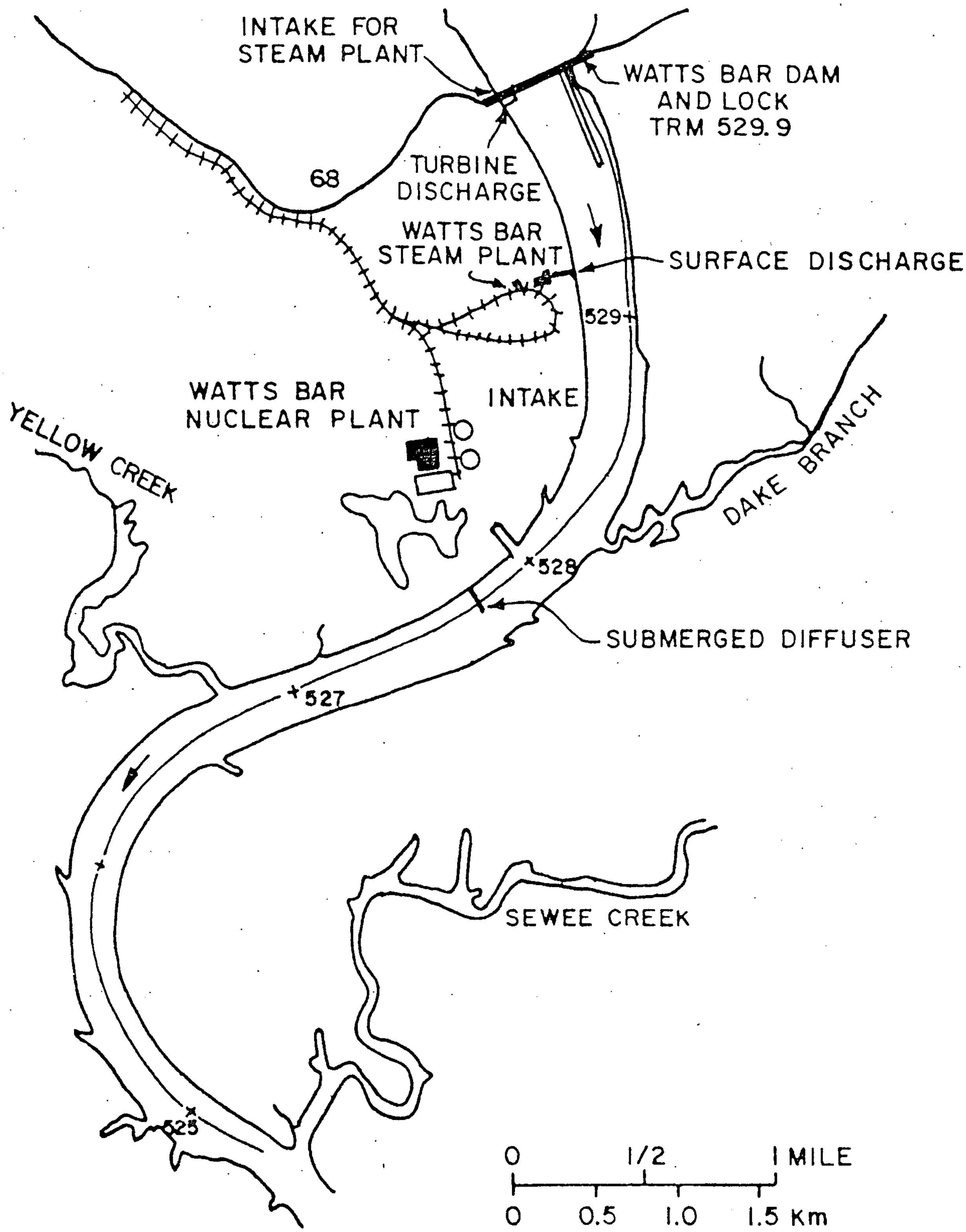

Figure 1. Tennessee River (upper Chickamauga Reservoir), indicating the locations of various facilities associated with the Watts Bar Nuclear Plant

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNIT 1
REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

REACTOR CONTAINMENT BUILDING
INTEGRATED LEAK RATE TEST
WATTS BAR NUCLEAR PLANT UNIT 1

CONDUCTED JUNE 22-29, 1994

Docket No. 50-390

Prepared by:
Watts Bar Nuclear Plant
Technical Support
and
Corporate Technical Support
Systems Technology

Prepared for:

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
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