1. Purpose

The purpose of this document is to verify the HEC-RAS steady-state calculations performed in "SOCH Model Calibration, Guntersville" (CDQ000020080041) for subcritical flow by using hand calculations. Subcritical flow was used in the HEC-RAS run because the reservoir being modeled had a dam at the most downstream point creating an impoundment. Also, because the water surface elevations (WSE) are ultimately what will be used from the modeling process. Using subcritical flow leads to larger WSEs and adds some conservatism to the overall model.

2. References

2.1 *Drainage Areas for Streams in Tennessee River Basin*, Report No. 0-5829-R-2, Tennessee Valley Authority, Division of Water Control Planning, Hydraulic Data Branch, Knoxville, TN, March 1970.

2.2 "Bellefonte Nuclear Plant, White Paper –Hydrologic Analysis, Revision 1", Tennessee Valley Authority, July 25, 2008. (EDMS No. L58 080730 001)

2.3 "Dam Rating Curve – Guntersville" CDQ000020080011 Revision 0 (EDMS No. L58 090224 004)

2.4 "Dam Rating Curve – Nickajack" CDQ000020080014 Revision 0 (EDMS No. L58 090216 007)

2.5 "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21149050B007, Rev. 0. TVA River Operations, TVA River Operations, River Scheduling Hourly Water Records Database – Microfilm Book 295-20.00. (EDMS No. L58 0902270800)

2.6 "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21149050B007, Rev. 0. TVA River Operations, TVA River Operations, River Scheduling Hourly Water Records Database. (EDMS No. L58 0902270800)

2.7 "SOCH Geometry Verification for Guntersville Reservoir" CDQ000020080032 Revision 0 (EDMS No. L58 090120 001)

2.8 "Sub basin (49-50) Guntersville Local Unit Hydrograph Validation, CDQ000020080059 Revision 0 (EDMS No. L58_090603002)

2.9 "SOCH Software Verification and Validation Report (SVVR)" (EDMS No. L58_090528004)

2.10 "SOCH User Manual", (EDMS No. L58 090528002)

2.11 *HEC-RAS, River Analysis System Hydraulic Reference Manual*, Revision 3.1, Report No. CPD-69, U.S. Army Corps of Engineers Hydraulic Engineering Center, November 2002.

2.12 EDMS No. L58 090226 802, "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21201260B026, Rev. 0, Sequatchie River FEMA Steady-State Profiles.

3. Assumptions and Methodology

3.1 Assumptions

3.1.1 Assumption: Assumptions in CDQ000020080041 are valid and used in this calculation. Technical Justification: See section 3.1, CDQ000020080041.

3.2 Unverified Assumptions - None

3.3 Methodology

HEC-RAS computes water WSE by using two widely accepted equations: Manning's and Bernoulli's equations as shown in the HEC-RAS Hydraulic Reference Manual (2-2 to 2-4) (Reference 2.13). Beginning with a known WSE at a downstream cross-section for sub-critical flow, HEC-RAS assumes the WSE at the next upstream cross-section and computes conveyance terms for both cross-sections based on Manning's equation. Based on the known flow, which is input by the user, and the conveyance values, HEC-RAS then computes the friction slope. The friction slope is used to calculate the loss from one cross-section to the next. This head loss in inserted into Bernoulli's equation along with other known parameters, including the known WSE at the downstream cross-section, and the upstream WSE is then solved for and compared to the assumed WSE. If the assumed WSE does not equal the calculated elevation, HEC-RAS adjusts its assumption and re-runs the series of equations until the assumed WSE and calculated WSE converge. This process is repeated up the reservoir, solving for the next upstream cross-section.

To verify this process, a hand calculation has been performed to check the 1973 and 2003 HEC-RAS runs that were used to model these historic floods. As stated earlier, the flows were known. They were user inputs at various cross-sections throughout the model. To verify the calculation, the cross-sections were plotted to measure the flow area and wetted perimeter associated with a WSE elevation at a given cross-section. Table 1 shows the parameters used. Tables 2 and 5 show the flows used for the 1973 and 2003 historic events. The cross-section points and hydraulic parameters used for the cross-sections that were checked are shown in Tables 3-4 and 6-7. Also included are the water surface elevations calculated by HEC-RAS.

4. **Design Input**

Table 1

Input Parameter	Symbol	Units
Water Surface Elevation	WSE	feet
Flow	Q	cfs
Manning's N	n	-
Downstream Reach Length	L	feet
Contraction Coefficient	0.1	-
Expansion Coefficient	0.3	-
Area	A	ft^2
Wetted Perimeter	P	ft
Hydraulic Radius	R	ft
Conveyance	K	-
Friction Slope	S_f	ft/ft
Velocity	V	ft/sec
Velocity Weighting Coefficient	α	-
Head loss	h_e	feet
Gravity constant	g	ft/sec^2
All parameters are referenced in the HEC-RAS Hydraulic Reference Manual. (Reference 2.13)		

Table 2

1973 Flood – Flows and Elevations					
River Sta	Q Total	W.S.E.	River Sta	Q Total	W.S.E.
	(cfs)	(ft)		(cfs)	(ft)
424.7	252,900	618.34	384.74	293,871	600.14
422.6	262,794	617.45	382.64	295,112	599.70
420.49	272,736	616.69	380.54	296,354	599.29
418.39	273,977	615.26	378.44	297,595	598.75
416.28	275,225	614.04	376.34	298,837	598.40
414.19	276,460	612.65	374.23	300,084	598.14
412.08	277,708	611.41	372.13	301,326	597.92
409.98	278,949	610.39	370.03	302,567	597.71
407.88	280,191	609.33	367.92	303,815	597.44
405.77	281,438	608.31	365.82	305,056	597.25
403.67	282,680	607.32	363.72	306,298	597.06
401.57	283,921	606.49	361.62	307,539	596.88
399.47	285,163	605.58	359.51	308,787	596.73
397.36	286,410	604.52	357.41	310,028	596.60
395.26	287,652	603.51	355.31	311,270	596.49
393.16	288,893	602.69	353.21	312,511	596.27
391.06	290,135	601.80	351.1	313,759	595.95
388.95	291,382	601.23	349	315,000	595.72
386.85	292,624	600.66			

Table 3

Cross-Section at R.M. 407.88				
Station	Elevation	Downstream Reach Lengths		
50	680	LOB	Channel	ROB
440	640	11500	11500	11500
610	636.5	Manning's n Values		
1000	608.8	LOB	Channel	ROB
1450	603.8	0.085	0.026	0.1
1900	603.5	Main Channel Bank Stations		
2825	603.8	Left Bank	Right Bank	
3050	610	3300	4860	
3300	603.5	Cont\Exp Coefficients		
3388	580.17	Contraction	Expansion	
3490	577.93	0.1	0.3	
3550	577.5			
3683	576.4			
3840	576.81			
4035	577.5			
4160	576.5			
4650	576.25			
4800	578.59			
4860	603.5			
4910	603.5			
5350	598			
5470	599			
5650	603.5			
6150	608.5			
6260	628.5			
6290	633.2			
6400	680			

Table 4

Cross-Section at R.M. 409.98				
Station	Elevation	Downstream Reach Lengths		
40	680	LOB	Channel	ROB
100	624	10600	10900	11200
170	609	Manning's n Values		
190	603.6	LOB	Channel	ROB
550	603.6	0.07	0.026	0.06
620	584.6	Main Channel Bank Stations		
710	579.6	Left Bank	Right Bank	
793	575.75	550	2180	
1000	578.3	Cont\Exp Coefficients		
1238	579.4	Contraction	Expansion	
1500	577.7	0.1	0.3	
1830	576.6			
2030	576.7			
2130	580.7			
2180	604			
2700	604			
2900	608.7			
3000	608.7			
3100	604			
3225	624			
3460	680			

Table 5

2003 Flood – Flows and Elevations					
River Sta	Q Total	W.S.E.	River Sta	Q Total	W.S.E.
	(cfs)	(ft)		(cfs)	(ft)
424.7	266,000	619.15	384.74	297,802	599.78
422.6	284,106	618.17	382.64	298,049	599.30
420.49	293,603	617.41	380.54	298,295	598.86
418.39	293,850	615.88	378.44	298,542	598.26
416.28	294,098	614.61	376.34	298,789	597.87
414.19	294,343	613.18	374.23	299,036	597.59
412.08	294,591	611.87	372.13	299,283	597.34
409.98	294,837	610.78	370.03	299,530	597.12
407.88	295,084	609.64	367.92	299,778	596.82
405.77	295,332	608.56	365.82	300,024	596.62
403.67	295,579	607.50	363.72	300,271	596.42
401.57	295,825	606.62	361.62	300,518	596.23
399.47	296,072	605.64	359.51	300,766	596.07
397.36	296,320	604.51	357.41	301,012	595.95
395.26	296,567	603.43	355.31	301,259	595.83
393.16	296,813	602.54	353.21	301,505	595.61
391.06	297,060	601.58	351.1	301,753	595.30
388.95	297,308	600.96	349	302,000	595.07
386.85	297,554	600.35			

Table 6

Cross-Section at R.M. 370.03						
Station	Elevation	Station	Elevation	Downstream Reach Lengths		
100	660	4860	581.3	LOB	Channel	ROB
300	640	5110	581	11200	11500	11500
700	620	5380	586.8	Manning's n Values		
1000	600	5850	586.6	LOB	Channel	ROB
1125	595	6020	557.5	0.07	0.021	0.08
1320	583	6160	552.4	Main Channel Bank Stations		
1800	580	6210	551.8	Left Bank	Right Bank	
2820	574.5	6325	550	1125	7270	
3320	579.6	6380	550.3	Cont\Exp Coefficients		
3520	584.4	6520	550.3	Contraction	Expansion	
3570	584.4	6640	556.5	0.1	0.3	
3650	560.3	6680	560			
3740	557	6730	575.3			
3925	557.5	7130	579.8			
4000	560.5	7200	584.3			
4050	570.4	7270	599.2			
4100	586.5	7330	604.2			
4475	586.6	7450	660			

Table 7

R.M. 372.13				
Station	Elevation	Downstream Reach Lengths		
0	660	LOB	Channel	ROB
500	600	9900	11200	11700
1900	600	Manning's n Values		
2400	640	LOB	Channel	ROB
2900	600	0.1	0.021	0.12
3000	584.3	Main Channel Bank Stations		
4200	580	Left Bank	Right Bank	
6080	581.1	2900	9560	
6860	584.5	Cont\Exp Coefficients		
6960	584.5	Contraction	Expansion	
7050	559.5	0.1	0.3	
7330	556.5			
7525	556.2			
7780	557			
8260	560.5			
8350	559.5			
8440	585.9			
9520	587			
9560	600			
11201	660			

5. Special Requirements/Limiting Conditions

N/A

6. Calculations

6.1 2003 Flood

Starting with the 2003 storm, cross-sections at river miles 370.03 and 372.13 were used. Using 597.12 ft from the HEC-RAS calculations as the known WSE for the cross-section at river mile 370.03, the WSE at river mile 372.13 was assumed to be 598.00 ft. This is not what HEC-RAS calculated for this section, but it will show that if the correct WSE is not assumed then the calculated WSE elevation will not be equal. Next, the correct WSE was chosen, the calculations were re-run and the assumed WSE was found to equal the calculated water surface elevation. The calculation procedure and equations were found in Reference 2.11.

Known:
Flow @ R.M. 370.03 = 299,530 cfs
WSE_l @ R.M. 370.03 = 597.12 ft
Flow Area (Channel) = 129,540 ft^2 – Measured
Flow Area (Left Overbank) = 79 ft^2 - Measured
Wetted Perimeter (Channel) = 6,152ft - Measured
Wetted Perimeter (Left Overbank) = 63ft - Measured

Flow @ R.M. 372.13 = 299,283 cfs
L_{LOB}=9900 ft
L_{CH}=11,200 ft
C = 0.1 for contraction and 0.3 for expansion

Assumed:
WSE_2 @ R.M. 372.13 = 598.00 ft
Flow Area (Channel) = 135,046 ft^2 – Measured
Wetted Perimeter (Channel) = 6,651 ft - Measured

HEC-RAS divided the flow into three parts, the channel, the left overbank (LOB) and the right overbank (ROB) and then calculated the conveyance term for each portion. R.M. 370.03 only had flow in the LOB and channel based on the WSE. R.M. 372.13 only had flow in the channel.

R.M. 370.03

$$K_{LOB} = \frac{1.486}{n} AR^{2/3}$$

With: n = Manning's n
A = flow area – ft^2
R = flow area/wetted perimeter
K = conveyance.

$$K_{LOB} = \frac{1.486}{0.07}(79)(79/63)^{2/3} = 1{,}951$$

$$K_{CH} = \frac{1.486}{0.021}(129{,}540)(129{,}540/6152)^{2/3} = 69{,}897{,}523$$

$$K_{Total} = 1{,}951 + 69{,}897{,}523 = 69{,}899{,}474$$

R.M. 372.13

$$K_{CH} = \frac{1.486}{0.021}(135{,}046)(135{,}046/6{,}651)^{2/3} = 71{,}123{,}168$$

Friction Slope

$Q = KS_f^{1/2}$, with the average friction slope being $\overline{S}_f = \left(\frac{Q_1 + Q_2}{K_1 + K_2}\right)^2$

With: Q = flow – cfs

$$\overline{S}_f = \left(\frac{299{,}530 + 299{,}283}{69{,}897{,}523 + 71{,}123{,}168} \right)^2 = 0.0000180$$

R.M. 370.03

$$S_f = \left(\frac{299{,}530}{69{,}897{,}523} \right)^2 = 0.0000184$$

$$Q_{LOB} = 1{,}951 * 0.0000184^{\ 1/2} = 8.4 cfs$$

$$V_{LOB} = 8.4 / 79 = 0.11 ft / \sec$$

$$Q_{CH} = 299{,}530 - 8.4 = 299{,}522 ft / \sec$$

$$V_{CH} = 299{,}522 / 129{,}540 = 2.31 ft / \sec$$

$$\overline{V} = 299{,}530 / 129{,}619 = 2.31 ft / \sec$$

R.M. 372.13

$$V_{CH} = 299{,}283 / 135{,}046 = 2.22 ft / \sec$$

Since R.M. 370.03 had a portion of the total flow in the overbank, a velocity weighting coefficient (α) was calculated. Had flow only existed in the channel, as it did at R.M. 372.13, $\alpha = 1$.

$$\alpha_1 = \frac{\left(Q_{LOB} V_{LOB}^2 + Q_{CH} V_{CH}^2 + Q_{ROB} V_{ROB}^2\right)}{Q\overline{V}^2} = \frac{\left(8.4 * 0.11^2 + 299{,}522 * 2.31^2\right)}{\left(299{,}530 * 2.31^2\right)} = 0.9264$$

$$\alpha_2 = 1$$

Next, the weighted downstream reach length (L) was calculated in order to determine the overall head loss in between the two sections.

$$L = \frac{\left(L_{LOB}\overline{Q}_{LOB} + L_{CH}\overline{Q}_{CH} + L_{ROB}\overline{Q}_{ROB}\right)}{\overline{Q}_{LOB} + \overline{Q}_{CH} + \overline{Q}_{ROB}} = \frac{(9900 * 4.2 + 11{,}200 * 299{,}407)}{299{,}407} = 11{,}200 ft$$

With: L = downstream reaches
Q = average flow

With this value, the head loss was computed as follows:

$$h_e = L\overline{S}_f + C\left| \frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g} \right|$$

With: C=expansion or contraction coefficient

$$h_e = 11{,}200 * 0.0000180 + 0.1\left|\frac{1*2.22^2}{64.4} - \frac{0.9264*2.31^2}{64.4}\right| = 0.20$$

$$WSE_2 + \frac{\alpha_2 V_2^2}{2g} = WS_1 + \frac{\alpha_1 V_1^2}{2g} + h_e \quad \text{(Bernoulli's Equation)}$$

$$WSE_2 + \frac{1*2.22^2}{64.4} = 597.12 + \frac{0.9264*2.31^2}{64.4} + 0.20$$

$$WSE_2 = 597.32 \neq 598.00(assumed)$$

Assumed WSE_2 = 597.72 and calculated again.

Assumed:
WSE @ R.M. 372.13 = 597.34
Flow Area (Channel) = 133,187 ft^2 – Measured
Wetted Perimeter (Channel) = 6,648 ft - Measured

$$K_{CH} = \frac{1.486}{0.021}(133{,}187)(133{,}187 / 6648)^{2/3} = 69{,}519{,}809$$

$$\overline{S}_f = \left(\frac{299{,}530 + 299{,}283}{69{,}897{,}523 + 69{,}519{,}809}\right)^2 = 0.0000184$$

$$V_{CH} = 299{,}283 / 133{,}187 = 2.25\,ft/\sec$$

$$h_e = 11{,}200 * 0.0000184 + 0.1\left|\frac{2.25^2}{64.4} - \frac{0.9264*2.31^2}{64.4}\right| = 0.21$$

$$WSE_2 + \frac{1*2.25^2}{64.4} = 597.12 + \frac{0.9264*2.31^2}{64.4} + 0.21$$

$$WSE_2 = 597.33 \cong 597.34(assumed) - OK$$

6.2 1973 Flood

The check elevation for the 1973 storm was computed the same way. The only difference was that the correct upstream WSE was assumed on the first iteration because it was established in the previous calculation that if the assumed elevation is not correct, it will not equal the calculated elevation. For this calculation, cross-sections at R.M. 407.88 and 409.98 were used. The calculation procedure and equations were found in Reference 2.11.

Known:
Flow @ R.M. 407.88 = 280,191 cfs
WSE_1 @ R.M. 407.88 = 609.33
Flow Area (Channel) = 48,956 ft^2 – Measured
Flow Area (Left Overbank) = 11,317 ft^2 - Measured
Flow Area (Right Overbank) = 9,019 ft^2 - Measured
Wetted Perimeter (Channel) = 1,568ft - Measured
Wetted Perimeter (Left Overbank) = 2,294ft - Measured
Wetted Perimeter (Right Overbank) = 1,295ft - Measured

Flow @ R.M. 409.98 = 278,949 cfs
L_{LOB}=10,600 ft
L_{CH}=10,900 ft
L_{LOB}=11,200 ft

C = 0.1 for contraction and 0.3 for expansion

Assumed:
WSE_2 @ R.M. 409.98 = 610.39
Flow Area (Channel) = 52,608 ft^2 – Measured
Flow Area (Left Overbank) = 2,927 ft^2 - Measured
Flow Area (Right Overbank) = 5,814 ft^2 - Measured
Wetted Perimeter (Channel) = 1,638 ft - Measured
Wetted Perimeter (Left Overbank) = 392 ft - Measured
Wetted Perimeter (Right Overbank) = 967 ft - Measured

R.M. 407.88

$$K_{LOB} = \frac{1.486}{0.085}(11,317)(11,317/2,294)^{2/3} = 573,354$$

$$K_{CH} = \frac{1.486}{0.026}(48,956)(48,956/1,568)^{2/3} = 27,743,290$$

$$K_{ROB} = \frac{1.486}{0.1}(9,019)(9,019/1,295)^{2/3} = 488,768$$

$$K_{Total} = 573{,}354 + 27{,}743{,}290 + 488{,}768 = 28{,}805{,}412$$

$$\overline{V} = \frac{Q}{A} = \frac{280{,}191}{(11{,}317 + 48{,}956 + 9{,}019)} = 4.04\,ft/\sec$$

$$S_{f(RM\,407.88)} = \left(\frac{280{,}191}{28{,}805{,}412}\right)^2 = 0.000095$$

R.M. 409.98

$$K_{LOB} = \frac{1.486}{0.07}(2{,}927)(2{,}927/392)^{2/3} = 237{,}375$$

$$K_{CH} = \frac{1.486}{0.026}(52{,}608)(52{,}608/1{,}638)^{2/3} = 30{,}380{,}099$$

$$K_{ROB} = \frac{1.486}{0.06}(5{,}814)(5{,}814/967)^{2/3} = 476{,}111$$

$$K_{Total} = 237{,}375 + 30{,}380{,}099 + 476{,}111 = 31{,}093{,}585$$

$$\overline{V} = \frac{Q}{A} = \frac{278{,}949}{(2{,}927 + 52{,}608 + 5{,}814)} = 4.55\,ft/\sec$$

$$\overline{S}_f = \left(\frac{280{,}191 + 278{,}949}{28{,}805{,}412 + 31{,}093{,}585}\right)^2 = 0.0000871$$

$$S_{f(RM\,409.98)} = \left(\frac{278{,}949}{31{,}093{,}585}\right)^2 = 0.0000805$$

R.M. 407.88

$$Q_{LOB} = KS_f^{\,1/2} = (573{,}354) * (0.000095)^{1/2} = 5{,}588\,cfs$$
$$V_{LOB} = 5{,}588/11{,}317 = 0.49\,ft/\sec$$

$$Q_{CH} = (27{,}743{,}290) * (0.000095)^{1/2} = 270{,}408\,cfs$$
$$V_{CH} = 270{,}408/48{,}956 = 5.52\,ft/\sec$$

$$Q_{ROB} = (488{,}768) * (0.000095)^{1/2} = 4{,}764 cfs$$
$$V_{ROB} = (4{,}764)/(9{,}019) = 0.53 ft/\sec$$

R.M. 409.98

$$Q_{LOB} = KS_f^{\ 1/2} = (237{,}375) * (0.0000805)^{1/2} = 2{,}130 cfs$$
$$V_{LOB} = 2{,}130 / 2{,}927 = 0.73 ft/\sec$$

$$Q_{CH} = (30{,}380{,}099) * (0.0000805)^{1/2} = 272{,}576 cfs$$
$$V_{CH} = 272{,}576 / 52{,}608 = 5.18 ft/\sec$$

$$Q_{ROB} = (476{,}111) * (0.0000805)^{1/2} = 4{,}272 cfs$$
$$V_{ROB} = (4{,}272)/(5{,}814) = 0.73 ft/\sec$$

$$L = \frac{\left(L_{LOB}\overline{Q}_{LOB} + L_{CH}\overline{Q}_{CH} + L_{ROB}\overline{Q}_{ROB}\right)}{\overline{Q}_{LOB} + \overline{Q}_{CH} + \overline{Q}_{ROB}}$$

$$L = \frac{\left(10{,}600 * \left(\frac{5{,}588 + 2{,}130}{2}\right) + 10{,}900 * \left(\frac{270{,}408 + 272{,}576}{2}\right) + 11{,}200 * \left(\frac{4{,}764 + 4{,}272}{2}\right)\right)}{279{,}570} = 10{,}912 ft$$

$$\alpha_1 = \frac{\left(Q_{LOB}V_{LOB}^2 + Q_{CH}V_{CH}^2 + Q_{ROB}V_{ROB}^2\right)}{Q\overline{V}^2}$$

$$\alpha_1 = \frac{\left(5{,}588 * 0.49^2 + 270{,}408 * 5.52^2 + 4764 * 0.53^2\right)}{\left(280{,}191 * 4.04^2\right)} = 1.80$$

$$\alpha_2 = \frac{\left(2{,}130 * 0.73^2 + 272{,}576 * 5.18^2 + 4{,}272 * 0.73^2\right)}{\left(278{,}949 * 4.55^2\right)} = 1.27$$

$h_e = L\overline{S}_f + C\left|\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right|$ Because the velocity decreased as it moved downstream, an expansion coefficient was used. C=0.3

$$h_e = 10{,}912 * 0.0000871 + 0.3\left|\frac{1.27 * 4.55^2}{64.4} - \frac{1.80 * 4.04^2}{64.4}\right| = 0.96$$

$$WSE_2 + \frac{1.27 * 4.55^2}{64.4} = 609.33 + \frac{1.80 * 4.04^2}{64.4} + 0.96$$

$$WSE_2 = 610.34 \cong 610.39(\textit{assumed water surface elevation})$$

7. Results/Conclusions

These hand calculations verify the process used by the HEC-RAS program to compute water surface elevations for steady state, subcritical flows. Below is a summary of the results.

Table 8

1973 Flood		2003 Flood	
HEC-RAS	Hand calculations	HEC-RAS	Hand calculations
610.39	610.34	597.34	597.33

1. Purpose

An unsteady state HEC-RAS model has been prepared as a confirmatory analysis for the SOCH Model calculation CDQ000020080041. The purpose of this calculation is to demonstrate that the unsteady-state HEC-RAS model and the SOCH model of the Guntersville Reservoir produce equivalent results given the same input. Inputs to this calculation include channel geometry, local inflow hydrographs, and historic flood elevations and discharges. The result of this calculation will be compared to the historic observed flood elevations and compared to the SOCH model results. This will confirm that the SOCH model is an acceptable tool for predicting flood elevations and discharges for storm events.

2. References

2.1 *Drainage Areas for Streams in Tennessee River Basin*, Report No. 0-5829-R-2, Tennessee Valley Authority, Division of Water Control Planning, Hydraulic Data Branch, Knoxville, TN, March 1970.

2.2 "Bellefonte Nuclear Plant, White Paper –Hydrologic Analysis, Revision 1", Tennessee Valley Authority, July 25, 2008. (EDMS No. L58 080730 001)

2.3 "Dam Rating Curve – Guntersville" CDQ000020080011 Revision 0 (EDMS No. L58 090224 004)"

2.4 "Dam Rating Curve – Nickajack" CDQ000020080014 Revision 0 (EDMS No. L58 090216 007)

2.5 "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21149050B007, Rev. 0. TVA River Operations, TVA River Operations, River Scheduling Hourly Water Records Database – Microfilm Book 295-20.00. (EDMS No. L58 0902270800)

2.6 "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21149050B007, Rev. 0. TVA River Operations, TVA River Operations, River Scheduling Hourly Water Records Database. (EDMS No. L58 0902270800)

2.7 "SOCH Geometry Verification for Guntersville Reservoir" CDQ000020080032 Revision 0 (EDMS No. L58 090120 001)

2.8 "Sub basin (49-50) Guntersville Local Unit Hydrograph Validation, CDQ000020080059 Revision 0 (EDMS No. L58 090603002)

2.9 "SOCH Software Verification and Validation Report (SVVR)" (EDMS No. L58 090528004)

2.10 "SOCH User Manual", (EDMS No. L58 090528002)

2.11 *HEC-RAS, River Analysis System Hydraulic Reference Manual*, Revision 3.1, Report No. CPD-69, U.S. Army Corps of Engineers Hydraulic Engineering Center, November 2002.

2.12 "Bellefonte Units 3 and 4 Hydrology Project Request for Information (RFI) Response Information Continuation Sheet," RFI Number BE21201260B026, Rev. 0, Sequatchie River FEMA Steady-State Profiles. (EDMS No. L58 090226 802)

2.13 Map of Guntersville Reservoir – Surface Areas for the 595, 620, 640 and 660 Foot Elevations Above Mean Sea Level. TVA Map #6 GIE 311 E 200801 R1 D

2.14 Open Channel Hydraulics, Ven Te Chow, Ph.D., McGraw-Hill Book Company, Inc., 1959, ISBN 07-010776-9, Section 5.

2.15 Civil Engineering Reference Manual for the PE Exam, Seventh Edition, Michael R. Lindeburg, PE, Professional Publications, Inc., 1999, ISBN 1-888577-40-1, Chapter 19 page 13

3. Assumptions and Methodology

3.1 Assumptions

3.1.1 Assumption: Assumptions in CDQ000020080041_Rev_0 are valid and used in this confirmatory calculation.
Technical Justification: See section 3.1, CDQ000020080041.

3.1.2 Assumption: The HEC-RAS model is a valid hydraulic model.
Technical Justification: HEC-RAS software has been developed and is used by the Army Corps of Engineers for Hydraulic Modeling of Rivers and Flood Studies and was not obtained and documented via a 10 CFR 50 Appendix B program. The Software is commonly accepted in jurisdictions throughout the United States. A hand calculation has been developed to show the accuracy of the HEC-RAS model on the Guntersville Reservoir (Appendix L of CDQ0000200841). The data and mapping are acceptable because of validation steps addressed in the Methodology section.

3.2 Unverified Assumptions - None

3.3 Methodology

3.3.1 The objective of calibrating a model is to adjust model parameters so that the model will accurately predict the outcome of a known historic event. The model will therefore be considered reliable to predict the outcome of events of other magnitudes. In the case of the HEC-RAS model, the results must accurately replicate observed elevation and discharges for the largest known historic flood events. The two largest flood events on record for the Guntersville Reservoir were storms that occurred in March of 1973 and in May of 2003. Data observed for these two storms were used for SOCH model calibration as well.

3.3.2 The HEC-RAS Model calibration process for the Guntersville Reservoir comprised the following steps:

3.3.2.1 A steady-state model of the reservoir was first developed using the U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 3.1.3. The steady flow data used initially to set-up the HEC-RAS model for each historic flood was determined by using the recorded peak elevations and peak flows from Nickajack Dam and Guntersville Dam for the upstream and downstream flows, respectively. The flow distribution for the remaining cross sections was then estimated based on the portion of drainage area draining at a given cross section. The downstream water surface elevations input as the Reach Boundary Conditions were the recorded peak elevations (see Section 4 for data reference). The HEC-RAS model was then adjusted by varying the flow distribution and Manning's n values to match the high-water marks from the 1973 and 2003 flood events at available river gage stations. The Manning's n values were checked against those recommended in Reference 2.14 for a regular section of a major stream (0.025-0.060) to ensure the values are reasonable. Some values fall below this level because the n value will decrease as the stage and discharge increase. This is discussed in Reference 2.14 on pages 104-105.

It should be noted that the Manning's n values in the HEC-RAS model differ from those of the SOCH model. The Manning's n value is the only parameter in SOCH that may be adjusted; consequently, the n value corrects for parameters other than channel roughness including cross-section segmentation. The following chart shows the comparison between the SOCH values and the HEC-RAS values.

River Station	HEC-RAS Left	HEC-RAS Channel	HEC-RAS Right	SOCH
424.7	0.05	0.024	0.09	0.023
422.6	0.09	0.024	0.067	0.023
420.49	0.09	0.024	0.055	0.023
418.39	0.1	0.026	0.1	0.023
416.28	0.095	0.026	0.09	0.027
414.19	0.05	0.026	0.11	0.027
412.08	0.085	0.026	0.085	0.027
409.98	0.07	0.026	0.06	0.027
407.88	0.085	0.026	0.1	0.027
405.77	0.065	0.024	0.065	0.027
403.67	0.11	0.024	0.11	0.024
401.57	0.075	0.024	0.075	0.024
399.47	0.06	0.024	0.06	0.022
397.36	0.1	0.024	0.12	0.022
395.26	0.1	0.024	0.05	0.022
393.16	0.055	0.024	0.055	0.022
391.06	0.07	0.024	0.12	0.022
388.95	0.08	0.021	0.1	0.022
386.85	0.075	0.021	0.15	0.021
384.74	0.07	0.021	0.15	0.021
382.64	0.07	0.021	0.145	0.021
380.54	0.07	0.021	0.1	0.021
378.44	0.06	0.021	0.1	0.021
376.34	0.07	0.021	0.07	0.021
374.23	0.09	0.021	0.12	0.021
372.13	0.1	0.021	0.12	0.021
370.03	0.07	0.021	0.08	0.021
367.92	0.1	0.021	0.1	0.021
365.82	0.1	0.021	0.09	0.021
363.72	0.12	0.021	0.09	0.021
361.62	0.13	0.021	0.15	0.021
359.51	0.12	0.021	0.1	0.021
357.41	0.03	0.021	0.06	0.021
355.31	0.1	0.025	0.065	0.022
353.21	0.11	0.025	0.15	0.023
351.1	0.15	0.025	0.1	0.024
349	0.1	0.025	0.1	0.024

3.3.2.2 The calibrated HEC-RAS model was then run to produce steady-state water surface profiles ranging from 100,000 cfs to 1,300,000 cfs in 100,000 cfs or 200,000 cfs increments. The 1,300,000 cfs profile is expected to be above the PMF level and was set as the upper bounds of the calibration The downstream boundary conditions were set at the level of the gate elevation, 595.44 ft, to account for reservoir pool until the flow increased to 400,000 cfs, the point at which the gate elevation intersects the dam rating curve (Attachment 3). The boundary conditions then followed the dam rating curve. The peak flow level in the Guntersville Reservoir in both the 1973 and 2003 floods events was approximately 300,000 cfs, so 300,000 cfs was used in the steady-state modeling as the highest observed discharge for the historic floods.

3.3.3 The Manning's *n* values determined in the steady-state calibration were then used to develop an unsteady-state HEC-RAS model of Guntersville Reservoir. Because the Tennessee River system comprises a series of dams and reservoirs with short riverine reaches, and typical storm durations are short, steady-state flow is not achieved in the reservoirs and unsteady-flow is the appropriate method of modeling the system. HEC RAS applies flows at specified river stations and only allows one flow per section. In order to apply multiple flows at a section additional cross sections have been interpolated in close proximity so that additional flows can be applied to the system. Recorded Nickajack discharges were used as the upstream flow (upstream boundary condition at RM 424.7) and recorded Guntersville elevations were used as the downstream boundary condition (RM 349). Recorded flows from the Sequatchie River at Whitwell were input (RM 422.6) with an 8-hour lag time to account for the travel time from the gage at Whitwell to the Tennessee River. The local inflow hydrographs developed from unit hydrographs (Attachments 7 and 8) were input to account for local inflow. As tabulated in Attachment 7, four hydrographs comprise the local inflows. "Total Local Runoff from dryland part of Subbasin 49" is the inflow hydrograph that drains to the northern part of the reservoir and was applied as uniform lateral flow from RM 424.695 to 391.06. "Total Local Runoff from dryland part of Subbasin 50" is the inflow hydrograph that drains to the southern part of the reservoir and was applied as uniform lateral flow from RM 391.06 to 349.01. "Runoff from rain on north reservoir" is the hydrograph that falls on the northern part of the reservoir surface and was applied as uniform lateral flow from RM 424.69 to 391.06. "Runoff from rain on south reservoir" is the hydrograph that falls on the southern part of the reservoir surface and was applied as uniform lateral flow from RM 391.05 to 349.01.

Unsteady state HEC-RAS calibration of the Guntersville Reservoir required modeling of the storage area that is achieved in the reservoir as the water surface elevation increases. These storage areas will fill up and eventually release the stored runoff back into the system with their discharge control modeled by the lateral weirs. The SOCH model accounts for these areas with a weighted width in the cross sections but in HEC-RAS separate storage areas can be added to the system and linked with lateral weirs to the main river. The volumes of these storage areas were extracted from Reference 2.13. The elevations, shapes and locations of the lateral weirs were measured from the same map. Calculated flood elevations were compared to the observed elevations at gage stations (six gage locations for the 1973 flood and four gage locations for the 2003 flood) and calculated flow for HEC-RAS was compared to observed flow at Guntersville Dam.

4. Design Input

4.1 Historical data included in appendices, attachments and references for CDQ000020080041_Rev_0.

Sect.	Input Parameter	Source	Location	Description
4.1	Initial HEC-RAS Geometry	Reference 2.7	Attachment 1	Initial HEC-RAS geometry was provided in the "SOCH Geometry Verification for Guntersville Reservoir" calculation and used in HEC-RAS steady-state and unsteady-state models.
4.2	Guntersville Dam Headwater Rating Curve	Reference 2.3	Attachment 3	The dam rating curve was provided in the "Dam Rating Curve-Guntersville" calculation and was used to establish boundary conditions in the HEC-RAS and SOCH steady-state models.
4.3	Nickajack Dam Tailwater Rating Curve	Reference 2.4	Attachment 4	The tailwater rating curve was provided in the "Dam Rating Curve – Nickajack" calculation and was used to compare results of the HEC-RAS and SOCH steady-state models.
4.4	1973 Storm Data			
	4.4.1 Elevations for gaging stations in Guntersville Reservoir	Reference 2.5	Attachment 5	The Guntersville Reservoir 1973 flood observed elevations originated from TVA's Hourly Water Records and were used as boundary conditions in the HEC-RAS and SOCH models and used to compare the SOCH model results.
	4.4.2 Flows at gaging stations in Guntersville Reservoir	Reference 2.5	Attachment 5	The Guntersville Reservoir 1973 flood observed flows originated from TVA's Hourly Water Records and were used as boundary conditions in the HEC-RAS and SOCH models and used to compare the SOCH model results.
	4.4.3 Flows for Sequatchie River at Whitwell	Reference 2.5	Appendix B	The 1973 observed flows in the Sequatchie river originated from TVA's Bi-Hourly Streamflow Reports and were used as inflow in the SOCH model.
4.5	2003 Storm Data			
	4.5.1 Elevations for gaging stations in Guntersville Reservoir	Reference 2.6	Attachment 6	The Guntersville Reservoir 2003 flood observed elevations originated from TVA's Hourly Water Records and were used as boundary conditions in the HEC-RAS and SOCH models and used to compare the SOCH model results.

	4.5.2 Flows at gaging stations in Guntersville Reservoir	Reference 2.6	Attachment 6	The Guntersville Reservoir 2003 flood observed flows originated from TVA's Hourly Water Records and were used as boundary conditions in the HEC-RAS and SOCH models and used to compare the SOCH model results.
	4.5.3 Flows for Sequatchie River at Whitwell	Reference 2.6	Appendix C	The 2003 observed flows in the Sequatchie river originated from TVA's Bi-Hourly Streamflow Reports and were used as inflow in the SOCH model.
4.6	1973 Locals Developed from Unit Hydrographs	Reference 2.8	Attachment 7	The local inflows for basins 49 and 50 were provided as part of the "Sub basin (49-50) Guntersville Local Unit Hydrograph Validation" calculation and were used as local inflow in the SOCH model and to validate the unit hydrographs.
4.7	2003 Locals Developed from Unit Hydrographs	Reference 2.8	Attachment 7	The local inflows for basins 49 and 50 were provided as part of the "Sub basin (49-50) Guntersville Local Unit Hydrograph Validation" calculation and were used as local inflow in the SOCH model and to validate the unit hydrographs.
4.8	Initial SOCH Geometry	Reference 2.7	Attachment 8	The initial SOCH geometry was provided in the "SOCH Geometry Verification for Guntersville Reservoir" calculation and used in the SOCH model.

5. Special Requirements/Limiting Conditions

N/A

6. Calculations

6.1 The steady-state HEC-RAS model was developed according to steps 6.1 – 6.2 in CDQ000020080041.

6.2 Unsteady-state HEC-RAS calibration of the Guntersville Reservoir required modeling of the storage area that is achieved in the reservoir as the water surface elevation increases. These storage areas will fill up and eventually release the stored runoff back into the system with their discharge modeled by the lateral weirs. The volumes of these storage areas were extracted from Reference 2.13. Thirty-two (32) storage areas were added to the model and linked to the main channel at each cross section with a lateral weir. The elevations, shapes and locations of the lateral weirs were measured from the topography in Reference 2.13. Weir locations were set at the narrowest section leading to the storage areas. This is where the weir would have the most influence on the discharge rate back into the main channel. The weir coefficient has been set at 3.0 within the commonly accepted range of values for broad crested weirs (Reference 2.15). Reference 2.11 suggests using 3.0 for flow over elevated roadway approach embankments which would be similar to the natural restrictions being modeled. Coefficients between 1 and 3 were tested with a maximum variation of less than one foot primarily on the front side of the storm while the storage areas are filling up.

6.4 Similar to the SOCH model, the unsteady-state HEC-RAS model requires a warm up stage to simulate the runoff and storage levels prior to the referenced storm. This improves the fit to the referenced storm gages on the front side of the storm.

6.3 The local inflows to Guntersville Reservoir for basins 49 and 50 were combined with the observed flow data for the flood to reproduce the observed elevations at gage locations along the reservoir. Gage data and observed flow data were extracted from Reference 2.5 for the 1973 storm and Reference 2.6 for the 2003 storm. Local inflow information was taken from Reference 2.8.

7. Results/Conclusions

7.1 **HEC-RAS 1973 Run**
The calibrated HEC-RAS model was run under unsteady-conditions and compared to the observed 1973 flood. The modeled peak flood elevations were within tolerable limits of the observed flood elevations at each of the gage stations (Figure 1). Figure 3 shows a comparison of the runoffs at the gages throughout the 1973 storm.

7.2 **HEC-RAS 2003 Run**
The calibrated HEC-RAS model was run under unsteady-conditions and compared to the observed 2003 flood. The modeled peak flood elevations were conservatively above the observed elevations at each gage station and within one foot of the peak elevation at all gage locations except the Nickajack tailwater which was within two feet of the peak elevation (Figure 2). Figure 4 shows a comparison of the runoffs at the gages throughout the 2003 storm.

7.3 This calibration process provided model results that reproduced the historic floods (1973 and 2003) using steady-state and unsteady-state models. The HEC-RAS model accurately replicated observed elevations and discharges for the two known historic flood events. All peak flood elevations were within tolerable limits of the historic flood peak elevations representing an accurate calibration. Because the HEC-RAS model results accurately replicated historic floods, it is demonstrated that the unsteady-state HEC-RAS model and the SOCH model of the Guntersville Reservoir produce equivalent results given the same input This confirms that the SOCH model is an acceptable tool for predicting flood elevations and discharges for storm events.

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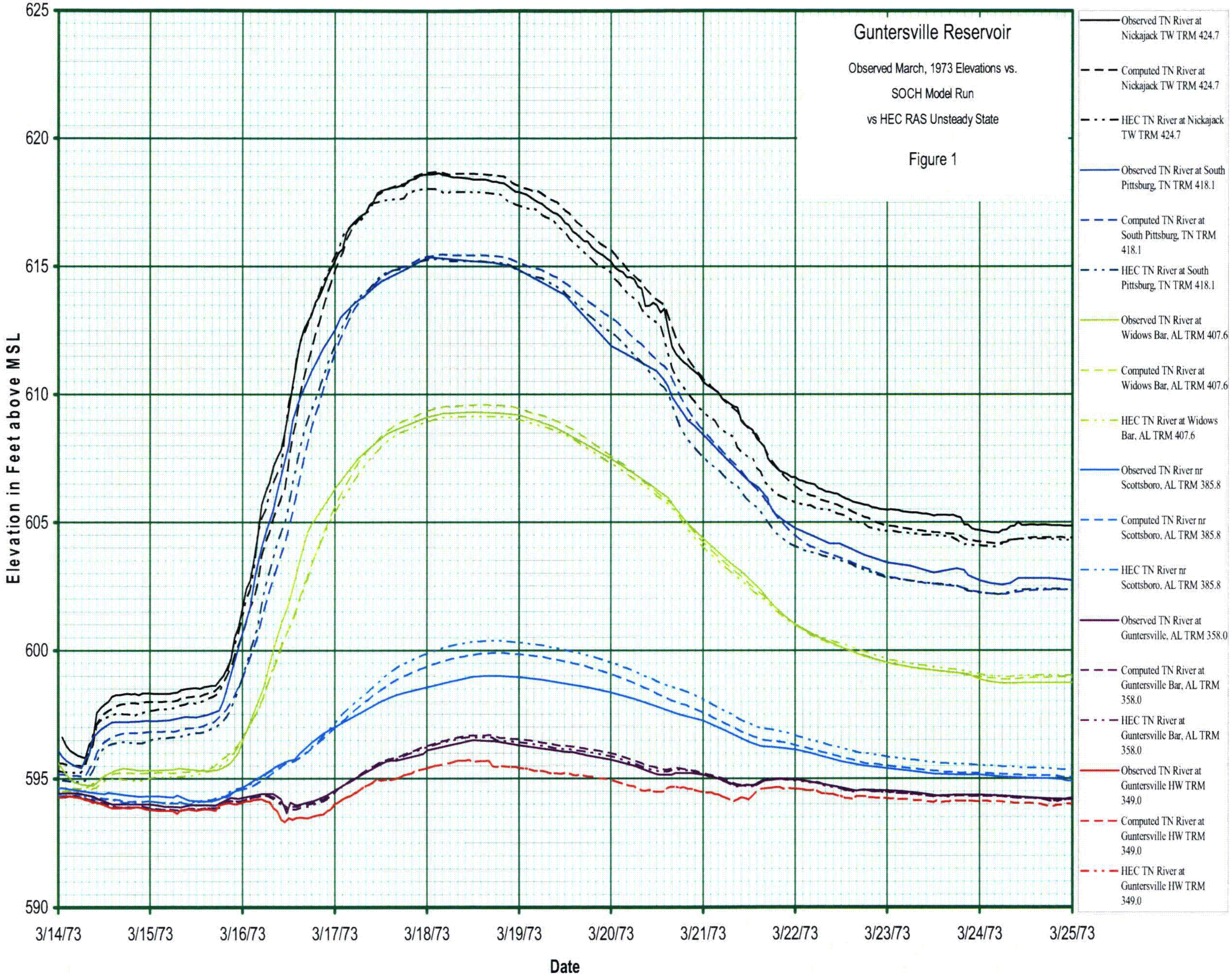
Subject: Unsteady HEC-RAS Model, Guntersville		Prepped	JDK
Appendix M		Checked	WBB

TVA



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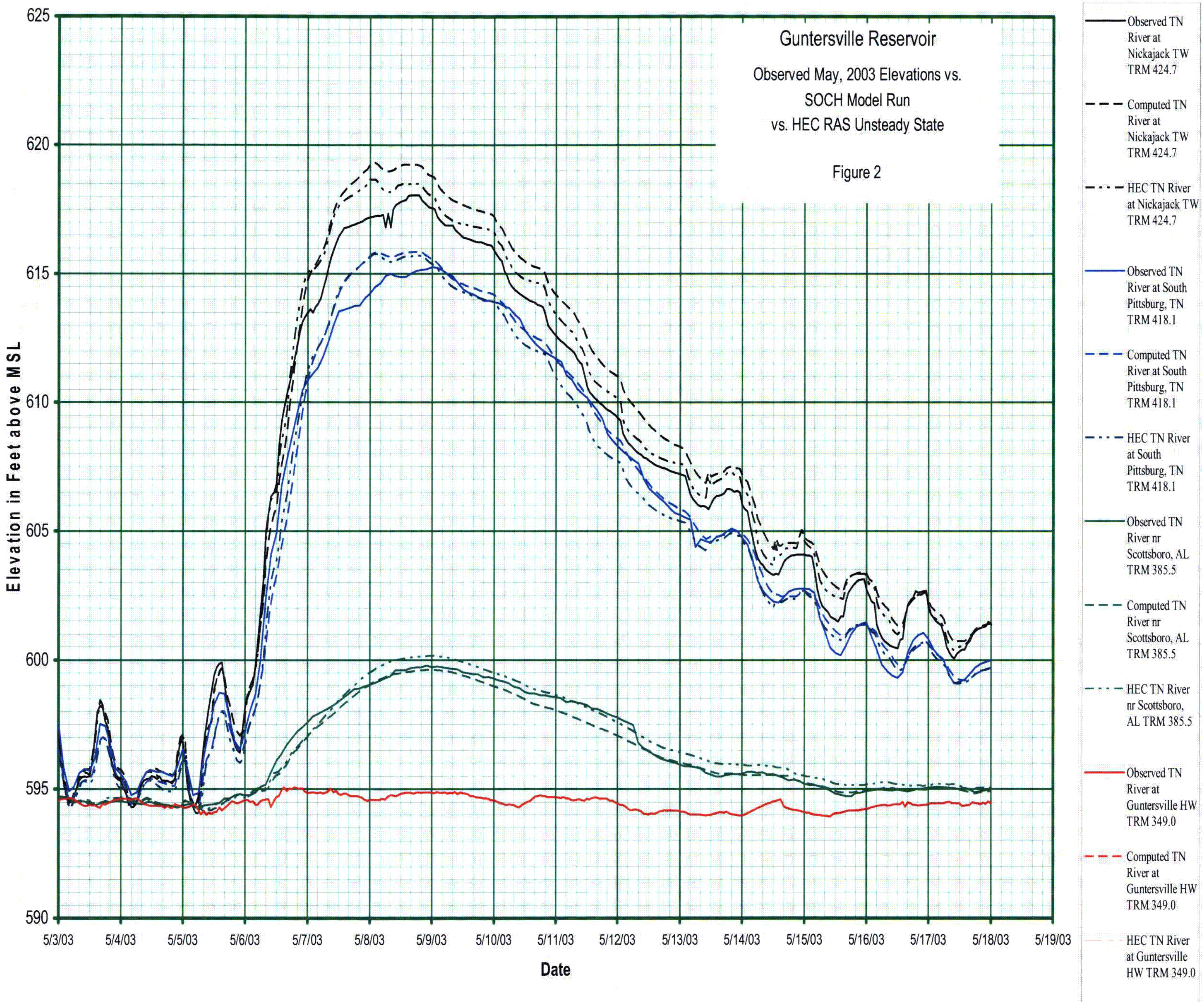
Subject: Unsteady HEC-RAS Model, Guntersville		Prepped	JDK
Appendix M		Checked	WBB



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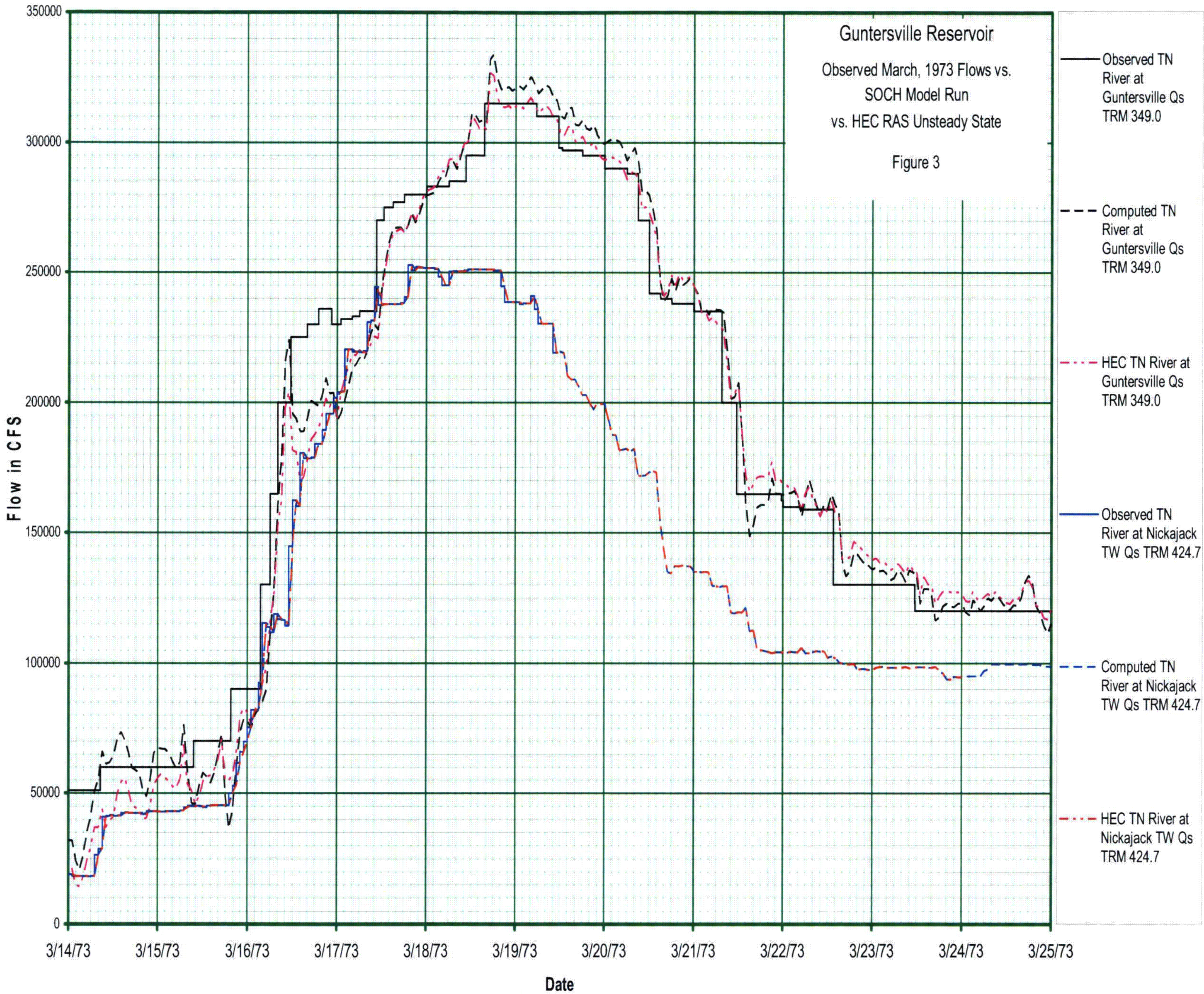
Calculation No. CDQ000020080041	Rev: 0	Plant: GEN	Page: 11
Subject: Unsteady HEC-RAS Model, Guntersville		Prepped	JDK
Appendix M		Checked	WBB



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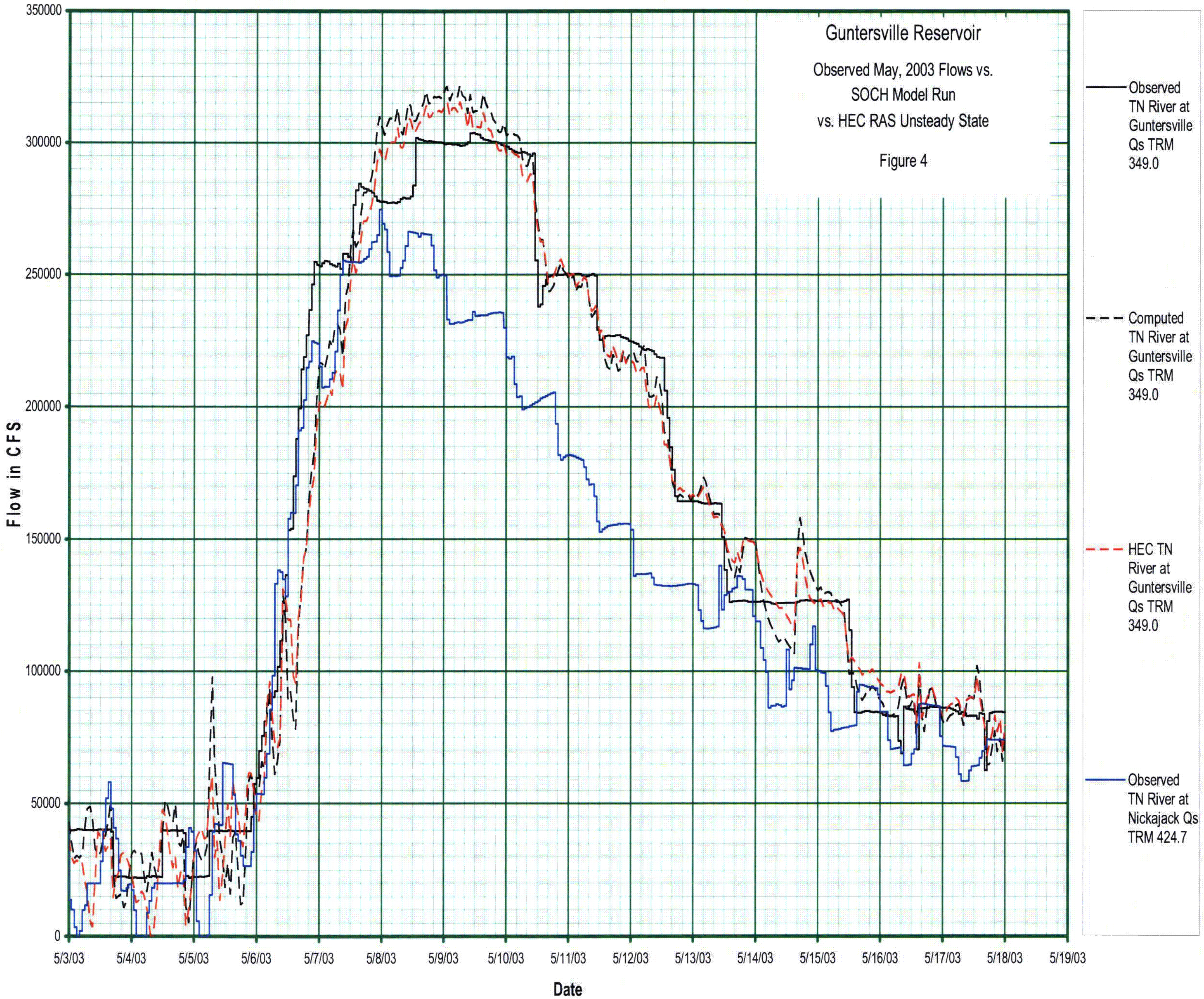
Calculation No. CDQ000020080041	Rev: 0	Plant: GEN	Page: 12
Subject: Unsteady HEC-RAS Model, Guntersville		Prepped	JDK
Appendix M		Checked	WBB



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Calculation No. CDQ000020080041		Rev: 0	Plant: GEN	Page: 1
Subject: SOCH Model Calibration, Guntersville			Prepped	JTS
Appendix N			Checked	WBB

1. Purpose

A steady-state HEC-RAS model has been prepared as a confirmatory analysis for the SOCH model calculation CDQ000020080041_Rev_0. The purpose of this calculation is to demonstrate that the steady-state HEC-RAS model and a steady-state SOCH model of the Guntersville Reservoir produce equivalent results given the same input. Inputs to this calculation include channel geometry, Manning's *n* values, and dam rating curves. The result of this calculation will compare HEC-RAS steady-state profiles to SOCH model steady-state profiles. This will confirm that the SOCH model and the HEC-RAS model produce equivalent results.

2. References

2.1 *Drainage Areas for Streams in Tennessee River Basin*, Report No. 0-5829-R-2, Tennessee Valley Authority, Division of Water Control Planning, Hydraulic Data Branch, Knoxville, TN, March 1970.

2.2 "Bellefonte Nuclear Plant, White Paper –Hydrologic Analysis, Revision 1", Tennessee Valley Authority, July 25, 2008. (EDMS No. L58 080730 001)

2.3 "Dam Rating Curve – Guntersville" CDQ000020080011 Revision 0 (EDMS No. L58 090224 004)

2.4 "SOCH Geometry Verification for Guntersville Reservoir" CDQ000020080032 Revision 0 (EDMS No. L58 090120 001)

2.5 "SOCH Software Verification and Validation Report (SVVR)" (EDMS No. L58 090528004)

2.6 "SOCH User Manual", (EDMS No. L58 090528002)

2.7 *HEC-RAS, River Analysis System Hydraulic Reference Manual*, Revision 3.1, Report No. CPD-69, U.S. Army Corps of Engineers Hydraulic Engineering Center, November 2002.

3. Assumptions and Methodology

3.1 Assumptions

3.1.1 Assumption: Assumptions in CDQ000020080041_Rev_0 are valid and used in this confirmatory calculation.
Technical Justification: See section 3.1, CDQ000020080041.

3.1.2 Assumption: The HEC-RAS model is a valid hydraulic model.
Technical Justification: HEC-RAS software has been developed and is used by the Army Corps of Engineers for Hydraulic Modeling of Rivers and Flood Studies and was not obtained and documented via a 10 CFR 50 Appendix B program. The Software is commonly accepted in jurisdictions throughout the United States. A hand calculation has been developed to show the accuracy of the HEC-RAS model on the Guntersville Reservoir (Appendix L of CDQ0000200841).

3.2 Unverified Assumptions - None

3.3 Methodology

As described in section 3.3 of CDQ000020080041, a steady-state SOCH model of the Guntersville Reservoir was calibrated to coincide with steady-state flow profiles in the range of the PMF.

To compare the results of a steady-state SOCH model to the results of a steady-state HEC-RAS model given the same inputs, a HEC-RAS model was also developed. The downstream boundary conditions for both the SOCH model and the HEC-RAS model were set at the level of the gate elevation, 595.44 ft, to account for reservoir pool until the flow increased to 400,000 cfs, the point at which the gate elevation intersects the dam rating curve (Attachment 3). The boundary conditions then followed the dam rating curve.

The Manning's *n* values from the calibrated SOCH model were then inserted into the HEC-RAS geometry and the HEC-RAS model was run at uniform flows of 100,000 cfs, 300,000 cfs, and 1,200,000 cfs with the same boundary conditions as the SOCH model and the results of the two models were compared.

4. Design Input

4.1

Sect.	Input Parameter	Source	Location
4.1	HEC-RAS Geometry	Reference 2.7	Attachment 1
4.2	Guntersville Dam Headwater Rating Curve	Reference 2.3	Attachment 3
4.3	SOCH Steady-State Profiles	CDQ000020080041	Appendix A
4.4	SOCH Steady-State Model Output	CDQ000020080041	Appendix I

5. Special Requirements/Limiting Conditions

N/A

6. Calculations

6.1 The Manning's *n* values from the calibrated SOCH model were inserted into the HEC-RAS geometry and the HEC-RAS model was run at 100,000 cfs, 300,000 cfs, and 1,200,000 cfs with the same boundary conditions as the SOCH model. The results of the two models were tabulated and shown in Section 7. The elevation profiles for the two models are shown in Figure 1.

7. Results/Conclusions

The results of the SOCH and HEC-RAS models run at the steady-state flow of 100,000 cfs are tabulated in Table 1 and shown in Figure 1. When given the same inputs the SOCH model and HEC-RAS model produce comparable results. The results of the SOCH model are conservatively higher than the HEC-RAS model.

Table 1. Results of Steady-State HEC-RAS and SOCH at 100,000 cfs

Tennessee River Mile	Elevation (ft)		Velocity (ft/s)		Area (sq. ft)		Manning's n		Froude No.	
	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS
424.70	604.92	603.94	3.35	3.48	29863	28721	0.023	0.023	0.32	0.12
420.49	603.31	602.75	3.25	3.35	30725	29838	0.023	0.023	0.22	0.14
416.28	602.30	601.63	3.41	3.55	29309	28141	0.027	0.027	0.22	0.14
412.08	600.87	600.25	3.01	3.10	33261	32229	0.027	0.027	0.16	0.12
407.88	599.57	599.06	2.99	3.09	33438	32469	0.027	0.027	0.17	0.12
403.67	598.65	598.11	3.05	3.28	32816	30989	0.024	0.024	0.14	0.12
399.47	597.86	597.46	2.18	2.66	45796	43879	0.022	0.022	0.17	0.09
395.26	597.26	597.00	2.62	2.79	38103	37516	0.022	0.022	0.26	0.09
391.06	596.70	596.60	2.12	2.14	47181	47003	0.022	0.022	0.09	0.09
386.85	596.37	596.29	1.62	1.63	61886	61542	0.021	0.021	0.08	0.07
382.64	596.11	596.05	1.24	1.25	80624	80268	0.021	0.021	0.08	0.06
378.44	595.92	595.86	1.48	1.51	67571	67220	0.021	0.021	0.11	0.07
374.23	595.81	595.75	0.92	0.92	108867	108451	0.021	0.021	0.06	0.04
370.03	595.74	595.68	0.84	0.85	118724	118299	0.021	0.021	0.04	0.03
365.82	595.63	595.61	0.74	0.74	134476	134255	0.021	0.021	0.03	0.03
361.62	595.58	595.56	0.83	0.83	120780	120627	0.021	0.021	0.05	0.03
357.41	595.54	595.53	0.69	0.70	145319	145105	0.021	0.021	0.05	0.02
353.21	595.52	595.49	0.87	0.87	115280	115184	0.023	0.023	0.04	0.03
349.00	595.44	595.44	0.83	0.83	120287	120240	0.024	0.024	0.03	0.03

The results of the SOCH and HEC-RAS models run at the steady-state flow of 300,000 cfs are tabulated in Table 2 and shown in Figure 1. When given the same inputs the SOCH model and HEC-RAS model produce comparable results. The results of the SOCH model are conservatively higher than the HEC-RAS model.

Table 2. Results of Steady-State HEC-RAS and SOCH at 300,000 cfs

Tennessee River Mile	Elevation (ft)		Velocity (ft/s)		Area (sq. ft)		Manning's n		Froude No.	
	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS
424.70	619.73	619.25	5.44	6.19	55139	53712	0.023	0.023	0.58	0.18
420.49	617.79	617.56	3.44	4.32	87188	86111	0.023	0.023	0.21	0.17
416.28	615.77	615.06	3.75	5.52	80079	75937	0.027	0.027	0.22	0.21
412.08	612.93	612.19	5.01	5.70	59864	57887	0.027	0.027	0.26	0.18
407.88	610.57	609.77	4.10	5.88	73203	69457	0.027	0.027	0.23	0.19
403.67	608.12	607.22	3.71	6.65	80909	75907	0.024	0.024	0.16	0.21
399.47	605.80	605.27	3.55	5.60	84469	82120	0.022	0.022	0.30	0.17
395.26	603.57	603.26	5.74	6.83	52272	51681	0.022	0.022	0.62	0.19
391.06	601.81	601.72	4.80	4.87	62591	62450	0.022	0.022	0.18	0.19
386.85	600.59	600.48	3.76	3.79	79900	79429	0.021	0.021	0.17	0.15
382.64	599.59	599.44	3.03	3.06	99001	98221	0.021	0.021	0.19	0.12
378.44	598.64	598.42	3.66	3.80	82101	80891	0.021	0.021	0.28	0.17
374.23	598.05	597.77	2.44	2.48	123157	121394	0.021	0.021	0.15	0.10
370.03	597.61	597.31	2.30	2.34	130272	128400	0.021	0.021	0.10	0.09
365.82	596.93	596.83	2.09	2.10	143868	143067	0.021	0.021	0.09	0.08
361.62	596.55	596.46	2.38	2.39	125938	125387	0.021	0.021	0.14	0.09
357.41	596.27	596.18	2.00	2.05	150430	149619	0.021	0.021	0.14	0.07
353.21	596.06	595.91	2.56	2.57	117444	116837	0.023	0.023	0.11	0.08
349.00	595.44	595.44	2.50	2.50	120287	120240	0.024	0.024	0.08	0.08

The results of the SOCH and HEC-RAS models run at the steady-state flow of 1,200,000 cfs are tabulated in Table 3 and shown in Figure 1. When given the same inputs the SOCH model and HEC-RAS model produce comparable results.

Table 3. Results of Steady-State HEC-RAS and SOCH at 1,200,000 cfs

Tennessee River Mile	Elevation (ft)		Velocity (ft/s)		Area (sq. ft)		Manning's n		Froude No.	
	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS	SOCH	HEC-RAS
424.70	648.67	648.41	8.28	12.53	144944	144217	0.023	0.023	1.02	0.27
420.49	646.42	647.38	3.82	5.66	314441	322980	0.023	0.023	0.16	0.14
416.28	643.54	644.51	4.07	7.50	294652	302801	0.027	0.027	0.16	0.18
412.08	641.34	641.42	8.04	10.68	149318	149655	0.027	0.027	0.34	0.24
407.88	638.26	638.29	5.35	10.08	224416	224896	0.027	0.027	0.25	0.23
403.67	635.76	635.54	3.65	10.45	328748	327339	0.024	0.024	0.11	0.24
399.47	634.06	633.71	5.04	9.52	238097	236147	0.022	0.022	0.42	0.21
395.26	630.94	629.83	6.32	13.20	189794	183129	0.022	0.022	0.55	0.29
391.06	628.55	628.26	7.06	8.23	170028	168584	0.022	0.022	0.19	0.21
386.85	627.54	627.31	5.54	6.20	216644	215199	0.021	0.021	0.17	0.16
382.64	626.73	626.54	4.53	4.98	264657	263272	0.021	0.021	0.32	0.13
378.44	625.76	625.62	4.38	5.44	274014	272905	0.021	0.021	0.29	0.15
374.23	625.35	625.24	3.67	4.00	327370	326369	0.021	0.021	0.16	0.10
370.03	624.95	624.82	3.89	4.02	308163	307287	0.021	0.021	0.13	0.10
365.82	624.60	624.49	3.34	3.47	359192	358332	0.021	0.021	0.10	0.09
361.62	624.16	624.00	3.55	4.38	337725	336383	0.021	0.021	0.15	0.11
357.41	623.94	623.76	2.75	3.52	437096	437496	0.021	0.021	0.15	0.08
353.21	623.34	623.10	5.25	5.35	228777	227732	0.023	0.023	0.19	0.13
349.00	622.10	622.10	5.37	5.42	223538	223532	0.024	0.024	0.14	0.12

TVA			
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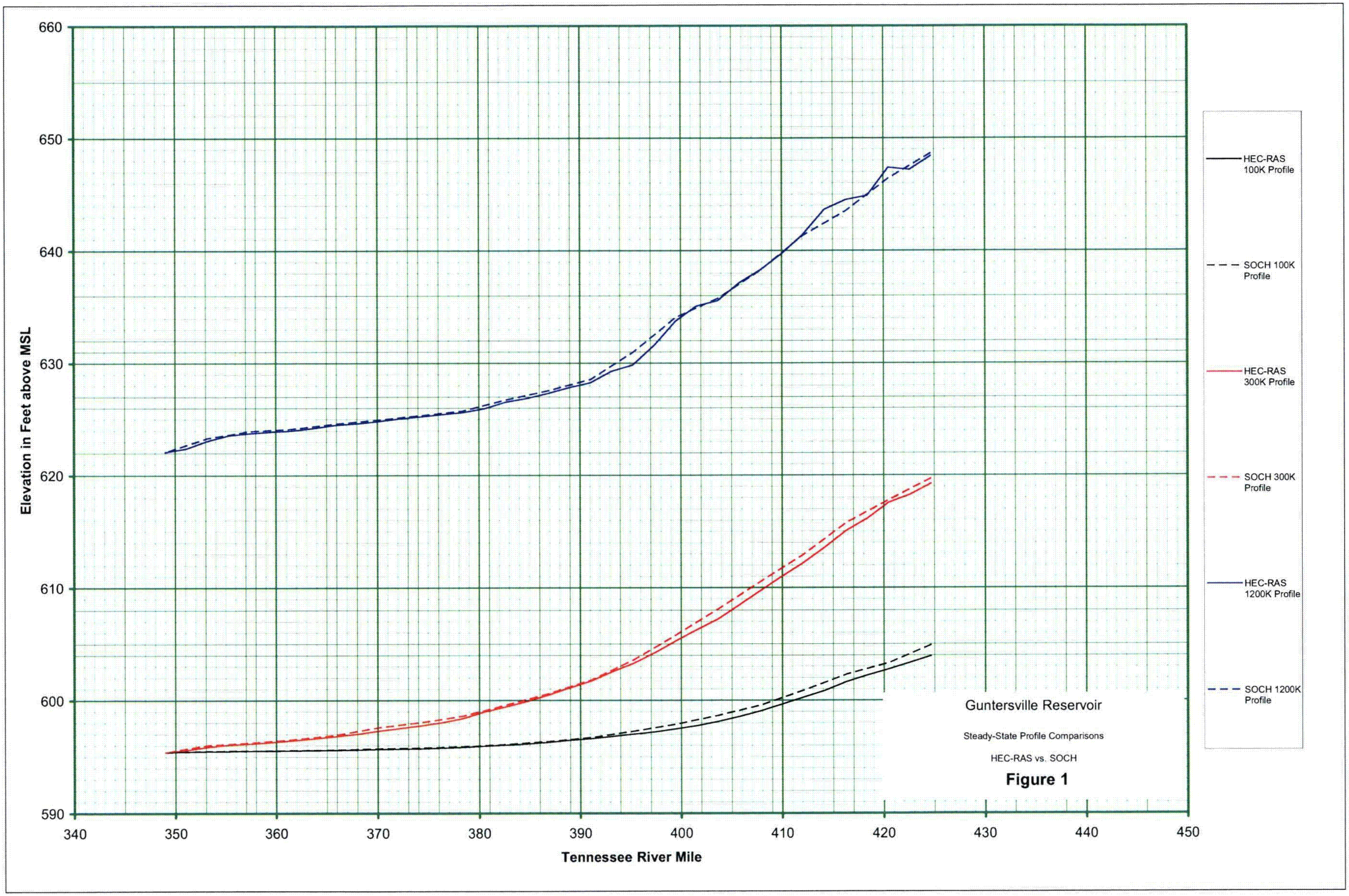
Appendix N		Checked	WBB



1. Purpose

The purpose of this document is to evaluate the sensitivity of the Manning's *n* values used to calculate the $R^{2/3}$ value and whether there is a need to revise the SOCH geometry file as a result of calibration of the steady-state SOCH model that was performed in "SOCH Model Calibration, Guntersville" (CDQ000020080041). During the calibration process, the Manning's *n* values, which were used to compute the $R^{2/3}$ term in the SOCH geometry file, were adjusted slightly to achieve calibration at the PMF level and to reproduce the historic flood events.

2. References

2.1 "SOCH Geometry Verification for Guntersville Reservoir" CDQ000020080032 Revision 0 (EDMS No. L58 090120 001)

2.2 "SOCH Software Verification and Validation Report (SVVR)" (EDMS No. L58 090528004)

2.3 "SOCH User Manual", (EDMS No. L58 090528002)

2.4 *HEC-RAS, River Analysis System Hydraulic Reference Manual*, Revision 3.1, Report No. CPD-69, U.S. Army Corps of Engineers Hydraulic Engineering Center, November 2002.

2.5 "Weighted Width (WWIDTH) Version 1.0 Conveyance (CONVEY) Version 1.0 User Manual." Revision 0 (EDMS No. L58 090213 001)

2.6 "Software Verification and Validation Report (SVVR) Weighted Width (WWIDTH) Version 1.0 and Conveyance (CONVEY) Version 1.0." Revision 0 (EDMS No. L58 090210 005)

3. Assumptions and Methodology

3.1 Assumptions

3.1.1 Assumption: Assumptions in CDQ000020080041 are valid and used in this calculation. Technical Justification: See Section 3.1, CDQ000020080041.

3.2 Unverified Assumptions -None

3.3 Methodology

During the calibration of the SOCH model described in "SOCH Model Calibration, Guntersville" (CDQ000020080041), the Manning's *n* values in the calibrated steady-state HEC-RAS model were used to compute the $R^{2/3}$ value in the SOCH geometry file. The Manning's *n* values were then adjusted further for use in the SOCH model to ensure that the SOCH model was calibrated at the PMF level and reproduced the historic flood events. This calibration of Manning's *n* values in SOCH created slight inconsistencies in Manning's *n* values between the HEC-RAS file used to create the SOCH geometry file and the SOCH Manning's *n* values used in calibration.

To evaluate the sensitivity of the Manning's *n* values used to determine the $R^{2/3}$ value and the need to revise the SOCH geometry file, a new SOCH geometry file was created containing $R^{2/3}$ values generated with the Manning's *n* values determined in calibration. The $R^{2/3}$ values were generated by using TVA's CONVEY.EXE program as described in Reference 2.1. This new SOCH geometry file was used to generate a set of steady-state profiles ranging from 100,000 cfs to 1,300,000 cfs following the procedures described in Section 6.2 of CDQ000020080041. These new profiles were then compared to the steady-state profiles generated by using the original SOCH geometry file from Section 6.1 of CDQ000020080041 to show that the difference in the steady-state profiles generated from the two geometry files is minimal.

4. Design Input

Table 1

Input Parameter	Symbol	Units
Water Surface Elevation	WSE	feet
Flow	Q	cfs
Manning's *n*	n	-
Downstream Reach Length	L	feet
Area	A	ft^2
Conveyance	R	feet
Weighted Width	W	acre

5. Special Requirements/Limiting Conditions

N/A

6. Calculations

As stated in previous sections, the Manning's *n* values calibrated for the HEC-RAS geometry file were adjusted further during the SOCH calibration process. To ensure that these minor changes did not invalidate the existing SOCH geometry file (GuntersvilleRev4.0.geo) for the Guntersville Reservoir, a new geometry file was created from the existing cross-sections, reach lengths and storage volumes along with the new Manning's *n* values. To accomplish this, the modified Manning's *n* values were input into a HEC-RAS geometry file which was used to create a data input file (GuntersvilleAppenO.dat) as described in TVA's WWIDTH-CONVEY User's Manual (Reference 2.5). This .dat file was used as the input into the TVA's CONVEY.EXE program. The outputs from the program were an output file (GuntersvilleAppenO.out) and a GuntersvilleAppenO.prt file (see attached). The contents of the Guntersville.prt represent the elevation steps along each cross-section, incremental cross-sectional area, a conveyance term, $R^{2/3}$, and a weighted width term. Because the Manning's *n* value is the only parameter that was adjusted, the conveyance term is the only value that changed. The conveyance terms in the existing SOCH geometry file were replaced with the newly-calculated conveyance terms and the SOCH geometry file was saved as "GuntersvilleAppenO.geo" (see attached). The new $R^{2/3}$ values were compared to the $R^{2/3}$ values from the existing geometry file in Table 2 below.

Table 2

Conveyance Term ($R^{2/3}$) Comparison

RM	SOCH Geometry - Version 4.0 Maximum $R^{2/3}$	SOCH Geometry - AppenO Maximum $R^{2/3}$	Change	RM	SOCH Geometry - Version 4.0 Maximum $R^{2/3}$	SOCH Geometry – AppenO Maximum $R^{2/3}$	Change
424.70	11.95	11.83	1.00%	384.74	13.06	13.06	0.00%
422.60	9.91	9.77	1.41%	382.64	12.91	12.91	0.00%
420.49	11.68	11.54	1.20%	380.54	12.68	12.68	0.00%
418.39	8.76	8.41	4.00%	378.44	12.29	12.29	0.00%
416.28	9.64	9.76	-1.24%	376.34	14.45	14.45	0.00%
414.19	15.53	15.62	-0.58%	374.23	14.83	14.83	0.00%
412.08	14.94	15.02	-0.54%	372.13	14.70	14.70	0.00%
409.98	15.36	15.47	-0.72%	370.03	17.84	17.84	0.00%
407.88	10.37	10.49	-1.16%	367.92	15.27	15.27	0.00%
405.77	9.53	10.14	-6.40%	365.82	17.06	17.06	0.00%
403.67	6.82	6.82	0.00%	363.72	15.96	15.96	0.00%
401.57	10.84	10.84	0.00%	361.62	13.15	13.15	0.00%
399.47	10.51	10.14	3.52%	359.51	14.26	14.26	0.00%
397.36	7.24	7.06	2.49%	357.41	12.32	12.32	0.00%
395.26	8.68	8.42	3.00%	355.31	17.63	17.54	0.51%
393.16	10.45	10.28	1.63%	353.21	19.79	19.78	0.05%
391.06	11.29	11.21	0.71%	351.10	19.56	19.56	0.00%
388.95	11.59	11.64	-0.43%	349.00	22.88	22.87	0.04%
386.85	12.06	12.06	0.00%				

As shown above, the percent change between conveyance terms for the two geometry files varies between -6.4% to 4.0%.

After the new geometry file (GuntersvilleAppenO.geo) was built, it was used to generate SOCH steady-state profiles from 100,000 cfs to 1,300,000 cfs. The resulting WSEs are shown in Table 3.

Table 3

SOCH Steady-State Profile Comparison						
	Guntersville SOCH GeometryRev4.0.geo			Guntersville SOCH Geometry AppendixO.geo		
RM	100,000 cfs	300,000 cfs	1,200,000 cfs	100,000 cfs	300,000 cfs	1,200,000 cfs
424.70	604.92	619.73	648.67	604.92	619.73	648.76
420.49	603.31	617.79	646.42	603.31	617.79	646.46
416.28	602.30	615.77	643.54	602.30	615.74	643.41
412.08	600.87	612.93	641.34	600.87	612.91	641.22
407.88	599.57	610.57	638.26	599.57	610.55	638.19
403.67	598.65	608.12	635.76	598.65	608.16	635.94
399.47	597.86	605.80	634.06	597.86	605.84	634.25
395.26	597.26	603.57	630.94	597.26	603.60	631.02
391.06	596.70	601.81	628.55	596.70	601.82	628.59
386.85	596.37	600.59	627.54	596.37	600.60	627.57
382.64	596.11	599.59	626.73	596.11	599.59	626.75
378.44	595.92	598.64	625.76	595.92	598.64	625.78
374.23	595.81	598.05	625.35	595.81	598.05	625.37
370.03	595.74	597.61	624.95	595.74	597.61	624.96
365.82	595.63	596.93	624.60	595.63	596.93	624.61
361.62	595.58	596.55	624.16	595.58	596.55	624.17
357.41	595.54	596.27	623.94	595.54	596.27	623.95
353.21	595.52	596.06	623.34	595.52	596.06	623.35
349.00	595.44	595.44	622.10	595.44	595.44	622.10

The 100,000, 300,000 and 1,200,000 flow profiles were shown as a sample of the WSE calculated. As shown in the bold outlined cells, the largest differences occurred at the 1,200,000 cfs profile with a difference of 0.19 feet. The 300,000 cfs runs differed by 0.04 feet or less and the 100,000 cfs runs did not differ.

7. Results/Conclusions

The comparison runs (Figures 1-3) show that the elevation differences in flood profiles are negligible with all WSEs varying by a less than 0.19 feet. Most varied by less than one tenth of a foot. The maximum elevation difference in WSE occurred at the 1,200,000 cfs profile, which is in the range of the probable maximum flood event. The maximum elevation difference that occurred at this flow was 0.19 feet. With the overall difference in WSEs being minimal, it is shown that the sensitivity of the Manning's *n* values used to generate the $R^{2/3}$ value is low, and it is therefore not necessary to revise the SOCH geometry file as a result of model calibration.

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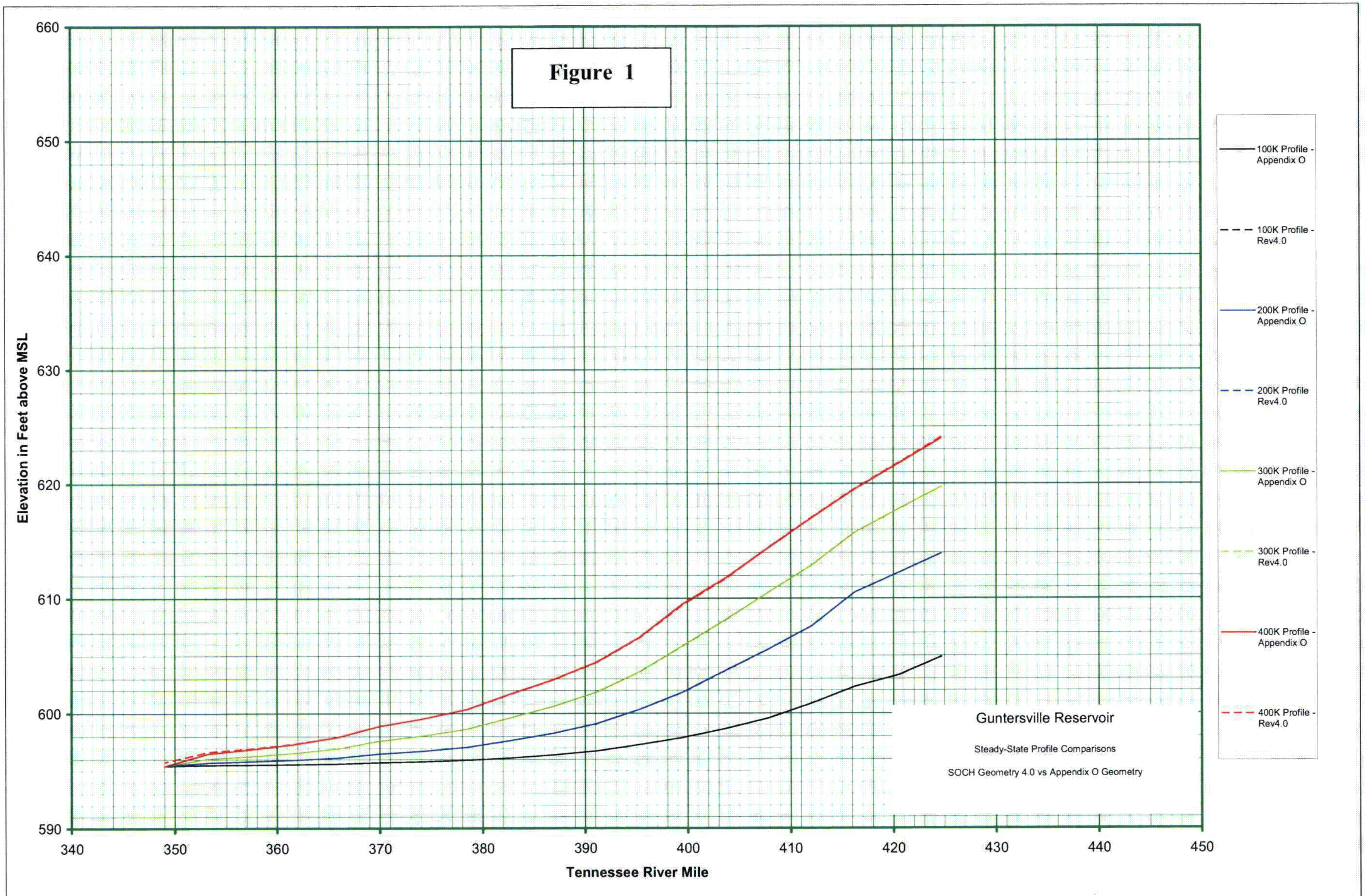
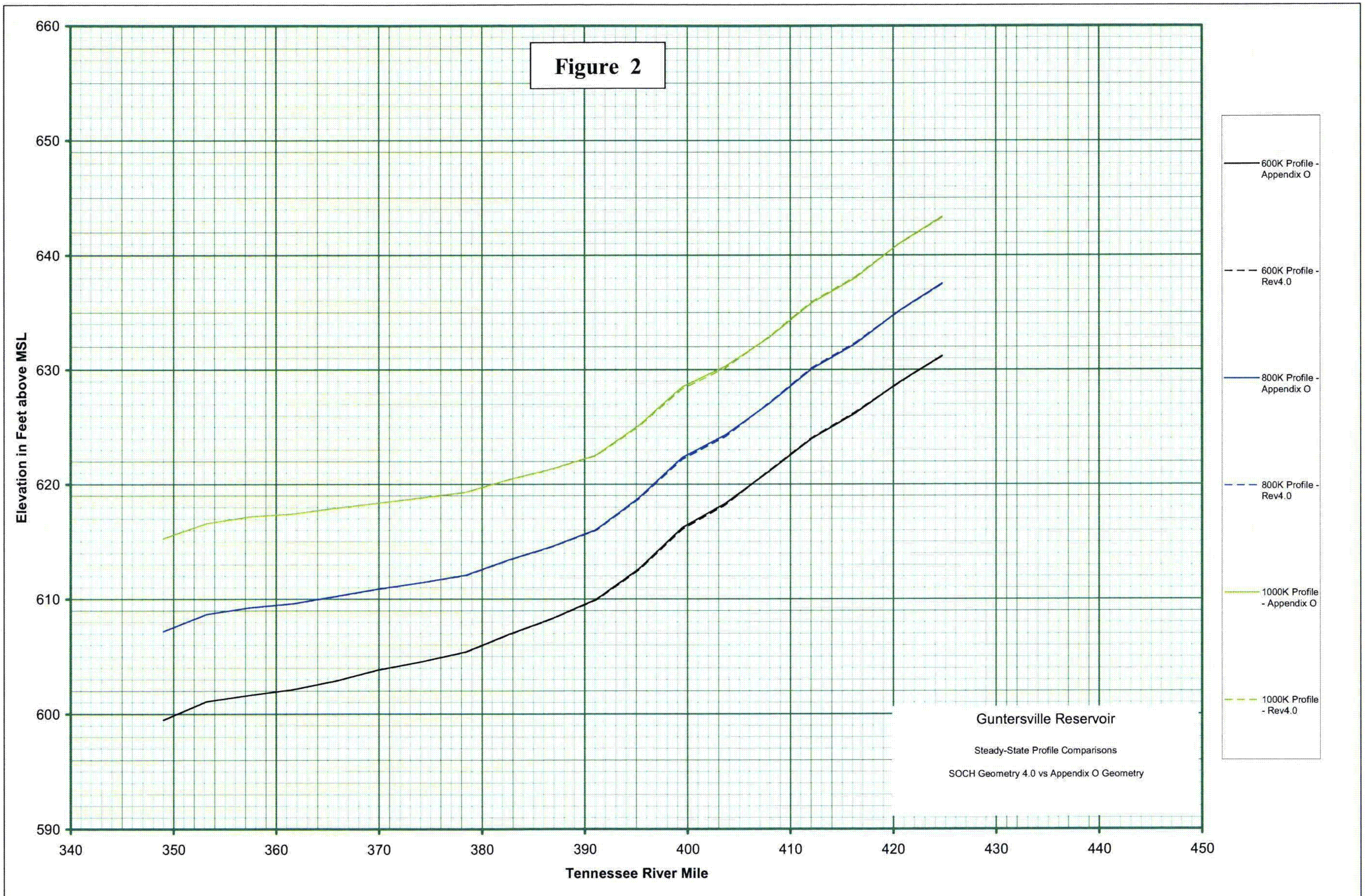
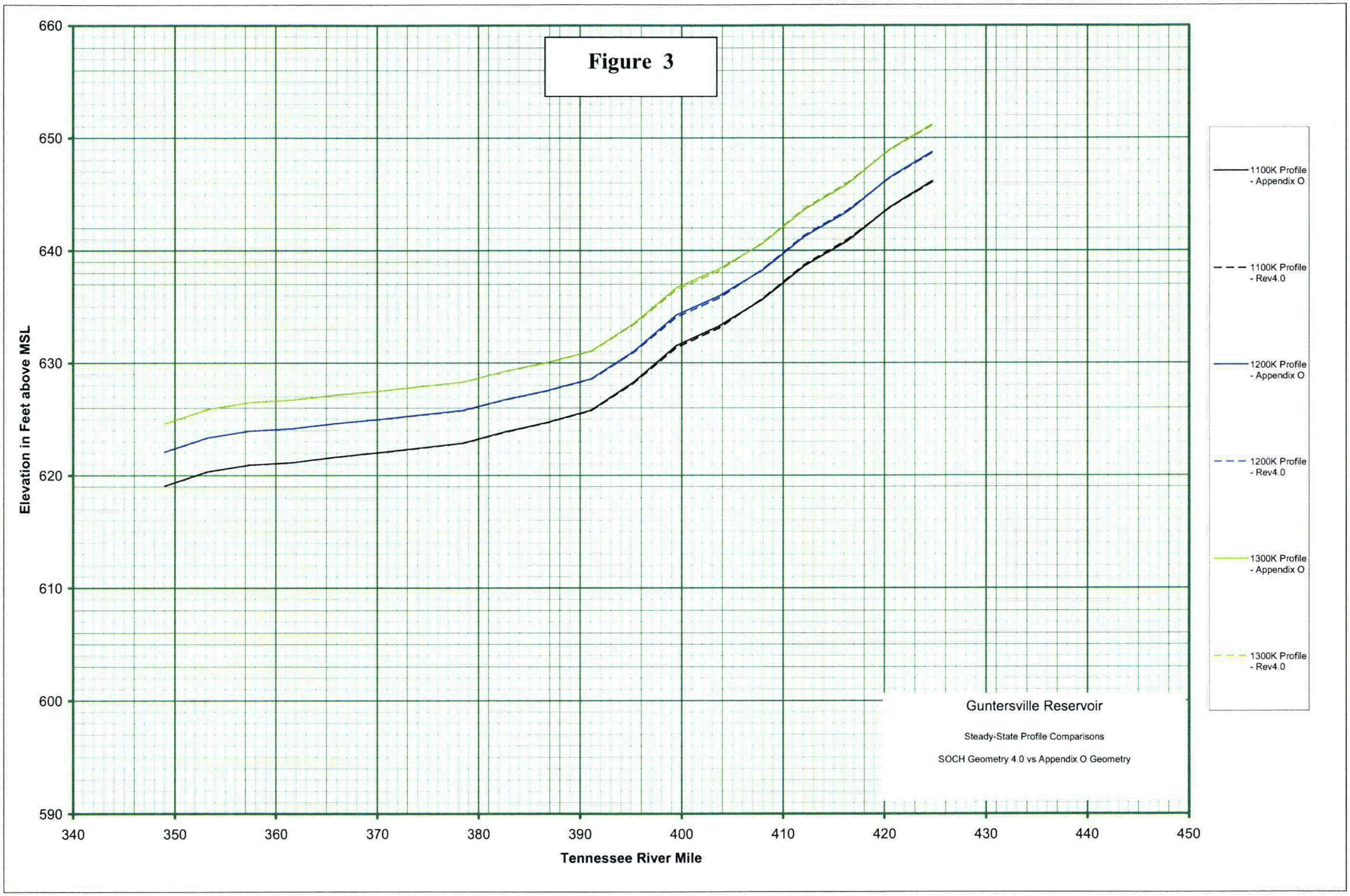
Subject: SOCH Model Calibration, Guntersville		Prepped	JAW
Appendix O		Checked	WBB



Calculation No. CDQ000020080041	Rev: 0	Plant: GEN	Page: 7 of 8
Subject: SOCH Model Calibration, Guntersville		Prepped	JAW
Appendix O		Checked	WBB



Calculation No. CDQ000020080041	Rev: 0	Plant: GEN	Page: 8 of 8
Subject: SOCH Model Calibration, Guntersville		Prepped	JAW
Appendix O		Checked	WBB



CDQ000020080041 Rev 0

Appendix P - Calibrated Steady-State HEC-RAS Model
with files:

Guntersville.f01
Guntersville.f02
Guntersville.g01
Guntersville.p01
Guntersville.p02
Guntersville.prj

CDQ000020080041 Rev 0

Appendix Q - Convey and SOCH Geometry Files
with files:

Building Guntersville SOCH GeometryRev4.0.xls
GuntersvilleHECRAStoCONVEYREV3.0.xls
GuntersvilleREV3.0.dat
GuntersvilleREV3.0.out
GuntersvilleREV3.0.prt
GuntersvilleRev4.0.geo
GuntersvilleRev4.1.geo

```
Geom Title=BLN GUNT REV 8
Program Version=3.11
Viewing Rectangle= 0 , 1 , 1 , 0

River Reach=RIVER-1        ,Reach-1
Reach XY= 2
        .5        .95        .5        .05
Rch Text X Y=0.5,0.725
Reverse River Text= 0

Type RM Length L Ch R = 1 ,424.7   ,10500,10500,10500
BEGIN DESCRIPTION:
MILE 424.7
END DESCRIPTION:
Node Last Edited Time=Oct/08/2008 08:34:50
#Sta/Elev= 26
     100     700     200     660     220     608     450     608     770     613
     810   608.5     875   587.5     890     585    1120   577.5    1400     575
    1600     576    1880     577    1940   587.5    2030   618.2    2860   618.2
    3080     623    3190     628    3300     640    3650     640    3700     660
    4030     680    4250     680    4550     660    5300     660    5500     680
    6650     700
#Mann= 4 ,-1 , 0
     100     .05       0     770    .016       0    2030     .09       0
    4030     .09       0
Bank Sta=770,2030
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,422.6   ,10800,10800,14500
BEGIN DESCRIPTION:
MILE 422.6
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 22
    1850     680    1900     633    1930     628    1980     608    2075     602
    2100  585.61    2192  582.52    2300  583.08    2435   578.7    2520  577.66
    2700   579.8    3008  584.84    3135  583.15    3300  590.11    3340     613
    3440   618.2    3725   618.2    3975   613.4    5800     620    7300     640
    8150     660    8330     680
#Mann= 3 , 0 , 0
    1850     .09       0    2075    .029       0    3340    .067       0
Bank Sta=2075,3340
XS Rating Curve= 0
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Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,420.49 ,9200,10500,11000
BEGIN DESCRIPTION:
MILE 420.49
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 35

2050	680	3070	628.5	3150	613.2	3570	613.4	3600	586.7
3650	581	3700	579	3900	579	4000	580	4050	586
4110	614	4540	609	4750	615.5	5000	608.5	5490	608.5
5710	614.8	5810	613	5886	591	6000	587.4	6100	583
6190	580	6292	579	6400	580.5	6472	585	6760	585.6
6800	585.6	6900	588.8	6960	614	8020	608.5	8900	608.8
9500	614.8	10500	620	11200	640	11550	660	11800	680

#Mann= 3 , 0 , 0

2050	.09	0	3570	.025	0	6960	.055	0

Bank Sta=3570,6960
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,418.39 ,11000,11000,11000
BEGIN DESCRIPTION:
MILE 418.39
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 20

2000	680	2450	618.5	2580	613.5	3930	608.5	4780	608.5
5080	613.3	5240	613.3	5325	608.8	5488	578.2	5507	576.5
5550	574.6	5900	567.7	6140	570.2	6250	576.5	6315	582
6400	608.5	7230	613	7730	618.5	7900	633.2	8000	680

#Mann= 3 , 0 , 0

2000	.1	0	5325	.022	0	6400	.1	0

Bank Sta=5325,6400
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,416.28 ,11200,12300,12800
BEGIN DESCRIPTION:
MILE 416.28
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 39

2010	680	2050	623	2100	608.5	2200	603	2370	603
2810	608.4	3080	608.4	3100	585.5	3140	581	3206	580.76
3272	579.2	3449	580.99	3495	584	3575	608.4	3650	614

```
  4420  608.4   4490  585.5   4560    583   4750    580   5040    580
  5275  580.3   5360  581.6   5400  585.5   5410  608.4   5670  608.4
  6160    613   6680    620   6820  618.5   7050  608.4   8050    610
  8100    680   8420    680   8500    660   8600    640   8750    620
  8890    610   9750    610  10400    620  10700    680
#Mann= 3 , 0 , 0
  2010   .095      0   3080   .034      0   5410    .09      0
Bank Sta=3080,5410
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,414.19  ,10700,10200,9800
BEGIN DESCRIPTION:
MILE 414.19
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 32
    50    680    280  613.5    320    609    450    603    600  603.3
   880  608.7   1220  608.7   1270    604   1540    604   1810  608.7
  1860    584   1960  578.7   2050  578.5   2100  579.2   2160    580
  2310    582   2350    584   2400    609   3130  608.6   3220  603.5
  3375    604   3870  608.3   3970  608.3   4020  583.5   4100  582.1
  4200  581.8   4480    580   4780    582   5270    584   5330    609
  5380  618.6   6150    680
#Mann= 3 , 0 , 0
    50    .05      0   1810   .025      0   5330    .11      0
Bank Sta=1810,5330
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,412.08  ,11700,11000,10200
BEGIN DESCRIPTION:
MILE 412.08
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 18
    60    680    160    623    230    609    300  603.4    425  582.9
   600  577.9    830  576.6   1276  579.2   1400  578.8   1700  578.2
  1760  579.7   1775    581   1863  587.5   2030  618.2   2480  603.5
  3150  608.6   3350  623.5   3360    680
#Mann= 3 , 0 , 0
    60   .085      0    300   .025      0   2030   .085      0
Bank Sta=300,2030
XS Rating Curve= 0
Exp/Cntr=0.3,0.1
```

```
Type RM Length L Ch R = 1 ,409.98  ,10600,10900,11200
BEGIN DESCRIPTION:
MILE 409.98
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 21
     40    680    100    624    170    609    190  603.6    550  603.6
    620  584.6    710  579.6    793 575.75   1000  578.3   1238  579.4
   1500  577.7   1830  576.6   2030  576.7   2130  580.7   2180    604
   2700    604   2900  608.7   3000  608.7   3100    604   3225    624
   3460    680
#Mann= 3 , 0 , 0
     40    .07      0    550   .023      0   2180    .06      0
Bank Sta=550,2180
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,407.88  ,11500,11500,11500
BEGIN DESCRIPTION:
MILE 407.88
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 27
     50    680    440    640    610  636.5   1000  608.8   1450  603.8
   1900  603.5   2825  603.8   3050    610   3300  603.5   3388 580.17
   3490 577.93   3550  577.5   3683  576.4   3840 576.81   4035  577.5
   4160  576.5   4650 576.25   4800 578.59   4860  603.5   4910  603.5
   5350    598   5470    599   5650  603.5   6150  608.5   6260  628.5
   6290  633.2   6400    680
#Mann= 3 , 0 , 0
     50   .085      0   3300   .025      0   4860     .1      0
Bank Sta=3300,4860
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,405.77  ,10400,10500,10400
BEGIN DESCRIPTION:
MILE 405.77
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 30
    100    680    350    620    600  606.2    680  603.8   1380  598.8
   2320  598.8   2750  603.5   3550    604   3600    578   3625    571
   3943  569.9   4100    567   4225    564   4350  564.5   4535  570.2
   4684  579.2   4760    604   4810    609   4850  613.5   5100    614
   5250    609   5350  603.5   5740  603.9   6150    600   6750    610
```

```
   7000    620   8160    620   8560    640   8760    660   8860    680
#Mann= 3 , 0 , 0
    100   .065      0   3550   .025      0   4760   .065      0
Bank Sta=3550,4760
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,403.67  ,10800,11400,10400
BEGIN DESCRIPTION:
MILE 403.67
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 42
     50    680    400    660    900    640    950    620   1000    610
   2000    600   2300    602   3560    604   4140    604   4300  598.8
   4440  598.8   4540    594   4600    594   4660    599   4950    604
   5050    604   5070    599   5150    599   5250    604   5290    604
   5330    577   5400  575.3   5750    574   5810  574.1   6040  574.8
   6141  573.3   6390  573.4   6539  574.2   6650    599   6760    603
   6900    599   7950    599   8460    604   8670    609   9125    609
   9330    614   9800    618   9900    619   9950    624  11100    640
  11399    660  11400    680
#Mann= 3 , 0 , 0
     50    .11      0   5290   .027      0   6650    .11      0
Bank Sta=5290,6650
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,401.57  ,11300,11000,11500
BEGIN DESCRIPTION:
MILE 401.57
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 31
    100    680    250    620    700    600   1100  599.5   1750  598.8
   1780    594   2040    594   2530    604   2600    604   2681  581.3
   2769    574   2794  572.2   3077  574.5   3406  574.6   3469  573.7
   3600    576   3700    604   4075    604   4275    599   4370    576
   4410  574.7   4600  573.4   4830    574   4920    576   5000    604
   5190    604   5425    599   6290    599   7025    594   8400  595.5
   8401    680
#Mann= 3 , 0 , 0
    100   .075      0   2600   .021      0   5000   .075      0
Bank Sta=2600,5000
XS Rating Curve= 0
Exp/Cntr=0.3,0.1
```

```
Type RM Length L Ch R = 1 ,399.47  ,10000,11300,11800
BEGIN DESCRIPTION:
MILE 399.47
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 33
     100     680     500     660    1400     640    1550     630    2050     630
    2200     640    2700     660    2900     680    2950     620    3025     594
    3540     594    4330     599    4400     594    4463   572.2    4550   571.2
    4720   568.4    4810   569.2    4940     571    5010   569.4    5100   567.4
    5293   564.1    5400   567.2    5510     569    5653     575    5850     599
    6450     599    6820     594    7820     594    7975     599    8060     600
    8320     620    8675   657.5    8850     680
#Mann= 5 ,-1 , 0
     100      .1       0    2900     .06       0    4400    .033       0
    5850     .06       0    7975      .1       0
Bank Sta=4400,5850
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,397.36  ,11500,10600,7000
BEGIN DESCRIPTION:
MILE 397.36
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 31
      10     660     200     640     350     620     600     600    1270     589
    1880   594.3    2210   594.3    2380   599.2    2720   599.2    2760     579
    2780   573.3    2800   570.3    3160   568.3    3270   567.1    3400   566.4
    3647   566.2    3920   573.3    4010     594    4020     599    4050     599
    4120     619    4150     619    4200     640    4300     660    4475     640
    5315     620    5675     610    8195     610    8295     620    8395     640
    8495     660
#Mann= 3 , 0 , 0
      10      .1       0    2720    .015       0    4020     .12       0
Bank Sta=2720,4020
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,395.26  ,11300,11500,13000
BEGIN DESCRIPTION:
MILE 395.26
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 28
```

```
    50   660    80   619   175   590   230   572   300 567.5
   350   567   500   561   700 558.5   945 558.5  1025   561
  1150   563  1250 589.5  1290 594.2  1310 599.5  1860 599.5
  1930 594.2  2460 594.2  2640 599.2  2660 604.2  3120   640
  3300   660  3475   640  4315   620  4675   610  7195   610
  7295   620  7395   640  7495   660
#Mann= 4 ,-1 , 0
    50    .1     0   175  .029     0  1290   .05     0
  2660    .1     0
Bank Sta=175,1290
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,393.16  ,10000,10300,10000
BEGIN DESCRIPTION:
MILE 393.16
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 41
    90   660   210   628   220 594.5   350 594.5   404 572.5
   438 566.3   540 565.6   754 565.6   900 569.3   950 569.8
   996 572.5  1100   600  1140   602  1340   593  1350   593
  1660   602  1900 594.5  1970   573  2300   565  2590 568.8
  2640 572.8  2710 594.3  3540 594.5  3700 619.2  3750   660
  3850   650  3970   640  4430   630  4530   620  4830   620
  5150   630  5850   640  6110   640  6200   630  6310   620
  6550   610  6900   610  7210   620  7370   630  9450   640
  9450   660
#Mann= 5 ,-1 , 0
    90  .055     0   350   .02     0  1100  .055     0
  1900   .02     0  3540   .08     0
Bank Sta=350,3540
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,391.06  ,10500,10300,10000
BEGIN DESCRIPTION:
MILE 391.06
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 38
    39   660    40 599.5    90   590  1090   590  1140 599.5
  1490 599.5  1567 589.5  1588 584.5  1630 575.4  1675 575.2
  1729 569.94 1954 569.1  2225 569.2  2270   569  2463 568.8
  2700 566.5  2960 572.1  3025   579  3140 594.5  3250 594.5
  3325   610  3500   660  3600   650  3720   640  4180   630
```

```
   4280    620   4580    620   4900    630   5600    640   5860    640
   5950    630   6060    620   6300    610   6650    610   6960    620
   7120    630   9200    640   9200    660
#Mann= 4 ,-1 , 0
     39    .07      0     40    .04      0   1490   .024      0
   3140    .12      0
Bank Sta=40,3140
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,388.95  ,11500,11000,9000
BEGIN DESCRIPTION:
MILE 388.95
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 46
     80    660    190    640    400    620    650    600    750    595
    800  589.5   1420  595.3   1730    588   1950    602   1980  599.5
   2060  567.3   2100  566.5   2435  566.1   2527  565.6   2700  565.2
   2825  564.8   3023  564.5   3178  564.8   3508  565.4   3560  577.4
   3583    584   3610  594.5   3700    597   4030    589   4260  584.5
   4470  584.5   4600  594.5   4710    599   4770  604.5   5200    660
   5300    650   5420    640   5880    630   5980    620   6280    620
   6600    630   7300    640   7560    640   7650    630   7760    620
   8000    610   8350    610   8660    620   8830    630  10900    640
  10900    660
#Mann= 3 , 0 , 0
     80    .08      0    750   .035      0   4600     .1      0
Bank Sta=750,4600
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,386.85  ,10400,11000,13000
BEGIN DESCRIPTION:
MILE 386.85
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 45
     50    660    150    640    360    619    470  599.5    530  594.5
    830  589.5   1075  589.5   1240  594.5   1430  594.5   1569  577.3
   1626    568   1760  567.2   1810  565.7   1927    562   2070  564.2
   2150  563.5   2225  559.1   2450  563.7   2735  566.9   2751  569.5
   2833  579.5   2910  589.4   3650  589.4   4125  584.6   4460  584.4
   4690  589.5   4730  594.5   4790  604.5   4950    660   5050    650
   5170    640   5630    630   5730    620   6030    620   6350    630
   7050    640   7310    640   7400    630   7510    620   7750    610
```

```
   8100    610   8410    620   8570    630  10650    640  10650    660
#Mann= 3 , 0 , 0
     50   .075      0    530   .019      0   4730    .15      0
Bank Sta=530,4730
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,384.74  ,12200,12200,11000
BEGIN DESCRIPTION:
MILE 384.74
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 42
     80    680    260    640    400    620    500    600    650    595
    800    590    860  584.5   1400  584.5   1870  589.5   2450  592.5
   2475  592.5   2525  584.6   2717    565   3300  565.5   3580    565
   3750    566   3990  566.5   4000  567.1   4050    572   4075    576
   4117  593.2   4800  583.5   4990  589.5   5200    680   5780    660
   5880    650   6000    640   6460    630   6560    620   6860    620
   7180    630   7880    640   8140    640   8230    630   8340    620
   8580    610   8930    610   9240    620   9400    630  11480    640
  11480    660  11480    680
#Mann= 3 , 0 , 0
     80    .07      0    650   .016      0   4990    .15      0
Bank Sta=650,4990
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,382.64  ,9800,9800,9800
BEGIN DESCRIPTION:
MILE 382.64
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 40
     50    660    200    640    450    620    600    600    750  594.8
    975    588   1940  584.5   2350  584.7   2600  589.3   2900  589.2
   3030    567   3100  563.5   3325  563.2   3550  564.2   3820  563.4
   4290  566.1   4350    567   4490  591.6   4625  589.5   4775  584.7
   5450  584.7   5920  589.4   5950    596   6200    660   6300    650
   6420    640   6880    630   6980    620   7280    620   7600    630
   8300    640   8560    640   8650    630   8760    620   9000    610
   9350    610   9660    620   9820    630  11900    640  11900    660
#Mann= 3 , 0 , 0
     50    .07      0    750   .016      0   5950   .145      0
Bank Sta=750,5950
XS Rating Curve= 0
```

Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,380.54 ,14000,10700,7500
BEGIN DESCRIPTION:
MILE 380.54
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 28

```
    50    660    250  581.5    500    577   1380  584.5   1690  589.3
  2010  590.8   2150    589   2200    586   2250  576.1   2438  563.8
  2850  564.1   3113  561.9   3650  564.8   3670    566   3740    589
  3850  588.9   4000  583.6   4070    595   4090    604   4200    620
  4400    660   5700    640   6500    620   7300    602   8000    602
  8600    620   9500    640   9650    660
```

#Mann= 3 , 0 , 0

```
    50    .07      0    250   .016      0   4070     .1      0
```

Bank Sta=250,4070
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,378.44 ,9000,10500,11000
BEGIN DESCRIPTION:
MILE 378.44
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 22

```
  1250    660   1600    600   2300    591   5400  589.2   5580  588.9
  5670    564   5800    561   5990    559   6300  556.4   6750  563.1
  6790  570.6   7020  585.2   7150    592   7250    660   8550    640
  9250    620   9800    610  10250    602  10950    602  11350    620
 12400    640  12600    660
```

#Mann= 3 , 0 , 0

```
  1250    .06      0   2300   .016      0   7150     .1      0
```

Bank Sta=2300,7150
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,376.34 ,9000,10800,13000
BEGIN DESCRIPTION:
MILE 376.34
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 37

```
    50    660    520    640   1040    620   1200    600   1400    600
  2040    620   3520    640   3900    640   4140  619.5   4490  589.5
  4750  579.5   4910  579.5   4980  584.5   5270  584.5   5530  559.5
```

```
   5950  561.3   6150  559.5   6300  559.5   6510  561.3   6675  574.3
   6690  580.3   6725  581.8   6890  584.5   7680  584.5   7700  579.5
   7790  579.5   8100  584.5   8300  584.5   8400  579.5   8600  579.5
   9080  584.5  10100    588  10550    595  10700    600  10900    620
  11100    640  11450    660
#Mann= 3 , 0 , 0
     50    .07      0   4490   .018      0  10550    .07      0
Bank Sta=4490,10550
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,374.23  ,12700,11700,11300
BEGIN DESCRIPTION:
MILE 374.23
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 37
      0    660      0    640   1100    620   1200    600   1400    600
   2100    620   3000    640   3200    660   3400    640   4300    600
   4700  584.5   5200  584.5   6330  579.2   7820  584.8   8270  589.5
   8360  584.5   8710  559.5   8720  559.8   8790  559.8   8930  558.5
   9060  558.5   9200  559.2   9360    560   9430    560   9550  559.8
   9720  560.9   9780    561   9960    584  10250  581.1  10620  584.5
  10650    589  10700  594.5  10760  594.5  10800  604.5  10860    620
  10950    640  10980    660
#Mann= 3 , 0 , 0
      0    .09      0   4300    .02      0  10700    .12      0
Bank Sta=4300,10700
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,372.13  ,9900,11200,11700
BEGIN DESCRIPTION:
MILE 372.13 Adjusted for DS width
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 20
      0    660    500    600   1900    600   2400    640   2900    600
   3000  584.3   4200    580   6080  581.1   6860  584.5   6960  584.5
   7050  559.5   7330  556.5   7525  556.2   7780    557   8260  560.5
   8350  559.5   8440  585.9   9520    587   9560    600  11201    660
#Mann= 3 , 0 , 0
      0     .1      0   2900    .02      0   9560    .12      0
Bank Sta=2900,9560
XS Rating Curve= 0
Exp/Cntr=0.3,0.1
```

```
Type RM Length L Ch R = 1 ,370.03  ,11200,11500,11500
BEGIN DESCRIPTION:
MILE 370.03
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 36
    100   660   300   640   700   620  1000   600  1125   595
   1320   583  1800   580  2820 574.5  3320 579.6  3520 584.4
   3570 584.4  3650 560.3  3740   557  3925 557.5  4000 560.5
   4050 570.4  4100 586.5  4475 586.6  4860 581.3  5110   581
   5380 586.8  5850 586.6  6020 557.5  6160 552.4  6210 551.8
   6325   550  6380 550.3  6520 550.3  6640 556.5  6680   560
   6730 575.3  7130 579.8  7200 584.3  7270 599.2  7330 604.2
   7450   660
#Mann= 3 , 0 , 0
    100   .07     0  1125   .02     0  7270   .08     0
Bank Sta=1125,7270
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,367.92  ,9500,10300,10400
BEGIN DESCRIPTION:
MILE 367.92
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 38
     50   660   300   640   800   620  1300   610  2300   600
   2400   595  2800   590  5220 584.4  5510 579.4  5780 581.8
   5940 581.6  6000 584.8  6100 584.4  6230 558.3  6330 555.1
   6390 555.7  6500 558.7  6590 563.1  6660 584.4  7070 584.4
   7190 579.4  7330 579.4  7600 584.4  7650 584.4  7720 559.8
   7775   558  7950 555.9  8025   556  8300 554.4  8530 556.4
   8670 584.4  9140 584.4  9280   589  9400   600 10070   600
  10150   620 10250   640 10450   660
#Mann= 3 , 0 , 0
     50    .1     0  2300  .022     0  9400    .1     0
Bank Sta=2300,9400
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,365.82  ,11000,11000,10300
BEGIN DESCRIPTION:
MILE 365.82
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
```

```
#Sta/Elev= 31
  -665   660  1135   640  1935   600  2200 585.2  4150 574.6
  4250 579.3  4600 579.3  4620   574  4700 561.3  4800   557
  5200 555.7  5470 555.7  5580   554  5850 553.2  5950 559.8
  5980 560.2  6070 579.5  7200 579.5  7260 584.5  7450 589.4
  7500 589.4  7600 584.5  7650 579.4  8125 579.4  8600 584.4
  8680 589.4  9160 594.4  9200   596  9280   599  9450   600
  9850   660
#Mann= 3 , 0 , 0
  -665    .1     0  1935  .025     0  9200   .09     0
Bank Sta=1935,9200
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,363.72  ,12000,10600,6500
BEGIN DESCRIPTION:
MILE 363.72
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 38
    50   660   150   640   350   620   700   600  1000   600
  1270   590  1360 578.8  1930   576  2120 584.2  2270   584
  2340   582  2475 558.9  2770 550.3  3000 550.5  3130 549.7
  3190   551  3370   552  3470   554  3530   574  3550   583
  4110   586  4175   576  4250 567.6  4350 565.2  4470 567.1
  4500   577  4700   580  5550   579  5625 572.1  5770 571.4
  5810 571.5  6000 571.2  6350   573  6650   576  6745   597
  6850   620  9500   640  9501   660
#Mann= 3 , 0 , 0
    50   .12     0  1000  .025     0  6745   .09     0
Bank Sta=1000,6745
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,361.62  ,12300,11700,4000
BEGIN DESCRIPTION:
MILE 361.62
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 36
    40   660   338   596   420 579.5  1270   577  2475 579.5
  2800   579  2950   579  3100 578.9  3240 579.7  3340 582.2
  3375 582.7  3490 551.8  3590   550  3834 548.8  4100 545.6
  4320 548.2  4525 553.8  4560   556  4650 577.8  4830 580.34
  5200 576.5  5370   579  5430   584  5590   594  5690   599
  5840   600  5975   620  6460 639.5  6610   660  6890   620
```

```
   7090    610   8090    602   8990    602   9390    610  10390    620
  11660    660
#Mann= 3 , 0 , 0
     40    .13      0    338   .029      0   5590    .15      0
Bank Sta=338,5590
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,359.51  ,10500,9200,10000
BEGIN DESCRIPTION:
MILE 359.51
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 56
    100    660    700    620    800    600    900  595.2   1010    594
   1030    586   1070    579   1140    574   1160    569   1200    564
   1201    559   1260  559.6   1330  563.1   1380  571.7   1400  577.5
   1410    574   1440  577.3   1630    576   2425  575.7   2600    576
   2800  573.8   2910    574   3030  578.3   3280  577.2   3500    581
   3640    574   4060  578.2   4225  572.3   4250    555   4300    551
   4310  549.3   4490  548.2   4600  547.5   4770  547.1   4940  548.8
   5225  558.3   5310  559.8   5350  579.5   5580  576.2   5750    576
   6300  578.5   6650  583.3   7050  587.2   7120  586.7   7600    589
   8100    595   8200    600   8380    640   8520    660   8800    620
   9000    610  10000    602  10900    602  11300    610  12300    620
  13570    660
#Mann= 3 , 0 , 0
    100    .12      0   1010   .025      0   8100     .1      0
Bank Sta=1010,8100
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

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MILE 357.41
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
#Sta/Elev= 35
     50    660    208    596    250  579.4   1500  576.3   2040  577.1
   2580  576.3   3930  574.2   4160  546.5   4220  542.5   4500  536.5
   4690    537   4760  538.5   4870  537.5   4950  538.5   5030    541
   5070  546.5   5140    579   5310    579   5330  574.2   5580  580.5
   5720  586.7   5790    589   5870  594.2   6110  594.2   6230  589.2
   6470  589.2   6550  594.2   6780  599.2   6990  599.2   7190    594
   8400    600  10850    604  11300    610  11600    620  11601    660
#Mann= 5 ,-1 , 0
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```
   50   .026     0  3930   .026     0  5870    .06     0
 7190   .026     0  8400    .07     0
Bank Sta=208,5870
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,355.31  ,10700,11000,10200
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 1000  570.5   1790  574.2   1990    574   2160  547.7   2200  546.3
 2300  545.1   2370  545.4   3130  545.1   3220  546.8   3350    574
 3610  578.7   4470    569   5530    569   5900    574   6060    579
 6120    584   6170    595   6620    640   6700    642   7290    640
 8050    620   8230    600   8250    595   8280  580.5   8450    578
 8660    580   8700  594.5   8750    600   8820    620   8980    640
 9170    660
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XS Rating Curve= 0
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 2025  574.8   2246  575.3   2351  573.1   2443  566.9   2488    554
 2555  544.5   2563  543.5   2623  540.7   2700  538.6   2770  537.5
 2880  537.3   2970  536.9   3040  537.3   3125  538.6   3200    540
 3260  541.5   3450  544.3   3525  547.5   3580    569   3620    574
 3670  572.6   3712    569   3800  565.7   3974  564.6   4227  577.5
 4327  586.2   4500    589   4550    594   4551    660
#Mann= 3 , 0 , 0
  100    .11     0   600   .025     0  4550    .15     0
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XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Type RM Length L Ch R = 1 ,351.1   ,11400,11300,11300
```

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MILE 351.1
END DESCRIPTION:
Node Last Edited Time=Sep/10/2008 11:26:35
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540	599	560	594	600	589	670	584	1310	579
1600	574	2093	569.5	2350	568.9	2460	574.5	2628	573.2
2680	554	2703	549.5	2730	539.1	2875	532.9	2950	531.3
3030	529.7	3110	528.9	3200	530	3280	530.3	3350	531.9
3400	533.7	3430	539	3460	544	3470	549	3500	559
3550	569	3680	600	3700	620	3702	660		

#Mann= 3 , 0 , 0

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Bank Sta=560,3680
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

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MILE 349.0
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2190	579	2300	543.5	2380	541	2570	541.3	2650	540.7
2725	536	2800	534.5	2980	535.5	3075	535	3160	536
3500	544.5	3550	575.4	3720	578	3840	586	4010	586
4050	593	4090	600	4150	620	4390	680		

#Mann= 3 , 0 , 0

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Bank Sta=255,4050
XS Rating Curve= 0
Exp/Cntr=0.3,0.1

Chan Stop Cuts=-1

CHAPTER 2

Theoretical Basis for One-Dimensional Flow Calculations

This chapter describes the methodologies used in performing the one-dimensional flow calculations within HEC-RAS. The basic equations are presented along with discussions of the various terms. Solution schemes for the various equations are described. Discussions are provided as to how the equations should be applied, as well as applicable limitations.

Contents

General

This chapter describes the theoretical basis for one-dimensional water surface profile calculations. Discussions contained in this chapter are limited to steady flow water surface profile calculations and unsteady flow routing. When sediment transport calculations are added to the HEC-RAS system, discussions concerning this topic will be included in this manual.

Steady Flow Water Surface Profiles

HEC-RAS is currently capable of performing one-dimensional water surface profile calculations for steady gradually varied flow in natural or constructed channels. Subcritical, supercritical, and mixed flow regime water surface profiles can be calculated. Topics discussed in this section include: equations for basic profile calculations; cross section subdivision for conveyance calculations; composite Manning's n for the main channel; velocity weighting coefficient alpha; friction loss evaluation; contraction and expansion losses; computational procedure; critical depth determination; applications of the momentum equation; and limitations of the steady flow model.

Equations for Basic Profile Calculations

Water surface profiles are computed from one cross section to the next by solving the Energy equation with an iterative procedure called the standard step method. The Energy equation is written as follows:

$$Y_2 + Z_2 + \frac{\alpha_2 V_2^2}{2g} = Y_1 + Z_1 + \frac{\alpha_1 V_1^2}{2g} + h_e \qquad (2\text{-}1)$$

Where: Y_1, Y_2 = depth of water at cross sections

Z_1, Z_2 = elevation of the main channel inverts

V_1, V_2 = average velocities (total discharge/ total flow area)

α_1, α_2 = velocity weighting coefficients

g = gravitational acceleration

h_e = energy head loss

A diagram showing the terms of the energy equation is shown in Figure 2-1.

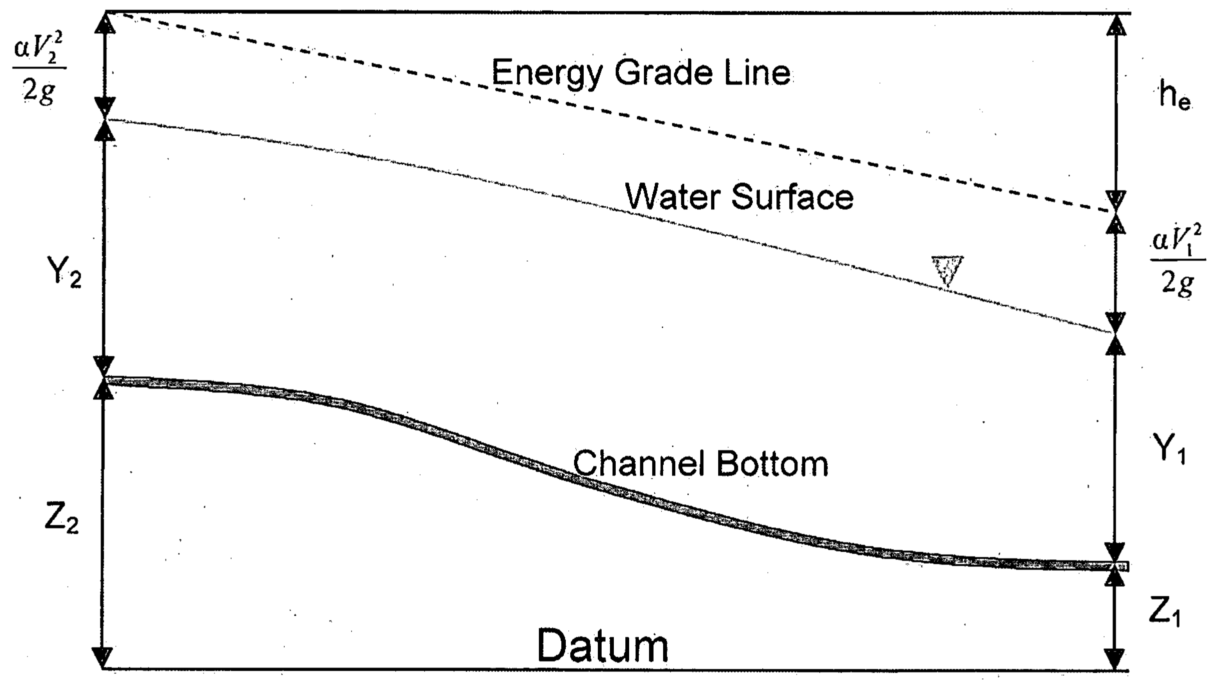


Figure 2.1 Representation of Terms in the Energy Equation

The energy head loss (h_e) between two cross sections is comprised of friction losses and contraction or expansion losses. The equation for the energy head loss is as follows:

$$h_e = L\overline{S}_f + C\left|\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right| \qquad (2\text{-}2)$$

Where: L = discharge weighted reach length

$\overline{S}_f$ = representative friction slope between two sections

C = expansion or contraction loss coefficient

The distance weighted reach length, L, is calculated as:

$$L = \frac{L_{lob}\,\overline{Q}_{lob} + L_{ch}\,\overline{Q}_{ch} + L_{rob}\,\overline{Q}_{rob}}{\overline{Q}_{lob} + \overline{Q}_{ch} + \overline{Q}_{rob}} \qquad (2\text{-}3)$$

where: L_{lob}, L_{ch}, L_{rob} = cross section reach lengths specified for flow in the left overbank, main channel, and right overbank, respectively

$\overline{Q}_{lob}, \overline{Q}_{ch}, \overline{Q}_{rob}$ = arithmetic average of the flows between sections for the left overbank, main channel, and right overbank, respectively

Cross Section Subdivision for Conveyance Calculations

The determination of total conveyance and the velocity coefficient for a cross section requires that flow be subdivided into units for which the velocity is uniformly distributed. The approach used in HEC-RAS is to subdivide flow in the **overbank** areas using the input cross section n-value break points (locations where n-values change) as the basis for subdivision (Figure 2-2). Conveyance is calculated within each subdivision from the following form of Manning's equation (based on English units):

$$Q = K\,S_f^{1/2} \qquad (2\text{-}4)$$

$$K = \frac{1.486}{n} A R^{2/3} \qquad (2\text{-}5)$$

where: K = conveyance for subdivision

n = Manning's roughness coefficient for subdivision

A = flow area for subdivision

R = hydraulic radius for subdivision (area / wetted perimeter)

The program sums up all the incremental conveyances in the overbanks to obtain a conveyance for the left overbank and the right overbank. The main channel conveyance is normally computed as a single conveyance element. The total conveyance for the cross section is obtained by summing the three subdivision conveyances (left, channel, and right).

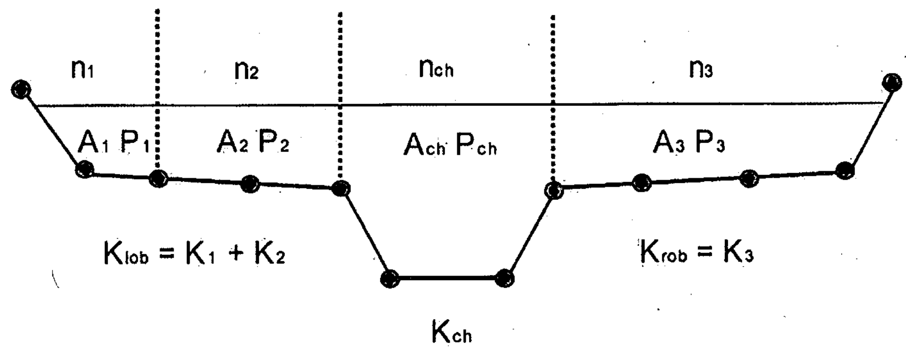


Figure 2.2 HEC-RAS Default Conveyance Subdivision Method

An alternative method available in HEC-RAS is to calculate conveyance between every coordinate point in the overbanks (Figure 2.3). The conveyance is then summed to get the total left overbank and right overbank values. This method is used in the Corps HEC-2 program. The method has been retained as an option within HEC-RAS in order to reproduce studies that were originally developed with HEC-2.

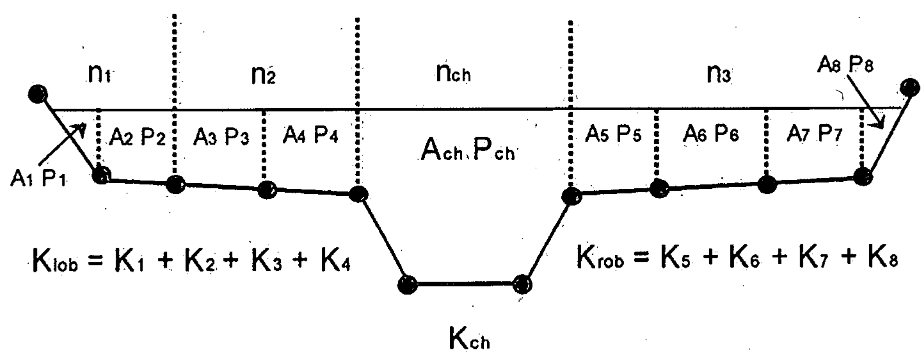


Figure 2.3 Alternative Conveyance Subdivision Method (HEC-2 style)

The two methods for computing conveyance will produce different answers whenever portions on the overbank have ground sections with significant vertical slopes. In general, the HEC-RAS default approach will provide a lower total conveyance for the same water surface elevation.

In order to test the significance of the two ways of computing conveyance, comparisons were performed using 97 data sets from the HEC profile accuracy study (HEC, 1986). Water surface profiles were computed for the 1% chance event using the two methods for computing conveyance in HEC-RAS. The results of the study showed that the HEC-RAS default approach will generally produce a higher computed water surface elevation. Out of the 2048 cross section locations, 47.5% had computed water surface elevations within 0.10 ft. (30.48 mm), 71% within 0.20 ft. (60.96 mm), 94.4% within 0.4 ft. (121.92 mm), 99.4% within 1.0 ft. (304.8 mm), and one cross section had a difference of 2.75 ft. (0.84 m). Because the differences tend to be in the same direction, some effects can be attributed to propagation of downstream differences.

The results from the conveyance comparisons do not show which method is more accurate, they only show differences. In general, it is felt that the HEC-RAS default method is more commensurate with the Manning equation and the concept of separate flow elements. Further research, with observed water surface profiles, will be needed to make any conclusions about the accuracy of the two methods.

Composite Manning's n for the Main Channel

Flow in the **main channel** is not subdivided, except when the roughness coefficient is changed within the channel area. HEC-RAS tests the applicability of subdivision of roughness within the main channel portion of a cross section, and if it is not applicable, the program will compute a single composite n value for the entire main channel. The program determines if the main channel portion of the cross section can be subdivided or if a composite main channel n value will be utilized based on the following criterion: if a main channel side slope is steeper than 5H:1V and the main channel has more than one n-value, a composite roughness n_c will be computed [Equation 6-17, Chow, 1959]. The channel side slope used by HEC-RAS is defined as the horizontal distance between adjacent n-value stations within the main channel over the difference in elevation of these two stations (see S_L and S_R of Figure 2.4).

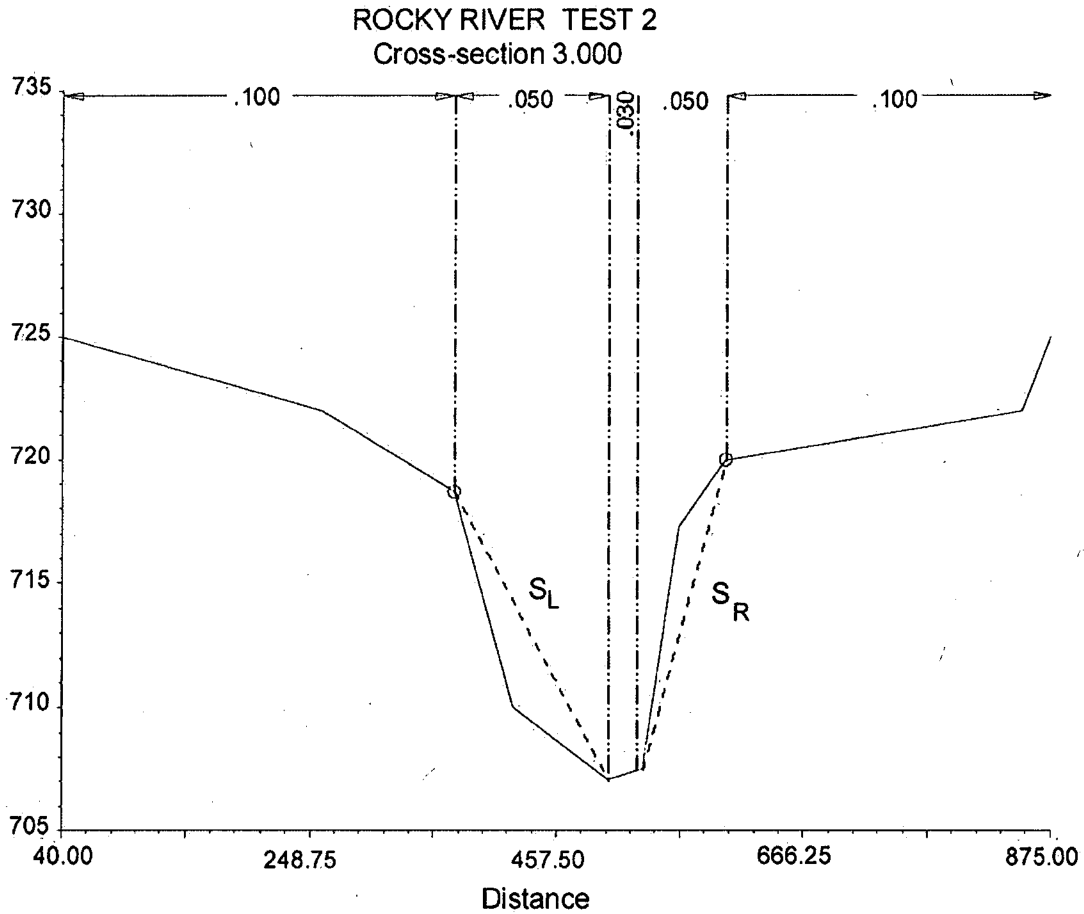


Figure 2.4 Definition of Bank Slope for Composite n_c Calculation

For the determination of n_c, the main channel is divided into N parts, each with a known wetted perimeter P_i and roughness coefficient n_i.

$$n_c = \left[\frac{\sum_{i=1}^{N} \left(P_i \, n_i^{1.5} \right)}{P} \right]^{2/3} \tag{2-6}$$

where: n_c = composite or equivalent coefficient of roughness

P = wetted perimeter of entire main channel

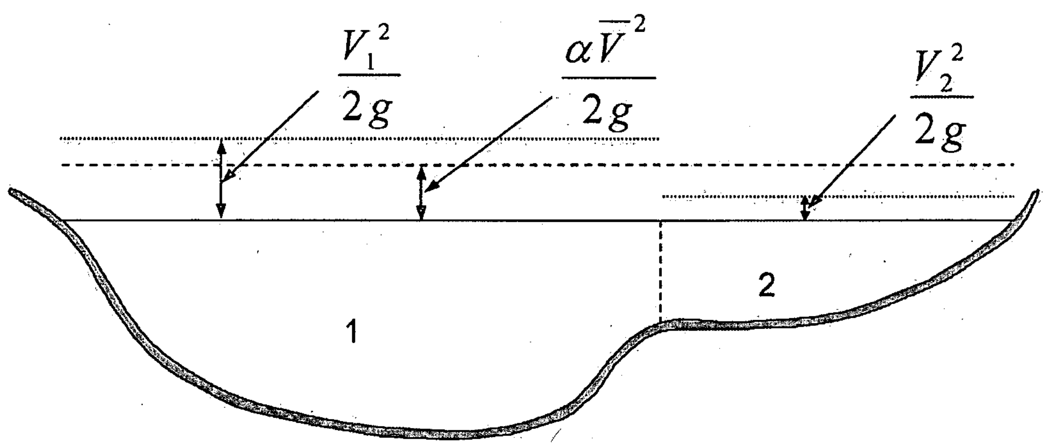
P_i = wetted perimeter of subdivision I

n_i = coefficient of roughness for subdivision I

The computed composite n_c should be checked for reasonableness. The computed value is the composite main channel n value in the output and summary tables.

Evaluation of the Mean Kinetic Energy Head

Because the HEC-RAS software is a one-dimensional water surface profiles program, only a single water surface and therefore a single mean energy are computed at each cross section. For a given water surface elevation, the mean energy is obtained by computing a flow weighted energy from the three subsections of a cross section (left overbank, main channel, and right overbank). Figure 2.5 below shows how the mean energy would be obtained for a cross section with a main channel and a right overbank (no left overbank area).



V_1 = mean velocity for subarea 1

V_2 = mean velocity for subarea 2

Figure 2.5 Example of How Mean Energy is Obtained

To compute the mean kinetic energy it is necessary to obtain the velocity head weighting coefficient alpha. Alpha is calculated as follows:

Mean Kinetic Energy Head = Discharge-Weighted Velocity Head

$$\alpha \frac{\overline{V}^2}{2g} = \frac{Q_1 \frac{V_1^2}{2g} + Q_2 \frac{V_2^2}{2g}}{Q_1 + Q_2} \qquad (2\text{-}7)$$

$$\alpha = \frac{2g\left[Q_1 \frac{V_1^2}{2g} + Q_2 \frac{V_2^2}{2g}\right]}{(Q_1 + Q_2)\overline{V}^2} \quad (2\text{-}8)$$

$$\alpha = \frac{Q_1 V_1^2 + Q_2 V_2^2}{(Q_1 + Q_2)\overline{V}^2} \quad (2\text{-}9)$$

In General:

$$\alpha = \frac{\left[Q_1 V_1^2 + Q_2 V_2^2 + \ldots + Q_N V_N^2\right]}{Q\overline{V}^2} \quad (2\text{-}10)$$

The velocity coefficient, α, is computed based on the conveyance in the three flow elements: left overbank, right overbank, and channel. It can also be written in terms of conveyance and area as in the following equation:

$$\alpha = \frac{(A_t)^2\left[\frac{K_{lob}^3}{A_{lob}^2} + \frac{K_{ch}^3}{A_{ch}^2} + \frac{K_{rob}^3}{A_{rob}^2}\right]}{K_t^3} \quad (2\text{-}11)$$

Where: A_t = total flow area of cross section

A_{lob}, A_{ch}, A_{rob} = flow areas of left overbank, main channel and right overbank, respectively

K_t = total conveyance of cross section

K_{lob}, K_{ch}, K_{rob} = conveyances of left overbank, main channel and right overbank, respectively

Friction Loss Evaluation

Friction loss is evaluated in HEC-RAS as the product of $\overline{S}_f$ and L (Equation 2-2), where $\overline{S}_f$ is the representative friction slope for a reach and L is defined by Equation 2-3. The friction slope (slope of the energy gradeline) at each cross section is computed from Manning's equation as follows:

$$S_f = \left(\frac{Q}{K}\right)^2 \tag{2-12}$$

Alternative expressions for the representative reach friction slope ($\bar{S}_f$) in HEC-RAS are as follows:

<u>Average Conveyance Equation</u>

$$\bar{S}_f = \left(\frac{Q_1 + Q_2}{K_1 + K_2}\right)^2 \tag{2-13}$$

<u>Average Friction Slope Equation</u>

$$\bar{S}_f = \frac{S_{f1} + S_{f2}}{2} \tag{2-14}$$

<u>Geometric Mean Friction Slope Equation</u>

$$\bar{S}_f = \sqrt{S_{f1} \times S_{f2}} \tag{2-15}$$

<u>Harmonic Mean Friction Slope Equation</u>

$$\bar{S}_f = \frac{2(S_{f1} \times S_{f2})}{S_{f1} + S_{f2}} \tag{2-16}$$

Equation 2-13 is the "default" equation used by the program; that is, it is used automatically unless a different equation is requested by input. The program also contains an option to select equations, depending on flow regime and profile type (e.g., S1, M1, etc.). Further discussion of the alternative methods for evaluating friction loss is contained in Chapter 4, "Overview of Optional Capabilities."

Contraction and Expansion Loss Evaluation

Contraction and expansion losses in HEC-RAS are evaluated by the following equation:

$$h_{ce} = C\left|\frac{\alpha_1 V_1^2}{2g} - \frac{\alpha_2 V_2^2}{2g}\right| \tag{2-17}$$

Where: C = the contraction or expansion coefficient

The program assumes that a contraction is occurring whenever the velocity head downstream is greater than the velocity head upstream. Likewise, when the velocity head upstream is greater than the velocity head downstream, the program assumes that a flow expansion is occurring. Typical "C" values can be found in Chapter 3, "Basic Data Requirements."

Computation Procedure

The unknown water surface elevation at a cross section is determined by an iterative solution of Equations 2-1 and 2-2. The computational procedure is as follows:

1. Assume a water surface elevation at the upstream cross section (or downstream cross section if a supercritical profile is being calculated).

2. Based on the assumed water surface elevation, determine the corresponding total conveyance and velocity head.

3. With values from step 2, compute $\overline{S}_f$ and solve Equation 2-2 for h_e.

4. With values from steps 2 and 3, solve Equation 2-1 for WS_2.

5. Compare the computed value of WS_2 with the value assumed in step 1; repeat steps 1 through 5 until the values agree to within .01 feet (.003 m), or the user-defined tolerance.

The criterion used to assume water surface elevations in the iterative procedure varies from trial to trial. The first trial water surface is based on projecting the previous cross section's water depth onto the current cross section. The second trial water surface elevation is set to the assumed water surface elevation plus 70% of the error from the first trial (computed W.S. - assumed W.S.). In other words, W.S. new = W.S. assumed + 0.70 * (W.S. computed - W.S. assumed). The third and subsequent trials are generally based on a "Secant" method of projecting the rate of change of the difference between computed and assumed elevations for the previous two trials. The equation for the secant method is as follows:

$$WS_I = WS_{I-2} - Err_{I-2} * Err\_Assum / Err\_Diff \tag{2-18}$$

Where: WS_I = the new assumed water surface

WS_{I-1} = the previous iteration's assumed water surface

WS_{I-2} = the assumed water surface from two trials previous

Err_{I-2} = the error from two trials previous (computed water surface minus assumed from the I-2 iteration)

Err_Assum = the difference in assumed water surfaces from the previous two trials. Err_Assum = WS_{I-2} - WS_{I-1}

Err_Diff = the assumed water surface minus the calculated water surface from the previous iteration (I-1), plus the error from two trials previous (Err_{I-2}). Err_Diff = WS_{I-1} - WS_Calc_{I-1} + Err_{I-2}

The change from one trial to the next is constrained to a maximum of 50 percent of the assumed depth from the previous trial. On occasion the secant method can fail if the value of Err_Diff becomes too small. If the Err_Diff is less than 1.0E-2, then the secant method is not used. When this occurs, the program computes a new guess by taking the average of the assumed and computed water surfaces from the previous iteration.

The program is constrained by a *maximum number of iterations* (the default is 20) for balancing the water surface. While the program is iterating, it keeps track of the water surface that produces the minimum amount of error between the assumed and computed values. This water surface is called the *minimum error water surface*. If the maximum number of iterations is reached before a balanced water surface is achieved, the program will then calculate critical depth (if this has not already been done). The program then checks to see if the error associated with the *minimum error water surface* is within a predefined tolerance (the default is 0.3 ft or 0.1 m). If the minimum error water surface has an associated error less than the predefined tolerance, and this water surface is on the correct side of critical depth, then the program will use this water surface as the final answer and set a warning message that it has done so. If the minimum error water surface has an associated error that is greater than the predefined tolerance, or it is on the wrong side of critical depth, the program will use critical depth as the final answer for the cross section and set a warning message that it has done so. The rationale for using the minimum error water surface is that it is probably a better answer than critical depth, as long as the above criteria are met. Both the minimum error water surface and critical depth are only used in this situation to allow the program to continue the solution of the water surface profile. Neither of these two answers are considered to be valid solutions, and therefore warning messages are issued when either is used. In general, when the program cannot balance the energy equation at a cross section, it is usually caused by an inadequate number of cross sections (cross sections spaced too far apart) or bad cross section data. Occasionally, this can occur because the program is attempting to calculate a subcritical water surface when the flow regime is actually supercritical.

When a "balanced" water surface elevation has been obtained for a cross section, checks are made to ascertain that the elevation is on the "right" side of the critical water surface elevation (e.g., above the critical elevation if a subcritical profile has been requested by the user). If the balanced elevation is on the "wrong" side of the critical water surface elevation, critical depth is assumed for the cross section and a "warning" message to that effect is displayed by the program. The program user should be aware of critical depth assumptions and determine the reasons for their occurrence, because in many cases they result from reach lengths being too long or from misrepresentation of the effective flow areas of cross sections.

For a subcritical profile, a preliminary check for proper flow regime involves checking the Froude number. The program calculates the Froude number of the "balanced" water surface for both the main channel only and the entire cross section. If either of these two Froude numbers are greater than 0.94, then the program will check the flow regime by calculating a more accurate estimate of critical depth using the minimum specific energy method (this method is described in the next section). A Froude number of 0.94 is used instead of 1.0, because the calculation of Froude number in irregular channels is not accurate. Therefore, using a value of 0.94 is conservative, in that the program will calculate critical depth more often than it may need to.

For a supercritical profile, critical depth is automatically calculated for every cross section, which enables a direct comparison between balanced and critical elevations.

Critical Depth Determination

Critical depth for a cross section will be determined if any of the following conditions are satisfied:

(1) The supercritical flow regime has been specified.

(2) The calculation of critical depth has been requested by the user.

(3) This is an external boundary cross section and critical depth must be determined to ensure the user entered boundary condition is in the correct flow regime.

(4) The Froude number check for a subcritical profile indicates that critical depth needs to be determined to verify the flow regime associated with the balanced elevation.

(5) The program could not balance the energy equation within the

CDQ000020080041 Rev 0

Attachment_03_Guntersville Rating Curve.pdf

with attachments:

Guntersville Rating Curves.xls

Attachment 4

Source: Reference 2.4

Calculation No: CDQ000020080041

Nickajack Steady-State Tailwater Rating

Q*1000	Q	Elevation
0	0	595.5
50	50,000	597.8
70	70,000	600.0
100	100,000	603.0
150	150,000	607.5
200	200,000	611.6
250	250,000	614.8
300	300,000	617.8
350	350,000	620.3
400	400,000	622.4
450	450,000	624.5
500	500,000	626.6
600	600,000	630.3
700	700,000	633.7
800	800,000	637.0
1000	1,000,000	642.2
1200	1,200,000	647.4
1400	1,400,000	652.3
1500	1,500,000	654.5

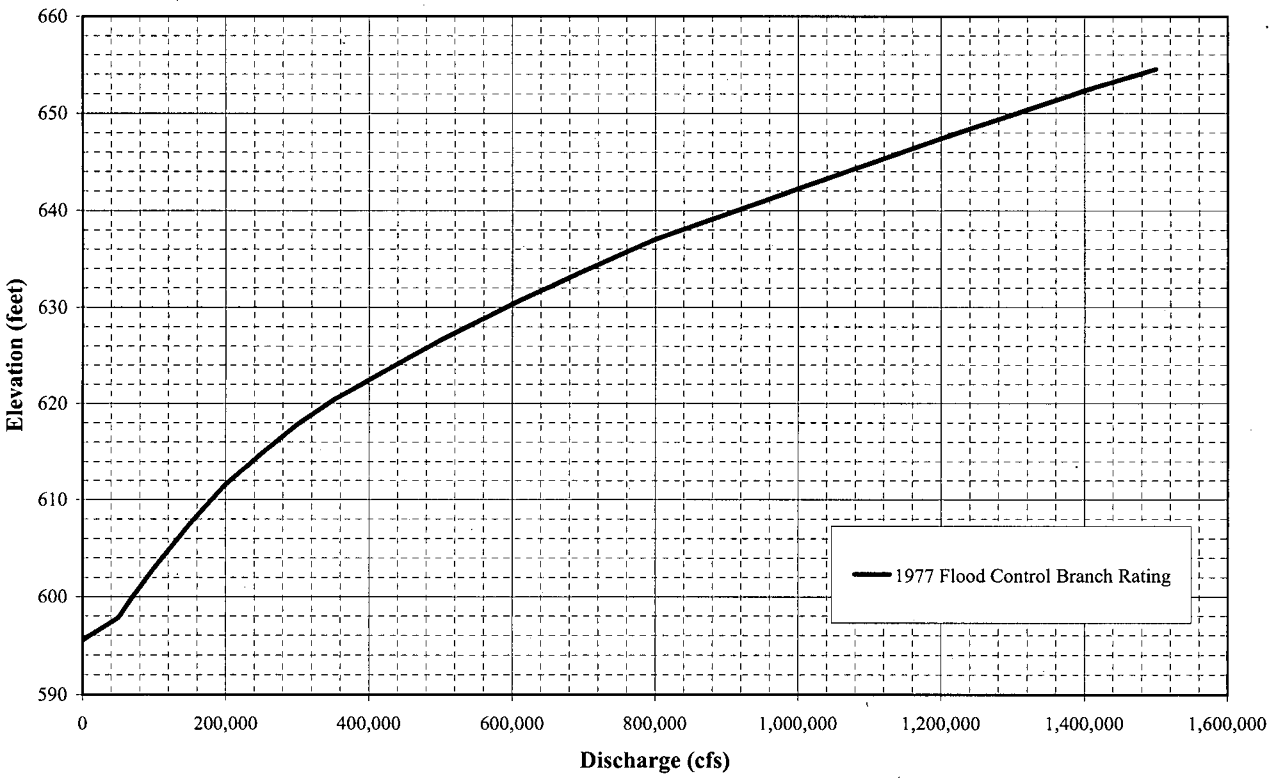
Based on 1977 Data
Book # 107-96.01

Attachment 4

Source: Reference 2.4

Calculation No: CDQ000020080041

Nickajack Steady-State Tailwater Rating



Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q 1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		HW Elev	Discharge Q (cfs)
3/14/73 0:00	0.0	594.25	51000
3/14/73 6:00	6.0	594.25	51000
3/14/73 8:30	8.5	594.10	51000
3/14/73 9:30	9.5	594.10	60000
3/14/73 13:00	13.0	593.95	60000
3/15/73 0:00	24.0	593.80	60000
3/15/73 6:00	30.0	593.75	60000
3/15/73 9:30	33.5	593.75	60000
3/15/73 10:30	34.5	593.75	70000
3/15/73 17:00	41.0	593.75	70000
3/15/73 18:00	42.0	593.90	70000
3/15/73 19:30	43.5	594.00	70000
3/15/73 21:30	45.5	594.00	90000
3/16/73 0:00	48.0	594.00	90000
3/16/73 3:30	51.5	594.10	90000
3/16/73 6:00	54.0	594.15	130000
3/16/73 8:00	56.0	594.10	165000
3/16/73 9:30	57.5	593.70	200000
3/16/73 11:30	59.5	593.40	200000
3/16/73 12:30	60.5	593.40	225000
3/16/73 16:00	64.0	593.40	225000
3/16/73 19:00	67.0	593.50	230000
3/16/73 22:30	70.5	593.80	236000
3/16/73 23:30	71.5	593.95	230000
3/17/73 0:00	72.0	594.00	230000
3/17/73 1:00	73.0	594.10	230000
3/17/73 4:00	76.0	594.25	232000
3/17/73 6:00	78.0	594.40	233000
3/17/73 10:30	82.5	594.90	235000
3/17/73 12:30	84.5	595.00	270000
3/17/73 15:00	87.0	595.00	275000
3/17/73 18:00	90.0	595.20	277000
3/18/73 0:00	96.0	595.40	280000
3/18/73 6:00		595.60	283000
3/18/73 10:30		595.60	285000
3/18/73 11:30		595.60	295000
3/18/73 15:30		595.60	295000
3/18/73 16:30		595.55	315000
3/19/73 0:00		595.40	315000
3/19/73 5:30		595.30	315000
3/19/73 6:30		595.30	310000
3/19/73 11:30		595.20	310000
3/19/73 12:30		595.20	298000
3/19/73 18:00		595.10	297000
3/20/73 0:00		595.00	295000

TN River at Guntersville, AL TRM 358.0
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev
3/14/73 0:00	594.42
3/14/73 2:00	594.43
3/14/73 3:00	594.43
3/14/73 5:00	594.43
3/14/73 9:00	594.30
3/14/73 10:00	594.23
3/14/73 14:00	594.00
3/14/73 22:00	594.00
3/15/73 0:00	594.00
3/15/73 2:00	593.95
3/15/73 4:00	593.90
3/15/73 6:00	593.90
3/15/73 8:00	593.88
3/15/73 10:00	593.95
3/15/73 11:00	593.97
3/15/73 17:00	593.95
3/15/73 21:00	594.25
3/15/73 23:00	594.22
3/16/73 0:00	594.25
3/16/73 5:00	594.40
3/16/73 7:00	594.40
3/16/73 8:00	594.40
3/16/73 10:00	594.20
3/16/73 11:30	593.66
3/16/73 12:30	594.06
3/16/73 14:00	593.95
3/16/73 19:00	594.15
3/16/73 22:00	594.35
3/17/73 0:00	594.53
3/17/73 6:00	595.06
3/17/73 12:00	595.57
3/17/73 14:00	595.70
3/17/73 16:00	595.70
3/17/73 23:00	595.95
3/18/73 0:00	596.10
3/18/73 12:00	596.50
3/18/73 18:00	596.45
3/19/73 0:00	596.30
3/19/73 12:00	596.05
3/19/73 14:00	596.02
3/19/73 15:00	596.00
3/19/73 18:00	595.90
3/20/73 0:00	595.72
3/20/73 6:00	595.50
3/20/73 10:00	595.27

TN River nr Scottsboro, AL TRM 385.8
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev
3/14/73 0:00	594.64
3/14/73 1:00	594.64
3/14/73 9:00	594.45
3/14/73 12:00	594.40
3/14/73 13:00	594.45
3/14/73 18:00	594.35
3/14/73 21:00	594.30
3/15/73 0:00	594.32
3/15/73 2:00	594.32
3/15/73 6:00	594.26
3/15/73 7:00	594.35
3/15/73 10:00	594.15
3/15/73 14:00	594.12
3/15/73 16:00	594.12
3/15/73 18:00	594.20
3/16/73 0:00	594.65
3/16/73 6:00	595.20
3/16/73 9:00	595.50
3/16/73 12:00	595.70
3/16/73 13:30	595.75
3/16/73 15:00	596.00
3/16/73 18:00	596.40
3/16/73 21:00	596.76
3/17/73 0:00	597.00
3/17/73 6:00	597.50
3/17/73 12:00	598.00
3/17/73 16:00	598.26
3/17/73 18:00	598.33
3/18/73 0:00	598.55
3/18/73 6:00	598.76
3/18/73 12:00	598.96
3/18/73 15:00	599.00
3/18/73 17:00	599.00
3/18/73 19:00	599.00
3/19/73 0:00	598.95
3/19/73 6:00	598.85
3/19/73 12:00	598.70
3/19/73 18:00	598.55
3/20/73 0:00	598.35
3/20/73 6:00	598.10
3/20/73 12:00	597.80
3/20/73 18:00	597.48
3/21/73 0:00	597.25
3/21/73 6:00	596.85
3/21/73 12:00	596.42

JMF 2/18/09
Gage Heights in blue were abstracted from the original streamgage chart - see the Guntersville section in white notebook titled 'OBSERVED DATA 1973 FLOOD'

JMF 2/18/09
Data in red abstracted from plot of observed data

TN River at Widows Bar, AL TRM 407.6 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev	Date and Time	Gage Ht	WS Elev
3/14/73 0:00	595.61	3/14/73 0:00		595.61
3/14/73 2:00	595.16	3/14/73 2:00		595.16
3/14/73 4:00	594.86	3/14/73 4:00		594.86
3/14/73 6:00	594.76	3/14/73 6:00		594.76
3/14/73 9:00	594.71	3/14/73 9:00		594.71
3/14/73 10:00	594.83	3/14/73 10:00		594.83
3/14/73 12:00	595.11	3/14/73 12:00		595.11
3/14/73 15:00	595.32	3/14/73 15:00		595.32
3/14/73 17:00	595.40	3/14/73 17:00		595.40
3/14/73 19:00	595.36	3/14/73 19:00		595.36
3/14/73 21:00	595.31	3/14/73 21:00		595.31
3/15/73 0:00	595.31	3/15/73 0:00		595.31
3/15/73 1:00	595.32	3/15/73 1:00		595.32
3/15/73 6:00	595.34	3/15/73 6:00		595.34
3/15/73 7:30	595.39	3/15/73 7:30		595.39
3/15/73 14:00	595.29	3/15/73 14:00		595.29
3/15/73 17:00	595.32	3/15/73 17:00		595.32
3/15/73 19:00	595.42	3/15/73 19:00		595.42
3/15/73 21:00	595.62	3/15/73 21:00		595.62
3/15/73 23:00	596.01	3/15/73 23:00		596.01
3/16/73 0:00	596.46	3/16/73 0:00	15.45	596.46
3/16/73 2:00	597.19	3/16/73 2:00	16.12	597.13
3/16/73 5:30	598.51	3/16/73 4:00	16.88	597.89
3/16/73 8:00	600.01	3/16/73 6:00	17.80	598.81
3/16/73 10:00	601.01	3/16/73 8:00	18.98	599.99
3/16/73 12:00	601.81	3/16/73 10:00	19.85	600.86
3/16/73 16:00	604.11	3/16/73 12:00	20.70	601.71
3/16/73 17:00	604.61	3/16/73 14:00	21.85	602.86
3/16/73 18:00	604.91	3/16/73 16:00	23.05	604.06
3/16/73 23:00	606.06	3/16/73 18:00	23.80	604.81
3/17/73 0:00	606.31	3/16/73 20:00	24.35	605.36
3/17/73 6:00	607.49	3/16/73 22:00	24.80	605.81
3/17/73 8:00	607.76	3/17/73 0:00	25.25	606.26
3/17/73 13:00	608.39	3/17/73 2:00	25.65	606.66
3/17/73 15:00	608.56	3/17/73 4:00	26.05	607.06
3/17/73 19:00	608.81	3/17/73 6:00	26.40	607.41
3/18/73 0:00	609.11	3/17/73 8:00	26.70	607.71
3/18/73 3:00	609.21	3/17/73 10:00	26.95	607.96
3/18/73 4:00	609.26	3/17/73 12:00	27.20	608.21
3/18/73 5:00	609.26	3/17/73 14:00	27.45	608.46
3/18/73 12:00	609.31	3/17/73 16:00	27.60	608.61
3/18/73 18:00	609.27	3/17/73 18:00	27.71	608.72
3/18/73 22:00	609.22	3/17/73 20:00	27.80	608.81
3/19/73 0:00	609.19	3/17/73 22:00	27.93	608.94
3/19/73 4:00	609.01	3/18/73 0:00	28.05	609.06

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q 1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		HW Elev	Discharge Q (cfs)
3/20/73 6:00		594.60	290000
3/20/73 9:00		594.50	288000
3/20/73 12:00		594.45	270000
3/20/73 15:00		594.55	242000
3/20/73 18:00		594.55	240000
3/21/73 0:00		594.45	238000
3/21/73 6:00		594.20	235000
3/21/73 7:30		594.10	235000
3/21/73 9:30		594.10	200000
3/21/73 11:30		594.20	200000
3/21/73 13:30		594.30	165000
3/21/73 15:00		594.50	165000
3/21/73 18:00		594.60	165000
3/21/73 23:30		594.60	165000
3/22/73 0:00		594.60	
3/22/73 0:30		594.60	160000
3/22/73 5:00		594.60	160000
3/22/73 6:00		594.50	159000
3/22/73 8:00		594.40	159000
3/22/73 11:00		594.40	159000
3/22/73 13:30		594.30	159000
3/22/73 15:30		594.25	130000
3/23/73 0:00		594.25	130000
3/23/73 3:00		594.20	130000
3/23/73 6:00		594.15	130000
3/23/73 9:00		594.10	130000
3/23/73 11:30		594.10	130000
3/23/73 12:30		594.10	120000
3/23/73 18:00		594.10	120000
3/24/73 0:00		594.10	120000
3/24/73 6:00		594.10	120000
3/24/73 12:00		594.05	120000
3/24/73 18:00		594.00	120000
3/25/73 0:00		594.00	120000

TN River at Guntersville, AL TRM 358.0
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev
3/20/73 12:00	595.17
3/20/73 13:00	595.15
3/20/73 16:00	595.15
3/20/73 17:00	595.22
3/20/73 21:00	595.22
3/21/73 0:00	595.15
3/21/73 2:30	595.07
3/21/73 3:00	595.04
3/21/73 4:00	595.00
3/21/73 9:00	594.72
3/21/73 10:00	594.72
3/21/73 11:00	594.75
3/21/73 14:00	594.75
3/21/73 16:00	594.92
3/21/73 18:00	594.95
3/21/73 21:00	594.99
3/21/73 23:00	594.97
3/22/73 0:00	594.97
3/22/73 2:00	594.93
3/22/73 12:00	594.65
3/22/73 16:00	594.51
3/22/73 17:00	594.55
3/22/73 20:00	594.55
3/23/73 0:00	594.53
3/23/73 4:00	594.50
3/23/73 10:00	594.40
3/23/73 13:00	594.34
3/23/73 18:00	594.37
3/24/73 0:00	594.37
3/24/73 6:00	594.34
3/24/73 12:00	594.26
3/24/73 18:00	594.21
3/24/73 22:00	594.20
3/25/73 0:00	594.25

TN River nr Scottsboro, AL TRM 385.8
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev
3/21/73 15:00	596.26
3/21/73 16:00	596.25
3/21/73 18:00	596.23
3/22/73 0:00	596.12
3/22/73 4:00	596.00
3/22/73 12:00	595.66
3/22/73 18:00	595.49
3/22/73 21:00	595.45
3/23/73 0:00	595.40
3/23/73 6:00	595.30
3/23/73 12:00	595.18
3/23/73 18:00	595.15
3/23/73 23:00	595.15
3/24/73 0:00	595.14
3/24/73 6:00	595.06
3/24/73 12:00	595.02
3/24/73 18:00	595.00
3/24/73 21:00	594.96
3/24/73 23:00	594.90
3/25/73 0:00	594.92

TN River at Widows Bar, AL TRM 407.6 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev
3/19/73 9:00	608.75		3/18/73 2:00	28.15	609.16
3/19/73 12:00	608.51		3/18/73 4:00	28.20	609.21
3/19/73 18:00	608.01		3/18/73 6:00	28.22	609.23
3/20/73 0:00	607.49		3/18/73 8:00	28.23	609.24
3/20/73 9:00	606.61		3/18/73 10:00	28.24	609.25
3/20/73 15:00	605.96		3/18/73 12:00	28.24	609.25
3/20/73 18:00	605.31		3/18/73 14:00	28.24	609.25
3/20/73 20:00	604.96		3/18/73 16:00	28.23	609.24
3/21/73 0:00	604.36		3/18/73 18:00	28.21	609.22
3/21/73 7:00	603.41		3/18/73 20:00	28.20	609.21
3/21/73 10:00	603.07		3/18/73 22:00	28.17	609.18
3/21/73 15:00	602.36		3/19/73 0:00	28.12	609.13
3/21/73 18:00	601.81		3/19/73 2:00	28.02	609.03
3/21/73 21:00	601.37		3/19/73 4:00	27.95	608.96
3/22/73 0:00	601.01		3/19/73 6:00	27.85	608.86
3/22/73 6:00	600.51		3/19/73 8:00	27.75	608.76
3/22/73 12:00	600.11		3/19/73 10:00	27.63	608.64
3/22/73 18:00	599.76		3/19/73 12:00	27.46	608.47
3/23/73 0:00	599.51		3/19/73 14:00	27.30	608.31
3/23/73 6:00	599.33		3/19/73 16:00	27.12	608.13
3/23/73 12:00	599.21		3/19/73 18:00	26.95	607.96
3/23/73 18:00	599.11		3/19/73 20:00	26.77	607.78
3/23/73 21:00	599.06		3/19/73 22:00	26.61	607.62
3/24/73 0:00	598.86		3/20/73 0:00	26.42	607.43
3/24/73 3:00	598.76		3/20/73 2:00	26.24	607.25
3/24/73 6:00	598.71		3/20/73 4:00	26.12	607.13
3/24/73 10:00	598.71		3/20/73 6:00	25.83	606.84
3/24/73 12:00	598.73		3/20/73 8:00	25.65	606.66
3/25/73 0:00	598.73		3/20/73 10:00	25.40	606.41
			3/20/73 12:00	25.2	606.21
			3/20/73 14:00	24.96	605.97
			3/20/73 16:00	24.7	605.71
			3/20/73 18:00	24.24	605.25
			3/20/73 20:00	23.88	604.89
			3/20/73 22:00	23.58	604.59
			3/21/73 0:00	23.28	604.29
			3/21/73 7:00		603.41
			3/21/73 10:00		603.07
			3/21/73 15:00		602.36
			3/21/73 18:00		601.81
			3/21/73 21:00		601.37
			3/22/73 0:00		601.01
			3/22/73 6:00		600.51
			3/22/73 12:00		600.11
			3/22/73 18:00		599.76

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q 1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		HW Elev	Discharge Q (cfs)

TN River at Guntersville, AL TRM 358.0
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev

TN River nr Scottsboro, AL TRM 385.8
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	WS Elev

TN River at Widows Bar, AL TRM 407.6 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev
			3/23/73 0:00		599.51
			3/23/73 6:00		599.33
			3/23/73 12:00		599.21
			3/23/73 18:00		599.11
			3/23/73 21:00		599.06
			3/24/73 0:00		598.86
			3/24/73 3:00		598.76
			3/24/73 6:00		598.71
			3/24/73 10:00		598.71
			3/24/73 12:00		598.73
			3/25/73 0:00		598.73

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev
3/14/73 0:00	596.11		3/14/73 0:00		596.11
3/14/73 1:00	595.86		3/14/73 1:00		595.86
3/14/73 2:00	595.71		3/14/73 2:00		595.71
3/14/73 3:00	595.61		3/14/73 3:00		595.61
3/14/73 4:00	595.51		3/14/73 4:00		595.51
3/14/73 5:00	595.46		3/14/73 5:00		595.46
3/14/73 6:00	595.41		3/14/73 6:00		595.41
3/14/73 7:00	595.76		3/14/73 7:00		595.76
3/14/73 8:00	595.91		3/14/73 8:00		595.91
3/14/73 9:00	596.61		3/14/73 9:00		596.61
3/14/73 11:00	596.90		3/14/73 11:00		596.90
3/14/73 13:00	597.11		3/14/73 13:00		597.11
3/14/73 14:00	597.19		3/14/73 14:00		597.19
3/14/73 15:00	597.21		3/14/73 15:00		597.21
3/14/73 16:00	597.21		3/14/73 16:00		597.21
3/14/73 18:00	597.21		3/14/73 18:00		597.21
3/14/73 21:00	597.22		3/14/73 21:00		597.22
3/14/73 23:00	597.26		3/14/73 23:00		597.26
3/15/73 1:00	597.24		3/15/73 1:00		597.24
3/15/73 5:00	597.28		3/15/73 5:00		597.28
3/15/73 9:00	597.41		3/15/73 9:00		597.41
3/15/73 12:00	597.39		3/15/73 12:00		597.39
3/15/73 15:00	597.49		3/15/73 15:00		597.49
3/15/73 18:00	597.66		3/15/73 18:00		597.66
3/15/73 19:00	598.01		3/15/73 19:00		598.01
3/15/73 20:00	598.51		3/15/73 20:00		~~598.51~~
3/16/73 0:00	600.66		3/16/73 0:00	18.81	599.82
3/16/73 2:00	601.66		3/16/73 2:00	20.02	601.03
3/16/73 3:30	603.01		3/16/73 4:00	21.11	602.12
3/16/73 5:00	604.01		3/16/73 6:00	22.91	603.92
3/16/73 6:00	604.56		3/16/73 8:00	23.97	604.98
3/16/73 8:00	605.51		3/16/73 10:00	24.77	605.78
3/16/73 9:00	606.21		3/16/73 12:00	25.94	606.95
3/16/73 12:00	608.01		3/16/73 14:00	27.38	608.39
3/16/73 13:00	609.01		3/16/73 16:00	28.80	609.81
3/16/73 15:00	609.91		3/16/73 18:00	29.42	610.43
3/16/73 18:00	610.91		3/16/73 20:00	30.03	611.04
3/16/73 21:00	611.81		3/16/73 22:00	30.66	611.67
3/17/73 0:00	612.51		3/17/73 0:00	31.17	612.18
3/17/73 1:30	613.01		3/17/73 2:00	31.53	612.54
3/17/73 5:00	613.56		3/17/73 4:00	32.21	613.22
3/17/73 8:00	613.90		3/17/73 6:00	32.55	613.56
3/17/73 10:00	614.15		3/17/73 8:00	32.79	613.80
3/17/73 12:00	614.40		3/17/73 10:00	33.07	614.08
3/17/73 14:00	614.55		3/17/73 12:00	33.41	614.42

JMF 2/16/09 Data in red abstracted from plot of observed data

JMF 2/18/09 Gage Heights in blue are from USGS bi-hourly tabulation - see the Guntersville section in white notebook titled 'OBSERVED DATA 1973 FLOOD'

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		TW Elev	Date	Time	Discharge Q (cfs)
3/14/73 0:00	0.0	597.00	3/14/1973	1	19000
3/14/73 2:00	2.0	596.40		2	18400
3/14/73 4:00	4.0	596.05		3	18400
3/14/73 6:00	6.0	595.90		4	18400
3/14/73 6:30	6.5	595.90		5	18400
3/14/73 7:30	7.5	596.10		6	18100
3/14/73 8:30	8.5	596.40		7	18400
3/14/73 9:30	9.5	597.25		8	26500
3/14/73 10:30	10.5	597.55		9	28700
3/14/73 15:00	15.0	598.30		10	41000
3/15/73 0:00	24.0	598.25		11	41300
3/15/73 6:00	30.0	598.30		12	41600
3/15/73 9:00	33.0	598.40		13	41300
3/15/73 12:00	36.0	598.50		14	41500
3/15/73 17:00	41.0	598.60		15	42400
3/15/73 18:00	42.0	598.80		16	42700
3/15/73 18:30	42.5	599.00		17	42400
3/15/73 21:00	45.0	599.75		18	42400
3/16/73 0:00	48.0	601.60		19	42400
3/16/73 3:30	51.5	603.90		20	42400
3/16/73 4:30	52.5	605.00		21	42000
3/16/73 6:00	54.0	606.10		22	43200
3/16/73 10:30	58.5	608.30		23	43200
3/16/73 11:30	59.5	608.90		24	43200
3/16/73 12:30	60.5	609.75	3/15/1973	1	43000
/16/73 14:30	62.5	611.60		2	43000
/16/73 16:00	64.0	612.50		3	43200
/16/73 18:00	66.0	613.10		4	43200
/16/73 23:30	71.5	615.00		5	43200
3/17/73 0:00	72.0	615.25		6	43200
3/17/73 1:30	73.5	615.60		7	43500
3/17/73 2:30	74.5	616.20		8	44600
3/17/73 6:00	78.0	616.90		9	45200
3/17/73 7:30	79.5	617.15		10	44900
/17/73 11:00	83.0	617.80		11	45200
/17/73 12:00	84.0	618.00		12	44900
/17/73 17:30	89.5	618.20		13	44600
/17/73 19:30	91.5	618.30		14	45200
/17/73 22:00	94.0	618.60		15	45500
3/18/73 0:00	96.0	618.60		16	45500
3/18/73 6:00		618.50		17	45500
3/18/73 12:00		618.50		18	45500
3/18/73 18:00		618.30		19	45500
3/18/73 19:30		618.25		20	50100
3/18/73 21:30		618.10		21	52900

Guntersville HW from hourly water records.
Checked 1/7/09 JMF

Nickajack TW from hourly water record
Checked 1/7/09 JMF

				Guntersville HW	Nickajack TW
3/14/1973	1	3/14/73 1:00	1	594.26	596.6
	2	3/14/73 2:00	2	594.31	596.3
	3	3/14/73 3:00	3	594.31	596.1
	4	3/14/73 4:00	4	594.29	596
	5	3/14/73 5:00	5	594.26	595.9
	6	3/14/73 6:00	6	594.23	595.85
	7	3/14/73 7:00	7	594.17	595.8
	8	3/14/73 8:00	8	594.15	596.33
	9	3/14/73 9:00	9	594.06	596.49
	10	3/14/73 10:00	10	594.08	597.56
	11	3/14/73 11:00	11	594.01	597.76
	12	3/14/73 12:00	12	593.97	597.88
	13	3/14/73 13:00	13	593.9	597.99
	14	3/14/73 14:00	14	593.86	598.18
	15	3/14/73 15:00	15	593.85	598.25
	16	3/14/73 16:00	16	593.85	598.26
	17	3/14/73 17:00	17	593.87	598.28
	18	3/14/73 18:00	18	593.85	598.3
	19	3/14/73 19:00	19	593.85	598.28
	20	3/14/73 20:00	20	593.88	598.3
	21	3/14/73 21:00	21	593.88	598.26
	22	3/14/73 22:00	22	593.85	598.32
	23	3/14/73 23:00	23	593.8	598.32
	24	3/15/73 0:00	24	593.79	598.32
3/15/1973	25	3/15/73 1:00	25	593.77	598.31
	26	3/15/73 2:00	26	593.76	598.31
	27	3/15/73 3:00	27	593.76	598.31
	28	3/15/73 4:00	28	593.76	598.31
	29	3/15/73 5:00	29	593.76	598.3
	30	3/15/73 6:00	30	593.73	598.33
	31	3/15/73 7:00	31	593.64	598.35
	32	3/15/73 8:00	32	593.78	598.45
	33	3/15/73 9:00	33	593.78	598.49
	34	3/15/73 10:00	34	593.8	598.5
	35	3/15/73 11:00	35	593.78	598.52
	36	3/15/73 12:00	36	593.76	598.51
	37	3/15/73 13:00	37	593.78	598.5
	38	3/15/73 14:00	38	593.8	598.56
	39	3/15/73 15:00	39	593.8	598.59
	40	3/15/73 16:00	40	593.78	598.62
	41	3/15/73 17:00	41	593.75	598.62
	42	3/15/73 18:00	42	593.95	598.81
	43	3/15/73 19:00	43	594	598.99
	44	3/15/73 20:00	44	594.03	599.29
	45	3/15/73 21:00	45	594.03	599.62

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev
3/17/73 18:00	614.85
3/17/73 23:00	615.25
3/18/73 0:00	615.30
3/18/73 1:00	615.35
3/18/73 12:00	615.20
3/18/73 17:00	615.15
3/18/73 22:00	615.00
3/19/73 0:00	614.85
3/19/73 12:00	613.90
3/20/73 0:00	611.90
3/20/73 12:00	610.90
3/20/73 14:00	610.55
3/20/73 15:00	610.30
3/20/73 16:00	609.90
3/20/73 20:00	609.00
3/20/73 22:00	608.75
3/21/73 6:00	607.50
3/21/73 12:00	606.61
3/21/73 14:30	606.36
3/21/73 17:00	605.91
3/21/73 17:06	605.76
3/21/73 18:00	605.51
3/21/73 19:00	605.31
3/21/73 21:00	605.06
3/22/73 0:00	604.76
3/22/73 6:00	604.36
3/22/73 9:00	604.16
3/22/73 11:30	604.16
3/22/73 18:00	603.71
3/22/73 21:00	603.56
3/23/73 0:00	603.41
3/23/73 6:00	603.29
3/23/73 12:00	603.01
3/23/73 18:00	603.19
3/23/73 20:00	603.11
3/23/73 21:00	602.91
3/24/73 0:00	602.71
3/24/73 3:00	602.61
3/24/73 6:00	602.56
3/24/73 8:00	602.61
3/24/73 10:00	602.80
3/24/73 18:00	602.80
3/24/73 21:00	602.76
3/25/73 0:00	602.72

Date and Time	Gage Ht	WS Elev
3/17/73 14:00	33.60	614.61
3/17/73 16:00	33.71	614.72
3/17/73 18:00	33.82	614.83
3/17/73 20:00	33.99	615.00
3/17/73 22:00	34.15	615.16
3/18/73 0:00	34.22	615.23
3/18/73 2:00	34.28	615.29
3/18/73 4:00	34.29	615.30
3/18/73 6:00	34.21	615.22
3/18/73 8:00	34.20	615.21
3/18/73 10:00	34.18	615.19
3/18/73 12:00	34.16	615.17
3/18/73 14:00	34.20	615.21
3/18/73 16:00	34.17	615.18
3/18/73 18:00	34.15	615.16
3/18/73 20:00	34.09	615.10
3/18/73 22:00	33.93	614.94
3/19/73 0:00	33.83	614.84
3/19/73 2:00	33.64	614.65
3/19/73 4:00	33.59	614.60
3/19/73 6:00	33.41	614.42
3/19/73 8:00	33.18	614.19
3/19/73 10:00	33.06	614.07
3/19/73 12:00	32.88	613.89
3/19/73 14:00	32.70	613.71
3/19/73 16:00	32.45	613.46
3/19/73 18:00	32.19	613.20
3/19/73 20:00	31.96	612.97
3/19/73 22:00	31.71	612.72
3/20/73 0:00	31.49	612.50
3/20/73 2:00	31.21	612.22
3/20/73 4:00	30.98	611.99
3/20/73 6:00	30.66	611.67
3/20/73 8:00	30.50	611.51
3/20/73 10:00	30.10	611.11
3/20/73 12:00	29.95	610.96
3/20/73 14:00	29.73	610.74
3/20/73 16:00	28.91	609.92
3/20/73 18:00	28.36	609.37
3/20/73 20:00	28.01	609.02
3/20/73 22:00	27.74	608.75
3/21/73 0:00	27.37	608.38
3/21/73 2:00	27.08	608.09
3/21/73 4:00	26.85	607.86
3/21/73 6:00	26.50	607.51

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time	TW Elev	Date	Time	Discharge Q (cfs)
3/19/73 0:00	617.90		22	61700
3/19/73 4:30	617.60		23	66000
3/19/73 6:30	617.30		24	69900
3/19/73 9:30	617.10	3/16/1973	1	75400
3/19/73 10:30	617.00		2	82100
3/19/73 12:30	616.75		3	81800
3/19/73 13:30	616.50		4	92500
3/19/73 15:30	616.20		5	115400
3/19/73 19:30	615.75		6	113900
3/19/73 23:30	615.25		7	111800
3/20/73 0:00	615.20		8	118800
3/20/73 3:30	614.70		9	116800
3/20/73 7:30	614.10		10	116500
3/20/73 8:30	613.90		11	114400
3/20/73 14:00	613.25		12	144700
3/20/73 16:00	612.00		13	162500
3/20/73 16:30	611.75		14	160200
3/21/73 0:00	610.50		15	180600
3/21/73 3:30	610.00		16	178400
3/21/73 4:30	609.95		17	178400
3/21/73 8:30	609.50		18	178800
3/21/73 9:30	609.25		19	184100
3/21/73 13:30	608.45		20	184100
3/21/73 14:30	608.25		21	189400
3/21/73 15:30	608.00		22	195600
3/21/73 16:30	607.75		23	195600
3/21/73 18:00	607.40		24	201700
3/21/73 21:00	606.90	3/17/1973	1	203900
3/22/73 0:00	606.70		2	204200
3/22/73 6:00	606.40		3	220500
3/22/73 12:00	606.00		4	220500
3/22/73 18:00	605.70		5	219400
3/22/73 20:00	605.50		6	219600
3/23/73 0:00	605.50		7	219300
3/23/73 6:00	605.40		8	219900
3/23/73 12:00	605.40		9	230900
3/23/73 18:00	605.40		10	231500
3/23/73 19:00	605.25		11	244400
3/23/73 20:00	605.00		12	237500
3/23/73 21:00	604.90		13	237800
3/23/73 22:00	604.75		14	237800
3/23/73 23:00	604.60		15	237800
3/24/73 0:00	604.55		16	237800
3/24/73 5:30	604.55		17	237800
3/24/73 6:30	604.60		18	238300

Guntersville HW from hourly water records.
Checked 1/7/09 JMF

Nickajack TW from hourly water record
Checked 1/7/09 JMF

				Guntersville HW	Nickajack TW
	46	3/15/73 22:00	46	594	600.5
	47	3/15/73 23:00	47	594.02	600.94
	48	3/16/73 0:00	48	594.06	601.65
3/16/1973	49	3/16/73 1:00	49	594.12	602.4
	50	3/16/73 2:00	50	594.12	602.72
	51	3/16/73 3:00	51	594.16	603.5
	52	3/16/73 4:00	52	594.18	604.44
	53	3/16/73 5:00	53	594.2	605.67
	54	3/16/73 6:00	54	594.12	606.19
	55	3/16/73 7:00	55	594.08	606.56
	56	3/16/73 8:00	56	593.85	607.19
	57	3/16/73 9:00	57	593.74	607.53
	58	3/16/73 10:00	58	593.4	607.84
	59	3/16/73 11:00	59	593.3	608.54
	60	3/16/73 12:00	60	593.46	609.37
	61	3/16/73 13:00	61	593.4	610.39
	62	3/16/73 14:00	62	593.47	611.27
	63	3/16/73 15:00	63	593.48	612.07
	64	3/16/73 16:00	64	593.47	612.54
	65	3/16/73 17:00	65	593.45	612.85
	66	3/16/73 18:00	66	593.5	613.1
	67	3/16/73 19:00	67	593.55	613.6
	68	3/16/73 20:00	68	593.58	613.85
	69	3/16/73 21:00	69	593.6	614.19
	70	3/16/73 22:00	70	593.73	614.62
	71	3/16/73 23:00	71	593.8	614.91
	72	3/17/73 0:00	72	594	615.21
3/17/1973	73	3/17/73 1:00	73	594	615.54
	74	3/17/73 2:00	74	594.18	615.67
	75	3/17/73 3:00	75	594.26	616.32
	76	3/17/73 4:00	76	594.32	616.56
	77	3/17/73 5:00	77	594.42	616.73
	78	3/17/73 6:00	78	594.5	616.88
	79	3/17/73 7:00	79	594.62	616.99
	80	3/17/73 8:00	80	594.7	617.08
	81	3/17/73 9:00	81	594.76	617.4
	82	3/17/73 10:00	82	594.84	617.52
	83	3/17/73 11:00	83	594.96	617.86
	84	3/17/73 12:00	84	594.92	617.94
	85	3/17/73 13:00	85	594.94	618
	86	3/17/73 14:00	86	594.94	618.03
	87	3/17/73 15:00	87	594.95	618.07
	88	3/17/73 16:00	88	595	618.1
	89	3/17/73 17:00	89	595.05	618.14
	90	3/17/73 18:00	90	595.13	618.15

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev
			3/21/73 8:00	26.30	607.31
			3/21/73 10:00	25.87	606.88
			3/21/73 12:00	25.55	606.56
			3/21/73 14:00	25.31	606.32
			3/21/73 16:00	24.94	605.95
			3/21/73 18:00	24.36	605.37
			3/21/73 20:00	24.06	605.07
			3/21/73 22:00	23.83	604.84
			3/22/73 0:00	23.65	604.66
			3/22/73 6:00		604.36
			3/22/73 9:00		604.16
			3/22/73 11:30		604.16
			3/22/73 18:00		603.71
			3/22/73 21:00		603.56
			3/23/73 0:00		603.41
			3/23/73 6:00		603.29
			3/23/73 12:00		603.01
			3/23/73 18:00		603.19
			3/23/73 20:00		603.11
			3/23/73 21:00		602.91
			3/24/73 0:00		602.71
			3/24/73 3:00		602.61
			3/24/73 6:00		602.56
			3/24/73 8:00		602.61
			3/24/73 10:00		602.80
			3/24/73 18:00		602.80
			3/24/73 21:00		602.76
			3/25/73 0:00		602.72

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		TW Elev	Date	Time	Discharge Q (cfs)
3/24/73 10:00		604.90		19	240600
3/24/73 12:00		604.90		20	252900
3/24/73 15:00		604.80		21	250900
3/24/73 18:00		604.80		22	252200
3/25/73 0:00		604.80		23	251900
				24	251600
			3/18/1973	1	251600
				2	251600
				3	251300
				4	248400
				5	245000
				6	245000
				7	250300
				8	250500
				9	250300
				10	250500
				11	250900
				12	251100
				13	251100
				14	251100
				15	251100
				16	251100
				17	251100
				18	251100
				19	250500
				20	250800
				21	244700
				22	238600
				23	238600
				24	238600
			3/19/1973	1	238600
				2	237800
				3	238100
				4	238100
				5	241000
				6	235800
				7	230400
				8	230400
				9	230400
				10	230400
				11	219100
				12	219400
				13	219100
				14	210200
				15	208900

Guntersville HW from hourly water records.
Checked 1/7/09 JMF

	91	3/17/73 19:00	91	595.17
	92	3/17/73 20:00	92	595.2
	93	3/17/73 21:00	93	595.3
	94	3/17/73 22:00	94	595.33
	95	3/17/73 23:00	95	595.36
	96	3/18/73 0:00	96	595.4
3/18/1973	97	3/18/73 1:00	97	595.45
	98	3/18/73 2:00	98	595.5
	99	3/18/73 3:00	99	595.52
	100	3/18/73 4:00	100	595.55
	101	3/18/73 5:00	101	595.6
	102	3/18/73 6:00	102	595.6
	103	3/18/73 7:00	103	595.64
	104	3/18/73 8:00	104	595.7
	105	3/18/73 9:00	105	595.7
	106	3/18/73 10:00	106	595.7
	107	3/18/73 11:00	107	595.72
	108	3/18/73 12:00	108	595.64
	109	3/18/73 13:00	109	595.66
	110	3/18/73 14:00	110	595.68
	111	3/18/73 15:00	111	595.68
	112	3/18/73 16:00	112	595.7
	113	3/18/73 17:00	113	595.48
	114	3/18/73 18:00	114	595.45
	115	3/18/73 19:00	115	595.48
	116	3/18/73 20:00	116	595.48
	117	3/18/73 21:00	117	595.47
	118	3/18/73 22:00	118	595.45
	119	3/18/73 23:00	119	595.45
	120	3/19/73 0:00	120	595.42
3/19/1973	121	3/19/73 1:00	121	595.4
	122	3/19/73 2:00	122	595.38
	123	3/19/73 3:00	123	595.35
	124	3/19/73 4:00	124	595.3
	125	3/19/73 5:00	125	595.3
	126	3/19/73 6:00	126	595.3
	127	3/19/73 7:00	127	595.26
	128	3/19/73 8:00	128	595.22
	129	3/19/73 9:00	129	595.2
	130	3/19/73 10:00	130	595.2
	131	3/19/73 11:00	131	595.18
	132	3/19/73 12:00	132	595.14
	133	3/19/73 13:00	133	595.2
	134	3/19/73 14:00	134	595.15
	135	3/19/73 15:00	135	595.12

Nickajack TW from hourly water record
Checked 1/7/09 JMF

618.34
618.39
618.43
618.54
618.58
618.59
618.59
618.6
618.64
618.57
618.55
618.5
618.48
618.47
618.45
618.44
618.43
618.4
618.39
618.39
618.39
618.36
618.31
618.31
618.26
618.25
618.15
618.02
617.91
617.9
617.85
617.8
617.7
617.6
617.5
617.43
617.29
617.19
617.09
617.05
616.91
616.7
616.62
616.37
616.26

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		TW Elev	Date	Time	Discharge Q (cfs)
				16	208900
				17	206100
				18	203000
				19	203000
				20	200000
				21	197200
				22	199600
				23	199400
				24	199600
			3/20/1973	1	193600
				2	187500
				3	187500
				4	181700
				5	182000
				6	182300
				7	181300
				8	182300
				9	172100
				10	171800
				11	172100
				12	173100
				13	173600
				14	173100
				15	154700
				16	143600
				17	134800
				18	134500
				19	137400
				20	137200
				21	137500
				22	137200
				23	137200
				24	135100
			3/21/1973	1	135100
				2	134800
				3	135100
				4	134800
				5	129500
				6	129500
				7	129200
				8	129500
				9	129500
				10	119300
				11	119100
				12	119600

Guntersville HW from hourly
water records.
Checked 1/7/09 JMF

	136	3/19/73 16:00	136	595.15
	137	3/19/73 17:00	137	595.12
	138	3/19/73 18:00	138	595.08
	139	3/19/73 19:00	139	595.08
	140	3/19/73 20:00	140	595.05
	141	3/19/73 21:00	141	595
	142	3/19/73 22:00	142	595
	143	3/19/73 23:00	143	594.98
	144	3/20/73 0:00	144	594.95
3/20/1973	145	3/20/73 1:00	145	594.9
	146	3/20/73 2:00	146	594.85
	147	3/20/73 3:00	147	594.8
	148	3/20/73 4:00	148	594.75
	149	3/20/73 5:00	149	594.72
	150	3/20/73 6:00	150	594.7
	151	3/20/73 7:00	151	594.62
	152	3/20/73 8:00	152	594.54
	153	3/20/73 9:00	153	594.52
	154	3/20/73 10:00	154	594.56
	155	3/20/73 11:00	155	594.5
	156	3/20/73 12:00	156	594.48
	157	3/20/73 13:00	157	594.48
	158	3/20/73 14:00	158	594.5
	159	3/20/73 15:00	159	594.65
	160	3/20/73 16:00	160	594.69
	161	3/20/73 17:00	161	594.69
	162	3/20/73 18:00	162	594.64
	163	3/20/73 19:00	163	594.67
	164	3/20/73 20:00	164	594.6
	165	3/20/73 21:00	165	594.6
	166	3/20/73 22:00	166	594.55
	167	3/20/73 23:00	167	594.5
	168	3/21/73 0:00	168	594.48
3/21/1973	169	3/21/73 1:00	169	594.45
	170	3/21/73 2:00	170	594.4
	171	3/21/73 3:00	171	594.4
	172	3/21/73 4:00	172	594.38
	173	3/21/73 5:00	173	594.3
	174	3/21/73 6:00	174	594.25
	175	3/21/73 7:00	175	594.18
	176	3/21/73 8:00	176	594.12
	177	3/21/73 9:00	177	594.18
	178	3/21/73 10:00	178	594.27
	179	3/21/73 11:00	179	594.23
	180	3/21/73 12:00	180	594.18

Nickajack TW from hourly
water record
Checked 1/7/09 JMF

616.14
615.98
615.97
615.76
615.6
615.5
615.42
615.28
615.18
614.96
614.84
614.78
614.57
614.57
614.49
614.2
614.13
613.77
613.66
613.57
613.48
613.2
613.35
612.54
611.86
611.59
611.41
611.25
611.13
610.99
610.87
610.75
610.49
610.35
610.28
610.17
610.07
609.82
609.74
609.62
609.53
609.47
608.95
608.8
608.7

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Date and Time		TW Elev	Date	Time	Discharge Q (cfs)
				13	119400
				14	121300
				15	112400
				16	112700
				17	105000
				18	105100
				19	104800
				20	104500
				21	103900
				22	104200
				23	104200
				24	104200
			3/22/1973	1	104100
				2	104400
				3	104300
				4	104300
				5	105900
				6	103700
				7	104000
				8	104300
				9	104800
				10	104500
				11	104700
				12	102200
				13	102600
				14	102200
				15	100500
				16	100000
				17	99700
				18	99700
				19	99800
				20	97500
				21	97900
				22	97800
				23	97500
				24	97500
			3/23/1973	1	98400
				2	98700
				3	98700
				4	98400
				5	98400
				6	98400
				7	98400
				8	98400
				9	98700

Guntersville HW from hourly water records.
Checked 1/7/09 JMF

Nickajack TW from hourly water record
Checked 1/7/09 JMF

				Guntersville HW	Nickajack TW
	181	3/21/73 13:00	181	594.33	608.6
	182	3/21/73 14:00	182	594.5	608.27
	183	3/21/73 15:00	183	594.6	608.11
	184	3/21/73 16:00	184	594.62	607.94
	185	3/21/73 17:00	185	594.63	607.47
	186	3/21/73 18:00	186	594.65	607.28
	187	3/21/73 19:00	187	594.66	607.13
	188	3/21/73 20:00	188	594.66	607
	189	3/21/73 21:00	189	594.6	606.94
	190	3/21/73 22:00	190	594.65	606.87
	191	3/21/73 23:00	191	594.62	606.76
	192	3/22/73 0:00	192	594.62	606.75
	193	3/22/73 1:00		594.6	606.63
	194	3/22/73 2:00		594.58	606.6
	195	3/22/73 3:00		594.55	606.53
	196	3/22/73 4:00		594.55	606.5
	197	3/22/73 5:00		594.51	606.47
	198	3/22/73 6:00		594.48	606.32
	199	3/22/73 7:00		594.42	606.27
	200	3/22/73 8:00		594.42	606.19
	201	3/22/73 9:00		594.4	606.17
	202	3/22/73 10:00		594.4	606.13
	203	3/22/73 11:00		594.33	606.1
	204	3/22/73 12:00		594.32	606
	205	3/22/73 13:00		594.23	605.93
	206	3/22/73 14:00		594.23	605.88
	207	3/22/73 15:00		594.2	605.79
	208	3/22/73 16:00		594.32	605.75
	209	3/22/73 17:00		594.31	605.72
	210	3/22/73 18:00		594.31	605.68
	211	3/22/73 19:00		594.26	605.65
	212	3/22/73 20:00		594.26	605.57
	213	3/22/73 21:00		594.25	605.56
	214	3/22/73 22:00		594.25	605.51
	215	3/22/73 23:00		594.24	605.49
	216	3/23/73 0:00		594.24	605.48
	217	3/23/73 1:00		594.22	605.49
	218	3/23/73 2:00		594.22	605.48
	219	3/23/73 3:00		594.2	605.46
	220	3/23/73 4:00		594.2	605.4
	221	3/23/73 5:00		594.2	605.39
	222	3/23/73 6:00		594.18	605.37
	223	3/23/73 7:00		594.15	605.37
	224	3/23/73 8:00		594.15	605.35
	225	3/23/73 9:00		594.15	605.33

Attachment 5

Source: Reference 2.5

Calculation No: CDQ000020080041

TN River at South Pittsburg, TN TRM 418.1 Gage Zero 581.01
1973 Flood - Book 295-20.00
Entered by BCH 6/2/08
Checked by JMF 2/18/09
See comments on 3/16/73 @ 0:00

REVISED 2/19/09

Date and Time	WS Elev		Date and Time	Gage Ht	WS Elev

Nickajack Dam TRM 424.7
TW 1973 Flood - Book 295-20.00
Q from microfilmed hourly water records
Entered by BCH 6/2/08
Checked by JMF 8/4/08

Guntersville HW from hourly water records.
Checked 1/7/09 JMF

Nickajack TW from hourly water record
Checked 1/7/09 JMF

Date and Time		TW Elev	Date	Time	Discharge Q (cfs)					
				10	98200		226	3/23/73 10:00	594.1	605.33
				11	98400		227	3/23/73 11:00	594.1	605.3
				12	98500		228	3/23/73 12:00	594.08	605.25
				13	98500		229	3/23/73 13:00	594.15	605.27
				14	98500		230	3/23/73 14:00	594.08	605.27
				15	98400		231	3/23/73 15:00	594.1	605.27
				16	98400		232	3/23/73 16:00	594.1	605.26
				17	98700		233	3/23/73 17:00	594.16	605.28
				18	97400		234	3/23/73 18:00	594.14	605.21
				19	96200		235	3/23/73 19:00	594.13	605.17
				20	93800		236	3/23/73 20:00	594.13	604.89
				21	93900		237	3/23/73 21:00	594.13	604.9
				22	94900		238	3/23/73 22:00	594.13	604.75
				23	94700		239	3/23/73 23:00	594.12	604.7
				24	94700		240	3/24/73 0:00	594.12	604.67
			3/24/1973	1	95100		241	3/24/73 1:00	594.14	604.64
				2	95100		242	3/24/73 2:00	594.14	604.63
				3	95100		243	3/24/73 3:00	594.1	604.6
				4	95100		244	3/24/73 4:00	594.12	604.6
				5	94800		245	3/24/73 5:00	594.12	604.57
				6	97000		246	3/24/73 6:00	594.1	604.67
				7	97600		247	3/24/73 7:00	594.08	604.69
				8	99700		248	3/24/73 8:00	594.08	604.83
				9	99700		249	3/24/73 9:00	594.05	604.85
				10	99700		250	3/24/73 10:00	594.05	604.99
				11	99700		251	3/24/73 11:00	594.05	604.88
				12	99700		252	3/24/73 12:00	594.05	604.88
				13	99700		253	3/24/73 13:00	594.05	604.89
				14	99700		254	3/24/73 14:00	594.03	604.9
				15	99700		255	3/24/73 15:00	594.03	604.88
				16	99600		256	3/24/73 16:00	594	604.89
				17	99600		257	3/24/73 17:00	593.95	604.9
				18	99600		258	3/24/73 18:00	593.92	604.88
				19	99500		259	3/24/73 19:00	593.92	604.86
				20	99500		260	3/24/73 20:00	593.96	604.86
				21	99500		261	3/24/73 21:00	593.96	604.86
				22	98600		262	3/24/73 22:00	594	604.85
				23	98900		263	3/24/73 23:00	594.02	604.84
				24	98900		264	3/25/73 0:00	594	604.84

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/3/2003 1:00	596.03	13788
5/3/2003 2:00	595.40	9936
5/3/2003 3:00	594.78	3404
5/3/2003 4:00	594.46	0
5/3/2003 5:00	594.53	1976
5/3/2003 6:00	594.68	9811
5/3/2003 7:00	595.03	11693
5/3/2003 8:00	595.34	19827
5/3/2003 9:00	595.45	19920
5/3/2003 10:00	595.49	19933
5/3/2003 11:00	595.46	19915
5/3/2003 12:00	595.50	19933
5/3/2003 13:00	596.02	28216
5/3/2003 14:00	596.89	39469
5/3/2003 15:00	597.98	52075
5/3/2003 16:00	598.23	58027
5/3/2003 17:00	598.13	48091
5/3/2003 18:00	597.63	40849
5/3/2003 19:00	597.38	36678
5/3/2003 20:00	596.30	24858
5/3/2003 21:00	595.79	17199
5/3/2003 22:00	595.45	17000
5/3/2003 23:00	595.36	18242
5/4/2003 0:00	595.32	19596
5/4/2003 1:00	595.02	17338
5/4/2003 2:00	594.81	9793
5/4/2003 3:00	594.38	409
5/4/2003 4:00	594.49	0
5/4/2003 5:00	594.41	0
5/4/2003 6:00	594.52	0
5/4/2003 7:00	594.86	8900
5/4/2003 8:00	595.17	13288
5/4/2003 9:00	595.34	18148
5/4/2003 10:00	595.38	19977
5/4/2003 11:00	595.40	19964
5/4/2003 12:00	595.50	19918

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/3/2003 2:00	14.87	595.88
5/3/2003 4:00	13.92	594.93
5/3/2003 6:00	14.08	595.09
5/3/2003 8:00	14.61	595.62
5/3/2003 10:00	14.77	595.78
5/3/2003 12:00	14.70	595.71
5/3/2003 14:00	15.15	596.16
5/3/2003 16:00	16.52	597.53
5/3/2003 18:00	16.43	597.44
5/3/2003 20:00	15.74	596.75
5/3/2003 22:00	14.78	595.79
5/4/2003 0:00	14.57	595.58
5/4/2003 2:00	14.28	595.29
5/4/2003 4:00	13.76	594.77
5/4/2003 6:00	13.86	594.87
5/4/2003 8:00	14.33	595.34
5/4/2003 10:00	14.65	595.66
5/4/2003 12:00	14.72	595.73
5/4/2003 14:00	14.66	595.67
5/4/2003 16:00	14.66	595.67
5/4/2003 18:00	14.57	595.58
5/4/2003 20:00	14.49	595.50
5/4/2003 22:00	14.87	595.88
5/5/2003 0:00	15.55	596.56
5/5/2003 2:00	14.73	595.74
5/5/2003 4:00	13.77	594.78
5/5/2003 6:00	13.83	594.84
5/5/2003 8:00	15.22	596.23
5/5/2003 10:00	16.25	597.26
5/5/2003 12:00	17.23	598.24
5/5/2003 14:00	17.71	598.72
5/5/2003 16:00	17.69	598.70
5/5/2003 18:00	16.68	597.69
5/5/2003 20:00	15.84	596.85
5/5/2003 22:00	15.54	596.55
5/6/2003 0:00	16.24	597.25

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/3/2003 2:00	19.69	594.69
5/3/2003 4:00	19.62	594.62
5/3/2003 6:00	19.50	594.50
5/3/2003 8:00	19.51	594.51
5/3/2003 10:00	19.53	594.53
5/3/2003 12:00	19.42	594.42
5/3/2003 14:00	19.37	594.37
5/3/2003 16:00	19.45	594.45
5/3/2003 18:00	19.55	594.55
5/3/2003 20:00	19.50	594.50
5/3/2003 22:00	19.52	594.52
5/4/2003 0:00	19.53	594.53
5/4/2003 2:00	19.50	594.50
5/4/2003 4:00	19.56	594.56
5/4/2003 6:00	19.44	594.44
5/4/2003 8:00	19.42	594.42
5/4/2003 10:00	19.49	594.49
5/4/2003 12:00	19.50	594.50
5/4/2003 14:00	19.39	594.39
5/4/2003 16:00	19.42	594.42
5/4/2003 18:00	19.39	594.39
5/4/2003 20:00	19.33	594.33
5/4/2003 22:00	19.28	594.28
5/5/2003 0:00	19.36	594.36
5/5/2003 2:00	19.41	594.41
5/5/2003 4:00	19.43	594.43
5/5/2003 6:00	19.28	594.28
5/5/2003 8:00	19.37	594.37
5/5/2003 10:00	19.39	594.39
5/5/2003 12:00	19.41	594.41
5/5/2003 14:00	19.46	594.46
5/5/2003 16:00	19.63	594.63
5/5/2003 18:00	19.64	594.64
5/5/2003 20:00	19.75	594.75
5/5/2003 22:00	19.80	594.80
5/6/2003 0:00	19.75	594.75

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/4/2003 13:00	595.46	19849
5/4/2003 14:00	595.38	19889
5/4/2003 15:00	595.48	19879
5/4/2003 16:00	595.33	19931
5/4/2003 17:00	595.31	19941
5/4/2003 18:00	595.31	20003
5/4/2003 19:00	595.27	19942
5/4/2003 20:00	595.22	19870
5/4/2003 21:00	595.41	21053
5/4/2003 22:00	596.20	33638
5/4/2003 23:00	596.84	40910
5/5/2003 0:00	596.82	39423
5/5/2003 1:00	596.05	32292
5/5/2003 2:00	595.04	5689
5/5/2003 3:00	594.59	0
5/5/2003 4:00	594.33	0
5/5/2003 5:00	594.37	0
5/5/2003 6:00	594.70	486
5/5/2003 7:00	595.56	15664
5/5/2003 8:00	596.74	39414
5/5/2003 9:00	597.48	42284
5/5/2003 10:00	598.16	42111
5/5/2003 11:00	598.78	41806
5/5/2003 12:00	599.38	65232
5/5/2003 13:00	599.72	65110
5/5/2003 14:00	599.85	64985
5/5/2003 15:00	599.89	64884
5/5/2003 16:00	599.13	53284
5/5/2003 17:00	598.23	38354
5/5/2003 18:00	597.84	35882
5/5/2003 19:00	597.09	30429
5/5/2003 20:00	596.71	26417
5/5/2003 21:00	596.51	26447
5/5/2003 22:00	596.41	26479
5/5/2003 23:00	597.29	31816
5/6/2003 0:00	598.19	47526

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/6/2003 2:00	17.06	598.07
5/6/2003 4:00	17.67	598.68
5/6/2003 6:00	18.98	599.99
5/6/2003 8:00	21.41	602.42
5/6/2003 10:00	23.10	604.11
5/6/2003 12:00	23.93	604.94
5/6/2003 14:00	25.77	606.78
5/6/2003 16:00	26.79	607.80
5/6/2003 18:00	27.68	608.69
5/6/2003 20:00	28.63	609.64
5/6/2003 22:00	29.47	610.48
5/7/2003 0:00	29.87	610.88
5/7/2003 2:00	30.12	611.13
5/7/2003 4:00	30.34	611.35
5/7/2003 6:00	30.81	611.82
5/7/2003 8:00	31.36	612.37
5/7/2003 10:00	32.04	613.05
5/7/2003 12:00	32.53	613.54
5/7/2003 14:00	32.60	613.61
5/7/2003 16:00	32.67	613.68
5/7/2003 18:00	32.74	613.75
5/7/2003 20:00	32.77	613.78
5/7/2003 22:00	33.04	614.05
5/8/2003 0:00	33.24	614.25
5/8/2003 2:00	33.48	614.49
5/8/2003 4:00	33.64	614.65
5/8/2003 6:00	33.92	614.93
5/8/2003 8:00	34.00	615.01
5/8/2003 10:00	33.90	614.91
5/8/2003 12:00	33.87	614.88
5/8/2003 14:00	33.88	614.89
5/8/2003 16:00	34.02	615.03
5/8/2003 18:00	34.11	615.12
5/8/2003 20:00	34.15	615.16
5/8/2003 22:00	34.18	615.19
5/9/2003 0:00	34.26	615.27

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/6/2003 2:00	19.78	594.78
5/6/2003 4:00	19.86	594.86
5/6/2003 6:00	20.09	595.09
5/6/2003 8:00	20.17	595.17
5/6/2003 10:00	20.64	595.64
5/6/2003 12:00	21.09	596.09
5/6/2003 14:00	21.36	596.36
5/6/2003 16:00	21.71	596.71
5/6/2003 18:00	21.97	596.97
5/6/2003 20:00	22.22	597.22
5/6/2003 22:00	22.39	597.39
5/7/2003 0:00	22.57	597.57
5/7/2003 2:00	22.81	597.81
5/7/2003 4:00	22.91	597.91
5/7/2003 6:00	23.02	598.02
5/7/2003 8:00	23.11	598.11
5/7/2003 10:00	23.24	598.24
5/7/2003 12:00	23.38	598.38
5/7/2003 14:00	23.55	598.55
5/7/2003 16:00	23.70	598.70
5/7/2003 18:00	23.87	598.87
5/7/2003 20:00	23.89	598.89
5/7/2003 22:00	23.98	598.98
5/8/2003 0:00	24.03	599.03
5/8/2003 2:00	24.11	599.11
5/8/2003 4:00	24.21	599.21
5/8/2003 6:00	24.29	599.29
5/8/2003 8:00	24.37	599.37
5/8/2003 10:00	24.60	599.60
5/8/2003 12:00	24.60	599.60
5/8/2003 14:00	24.60	599.60
5/8/2003 16:00	24.68	599.68
5/8/2003 18:00	24.71	599.71
5/8/2003 20:00	24.72	599.72
5/8/2003 22:00	24.78	599.78
5/9/2003 0:00	24.71	599.71

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/6/2003 1:00	598.53	53680
5/6/2003 2:00	598.81	53615
5/6/2003 3:00	599.04	53561
5/6/2003 4:00	599.79	59791
5/6/2003 5:00	600.83	68793
5/6/2003 6:00	601.88	85260
5/6/2003 7:00	603.04	98238
5/6/2003 8:00	604.99	133148
5/6/2003 9:00	605.73	138106
5/6/2003 10:00	606.35	137470
5/6/2003 11:00	606.49	134673
5/6/2003 12:00	606.84	128254
5/6/2003 13:00	608.32	157744
5/6/2003 14:00	609.25	159931
5/6/2003 15:00	609.79	159864
5/6/2003 16:00	610.35	170291
5/6/2003 17:00	610.76	191042
5/6/2003 18:00	611.19	191908
5/6/2003 19:00	611.70	202528
5/6/2003 20:00	612.27	214714
5/6/2003 21:00	612.77	217105
5/6/2003 22:00	613.15	224759
5/6/2003 23:00	613.33	224345
5/7/2003 0:00	613.50	223738
5/7/2003 1:00	613.62	215166
5/7/2003 2:00	613.50	207304
5/7/2003 3:00	613.71	207621
5/7/2003 4:00	613.84	207571
5/7/2003 5:00	614.06	210297
5/7/2003 6:00	614.44	212841
5/7/2003 7:00	614.79	220942
5/7/2003 8:00	615.24	236465
5/7/2003 9:00	615.67	249907
5/7/2003 10:00	615.97	255351
5/7/2003 11:00	616.22	255035
5/7/2003 12:00	616.45	254812

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/9/2003 2:00	34.23	615.24
5/9/2003 4:00	34.13	615.14
5/9/2003 6:00	33.98	614.99
5/9/2003 8:00	33.90	614.91
5/9/2003 10:00	33.63	614.64
5/9/2003 12:00	33.38	614.39
5/9/2003 14:00	33.28	614.29
5/9/2003 16:00	33.19	614.20
5/9/2003 18:00	33.08	614.09
5/9/2003 20:00	32.94	613.95
5/9/2003 22:00	32.94	613.95
5/10/2003 0:00	32.89	613.90
5/10/2003 2:00	32.84	613.85
5/10/2003 4:00	32.73	613.74
5/10/2003 6:00	32.67	613.68
5/10/2003 8:00	32.44	613.45
5/10/2003 10:00	32.23	613.24
5/10/2003 12:00	31.81	612.82
5/10/2003 14:00	31.52	612.53
5/10/2003 16:00	31.28	612.29
5/10/2003 18:00	31.08	612.09
5/10/2003 20:00	30.93	611.94
5/10/2003 22:00	30.81	611.82
5/11/2003 0:00	30.68	611.69
5/11/2003 2:00	30.58	611.59
5/11/2003 4:00	30.05	611.06
5/11/2003 6:00	29.88	610.89
5/11/2003 8:00	29.54	610.55
5/11/2003 10:00	29.34	610.35
5/11/2003 12:00	29.15	610.16
5/11/2003 14:00	28.93	609.94
5/11/2003 16:00	28.67	609.68
5/11/2003 18:00	28.35	609.36
5/11/2003 20:00	27.77	608.78
5/11/2003 22:00	27.51	608.52
5/12/2003 0:00	27.28	608.29

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/9/2003 2:00	24.75	599.75
5/9/2003 4:00	24.71	599.71
5/9/2003 6:00	24.68	599.68
5/9/2003 8:00	24.64	599.64
5/9/2003 10:00	24.63	599.63
5/9/2003 12:00	24.52	599.52
5/9/2003 14:00	24.49	599.49
5/9/2003 16:00	24.44	599.44
5/9/2003 18:00	24.43	599.43
5/9/2003 20:00	24.32	599.32
5/9/2003 22:00	24.34	599.34
5/10/2003 0:00	24.27	599.27
5/10/2003 2:00	24.21	599.21
5/10/2003 4:00	24.15	599.15
5/10/2003 6:00	24.09	599.09
5/10/2003 8:00	23.96	598.96
5/10/2003 10:00	23.91	598.91
5/10/2003 12:00	23.76	598.76
5/10/2003 14:00	23.70	598.70
5/10/2003 16:00	23.69	598.69
5/10/2003 18:00	23.63	598.63
5/10/2003 20:00	23.63	598.63
5/10/2003 22:00	23.57	598.57
5/11/2003 0:00	23.56	598.56
5/11/2003 2:00	23.51	598.51
5/11/2003 4:00	23.37	598.37
5/11/2003 6:00	23.39	598.39
5/11/2003 8:00	23.35	598.35
5/11/2003 10:00	23.31	598.31
5/11/2003 12:00	23.24	598.24
5/11/2003 14:00	23.12	598.12
5/11/2003 16:00	23.10	598.10
5/11/2003 18:00	23.01	598.01
5/11/2003 20:00	22.92	597.92
5/11/2003 22:00	22.83	597.83
5/12/2003 0:00	22.77	597.77

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/7/2003 13:00	616.61	254697
5/7/2003 14:00	616.78	254788
5/7/2003 15:00	616.80	254602
5/7/2003 16:00	616.84	254504
5/7/2003 17:00	616.88	254980
5/7/2003 18:00	616.92	255969
5/7/2003 19:00	616.96	256739
5/7/2003 20:00	617.00	259806
5/7/2003 21:00	617.04	262381
5/7/2003 22:00	617.12	262580
5/7/2003 23:00	617.16	264929
5/8/2003 0:00	617.20	274653
5/8/2003 1:00	617.22	269242
5/8/2003 2:00	617.25	267071
5/8/2003 3:00	617.26	258676
5/8/2003 4:00	617.27	249482
5/8/2003 5:00	617.29	249508
5/8/2003 6:00	616.80	249465
5/8/2003 7:00	617.34	249611
5/8/2003 8:00	616.80	252516
5/8/2003 9:00	617.51	255313
5/8/2003 10:00	617.67	260907
5/8/2003 11:00	617.74	266393
5/8/2003 12:00	617.81	266076
5/8/2003 13:00	617.84	265919
5/8/2003 14:00	617.87	265603
5/8/2003 15:00	618.03	264425
5/8/2003 16:00	618.05	265688
5/8/2003 17:00	618.05	265520
5/8/2003 18:00	618.05	265372
5/8/2003 19:00	618.05	265131
5/8/2003 20:00	617.87	261107
5/8/2003 21:00	617.76	251769
5/8/2003 22:00	617.65	248938
5/8/2003 23:00	617.58	249763
5/9/2003 0:00	617.56	250118

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/12/2003 2:00	27.08	608.09
5/12/2003 4:00	26.92	607.93
5/12/2003 6:00	26.75	607.76
5/12/2003 8:00	26.60	607.61
5/12/2003 10:00	26.00	607.01
5/12/2003 12:00	25.65	606.66
5/12/2003 14:00	25.46	606.47
5/12/2003 16:00	25.27	606.28
5/12/2003 18:00	25.10	606.11
5/12/2003 20:00	24.87	605.88
5/12/2003 22:00	24.70	605.71
5/13/2003 0:00	24.61	605.62
5/13/2003 2:00	24.52	605.53
5/13/2003 4:00	24.44	605.45
5/13/2003 6:00	23.36	604.37
5/13/2003 8:00	23.68	604.69
5/13/2003 10:00	23.60	604.61
5/13/2003 12:00	23.55	604.56
5/13/2003 14:00	23.75	604.76
5/13/2003 16:00	23.81	604.82
5/13/2003 18:00	23.97	604.98
5/13/2003 20:00	24.08	605.09
5/13/2003 22:00	23.98	604.99
5/14/2003 0:00	23.72	604.73
5/14/2003 2:00	23.46	604.47
5/14/2003 4:00	22.88	603.89
5/14/2003 6:00	22.07	603.08
5/14/2003 8:00	21.66	602.67
5/14/2003 10:00	21.43	602.44
5/14/2003 12:00	21.26	602.27
5/14/2003 14:00	21.21	602.22
5/14/2003 16:00	21.42	602.43
5/14/2003 18:00	21.63	602.64
5/14/2003 20:00	21.71	602.72
5/14/2003 22:00	21.75	602.76
5/15/2003 0:00	21.75	602.76

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/12/2003 2:00	22.66	597.66
5/12/2003 4:00	22.58	597.58
5/12/2003 6:00	22.48	597.48
5/12/2003 8:00	21.78	596.78
5/12/2003 10:00	21.58	596.58
5/12/2003 12:00	21.48	596.48
5/12/2003 14:00	21.32	596.32
5/12/2003 16:00	21.21	596.21
5/12/2003 18:00	21.12	596.12
5/12/2003 20:00	21.07	596.07
5/12/2003 22:00	21.03	596.03
5/13/2003 0:00	20.94	595.94
5/13/2003 2:00	20.88	595.88
5/13/2003 4:00	20.87	595.87
5/13/2003 6:00	20.84	595.84
5/13/2003 8:00	20.79	595.79
5/13/2003 10:00	20.63	595.63
5/13/2003 12:00	20.57	595.57
5/13/2003 14:00	20.49	595.49
5/13/2003 16:00	20.49	595.49
5/13/2003 18:00	20.55	595.55
5/13/2003 20:00	20.58	595.58
5/13/2003 22:00	20.58	595.58
5/14/2003 0:00	20.59	595.59
5/14/2003 2:00	20.66	595.66
5/14/2003 4:00	20.67	595.67
5/14/2003 6:00	20.63	595.63
5/14/2003 8:00	20.65	595.65
5/14/2003 10:00	20.56	595.56
5/14/2003 12:00	20.58	595.58
5/14/2003 14:00	20.51	595.51
5/14/2003 16:00	20.44	595.44
5/14/2003 18:00	20.33	595.33
5/14/2003 20:00	20.36	595.36
5/14/2003 22:00	20.32	595.32
5/15/2003 0:00	20.21	595.21

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/9/2003 1:00	617.51	249748
5/9/2003 2:00	617.21	233031
5/9/2003 3:00	617.08	231398
5/9/2003 4:00	616.98	231441
5/9/2003 5:00	616.88	231617
5/9/2003 6:00	616.88	231988
5/9/2003 7:00	616.88	231791
5/9/2003 8:00	616.88	232001
5/9/2003 9:00	616.70	232562
5/9/2003 10:00	616.61	232920
5/9/2003 11:00	616.50	232882
5/9/2003 12:00	616.41	235885
5/9/2003 13:00	616.39	234379
5/9/2003 14:00	616.36	234480
5/9/2003 15:00	616.33	234622
5/9/2003 16:00	616.28	234567
5/9/2003 17:00	616.24	234719
5/9/2003 18:00	616.22	235095
5/9/2003 19:00	616.22	235466
5/9/2003 20:00	616.20	235657
5/9/2003 21:00	616.15	235643
5/9/2003 22:00	616.12	235724
5/9/2003 23:00	616.09	235655
5/10/2003 0:00	615.89	229854
5/10/2003 1:00	615.74	218796
5/10/2003 2:00	615.60	218211
5/10/2003 3:00	615.50	219047
5/10/2003 4:00	615.10	208503
5/10/2003 5:00	614.94	203596
5/10/2003 6:00	614.66	204023
5/10/2003 7:00	614.51	199119
5/10/2003 8:00	614.39	199492
5/10/2003 9:00	614.30	199860
5/10/2003 10:00	614.22	200494
5/10/2003 11:00	614.15	201157
5/10/2003 12:00	614.09	201693

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/15/2003 2:00	21.74	602.75
5/15/2003 4:00	21.58	602.59
5/15/2003 6:00	20.61	601.62
5/15/2003 8:00	20.10	601.11
5/15/2003 10:00	19.46	600.47
5/15/2003 12:00	19.26	600.27
5/15/2003 14:00	19.16	600.17
5/15/2003 16:00	19.53	600.54
5/15/2003 18:00	19.97	600.98
5/15/2003 20:00	20.25	601.26
5/15/2003 22:00	20.39	601.40
5/16/2003 0:00	20.44	601.45
5/16/2003 2:00	19.91	600.92
5/16/2003 4:00	19.39	600.40
5/16/2003 6:00	18.81	599.82
5/16/2003 8:00	18.55	599.56
5/16/2003 10:00	18.38	599.39
5/16/2003 12:00	18.29	599.30
5/16/2003 14:00	18.51	599.52
5/16/2003 16:00	19.28	600.29
5/16/2003 18:00	19.74	600.75
5/16/2003 20:00	19.93	600.94
5/16/2003 22:00	20.03	601.04
5/17/2003 0:00	19.79	600.80
5/17/2003 2:00	19.38	600.39
5/17/2003 4:00	19.15	600.16
5/17/2003 6:00	18.93	599.94
5/17/2003 8:00	18.41	599.42
5/17/2003 10:00	18.08	599.09
5/17/2003 12:00	18.14	599.15
5/17/2003 14:00	18.22	599.23
5/17/2003 16:00	18.44	599.45
5/17/2003 18:00	18.69	599.70
5/17/2003 20:00	18.83	599.84
5/17/2003 22:00	18.90	599.91
5/18/2003 0:00	18.99	600.00

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev
5/15/2003 2:00	20.16	595.16
5/15/2003 4:00	20.15	595.15
5/15/2003 6:00	20.10	595.10
5/15/2003 8:00	20.03	595.03
5/15/2003 10:00	19.94	594.94
5/15/2003 12:00	19.82	594.82
5/15/2003 14:00	19.78	594.78
5/15/2003 16:00	19.72	594.72
5/15/2003 18:00	19.71	594.71
5/15/2003 20:00	19.84	594.84
5/15/2003 22:00	19.86	594.86
5/16/2003 0:00	19.92	594.92
5/16/2003 2:00	19.94	594.94
5/16/2003 4:00	19.97	594.97
5/16/2003 6:00	19.97	594.97
5/16/2003 8:00	19.96	594.96
5/16/2003 10:00	19.94	594.94
5/16/2003 12:00	19.97	594.97
5/16/2003 14:00	19.94	594.94
5/16/2003 16:00	19.90	594.90
5/16/2003 18:00	19.95	594.95
5/16/2003 20:00	20.01	595.01
5/16/2003 22:00	20.02	595.02
5/17/2003 0:00	20.06	595.06
5/17/2003 2:00	20.07	595.07
5/17/2003 4:00	20.08	595.08
5/17/2003 6:00	20.07	595.07
5/17/2003 8:00	20.05	595.05
5/17/2003 10:00	20.03	595.03
5/17/2003 12:00	19.99	594.99
5/17/2003 14:00	20.06	595.06
5/17/2003 16:00	19.98	594.98
5/17/2003 18:00	19.88	594.88
5/17/2003 20:00	19.93	594.93
5/17/2003 22:00	19.95	594.95
5/18/2003 0:00	19.99	594.99

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/10/2003 13:00	614.02	202361
5/10/2003 14:00	613.96	203081
5/10/2003 15:00	613.92	203685
5/10/2003 16:00	613.87	204164
5/10/2003 17:00	613.79	204591
5/10/2003 18:00	613.76	205064
5/10/2003 19:00	613.71	205428
5/10/2003 20:00	613.40	193628
5/10/2003 21:00	612.98	181863
5/10/2003 22:00	612.83	179929
5/10/2003 23:00	612.70	180994
5/11/2003 0:00	612.58	181627
5/11/2003 1:00	612.47	181821
5/11/2003 2:00	612.37	181632
5/11/2003 3:00	612.29	181299
5/11/2003 4:00	612.19	180858
5/11/2003 5:00	612.11	180469
5/11/2003 6:00	612.02	179941
5/11/2003 7:00	611.92	177285
5/11/2003 8:00	611.70	172662
5/11/2003 9:00	611.57	170603
5/11/2003 10:00	611.47	170747
5/11/2003 11:00	611.07	166228
5/11/2003 12:00	610.60	156742
5/11/2003 13:00	610.39	152776
5/11/2003 14:00	610.29	153746
5/11/2003 15:00	610.17	154483
5/11/2003 16:00	610.07	155027
5/11/2003 17:00	609.96	155227
5/11/2003 18:00	609.88	155354
5/11/2003 19:00	609.79	155542
5/11/2003 20:00	609.71	155813
5/11/2003 21:00	609.65	155787
5/11/2003 22:00	609.58	155803
5/11/2003 23:00	609.51	155815
5/12/2003 0:00	609.40	155728

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/12/2003 1:00	609.29	153667
5/12/2003 2:00	608.78	136047
5/12/2003 3:00	608.59	136716
5/12/2003 4:00	608.43	136753
5/12/2003 5:00	608.33	136759
5/12/2003 6:00	608.20	136758
5/12/2003 7:00	608.09	136837
5/12/2003 8:00	608.01	137007
5/12/2003 9:00	607.96	135431
5/12/2003 10:00	607.85	132676
5/12/2003 11:00	607.81	132565
5/12/2003 12:00	607.73	132377
5/12/2003 13:00	607.67	132194
5/12/2003 14:00	607.59	132189
5/12/2003 15:00	607.54	132189
5/12/2003 16:00	607.50	132125
5/12/2003 17:00	607.45	132244
5/12/2003 18:00	607.43	132329
5/12/2003 19:00	607.38	132413
5/12/2003 20:00	607.34	132591
5/12/2003 21:00	607.30	132752
5/12/2003 22:00	607.27	132972
5/12/2003 23:00	607.24	133108
5/13/2003 0:00	607.21	133051
5/13/2003 1:00	607.17	132835
5/13/2003 2:00	607.14	132511
5/13/2003 3:00	606.79	123097
5/13/2003 4:00	606.42	119022
5/13/2003 5:00	606.24	116100
5/13/2003 6:00	606.11	116091
5/13/2003 7:00	606.00	116171
5/13/2003 8:00	605.96	116372
5/13/2003 9:00	605.97	116571
5/13/2003 10:00	605.93	116893
5/13/2003 11:00	605.84	139979
5/13/2003 12:00	606.04	123294

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/13/2003 13:00	606.25	128849
5/13/2003 14:00	606.34	129656
5/13/2003 15:00	606.37	130165
5/13/2003 16:00	606.39	131324
5/13/2003 17:00	606.47	131628
5/13/2003 18:00	606.63	136020
5/13/2003 19:00	606.63	135796
5/13/2003 20:00	606.60	134869
5/13/2003 21:00	606.52	130954
5/13/2003 22:00	606.56	130933
5/13/2003 23:00	606.49	130735
5/14/2003 0:00	606.01	120753
5/14/2003 1:00	605.86	118862
5/14/2003 2:00	605.75	118750
5/14/2003 3:00	605.21	108730
5/14/2003 4:00	604.73	104178
5/14/2003 5:00	604.28	99618
5/14/2003 6:00	603.95	86157
5/14/2003 7:00	603.74	86740
5/14/2003 8:00	603.66	87027
5/14/2003 9:00	603.50	87444
5/14/2003 10:00	603.42	87138
5/14/2003 11:00	603.33	86441
5/14/2003 12:00	603.28	86748
5/14/2003 13:00	603.34	108159
5/14/2003 14:00	603.30	92960
5/14/2003 15:00	603.54	96446
5/14/2003 16:00	603.79	101189
5/14/2003 17:00	603.91	101128
5/14/2003 18:00	603.98	101039
5/14/2003 19:00	604.04	100949
5/14/2003 20:00	604.06	100887
5/14/2003 21:00	604.08	100777
5/14/2003 22:00	604.08	110132
5/14/2003 23:00	604.08	117068
5/15/2003 0:00	604.07	100383

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

Attachment 6
Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/15/2003 1:00	604.05	100084
5/15/2003 2:00	604.04	99473
5/15/2003 3:00	603.99	99216
5/15/2003 4:00	603.49	94344
5/15/2003 5:00	602.73	84368
5/15/2003 6:00	602.33	77248
5/15/2003 7:00	602.06	77789
5/15/2003 8:00	601.97	77985
5/15/2003 9:00	601.86	78179
5/15/2003 10:00	601.68	78402
5/15/2003 11:00	601.60	78616
5/15/2003 12:00	601.56	78810
5/15/2003 13:00	601.48	79070
5/15/2003 14:00	601.67	79334
5/15/2003 15:00	601.67	79428
5/15/2003 16:00	602.26	92295
5/15/2003 17:00	602.59	94847
5/15/2003 18:00	602.78	94651
5/15/2003 19:00	602.91	94385
5/15/2003 20:00	603.01	94065
5/15/2003 21:00	603.09	93814
5/15/2003 22:00	603.10	93643
5/15/2003 23:00	603.12	93451
5/16/2003 0:00	602.71	91031
5/16/2003 1:00	602.49	84444
5/16/2003 2:00	602.26	84473
5/16/2003 3:00	602.18	84463
5/16/2003 4:00	601.36	73847
5/16/2003 5:00	601.06	70563
5/16/2003 6:00	600.85	70796
5/16/2003 7:00	600.72	70936
5/16/2003 8:00	600.63	71094
5/16/2003 9:00	600.55	69247
5/16/2003 10:00	600.50	64275
5/16/2003 11:00	600.47	64374
5/16/2003 12:00	600.44	64616

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Nickajack Dam TRM 424.7
TW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	TW elev	Discharge Q (cfs)
5/16/2003 13:00	600.77	68824
5/16/2003 14:00	600.82	70314
5/16/2003 15:00	601.66	79761
5/16/2003 16:00	602.13	87537
5/16/2003 17:00	602.27	87595
5/16/2003 18:00	602.41	87504
5/16/2003 19:00	602.66	87297
5/16/2003 20:00	602.59	87182
5/16/2003 21:00	602.63	87011
5/16/2003 22:00	602.66	86805
5/16/2003 23:00	602.68	86719
5/17/2003 0:00	601.98	75275
5/17/2003 1:00	601.76	71658
5/17/2003 2:00	601.61	71614
5/17/2003 3:00	601.48	71577
5/17/2003 4:00	601.41	71441
5/17/2003 5:00	601.33	71242
5/17/2003 6:00	600.95	67401
5/17/2003 7:00	600.51	61118
5/17/2003 8:00	600.29	58465
5/17/2003 9:00	600.13	58482
5/17/2003 10:00	600.04	58610
5/17/2003 11:00	600.24	62280
5/17/2003 12:00	600.32	64062
5/17/2003 13:00	600.38	64137
5/17/2003 14:00	600.38	64264
5/17/2003 15:00	600.63	67070
5/17/2003 16:00	600.74	69775
5/17/2003 17:00	600.98	71268
5/17/2003 18:00	601.11	74100
5/17/2003 19:00	601.20	74073
5/17/2003 20:00	601.23	74016
5/17/2003 21:00	601.27	73971
5/17/2003 22:00	601.30	73974
5/17/2003 23:00	601.48	73960
5/18/2003 0:00	601.37	73956

TN River at South Pittsburg TRM 418.1
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

TN River nr Scottboro TRM 385.5
Stage and WS Elev from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	Stage	WS elev

Attachment 6

Source: Reference 2.6

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/3/2003 1:00	594.61	39802
5/3/2003 2:00	594.63	39820
5/3/2003 3:00	594.63	40062
5/3/2003 4:00	594.66	40354
5/3/2003 5:00	594.65	40151
5/3/2003 6:00	594.60	39994
5/3/2003 7:00	594.53	40040
5/3/2003 8:00	594.46	40015
5/3/2003 9:00	594.39	40067
5/3/2003 10:00	594.35	40104
5/3/2003 11:00	594.35	40046
5/3/2003 12:00	594.39	40192
5/3/2003 13:00	594.36	40276
5/3/2003 14:00	594.38	40198
5/3/2003 15:00	594.32	40103
5/3/2003 16:00	594.26	40266
5/3/2003 17:00	594.43	39366
5/3/2003 18:00	594.39	22649
5/3/2003 19:00	594.45	22276
5/3/2003 20:00	594.50	22551
5/3/2003 21:00	594.56	22435
5/3/2003 22:00	594.60	22469
5/3/2003 23:00	594.61	22127
5/4/2003 0:00	594.63	22062
5/4/2003 1:00	594.63	22009
5/4/2003 2:00	594.63	22112
5/4/2003 3:00	594.61	21975
5/4/2003 4:00	594.60	22043
5/4/2003 5:00	594.63	22068
5/4/2003 6:00	594.64	21936
5/4/2003 7:00	594.58	22633
5/4/2003 8:00	594.49	22373
5/4/2003 9:00	594.42	22584
5/4/2003 10:00	594.39	22511
5/4/2003 11:00	594.36	22468
5/4/2003 12:00	594.34	22256

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/4/2003 13:00	594.34	39823
5/4/2003 14:00	594.34	39797
5/4/2003 15:00	594.35	39740
5/4/2003 16:00	594.34	39865
5/4/2003 17:00	594.27	39880
5/4/2003 18:00	594.35	39857
5/4/2003 19:00	594.28	39756
5/4/2003 20:00	594.27	39891
5/4/2003 21:00	594.43	38854
5/4/2003 22:00	594.36	22588
5/4/2003 23:00	594.34	21918
5/5/2003 0:00	594.29	22343
5/5/2003 1:00	594.27	22285
5/5/2003 2:00	594.30	22304
5/5/2003 3:00	594.33	22489
5/5/2003 4:00	594.39	22364
5/5/2003 5:00	594.37	22510
5/5/2003 6:00	594.20	22674
5/5/2003 7:00	594.01	39791
5/5/2003 8:00	594.15	39588
5/5/2003 9:00	594.00	39686
5/5/2003 10:00	594.09	39529
5/5/2003 11:00	594.03	39701
5/5/2003 12:00	594.10	39501
5/5/2003 13:00	594.12	39623
5/5/2003 14:00	594.28	39867
5/5/2003 15:00	594.16	39679
5/5/2003 16:00	594.25	39571
5/5/2003 17:00	594.35	39494
5/5/2003 18:00	594.44	39604
5/5/2003 19:00	594.53	39615
5/5/2003 20:00	594.48	39720
5/5/2003 21:00	594.45	39530
5/5/2003 22:00	594.48	39471
5/5/2003 23:00	594.52	44928
5/6/2003 0:00	594.57	57345

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/6/2003 1:00	594.57	59547
5/6/2003 2:00	594.50	69707
5/6/2003 3:00	594.53	75434
5/6/2003 4:00	594.39	80823
5/6/2003 5:00	594.39	87743
5/6/2003 6:00	594.53	90114
5/6/2003 7:00	594.58	90095
5/6/2003 8:00	594.59	92314
5/6/2003 9:00	594.61	101505
5/6/2003 10:00	594.30	111479
5/6/2003 11:00	594.53	122688
5/6/2003 12:00	594.70	136338
5/6/2003 13:00	594.73	153454
5/6/2003 14:00	594.96	153920
5/6/2003 15:00	595.05	173803
5/6/2003 16:00	594.93	187806
5/6/2003 17:00	595.02	199430
5/6/2003 18:00	594.99	214192
5/6/2003 19:00	595.07	218971
5/6/2003 20:00	595.02	227157
5/6/2003 21:00	595.02	236539
5/6/2003 22:00	595.02	246283
5/6/2003 23:00	594.90	254872
5/7/2003 0:00	594.84	253693
5/7/2003 1:00	594.86	253204
5/7/2003 2:00	594.88	254273
5/7/2003 3:00	594.86	255204
5/7/2003 4:00	594.84	255072
5/7/2003 5:00	594.88	254070
5/7/2003 6:00	594.83	253525
5/7/2003 7:00	594.86	253031
5/7/2003 8:00	594.90	254114
5/7/2003 9:00	595.02	252237
5/7/2003 10:00	594.88	258022
5/7/2003 11:00	594.92	257867
5/7/2003 12:00	594.80	256629

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/7/2003 13:00	594.77	254607
5/7/2003 14:00	594.83	276376
5/7/2003 15:00	594.82	281878
5/7/2003 16:00	594.76	284435
5/7/2003 17:00	594.72	283233
5/7/2003 18:00	594.73	282613
5/7/2003 19:00	594.72	282228
5/7/2003 20:00	594.71	281783
5/7/2003 21:00	594.68	281013
5/7/2003 22:00	594.59	279557
5/7/2003 23:00	594.54	277884
5/8/2003 0:00	594.57	277592
5/8/2003 1:00	594.60	277680
5/8/2003 2:00	594.58	277418
5/8/2003 3:00	594.58	277045
5/8/2003 4:00	594.60	277121
5/8/2003 5:00	594.63	277301
5/8/2003 6:00	594.60	277000
5/8/2003 7:00	594.71	277502
5/8/2003 8:00	594.75	278552
5/8/2003 9:00	594.75	279051
5/8/2003 10:00	594.72	278760
5/8/2003 11:00	594.75	278771
5/8/2003 12:00	594.82	279530
5/8/2003 13:00	594.84	283698
5/8/2003 14:00	594.85	301718
5/8/2003 15:00	594.86	301252
5/8/2003 16:00	594.85	301117
5/8/2003 17:00	594.82	300540
5/8/2003 18:00	594.87	300371
5/8/2003 19:00	594.87	300674
5/8/2003 20:00	594.86	300413
5/8/2003 21:00	594.87	300221
5/8/2003 22:00	594.87	300103
5/8/2003 23:00	594.88	300129
5/9/2003 0:00	594.86	299914

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/9/2003 1:00	594.84	299444
5/9/2003 2:00	594.89	299627
5/9/2003 3:00	594.86	299681
5/9/2003 4:00	594.86	299356
5/9/2003 5:00	594.87	299490
5/9/2003 6:00	594.82	299118
5/9/2003 7:00	594.85	298759
5/9/2003 8:00	594.84	299039
5/9/2003 9:00	594.89	299411
5/9/2003 10:00	594.81	300270
5/9/2003 11:00	594.87	303567
5/9/2003 12:00	594.84	303686
5/9/2003 13:00	594.83	303295
5/9/2003 14:00	594.81	303025
5/9/2003 15:00	594.72	301985
5/9/2003 16:00	594.72	301330
5/9/2003 17:00	594.70	301180
5/9/2003 18:00	594.67	300726
5/9/2003 19:00	594.67	300371
5/9/2003 20:00	594.65	300402
5/9/2003 21:00	594.65	300177
5/9/2003 22:00	594.62	299819
5/9/2003 23:00	594.56	299110
5/10/2003 0:00	594.57	298668
5/10/2003 1:00	594.52	298464
5/10/2003 2:00	594.48	297591
5/10/2003 3:00	594.45	297075
5/10/2003 4:00	594.41	296553
5/10/2003 5:00	594.38	296131
5/10/2003 6:00	594.41	296132
5/10/2003 7:00	594.40	296447
5/10/2003 8:00	594.38	296169
5/10/2003 9:00	594.32	295569
5/10/2003 10:00	594.29	294870
5/10/2003 11:00	594.40	295830
5/10/2003 12:00	594.45	255536

Attachment 6

Source: Reference 2.6

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/10/2003 13:00	594.51	237981
5/10/2003 14:00	594.52	238786
5/10/2003 15:00	594.61	245867
5/10/2003 16:00	594.71	247946
5/10/2003 17:00	594.73	249197
5/10/2003 18:00	594.75	249817
5/10/2003 19:00	594.74	250072
5/10/2003 20:00	594.72	250087
5/10/2003 21:00	594.69	249932
5/10/2003 22:00	594.70	249888
5/10/2003 23:00	594.69	250043
5/11/2003 0:00	594.70	250222
5/11/2003 1:00	594.68	250427
5/11/2003 2:00	594.66	250152
5/11/2003 3:00	594.69	250436
5/11/2003 4:00	594.65	250418
5/11/2003 5:00	594.64	250192
5/11/2003 6:00	594.58	249691
5/11/2003 7:00	594.56	249299
5/11/2003 8:00	594.59	249423
5/11/2003 9:00	594.61	249982
5/11/2003 10:00	594.58	250192
5/11/2003 11:00	594.54	249594
5/11/2003 12:00	594.63	229103
5/11/2003 13:00	594.59	225258
5/11/2003 14:00	594.66	225907
5/11/2003 15:00	594.67	226761
5/11/2003 16:00	594.68	227005
5/11/2003 17:00	594.63	226775
5/11/2003 18:00	594.64	226756
5/11/2003 19:00	594.65	227033
5/11/2003 20:00	594.62	227138
5/11/2003 21:00	594.55	226517
5/11/2003 22:00	594.56	226078
5/11/2003 23:00	594.49	225740
5/12/2003 0:00	594.45	225001

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/12/2003 1:00	594.40	224661
5/12/2003 2:00	594.38	224184
5/12/2003 3:00	594.33	223766
5/12/2003 4:00	594.25	222898
5/12/2003 5:00	594.18	221905
5/12/2003 6:00	594.20	221524
5/12/2003 7:00	594.22	221794
5/12/2003 8:00	594.18	221592
5/12/2003 9:00	594.15	221043
5/12/2003 10:00	594.05	219892
5/12/2003 11:00	594.03	218937
5/12/2003 12:00	594.01	218630
5/12/2003 13:00	594.07	218521
5/12/2003 14:00	594.04	206040
5/12/2003 15:00	594.07	195803
5/12/2003 16:00	594.14	184835
5/12/2003 17:00	594.15	176247
5/12/2003 18:00	594.18	166175
5/12/2003 19:00	594.17	164269
5/12/2003 20:00	594.18	164193
5/12/2003 21:00	594.17	164213
5/12/2003 22:00	594.16	164206
5/12/2003 23:00	594.17	164306
5/13/2003 0:00	594.14	164212
5/13/2003 1:00	594.14	164237
5/13/2003 2:00	594.11	164172
5/13/2003 3:00	594.07	164002
5/13/2003 4:00	594.02	163599
5/13/2003 5:00	594.01	163471
5/13/2003 6:00	594.01	163409
5/13/2003 7:00	594.01	163475
5/13/2003 8:00	594.02	163470
5/13/2003 9:00	594.00	163565
5/13/2003 10:00	593.99	163393
5/13/2003 11:00	594.00	163409
5/13/2003 12:00	594.00	150834

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/13/2003 13:00	594.05	138389
5/13/2003 14:00	594.07	130028
5/13/2003 15:00	594.10	126053
5/13/2003 16:00	594.12	126359
5/13/2003 17:00	594.09	126382
5/13/2003 18:00	594.13	126589
5/13/2003 19:00	594.06	126579
5/13/2003 20:00	594.03	126637
5/13/2003 21:00	594.02	126578
5/13/2003 22:00	594.00	126198
5/13/2003 23:00	593.98	126179
5/14/2003 0:00	593.98	126219
5/14/2003 1:00	594.02	126246
5/14/2003 2:00	594.07	126233
5/14/2003 3:00	594.12	126281
5/14/2003 4:00	594.17	126196
5/14/2003 5:00	594.22	126161
5/14/2003 6:00	594.27	126042
5/14/2003 7:00	594.32	125572
5/14/2003 8:00	594.37	125407
5/14/2003 9:00	594.42	125694
5/14/2003 10:00	594.45	125718
5/14/2003 11:00	594.48	125689
5/14/2003 12:00	594.52	125790
5/14/2003 13:00	594.55	125828
5/14/2003 14:00	594.58	125775
5/14/2003 15:00	594.61	125816
5/14/2003 16:00	594.35	125866
5/14/2003 17:00	594.28	126220
5/14/2003 18:00	594.24	126737
5/14/2003 19:00	594.22	126687
5/14/2003 20:00	594.20	126781
5/14/2003 21:00	594.18	126608
5/14/2003 22:00	594.16	126594
5/14/2003 23:00	594.14	126607
5/15/2003 0:00	594.12	126531

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/15/2003 1:00	594.08	126568
5/15/2003 2:00	594.08	126410
5/15/2003 3:00	594.04	126535
5/15/2003 4:00	594.02	126453
5/15/2003 5:00	594.00	126405
5/15/2003 6:00	594.00	126299
5/15/2003 7:00	593.97	126328
5/15/2003 8:00	593.96	126191
5/15/2003 9:00	593.95	126089
5/15/2003 10:00	593.94	126197
5/15/2003 11:00	594.01	126551
5/15/2003 12:00	594.07	127022
5/15/2003 13:00	594.06	115589
5/15/2003 14:00	594.09	93814
5/15/2003 15:00	594.12	84377
5/15/2003 16:00	594.14	84104
5/15/2003 17:00	594.17	84213
5/15/2003 18:00	594.17	84540
5/15/2003 19:00	594.17	84855
5/15/2003 20:00	594.18	84753
5/15/2003 21:00	594.17	84565
5/15/2003 22:00	594.19	84306
5/15/2003 23:00	594.21	84494
5/16/2003 0:00	594.23	84408
5/16/2003 1:00	594.25	84190
5/16/2003 2:00	594.29	83400
5/16/2003 3:00	594.31	83042
5/16/2003 4:00	594.34	82829
5/16/2003 5:00	594.36	82983
5/16/2003 6:00	594.38	82782
5/16/2003 7:00	594.39	82792
5/16/2003 8:00	594.36	73514
5/16/2003 9:00	594.36	68690
5/16/2003 10:00	594.40	86551
5/16/2003 11:00	594.42	85582
5/16/2003 12:00	594.41	85527

Attachment 6

Source: Reference 2.6

Calculation No: CDQ000020080041

Guntersville Dam TRM 349.0
HW and Q from TVA River Operations, River Scheduling, Hourly Water Records database
Entered by JMF 7/30/08
Checked by SCB 8/4/08

Date and Time	HW elev	Discharge Q (cfs)
5/16/2003 13:00	594.41	85389
5/16/2003 14:00	594.51	84518
5/16/2003 15:00	594.31	70193
5/16/2003 16:00	594.49	85747
5/16/2003 17:00	594.45	85846
5/16/2003 18:00	594.40	85908
5/16/2003 19:00	594.39	85963
5/16/2003 20:00	594.36	86524
5/16/2003 21:00	594.38	86378
5/16/2003 22:00	594.39	86244
5/16/2003 23:00	594.40	86243
5/17/2003 0:00	594.43	86154
5/17/2003 1:00	594.44	86039
5/17/2003 2:00	594.44	86070
5/17/2003 3:00	594.45	86038
5/17/2003 4:00	594.46	85716
5/17/2003 5:00	594.45	85158
5/17/2003 6:00	594.46	84671
5/17/2003 7:00	594.49	83756
5/17/2003 8:00	594.51	84349
5/17/2003 9:00	594.46	83769
5/17/2003 10:00	594.46	82918
5/17/2003 11:00	594.45	83031
5/17/2003 12:00	594.44	83093
5/17/2003 13:00	594.34	82958
5/17/2003 14:00	594.37	81843
5/17/2003 15:00	594.38	83962
5/17/2003 16:00	594.40	83745
5/17/2003 17:00	594.49	62350
5/17/2003 18:00	594.46	80886
5/17/2003 19:00	594.45	84025
5/17/2003 20:00	594.42	84370
5/17/2003 21:00	594.48	84489
5/17/2003 22:00	594.43	84558
5/17/2003 23:00	594.53	84511
5/18/2003 0:00	594.45	84401

CDQ000020080041 Rev 0
Attachment_07_ Guntersville Total Local Inflow Hydrographs
with attachments:

Guntersville (SB 49 & 50) Total Local Inflow Hydrographs 1973 & 2003 Rev E (15Apr2009).xls

576	0	0	0	424.7 #01
580	3051	2.34	868	0.016
585	7775	3.83	1071	
590	13082	5.27	1117	
595	18558	6.52	1452	
600	24184	7.64	5191	
605	29961	8.65	8929	
610	36484	9.4	12667	
615	45131	9.73	16406	
620	55753	9.98	20144	
625	69918	9.9	29600	
630	84725	9.94	39056	
635	99829	10.08	48513	
640	115171	10.28	57969	
645	132418	10.36	65279	
650	149738	10.53	72589	
660	184594	10.97	87208	
670	229294	10.98	101828	
680	278394	11.02	116448	
690	334894	11	131068	
700	397394	10.97	145687	
577.66	0	0	0	422.6 #02
580	405	1.18	317	0.029
585	3584	2.25	1060	
590	9282	3.9	1204	
595	15356	5.39	1404	
600	21511	6.68	3857	
605	27813	7.84	6311	
610	34498	8.84	8765	
615	41806	9.68	11219	
620	56291	9.32	13672	
625	76510	8.82	18605	
630	98673	8.64	23537	
635	122835	8.6	28469	
640	148922	8.65	33401	
645	176504	8.79	37206	
650	205175	8.97	41010	
655	234935	9.17	44815	
660	265784	9.39	48619	
665	297303	9.68	52423	
670	329074	9.99	56228	
680	393371	10.62	63836	
579	0	0	0	420.49 #03
580	349	0.79	472	0.025
585	3824	2.74	751	
590	10294	3.69	1288	

595	17772	5.13	1353	
600	25491	6.39	3274	
605	33439	7.49	5196	
610	43964	6.59	7118	
615	69088	5.61	9039	
620	103538	6.01	10961	
625	140968	6.55	12565	
630	179421	7.11	14168	
635	219155	7.66	15772	
640	260258	8.17	17375	
645	302514	8.69	18274	
650	345701	9.19	19173	
655	389822	9.66	20072	
660	434875	10.12	20971	
665	480798	10.57	21870	
670	527529	11	22768	
680	623414	11.82	24566	
567.7	0	0	0	418.39 #04
570	388	1.1	352	0.022
575	3002	2.68	712	
580	6803	4.12	847	
585	11044	5.42	948	
590	15514	6.58	995	
595	20199	7.61	1293	
600	25096	8.54	3180	
605	30207	9.39	5067	
610	37394	9.75	6955	
615	57401	8.19	8842	
620	83106	7.22	10729	
625	109883	6.85	12381	
630	137133	6.73	14033	
635	164839	6.75	15685	
640	192831	6.84	17336	
645	221058	6.98	18256	
650	249522	7.14	19175	
660	307158	7.51	21013	
670	365740	7.9	22851	
680	425267	8.29	24690	
579.2	0	0	0	416.28 #05
580	44	0.54	111	0.034
585	5369	2.59	1284	
590	11990	4.29	1344	
595	18807	5.66	1617	
600	25816	6.84	3301	
605	33554	7.78	4985	
610	45913	7.25	6668	

615	75508	5.64	8352	
620	111039	5.75	10036	
625	149476	6.05	11233	
630	188273	6.45	12430	
635	227418	6.88	13627	
640	266911	7.31	14824	
645	306720	7.75	15572	
650	346815	8.18	16320	
655	387195	8.6	17068	
660	427861	9.01	17816	
665	468800	9.41	18564	
670	509999	9.81	19312	
680	593178	10.57	20808	
578.5	0	0	0	414.19 #06
580	223	1	217	0.025
585	6066	2.29	1644	
590	14919	4.1	1684	
595	23983	5.53	1768	
600	33258	6.76	3290	
605	43715	7.08	4811	
610	62614	5.87	6333	
615	87905	6.76	7854	
620	113452	7.64	9376	
625	139353	8.47	10550	
630	165653	9.26	11723	
635	192353	10.01	12897	
640	219453	10.72	14071	
645	246953	11.4	14832	
650	274853	12.05	15592	
655	303153	12.67	16353	
660	331853	13.26	17113	
665	360953	13.84	17874	
670	390453	14.39	18634	
680	450654	15.43	20156	
576.6	0	0	0	412.08 #07
580	2283	1.5	1260	0.025
585	9002	3.43	1472	
590	16307	4.92	1553	
595	23926	6.19	2019	
600	31833	7.3	2944	
605	40219	8.3	3868	
610	51954	8.76	4793	
615	65876	9.06	5718	
620	81101	9.37	6642	
625	96950	9.78	7072	
630	112943	10.23	7503	

635	128985	10.7	7933		
640	145074	11.18	8363		
645	161212	11.66	8695		
650	177398	12.13	9026		
655	193633	12.61	9358		
660	209915	13.07	9690		
665	226246	13.53	10022		
670	242626	13.98	10353		
680	275529	14.87	11017		
575.75	0	0	0	409.98	#08
580	3203	1.73	1494	0.023	
585	10576	3.64	1704		
590	18253	5.17	1737		
595	26075	6.47	2258		
600	34043	7.63	3995		
605	43214	8.51	5733		
610	57139	8.76	7471		
615	72137	9.1	9209		
620	87407	9.52	10947		
625	102947	9.98	12222		
630	118664	10.46	13498		
635	134513	10.95	14773		
640	150494	11.43	16048		
645	166606	11.91	17032		
650	182850	12.38	18015		
655	199226	12.85	18998		
660	215733	13.3	19982		
665	232372	13.75	20965		
670	249143	14.19	21948		
680	283080	15.03	23915		
576.25	0	0	0	407.88	#09
580	4254	2.09	1406	0.025	
585	11404	3.96	1445		
590	18709	5.43	1476		
595	26169	6.69	1719		
600	34143	7.74	3528		
605	47048	7.91	5336		
610	70618	7.24	7145		
615	96738	7.04	8953		
620	123348	7.11	10762		
625	150448	7.29	12058		
630	178038	7.53	13354		
635	206127	7.78	14650		
640	234859	8.02	15947		
645	264341	8.3	16876		
650	294124	8.58	17804		

655	324210	8.87	18733	
660	354599	9.15	19662	
665	385290	9.43	20591	
670	416284	9.71	21520	
680	479179	10.25	23378	
564	0	0	0	405.77 #10
565	118	0.75	182	0.025
570	2016	2.21	614	
575	6641	3.52	1003	
580	11903	4.92	1090	
585	17417	6.23	1115	
590	23056	7.4	1140	
595	28819	8.45	1348	
600	36001	9.1	2621	
605	54347	7.98	3893	
610	82048	7.13	5165	
615	112449	6.84	6438	
620	145160	6.83	7710	
625	184512	6.74	8051	
630	224469	6.89	8391	
635	265029	7.1	8732	
640	306194	7.36	9073	
650	389835	7.93	9404	
660	474894	8.52	9735	
670	561119	9.13	10066	
680	648260	9.73	10397	
573.3	0	0	0	403.67 #11
575	1005	0.96	1055	0.027
580	7038	3.18	1232	
585	13309	4.78	1255	
590	19729	6.12	1284	
595	26375	7.27	1348	
600	35388	7.83	2732	
605	59988	6.47	4115	
610	97228	5.52	5499	
615	138671	5.22	6883	
620	182485	5.16	8267	
625	227472	5.25	8563	
630	273823	5.37	8859	
635	322034	5.52	9155	
640	372105	5.67	9452	
645	423604	5.84	9648	
650	476102	6.02	9844	
655	529599	6.21	10040	
660	584095	6.39	10237	
670	694962	6.79	10629	

680	807585	7.19	11022	
572.2	0	0	0	401.57 #12
575	1273	1.01	2051	0.021
580	8407	3.16	2434	
585	16110	4.7	3557	
590	24172	5.97	3715	
595	33408	6.91	4830	
600	55258	6.12	11420	
605	90331	4.83	18010	
610	129676	5.08	24599	
615	169583	5.43	31189	
620	210053	5.82	37779	
625	250836	6.22	42908	
630	291682	6.63	48038	
635	332590	7.03	53167	
640	373561	7.43	58296	
645	414595	7.82	61059	
650	455692	8.2	63822	
655	496852	8.58	66585	
660	538074	8.94	69348	
670	620707	9.66	74874	
680	703592	10.34	80400	
564.1	0	0	0	399.47 #13
565	37	0.59	170	0.033
570	1867	1.77	1632	
575	7281	3.33	2459	
580	13410	4.85	2572	
585	19816	6.11	4065	
590	26501	7.21	4236	
595	35116	7.85	5506	
600	55277	7.14	11972	
605	80737	7.06	18437	
610	106594	7.35	24902	
615	132849	7.78	31367	
620	159500	8.25	37833	
625	186479	8.74	43112	
630	213715	9.24	48391	
635	244084	9.63	53671	
640	275460	10	58950	
650	343235	10.66	64763	
660	419035	11.19	70577	
670	500743	11.69	76390	
680	586313	12.19	82203	
566.2	0	0	0	397.36 #14
570	2127	1.72	1510	0.015
575	7585	3.51	1854	

580	13449	5.03	1915	
585	19483	6.32	2709	
590	25764	7.44	3170	
595	35405	7.72	4120	
600	50008	7.44	5106	
605	67476	7.28	6091	
610	85343	7.33	7076	
615	116786	6.67	8061	
620	149808	6.36	9047	
625	184431	6.2	9491	
630	220476	6.14	9936	
635	257943	6.12	10380	
640	296832	6.13	10824	
645	336785	6.18	11187	
650	377444	6.25	11549	
655	418810	6.33	11911	
660	460882	6.41	12273	
665	0	0	12636	
558.5	0	0	0	395.26 #15
560	493	1.13	1631	0.029
565	3645	2.85	2989	
570	7866	4.19	3613	
575	12627	5.51	3846	
580	17585	6.71	3980	
585	22713	7.77	7187	
590	28013	8.73	7442	
595	33995	9.5	9675	
600	43480	9.71	15443	
605	56078	9.75	21211	
610	69002	10.03	26979	
615	95504	9.08	32747	
620	123557	8.68	38515	
625	153133	8.53	41768	
630	184224	8.5	45020	
635	216829	8.54	48273	
640	250948	8.62	51526	
645	286119	8.77	53306	
650	321876	8.94	55085	
660	395152	9.33	58645	
565	0	0	0	393.16 #16
570	3211	2.12	2728	0.02
575	9249	3.72	3367	
580	15865	5.15	3534	
585	22799	6.34	5979	
590	30053	7.4	6249	
595	38324	6.75	8124	

600	52783	7.48	13641		
605	69437	8.12	19159		
610	86478	8.8	24676		
615	106125	9.28	30194		
620	127315	9.71	35712		
625	151639	9.99	38897		
630	177734	10.24	42082		
635	208962	10.26	45267		
640	248640	10.08	48453		
645	294055	9.93	50169		
650	339894	9.92	51886		
655	386132	9.99	53602		
660	432745	10.1	55319		
665	0	0	57035		
566.5	0	0	0	391.06	#17
570	1437	1.17	1273	0.024	
575	7661	3.24	1471		
580	14600	4.72	1598		
585	21868	6.01	1847		
590	29432	7.13	1922		
595	42525	7.32	2498		
600	56888	7.73	2720		
605	73131	8.29	2942		
610	89497	8.92	3165		
615	108404	9.35	3387		
620	128774	9.74	3609		
625	152282	9.98	3716		
630	177603	10.19	3823		
635	208037	10.17	3931		
640	246884	9.95	4038		
645	291432	9.75	4139		
650	336367	9.68	4240		
655	381665	9.7	4341		
660	427301	9.77	4442		
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565	140	0.42	637	0.035	
570	6726	2.75	1790		
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580	21810	5.84	1870		
585	29701	6.44	2587		
590	39749	6.63	3316		
595	54283	6.21	4310		
600	73454	7.1	4565		
605	94046	8.13	4819		
610	115231	9.14	5073		

615	139359	9.89	5328		
620	165369	10.55	5582		
625	194923	11.03	5727		
630	226683	11.46	5872		
635	263923	11.65	6016		
640	309921	11.64	6161		
645	361911	11.65	6310		
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655	467762	11.97	6608		
660	521571	12.19	6757		
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585	25633	5.93	1965		
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635	269256	11.92	6649		
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565	0	0	0	384.74	#20
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610	130828	9.38	5056		
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625	213603	11.44	5393		
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640	329399	12.12	5604	
645	381270	12.04	5667	
650	433612	12.06	5729	
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563.2	0	0	0	382.64 #21
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580	21770	6.02	1807	
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600	101197	7.18	13517	
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610	155424	9.37	21972	
615	185402	10.22	26200	
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625	252077	11.54	38901	
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645	440499	12.42	68886	
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655	556833	12.62	78021	
660	615816	12.78	82588	
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580	23320	5.14	3109	
585	35290	5.49	5782	
590	50629	5.85	7544	
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615	163694	10.18	27275	
620	193345	10.62	31642	
625	225242	10.99	40313	
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635	295978	11.56	57655	
640	334816	11.79	66325	
645	375812	11.98	71028	
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655	463807	12.33	80432		
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620	227515	9.34	34480		
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635	355298	10.61	45294		
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650	503787	11.53	51932		
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610	193331	9.35	27357		
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620	267906	10.9	36563		
625	308257	11.53	40142		
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635	398086	12.54	47300		
640	447565	12.94	50878		
645	500977	13.27	52344		
650	555415	13.63	53810		
660	667365	14.33	56741		
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560	573	0.8	1117	0.02	

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595	103721	6.49	14017	
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575	23080	6.44	1877	
580	30211	7.57	1923	
585	51070	4.45	9062	
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600	148346	7.91	15463	
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610	231980	9.44	17959	
615	276073	10.13	19207	
620	321683	10.76	20455	
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635	467615	12.42	23705	
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635	445640	14.22	10874		
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565	13162	5.34	1484		
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575	29069	5.24	3375		
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660	670011	17.63	42916		
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585	74963	7.59	4900		
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650	335141	19.03	5112	
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670	417542	21.65	5446	
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Attachment 9_ SOCH Input Preprocessor, Steady-State with file:

Guntersville_100Ksteps_BuildSOCHdata (5).xls

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Attachment_10 SOCH Input Preprocessor, March 1973 with file:

Guntersville_Mar1973_BuildSOCHdata (5).xls

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Attachment_11 SOCH Input Preprocessor, May 2003 Flood with file:

Guntersville_May2003_BuildSOCHdata (5).xls

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Attachment_12_Macro File for SOCH Input Preprocessor with file:

SOCH_Macros.xls

CDQ000020080041 Rev 0

Attachment_13_Macro File for Extraction of SOCH Output with file:

Flood_ExtractSelectedSOCHOutputHydrographs.xls