5.3 COOLING SYSTEM IMPACTS

Section 5.3 describes the range of impacts on the environment and human health from the operation of the Clinch River (CR) Small Modular Reactor (SMR) Project cooling system. The cooling system includes the cooling water intake system (Subsection 5.3.1), the cooling water discharge system (Subsection 5.3.2), and the system for discharging heat to the atmosphere (Subsection 5.3.3). In addition to the evaluation of physical and ecological impacts from these three components, impacts to public health are evaluated (Subsection 5.3.4) based on potential effects from microorganisms and noise.

5.3.1 Intake System

The design of the cooling water intake structure is described in Subsection 3.4.2.1. The hydrodynamic and physical impacts from operation of the intake structure are described in Subsection 5.3.1.1. The impacts on aquatic ecosystems from operation of the intake are described in Subsection 5.3.1.2.

5.3.1.1 Hydrodynamic Description and Physical Impacts

The proposed location of the intake structure is on the shoreline of the Clinch River arm of the Watts Bar Reservoir at approximately Clinch River Mile (CRM) 17.9. As discussed in Subsection 3.4.2.1, the intake structure is proposed to be a common intake for all SMRs and contain pumps, trash racks, and appropriate water screen technology to minimize effects on aquatic biota. The front face of the structure is to be located at the existing river bank. The river bank is to be excavated to provide a short intake channel, approximately 50 feet (ft) wide, to ensure sufficient water depth to provide water under conditions of low flow (Figures 3.4-2 and 3.4-3).

Hydrological conditions in the reservoir adjacent to the Clinch River Nuclear (CRN) Site are discussed in Subsections 5.2.1.1.1 and 5.2.1.2.1. On the average, the design withdrawal rate for the facility is approximately 0.9 percent of the average flow rate in the portion of Watts Bar Reservoir adjacent to the CRN Site. In the most conservative scenario, assuming a maximum water withdrawal rate by the plant and a minimum release from Melton Hill Dam (400 cubic feet per second [cfs]), the facility withdrawal rate would be approximately 17 percent of the daily average reservoir flow past the plant. Considering all of Watts Bar Reservoir, these estimates are conservative because the water released from Melton Hill Dam is not the only source of water for the reservoir. The Tennessee River below Fort Loudoun Dam comprises the main body of Watts Bar Reservoir and supports a much larger conveyance than that of the Clinch River arm of the Watts Bar Reservoir. Based on a comparison of the volume of water to be withdrawn by the CRN facility and the overall volume of water available in Watts Bar Reservoir, CRN facility operations would not significantly affect water levels or flow rates within the reservoir.

As discussed in Subsection 3.4.2.1, the maximum intake inlet velocity, trash rack flow-through velocity, and water screens flow-through velocity are to be designed to be less than 0.5 ft per second (s), in accordance with Clean Water Act (CWA) Section 316(b) regulations for protection of aquatic life. As discussed in detail in Subsection 5.3.1.2, this intake velocity is sufficiently low so that the majority of fish or other swimming organisms can avoid being trapped on the intake screens. Given the limited intake velocities and flow rates, the withdrawal zone created by the intake is expected to be weak and limited to the area immediately in front of the intake structure.

CWA Section 316(b) also requires that “for cooling water intake structures located in a lake or reservoir, the total design intake flow must not disrupt the natural thermal stratification or turnover pattern (where present)…” (40 CFR 125.84) As discussed in Subsection 2.3.1.1.2.7, a daily thermal gradient was documented in 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. As a result, there is no established thermal stratification or stable thermocline to be disrupted in this reach of this reservoir. In addition, as discussed in Subsection 3.4.2.5, releases from Melton Hill Dam are currently episodic, occurring for only one hour each day. Once the project is operational, a bypass will be added to Melton Hill Dam to provide a continuous release of 400 cubic feet per second (cfs). As a result, there will be continuous flushing of the reservoir and greater mixing during all seasons. Therefore, any short-term diurnal stratification that is currently present would not be present once the project is operational.

As discussed in Subsection 5.2.1.2.1, the design intake flow for the facility is approximately 0.9 percent of the average flow in this portion of the reservoir. Therefore, the withdrawal by the intake of such a small proportion of water in a localized area of this large reservoir would not be expected to noticeably alter thermal patterns. There is no stable thermocline or substantial turnover pattern to be disrupted in this relatively shallow and well-mixed reach of the reservoir. In addition, as discussed in NUREG-1437, Revision 1 (2013), the U.S. Nuclear Regulatory Commission (NRC) has found that effects on thermal stratification in lakes at operating nuclear power plants are limited to the areas in the vicinity of the intake and discharge structures, and the NRC determined that these impacts have been SMALL.

For reasons discussed above, physical impacts from operation of the intake structure, including bottom scouring, induced turbidity, silt buildup, and alteration of thermal stratification patterns, are not expected to be significant. Therefore, hydrodynamic and physical impacts of water withdrawals during SMR operations would be SMALL.

5.3.1.2 Aquatic Ecosystems

This subsection discusses the potential impacts on the aquatic community of the Clinch River arm of the Watts Bar Reservoir from the operation of the intake structure for the CR SMR Project. The ecological characteristics of the potentially affected reservoir community adjacent to the CRN Site are described in Section 2.4. The operation of the cooling system and its use of the reservoir as the source of makeup water are described in Subsections 5.2.1.2.1 and 5.3.1.1. As noted in Subsection 5.3.1.1, operation of the CRN facility would not significantly affect water levels or flow rates in the reservoir. Thus, aquatic ecosystems and associated riparian habitats of the floodplain would not be affected by hydrological changes from facility operation.

For aquatic resources, the primary concerns related to the water intake are impacts associated with the relative amount of water drawn from the Clinch River arm of the Watts Bar Reservoir and the potential for organisms to be impinged on the intake screens of the intake structure or entrained within the circulating water system (CWS). Impingement occurs when organisms are trapped against the intake screens by the force of the water passing through the intake structure. Impingement can result in starvation, exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged periods of time), descaling, and other physical injuries. Entrainment occurs when organisms are incorporated into the intake water flow and drawn through the intake structure into the CWS. Organisms that become entrained normally are relatively small forms that float or swim freely in the water column, including plankton and early life stages of fish. As entrained organisms pass through the cooling system, they are subject to mechanical, thermal, and toxic stresses that often are lethal. (Reference 5.3-1)

As discussed in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Rev. 1, U.S. Nuclear Regulatory Commission (NRC) has determined that entrainment and impingement of fish and shellfish has not been a problem at operating nuclear facilities with cooling towers. This is due to the relatively low rates of water withdrawal required by facilities that utilize cooling towers in a closed-cycle cooling system. NRC did not identify any operating nuclear power plants with cooling towers operated in closed-cycle mode that reported reduced populations of aquatic organisms due to entrainment and impingement. Accordingly, NRC concluded that the effects of entrainment and impingement of aquatic organisms at nuclear facilities with a closed-cycle, cooling-tower-based heat dissipation system would be SMALL.

Closed-cycle, recirculating, cooling-water systems using fresh water can reduce water withdrawals by 96 percent to 98 percent of the amount that the facility would withdraw if it employed a once-through cooling system (Reference 5.3-1). This substantial reduction in water withdrawal capacity results in a corresponding reduction in entrainment and impingement of aquatic organisms.

The data from the U.S. Environmental Protection Agency (EPA) impingement studies suggested that a through-screen velocity of 0.5 feet per second (ft/s) would protect 96 percent of the fish tested. (Reference 5.3-1) The intake structure for the CR SMR Project is to be designed in accordance with Section 316(b) to limit through-screen velocity to no more than 0.5 ft/s and minimize the impact of the intake system on aquatic organisms. Thus, the design and construction of the intake structure is expected to prevent the impingement of the majority of fish or other swimming organisms that may come into contact with the intake structure.

The hydrological and ecological characteristics of the Clinch River arm of the Watts Bar Reservoir are additional factors limiting the potential for cooling system impacts on aquatic organisms from entrainment and impingement. As discussed in Subsection 5.2.1.2.1, based on the expected average water withdrawal through the intake structure, the design withdrawal rate for the facility is only approximately 0.9 percent of the annual average flow in the reservoir adjacent to the CRN Site. Under the most conservative scenario, based on the expected maximum withdrawal through the intake structure and a minimum daily average release from Melton Hill Dam, the facility withdrawal would be approximately 17 percent of the daily average flow in the reservoir adjacent to the CRN Site. Thus, the proportion of water withdrawn through the intake structure would be minimal under normal conditions and would be small even under the most conservative scenario. Also, the location of the intake structure on the shoreline of the reservoir is not near any known important spawning areas or other sensitive habitats. As discussed in Subsection 2.4.2, the reservoir adjacent to the CRN Site supports a community of relatively common species of aquatic organisms and is not known to provide habitat for listed species.

Subsection 2.4.2.1.1 includes a description of an investigation by Tennessee Valley Authority (TVA) in 2011 of ichthyoplankton in Watts Bar Reservoir adjacent to the CRN Site. The temporal occurrence, composition, and abundance of fish eggs and larvae in that part of the reservoir were characterized by data collected at an upstream location, immediately upstream of the location of the intake structure, and a downstream location.

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 from each family are discussed in Subsection 2.4.2.1.1. More than 53 percent of the eggs collected were from the freshwater drum (family Sciaenidae), followed by shad (Clupeidae), and temperate basses (Moronidae). More than 67 percent of the larvae collected were Clupeid species, followed by suckers (Catostomidae), temperate basses, sunfishes (Centrarchidae), and others contributing less than 2 percent (Table 2.4.2-3). The species abundance data were used with sample volume data to calculate species-specific densities of fish eggs and larvae in the water column. (Reference 5.3-2)

The data from the upstream location provide an indication of the ichthyoplankton densities at the proposed location of the intake structure. These density data are summarized in Table 5.3-1, which shows densities of fish eggs and larvae by family (in numbers/1000 cubic meter [m^3]) based on the locations across the channel where they were collected along the transect. The results are totaled and averaged for day and night and for a 24-hour (hr) period. The average annual density for a 24-hr period was 337.5 eggs/1000 m^3 and 91.0 larvae/1000 m^3. Thus, the average annual total density of both fish eggs and larvae for a 24-hr period was 428.5 organisms/1000 m^3.

This annual average total density was used with the average reservoir flow past the CRN Site and the average and maximum estimated water withdrawals through the intake structure to estimate the average and maximum rates of entrainment of fish eggs and larvae at the intake structure during operation of the CR SMR Project. The results predict an average entrainment rate of 0.88 percent and a maximum entrainment rate of 1.5 percent of the total number of fish eggs and larvae in the reservoir at the intake structure. This evaluation conservatively assumes that biotic entrainment equals hydraulic entrainment (calculated in Subsection 5.2.1.2.1 as an average of 0.9 percent) and does not account for any potential reductions in entrainment that may result from factors such as intake screens or larval behavior.

These results are consistent with the conclusion by NRC that the effects of entrainment of aquatic organisms at nuclear facilities with a closed-cycle, cooling-tower-based heat dissipation system are SMALL. Impingement would be minimized by the design of the intake structure. Entrainment of ichthyoplankton under normal conditions would be less than 1 percent, and it would not exceed 1.5 percent under the most conservative water withdrawal scenario. Based on the species present, the predominant fish eggs and larvae entrained would be common species. The minimal reductions in numbers of fish eggs and larvae associated with the operation of the intake structure would not reduce the populations of important species (listed species or those considered commercially or recreationally valuable) or of mussels that may depend on fish as hosts for their larvae. Based on the use of closed-cycle cooling, the proportion of water that would be withdrawn, the expected design and location of the intake, and the composition of the aquatic community, the impacts from entrainment, impingement, or other effects on fish and other organisms due to the operation of the cooling water intake system for the CR SMR Project would be SMALL.

5.3.2 Discharge System

This subsection describes the impacts of the discharge system during operation of the CR SMR Project. The hydrothermal discharge and its physical impacts are described in Subsection 5.3.2.1. The impacts on aquatic organisms from operation of the discharge are described in Subsection 5.3.2.2.

5.3.2.1 Thermal Discharges and Other Physical Impacts

The design of the discharge structure, described in Subsection 3.4.2.3, consists of a bottom-mounted, cylindrical, multi-port diffuser situated approximately perpendicular to the flow at approximately CRM 15.5. Plans are for ports located in the downstream, upper quadrant of the diffuser pipe to disperse the heated water into the flow of the reservoir. Discharges from the CR SMR Project will be permitted under the Tennessee Department of Environment and Conservation (TDEC) National Pollutant Discharge Elimination System (NPDES) program, which regulates the discharge of pollutants into waters of the state. Under NPDES regulations, waste heat is regarded as thermal pollution and is regulated, as are chemical pollutants.

Computer modeling was performed to evaluate the thermal effects of the discharge from the CR SMR Project on both a local and regional scale. The computer codes are commercially available software products which have been vetted by developers and are successfully applied on projects similar to the SMR project. The computer modeling simulated the geometry of the water body, the shapes of the SMR intake and discharge structures, the reservoir flow conditions, and the intake and discharge rates, to reproduce the transport and movement of mass, momentum, and thermal energy in the reservoir. The modeling included consideration of viscosity, buoyancy, flow advection, turbulent diffusion, and other physical parameters, and included site-specific calibration against actual field measurements.

The local-scale analysis focused on thermal effects in the immediate vicinity of the SMR discharge and included a computational model spanning the reach of reservoir from about CRM 13.5 to CRM 21.0. The regional-scale analysis focused on thermal effects in Watts Bar Reservoir at locations farther away from the SMR site. Of particular interest are potential impacts in the portion of the reservoir near the confluence of the Clinch River and Emory River (e.g., to assess potential impacts on the Kingston Fossil Plant), and the reach of the reservoir near the confluence of the Clinch River and the Tennessee River (e.g., to assess potential impacts on the main body of the reservoir). The regional-scale analysis included a computational model encompassing all of Watts Bar Reservoir.

Local-scale modeling was initially performed to evaluate alternatives for managing the SMR blowdown. The results of the analysis of those alternatives are presented in Subsection 9.4.2.2.2. The two preferred alternatives from the initial analysis each required installation of a new low-level outlet structure at Melton Hill Dam. The purpose of the bypass is to provide a continuous, minimum release from the dam during periods of idle operation of the existing hydroelectric generating units at the dam. With the bypass, sufficient flow is provided in the Clinch River arm of the Watts Bar Reservoir at all times to assimilate blowdown from the CR SMR Project. The hydrothermal impacts of the CR SMR Project discharge are the same for both preferred alternatives; the only difference being in the type of hydraulic equipment used to control the bypass release from the dam. The initial analysis was based on a preliminary estimate of 3944 gallons per minute (gpm) for the SMR blowdown flowrate and a bypass flow rate of 200 cfs. Following further development of the plant parameter envelope (PPE), provided in Tables 3.1-1 and 3.1-2, a supplemental analysis of the preferred alternatives was performed. The supplemental analysis was based on a blowdown flow rate of 12,800 gpm and a bypass flow rate of 400 cfs.

The baseline temperature of water in the Clinch River arm of the Watts Bar Reservoir is summarized in Subsection 2.3.1.1.2.7. The flow conditions in the reservoir are summarized in Subsections 2.3.1.1.2.4 and 2.3.1.1.2.6. The local-scale analysis was conducted for both steady and unsteady flow conditions. As discussed in Subsection 2.3.1.1.2.4, flow rates and directions in the Clinch River arm of the Watts Bar Reservoir are a function of the relative release rates from Melton Hill, Fort Loudoun, and Watts Bar Dams. Although the Reservoir Operations Study (ROS) operating policy for Melton Hill Dam requires a minimum daily average release rate of 400 cfs, this may be achieved with a very short (less than 1 hr) period of operation of the hydro generating units at the dam, followed by up to 46 hr of no water release, before water is again released for another short period of operation. As discussed in Subsection 2.3.1.1.2.6, this manner of operation can lead to reversal of flow direction, or sloshing, of the reservoir. To address this behavior, the local-scale modeling analysis also examined the assimilation of the blowdown from the SMR plant for unsteady conditions in the Clinch River arm of Watts Bar Reservoir created by infrequent operation of the existing hydro units at Melton Hill Dam.

In the supplemental analysis, for the steady, minimum flow situation, the thermal plume from the SMR diffuser was evaluated using CORMIX, a water quality model used to assess and perform environmental impact assessment of mixing zones resulting from wastewater discharges from point sources. Modeling was conducted to evaluate worst-case scenarios under both extreme winter conditions and extreme summer conditions while the CRSMR Project is operating at 100 percent power (800 megawatts electric [MWe]). The steady flow rate was assumed to be 400 cfs, corresponding to the minimum daily average release from Melton Hill Dam as specified by the TVA ROS operating policy. The results suggest that for steady flow in the reservoir at or above 400 cfs, the thermal effluent from the SMR plant under PPE conditions could be assimilated within regulatory limits at a minimum distance of 50 ft from the diffuser.

For regulatory limits enforced on an hourly basis, the mixing zone for the diffuser discharge needs to be large enough to capture unsteady events wherein the thermal plume from the SMR billows laterally and upstream during sloshing events. To evaluate the thermal plume for these conditions, the model for local-scale analyses is capable of simulating the three dimensional, unsteady behavior of the SMR thermal discharge in the reservoir. The computational domain for the local-scale model included the natural geometry of the Clinch River arm of the Watts Bar Reservoir between approximately CRM 13.5 and CRM 21.0 (7.5 miles [mi]). The model inputs include the bathymetry of the reservoir and the basic configurations of the CR SMR Project intake and diffuser, as well as time histories for the ambient flow and temperature in the reservoir and the flow and temperature of the SMR blowdown.

In the supplemental analysis, two of the unsteady scenarios analyzed using the local-scale model included the behavior of the thermal plume for operation of the CR SMR Project at full power under extreme winter conditions and under extreme summer conditions. In terms of reservoir flow, operating conditions of Watts Bar Reservoir leading to perhaps the most challenging conditions for assimilation of the SMR thermal discharge are an extreme winter event and an extreme summer event, respectively, as presented in Figures 5.3-1 and 5.3-2. These diagrams show the flow rates from Melton Hill Dam (MHH), Watts Bar Dam (WBH), and Fort Loudoun Dam (FLH), and the flow rate in the reservoir at the CR SMR Project discharge location through a representative 48 hr period. Figures 5.3-1 and 5.3-2 show that Melton Hill Dam releases water for power generation through the hydroelectric plant at approximately 5000 cfs for 1 hr at the beginning of the first day, then releases a continuous flow of 400 cfs (through the bypass), and then releases flow through the hydroelectric plant at approximately 5000 cfs again for 1 hr at the end of the second day. In both scenarios, the flow in the reservoir increases immediately in reaction to the higher release volume during the first 2 hr. Once the release from the hydroelectric unit is completed, the flow rate at the discharge drops, and by hour 3 it reverses, flowing upstream in the reservoir. In the winter scenario (Figure 5.3-1), the sloshing in the reservoir continues for approximately 24 hr, decreasing in magnitude throughout that period until the reservoir reaches a steady flow rate of 400 cfs in the downstream direction. In the summer scenario (Figure 5.3-2), the sloshing continues for almost the entire 48-hr period.

The reversal of flow in the reservoir temporarily reduces downstream dispersion and transport of the discharge from the CR SMR Project. This causes the thermal plume to occupy a wider area of the reservoir as it is transported laterally and upstream from the discharge during the reverse flow event.

The behavior of the thermal plume must comply with the general water quality criteria for the State of Tennessee, which are provided by TDEC. For effluent entering the reservoir from the SMR discharge, the water quality criteria at the boundary of the mixing zone require that:

- The maximum change in river water temperature (ΔTR) caused by the effluent shall not exceed 5.4 degrees Fahrenheit (°F) relative to an upstream control point.
- The maximum river water temperature (TR) caused by the effluent shall not exceed 86.9°F.
- The maximum water temperature-rate-of-change (TROC) in the river shall not exceed ±3.6°F/hr.

The hydrothermal modeling results for the CR SMR Project indicate that these regulatory limits would be approached only under worst-case conditions. Extreme winter conditions would challenge regulatory limits for the river temperature rise (ΔTR) and the river TROC. Extreme summer conditions would challenge regulatory limits for the maximum river TR.

Spatially, the criteria for water temperature would be applied along the boundaries of an instream mixing zone surrounding the plant discharge. The water quality criteria do not outline any detailed procedures as to how the size and shape of mixing zones should be defined. Under these circumstances, the exact dimensions of mixing zones typically are determined on a case-by-case basis using analyses and recommendations provided by the permittee. Beyond this, some guidelines for the size and shape of mixing zones can be found in regulatory literature and correspondence from EPA. EPA would review any NPDES permit for the CR SMR Project issued by TDEC.

Because of the oscillation of flow within the reservoir due to the unsteady flow conditions, the shape and extent of the thermal plume, and the magnitude of ΔTR, TROC, and maximum TR all change throughout the 48-hr flow cycles depicted in Figure 5.3-1 and Figure 5.3-2. For winter conditions, the point in time with the most extreme temperature impact is hour 13. From results of the local-scale model, the configuration of the thermal plume at hour 13 is shown in Figure 5.3-3, along with configurations at other points in time, as identified in Figure 5.3-1. The figure shows the distribution of the change in temperature from ambient conditions within the plume (ΔTR), as well as the average ΔTR calculated around the perimeter of a 150 ft diameter mixing zone. For summer conditions, the point in time when ΔTR, and subsequently TR, is perhaps the most extreme is hour 46. The configuration of the thermal plume at hour 46 is shown in Figure 5.3-4, along with the configuration at other points in time, as identified in Figure 5.3-1.

The analysis also evaluated the maximum upstream travel distance of the thermal plume in both extreme winter and summer conditions to verify that the plume likely would not reach the SMR intake in any measureable amount. Figure 5.3-5 shows the approximate zone of influence of the thermal plume during extreme winter conditions. The most extreme condition occurs at hour 6 of the 48-hr cycle. Figure 5.3-5 shows that the maximum upstream extent of the plume would be to approximately CRM 16.3, more than 1.5 mi downstream of the SMR intake. Figure 5.3-6 shows the approximate zone of influence of the thermal plume during extreme summer conditions. The most extreme condition occurs at hour 38 of the 48-hr cycle. Figure 5.3-6 shows that the maximum upstream extent of the plume would be to approximately CRM 16.6, approximately 1.3 mi downstream of the SMR intake.

The result of the supplemental local-scale simulations suggest that the blowdown from the CR SMR Project operating at full power requires not only a bypass flow of about 400 cfs from Melton Hill Dam, but also a mixing zone commensurate to a circular area with a diameter of approximately 150 ft. The actual mixing zone would be established during the NPDES permitting process and is therefore deferred to the combined license application (COLA). However, a significant portion (more than half) of the Clinch River arm of the Watts Bar Reservoir is expected to remain hydrothermally unobstructed, allowing for the passage of fish and other aquatic life even during the relatively infrequent periods of extreme operating conditions. Although regulatory requirements based on compliance at the boundary of a 150-ft diameter mixing zone are satisfied, local pockets of warm water can slosh into regions beyond the mixing zone. For extreme winter conditions, the temperature rise in these pockets can be high. For PPE bounding conditions in Table 3.1-2, these are considered to fall within the range of acceptability for thermal compliance because they are brief and provide a zone of passage for aquatic life. The results also indicate that the intake for the CR SMR Project is far enough upstream that there is essentially no threat of blowdown being recirculated into the intake.

To assess potential water quality and hydrothermal impacts of the CR SMR Project at a regional-scale, a CE-QUAL-W2 (W2) water quality model was developed for Watts Bar Reservoir. W2 is formulated to simulate the behavior of rivers and reservoirs with traits that vary primarily throughout the depth and in the direction of flow. The parameters of primary concern for the Watts Bar model include flow, stage, water temperature, dissolved oxygen (DO), and algae biomass. The model includes the main body of Watts Bar Reservoir, major tributary inflows, and industrial discharges that potentially have a significant impact on reservoir water quality, including the withdrawal and thermal discharge for the CR SMR Project.

The calibrated W2 models for 2004, 2008, and 2013 were used to conduct simulations of the effects of SMR operation on temperature, algae, and DO in the Clinch River and Tennessee River portions of Watts Bar Reservoir. These years were selected to represent a normal flow year (2004), a low flow year (2008), and a high flow year (2013). The year 2013 also represented a year in which data were available; preapplication studies of the reservoir were conducted in 2013 to support the SMR evaluation.

W2 modeling results were summarized at the 1.5 meters (m; 5 ft) depth, the normal monitoring depth required by TDEC. TDEC’s criteria for the Fish and Aquatic Life stream classification (Rule 1200-04-03-.03) are stated as follows:

- DO: In lakes and reservoirs, the DO concentrations shall be measured at mid-depth in waters having a total depth of 10 ft or less, and at a depth of 5 ft in waters having a total depth of greater than 10 ft and shall not be less than 5.0 milligrams per liter (mg/L).
- Temperature: The maximum water temperature change shall not exceed 3 degrees Celsius (°C; 3°F) relative to an upstream control point. The temperature of the water shall not exceed 30.5°C (86.9°F) and the maximum rate of change shall not exceed 2°C (35.6°F)/hr. The temperature of recognized trout waters shall not exceed 20°C (68°F). There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. The temperature in flowing streams shall be measured at mid-depth.
- The temperature of impoundments where stratification occurs will be measured at mid-depth in the epilimnion (see definition in Rule 0400-40-03-.04) for warm water fisheries and mid-depth in the hypolimnion (see definition in Rule 0400-40-03-.04) for cold water fisheries.
- A successful demonstration as determined by TDEC conducted for thermal discharge limitations under Section 316(a) of the CWA, (33 USC 1326) shall constitute compliance with this section.

TDEC's criteria for the Domestic Water Supply stream classification is stated as follows:

- Temperature: The maximum water temperature change shall not exceed 3°C (5.4°F) relative to an upstream control point. The temperature of the water shall not exceed 30.5°C (86.9°F) and the maximum rate of change shall not exceed ±2°C (±3.6°F)/hr. The temperature of impoundments where stratification occurs will be measured at a depth of 5 ft or mid-depth, whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

The results of the regional-scale modeling suggest that SMR effects would have de minimis impact on temperature, algae, and DO at sites further downstream in Watts Bar Reservoir. The modeling analyses suggest that the water temperature in these areas would perhaps be attenuated very slightly by the 400 cfs bypass at Melton Hill Dam (i.e., compared to the present conditions wherein there is no release).

In summary, hydrothermal modeling simulations were performed to evaluate impacts in the reservoir under various operational alternatives, including conditions with minimum, steady flow in the reservoir and conditions with unsteady flows in the reservoir. The results indicate that with a minimum steady flow of 400 cfs through the planned Melton Hill Dam bypass, the thermal effluent from the CR SMR Project operating under PPE conditions ideally could be assimilated within regulatory limits at a distance of about 50 ft from the diffuser. To allow for unsteady flow and PPE conditions, a mixing zone commensurate to a circular area of diameter of approximately 150 ft is expected to be sufficient. Because the discharge would be managed in accordance with requirements of the TDEC NPDES permit, and the modeling indicates compliance with the thermal water quality criteria, thermal impacts from operation of the CR SMR Project discharge would be SMALL, and mitigation beyond operation of the Melton Hill Dam bypass is not warranted.

5.3.2.2 Aquatic Ecosystems

Operation of the CR SMR CWS produces liquid effluent that is discharged to the Clinch River arm of the Watts Bar Reservoir and has thermal and chemical effects as described in Subsections 5.3.2.1 and 5.2.2.2, respectively. The majority of the waste heat produced by the SMRs would be discharged to the atmosphere through evaporation in the cooling towers. In a closed-cycle system, evaporation causes the accumulation of minerals in the water of the system. To limit this buildup of dissolved solids (minerals and salts), some water would be regularly removed from the system (blowdown) and replaced with makeup water from the reservoir. The discharge of this heated blowdown water can have thermal and chemical effects on biota in the receiving water body, the Clinch River arm of the Watts Bar Reservoir. This subsection discusses the potential impacts from the cooling water discharge on aquatic organisms in the reservoir. The ecological characteristics of the potentially affected reservoir community adjacent to the CRN Site are described in Section 2.4.

As discussed in NUREG-1437, Rev. 1, NRC has determined that thermal discharges from operating closed-cycle nuclear facilities with cooling towers have not been a problem with respect to heated effluents directly killing aquatic organisms. NRC studies also have evaluated other effects on biota resulting from cooling system discharges from operating closed-cycle nuclear facilities with cooling towers. The issues NRC evaluated included the following:

- Cold shock
- Thermal plume barriers to migrating fish
- Effects on the regional geographic distribution of aquatic organisms
- Premature emergence of aquatic insects
- Establishment and proliferation of nuisance species
- Low dissolved oxygen and gas supersaturation
- Accumulation of nonradiological contaminants in sediments or biota
- Exposure of aquatic organisms to radionuclides

For each of these issues, NRC determined that the effects of the cooling system discharge have been SMALL for operating closed-cycle nuclear facilities with cooling towers.

The results of the thermal discharge evaluation performed by TVA to evaluate the local and regional effects of the CR SMR Project discharge are consistent with the conditions assumed under NRC's evaluation. For example, as discussed in Subsection 5.3.2.1, modeling of the effects of the discharge from the CR SMR Project found that under worst-case conditions, the plant thermal effluent could be safely assimilated using a mixing zone commensurate to a circular area of diameter of approximately 150 ft. A 150-ft diameter mixing zone encompasses approximately 45 percent of the width of the Clinch River arm of the Watts Bar Reservoir in the area of the discharge, which leaves more than half of the width of the reservoir hydrothermally unobstructed for passage of fish. In extreme winter conditions, local pockets of warm water can slosh into regions beyond the mixing zone; however, these are of brief duration, and a zone of passage for fish would remain. Additional modeling was performed at a regional scale to evaluate the discharge in the context of the full extent of Watts Bar Reservoir, and it showed that the CR SMR Project discharge would have a negligible impact on temperature (outside of the area local to the mixing zone), algae, and dissolved oxygen in the reservoir. Accordingly, NRC's conclusions are applicable for the CRN Site, and the effects of the cooling system discharge would be SMALL.

Chemical impacts from the CR SMR Project cooling system discharge on water quality of the Clinch River arm of the Watts Bar Reservoir are discussed in Subsection 5.2.2.2. Because cooling towers concentrate minerals and salts as well as organic compounds that enter the system in makeup water, cooling tower water chemistry must be modified with the addition of anti-scaling compounds and corrosion inhibitors. Biocides are also added to the system to prevent the growth of bacteria and algae. It is anticipated that the facility's blowdown discharge would contain the nonradioactive liquid waste constituents and concentrations listed in Table 3.6-1. Radionuclides anticipated to occur in the discharge from the facility are discussed in Section 3.5 and listed in Table 3.5-1. The effluent from the liquid radioactive waste treatment system would be combined with the flow from the holding pond before entering the reservoir through the discharge structure. Chemical constituent levels in the cooling system discharge will be regulated by TDEC through an NPDES permit. The concentrations of constituents in the facility discharge would be limited by the NPDES permit to comply with state water quality standards for the protection of aquatic organisms.

On the basis of the NRC's determination of insignificant biological impacts associated with thermal discharges from operating closed-cycle nuclear facilities with cooling towers, the results of the modeling of the thermal plume from the discharge at the CRN Site, the regulation of the temperature effects of the discharge in accordance with requirements of the NPDES permit and CWA Section 316(a), and the regulation of the chemical concentrations in the discharge in accordance with requirements of the NPDES permit, impacts on aquatic organisms from operation of the CR SMR cooling water discharge would be SMALL.

5.3.3 Heat Discharge System

This subsection describes the impacts from operation of the heat-discharge system for the CR SMR Project. Subsection 5.3.3.1 discusses the physical effects from the transfer of heat to the atmosphere, and Subsection 5.3.3.2 discusses the potential for theses physical effects to impact terrestrial ecosystems.

5.3.3.1 Heat Dissipation to the Atmosphere

The cooling system design for the CR SMR Project includes linear mechanical draft cooling towers (LMDCT) for the transfer and dissipation of heat from SMR cooling water to the atmosphere. The planned LMDCT use circulating makeup water from the Clinch River arm of the Watts Bar Reservoir. Releases from cooling towers consist of a vapor plume that is visible when water vapor released from the towers condenses in cooler ambient air. Small water droplets associated with the towers' circulating water also are emitted and escape with the exhaust air. These droplets are referred to as drift and contain dissolved solids. Potential impacts from these releases on the CRN Site and immediate surroundings include:

- Aesthetics related to an elevated visible plume
- Ground level fogging and icing
- Deposition of dissolved solids in drift that escapes from the circulating water
- Cloud formation and shading
- Additional precipitation from the vapor plume
- An increase in humidity
- Interaction with other vapor plumes from existing sources in the vicinity of the CRN Site

Computer modeling of the CR SMR Project's LMDCT used the Electric Power Research Institute's (EPRI) Seasonal and Annual Cooling Tower Impact (SACTI) model for evaluating potential impacts to the CRN Site and its immediate surroundings. A description of the modeling and results of the study are presented below.

The SACTI model uses hourly meteorological data to calculate seasonal and annual impacts associated with the released vapor plume and drift deposition. Meteorological data used as input to the cooling tower model were from the CRN Site's meteorological monitoring program for the period from April 21, 2011 through July 9, 2013. Other SACTI model inputs include ceiling height and mixing height data, which were not collected as part of the onsite monitoring program. Ceiling height data used were from Lovell Field Airport in Chattanooga, as obtained from the National Climatic Data Center, which was determined to be the best source of available ceiling height data for the CRN Site. Mixing height data are not collected at all National Weather Service Stations. The Lovell Field Airport mixing height data are considered representative for the Appalachian Ridge and Valley Region of Tennessee. These data are provided by the EPA Support Center for Regulatory Atmospheric Modeling (SCRAM) database website for Tennessee. Ceiling height data used from Lovell Field were concurrent with the onsite meteorological data. The design of the facility's cooling towers is not yet final; thus, certain details, such as tower-specific performance curves and some design values, were not available. However, the current design for the CR SMR Project does use LMDCT. A representative set of cooling tower parameters was developed based on the required heat rejection for the CR SMR Project. Bounding cooling tower parameters were used where applicable. The representative data selected for the project's cooling tower evaluation were based on design parameters consistent with Case Study 1 of the SACTI User's Manual, as the heat rejection for Case Study 1 is similar to that of the CR SMR Project. SACTI Model Case Study 1 included two LMDCT with a total heat rejection of 1400 megawatts (MW). The CR SMR Project is designed for a total heat rejection of approximately 1640 MW. Where appropriate, cooling tower data for the project were prorated from the SACTI Model's Case Study 1 input data.

The cooling towers area on the site layout is located approximately 500 ft to the west of the power block area, at an elevation of approximately 810 ft above mean sea level (msl). The cooling towers are located 2950 ft (899 m) from the northern boundary of the CRN Site, 1400 ft (426 m) from the western boundary, 635 ft (193 m) from the southern boundary, and 2300 ft (701 m) from the eastern boundary. As shown in Table 3.1-2, Item 3.3.1, the design footprint of the cooling towers area occupies approximately 6 acres (ac).

Representative cooling tower parameters for the project are presented in Table 5.3-2. The modeled cooling tower configuration includes two towers consisting of nine cells each. Cooling tower cells are evenly spaced by 11.0 m. (Metric units are presented here to be consistent with the SACTI model input requirements.) Each tower modeled is 99.0 m long by 11.0 m wide. The release height of the cells above ground level is 19.8 m (65 ft, from Table 3.1-2, Item 3.3.8). The total cooling water flow rate would be up to 755,000 gpm (Table 3.1-2, Item 3.3.12). The circulating water system would operate at up to four cycles of concentration. Section 3.4 of this report provides additional information on the cooling system description, operating modes, and water intake and discharge characteristics.

Table 5.3-3 provides the drift droplet mass spectrum used for the SACTI modeling based on a Marley cooling tower, which is expected to have characteristics similar to the actual cooling towers that may be included in the eventual design. Excel drift eliminators are included to mitigate drift deposition and drift impacts. The two cooling tower housings were assumed to be 11.0 m apart, which is closer than the SACTI Model Case Study 1. Positioning the towers closer conservatively increases drift deposition by concentrating the releases from the towers. The cooling tower orientation was determined based on a sensitivity study of varying tower orientations and deposition rates. The sensitivity analysis demonstrated that an east-west lengthwise orientation generated the most conservative deposition rates.

Because the design of the cooling towers is not yet final, the density of total dissolved solids (TDS) in the CR SMR Project's cooling tower water is unknown. For the SACTI modeling, the TDS density was assumed equal to that of salt, 2.17 grams per cubic centimeter (gm/cm^3). This is considered an acceptable assumption given that an order-of-magnitude approach [in the SACTI Model] is utilized when analyzing depositions, so small differences in density are negligible with respect to the conclusions derived in the calculation." Other dissolved solids potentially found in the cooling water, such as ferric nitrate, ferric chloride, potassium nitrate, and magnesium nitrate are relatively comparable in density to salt.

SACTI modeling was performed using a polar receptor grid with radials at the 16 compass directions. Receptors along each radial were spaced at 10-m, 100-m, or 200-m increments depending on the parameter modeled. Modeling was conducted to evaluate the following:

- Groundlevel fogging and icing

- Additional precipitation and humidity
- Salt deposition
- Deposition of TDS
- Hours of plume shadowing
- Plume length frequencies

Results of the SACTI modeling are discussed below.

5.3.3.1.1 Groundlevel Fogging and Icing

Groundlevel fogging occurs when the visible vapor plume directly impacts groundlevel locations downwind of the tower. Icing is predicted under temperature conditions low enough for the freezing of plume water on groundlevel surfaces. The cooling tower analysis demonstrated that due to the relatively small size of these cooling towers in comparison to a cooling tower servicing a large power plant, and the temperature and climate of the area, there were no hours of fogging or icing calculated by the SACTI code at any distance from the towers. Therefore no fogging or icing impacts are expected on transportation areas around the CRN Site and impacts are categorized as SMALL.

5.3.3.1.2 Additional Precipitation and Humidity

Table 5.3-4 provides annual average water deposition rates from the SACTI model for distances out to 1000 m. The modeling predicted the greatest annual water deposition would occur at 100 m from the cooling towers for all directions. The greatest level of deposition on an annual average basis is 97,000 kilograms per square kilometer per month (kg/km2-mo), which occurs to the west of the towers. This value, which is equivalent to approximately 0.004 inches (in.) of water per month, is insignificant for the Oak Ridge area because the Oak Ridge National Weather Service Station reports approximately 3 in. of precipitation per month or more (Table 2.7.1-2). Thus, additional water deposition from the cooling towers would be negligible. No calculations for humidity levels are provided by the SACTI model. Some increase in relative humidity may occur close to the towers and in the elevated plume. However, with low levels of water deposition and no prediction of fogging or icing, impacts on groundlevel humidity are expected to be minimal. Based on this analysis, the effects of cooling tower operation on precipitation and humidity are expected to be SMALL.

5.3.3.1.3 Salt Deposition

The SMR project design includes efficient drift eliminators to mitigate the impacts of water droplets (drift) discharged from the top of the cooling towers. However, some water in the form of drift would still be discharged from the tower with the exhaust air. Once released, drift is carried downwind from the towers. Because drift consists of water originating from within the cooling towers, it has the same concentration of salts and other dissolved solids as the water circulating in the towers. As shown in Table 3.1-2, Item 3.3.6, the design of the cooling towers would utilize up to four cycles of concentration. Salt drift is of primary concern, because salt particles deposited in the surroundings may have adverse effects on the environment. Based on sodium (Na) and chloride (Cl) concentrations in the cooling tower's circulating water (as shown in Table 5.3-2), a salt (NaCl) concentration of 0.010086 grams of salt/gram of solution was modeled in the SACTI model.

NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,* provides a basis for interpreting salt deposition rates based on levels at which vegetation may be affected. Deposition rates of 1 to 2 kilograms per hectare per month (kg/ha/mo or kg/ha-mo), which is equivalent to 100 to 200 kg/km^2-mo, are generally not damaging to plants. Deposition rates of 10 to 20 kg/ha/mo (1000 to 2000 kg/km^2-mo) cause leaf damage in many species. These effects levels and the potential for impacts on terrestrial vegetation at the CRN Site are discussed further in Subsection 5.3.3.2.1.

Table 5.3-5 provides annual average downwind salt deposition rates from the SACTI model for distances out to 1000 m. The SACTI model predicted that the maximum salt deposition rate would occur at 100 m for all directions. At this distance, the greatest annual average deposition predicted is 6276 kg/km^2-mo to the west. The average salt deposition at 100 m based on all directions is predicted to be 2983 kg/km^2-mo.

At 200 m, annual average salt deposition rates are predicted by the model to be below 1000 kg/km^2-mo in all directions except for the west and west-northwest. At 300 m and beyond, annual average salt deposition rates are below 1000 kg/km^2-mo in all directions, and the greatest annual average deposition predicted is 605 kg/km^2-mo to the west of the towers. Salt deposition rates at 300 m also are below 1000 kg/km^2-mo in all seasons. At 600 m and beyond, the greatest annual average deposition rate is below 100 kg/ km^2-mo for all directions. A distance of 600 m from the cooling towers extends beyond the site boundary, to just over the other side of the river, in the south-southeast through northwest directions (clockwise).

Seasonal salt deposition values for distances out to 1000 m also are provided in Table 5.3-5. For the individual seasons at 600 m, salt deposition rates are below 100 kg/ km^2-mo except for the rate in the westerly direction from the tower during the summer season (111 kg/ km^2-mo). Based on this analysis, the effects of salt deposition from cooling tower operation are expected to be limited to the area of the cooling towers and would be SMALL.

5.3.3.1.4 TDS Deposition

Deposition of TDS other than salt was modeled and annual average values out to a distance of 1000 m are presented in Table 5.3-6. Maximum TDS deposition for all directions occurs at 100 m. At 100 m from the cooling towers, the greatest predicted deposition is 93,928 kg/km^2-mo to the west of the cooling towers, while the average deposition at 100 m is 44,972 kg/km^2-mo. At 300 m from the cooling towers, TDS deposition drops considerably. The maximum TDS deposition at 300 m is 5079 kg/km^2-mo, while the average at 300 m is 2545 kg/km^2-mo.

Seasonal TDS deposition values for distances out to 1000 m also are provided in Table 5.3-6. Similar to the salt analysis, the greatest TDS deposition occurs adjacent to the cooling towers, and deposition drops off rapidly with distance. Thus, the effects of TDS deposition from cooling tower operation are expected to be limited to the area of the cooling towers and would be SMALL.

5.3.3.1.5 Plume Shadowing

The frequency of annual plume shadowing, or shading, in hours per year (hr/yr) out to a distance of 1000 m is presented in Table 5.3-7. SACTI model results predict a maximum of 634 hr/yr of plume shadowing at 200 m to the northeast of the cooling towers. At 200 m to the northeast, the cooling tower plume would be over the SMR facilities. The maximum number of hours of plume shadowing at 400 m is 283 hr to the west-southwest and is equivalent to just over 3 percent of the year. The nearest residences are located at approximately 500 m to 600 m to the west-southwest and southwest of the cooling towers. At 600 m, the maximum number of hours of plume shadowing to the west-southwest is 237 hr/yr, or 2.7 percent of the year.

The plume modeling evaluates the hours of shadowing per year based on plume sectors, where each sector consists of a 22.5 degree arc. Thus, any specific point within these 22.5 degree sectors is likely to experience plume shadowing less than the percentages given here. In addition, plume shadowing varies seasonally. At 600 m, for example, maximum plume shadowing is predicted to occur 3.9, 3.7, 5.8, and 2.7 percent of the time during the winter, spring, summer, and fall seasons, respectively. Seasonal hours of plume shadowing for distances out to 1000 m are presented in Table 5.3-7. Because the predicted frequencies of plume shadowing beyond the CRN Site are low, impacts would be SMALL.

5.3.3.1.6 Plume Length Frequency

Annual plume length frequencies calculated by the SACTI model are presented in Table 5.3-8 for plume lengths up to 1000 m. Predicted visible plumes extend no more than 3200 m from the towers. Plumes at this distance occur to the south, south-southwest, north-northwest, north, north-northeast, and south-southeast directions. However, the frequency of a visible plume at this distance is very low, with the greatest value being 0.09 percent of the time (annually) in the south-southeasterly direction. For other wind directions, the predicted plume does not extend beyond 2100 m. For these cases, a visible plume at 2100 m is also infrequent.

On an annual average basis, visible plumes occur up to 5.4 and 5.0 percent of the time out to a distance of approximately 200 m to the east and east-southeast directions of the towers, respectively. For other directions, a plume out to 200 m occurs less than 3.4 percent of the time annually. Table 5.3-8 also provides seasonal plume length frequencies for distances out to 3200 m. Visible plumes are more frequent in winter and fall than in spring and summer. In winter, predicted visible plumes occur 5 percent of the time out to approximately 800 m in the east direction and 300 m in the east-southeast direction from the cooling towers. During summer, the

5 percent visible plume frequency level extends to only between 100 m and 200 m for any direction.

At 300 m, a visible plume is expected less than 3 percent of the time annually for the east and east-southeast directions and less than 2 percent of the time for any of the other directions. Based on these distances and directions, locations with overhead visible plumes occurring more than 3 percent of the time annually are predicted to be restricted to the CRN Site on or adjacent to the CR SMR Project.

Visible plume frequency calculations evaluated all hours of the year including night-time hours and periods of poor visibility (e.g., periods of precipitation and fog). During night-time hours and weather conditions producing poor visibility, visible plumes from the cooling tower would be obscured or hidden. Cooler temperature conditions, such as during the night-time hours, create greater occurrences of condensation and the likelihood of a visible plume. In addition, modeling indicates long visible plumes can be generated during periods when atmospheric conditions are close to or at saturation, conditions often associated with precipitation that can obscure a predicted visible plume. As a result, the SACTI model produces conservative results, and the occurrence of visible plumes from the project's cooling towers is expected to be less frequent than predicted by the model. Impacts on terrestrial ecosystems from the occurrence of visible plumes would be SMALL.

5.3.3.1.7 Plume Interaction with Existing Sources

The nearest large facility to the CRN Site is Hittman Transportation, located approximately 2 kilometers (km) north of the cooling towers. At this distance, the SACTI model results indicate that water and salt deposition decline significantly (Tables 5.3-4 and 5.3-5). This reduction in deposition rates is reflective of reduced concentrations of plume contaminants. Further, the frequency of a visible plume at 2 km in this direction is only about 15 hr/yr (Table 5.3-8). The impacts of the cooling towers on other facilities, as well their interaction with other nearby air pollution sources, will be addressed during consultation with TDEC regarding air quality permitting. Given the limited concentrations of salt and TDS in drift and the distance to other potential sources of vapor plumes, the potential for interaction of the SMR plume with other plumes would be negligible, and the impact would be SMALL.

5.3.3.1.8 Holding Pond

The planned CR SMR Project includes a holding pond to mix discharge streams from the cooling towers and miscellaneous demineralized water users for the facility. This provides that any discharge from the holding pond into the reservoir would be homogeneous in temperature and composition. The intent of the holding pond is not for heat removal from the facility discharge or for management of discharge flow rates, and cooling effects of the pond are not given credit in the hydrothermal analysis. The purpose of the pond is for discharge flow mixing only. Nevertheless, this mixing would act to further reduce temperatures and moderate flow rates, making this is a conservative modelling assumption for purposes of the hydrothermal analysis. Assuming the holding pond was to function under a “worst case” scenario as a cooling pond, NUREG-1555 states:

- The plume will exist as ground level fog, but will evaporate within 300 m or lift to become stratus for wind speeds greater than 2.2 meters per second (m/s).
- The plume will exist as fog over the pond, lifting to become stratus for winds less than or equal to 2.2 m/s.

An analysis of nearby areas of importance shows that the closest such area is Interstate 40, which is located 900 m from the CRN Site’s nearest boundary. Because this area is greater than 300 m from the location of the holding pond, potential “worst case” scenario impacts from the holding pond would be SMALL.

5.3.3.2 Terrestrial Ecosystems

The terrestrial ecosystems at the CRN Site that could be affected by operation of the SMR system for discharging heat to the atmosphere are described in Subsection 2.4.1. Heat dissipation systems at nuclear power facilities potentially can impact terrestrial ecological communities through effects such as those evaluated and discussed in Subsection 5.3.3.1 (salt deposition; increased precipitation, humidity, fogging, and icing; and plume shading), as well as noise, and bird collisions with cooling towers.

5.3.3.2.1 Salt Deposition

As discussed in NUREG-1437, Rev. 0, salts from cooling tower operation are deposited on plants by droplet and particulate fallout, rainfall, and wind. In most humid environments, rain would wash salts off of vegetation, but exposure can become substantial during periods between rainfall events. Plants damaged by salt drift and deposition may show acute symptoms, such as discolored or necrotic tissue, stunted growth, or deformities. Chronic symptoms are less apparent but may include reduced growth, chlorosis, or increased susceptibility to insects or disease. Foliar uptake of salt is affected by the characteristics of the leaves, salt concentration, temperature, humidity, and the length of time the leaf is wet. Salt on foliage is absorbed in solution, so rainfall, dew, and humidity can enhance salt uptake. Because moisture and other plant and environmental factors affect salt deposition, uptake, and injury to plants, exposures likely to cause effects are difficult to predict.

Salt deposition also can damage vegetation through salinization of soil. However, in areas where rainfall is sufficient to leach salts from the soil, salinization usually does not occur. Consequently, NRC generally considers the risk to vegetation from soil salinization to be low.

As noted by NRC in NUREG-1437, Rev. 0 and NUREG-1555, the tolerances of native plants, crops, and ornamentals to salt deposition from drift are not precisely known. Accordingly, NRC recommends an order-of-magnitude approach to evaluating such effects, and NUREG-1555 identifies the following salt (NaCl) deposition thresholds for evaluating the potential for effects on vegetation:

- 1 to 2 kg/ha/mo (100 to 200 kg/km^2-mo): salt deposition generally not damaging to plants
- 10 to 20 kg/ha/mo (1000 to 2000 kg/km^2-mo): threshold range for visible leaf damage from salt deposition on leaves in any month during the growing season
- Hundreds or thousands of kg/ha/year: could cause damage sufficient to suggest the need for changes of tower-basin salinities or a re-evaluation of tower design, depending on the extent of the area impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition

The distance at which the SACTI model predicts the greatest salt deposition rate from the cooling towers is 100 m; the greatest annual average deposition is 6276 kg/km^2-mo to the west (Table 5.3-5). The average salt deposition for all directions at 100 m is 2983 kg/km^2-mo. A radius of 100 m from the cooling towers is within the developed area of the facility immediately surrounding the cooling towers. Thus, salt deposition is predicted to exceed the 1000 to 2000 kg/ km^2-mo threshold range for effects within that radius. As a result, there is the possibility that vegetation on slopes established immediately adjacent to the cooling towers to the west and south may be adversely affected by salt deposition.

At 200 m from the cooling towers, annual average salt deposition rates are predicted by the model to be below 1000 kg/ km^2-mo in all directions except for the west and west-northwest (Table 5.3-5). Thus, within this developed area of the facility, salt deposition is predicted to be within the threshold for adverse effects in almost all directions. However, the potential for impacts to vegetation on the slopes adjacent to the cooling towers may extend to the toe of the slope in the westerly direction.

At 300 m from the cooling towers and beyond, the model predicts that the maximum salt deposition drops below 1000 kg/km^2-mo (Table 5.3-5). The greatest annual average deposition predicted at 300 m is 605 kg/km^2-mo to the west of the towers. Seasonal salt deposition rates at 300 m are below 1000 kg/km^2-mo in all seasons. Thus, beyond 200 m from the cooling towers and throughout the remainder of the CRN Site, salt deposition is predicted to remain below the 1000 to 2000 kg/km^2-mo threshold range for adverse effects.

At 600 m and beyond, maximum annual average salt deposition for all directions is below 100 kg/km^2-mo, a level at which vegetation damage does not occur. For the individual seasons, salt deposition values also are below 100 kg/km^2-mo at 600 m except for the westerly direction from the towers during the summer season. In summer at 600 m to the west, the predicted salt deposition is 111 kg/ km^2-mo, which is within the 100 to 200 kg/ km^2-mo range where damage to vegetation generally does not occur.

Based on studies of operating nuclear power facilities with cooling towers, discussed in NUREG-1437, Rev. 1, most deposition of drift and salt from cooling towers occurs in relatively close proximity to the towers. Deposition rates generally have been below those known to cause measurable adverse effects on plants, and no deposition effects on plant communities or crops have been observed from the operation of cooling towers at most nuclear power facilities. The SACTI modeling for the operation of the cooling towers at the CRN Site similarly predicts only a minor potential for vegetation to be impacted, and the area potentially affected would be limited to the area between the cooling towers and the reservoir on the west side of the CRN Site. Whether localized impacts to vegetation occur in this area would be determined by the sensitivity to salt deposition of the vegetation established in the area and local climatic conditions, such as the frequency with which rainfall washes salt deposits from foliage. Given that the potentially affected vegetation would be vegetation established on slopes during facility development in a limited area adjacent to the cooling towers, and the minimal occurrence of deposition effects at other facilities operating cooling towers, the impacts of salt deposition at the CRN Site would be SMALL. Mitigation may be warranted if vegetation established on slopes to prevent soil erosion is adversely affected by salt deposition.

5.3.3.2.2 Increased precipitation, humidity, fogging, and icing

As discussed in Subsections 5.3.3.1.1 and 5.3.3.1.2, the SACTI model indicated that operation of the cooling towers would not produce additional fogging or icing at any distance from the towers, and additional water deposition from the cooling towers would be negligible. Some increase in relative humidity may occur close to the towers, but effects on groundlevel humidity are expected to be minimal. As discussed in NUREG-1437, Rev. 1, impacts from increased humidity at nuclear power facilities have not been observed. Thus, the effects of cooling tower operation on terrestrial vegetation or other biota at the CRN Site from precipitation, humidity, fogging, or icing are expected to be SMALL.

5.3.3.2.3 Noise

The principal source of noise associated with the heat discharge system is the operation of the mechanical draft cooling towers. Wildlife on the CRN Site and the adjacent Grassy Creek Habitat Protection Area would be exposed to elevated noise levels, which would have the potential to alter behavioral patterns. As discussed in Section 2.8, the ambient noise assessment performed prior to construction and preconstruction activities on the CRN Site concluded that sound levels onsite ranged between daytime levels of 46 to 48 A-weighted decibels (dBA) and nighttime levels of 41 to 49 dBA. As presented in Table 3.1-2, Item 3.3.10, the cooling towers at the CR SMR Project are expected to operate at less than 70 dBA at a distance of 1000 ft.

Subsection 4.3.1.4 discusses the potential effects of noise on wildlife in the context of noise generated by construction activities. As discussed in that section, construction-related noise is attenuated by natural factors such as vegetation, topography, and temperature, and it quickly decreases over relatively short distances. Prediction of the effects of noise on wildlife is limited by the paucity of information linking sound levels to effects on species. A study by the Federal Highway Administration that summarized information from the available literature on the effects of noise on wildlife populations indicated that birds have been studied the most. The review found that some studies indicated that bird numbers and breeding were adversely affected by proximity to roads and their associated noise, while other studies found the opposite effect, with reports of many bird species using roadside habitats despite the noise. The sensitivity of birds seems to vary by species, with some affected, some not affected, and others more common even near noisy interstate highways. For mammals, the review found that studies indicate large mammals may avoid noise, but the effect seems to be small to moderate, and small mammals occur in significant numbers in highway rights-of-way and do not seem to be adversely affected by road noise. (Reference 5.3-3) The threshold noise level at which birds and small mammals are frightened or startled is 80 to 85 dBA (893 NRC 2011). This noise level is expected to occur at less than 1000 ft from the cooling towers, and undeveloped areas of habitat potentially affected occur only in a small area immediately south and west of the cooling towers between the facility and the reservoir.

More sensitive species may be permanently displaced to more distant habitats as a result of elevated noise levels from cooling tower operation, while more tolerant species likely would remain nearby if available habitats are otherwise suitable. Wildlife displaced by noise can find refuge in available undisturbed habitats in the vicinity of the CRN Site. Based on the similarity of cooling tower operational noise and highway noise levels, the rapid attenuation of noise expected to occur beyond the cooling tower area, the ability of mobile wildlife to move away from the noise, and the habituation and limited sensitivity of many wildlife species to the noise levels likely to occur in habitat areas, the impacts of noise on wildlife from cooling tower operation are expected to be SMALL.

5.3.3.2.4 Bird Collisions with Cooling Towers

As shown in Table 3.1-2, Item 3.3.8, the height of the mechanical draft cooling towers is expected to be 65 ft above finished grade. As discussed in NUREG-1437, Rev. 1, NRC has determined that natural draft cooling towers, which are much taller (usually taller than 330 ft), cause some bird mortality from collisions. However, mechanical draft cooling towers are much smaller (usually less than 100 ft) and cause negligible mortality to birds. Therefore, adverse effects on bird populations from collisions with the mechanical draft cooling towers at the CR SMR Project would be SMALL.

5.3.4 Impacts to Members of the Public

This subsection describes two issues associated with operation of the cooling system for the CR SMR Project that potentially could impact human health: propagation of etiologic agents (pathogenic microorganisms) and noise.

5.3.4.1 Etiologic Agent (Microorganism) Impacts

As discussed in NUREG-1555, etiologic agents, including organisms formerly referred to as thermophilic microorganisms, can increase in occurrence and numbers due to the presence of heat in aquatic systems or can resist moderately high temperatures long enough to be released into a cooler water body where they can grow. When such microorganisms are etiologic agents capable of causing human disease (pathogens), they can pose a risk to public health if cooling towers and thermal discharges can harbor them or accelerate their growth once they are released into the environment.

Etiologic agents of concern in the context of cooling systems include bacteria such as *Vibrio* species (spp.), *Salmonella* spp., *Legionella* spp., *Shigella* spp., *Plesiomonas shigelloides*, and *Pseudomonas* spp*.;* thermophilic fungi; noroviruses; free-living amoebae of the genera *Naegleria and Acanthamoeba*; the protozoan *Cryptosporidium;* and toxin-producing algae such as *Karenia brevis*. Data from the Centers for Disease Control and Prevention (CDC) show that there were three outbreaks of waterborne illness from treated recreational waters and one from untreated recreational water in Tennessee between 2009 and 2010. The organisms responsible were *Cryptosporidium* spp., *Shigella* spp., *Escherichia coli*, and an unidentified species. (Reference 5.3-4) In the years 2011 to 2012, there were no reported waterborne illnesses in Tennessee (Reference 5.3-5). Data regarding waterborne pathogens and toxic algae were not available specifically for the Watts Bar Reservoir.

Characteristics of these etiologic agents associated with aquatic environments and cooling systems are described below:

> *Vibrio* spp., *V. cholerae* and *V. parahaemolyticus*, are human pathogens that cause severe diarrhea, but through different mechanisms. Cholera is transmitted to humans through water or food. *V. vulnificus* is an emerging pathogen of humans that causes wound infections, gastroenteritis, or primary septicemia. (Reference 5.3-6) V. cholerae has an optimal growth temperature range of 18°C (64.4°F to 37°C (98.6°F) (Reference 5.3-7).
>
> *Salmonella* spp. live in the intestinal tracts of humans and animals. *Salmonella* spp. are the cause of two types of salmonellosis: enteric fever (typhoid), resulting from bacterial invasion of the bloodstream, and acute gastroenteritis, resulting from a foodborne infection/intoxication. (Reference 5.3-8) *Salmonella* spp. enter the natural environment (water, soil, plants) through human or animal excretion. *Salmonella* spp. do not appear to multiply significantly in the natural environment, but they can survive several weeks in water and several years in soil if conditions are favorable. (Reference 5.3-9)
>
> *Shigella* spp. can cause a gastrointestinal disease called shigellosis, with symptoms that include diarrhea, fever, and stomach cramps. *Shigella* spp. can occur in water or food. Infection can occur from eating contaminated food, swimming in or drinking contaminated water, or contact with flies that carry the bacterium. Water may become contaminated from sewage or an infected person swimming or bathing.(Reference 5.3-10)

Plesiomonas shigelloides has been found in many aquatic ecosystems, including freshwater (ponds, streams, rivers), estuarine, and marine. The pathogen has been isolated from warm-blooded and cold-blooded animals, including freshwater fish and shellfish, and from many types of animals, including cattle, goats, swine, cats, dogs, monkeys, vultures, snakes, and toads. Symptoms from an infection are usually mild, although a more severe, dysenteric form of gastroenteritis may occur. Under laboratory conditions, *P. shigelloides* is able to grow at temperatures between 8°C (46.4°F) and 45°C (113°F), with an optimal range from 25°C (77°F) to 35°C (95°F). (Reference 5.3-11)

All of the *Pseudomonas* spp. are free-living bacteria found in soil and water. They are also found on the surfaces of plants and animals. *P. aeruginosa* exploits an existing break in the host defenses in order to infect the compromised tissues. It can infect almost all tissues, causing urinary tract infections, respiratory system infections, dermatitis, soft tissue infections, bacteremia, bone and joint infections, gastrointestinal infections, and a variety of systemic infections. (Reference 5.3-12) Its optimum temperature for growth is 37°C (98.6°F), and it is able to grow at temperatures as high as 42°C (107.6°F).

Karenia brevis is a dinoflagellate responsible for red tides in the Gulf of Mexico. It is a marine species and would not be found in the Clinch River arm of the Watts Bar Reservoir. (Reference 5.3-13)

Legionella spp. can cause Legionnaire’s disease, which is contracted from inhaling infected water droplets. The bacteria can be found in hot tubs, hot water tanks, large plumbing systems, decorative fountains, and cooling towers. (Reference 5.3-14) Symptoms of Legionnaire’s disease are similar to pneumonia, including cough, shortness of breath, high fever, muscle aches and headaches (Reference 5.3-15). *L. pneumophila* can withstand temperatures of 50°C (122°F) for several hours, but it remains dormant below 20°C (68°F) (Reference 5.3-16).

Naegleria fowleri is an amoeba found in warm freshwater and soil. Specifically, it is usually found in bodies of warm freshwater, such as lakes and rivers, geothermal water such as hot springs, warm water discharge from industrial plants, swimming pools that are poorly maintained with minimal or no chlorination, and water heaters. An infection can occur if the amoeba is inhaled through the nose; it cannot be contracted by drinking contaminated water. *N. fowleri* causes primary amoebic meningoencephalitis, a brain infection that leads to the destruction of brain tissue. Initial symptoms include headache, fever, nausea, or vomiting. Later symptoms include stiff neck, confusion, lack of attention to people and surroundings, loss of balance, seizures, and hallucinations. The disease usually causes death within about 5 days (range 1 to 12 days). *N. fowleri* infections are rare. In the 10 years from 2005 to 2014, 35 infections were reported in the United States. Of those cases, 31 people were infected by contaminated recreational water, three people were infected after performing nasal irrigation using contaminated tap water, and one person was infected by contaminated tap water. *N. fowleri* grows best at higher temperatures of up to 115°F (46°C) and can survive for short periods at higher temperatures. (Reference 5.3-17)

Acanthamoeba can cause *Acanthamoeba* keritìtis, an eye infection that can result in permanent vision impairment or blindness. Other symptoms include eye pain, eye redness, blurred vision, sensitivity to light, sensation of something in the eye and excessive tearing. *Acanthamoeba* can be found in freshwater bodies, soil, and air. People who wear contact lenses are the most susceptible to this infection. (Reference 5.3-18)

Cryptosporidium parvum is an obligate intracellular parasite. It can cause cryptosporidiosis, with symptoms that include mild to severe diarrhea, with severity increasing in young, old, and immuno-compromised individuals. Human exposure usually occurs by the ingestion of water contaminated with fecal material from an infected animal or food that was irrigated or washed with contaminated water. Swimming pools and other recreational waters are another vehicle for transmission of *Cryptosporidium* oocysts. The oocysts are difficult to eliminate with disinfectants like chlorine and can remain infectious for up to a year in both freshwater and seawater. Treated human wastewater can contain oocysts and could contaminate recreational waters downstream of a sewage treatment plant. (Reference 5.3-11)

Freshwater algal blooms can be harmful either by creating toxins or by generally impacting water quality such that they degrade aesthetic, ecological, or recreational value. Harmful algal blooms (HABs) are most often caused by cyanobacteria, but other types of algae can also cause toxicity. In addition to the production of neurotoxic, hepatotoxic, dermatotoxic, or other bioactive compounds, HABs can cause fish kills by depleting the oxygen in the water column. HABs can be naturally occurring or result of human activity. HABS usually are associated with significant increases in nutrient levels. (Reference 5.3-19)

Subsection 5.3.2.1 describes the potential effects of the hydrothermal discharge from the cooling system on water temperatures in the Clinch River arm of the Watts Bar Reservoir. The discharge will be managed in accordance with requirements of the TDEC NPDES permit, and the modeling indicates compliance with the thermal water quality criteria; therefore, thermal impacts from operation of the CR SMR Project discharge would be SMALL.

The maximum temperature measured in the Clinch River arm of the Watts Bar Reservoir during monitoring activities was 31.3°C (88.3°F) (at the monitoring location near CRM 16, approximately 0.5 mi upstream from the discharge location). Due to the complexity of the human-manipulated hydrology of this portion of the reservoir, temperatures can at times exceed TDEC's regulations without the additional discharge associated with the CR SMR Project. As discussed in Subsection 5.3.2.1, modeling of the effects of the discharge (incorporating a continuous 400 cfs bypass of the Melton Hill Dam) indicated that the thermal component of the discharge would be assimilated within 50 ft of the discharge structure.

No data are available concerning the occurrence of etiologic agents and thermophilic microorganisms in the Clinch River arm of the Watts Bar Reservoir near the CR SMR Site. As stated in NUREG-1437, Supplement 34, thermophilic microorganisms generally occur in water with temperatures between 77°F (25°C) and 176°F (80°C). Optimal growth has been reported at between 122°F (50°C) and 150°F (65.5°C). TDEC requires a water temperature of lower than 86.9°F (30.5°C); it is unlikely that populations of thermophilic or other etiologic agents would increase in the reservoir due to discharges from the CR SMR Project. Because the temperatures in the reservoir have at times exceeded TDEC's criteria in the absence of a discharge from the CR SMR Project, etiologic agents would not experience conditions that are substantially different from those that have previously occurred without causing their proliferation. The mixing zone where elevated temperatures from the discharge would occur would be a small area within the reservoir, and its temperatures would be at the low end of the range preferred by thermophilic etiologic agents. In addition, the few incidences of disease from etiologic agents reported in Tennessee would suggest that hydrothermal discharges on multiple reservoirs has had little or no effect on the proliferation of these agents. Based on these lines of evidence, the potential for etiologic agents associated with cooling system operation to impact public health is SMALL.

5.3.4.2 Noise

This subsection is focused on the potential human health effects associated with operation of the cooling system for the CR SMR Project. NUREG-1555 notes that the principal sources of noise from nuclear power facility operations include natural draft and mechanical draft cooling towers. Other sources may include auxiliary equipment such as pumps to supply cooling water. The main source of noise associated with the cooling system at the CR SMR Project is operation of the mechanical draft cooling towers.

The distance from the perimeter of the cooling tower block to the nearest property boundary is approximately 690 ft. The nearest offsite residence is located approximately 1900 ft southwest from the edge of the cooling tower block, across the Clinch River arm of the Watts Bar Reservoir from the CRN Site. The cooling towers are expected to produce noise levels of less than 70 dBA at a distance of 1000 ft during operation, as presented in Table 3.1-2, Item 3.3.10. For industrial and commercial areas, TVA uses a 60 dBA equivalent noise level as a design goal at the property line. NUREG-1437, Rev 1 indicates that noise levels below 65 dBA are considered acceptable outside a residence. It also notes that cooling towers emit noise of a broadband nature, which is largely indistinguishable from and is less obtrusive than noise of a specific tonal nature (such as transformer or loudspeaker noise). Noise produced by the cooling towers would be attenuated with distance and intervening vegetation. Considering that noise levels from the cooling towers are expected to be less than 70 dBA at 1000 ft from the towers and the nearest residence is almost twice that distance, noise levels at the nearest residence are expected to be attenuated to 65 dBA or less. Therefore, impacts to members of the public from noise associated with operation of the cooling system would be SMALL.

5.3.5 References

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Reference 5.3-18. Centers for Disease Control and Prevention, Acanthamoeba Keratitis, Website: http://www.cdc.gov/parasites/acanthamoeba/gen_info/acanthamoeba_keratitis.html, 2015.

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Table 5.3-1
Average annual densities of fish eggs and larvae (number/1000 m^3) collected at the upstream sample location (CRM 18.0) near the proposed intake for the CR SMR Project from February 2011 through January 2012

Fish Eggs								
	Day				**Night**			
Family	**RDB**	**Midchannel**	**Midchannel (bottom tow)**	**LDB**	**RDB**	**Midchannel**	**Midchannel (bottom tow)**	**LDB**
Sciaenidae	3.5	14.9	23.4	26.0	12.5	13.0	1671.1	6.3
Clupeidae	13.4	31.0	49.4	309.6	5.3	11.7	22.2	36.6
Moronidae	4.3	24.2	26.5	154.4	3.6	13.9	21.8	56.0
Unidentifiable	4.3	11.9	11.0	65.2	5.8	8.1	10.6	27.6
Total	25.6	82.0	110.3	555.7	27.1	46.7	1725.7	126.5
Avg	193.4				481.5			
24-hr Avg	337.5							
Fish Larvae								
Clupeidae	44.2	51.8	45.9	81.9	64.1	64.7	65.3	137.4
Catostomidae	0.9	0.4	0.0	0.9	0.9	1.3	0.0	1.8
Moronidae	8.7	11.0	11.5	21.7	6.2	9.4	8.3	13.6
Centrarchidae	5.6	5.1	0.9	2.6	4.5	2.7	2.8	22.1
Atherinopsidae	3.0	1.3	0.9	0.4	1.8	-	-	1.4
Cyprinidae	-	-	-	-	3.1	4.0	1.4	0.9
Sciaenidae	1.7	0.8	1.8	0.9	0.4	0.9	0.5	0.5
Percidae	-	-	-	0.9	-	0.4	-	0.9
Unidentifiable	-	0.4	0.4	-	0.9	-	-	-
Polyodontidae	-	-	-	0.4	-	-	-	-
Total	64.2	70.9	61.3	109.6	81.9	83.5	78.2	178.5
Avg	76.5				105.5			
24-hr Avg	91.0							

Notes:
Average Annual Density of Eggs and Larvae: 337.5 + 91.0 = 428.5/1000 m^3 = 0.4285/m^3
RDB = right descending bank
LDB = left descending bank
- = no fish eggs or larvae collected
Source: (470 Tennessee Valley Authority 2012)

Table 5.3-2
Cooling Tower Design Inputs for SACTI Model

Parameter	Design Value
Total Heat Rejection for All Units (MBtu/hr)	5593
Total Heat Rejection for All Units (MWt)	1640
Height of Cells Above Ground Level (m)	19.8
Cell Exit Diameter (m)	9.14
Cell Spacing (m)	11.0
Each Tower Length (m)	99.0
Each tower Width (m)	11.0
Maximum Number of Cells All Units	18
Sodium Concentration (ppm)	990
Chloride Concentration (ppm)	1527
Salt Concentration (g salt/g solution)[1]	0.010086
Total Dissolved Solids Concentration (g TDS/g solution)[1]	0.068
Salt Density (g/cm^3)	2.17
Cycles of Concentration	4
Air Flow Rate All Cells (kg/s)	16,186.8
Drift Rate All Cells (g/s)	200.7

[1] Based on four cycles of concentration

Notes:
cm^3 = cubic centimeter
g = grams
kg = kilograms
m = meters
MBtu/hr = million British thermal units per hour
MWt = megawatts thermal
ppm = parts per million
s = second
SACTI = Seasonal and Annual Cooling Tower Impact
TDS = total dissolved solids

Table 5.3-3
Cooling Tower Droplet Mass Spectrum[1]

Mass in Range Modeled	Droplet Size Provided by Marley (microns)	Droplet Size Used in SACTI (microns)
0.12	<10	5 - 10
0.08	10 - 15	10 - 15
0.20	15 - 35	15 - 35
0.20	35 - 65	35 - 65
0.20	65 - 115	65 - 115
0.10	115 - 170	115 - 170
0.05	170 - 230	170 - 230
0.04	230 - 375	230 - 375
0.008	375 - 525	375 - 525
0.002	>525	525 - 1000

[1] The size distribution provided by Marley (SPX Cooling Technologies) did not include bounding values at the upper and lower ends of the spectrum. Limits were added as needed for the SACTI modeling. Limits were set to half the lowest value and approximately twice the upper value as provided by Marley.

Table 5.3-4 (Sheet 1 of 3)
Water Deposition in kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Annual Average																	
100	40000	28000	33000	49000	97000	75000	53000	35000	37000	22000	21000	32000	62000	53000	48000	31000	45000
200	5300	3800	4500	7400	14000	10000	7300	4500	5600	2800	2800	6600	12000	12000	8300	4600	7000
300	3400	2600	3200	4700	8100	5900	4000	3000	3800	1700	1700	4600	8800	8200	6200	3500	4600
400	2000	1500	2400	3000	4500	3300	3000	1800	2100	1000	1200	2900	5200	5000	4800	2000	2900
500	870	610	940	1200	2000	1400	1200	770	760	430	460	960	1800	1700	1600	800	1100
600	230	180	280	450	820	580	350	190	230	110	150	400	830	780	530	230	400
700	230	180	270	430	800	570	330	190	230	110	140	390	810	770	510	230	390
800	230	180	250	320	480	340	300	190	230	110	120	330	600	570	480	230	310
900	230	180	250	310	440	300	300	190	230	110	110	320	570	540	480	230	300
1000	220	180	240	230	320	230	280	180	220	110	110	220	390	370	430	230	250
Winter																	
100	12000	10000	16000	19000	40000	47000	44000	37000	35000	27000	22000	28000	45000	28000	24000	14000	28000
200	2600	2700	4300	7800	9900	10000	9200	6300	6800	3900	3900	9900	18000	13000	8300	3700	7600
300	2500	2700	3400	6100	7200	7600	6100	4900	5400	2500	2400	8600	16000	11000	7600	3400	6100
400	1300	1400	2900	3400	3600	4100	4900	2800	3000	1500	1600	5400	9000	6900	6100	1800	3700
500	300	310	910	970	1100	1300	1600	1100	870	590	610	1500	2600	2100	1900	540	1100
600	170	170	310	580	730	720	520	320	340	170	220	720	1400	1100	680	230	530
700	170	170	290	560	720	700	500	320	340	170	200	710	1400	1100	660	230	520
800	170	170	270	380	440	390	470	320	340	170	160	580	1000	860	630	230	410
900	160	170	270	360	410	340	470	320	330	170	160	560	980	830	630	230	400
1000	160	170	240	250	260	250	400	310	320	160	160	400	670	560	580	230	320

Table 5.3-4 (Sheet 2 of 3)
Water Deposition in kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Spring																	
100	24000	22000	26000	46000	91000	79000	56000	38000	25000	21000	19000	31000	56000	42000	34000	30000	40000
200	4600	3800	3800	7100	16000	12000	6800	4300	5200	2400	2300	6500	12000	11000	7500	4300	6800
300	3000	2500	3100	4900	10000	7000	3600	2500	4000	1500	1400	4100	8200	8000	6000	3500	4600
400	1600	1400	1800	3100	5200	3500	2600	1500	1900	940	1100	2100	4700	4400	4300	1800	2600
500	530	540	710	1300	2100	1600	1100	700	540	380	430	810	1600	1500	1400	720	990
600	190	190	280	460	1000	740	300	150	200	100	120	410	770	770	490	220	400
700	190	190	270	450	970	720	290	150	200	100	110	400	750	760	480	220	390
800	190	190	250	350	530	390	270	150	200	100	91	310	610	590	450	220	310
900	190	190	240	340	460	330	270	150	200	99	89	300	580	570	450	220	290
1000	190	180	230	250	340	240	230	150	190	94	82	180	370	340	420	220	230
Summer																	
100	74000	48000	51000	79000	16000 0	94000	57000	30000	47000	20000	19000	31000	79000	85000	75000	48000	62000
200	6600	4500	4900	7600	16000	9400	5500	2900	4300	2200	2300	4300	8200	11000	7800	4900	6400
300	3300	2200	2700	3600	7400	3800	2000	1700	2600	1200	1400	2500	3800	5900	4000	2700	3200
400	2200	1400	2200	2600	4900	2600	1700	1100	1700	800	940	1600	2600	3500	3100	1700	2200
500	1300	840	1000	1400	2700	1500	940	610	850	360	370	630	1300	1600	1400	950	1100
600	230	160	220	290	760	390	190	100	160	72	100	180	380	490	340	180	260
700	230	160	210	280	750	380	180	100	160	72	100	170	370	480	330	180	260
800	230	160	200	240	480	270	160	100	160	72	95	150	240	290	300	180	210
900	220	160	200	230	440	250	160	100	160	72	94	150	220	260	290	180	200
1000	220	150	200	200	360	210	160	97	150	71	94	120	190	230	260	180	180

Table 5.3-4 (Sheet 3 of 3)
Water Deposition in kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Fall																	
100	45000	28000	39000	45000	89000	74000	55000	34000	42000	22000	24000	36000	68000	55000	57000	31000	47000
200	7100	4400	5100	7000	12000	9500	8300	5000	6300	2700	3100	6200	13000	11000	10000	5500	7300
300	4700	3400	3700	4500	7000	5100	4700	3300	3400	1500	1600	4000	8700	8500	7500	4800	4800
400	2800	1900	2700	2800	4200	3100	3100	1900	2000	990	1200	2800	5200	5500	6200	2700	3100
500	1300	730	1100	1200	1700	1300	1200	730	810	430	450	1000	1700	1800	2100	970	1200
600	340	220	360	480	740	490	420	200	240	120	160	350	840	830	650	320	420
700	340	220	340	480	710	480	400	200	240	120	150	350	810	820	630	320	410
800	340	220	310	340	450	310	360	200	240	120	120	300	590	590	590	320	340
900	340	210	300	320	420	290	360	200	240	110	120	300	560	560	590	320	330
1000	330	210	290	220	300	230	350	190	240	110	110	220	400	410	500	320	280

Table 5.3-5 (Sheet 1 of 3)
Salt Deposition kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Annual Average																	
100	2977	2067	2249	3259	6276	4781	3538	2593	2652	1634	1235	1950	3671	3334	3155	2364	2983
200	684	478	504	744	1425	1084	809	595	626	375	284	468	884	802	730	547	690
300	272.31	194.4	216.61	317.85	604.91	457.07	326.94	238.82	260.56	148.66	123.64	220.73	421.72	376.25	330.37	230.02	296.3
400	252.03	178.13	196.47	275.72	511.77	386.52	299.66	220.44	234.99	138.59	106.68	183.07	340.42	313.36	300.06	207.68	259.1
500	180.17	125.95	137.87	197.34	374.29	282.96	213.85	156.8	161.83	97.93	75.62	123.34	233.75	213.47	201.16	146.06	182.65
600	29.81	21.9	30.64	45.17	90.81	67.86	44.81	25.69	29.69	16.51	20.35	33.34	70.46	59.27	49.37	25.94	41.35
700	29.81	21.9	27.77	41.84	85.11	63.74	40.37	25.69	29.69	16.51	17.38	30.64	65.23	56.57	44.99	25.94	38.95
800	29.81	21.9	22.69	31.16	55.74	41.34	33.47	25.69	29.69	16.51	12.3	23.56	44.69	40.87	37.28	25.94	30.79
900	29.48	21.67	22.67	30.52	53.62	39.81	33.45	25.31	29.12	16.12	12.29	23.15	43.33	39.65	37.26	25.63	30.19
1000	28.79	21.2	22.19	28.11	50.26	37.74	32.38	24.52	27.97	15.34	12.1	20.32	38.19	34.69	35.32	25	28.38
Winter																	
100	733	709	721	626	1862	2474	2743	2569	2140	1797	1144	1477	2109	1342	1086	899	1527
200	189.89	182.55	201.11	222.67	494.75	619.48	686.32	626.19	552.19	432.56	288.36	408.33	634.79	411.73	313.73	239.86	406.53
300	99.09	97.37	115.26	156.99	276.78	321.27	308.33	273.99	262.64	181.7	138.18	247	406.09	269.04	207.14	125.61	217.9
400	82.75	78.56	99.36	100.24	189.21	239.44	279.11	246.07	226.49	166.59	110.3	191.79	296.2	204.35	176.33	101.4	174.26
500	49.29	47.71	59.66	59.42	129.47	164.97	187.09	166.2	142.06	112.75	77.84	111.33	175.22	118.48	99.41	63.51	110.28
600	14.26	12.97	25.19	39.13	61.38	62.82	50.76	35.06	37.65	23.76	28.6	43.13	83.07	55.67	45.41	17.45	39.77
700	14.26	12.97	21.8	34.14	57.09	57.11	45.39	35.06	37.65	23.76	23.52	40.27	77.37	54.95	40.63	17.45	37.09
800	14.26	12.97	16.31	20.27	30.34	32.06	38.07	35.06	37.65	23.76	15.28	30.32	52.75	39.98	32.39	17.45	28.06
900	13.68	12.62	16.27	19.25	28.74	30.18	38.02	34.48	36.15	22.95	15.28	29.62	50.74	38.67	32.39	17.1	27.26
1000	12.51	11.91	15.2	16.17	24.46	27.52	35.1	33.29	33.12	21.3	15.02	24.89	41.63	30.74	30.28	16.4	24.35

Table 5.3-5 (Sheet 2 of 3)
Salt Deposition kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Spring																	
100	1651	1505	1659	3075	5636	4930	3797	2982	1654	1529	1125	1718	3352	2459	2116	2261	2590
200	417	373	373	705	1320	1132	845	665	422	347	252	424	806	627	510	522	609
300	177.73	156.19	172.66	304.72	591.65	481.04	335.64	256.63	196.87	138.78	110.41	201.12	383.46	307.78	252.31	220.67	267.98
400	156.23	141.03	146.97	265.74	481.7	403.27	310.66	238.66	163.94	129.72	96.49	156.12	312.6	246.45	221.2	197.02	229.24
500	104.44	96.28	102.55	189.03	348.5	295.42	222.76	174.45	104.89	90.96	67.87	110.53	213.31	164.63	141.22	138.73	160.35
600	22.32	21.02	26.69	43.48	94.39	72.77	41.88	24.63	23.4	15.7	18.32	36.1	60.46	52.03	39.47	24.11	38.55
700	22.32	21.02	23.97	39.52	85.91	67.68	38.32	24.63	23.4	15.7	15.49	31.01	55.37	48.06	36.14	24.11	35.79
800	22.32	21.02	18.85	31.24	55.48	44.54	32.47	24.63	23.4	15.7	10.37	22.85	42.56	37.1	30.29	24.11	28.56
900	22.14	20.74	18.83	30.71	52.71	42.12	32.46	24.35	22.85	15.05	10.34	22.19	41.45	36.05	30.27	23.92	27.89
1000	21.75	20.18	18.41	27.91	49.15	39.53	31.2	23.8	21.73	13.76	10.12	18.75	35.14	29.41	29.01	23.55	25.84
Summer																	
100	5931	3772	3827	5969	11270	6677	3962	2386	3746	1574	1237	2151	5384	6092	5426	3780	4574
200	1282	826	826	1289	2457	1455	869	521	811	350	272	482	1178	1351	1180	834	999
300	473.49	303.53	315.64	484.57	940.68	554.23	322.39	196.88	305.3	133.12	111.03	198.38	460.88	535.58	455.98	313.66	381.58
400	454.62	292.13	303.95	459.37	863.82	506.41	306.04	187.58	292.58	124.4	102.23	176.34	415.61	484.08	429.71	299.45	356.14
500	342.72	218.84	220.36	338.39	643.26	379.37	227.6	139.3	216.65	91.4	71.72	124.9	308.34	352.57	311.47	222.11	263.06
600	42.78	28.53	32.01	48.74	111.44	66.28	37.52	17.81	27.39	11.96	12.82	22.94	58.77	62.63	52.81	30.28	41.54
700	42.78	28.53	30.65	46.42	107.97	63.39	34.18	17.81	27.39	11.96	11.95	21.78	54.72	59.17	48.82	30.28	39.86
800	42.78	28.53	28.44	41.43	81.09	47.53	29.02	17.81	27.39	11.96	10.47	17.76	39.9	45.57	41.45	30.28	33.84
900	42.49	28.53	28.43	41.12	79.03	46.79	29	17.62	27.2	11.96	10.46	17.68	38.82	44.43	41.42	30.28	33.45
1000	41.91	28.51	28.42	40.12	76.68	45.62	28.99	17.23	26.82	11.95	10.46	16.57	37.8	43.28	40.13	30.28	32.8

Table 5.3-5 (Sheet 3 of 3)
Salt Deposition kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Fall																	
100	3239	2032	2564	2799	5371	4574	3491	2394	3055	1675	1455	2452	3528	3034	3718	2222	2975
200	773	478	574	647	1224	1036	810	567	727	383	333	565	868	736	867	532	695
300	315.64	204.73	250.53	291.03	537.77	443.28	340.02	233.33	282.41	147.03	141	245.78	436.76	373.14	395.32	243.2	305.06
400	291.19	183.79	222.74	238.83	440.42	365.52	298.68	212.9	260.74	139.01	121	215.48	327.33	296.49	361.72	214.52	261.9
500	205.31	126.99	158.34	172.85	321.64	267.04	212.64	147.21	184.75	99.75	87.7	148.71	226.36	198.72	241.24	144.41	183.98
600	38.67	23.77	39.25	48.92	90.26	68.54	51.36	27.39	32.35	15.86	23.94	32.84	84.49	67.56	61.28	31.32	46.11
700	38.67	23.77	34.85	46.79	83.89	65.7	45.46	27.39	32.35	15.86	20.3	31.43	78.12	65.42	55.52	31.32	43.55
800	38.67	23.77	26.77	29.37	50.39	39.01	35.58	27.39	32.35	15.86	14.01	24.79	45.2	40.69	45.65	31.32	32.55
900	38.32	23.42	26.74	28.57	48.51	37.97	35.54	26.81	32.23	15.74	13.98	24.59	43.8	39.21	45.62	30.51	31.97
1000	37.61	22.72	26.21	25.61	45.04	36.05	35.26	25.66	31.99	15.51	13.7	22.26	39.04	34.66	42.2	28.89	30.15

Table 5.3-6 (Sheet 1 of 3)
TDS Deposition kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Annual Average																	
100	45567	31660	33854	49028	93928	71518	53352	39631	40548	24927	18407	29266	54604	49715	47381	36160	44972
200	7091	4965	5447	7939	15752	12025	8816	6189	6632	3967	3317	5176	9939	8542	7927	5669	7462
300	2445	1753	1739	2613	5079	3854	2767	2138	2448	1376	1059	1886	3627	3176	2721	2037	2545
400	2030	1441	1658	2383	4549	3434	2593	1781	1926	1113	968	1645	3166	2857	2567	1700	2238
500	1141	823	977	1389	2623	1967	1450	1003	1118	624	568	1004	1970	1743	1565	986	1309
600	389.08	302	422.04	493.52	921.96	688.79	577.52	349.87	458.92	218.35	290	443.66	920.53	786.06	760.77	386.18	525.58
700	327.31	258.57	269.83	393.86	679.22	500.26	360.64	287.89	385.54	175.99	158.96	367.81	726.6	649.62	504.45	319.67	397.89
800	291.22	227.25	247.28	339.65	537.23	388.18	313.67	250.66	330.13	153.97	135.36	330.42	623.8	582.33	461.71	276.27	343.07
900	257.96	199.34	232.78	296.1	458.88	336.07	304	222.96	286.61	138	131.76	290.28	535.19	489.04	434.97	243.86	303.61
1000	176.15	136.59	194.81	217.28	353.65	267.48	266.46	155.71	192.26	95.25	112.01	208.35	377.5	335.12	360.95	177.82	226.71
Winter																	
100	11058	10748	10587	8584	26948	36256	41488	39366	32548	27406	16995	21648	30445	19237	15761	13711	22674
200	2176	1979	2515	2776	6151	7270	7656	6731	6357	4798	3700	4240	6644	4080	3826	2612	4594
300	1034	935	1054	1527	2551	2830	2715	2699	2807	1867	1256	2098	3578	2322	1839	1262	2023
400	748	708	983	1235	2079	2382	2587	2061	1954	1366	1140	1813	3069	2069	1716	918	1677
500	490	466	646	867	1415	1525	1495	1233	1254	807	684	1221	2129	1478	1220	597	1095
600	311	289	478	604	857	793	786	595	751	374	450	743	1353	991	939	373	668
700	246	241	320	493	616	604	532	476	571	281	238	646	1158	861	658	307	516
800	204	203	294	434	481	495	494	425	475	249	206	604	1074	810	613	257	457
900	174.89	165.25	270.94	356.34	397.63	404.61	472.53	382.32	411.05	229.48	200.31	505.61	872.43	667.02	555.96	223.83	393.14
1000	128.34	123.23	223.74	240.01	277	286.47	413.49	251.15	282.72	147.48	170.94	340.32	557.58	418.35	455	166.21	280.13

Table 5.3-6 (Sheet 2 of 3)
TDS Deposition kg/km^2-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Spring																	
100	25464	23146	24803	46300	83983	73295	57233	45535	25309	23167	16717	25471	49839	36383	31583	34623	38928
200	4462	4016	4108	7457	14538	12585	9028	6780	4587	3748	2970	5053	8870	6619	5554	5358	6608
300	1791	1595	1374	2492	5047	4170	2756	2153	1965	1302	923	1833	3288	2710	2119	1898	2339
400	1303	1178	1278	2292	4438	3714	2598	1884	1403	1057	847	1560	2912	2437	1951	1608	2029
500	781	700	796	1348	2592	2076	1436	1023	866	600	505	965	1800	1507	1235	936	1198
600	374.87	326.61	389.08	478.44	956.6	679.25	486.05	264.47	461.56	222.47	257.18	420.29	787.39	716.35	691.07	363.23	492.18
700	330.68	272.61	228.56	397.2	754.05	524.15	292.89	231.02	388.61	161.2	134.44	337.63	652.93	612.78	476.03	309.13	381.49
800	302.22	254.26	208.16	356.78	639.6	436.62	253.09	202.23	332.06	132.9	112.68	297.17	592.25	572.29	439.96	264.37	337.29
900	259.25	229.89	196.56	313.89	525.84	375.32	250.06	177.9	285.4	120.95	108.5	267.72	527.61	490.05	413.01	230.11	298.25
1000	150.02	137.25	168.02	225.34	391.87	297.67	226.94	131.94	189.43	90.94	94.05	196.18	370.03	324.41	332.75	168.6	218.46
Summer																	
100	90590	57771	58105	90664	170044	100891	59892	36386	57193	24086	18514	32821	81225	92137	82039	57931	69393
200	12894	8319	8388	13202	26019	15436	9302	5271	8152	3522	2848	5358	13151	14158	12401	8429	10428
300	3766	2492	2429	3784	7581	4456	2672	1584	2421	1096	906	1647	3802	4339	3616	2597	3074
400	3500	2250	2380	3617	7114	4153	2518	1473	2265	968	839	1441	3456	4009	3434	2325	2859
500	1833	1180	1266	1901	3795	2237	1321	788	1202	513	465	812	1886	2152	1904	1240	1531
600	313.35	217.92	297.67	331.25	859.55	520.47	361.36	176.47	245.96	114.52	161	250.35	482.77	521.41	542.28	270.55	354.18
700	272.6	207.98	220.85	283.26	637.06	366.82	223.74	147.93	220.82	113.39	110.6	200.72	350.91	430.55	319.44	248.61	272.2
800	241.45	188.62	211.15	256.07	501.45	271.91	179.21	119.03	187.62	97.29	99.04	173.6	269.51	376.26	272.87	226.56	229.48
900	227.2	177.32	202.92	232.62	453.58	255.6	178.56	107.27	162.23	82.41	97.47	155.71	246.26	312.52	268.98	210.03	210.67
1000	182.52	122.27	170.63	199.57	388.78	230.33	159.73	88.27	128.37	64.62	80	122.83	217.84	252.17	237.88	142.72	174.28

Table 5.3-6 (Sheet 3 of 3)
TDS Deposition kg/km²-mo

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Fall																	
100	49710	31099	38497	41865	80049	68501	52347	36592	46948	25655	21726	37041	52056	44795	55892	33807	44786
200	8134	5010	6419	7255	14272	11881	9110	6051	7569	3954	3936	6012	10613	8502	9453	5724	7744
300	3038	1855	2027	2416	4577	3738	2946	2243	2722	1323	1218	2029	3878	3183	3246	2295	2671
400	2409	1506	1915	2134	4012	3252	2686	1752	2128	1106	1104	1828	3226	2756	3112	1829	2297
500	1390	891	1175	1337	2431	1937	1578	1015	1190	607	656	1071	2122	1801	1898	1124	1389
600	576	386	559	601	1017	800	746	425	427	185	330	413	1187	990	936	568	634
700	470.25	319.48	331.4	426.92	699.03	528.8	441.3	342.63	398.9	166.25	170.43	333.92	846.59	752.23	612.53	431.85	454.53
800	424.55	264.95	293.37	327.73	508.87	363.46	373.25	298.11	358.08	155.11	138.76	292.56	648.12	620.01	568.97	369.82	375.36
900	376.13	221.94	276.44	292.33	442.95	317.05	356.28	262.24	316.64	136.19	135.09	269.49	561.92	526.12	544.46	321.55	334.8
1000	248.37	166.39	229.06	206.83	339.51	256.16	299.57	173.01	184.13	86.11	115.41	197.11	402.5	366.68	452.65	243.26	247.92

Table 5.3-7
Hours of Plume Shadowing

Dist(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Annual Average																	
200	40	65	125.4	421.4	618.5	505.1	419.9	361.4	393.3	469.7	633.7	541.6	535	218.1	71	37.7	341
400	16	22	59.1	282.6	241.8	205.9	134.1	104	114	141.3	216.9	200.6	163.6	187.5	30	18	133.6
600	12	16	41.1	237.1	134.1	139.6	56.8	50	58	72	131.9	133.2	103.9	57.7	22	16	80.1
800	7	12.1	33.1	169	101.5	96.6	39	36	49	52	104.9	111.2	74.6	48.9	19	12	60.4
1000	5	8	29.1	131.5	81.8	73.5	24	30	44	50	85.8	91.7	65.9	37.8	13	6	48.6
Winter																	
200	4	3	10.1	30.7	42.4	134.7	191	180.5	211.3	263.8	343.5	139.5	38.9	34.2	14.8	5.7	103
400	2	1	2	7.6	28.4	98.6	72.6	62	67	88.3	140	92.4	29.6	9	6	3	44.4
600	2	1	0	4.5	21.4	84.3	32.8	36	34	45	86	69.2	26.4	7	6	2	28.6
800	1	1	0	4.5	17.4	61.9	20	27	29	31	68	59.2	25.4	7	4	1	22.3
1000	0	0	0	4.5	17.4	48.8	11	24	29	31	56.8	54.2	23.2	7	2	0	19.3
Spring																	
200	20	31	60.6	142.7	246.7	152.8	72	70	67	75	86	179.5	265.3	83.7	37.1	16	100.3
400	7	10	27	104.2	106.9	32.7	18	12	19	23	24	39	81.3	58.4	15	9	36.7
600	6	8	18	80.1	50.2	12.7	7	4	11	10	12	24	50.4	30.3	9	8	21.3
800	2	5	15	57.2	36.2	9.7	8	4	9	10	9	20	33.2	27.2	9	6	16.3
1000	1	3	13	50.6	25.5	6.7	5	2	9	10	8	16	27.7	21.1	6	3	13
Summer																	
200	9	12.8	27.1	192.8	210.2	47.6	32.5	30	26	25	27	43.4	158.1	78.5	8	6	58.4
400	4	7	11.9	139.4	22.5	11.5	6.5	7	7	5	7	8	13	113.1	4	3	23.1
600	1	4	9.1	126	4	4.5	1	4	5	2	6	6	6	13.4	2	3	12.3
800	1	4.1	6.1	84.8	3	3.5	1	3	5	1	6	6	3	8.7	2	3	8.8
1000	1	3	6.1	57	1	2	1	3	3	1	5	5	2	4.7	2	2	6.2
Fall																	
200	7	18.2	27.5	55.1	119.3	170.1	124.4	81	89	105.9	177.2	179.3	72.7	21.8	11.1	10	79.3
400	3	4	18.2	31.5	83.9	63.1	37	23	21	25	45.9	61.2	39.7	7	5	3	29.5
600	3	3	14	26.5	58.4	38.1	16	6	8	15	27.9	34	21.2	7	5	3	17.9
800	3	2	12	22.5	44.9	21.5	10	2	6	10	21.9	26	13	6	4	2	12.9
1000	3	2	10	19.4	38	16	7	1	3	8	16	16.4	13	5	3	1	10.1

Table 5.3-8 (Sheet 1 of 6)
Annual Plume Length Frequency

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
Annual Average																	
100	4.49	3.88	5.34	5.77	7.94	6.21	5.28	3.73	5.94	3.43	4.94	9.14	12.24	9.44	8.23	4	100
200	1.53	1.35	1.71	2.57	2.95	1.94	1.29	1.23	1.73	0.82	0.85	3.1	5.44	4.99	3.3	1.71	36.51
300	0.74	0.7	0.61	1.33	1.44	0.9	0.22	0.47	0.65	0.39	0.34	1.72	2.97	2.6	1.31	0.99	17.38
400	0.61	0.54	0.61	0.78	0.66	0.32	0.22	0.39	0.55	0.31	0.34	1.21	1.88	1.71	1.31	0.86	12.29
500	0.37	0.31	0.61	0.78	0.66	0.32	0.22	0.2	0.29	0.23	0.34	1.21	1.88	1.71	1.31	0.49	10.93
600	0.37	0.31	0.61	0.78	0.66	0.32	0.22	0.2	0.29	0.23	0.34	1.21	1.88	1.71	1.31	0.49	10.93
700	0.32	0.24	0.61	0.78	0.66	0.32	0.22	0.13	0.19	0.16	0.34	1.21	1.88	1.71	1.31	0.39	10.46
800	0.32	0.24	0.61	0.78	0.66	0.32	0.22	0.13	0.19	0.16	0.34	1.21	1.88	1.71	1.31	0.39	10.46
900	0.32	0.24	0.56	0.69	0.42	0.16	0.13	0.13	0.19	0.16	0.32	1.16	1.73	1.52	1.14	0.39	9.26
1000	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1200	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1300	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1400	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1500	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1600	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1700	0.27	0.21	0.56	0.69	0.42	0.16	0.13	0.07	0.17	0.15	0.32	1.16	1.73	1.52	1.14	0.33	9.04
1800	0.27	0.21	0.36	0.48	0.29	0.09	0.07	0.07	0.17	0.15	0.24	0.95	1.22	1.03	0.66	0.33	6.59
1900	0.27	0.21	0.36	0.48	0.29	0.09	0.07	0.07	0.17	0.15	0.24	0.95	1.22	1.03	0.66	0.33	6.59
2000	0.27	0.21	0.36	0.48	0.29	0.09	0.07	0.07	0.17	0.15	0.24	0.95	1.22	1.03	0.66	0.33	6.59
2100	0.27	0.21	0.14	0.19	0.08	0.05	0.03	0.07	0.17	0.15	0.12	0.4	0.59	0.48	0.41	0.33	3.7
2200	0.27	0.21	0	0	0	0	0	0.07	0.17	0.15	0	0	0	0	0	0.33	1.2
2300	0.17	0.14	0	0	0	0	0	0.03	0.12	0.09	0	0	0	0	0	0.19	0.73
2400	0.17	0.14	0	0	0	0	0	0.03	0.12	0.09	0	0	0	0	0	0.19	0.73
2500	0.17	0.14	0	0	0	0	0	0.03	0.12	0.09	0	0	0	0	0	0.19	0.73
2600	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
2700	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
2800	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
2900	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33

Table 5.3-8 (Sheet 2 of 6)
Annual Plume Length Frequency

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
3000	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
3100	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
3200	0.06	0.04	0	0	0	0	0	0.01	0.08	0.05	0	0	0	0	0	0.09	0.33
Winter																	
100	2.82	2.47	4.7	6.07	6.35	5.5	5.98	4.23	5.43	2.92	3.79	10.44	14.9	11.57	9.54	3.29	100
200	1.69	1.62	2.42	4.35	3.69	3.17	2.63	2.4	2.73	1.25	1.53	7.14	11.44	9	6.51	2.16	63.74
300	0.99	0.99	0.92	2.47	2.02	1.36	0.56	1.11	1.46	0.61	0.61	4.32	6.98	5.33	3.22	1.53	34.48
400	0.85	0.75	0.92	1.81	1.13	0.59	0.56	0.92	1.25	0.52	0.61	3.31	5.07	3.92	3.22	1.41	26.82
500	0.49	0.45	0.92	1.81	1.13	0.59	0.56	0.49	0.75	0.35	0.61	3.31	5.07	3.92	3.22	0.94	24.61
600	0.49	0.45	0.92	1.81	1.13	0.59	0.56	0.49	0.75	0.35	0.61	3.31	5.07	3.92	3.22	0.94	24.61
700	0.42	0.31	0.92	1.81	1.13	0.59	0.56	0.35	0.56	0.28	0.61	3.31	5.07	3.92	3.22	0.78	23.83
800	0.42	0.31	0.92	1.81	1.13	0.59	0.56	0.35	0.56	0.28	0.61	3.31	5.07	3.92	3.22	0.78	23.83
900	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.35	0.56	0.28	0.59	3.17	4.58	3.64	3.03	0.78	21.63
1000	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1100	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1200	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1300	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1400	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1500	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1600	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1700	0.42	0.31	0.82	1.62	0.89	0.28	0.31	0.21	0.49	0.23	0.59	3.17	4.58	3.64	3.03	0.7	21.3
1800	0.42	0.31	0.56	1.24	0.59	0.16	0.14	0.21	0.49	0.23	0.42	2.51	3	2.56	1.97	0.7	15.54
1900	0.42	0.31	0.56	1.24	0.59	0.16	0.14	0.21	0.49	0.23	0.42	2.51	3	2.56	1.97	0.7	15.54
2000	0.42	0.31	0.56	1.24	0.59	0.16	0.14	0.21	0.49	0.23	0.42	2.51	3	2.56	1.97	0.7	15.54
2100	0.42	0.31	0.21	0.49	0.16	0.07	0.09	0.21	0.49	0.23	0.26	1.08	1.48	1.32	1.36	0.7	8.91
2200	0.42	0.31	0	0	0	0	0	0.21	0.49	0.23	0	0	0	0	0	0.7	2.37
2300	0.21	0.12	0	0	0	0	0	0.07	0.38	0.12	0	0	0	0	0	0.4	1.29
2400	0.21	0.12	0	0	0	0	0	0.07	0.38	0.12	0	0	0	0	0	0.4	1.29
2500	0.21	0.12	0	0	0	0	0	0.07	0.38	0.12	0	0	0	0	0	0.4	1.29
2600	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73

Table 5.3-8 (Sheet 3 of 6)
Annual Plume Length Frequency

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
2700	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
2800	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
2900	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
3000	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
3100	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
3200	0.07	0.05	0	0	0	0	0	0.05	0.26	0.07	0	0	0	0	0	0.24	0.73
Spring																	
100	3.65	3.28	4.92	5.84	8.44	6.96	5.15	3.82	6.75	3.93	5.42	9.18	12	8.88	8.1	3.69	100
200	1.37	1.33	1.55	2.73	3.4	1.89	0.9	0.95	1.68	0.75	0.73	2.09	4.97	4.72	2.99	1.66	33.7
300	0.51	0.62	0.58	1.48	1.81	1.03	0.22	0.28	0.43	0.39	0.3	0.97	2.45	2.22	1.04	0.82	15.15
400	0.37	0.47	0.58	0.78	0.91	0.43	0.22	0.17	0.34	0.34	0.3	0.56	1.49	1.45	1.04	0.75	10.19
500	0.21	0.3	0.58	0.78	0.91	0.43	0.22	0.09	0.11	0.22	0.3	0.56	1.49	1.45	1.04	0.32	9.02
600	0.21	0.3	0.58	0.78	0.91	0.43	0.22	0.09	0.11	0.22	0.3	0.56	1.49	1.45	1.04	0.32	9.02
700	0.15	0.21	0.58	0.78	0.91	0.43	0.22	0.04	0.07	0.19	0.3	0.56	1.49	1.45	1.04	0.2	8.63
800	0.15	0.21	0.58	0.78	0.91	0.43	0.22	0.04	0.07	0.19	0.3	0.56	1.49	1.45	1.04	0.2	8.63
900	0.15	0.21	0.54	0.71	0.47	0.17	0.11	0.04	0.07	0.19	0.28	0.52	1.42	1.31	0.93	0.2	7.31
1000	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1100	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1200	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1300	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1400	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1500	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1600	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1700	0.13	0.17	0.54	0.71	0.47	0.17	0.11	0.04	0.06	0.19	0.28	0.52	1.42	1.31	0.93	0.17	7.19
1800	0.13	0.17	0.35	0.49	0.37	0.11	0.06	0.04	0.06	0.19	0.26	0.5	1.06	0.88	0.48	0.17	5.32
1900	0.13	0.17	0.35	0.49	0.37	0.11	0.06	0.04	0.06	0.19	0.26	0.5	1.06	0.88	0.48	0.17	5.32
2000	0.13	0.17	0.35	0.49	0.37	0.11	0.06	0.04	0.06	0.19	0.26	0.5	1.06	0.88	0.48	0.17	5.32
2100	0.13	0.17	0.06	0.15	0.13	0.09	0.04	0.04	0.06	0.19	0.11	0.17	0.5	0.26	0.24	0.17	2.49
2200	0.13	0.17	0	0	0	0	0	0.04	0.06	0.19	0	0	0	0	0	0.17	0.75
2300	0.09	0.11	0	0	0	0	0	0	0.04	0.15	0	0	0	0	0	0.09	0.49

Table 5.3-8 (Sheet 4 of 6)
Annual Plume Length Frequency

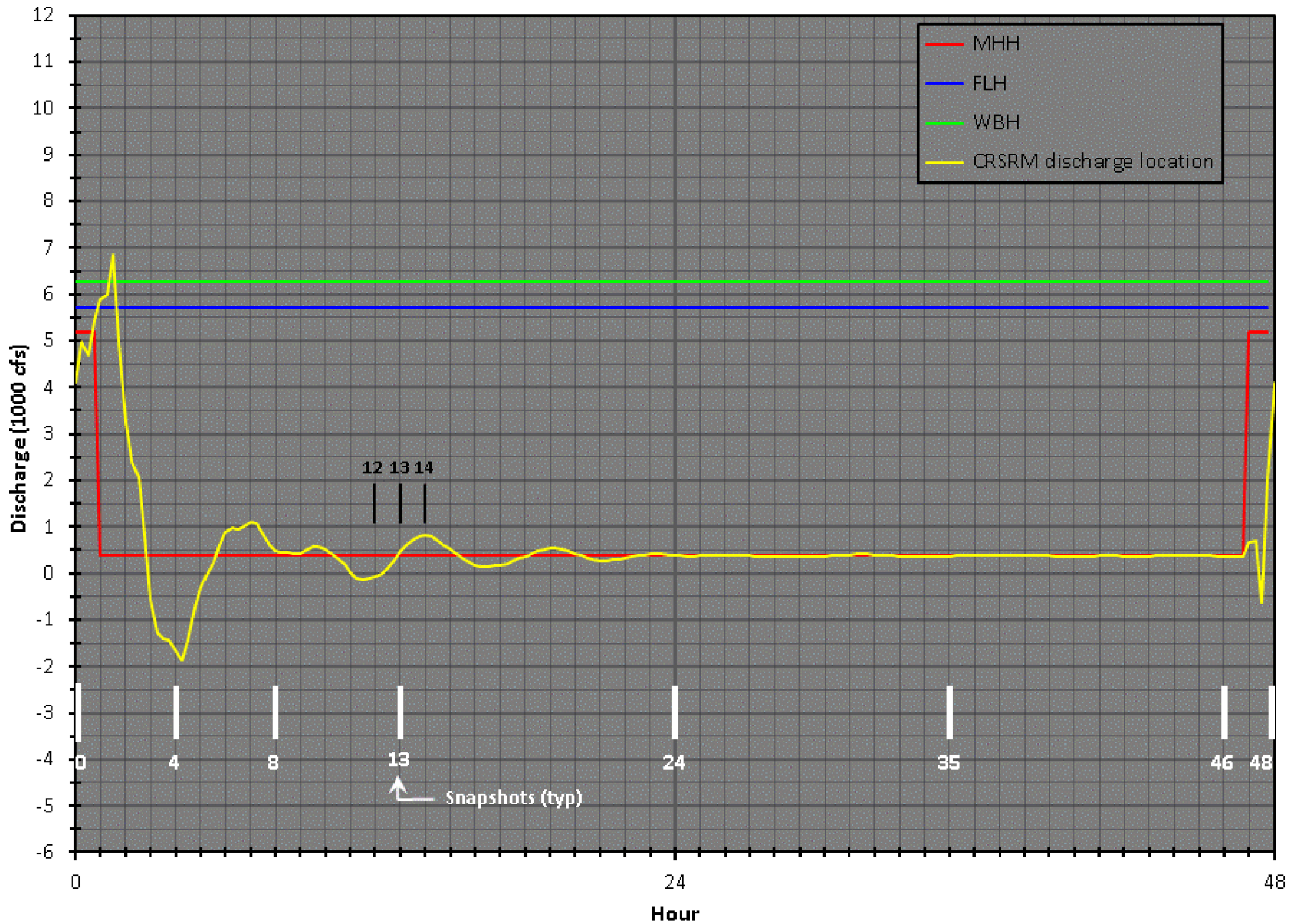
Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
2400	0.09	0.11	0	0	0	0	0	0	0.04	0.15	0	0	0	0	0	0.09	0.49
2500	0.09	0.11	0	0	0	0	0	0	0.04	0.15	0	0	0	0	0	0.09	0.49
2600	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
2700	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
2800	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
2900	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
3000	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
3100	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
3200	0.04	0.02	0	0	0	0	0	0	0.02	0.06	0	0	0	0	0	0.04	0.17
Summer																	
100	6.43	5.72	6.12	5.94	8.98	5.69	4.02	3.15	5.62	3.58	5.53	8.86	10.6	8.09	7.31	4.34	100
200	0.91	0.87	0.84	0.98	1.7	0.9	0.46	0.6	0.91	0.48	0.38	1.07	1.13	1.55	0.8	0.89	14.47
300	0.29	0.2	0.21	0.19	0.65	0.42	0.08	0.15	0.27	0.17	0.1	0.39	0.36	0.52	0.17	0.21	4.38
400	0.17	0.12	0.21	0.04	0.21	0.1	0.08	0.15	0.21	0.1	0.1	0.19	0.1	0.27	0.17	0.17	2.38
500	0.08	0.04	0.21	0.04	0.21	0.1	0.08	0.1	0.06	0.1	0.1	0.19	0.1	0.27	0.17	0.1	1.92
600	0.08	0.04	0.21	0.04	0.21	0.1	0.08	0.1	0.06	0.1	0.1	0.19	0.1	0.27	0.17	0.1	1.92
700	0.06	0.04	0.21	0.04	0.21	0.1	0.08	0.08	0.04	0.04	0.1	0.19	0.1	0.27	0.17	0.1	1.81
800	0.06	0.04	0.21	0.04	0.21	0.1	0.08	0.08	0.04	0.04	0.1	0.19	0.1	0.27	0.17	0.1	1.81
900	0.06	0.04	0.21	0.02	0.08	0.06	0.08	0.08	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.1	1.29
1000	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1100	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1200	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1300	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1400	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1500	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1600	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1700	0.04	0.04	0.21	0.02	0.08	0.06	0.08	0.04	0.04	0.04	0.1	0.19	0.08	0.08	0.06	0.06	1.2
1800	0.04	0.04	0.15	0.02	0.06	0.04	0.06	0.04	0.04	0.04	0.06	0.16	0.06	0.06	0.04	0.06	0.95
1900	0.04	0.04	0.15	0.02	0.06	0.04	0.06	0.04	0.04	0.04	0.06	0.16	0.06	0.06	0.04	0.06	0.95

Table 5.3-8 (Sheet 5 of 6)
Annual Plume Length Frequency

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
2000	0.04	0.04	0.15	0.02	0.06	0.04	0.06	0.04	0.04	0.04	0.06	0.16	0.06	0.06	0.04	0.06	0.95
2100	0.04	0.04	0.11	0	0	0	0	0.04	0.04	0.04	0	0.02	0.02	0	0	0.06	0.4
2200	0.04	0.04	0	0	0	0	0	0.04	0.04	0.04	0	0	0	0	0	0.06	0.25
2300	0.04	0.04	0	0	0	0	0	0.02	0.02	0.02	0	0	0	0	0	0.04	0.18
2400	0.04	0.04	0	0	0	0	0	0.02	0.02	0.02	0	0	0	0	0	0.04	0.18
2500	0.04	0.04	0	0	0	0	0	0.02	0.02	0.02	0	0	0	0	0	0.04	0.18
2600	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
2700	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
2800	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
2900	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
3000	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
3100	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
3200	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02
Fall																	
100	4.82	3.78	5.56	5.19	7.63	6.59	6.27	3.8	5.81	3.13	4.73	8.16	11.9	9.69	8.24	4.68	100
200	2.34	1.69	2.27	2.55	3.17	2.06	1.48	1.18	1.8	0.9	0.9	2.85	5.34	5.53	3.54	2.34	39.92
300	1.32	1.13	0.82	1.39	1.34	0.88	0.07	0.46	0.6	0.42	0.42	1.72	2.83	2.92	1.14	1.62	19.08
400	1.18	0.93	0.82	0.65	0.44	0.19	0.07	0.44	0.53	0.35	0.42	1.16	1.4	1.61	1.14	1.27	12.6
500	0.81	0.53	0.82	0.65	0.44	0.19	0.07	0.16	0.35	0.28	0.42	1.16	1.4	1.61	1.14	0.72	10.75
600	0.81	0.53	0.82	0.65	0.44	0.19	0.07	0.16	0.35	0.28	0.42	1.16	1.4	1.61	1.14	0.72	10.75
700	0.75	0.47	0.82	0.65	0.44	0.19	0.07	0.07	0.14	0.16	0.42	1.16	1.4	1.61	1.14	0.61	10.09
800	0.75	0.47	0.82	0.65	0.44	0.19	0.07	0.07	0.14	0.16	0.42	1.16	1.4	1.61	1.14	0.61	10.09
900	0.75	0.47	0.77	0.56	0.33	0.14	0.05	0.07	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.61	9.18
1000	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1100	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1200	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1300	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76

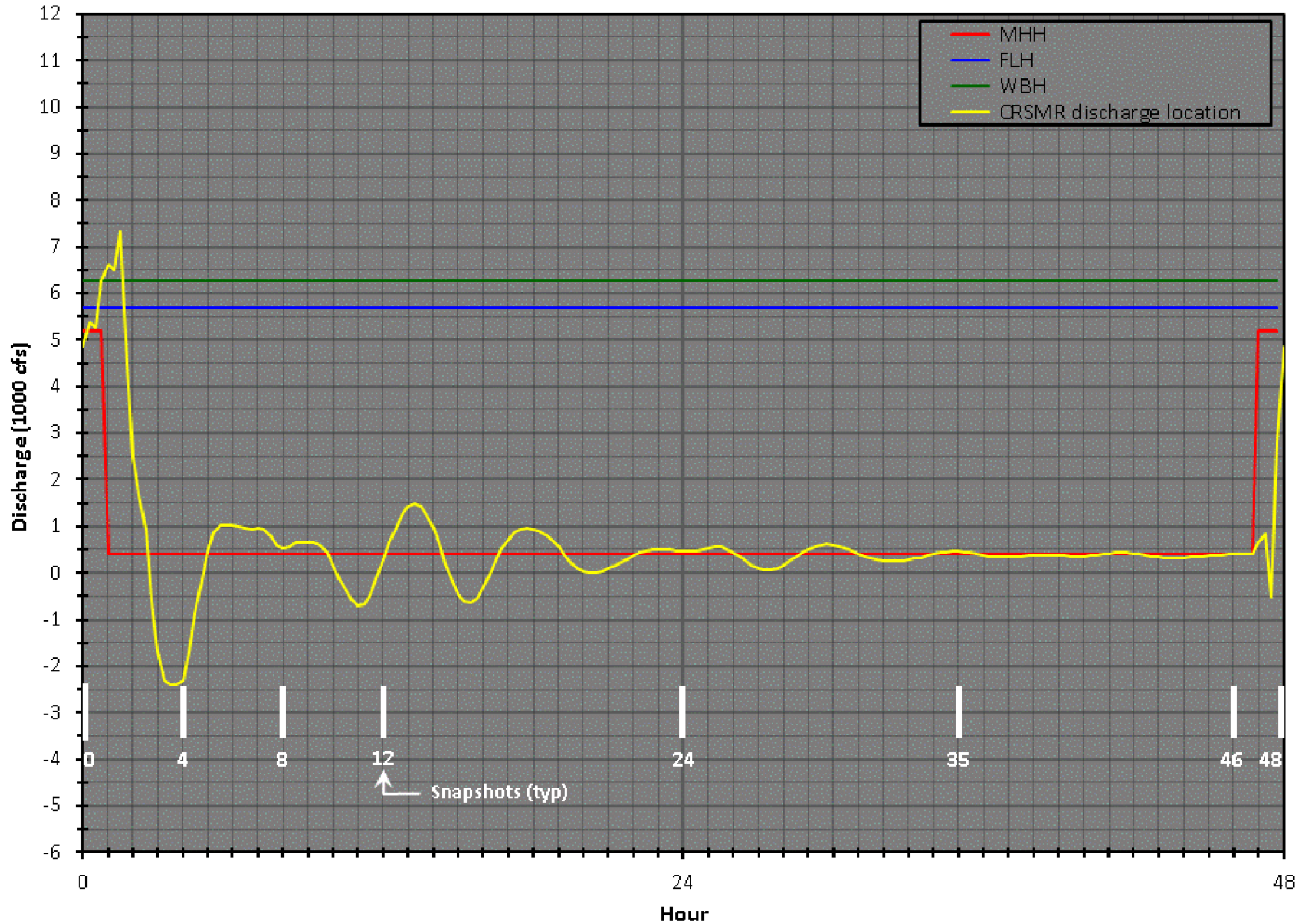
Table 5.3-8 (Sheet 6 of 6)
Annual Plume Length Frequency

Dist (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	AVG
1400	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1500	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1600	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1700	0.56	0.4	0.77	0.56	0.33	0.14	0.05	0.02	0.14	0.16	0.4	1.14	1.3	1.47	0.84	0.49	8.76
1800	0.56	0.4	0.42	0.28	0.19	0.05	0.02	0.02	0.14	0.16	0.26	0.93	1.04	0.9	0.35	0.49	6.2
1900	0.56	0.4	0.42	0.28	0.19	0.05	0.02	0.02	0.14	0.16	0.26	0.93	1.04	0.9	0.35	0.49	6.2
2000	0.56	0.4	0.42	0.28	0.19	0.05	0.02	0.02	0.14	0.16	0.26	0.93	1.04	0.9	0.35	0.49	6.2
2100	0.56	0.4	0.21	0.18	0.05	0.02	0	0.02	0.14	0.16	0.14	0.46	0.53	0.51	0.18	0.49	4.06
2200	0.56	0.4	0	0	0	0	0	0.02	0.14	0.16	0	0	0	0	0	0.49	1.77
2300	0.37	0.3	0	0	0	0	0	0.02	0.09	0.09	0	0	0	0	0	0.28	1.16
2400	0.37	0.3	0	0	0	0	0	0.02	0.09	0.09	0	0	0	0	0	0.28	1.16
2500	0.37	0.3	0	0	0	0	0	0.02	0.09	0.09	0	0	0	0	0	0.28	1.16
2600	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
2700	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
2800	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
2900	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
3000	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
3100	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53
3200	0.16	0.12	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0	0.12	0.53



Notes:
Snapshots are provided in Figure 5.3-3
MHH = Melton Hill Hydro plant
FLH = Fort Loudoun Hydro plant
WBH = Watts Bar Hydro plant
CR SMR = Clinch River Small Modular Reactor

Figure 5.3-1. River Flows for PPE Extreme Winter Conditions, Full Power



Note:
Snapshots are provided in Figure 5.3-4

Figure 5.3-2. River Flows for PPE Extreme Summer Conditions, Full Power

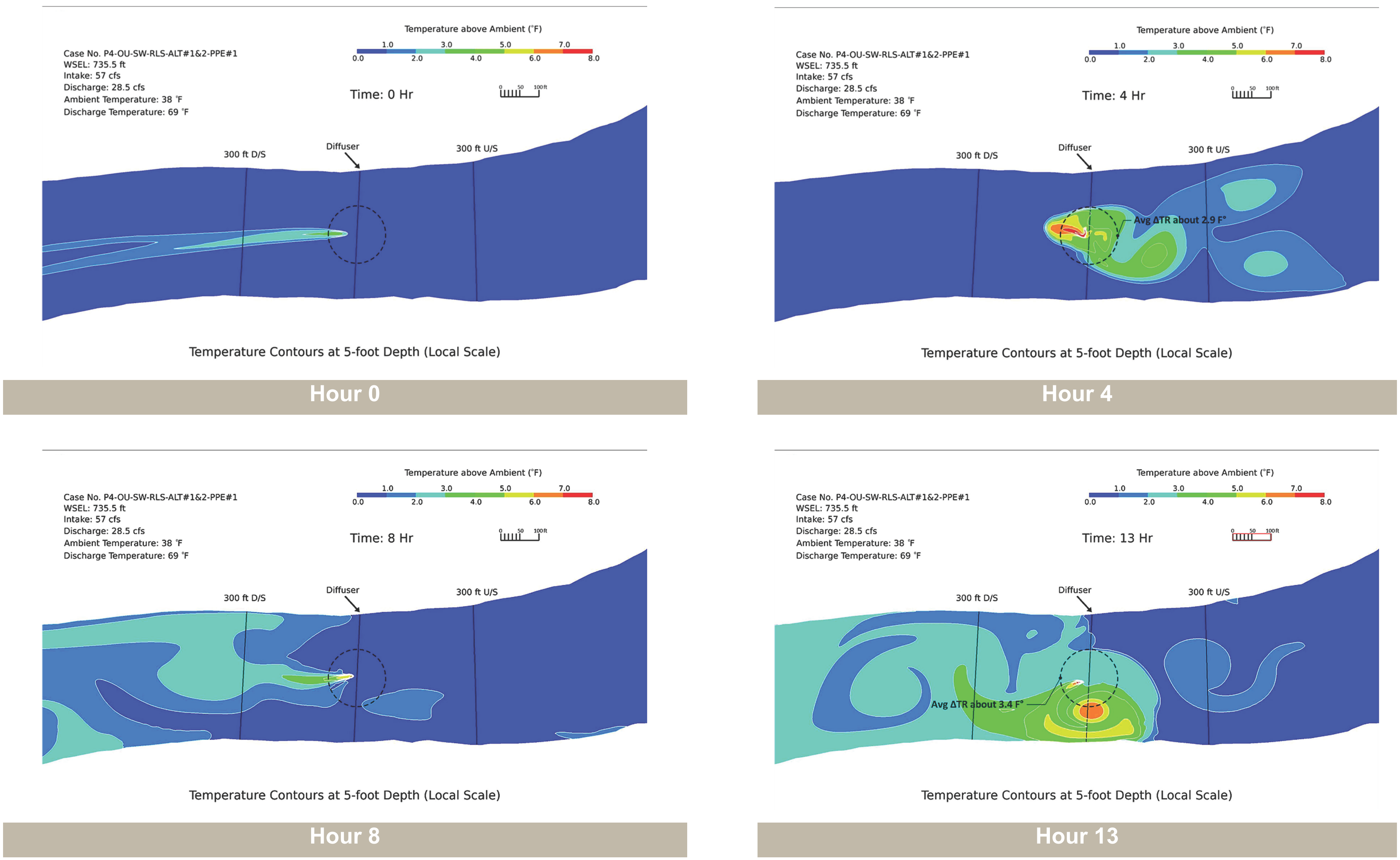


Figure 5.3-3. (Sheet 1 of 2) Temperatures at 5-Foot Depth for PPE Extreme Winter Conditions, Full Power

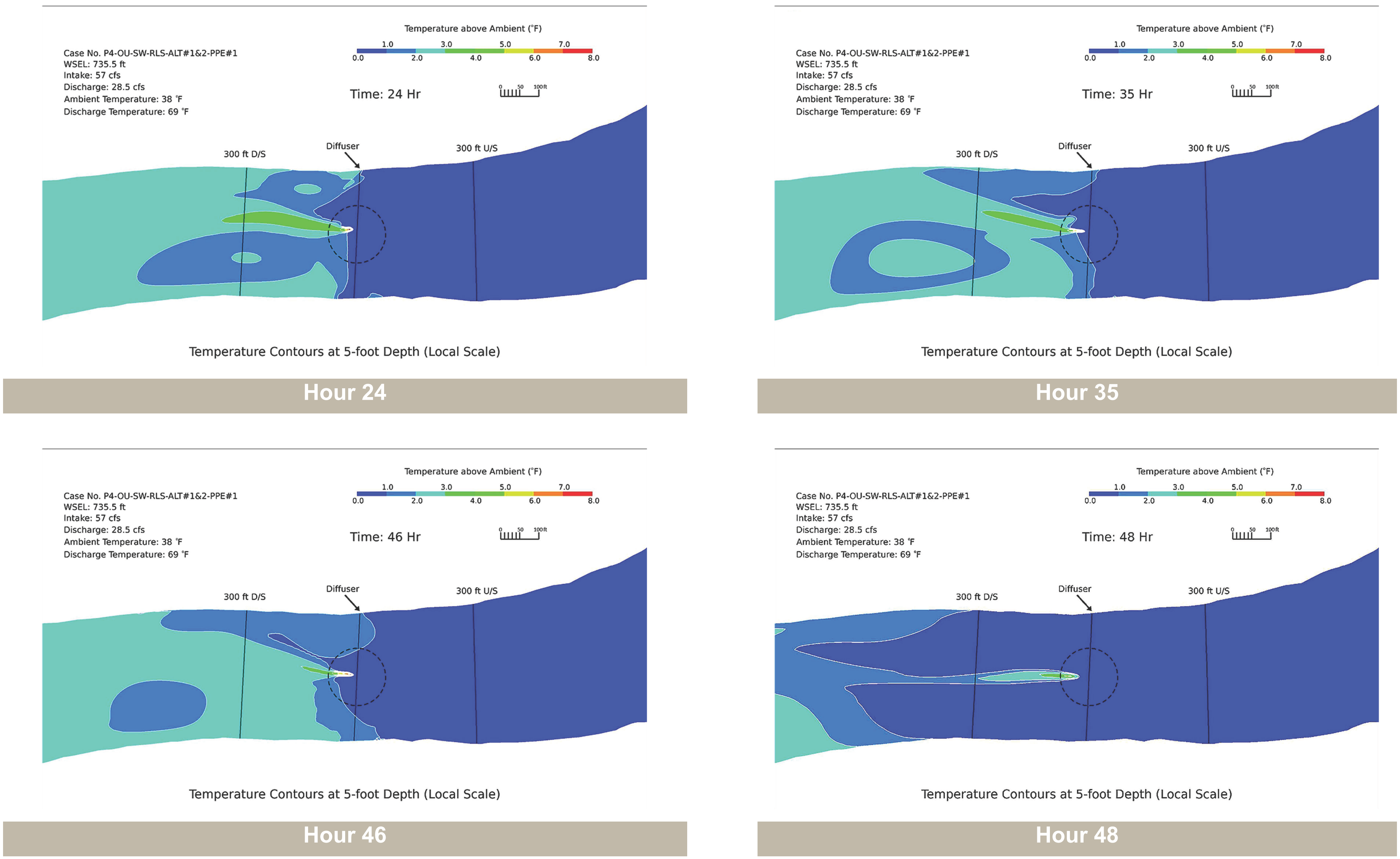


Figure 5.3-3. (Sheet 2 of 2) Temperatures at 5-Foot Depth for PPE Extreme Winter Conditions, Full Power

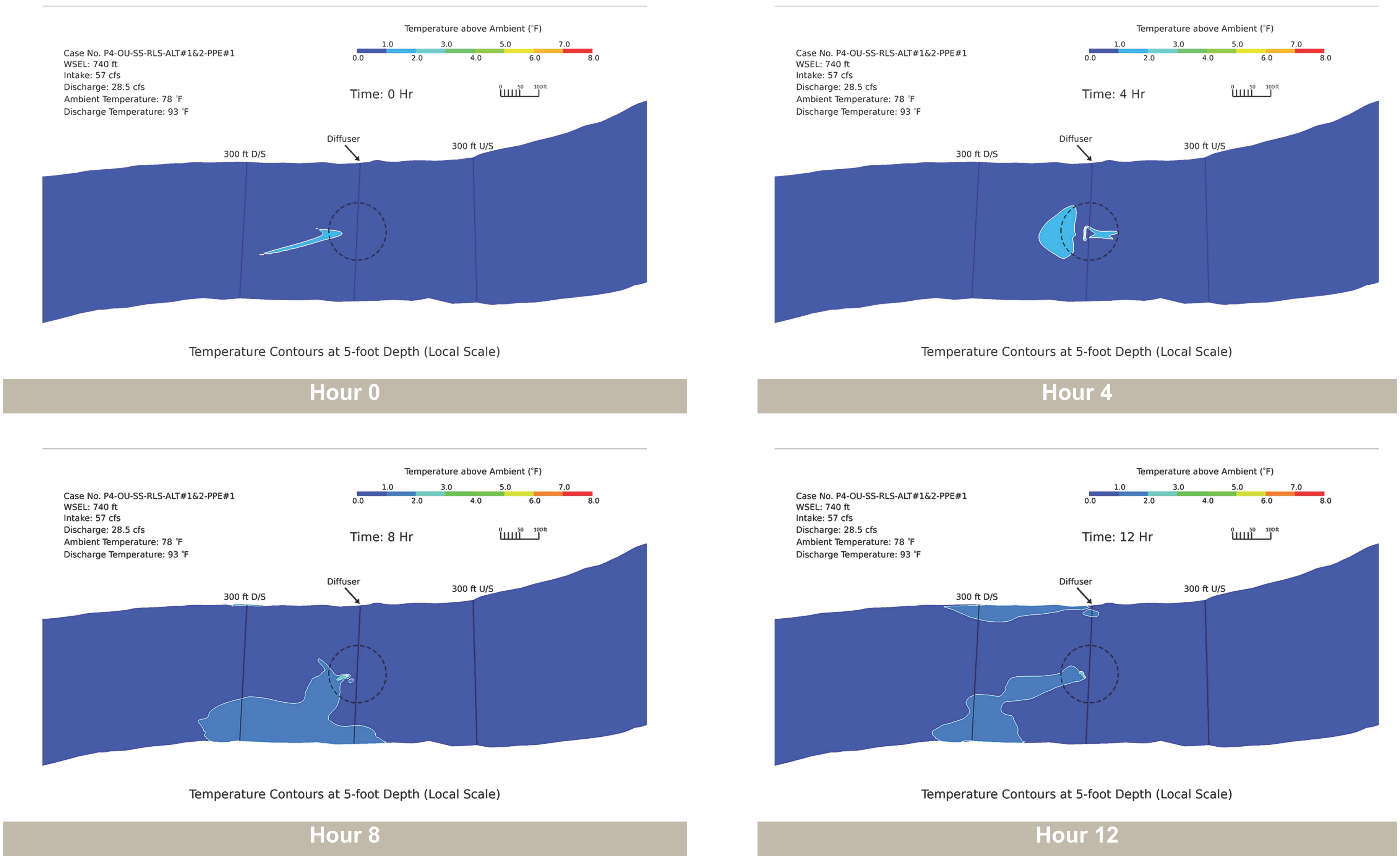


Figure 5.3-4. (Sheet 1 of 2) Temperatures at 5-Foot Depth for PPE Extreme Summer Conditions, Full Power

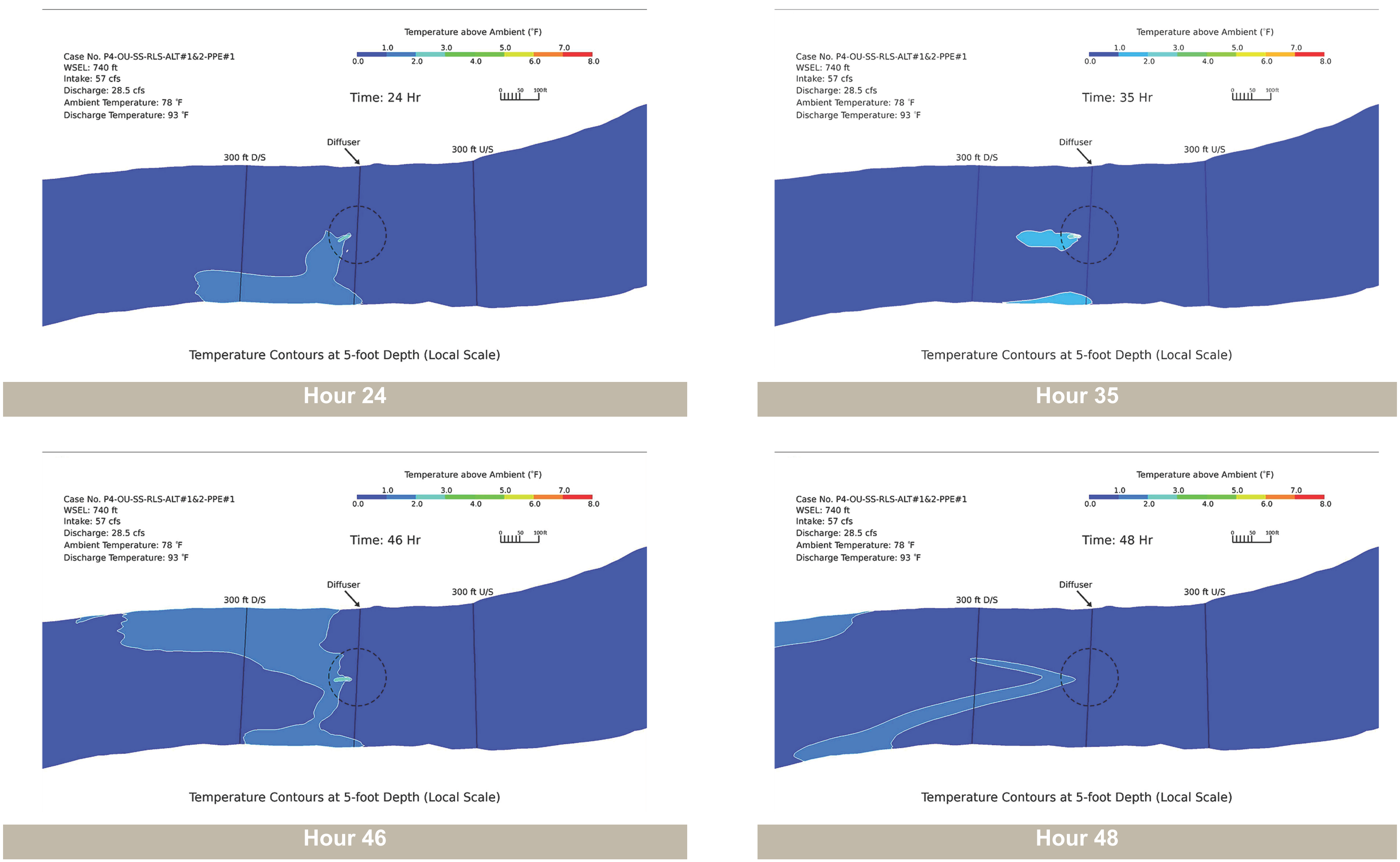
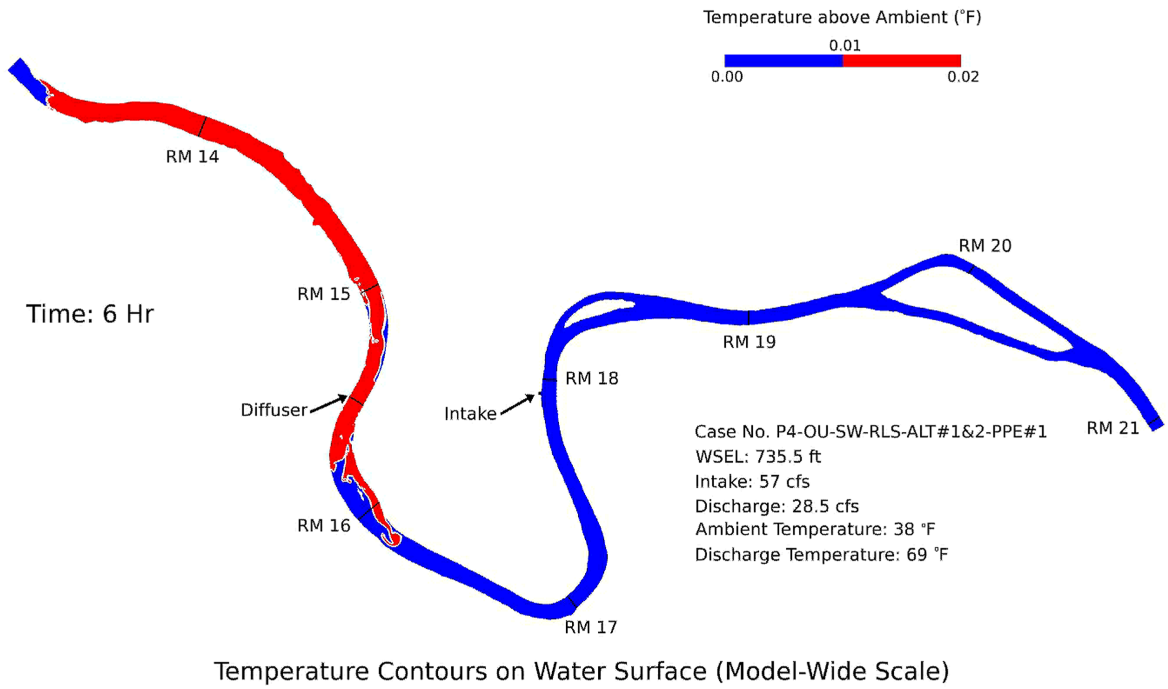


Figure 5.3-4. (Sheet 2 of 2) Temperatures at 5-Foot Depth for PPE Extreme Summer Conditions, Full Power



Hour 6

Figure 5.3-5. Approximate Zone of Influence of SMR Thermal Effluent at Water Surface for PPE Extreme Winter Conditions, Full Power

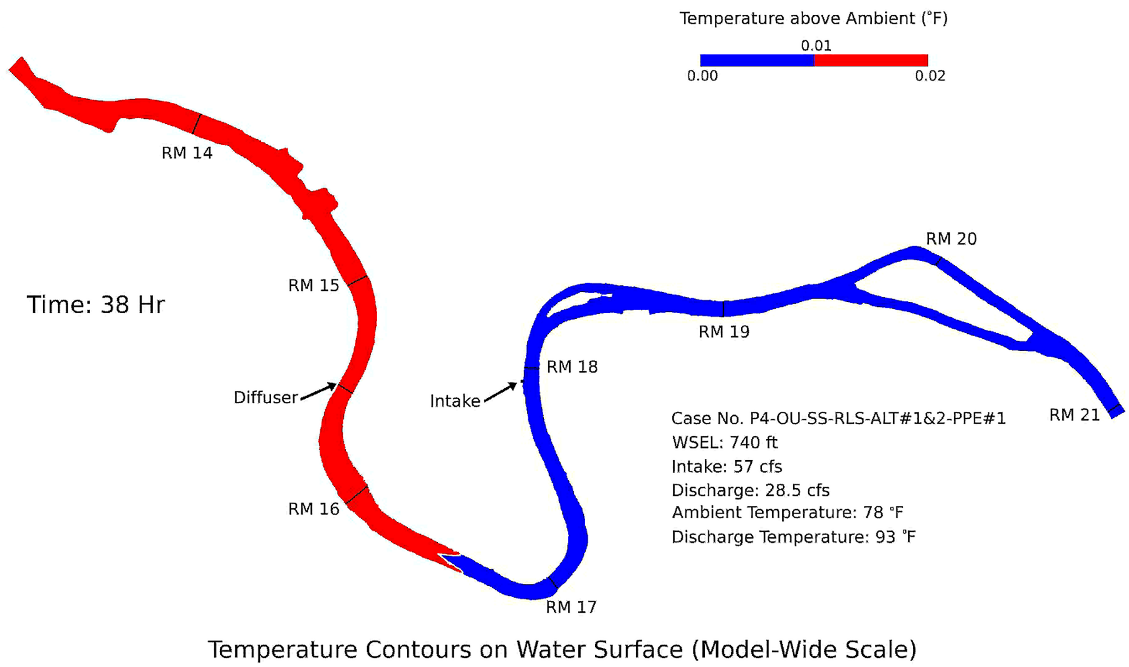


Figure 5.3-6. Approximate Zone of Influence of SMR Thermal Effluent at Water Surface for PPE Extreme Summer Conditions, Full Power