TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

December 5, 2012

10 CFR § 51.53(b)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

Subject: **REQUEST FOR ADDITIONAL INFORMATION REGARDING SUPPLEMENTAL CONDENSER COOLING WATER VELOCITY (TAC No. MD8203)**

References:
1. E-mail from Justin Poole (NRC) to Gordon Arent (TVA), dated September 6, 2012, "Draft RAI on FES"
2. TVA letter dated June 11, 2012, "Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant at Tennessee River Mile 528 from March 2010 through March 2011 (TAC No. MD8203)"
3. TVA letter dated February 25, 2010, "Watts Bar Nuclear Plant(WBN) Unit 2 – Additional Information Regarding Environmental Review (TAC No. MD8203)"
4. TVA letter dated October 22, 2009, "Additional Information in Support of TVA Final Supplemental Environmental Impact Statement (FSEIS) (TAC MD8303)"
5. TVA letter dated July 2, 2009, "Additional Information in Support of TVA Final Supplemental Environmental Impact Statement (FSEIS) (TAC MD8303)"
6. TVA letter dated February 15, 2008, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement for the Completion and Operation of Unit 2"

The purpose of this letter is to respond to the request for additional information (RAI) transmitted to TVA by Reference 1 concerning the water velocity at the intake of the Supplemental Condenser Cooling Water System (SCCW). The NRC staff noted that the SCCW intake water velocity differed among some TVA submittals with higher values reported in Reference 2 than in earlier submittals.

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Reference 2 provided velocities for one specific year and periods of higher flow during the year when compared to the yearly average. In contrast, much of the information provided for SCCW in References 3, 4, and 5 was intended to reflect multiyear annual averages. In addition, much of the information provided in Reference 3 and earlier documents was based on SCCW preoperational design values and in some instances reflected potential plant modifications that did not progress beyond a conceptual stage. Reference 2, on the other hand, incorporated actual operational data and modeling consistent with the current plant configuration. TVA's detailed response to the RAIs is provided in the enclosure.

SCCW intake flow information provided in the referenced documents was reviewed for consistency and was updated to reflect the current state of operational knowledge. As a result of this review, updates to information provided in Attachments H-12 and H-14 of Reference 4 are provided in the enclosure. The review also identified some information in previous environmental submittals for Unit 2 that warranted clarification or correction. These corrections are discussed in the enclosure and have been entered into the corrective action program. TVA evaluated each instance where a change was warranted and determined that the environmental impacts of the use of SCCW remain acceptable. No changes to SCCW or plant operation are needed and no additional environmental mitigation is deemed necessary.

There are no new regulatory commitments contained in this letter. If you have any questions, please contact Gordon Arent at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 5th day of December, 2012.

Respectfully,

R.A. Hruby, Jr.

Raymond A. Hruby, Jr.
General Manager, Technical Services
Watts Bar Unit 2

Enclosure:

TVA Response to Request for Additional Information Regarding Supplemental Condenser Cooling Water Velocity – WBN U2 cc (Enclosure):

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ENCLOSURE
TVA RESPONSE TO
REQUEST FOR ADDITIONAL INFORMATION REGARDING
SUPPLEMENTAL CONDENSER COOLING WATER VELOCITY – WBN U2

The Supplemental Condenser Cooling Water System (SCCW) was incorporated into the design of the Watts Bar Nuclear Plant (WBN) after several years of Unit 1 operation to improve the overall thermal efficiency of the plant. Use of the SCCW system is discretionary in that the plant can operate without the SCCW system; however, the power output of the plant will be reduced in most cases by that action.

TVA has performed a number of studies related to the SCCW performance. Design studies were performed to determine how to incorporate the system into the WBN design. Thermal hydraulic studies were performed to develop environmental impact statements and permitting documents, first for the operation of Unit 1, and then for Unit 1 and Unit 2 operation with SCCW. Specific studies to respond to NRC questions associated with the licensing of Unit 2 were also performed. This has resulted in a number of different submittals, often with different assumptions, over a relatively long period of time with associated documents not being submitted in chronological order, and in some cases the documents being submitted well after their issue date. This has contributed to a confusing timeline of SCCW information. Table 1 provides a chronological list of documents related to the SCCW discussed in this enclosure. The table also lists when the documents were submitted to the NRC.

Table 1 – Significant Document List

Document	Submittal & Date of Submittal
TVA Thermal Plume Modeling Report, dated December 5, 1997	TVA letter dated October 22, 2009, Attachment 50 (Reference 4)
TVA calculation MDN1027-980006, "The Sizing of the Supplemental Condenser Cooling Water (SCCW) System Supply, Discharge and Bypass Lines, " dated June 4, 1998	TVA letter dated February 25, 2010, Enclosure H-12 (Reference 3)
Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Project Environmental Assessment, date August 1998	TVA letter to NRC dated July 2, 2008 (Reference 5) The EA was one of two attachments to the letter.
2006 NPDES flow diagram for Watts Bar Nuclear Plant	TVA letter dated February 15, 2008, Appendix B (Reference 6)
Watts Bar Nuclear Plant (WBN) - Unit 2 - Final Supplemental Environmental Impact Statement for the Completion and Operation of Unit 2	TVA letter dated February 15, 2008 (Reference 6)
Spreadsheet File entitled "H-12_SCCW_Velocity"	TVA letter dated February 25, 2010, Enclosure H-12 (Reference 3)
Table 10 Simulation Results for Operation of Unit 1 and Unit 2 for Normal Winter and Summer Conditions – Flow Balance and Temperature, 2010	TVA letter dated February 25, 2010, Enclosure H-14 (Reference 3)

Document	Submittal & Date of Submittal
Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant at Tennessee River Mile 528 from March 2010 through March 2011	TVA letter dated June 11, 2012 (Reference 2)
Table 10 R1 Simulation Results for Operation of Unit 1 and Unit 2 for Normal Winter and Summer Conditions – Flow Balance and Temperature, 2012	This letter, dated December 5, 2012

Introduction

SCCW uses intake and discharge structures that were built to provide cooling water for the dismantled Watts Bar Fossil Plant. Gravity is the driving force providing the flow through both the intake and discharge structures. The intake is located on Watts Bar Reservoir immediately above Watts Bar Dam. Flow through the intake is routed to the Unit 2 cooling tower basin and mixes with the WBN Condenser Circulating Water (CCW). A portion of the SCCW flow is used as make-up for the loss of water that occurs in operation of the cooling towers. The remainder is discharged a short distance downstream of Watts Bar Dam into the Tennessee River (Chickamauga Reservoir). The SCCW intake and discharge flow will routinely vary due to changes in the water surface elevation in Watts Bar Reservoir.

<u>SCCW Intake Flow Rate</u>

Any discussion of SCCW Intake flow rates must take into account the following considerations:

1) SCCW intake flow is not and has not been directly measured. The intake flow is estimated from design calculations or from calculations supported by observation of water levels and plant performance.
2) Cooling Tower Evaporation, a significant factor in estimating SCCW intake flow, is also estimated.
3) SCCW discharge flow is instrumented and the method of measurement is stable at the flows associated with normal SCCW operation. Annual dye dilution tests show that the measured discharge flow rate is within about 10% of the test flow rate.
4) Water levels in the cooling tower basins are estimated because they are not recorded (abnormal levels only generate alarms). Also not specifically measured are the exact positions of the SCCW supply valve, the SCCW bypass valve, or the SCCW discharge valve.
5) The temperature of the SCCW inflow is not measured and is, therefore, estimated using plant performance data.

Because of these considerations, SCCW intake flow rates are estimates and should be qualified as approximate measures or amounts.

The first seven entries in Table 1 provided to the NRC by References 3, 4, 5, and 6 were based on conceptual or design information for SCCW and did not incorporate operational data. The last two listings in the table incorporated operational data as part of the development of SCCW flow rates.

The following discussion covers documents that were reviewed in the development of the Request for Additional Information (RAI) responses and were determined to contain information germane to the responses or were found to include statements that needed to be corrected or clarified.

TVA's Final Supplemental Environmental Impact Statement (FSEIS)

The FSEIS (Reference 6) provides a discussion of the impact of plant operation with SCCW in service. The SCCW flow rates used in the FSEIS were intended to approximate a multiyear annual average intake flow rate. As detailed in Reference 3, hourly hydrothermal simulations of plant operation over 30 years were used in the development of the information used in the FSEIS. The purpose of these simulations was to determine the thermal impact of SCCW and plant water discharges to the Tennessee River below Watts Bar Dam. Appendix B of the FSEIS provides the NPDES flow diagram, and that diagram shows an annual average SCCW intake flow rate of 270 cubic feet per second (cfs). The basis for the selection of this value could not be established based on a review of both design and environmental permitting reports and correspondence associated with the development and subsequent installation and operation of the SCCW system. This flow rate represents a reasonable value given the expected SCCW flow range from documents prepared in the 1997/1998 time period. An estimate of SCCW intake flow based on a recent evaluation provided later in this response shows an average annual intake flow of approximately 278 cfs would be a more accurate estimate. The difference between the two values is well within the error band for estimated SCCW intake flow.

The FSEIS text discussion of SCCW in Section 2.2 states that the average SCCW intake flow rate is about 200 cfs with a maximum intake flow rate of about 365 cfs. The value of 365 cfs corresponds to a design calculation value with Watts Bar Reservoir at a pool elevation of 745.0 ft mean sea level (msl). This elevation corresponds to the top of the Watts Bar Dam spillway gates. The FSEIS statement that 200 cfs is the average SCCW intake value is incorrect. This value is representative of the low end of the winter SCCW intake flow as seen in the design calculation, as opposed to an average flow, and is likely a typographical error based on the context of the sentence.

TVA's July 2, 2009 RAI Response

The SCCW Environmental Assessment (EA) was submitted to the NRC as an attachment to TVA's July 2, 2009 letter (Reference 5). A review of this document found that it included a sentence in which the SCCW discharge flow of 270 cfs was incorrectly equated with a flow rate of 135,000 gpm. A flow rate of 270 cfs would be equivalent to approximately 121,000 gpm. The discussion in the SCCW EA where these flow rates were cited related to water quality with respect to maximum in-stream total residual chlorine on either an instantaneous or weekly average basis. The EA values for river flow available to dilute the chloride releases are sufficiently large to provide adequate dilution for either a 121,000 or a 135,000 gpm discharge flow rate from SCCW. Thus, the conclusion made in the EA that the maximum in-stream total residual chloride concentration would be acceptable remains valid.

TVA's February 25, 2010 RAI Response

In December 2009, the NRC requested additional information associated with its environmental review of WBN Unit 2. The February 25, 2010 RAI response (Reference 3) provided several separate discussions of SCCW intake flow rates. With respect to the RAIs being addressed in this response, Attachments H-12 and H-14 of that response are of interest.

RAI H-12 asked the following question:

> *Provide through screen velocities for water entering the Supplemental Condenser Cooling Water (SCCW) system under normal operating conditions with WBN Units 1 and 2 operating. Provide a diagram of the SCCW intake structure that includes the dimensions of intake openings, location, and characteristics of trashracks and traveling screens to allow staff to validate the velocity provided.*

This is essentially the same question as Question 1 from the NRC e-mail to TVA (Reference 1). In response, Attachment H-12 of Reference 3 provided a file titled "H12_SCCW_Velocity" that gave the average water velocity at various locations and the wetted flow area of each location where a water velocity was provided in the SCCW intake structure. During the development of the response to Reference 1, it was determined that the calculations in the file titled "H12_SCCW_Velocity" assumed that the Watts Bar Reservoir would be at the nominal summer pool elevation but used the annual average SCCW intake flow rate of 270 cfs to determine the velocities. This flow rate is less than the approximately 135,000 gpm flow rate that would be expected when the Watts Bar Reservoir was at the summer pool level. Some of the flow areas vary with reservoir level and are larger at summer pool than they would be at other times of the year. These assumptions result in the velocities calculated in the spreadsheet being lower than what would be expected or would actually occur. The original information from H12_SCCW_Velocity is repeated below in Table 2. Table 3 provides the velocities that would be associated with the Watts Bar Reservoir summer pool elevation with a flow rate of 135,000 gpm. Table 4 provides the same information for the annual average flow rate and pool elevation developed from more recent simulations. These tables provide the flow area used in developing the velocities at the open area near the trashrack (gross area at face of trashrack), the open area of the trashrack (net open area of trashrack), the open area near the traveling screens (gross area at traveling screen), and the open area of the traveling screens (net open area at traveling screen). In Tables 3 and 4, the open area near the trashrack has been reduced to the area of the concrete opening instead of the area at the face of the steel bars.

Attachment H-12 also provided TVA calculation MDN1027-980006, "The Sizing of the Supplemental Condenser Cooling Water (SCCW) System Supply, Discharge and Bypass Lines" and drawings of the intake structure. This calculation was prepared to provide the basis for incorporation of SCCW into the plant design and to estimate flow rates for various operating conditions. This calculation provided the flow areas and hydraulic losses for all of the important features of the system needed to establish flow rates for various operating conditions. These conditions included summer and winter Watts Bar Reservoir levels as well as off-normal conditions such as a high Watts Bar Reservoir pool level due to intense precipitation. A range of system fouling was examined. The design for the system was established to ensure the ability of SCCW to supply approximately 135,000 gpm to the WBN cooling tower basin in the summer and approximately 115,000 gpm for winter Watts Bar Reservoir levels. Attachment H-12 provided the diagrams, dimensions, loss coefficients, and other information necessary for the NRC staff to validate the SCCW velocity information provided by TVA.

Table 2
February 25, 2010 RAI Response
Approximate Annual Average Conditions

		PLANT WITHDRAWAL IMPACTS						
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service				
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Normal Summer Pool	740.75	270 cfs 121,000 gpm 174 mgd	0.41 fps	0.49 fps	0.91 fps	0.56 fps	0.73 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	30.75	(ft)
Gross area of each bay at traveling screen (concrete)	**219.1**	**(ft²)**
Width of traveling screen panels (approx)	6	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	79%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens (http://www.millerwireworks.com/A-Wtable.html)	67.9%	
Gross area of each bay at traveling screen (screen tray)	**184.5**	**(ft²)**
Net open area of each bay at traveling screen (approx)	**98.6**	**(ft²)**
Width of face of trashrack each bay (face of outer vertical bars)	8.05	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	6.33	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	20	(t)
Approx no. horizontal bars trashrack each bay	11	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	5.5	(in)
Total net height of open area trashrack each bay	19.54	(ft)
Percent open area thru trasrack each bay (approx)	77%	
Gross area of each bay at face of trashrack	**161.04**	**(ft²)**
Net open area of each bay at trashrack (approx)	**123.76**	**(ft²)**

Table 3
December 2012 RAI Response
Summer Pool Conditions

		PLANT WITHDRAWAL IMPACTS							
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service					
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Normal Summer Pool	740.75	301 cfs 135,000 gpm 195 mgd	0.46 fps	0.54 fps	1.02 fps	0.65 fps	0.86 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	30.75	(ft)
Gross area of each bay at traveling screen (concrete)	**219.1**	**(ft^2)**
Width of traveling screen panels (approx)	6	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	79%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens (http://www.millerwireworks.com/A-Wtable.html)	67.9%	
Gross area of each bay at traveling screen (screen tray)	**184.5**	**(ft^2)**
Net open area of each bay at traveling screen (approx)	**98.6**	**(ft^2)**
Width of face of trashrack each bay (face of concrete opening)	7.67	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	5.95	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	20	(t)
Approx no. horizontal bars trashrack each bay	11	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	5.5	(in)
Total net height of open area trashrack each bay	19.54	(ft)
Percent open area thru trasrack each bay (approx)	77%	
Gross area of each bay at face of trashrack	**161.04**	**(ft^2)**
Net open area of each bay at trashrack (approx)	**123.76**	**(ft^2)**

Table 4
December 2012 RAI Response
Approximate Average Annual Conditions

		PLANT WITHDRAWAL IMPACTS						
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service				
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Annual Average Pool	739.03	278 cfs 125,000 gpm 180 mgd	0.45 fps	0.53 fps	1.00 fps	0.60 fps	0.80 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	29.03	(ft)
Gross area of each bay at traveling screen (concrete)	**206.8**	**(ft^2)**
Width of traveling screen panels (approx)	6	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	79%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens (http://www.millerwireworks.com/A-Wtable.html)	67.9%	
Gross area of each bay at traveling screen (screen tray)	**174.2**	**(ft^2)**
Net open area of each bay at traveling screen (approx)	**93.1**	**(ft^2)**
Width of face of trashrack each bay (face of concrete opening)	7.67	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	5.95	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	20	(t)
Approx no. horizontal bars trashrack each bay	11	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	5.5	(in)
Total net height of open area trashrack each bay	19.54	(ft)
Percent open area thru trasrack each bay (approx)	77%	
Gross area of each bay at face of trashrack	**161.04**	**(ft^2)**
Net open area of each bay at trashrack (approx)	**123.76**	**(ft^2)**

Attachment H-14 Table 10 of Reference 3 provided estimates of monthly SCCW intake flow for two unit operation of WBN. This simulation assumed a plant configuration that included plant modifications being considered and expected to be in place when Unit 2 begins operation. The following assumptions were made:

- the cooling tower basin and CCW intake flume trashracks would be installed for both units
- the Unit 1 blowdown weir would be open
- the Unit 2 blowdown weir would be closed
- the Unit 2 cooling tower basin walls would be raised to allow a higher level in the basin
- four Essential Raw Cooling Water (ERCW) and six Raw Cooling Water (RCW) pumps would be in service. This pump configuration is representative of an accident situation as opposed to normal plant operation
- the head – discharge relationship from the original thermal plume modeling studies performed in support of the 1998 SCCW environmental assessment was used to estimate SCCW intake flow.

A copy of the original table is provided below in Table 5.

Table 5

TVA Letter to NRC dated February 25, 2010 Attachment H-14
Table 10. Simulation Results for Operation of Unit 1 and Unit 2 for Normal Winter and Summer Conditions - Flow Balance and Temperature

Month	Inflow from Intake Pumping Station		Inflow from SCCW System		Cooling Tower Evaporation	Discharge from Diffusers/Outfall 101				Discharge to (+) or from (-) Storage in Yard Holding Pond		Discharge from Yard Holding Pond Overflow/Outfall 102		Discharge from SCCW System/Outfall 113			
	Flow	Temp	Flow	Temp		Flow	Temp End of Pipe	Temp End of Mixing Zone	Temp Rise End of Mixing Zone	Flow	Temp	Flow	Temp	Flow	Temp End of Pipe	Temp End of Mixing Zone	Temp Rise End of Mixing Zone
	(cfs)	(°F)	(cfs)	(°F)	(cfs)	(cfs)	(°F)	(°F)	(°F)	(cfs)	(°F)	(cfs)	(°F)	(cfs)	(°F)	(°F)	(°F)
Jan	174	46.0	205	44.2	59	54	63.3	46.1	0.1	NA	NA	NA	NA	266	63.3	46.0	1.8
Feb	174	45.5	205	43.9	58	54	65.2	45.6	0.1	NA	NA	NA	NA	267	65.2	45.5	1.6
Mar	174	50.9	205	49.1	59	54	69.4	51.0	0.1	NA	NA	NA	NA	266	69.4	50.9	1.8
Apr	174	58.7	262	56.5	59	67	74.0	58.9	0.2	NA	NA	NA	NA	310	74.0	58.7	2.2
May	174	66.1	274	64.1	60	70	79.0	66.3	0.2	NA	NA	NA	NA	318	79.0	66.1	2.0
Jun	174	73.0	274	71.6	62	69	83.6	73.1	0.1	NA	NA	NA	NA	317	83.6	73.0	1.4
Jul	174	77.6	275	76.6	63	69	85.8	77.8	0.1	NA	NA	NA	NA	317	85.8	77.6	1.0
Aug	174	79.1	275	78.3	64	69	85.3	79.2	0.1	NA	NA	NA	NA	316	85.3	79.1	0.8
Sep	174	77.0	275	76.4	64	69	81.5	77.0	0.1	NA	NA	NA	NA	316	81.5	77.0	0.6
Oct	174	69.4	275	68.6	63	69	74.7	69.5	0.1	NA	NA	NA	NA	317	74.7	69.4	0.8
Nov	174	59.8	274	58.6	61	69	69.3	59.9	0.1	NA	NA	NA	NA	318	69.3	59.8	1.2
Dec	174	51.1	205	49.4	60	54	64.9	51.1	0.1	NA	NA	NA	NA	265	64.9	51.1	1.7

The current and expected plant configuration for two-unit operation is somewhat different than that described in the preceding paragraph. TVA has re-performed the two-unit simulations based on the expected dual-unit operational configuration of the cooling tower basins and has incorporated other model improvements based on recent observations of SCCW. The updated simulations use the following plant configuration and assumptions:

- the Unit 2 cooling tower basin walls would not be raised
- the cooling tower basin trashracks would be installed on both units
- the CCW intake flume trashrack would be installed for Unit 1 but not for Unit 2
- the Unit 1 blowdown weir would be closed
- the Unit 2 blowdown weir would be open
- the Intake Pumping Station (IPS) flow would be based on normal operation with two ERCW and six RCW pumps running
- the SCCW inflow head-discharge relationship was revised to provide an inflow of 135,000 gpm when the reservoir elevation behind Watts Bar Dam is 740.5 ft msl and the water level in the Unit 2 cooling tower basin is 730.3 ft msl.

The revised Table 10 results are provided in Table 6.

<u>TVA's May 2012 Entrainment Report Submittal</u>

The estimated SCCW intake velocities provided in the May 2012 report, "Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant," were computed based on the period of time from March 1, 2010, to March 1, 2011 (Reference 2). In this period, the non-flood pool elevations behind Watts Bar Dam ranged between about 737 ft msl in the winter and 741 ft msl in the summer. Other noteworthy assumptions made include:

1. the width of the trashrack was reduced to the concrete opening dimension instead of using the frame dimension;
2. the height of the trashrack opening was increased from the bottom of the trashrack frame to the lake surface instead of the frame height;
3. the traveling screen effective flow area factor was changed to 0.503 instead of 0.534 as used in Attachment H-12 of the February 2010 RAI response; and,
4. the traveling screen width was reduced from 6.0 ft to 5.83 ft.

Assumptions 1, 2, and 3 were made to be consistent with similar assumptions in the IPS flow rate evaluation. Assumption 4 was considered to be a conservative scaling from a TVA drawing. These assumptions result in slightly higher intake flow rates, and thus higher velocities, than would be seen for the design case intake flow rate of 135,000 gpm. The SCCW intake flow rate in the May 2012 report was estimated based on the measured SCCW discharge flow and observations and estimates of other flows that enter and exit the cooling tower basins using regression analysis techniques. This is described in more detail in the specific response to RAI 2. The higher discharge flow rate, in conjunction with the higher Watts Bar reservoir elevation, were the most important factors that resulted in higher SCCW intake flow rates and thus higher velocities than had been reported in the earlier studies discussed above.

Assumption 3 is conservative but 0.503 is not the correct value. The IPS screens use a heavier wire than is used in the SCCW screens. Thus, the 0.534 value used in the Reference 3 response is considered more appropriate. The 6.0 ft screen width is considered the more appropriate value to use as it is the value used in the SCCW design calculation.

Table 7 provides the entrainment report information in the same format as was provided in the Reference 3 H-12 response. This includes the velocities at various locations associated with the SCCW intake structure as well as the areas associated with the velocities shown. Values related to the assumptions described above are denoted by bold rectangles. Table 8 provides the same information for the entrainment report winter pool elevation. Table 9 shows what entrainment report summer pool velocities would have been if the screen width, height, and SCCW flow area factor matched the values used in Reference 3.

In summary, the principle reasons for the difference between the values for the SCCW flow rate from the various studies are related to the time scales for the values chosen and the incorporation of operational data into the simulations. Table 4 provides information appropriate for the NPDES average annual SCCW flow conditions. Table 6 provides an appropriate multiyear evaluation of SCCW performance for use in evaluating the environmental impacts with respect to thermal discharges. A comparison of the data demonstrates that the earlier information provided to the NRC (References 3, 4, 5, and 6) is reasonable within the purpose and function of the reports.

Table 6

Table 10 Revised. Simulation Results of 11-06-2012 for Operation of Unit 1 and Unit 2 for Normal Winter and Summer Conditions - Flow Balance and Temperature

Month	Inflow from Intake Pumping Station		Inflow from SCCW System		Cooling Tower Evaporation	Discharge from Diffusers/Outfall 101				Discharge to (+) or from (-) Storage in Yard Holding Pond		Discharge from Yard Holding Pond Overflow/Outfall 102		Discharge from SCCW System/Outfall 113			
	Flow	Temp	Flow	Temp		Flow	Temp End of Pipe	Temp End of Mixing Zone	Temp Rise End of Mixing Zone	Flow	Temp	Flow	Temp	Flow	Temp End of Pipe	Temp End of Mixing Zone	Temp Rise End of Mixing Zone
	(cfs)	(°F)	(cfs)	(°F)	(cfs)	(cfs)	(°F)	(°F)	(°F)	(cfs)	(°F)	(cfs)	(°F)	(cfs)	(°F)	(°F)	(°F)
Jan	116	45.9	230	44.2	60	46	59.0	46.0	0.1	NA	NA	NA	NA	240	63.3	45.9	1.7
Feb	116	45.4	230	43.8	59	46	60.5	45.5	0.1	NA	NA	NA	NA	241	65.2	45.4	1.6
Mar	116	50.9	230	49.0	60	46	65.0	50.9	0.1	NA	NA	NA	NA	240	69.5	50.9	1.9
Apr	116	58.6	289	56.4	60	74	69.5	58.8	0.2	NA	NA	NA	NA	271	74.0	58.6	2.2
May	116	66.2	303	64.2	61	79	75.2	66.3	0.2	NA	NA	NA	NA	279	79.1	66.2	2.0
Jun	116	73.0	303	71.7	62	78	80.6	73.1	0.1	NA	NA	NA	NA	278	83.7	73.0	1.3
Jul	116	77.6	303	76.7	64	78	83.4	77.7	0.1	NA	NA	NA	NA	277	85.8	77.6	0.9
Aug	116	79.0	303	78.3	64	78	83.5	79.1	0.1	NA	NA	NA	NA	277	85.4	79.0	0.7
Sep	116	77.0	303	76.4	64	78	80.1	77.0	0.0	NA	NA	NA	NA	277	81.5	77.0	0.6
Oct	116	69.4	303	68.6	63	78	73.0	69.4	0.1	NA	NA	NA	NA	278	74.7	69.4	0.8
Nov	116	59.8	303	58.6	62	78	66.4	59.8	0.1	NA	NA	NA	NA	279	69.3	59.8	1.2
Dec	116	51.0	230	49.3	61	46	61.4	51.0	0.1	NA	NA	NA	NA	239	64.9	51.0	1.7

Notes (apply to entire table):

1. Unit 1 cooling tower basin trashrack installed
2. Unit 1 cooling tower blowdown weir closed
3. Unit 1 CCW intake flume trashrack installed
4. Unit 2 cooling tower basin trashrack installed
5. Unit 2 cooling tower blowdown weir open
6. Unit 2 CCW intake flume trashrack removed
7. WBN IPS inflow 52,100 gpm
8. SCCW inflow 135,000 gpm with Watts Bar Reservoir WSEL 740.5 and WBN Unit 2 cooling tower basin WSEL 730.3

Table 7
December 2012 RAI Response
Entrainment Report Summer Pool Conditions

		PLANT WITHDRAWAL IMPACTS						
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service				
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Normal Summer Pool	741	313 cfs 141,000 gpm 203 mgd	0.47 fps	0.58 fps	1.15 fps	0.44 fps	0.58 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	31.00	(ft)
Gross area of each bay at traveling screen (concrete)	**220.9**	**(ft^2)**
Width of traveling screen panels (approx)	5.83	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	79%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens	63.7%	
Gross area of each bay at traveling screen (screen tray)	**180.8**	**(ft^2)**
Net open area of each bay at traveling screen (approx)	**90.5**	**(ft^2)**
Width of face of trashrack each bay (face of outer vertical bars)	7.67	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	5.95	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	31	(t)
Approx no. horizontal bars trashrack each bay	16	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	8	(in)
Total net height of open area trashrack each bay	30.33	(ft)
Percent open area thru trasrack each bay (approx)	76%	
Gross area of each bay at face of trashrack	**237.46**	**(ft^2)**
Net open area of each bay at trashrack (approx)	**180.22**	**(ft^2)**

Table 8
December 2012 RAI Response
Entrainment Report Winter Pool Conditions

		PLANT WITHDRAWAL IMPACTS						
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service				
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Normal Summer Pool	737	238 cfs 107,000 gpm 154 mgd	0.41 fps	0.50 fps	1.00 fps	0.38 fps	0.51 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	27.00	(ft)
Gross area of each bay at traveling screen (concrete)	**192.4**	**(ft^2)**
Width of traveling screen panels (approx)	5.83	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	100%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens	50.3%	
Gross area of each bay at traveling screen (screen tray)	**157.5**	**(ft^2)**
Net open area of each bay at traveling screen (approx)	**79.2**	**(ft^2)**
Width of face of trashrack each bay (face of outer vertical bars)	7.67	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	5.97	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	27.00	(t)
Approx no. horizontal bars trashrack each bay	14	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	7	(in)
Total net height of open area trashrack each bay	26.42	(ft)
Percent open area thru trasrack each bay (approx)	76%	
Gross area of each bay at face of trashrack	**206.82**	**(ft^2)**
Net open area of each bay at trashrack (approx)	**156.95**	**(ft^2)**

Table 9
December 2012 RAI Response
Entrainment Report Summer Pool Conditions Original Screen Values

		PLANT WITHDRAWAL IMPACTS							
		Water Supplied by SCCW Intake		Average Velocity for expected No. of Bays in Service					
Number of Operating Units	Flow Condition	Watts Bar Dam Headwater Elevation (ft MSL)	Approx. SCCW Inflow	Gross area at traveling screen (concrete)	Gross area at traveling screen (screen panel)	Net open area at traveling screen (approx)	Gross area at face of trashrack	Net open area at trashrack (approx)
Two	Normal Summer Pool	741	313 cfs 141,000 gpm 203 mgd	0.47 fps	0.56 fps	1.05 fps	0.44 fps	0.58 fps

SCCW intake total no. of bays	6	
SCCW intake expected no. of bays in service with U1 & U2 operation	3	
Width of each bay at traveling screen (concrete)	7.13	(ft)
Invert elevation at each bay/traveling screens	710.00	(ft msl)
Height of each bay at normal summer pool	31.00	(ft)
Gross area of each bay at traveling screen (concrete)	**220.9**	**(ft^2)**
Width of traveling screen panels (approx)	6.0	(ft)
Heigh of traveling screen panels (approx)	2	(ft)
Width of panel circumferential supports (approx)	2	(in)
Percent of panel unobstructed by circumferential supports	79%	
Screen openings	3/8" x 3/8"	
Wire gage of screens	14	
Diameter of screen wire	0.08	(in)
Percent open area thru screens	67.9%	
Gross area of each bay at traveling screen (screen tray)	**186.0**	**(ft^2)**
Net open area of each bay at traveling screen (approx)	**99.4**	**(ft^2)**
Width of face of trashrack each bay (face of outer vertical bars)	7.67	(ft)
No. vertical bars of trashrack each bay	33	
Width of each vertical trashrack bar	0.625	(in)
Total width of vertical bars trashrack each bay	20.625	(in)
Total net width of open area trashrack each bay	5.95	(ft msl)
Elevation of top of trashrack opening	729.84	(ft)
Height of trashrack opening each bay (along slope)	31	(t)
Approx no. horizontal bars trashrack each bay	16	
Width of each horizontal trashrack bar	0.5	(in)
Total width of horizontal bars trashrack each bay	8	(in)
Total net height of open area trashrack each bay	30.33	(ft)
Percent open area thru trasrack each bay (approx)	76%	
Gross area of each bay at face of trashrack	**237.46**	**(ft^2)**
Net open area of each bay at trashrack (approx)	**180.22**	**(ft^2)**

Reference 1 – Specific RAI Responses

RAI Question 1

A diagram and a written description of the SCCW intake, the flow rate, and velocity at the SCCW intake. Include in this description the intake flow rate, the expected velocity entering the screen house through the intake sluice gates, into the wet well for the traveling water screens, through the SCCW trashracks, and through the screens for both summer and winter pools. (This description would be similar to that provided in your May 19, 2011, letter to the NRC, "Watts Bar Nuclear Plant (WBN) Unit 2 – Intake Pumping Station Water Velocity – Response to Request for Additional Information" (Accession No. ML11143A083)).

TVA Response - RAI Question 1

The intake structure for the SCCW system is located on the right-hand shoreline of Watts Bar Reservoir (facing downstream) immediately upstream of Watts Bar Dam. The location of the intake structure is shown in Figure 1. The intake is the same as that used for the demolished Watts Bar Fossil Plant (WBF). Plant records for WBF refer to the structure as the intake "screen house."

The WBF screen house includes six intake bays. These are shown in Figure 2. However, when the screen house was evaluated for the WBN SCCW system, TVA found that only three bays were needed to deliver the desired amount of flow for the SCCW system. As shown in Figure 2, the active bays include Bay 4, Bay 5, and Bay 6. Bay 1, Bay 2, and Bay 3 have not been restored and are not utilized in the current operation of SCCW.

A section view through one of the intake bays is shown in Figure 3. Moving along the path of flow, water from Watts Bar Reservoir enters each bay though an opening about 19.59 feet high and 7.67 feet wide. The opening is always submerged and includes a trashrack to protect the screen house from large debris. The invert elevation of the opening is 710 ft msl. Downstream of the intake opening, the flow in each bay enters a wet well containing an "outside" sluice gate, and then another wet well containing a traveling water screen. The outer wet wells are 7.67 feet wide and the wet wells containing the traveling water screen are 7.125 feet wide (see Figure 4). Downstream of the traveling water screens, the flow from all the active intake bays enters a common wet well containing "inside" sluice gates. This wet well directs the water to a tunnel that leads to supply lines for the SCCW intake conduit. All the wet wells have an invert elevation of 710 feet msl and contain a free surface that moves up and down in response to changes in the water surface elevation in Watts Bar Reservoir. The outer and inner sluice gates are provided to isolate the wet wells for the traveling water screens and the wet well for the supply tunnel. The gated openings are 6 feet wide and 8 feet high and are always submerged (see Figure 5).

The SCCW intake flow rate is the total flow through all three of the active intake bays. As a gravity flow system, the SCCW intake flow rate depends on the elevation of the water behind Watts Bar Dam (i.e., at the screen house), the elevation of the water at the exit of the SCCW intake conduit in the WBN Unit 2 cooling tower basin, and the hydraulic characteristics along the path of flow between these end points. Under normal operating conditions, all of the sluice gates for the active intake bays in the screen house are placed in the full open position and are not used to regulate the SCCW intake flow rate. Flow control is provided by adjusting the SCCW intake supply valve, the SCCW bypass valve, and the SCCW discharge valve, all of which are located in immediate vicinity of the WBN cooling towers. In general, these adjustments are made to provide an effective supply of water for SCCW to support operational objectives related to the plant thermal performance, the water levels in the cooling tower basins, and the impact of the SCCW discharge on the Tennessee River below Watts Bar Dam. These are manual changes and the system can operate for a considerable period of time without changes to the configuration. In addition to these control valves, the hydraulic characteristics of the path of flow for the SCCW intake can be influenced by fouling of the trashracks and traveling water screens at the screen house.

Intake velocities were provided in Reference 2 for both summer and winter pool elevations behind Watts Bar Dam. Since the startup of the SCCW system in 1999, Figure 6 shows the average and historical band for the pool elevation behind Watts Bar Dam. Different values have been used among the cited references, which will be discussed in the RAI answers to follow.

To provide a description of "the expected velocity entering the screen house through the intake sluice gates, into the wet well for the traveling water screens, through the SCCW trashracks, and through the screens", the following clarifications are provided for the intake velocities given in Attachment H-12 of the February 2010 RAI response and the May 2012 report entitled *"Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant"*.

- Attachment H-12 of the February 2010 RAI response

  The velocities provided in Attachment H-12 were estimated assuming Watts Bar Reservoir at elevation 740.75 feet msl, corresponding to a normal summer pool condition. In the active wet wells, this corresponds to a water depth of 30.75 feet. In Attachment H-12, spatial average velocities were provided for five cross-sectional areas, defined as follows:

  <u>Gross area at traveling water screens (concrete)</u>
  This is the vertical area of the concrete wet wells for the traveling water screens for the three active intake bays. Computationally, this is defined as three times the area of a concrete well of width 7.125 feet at a water depth of 30.75 feet.

  <u>Gross area at traveling water screens (screen panels)</u>
  This is the vertical area of the screen panels for the traveling water screens for the three active intake bays. Computationally, this is defined as three times the area of a screen panel of width approximately 6 feet at a water depth of 30.75 feet.

  <u>Net open area at traveling water screens (approx)</u>
  This is the vertical area of the openings through the traveling water screens for the three active intake bays. Computationally, this is defined as three times the area of a screen panel of width approximately 6 feet at a water depth of 30.75 feet, multiplied by the effective flow area factor for the traveling water screens. The effective flow area factor was estimated to be about 0.534. The traveling water screens were assumed to be free of any fouling.

  <u>Gross area at face of trashrack</u>
  This is the area corresponding to the width of the trashracks over the height of the submerged openings for the three active intake bays. Computationally, this is defined as three times a trashrack of width of approximately 8 feet and a height of 20 feet. Note that in this computation, the height of the opening along the slope of the trashrack was used rather than the vertical height of the opening (i.e., the computation is based on the area perpendicular to the trashrack).

Net open area at trashrack (approx)
This is the gross area at the face of the trashrack (as given above), reduced by the area obstructed by the trashrack bars for the three active intake bays. Computationally, this corresponds to three times an area of width approximately 6.33 feet and height approximately 19.54 feet. The trashracks were assumed to be free of any fouling.

- May 2012 report, *"Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant"*

The velocities provided in the May 2012 report *"Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant"* were computed using a pool elevation behind Watts Bar Dam of 741 feet msl for the summer and a pool elevation of 737 feet msl for the winter. In the active wet wells, these Reservoir levels correspond to water depths of 31 feet and 27 feet, respectively. In the May 2012 report, spatial average velocities were provided for three cross-sectional areas, defined as follows:

Entrance to SCCW screen house (face of trashracks)
This is the vertical area in front of the screen house for the three active intake bays. Computationally, this is defined as three times the area of the width of opening for a single bay, 7.125 feet, at a water depth of 31 feet for the summer and a water depth of 27 feet for the winter.

Entering wet well for traveling water screens
This is the vertical area of the sluice gates entering the wet wells for the three active intake bays. Computationally, this is defined as three times the area of a single sluice gate opening, 6 feet wide and 8 feet tall. Since the sluice gates are always submerged, this area does not differ between summer and winter conditions.

Through-screen velocity
This is the vertical area of the openings through the traveling water screens for the three active intake bays. Computationally, this is defined as three times the area of a screen panel of width approximately 6 feet at a water depth of 31 feet for the summer and a water depth of 27 feet for the winter, multiplied by the effective flow area factor for the traveling water screens. A value of 0.503 was used for the effective flow area factor. The traveling water screens were assumed to be free of any fouling.

The areas used are in the tables provided earlier in this enclosure.

Information related to winter pool conditions were only provided in the entrainment report. Because SCCW is a gravity flow system, summer and average annual conditions produce flow rates and velocities higher than the velocities that would occur for the range of winter pool conditions.

Summer and winter pool elevation velocities for the entrance to the wet well for the traveling screens (through the outside and inside sluice gates) were provided in the entrainment report (Reference 2). The wet well entrainment report velocities are higher than the velocities that would have been calculated using the assumptions and initial conditions in the Reference 3 simulations. The entrainment report velocities may be used by the NRC.

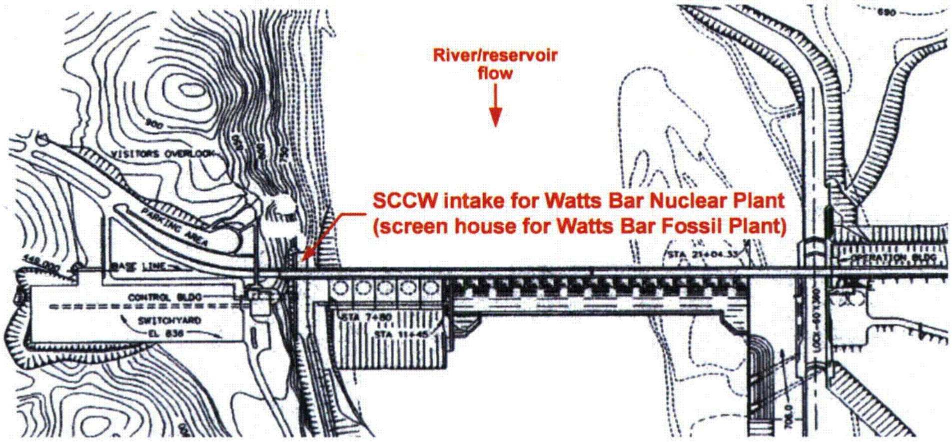
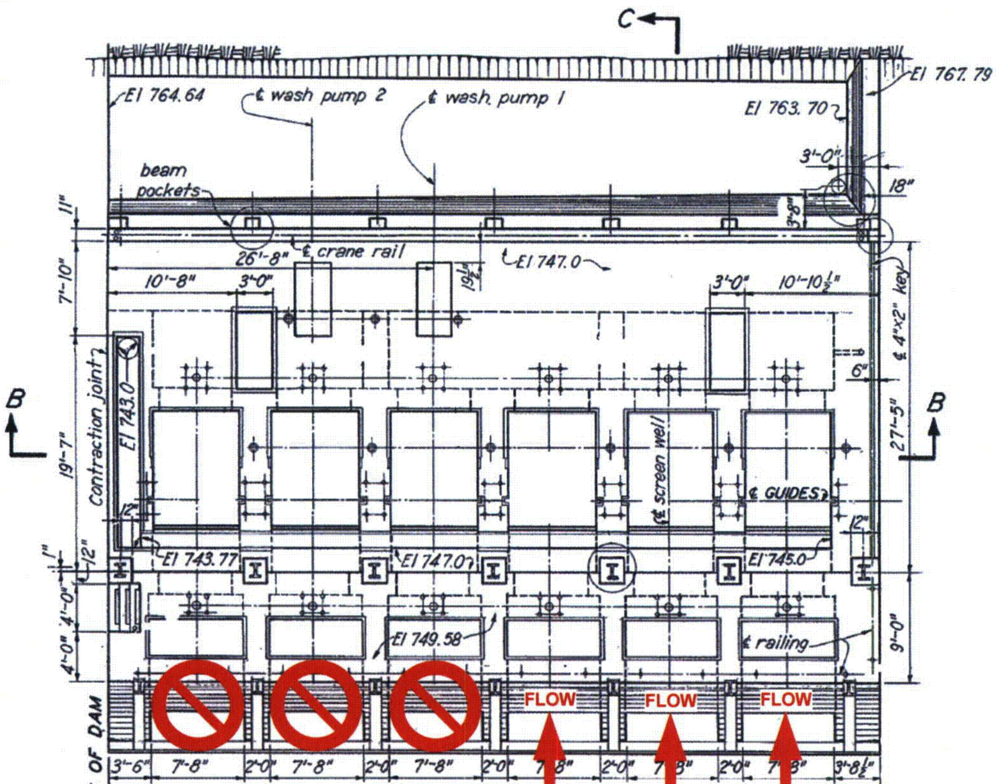
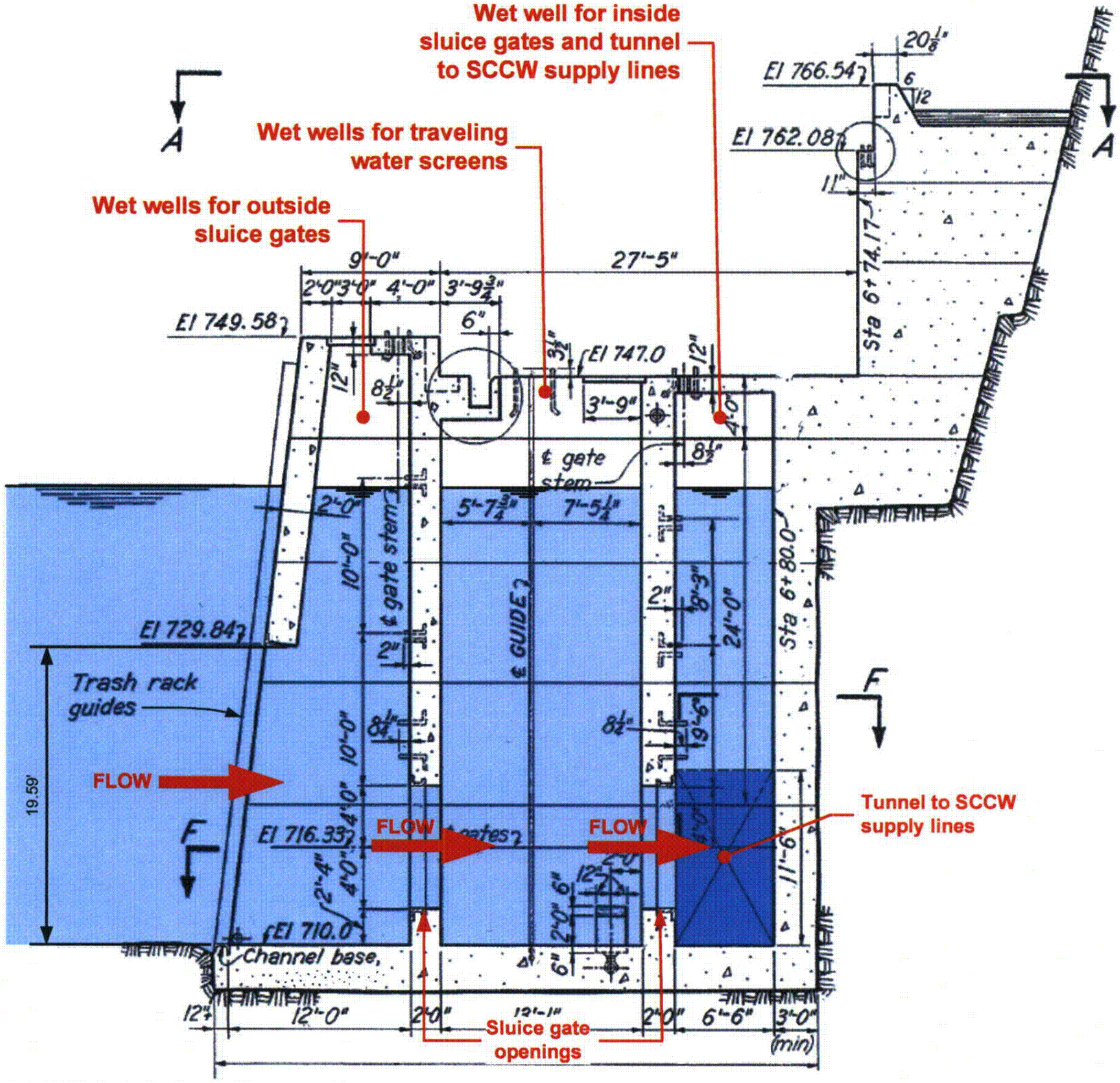


Figure 1. SCCW Intake for Watts Bar Nuclear Plant



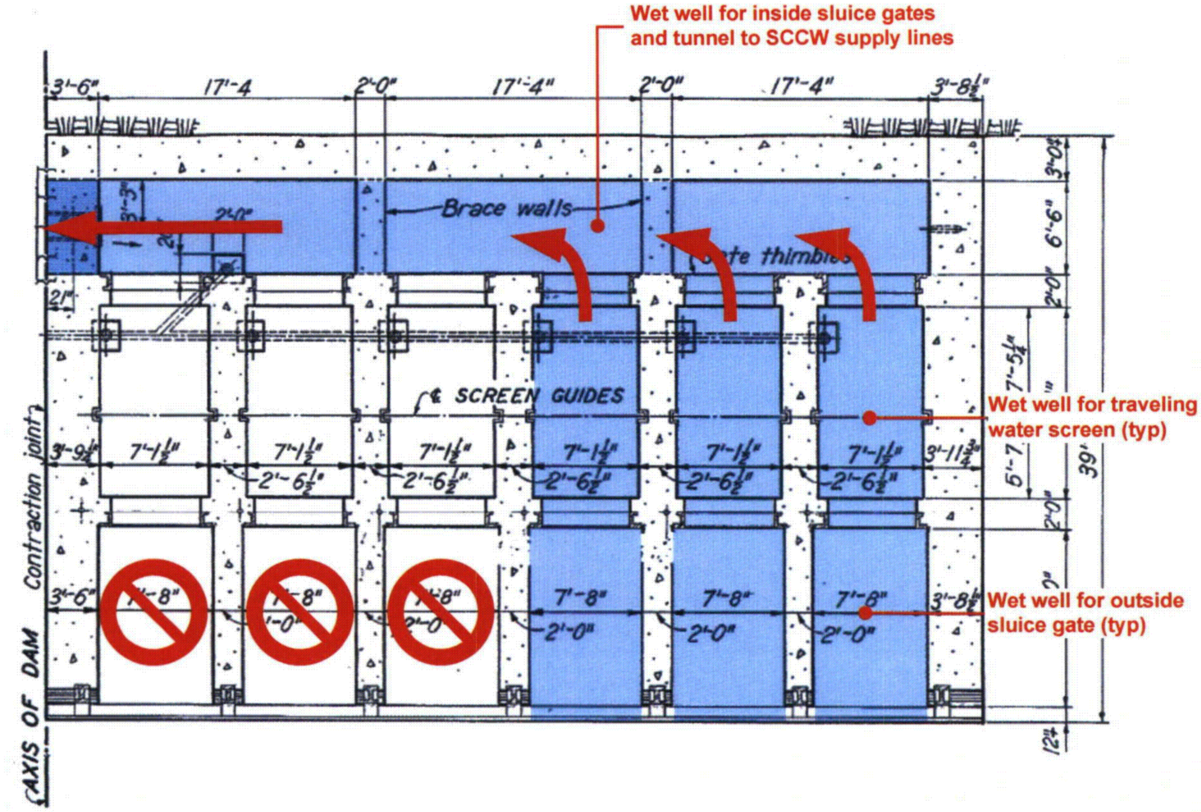
(SECTION A-A in Figures 3 and 5)

Figure 2. Plan View of SCCW Intake Screen House



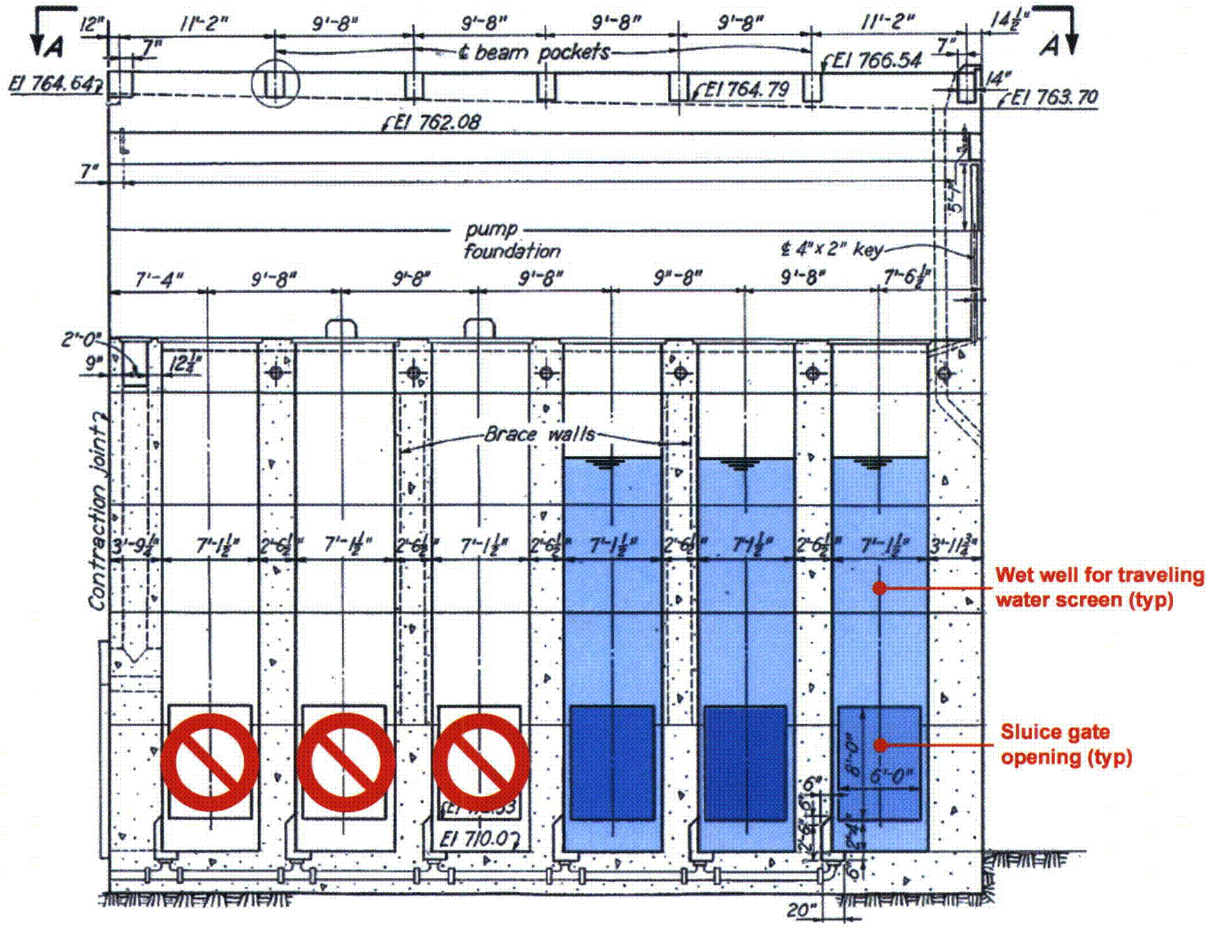
(SECTION C-C in Figure 2)

Figure 3. Section View Through One Screen House Intake Bay



(SECTION F-F in Figure 3)

Figure 4. Sectional View Showing Path of Flow Through Screen House



(SECTION B-B in Figure 2)

Figure 5. Sectional View through Wet Wells for Traveling Water Screens

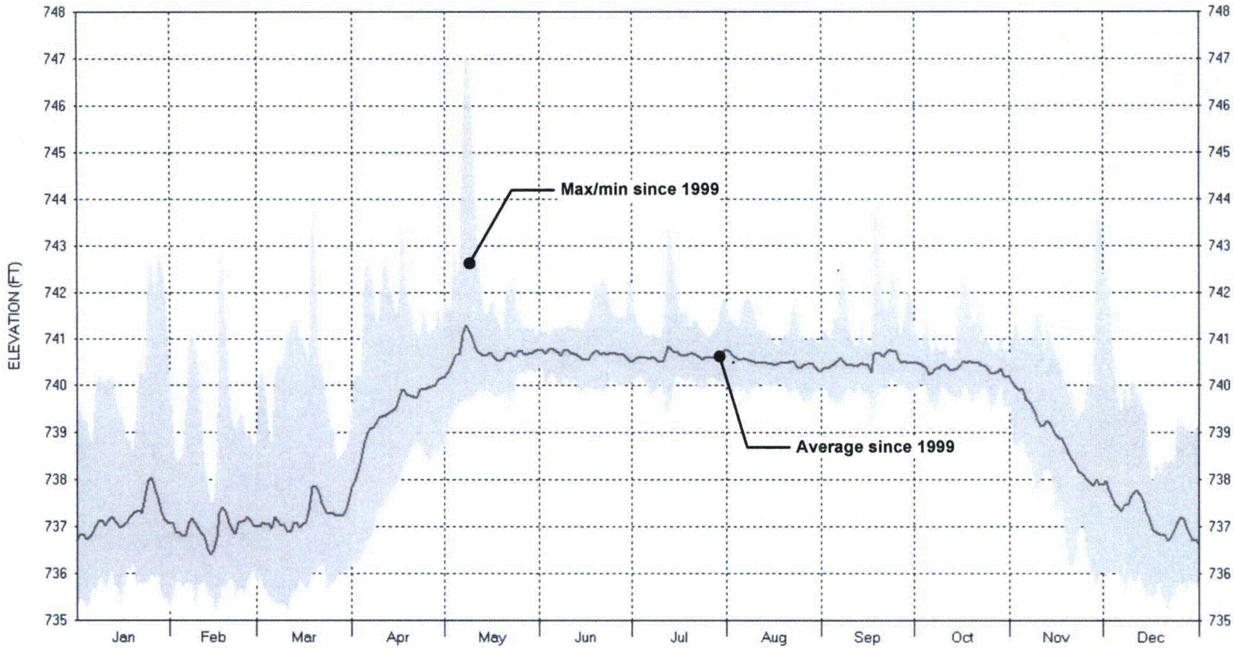


Figure 6. Historical Watts Bar Reservoir Pool Elevation Since 1999

RAI Question 2

A written explanation of the differences among the intake flow rates presented in Attachment H-14 (Table 10) and those in Attachment H-12 of the February 2010, RAI response, April 2011, RAI response, and the 2012 "Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant" document. The staff used the numbers from Attachment H-14 (Table 10) of the letter dated February 25, 2010, as the basis for the water balance provided in the Final Environmental Statement (FES). These numbers are not consistent with the numbers provided for intake flow rate to the SCCW and/or the intake pumping station (IPS) in the Attachment H-12 and/or H-11 of the February 25, 2010, RAI response, April 2011, RAI response, and the 2012 "Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant" document. The staff understands that the numbers reflect different operational scenarios such as nominal vs. maximum flows, nominal vs. minimum seasonal pool level, etc.

TVA Response - RAI Question 2

The following information addresses each of the referenced attachments or submittals.

- Attachment H-14 (Table 10) of the February 2010 RAI response

  The intake flow rates provided in Table 10 of Attachment H-14 were computed by the TVA WBN hydrothermal model using Equation (1)

$$QIN_{SCCW} = QIN_R \left(\frac{HWEL - WSELT2}{HWEL_R - WSELT2_R}\right)^{0.5}, \tag{1}$$

  where QIN_{SCCW} is the total SCCW intake flow rate (cfs), QIN_R is a reference intake flowrate for the SCCW system (cfs), $HWEL$ is the headwater (pool) elevation behind Watts Bar Dam (ft msl), $WSELT2$ is the water surface elevation in the WBN Unit 2 cooling tower basin (ft msl), $HWEL_R$ is a reference headwater (pool) elevation behind Watts Bar Dam (ft msl), and $WSELT2_R$ is a reference water surface elevation in the WBN Unit 2 cooling tower basin (ft msl). The following reference parameters were used:

  $QIN_R = 296.34\ cfs$ (or $133{,}000\ gpm$),
  $HWEL_R = 740.5\ ft\ msl$, and
  $WSELT2_R = 729.0\ ft\ msl$.

  The monthly values for the intake flow rates provided in Table 10 are based on typical seasonal values of the headwater elevation behind Watts Bar Dam ($HWEL$) presented in Attachment H-14, Table 8. The water surface elevation in the WBN Unit 2 cooling tower basin ($WSELT2$) is computed in the hydrothermal model based on a mass balance of the flows entering and exiting the plant cooling tower basins. In using Equation (1) it is assumed that the SCCW intake supply valve, the SCCW bypass valve, and the SCCW discharge valve are fixed to provide $QIN_{SCCW} = QIN_R$ when $HWEL = HWEL_R$ and $WSELT2 = WSELT2_R$, and that there is no fouling of the screen house trashracks and traveling water screens.

- Attachment H-12 of the February 2010 RAI response

  The intake flow rate provided in Attachment H-12 is the same as that given in the NPDES flow diagram provided in Appendix B of the TVA FSEIS (TVA, 2007). The NPDES flow diagram provides an estimate for the SCCW intake flow rate of 174.019 mgd, which is about 270 cfs. This is assumed to be a long-term or annual average value for the SCCW intake flow rate, in contrast to the monthly estimates provided in Attachment H-14 (Table 10). The NPDES flow diagram given in Appendix B of the TVA FSEIS is based on the operation of Unit 1.

- TVA's April 2011 RAI response

  The April 2011 letter discussed only IPS flow rates but did not discuss SCCW flow rates. The information in the April 2011 response supersedes the information provided in Reference 3 on IPS flow rates.

- 2012 document "*Estimates of Entrainment of Fish Eggs and Larvae at Watts Bar Nuclear Plant*"

  The subject entrainment study was based on a period of record from March 1, 2010 to March 1, 2011. QIN_{SCCW} estimates computed by Equation (1) were modified based on actual operational data and a simplified cooling tower flow balance provided in Equation (2), below. Neglecting minor losses, the basic flow balance is

$$QIN_{SCCW} + QIN_{ERCW} + QIN_{RCW} = QOUT_{BD} + QOUT_{SCCW} + QOUT_{EVAP}, \tag{2}$$

  where QIN_{SCCW} is as previously defined, QIN_{ERCW} in the plant inflow from the ERCW pumps, QIN_{RCW} is the plant inflow from the RCW pumps, $QOUT_{BD}$ is the cooling tower blowdown, $QOUT_{SCCW}$ is the discharge to the river via the SCCW outfall, and $QOUT_{EVAP}$ is the loss of water by the cooling tower evaporation.

  Using Equation (2), QIN_{SCCW} can be estimated based on indirect observations or estimates of the other parameters in the equation. Briefly, QIN_{ERCW} and $QOUT_{SCCW}$ are metered by plant instrumentation, QIN_{RCW} can be estimated based on the number of RCW pumps in service, $QOUT_{BD}$ can be estimated based on the volume of blowdown entering the plant low volume waste holding pond, and $QOUT_{EVAP}$ can be estimated based on the plant generation. The observations and/or estimates of each of these parameters contain uncertainties, so bias and statistical scatter is imbedded in the resulting estimates for QIN_{SCCW}. By this process, the resulting estimates for the daily average SCCW intake flow rate (i.e.,QIN_{SCCW}) for the period of study are shown in Figure 7.

  A regression analysis was performed to update the values of QIN_R and $WSELT2_R$ -- in particular, values producing a minimum mean-square difference between QIN_{SCCW} computed from Equation (1) and QIN_{SCCW} estimated from Equation (2). The analysis also required historical data for the pool elevation behind Watts Bar Dam, which also is shown in Figure 7. Since the water surface elevation in the Unit 2 cooling tower basin was unmetered, the regression analysis also assigned $WSELT2 = WSELT2_R$. The results yielded,

$QIN_R = 305\ cfs$ (or $136{,}884\ gpm$) and
$WSELT2_R = 731.6\ ft\ msl$. (Note this level is a curve fit parameter, not a physical basin elevation)

The reference value $HWEL_R = 740.5\ ft\ msl$ was left unchanged. The SCCW intake flowrate computed by Equation (1) with the revised reference values is also shown in Figure 7. Of particular note is that the scatter between the estimated and computed values of the SCCW flow rate is larger in the warm months of the year (e.g., June through September). A definitive basis for the scatter has not been determined but likely factors include: measurement uncertainties, the impact of other operation factors, such as manipulations of the SCCW intake supply, bypass, or discharge valves, and fouling of the trashracks at the screen house.

With updated values for the reference parameters, SCCW intake flow rates for the entrainment study were computed based on upper summer and winter pool elevations behind Watts Bar Dam representative of periods of sustained operation (e.g., five to seven days) during period of record from March 1, 2010, to March 1, 2011. The values selected were El. 741 ft msl for the summer and El. 737 ft msl for the winter (see also the statistical variations in Figure 6). The corresponding computed SCCW intake flow rates are 313 cfs and 238 cfs, respectively.

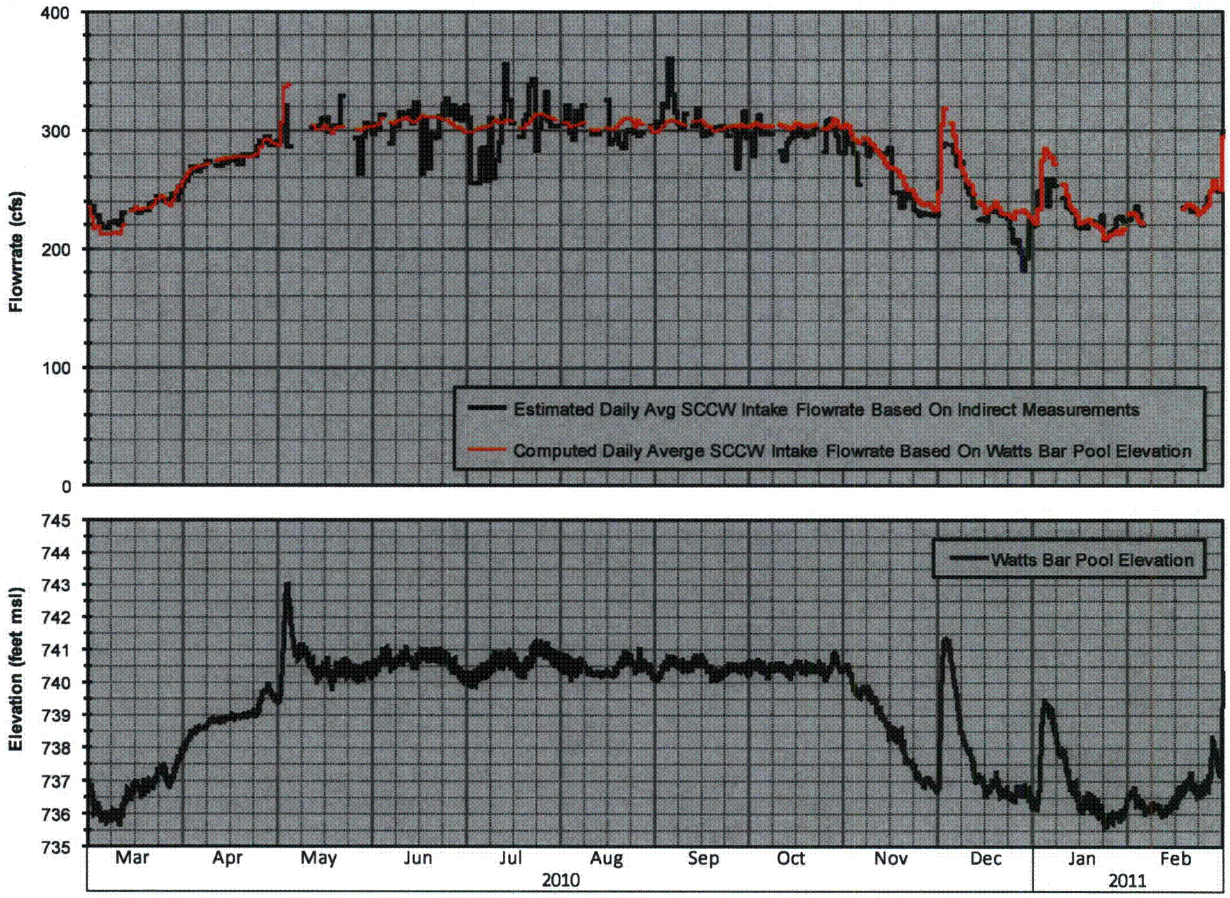


Figure 7. Estimated vs. Computed Values of the SCCW intake flow rate for March 1, 2011 through March 1, 2011; $QIN_R = 305\,cfs$, $HWEL_R = 740.5\,ft\,msl$, $WSELT2_R = 731.6\,ft\,msl$.

RAI Question 3

A written definition of the terms "approximate maximum average flow rate" (from May 2012 report) and the "Approximate SCCW inflow" from the February 25, 2010, RAI response (Attachment H-12) and a written discussion of the reason for the differences in the values for the SCCW flow rates from the two documents.

TVA Response - RAI Question 3

- "Approximate maximum average flow rate" from May 2012 report

  The qualifier "average" indicates that the velocity represents a spatial average over the cross-sectional areas identified in TVA's response to RAI Question 1. "Maximum" refers to a typical upper value of the SCCW intake flow rate that could occur over a period of several days based on the pool elevation behind Watts Bar Dam. There is no rigorous statistical definition or analysis behind this term; rather, it is based on an interpretation of historical data, such as that presented in Figure 7. "Approximate" is used for two reasons. First, the selection of representative pool elevations was made from an interpretation of the data and measurements have not been made of the SCCW intake flow rate. Second, as emphasized throughout this RAI response, uncertainty exists within assumptions that have been made to estimate the SCCW flow rates.

- "Approximate SCCW inflow" from the February 25, 2010, RAI response (Attachment H-12)

  The term "approximate" was added as a qualifier for the same reasons as discussed above. Additional information concerning an annual average pool elevation is provided below.

- Reason for the differences in the values for the SCCW flow rates from the two documents

  The primary reason for the difference between the values for the SCCW flow rate from the two documents is related to the time scales for the values. In the May 2012 report, the winter and summer flow rates are tied to specific representative pool elevations behind Watts Bar Dam for events extending over a period of several days. The value presented in the NPDES flow diagram, "approximately" 270 cfs, was considered to be more representative of an annual average value for the SCCW intake flow rate. A second significant difference is the use of operational data and the calculational method described in our response to RAI 2 for the entrainment report compared to earlier evaluations.

RAI Question 4

A written definition of the terms "maximum average velocity" (from May 2012 report) and the "average velocity expected" from the February 25, 2010, RAI response Attachment H-12) and a written discussion of the reason for the differences in the values for the through screen velocities for the SCCW trashrack and traveling screen.

TVA Response - RAI Question 4

- "Maximum average velocity" (from May 2012 report)

  In a manner similar to the answer to RAI Question 3, "maximum" is used to refer to a typical upper value of the SCCW intake velocity that could occur at the different locations over a period of several days based on the pool elevation behind Watts Bar Dam. The qualifier "average" indicates that the velocity represents a spatial average over the cross-sectional areas as identified in the TVA response to RAI Question 1. In this context, the values are not representative of "hot spots", or local areas of higher velocity, that occur within the cross-sections.

- "Average velocity expected" from the February 25, 2010, RAI response Attachment H-12

  In the February 25, 2010, RAI response Attachment H-12, "average" was used to convey that the calculations encompass both temporal and spatial averages--temporal in the context that the computation was performed using a flow rate representing an annual average, and spatial in the context that the velocity represents an average over the cross-sectional areas used in the computations.

- Reason for the differences in the values for the through screen velocities for the SCCW trashrack and traveling screen

  The different velocities are due to differences in the flow rates and cross-sectional areas used in the estimates as described above.