2017 Walter F. George Reservoir Report
Rivers and Reservoirs Monitoring Program

Alabama Department of Environmental Management

Field Operations Division
Rivers & Reservoirs Unit
June 2021

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LIST OF ACRONYMS

A&I	Agriculture and Industry water supply use classification
ADEM	Alabama Department of Environmental Management
AGPT	Algal Growth Potential Test
CHL *a*	Chlorophyll *a*
DO	Dissolved Oxygen
F&W	Fish and Wildlife
MAX	Maximum
MDL	Method Detection Limit
MIN	Minimum
MSC	Mean Standing Crop
NTU	Nephelometric Turbidity Units
OAW	Outstanding Alabama Waters
ONRW	Outstanding National Resource Water
PWS	Public Water Supply
QAPP	Quality Assurance Project Plan
RRMP	Rivers and Reservoirs Monitoring Program
S	Swimming and Other Whole Body Water-Contact Sports
SD	Standard Deviation
SOP	Standard Operating Procedures
TEMP	Temperature
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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INTRODUCTION

In 1962, Walter F. George Reservoir was created by the United States Army Corps of Engineers (USACE) to provide hydroelectric power and navigation along the Chattahoochee River. The reservoir stretches north from Ft. Gaines, GA to Phenix City, AL and covers 45,181 acres along the Alabama/Georgia state line. Streams flowing into the reservoir from Alabama include Hatchechubbee, Cowikee, Barbour, Cheneyhatchee, and Uchee Creeks. Pataula, Turner, Hannahatchee, Hichitee, and Upatoi Creeks flow in from Georgia.

The Alabama Department of Environmental Management (ADEM) monitored Walter F. George Reservoir as part of the 2014 and 2017 assessments of the Chattahoochee and Perdido-Escambia River Basins under the Rivers and Reservoirs Monitoring Program (RRMP). Implemented in 1990, the objectives of this program are to provide data that can be used to assess current water quality conditions, to identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2014 and 2017 Monitoring Strategy.

In 2001, the ADEM implemented specific water quality criteria for nutrient management at the lower and mid Walter F. George Reservoir stations, which have been monitored by ADEM since 1992. These criteria represent a growing season mean (April-October) chlorophyll *a* (chl *a*) concentration that is protective of Walter F. George Reservoir's Swimming and Fish & Wildlife (S/F&W) use classifications (Table 1).

The purpose of this report is to summarize data collected at eight stations in Walter F. George Reservoir during the 2014 and 2017 growing seasons and to evaluate growing season trends in lake trophic status and nutrient concentrations using ADEM's historic dataset. Monthly and/or mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chl *a*; algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's historical data and established criteria.

METHODS

Sampling stations were selected using historical data and previous assessments (Figure 1). Specific location information can be found in Table 1. Walter F. George Reservoir was sampled in the dam forebay, mid, and upper reservoir. Five tributary stations; Hatchechubbee, Cowikee, Barbour, Cheneyhatchee and Uchee Creeks, were also monitored.

Water quality sampling was conducted at monthly intervals through the growing season, April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2017), Surface Water Quality Assurance Project Plan (ADEM 2017), and Quality Management Plan (ADEM 2013).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions at each site. Monthly concentrations of these parameters were graphed with the closest available USACE flow data, at W. F. George Dam, and ADEM's previously collected data to help interpret the 2014 and 2017 results.

Figure 1. Walter F. George Reservoir with sampling locations.

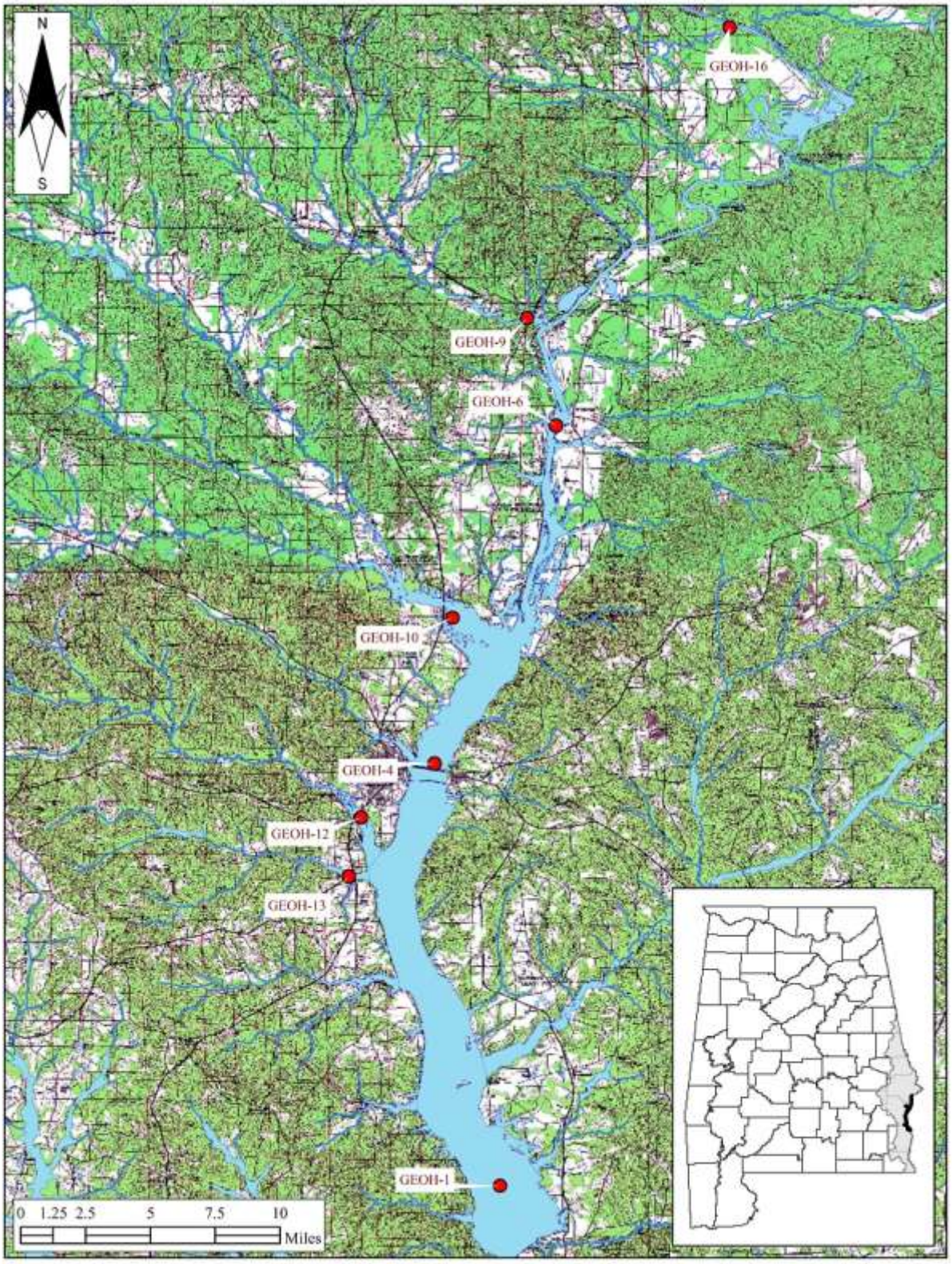


Table 1. Descriptions of the monitoring stations in Walter F. George Reservoir.

HUC	County	Station Number	Report Designation	Waterbody	Station Description	Chl *a* Criteria	Latitude	Longitude
031300031600	Henry	GEOH-1*	Lower	Chattahoochee R	Deepest point, main river channel, dam forebay. Mile 75.4.	15 ug/L	31.6570	-85.0829
031300031302	Barbour	GEOH-4*	Mid	Chattahoochee R	Deepest point, main river channel, approximately 0.25 miles upstream of U.S. Highway 82 causeway.	18 ug/L	31.8929	-85.1196
031300030903	Russell	GEOH-6	Upper	Chattahoochee R	Deepest point, main river channel, immediately downstream of Florence Marina State Park.		32.0818	-85.0516
031300030804	Russell	GEOH-9	Hatchechubbee Ck	Hatchechubbee Ck	Deepest point, main channel, Hatchechubee Ck embayment.		32.1419	-85.0678
031300031205	Barbour	GEOH-10	Cowikee Ck	Cowikee Ck	Deepest point, main channel, Cowikee Ck embayment.		31.9743	-85.1096
031300031307	Barbour	GEOH-12	Barbour Ck	Barbour Ck	Deepest point, main channel, Barbour Ck embayment.		31.8628	-85.1605
031300031310	Barbour	GEOH-13	Cheneyhatchee Ck	Cheneyhatchee Ck	Deepest point, main channel Cheneyhatchee Ck embayment.		31.8300	-85.1676
031300030505	Russell	GEOH-16	Uchee Ck	Uchee Ck	Deepest point, main creek channel, Uchee Ck embayment.		32.3044	-84.9545

*Growing season mean chl *a* criteria implemented at this station in 2001.

RESULTS

Growing season mean graphs for TN, TP, chl *a*, and TSS are provided in this section (Figures 2 and 3). Monthly graphs for TN, TP, chl *a*, TSS, DO, and TSI are also provided (Figures 4-9, 14 and 15). Mean monthly discharge is included in monthly graphs for TN, TP, chl *a*, TSS, and TSI as an indicator of flow and retention time in the months sampled. AGPT results appear in Table 2. Depth profile graphs of temperature, DO, and conductivity appear in Figures 10-13. Summary statistics of all data collected during 2014 and 2017 are presented in Appendix Tables 1 and 2, respectively. These tables contain the minimum, maximum, median, mean, and standard deviation of each parameter analyzed for all stations.

Stations with the highest concentrations of nutrients, chlorophyll, and TSS are noted in the paragraphs to follow. Though stations with lowest concentrations may not always be mentioned, review of the graphs that follow will indicate these stations that may be potential candidates for reference waterbodies and watersheds.

In 2014 and 2017, the highest mean growing season TN value calculated among Walter F. George mainstem stations was in the upper station, with Cowikee and Hatchechubbee Creeks the highest among the tributary stations (Figure 2). Mean growing season TN values in the lower and mid stations declined 2004-2008 but were higher in 2014 and 2017. The trend in the upper station appears to be increasing 1999-2017. Increasing trends are also apparent in Cheneyhatchee, Cowikee, and Hatchechubbee Creeks. Monthly TN concentrations in 2014 and 2017 generally decreased through the growing season in the lower station (Figure 4), while concentrations in the mid and upper stations were higher in the spring and fall. In 2014, historic high monthly TN concentrations were measured in the lower station in April and June and in the upper station in September. In 2017, historic high monthly TN concentrations were measured in the lower station in July and in the upper station in April.

In 2014 and 2017, the highest mean growing season TP value calculated among Walter F. George mainstem stations was in the upper station, with Uchee Creek the highest among the tributary stations (Figure 2). Mean growing season TP values in all stations have declined since 2004. In 2014, a historic monthly high TP concentration was measured in the lower station in May (Figure 5).

Specific water quality criteria for nutrient management have been established for the lower and mid stations in Walter F. George Reservoir. The mean growing season chl *a* value for the mid station exceeded the criteria limit in 2017 (Figure 3). In 2014, the highest mean growing season chl *a* value among mainstem stations was in the lower station while in 2017 the highest value was in the mid station. In 2014 and 2017, the highest mean chl *a* values among tributary stations were in Hatchechubbee Creek, however, in 2017, the mean value in Cowikee Creek was also notably high. With the exception of the upper station in July, all 2014 monthly chl *a* concentrations in mainstem stations were lower than historic means (Figure 6). In 2017, historic high monthly chl *a* concentrations were measured in the mid and upper stations in May.

In 2014 and 2017, the highest mean growing season TSS values calculated among Walter F. George mainstem stations were in the upper station (Figure 3). Among tributary stations the highest mean value in 2014 was in Uchee Creek and in Hatchechubbee Creek in 2017. In 2017, a historic monthly high TSS concentration was measured in June in the upper station (Figure 7). All other 2014 and 2017 monthly TSS concentrations measured in all mainstem stations were at or below historic means.

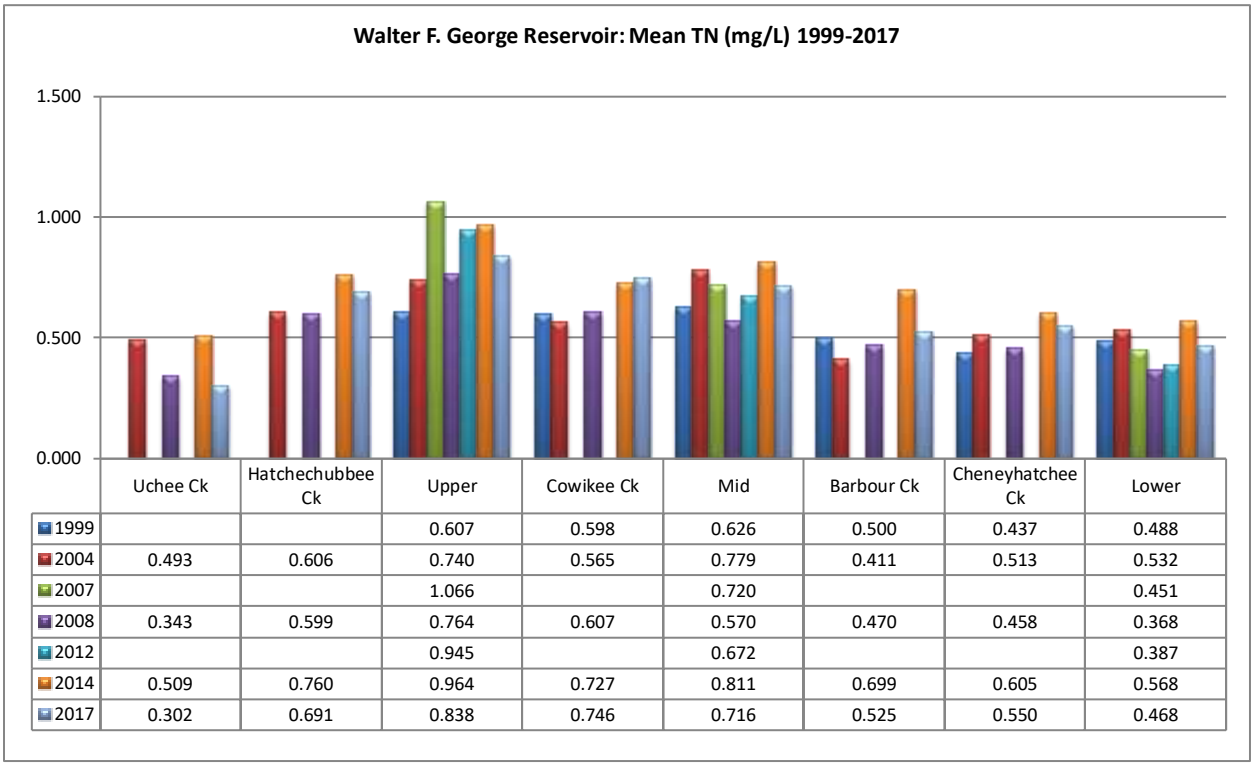
AGPT results in the lower station have alternated between co-limiting and phosphorus limiting 1999-2014 (Table 2). With the exception of nitrogen limiting conditions in the upper station in August 1999, the mid (1999-2014) and upper (1999-2017) stations have remained phosphorus limited in all years monitored. AGPT results in both the lower and mid stations remained below 5 mg/L MSC in 2014, the value that Raschke et al. (1987) defined as protective of reservoir and lake systems. The more riverine upper station was above 5 mg/l MSC and near 20mg/L MSC, the value that Raschke et al. (1987) defined as protective of flowing stream and river systems.

Dissolved oxygen (DO) measurements in the Cowikee Creek embayment station in July 2017 did not meet the ADEM Criteria (ADEM Admin. Code R. 335-6-10-.09) limit of 5.0 mg/L at 5.0 ft (1.5 m) (Figure 9). All other measurements of DO concentrations in 2014 and 2017 in Walter F. George Reservoir mainstem and tributary stations met the ADEM criteria (Figure 8 and 9). Based on monthly DO profiles in 2014, anoxic conditions existed between May, at depths greater than 4.0m, and August at depths greater than 12.0m in the lower station and in the upper

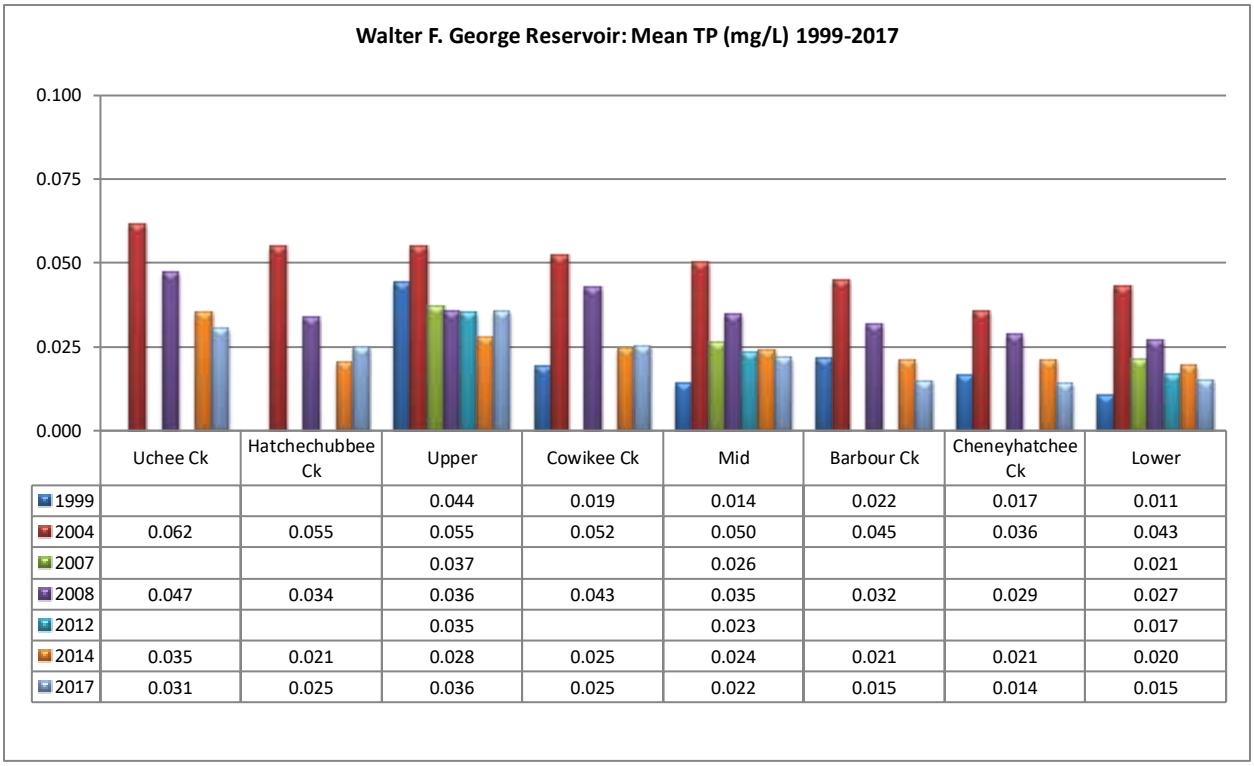
station in July at depths greater than 6.0m (Figure 10 and 11). Monthly DO profiles in 2017 indicate anoxic conditions in the lower station all months monitored. Anoxic conditions were also present in the upper station in May, August, and September (Figure 12 and 13). Based on the conductivity profile, a strong chemocline was evident in June 2017 in the lower station.

TSI values were calculated using 2014 and 2017 monthly chl *a* concentrations and Carlson's Trophic State Index. In 2014, the lower station was mesotrophic April and May and eutrophic or near eutrophic June through October, while the mid station was eutrophic or near eutrophic all months except July and August when it was oligotrophic (Figure 14). The upper station varied from oligotrophic to eutrophic throughout the growing season. Most TSI values for the tributary stations in 2014 were eutrophic through the growing season with lower values in the early spring and late fall. Cheneyhatchee Creek, however, had lower TSI values in July. In 2017, the mainstem stations remained eutrophic or near eutrophic all months monitored with the exception of the mid station in May when it reached hypereutrophic conditions (Figure 15). During 2017, the Cheneyhatchee Creek and Barbour Creek stations remained eutrophic all months monitored. The Cowikee Creek station was hypereutrophic in September, while the Hatchechubbee Creek station was hypereutrophic or near hypereutrophic in May, August and September. The Uchee Creek station remained oligotrophic or mesotrophic all months monitored.

Figure 2. Mean growing season TN and TP measured in Walter F. George Reservoir, April-October, 1999-2017. Stations are illustrated from upstream to downstream as the graph is read from left to right.

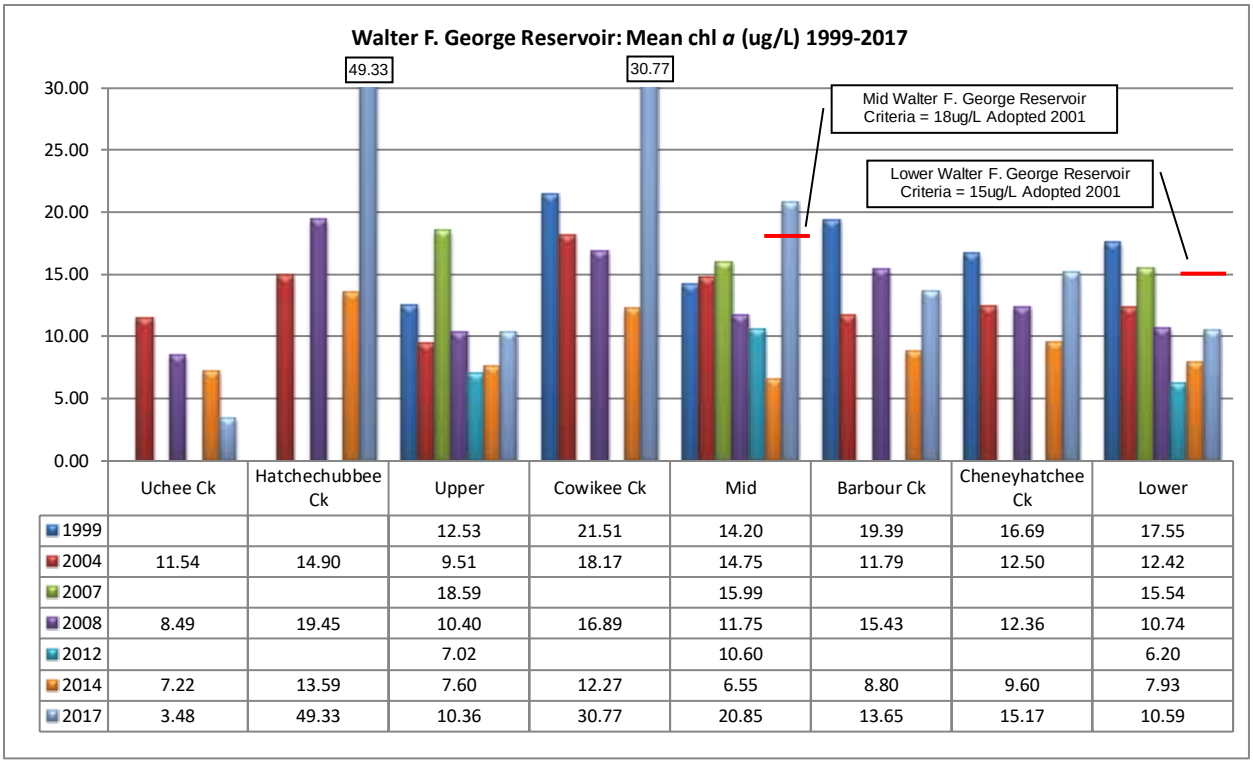


	Uchee Ck	Hatchechubbee Ck	Upper	Cowikee Ck	Mid	Barbour Ck	Cheneyhatchee Ck	Lower
1999			0.607	0.598	0.626	0.500	0.437	0.488
2004	0.493	0.606	0.740	0.565	0.779	0.411	0.513	0.532
2007			1.066		0.720			0.451
2008	0.343	0.599	0.764	0.607	0.570	0.470	0.458	0.368
2012			0.945		0.672			0.387
2014	0.509	0.760	0.964	0.727	0.811	0.699	0.605	0.568
2017	0.302	0.691	0.838	0.746	0.716	0.525	0.550	0.468

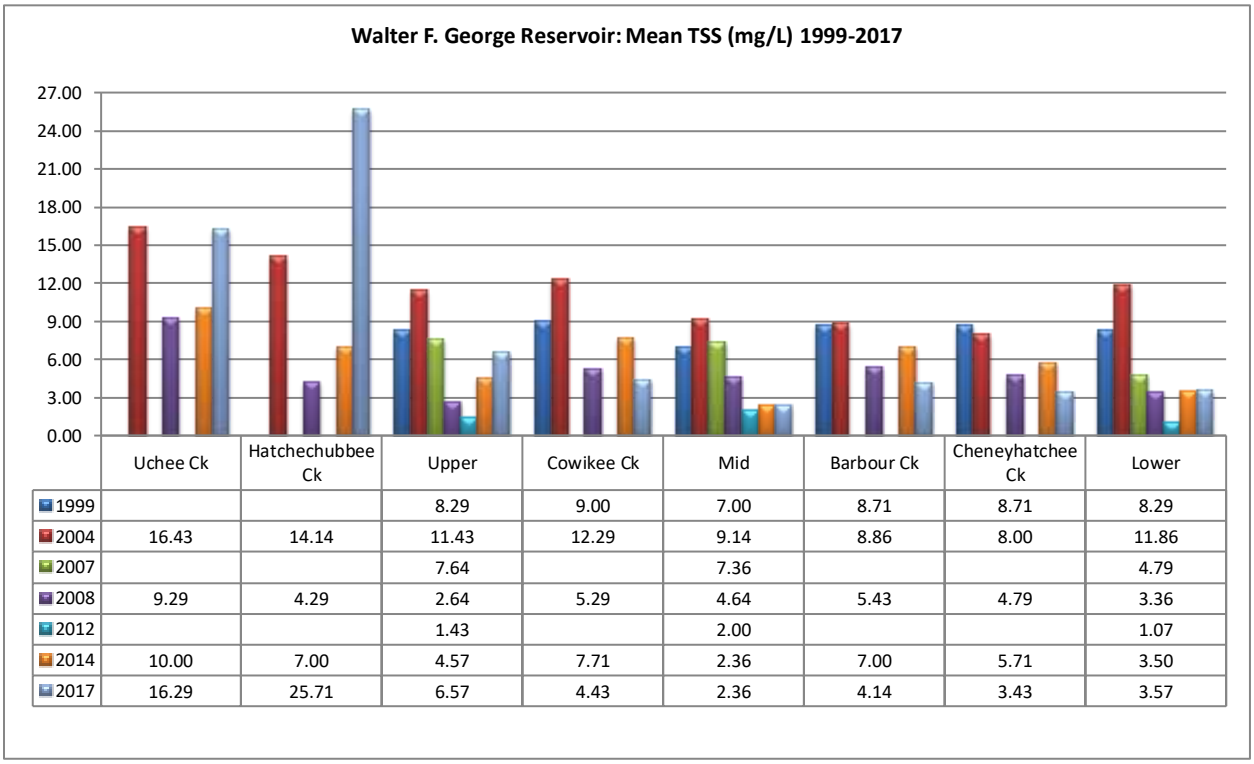


	Uchee Ck	Hatchechubbee Ck	Upper	Cowikee Ck	Mid	Barbour Ck	Cheneyhatchee Ck	Lower
1999			0.044	0.019	0.014	0.022	0.017	0.011
2004	0.062	0.055	0.055	0.052	0.050	0.045	0.036	0.043
2007			0.037		0.026			0.021
2008	0.047	0.034	0.036	0.043	0.035	0.032	0.029	0.027
2012			0.035		0.023			0.017
2014	0.035	0.021	0.028	0.025	0.024	0.021	0.021	0.020
2017	0.031	0.025	0.036	0.025	0.022	0.015	0.014	0.015

Figure 3. Mean growing season chl *a* and TSS measured in Walter F. George Reservoir, April-October, 1999-2017. Stations are illustrated from upstream to downstream as the graph is read from left to right. Chl *a* criteria applies to the growing season means of the lower and mid stations.

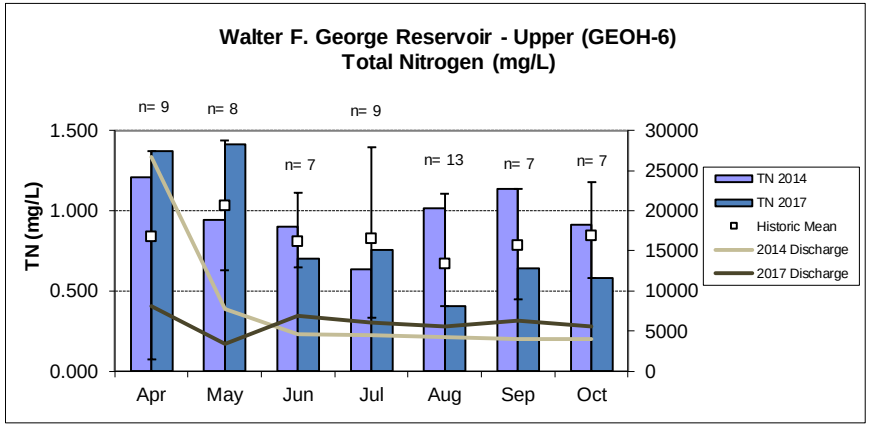


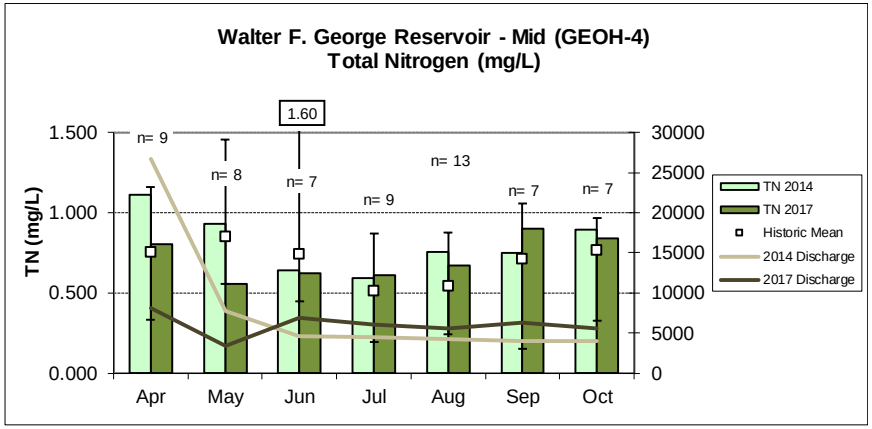
	Uchee Ck	Hatchechubbee Ck	Upper	Cowikee Ck	Mid	Barbour Ck	Cheneyhatchee Ck	Lower
1999			12.53	21.51	14.20	19.39	16.69	17.55
2004	11.54	14.90	9.51	18.17	14.75	11.79	12.50	12.42
2007			18.59		15.99			15.54
2008	8.49	19.45	10.40	16.89	11.75	15.43	12.36	10.74
2012			7.02		10.60			6.20
2014	7.22	13.59	7.60	12.27	6.55	8.80	9.60	7.93
2017	3.48	49.33	10.36	30.77	20.85	13.65	15.17	10.59



	Uchee Ck	Hatchechubbee Ck	Upper	Cowikee Ck	Mid	Barbour Ck	Cheneyhatchee Ck	Lower
1999			8.29	9.00	7.00	8.71	8.71	8.29
2004	16.43	14.14	11.43	12.29	9.14	8.86	8.00	11.86
2007			7.64		7.36			4.79
2008	9.29	4.29	2.64	5.29	4.64	5.43	4.79	3.36
2012			1.43		2.00			1.07
2014	10.00	7.00	4.57	7.71	2.36	7.00	5.71	3.50
2017	16.29	25.71	6.57	4.43	2.36	4.14	3.43	3.57

Figure 4. Monthly TN concentrations measured in Walter F. George Reservoir, April-October 2014 and 2017 vs. average monthly discharge. Monthly discharge acquired from USACE at W.F. George Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2017) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





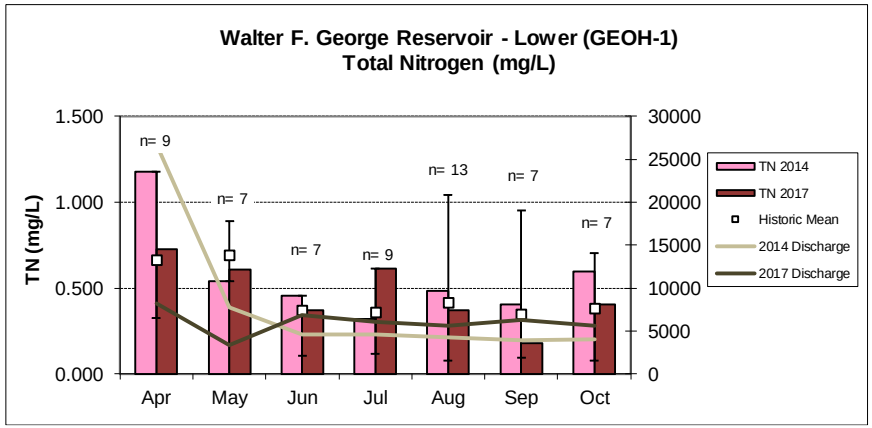


Figure 5. Monthly TP concentrations measured in Walter F. George Reservoir, April-October 2014 and 2017 vs. average monthly discharge. Monthly discharge acquired from USACE at W.F. George Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2017) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

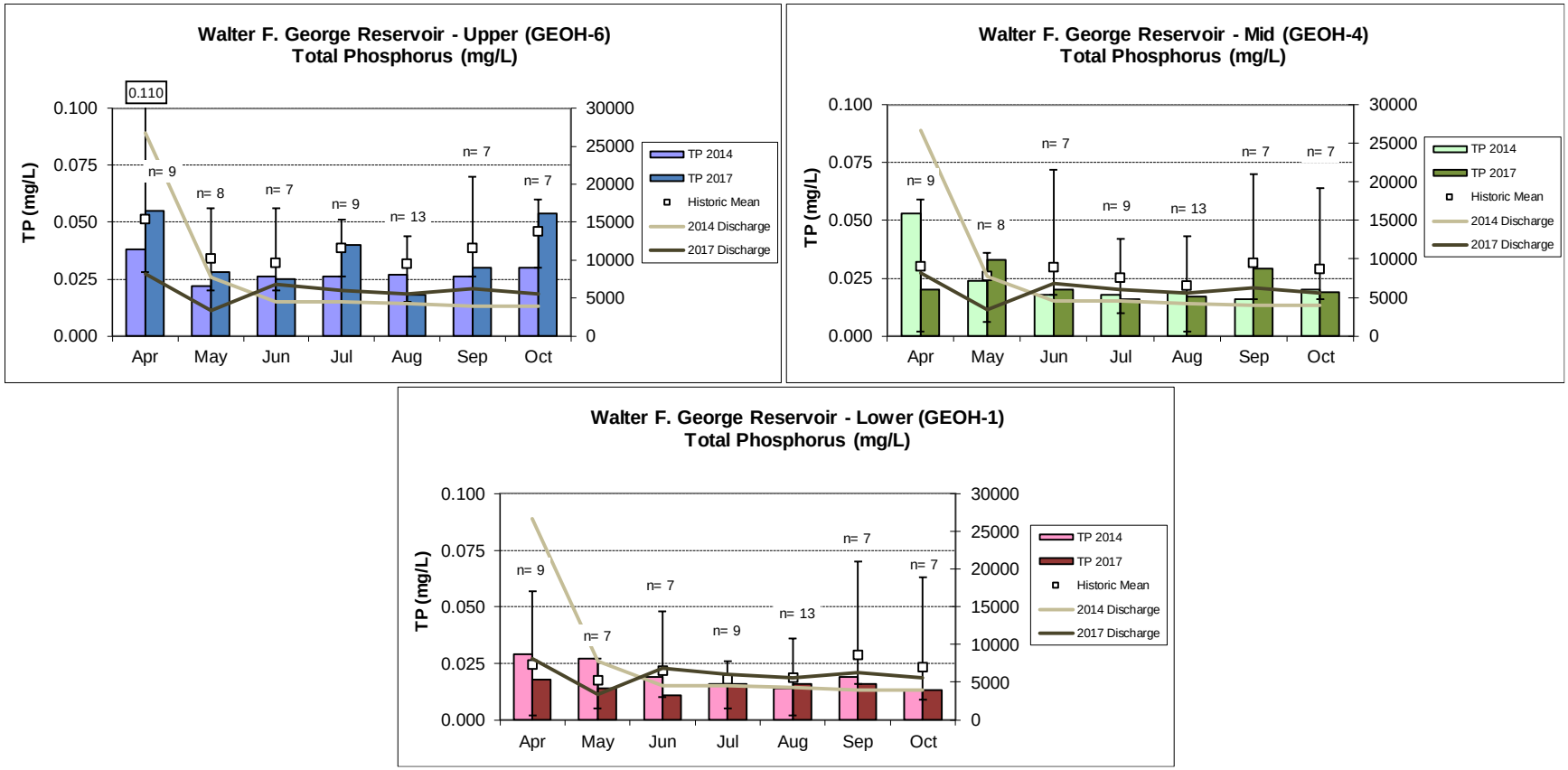


Figure 6. Monthly chl *a* concentrations measured in Walter F. George Reservoir, April-October 2014 and 2017 vs. average monthly discharge. Monthly discharge acquired from USACE at W.F. George Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2017) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.

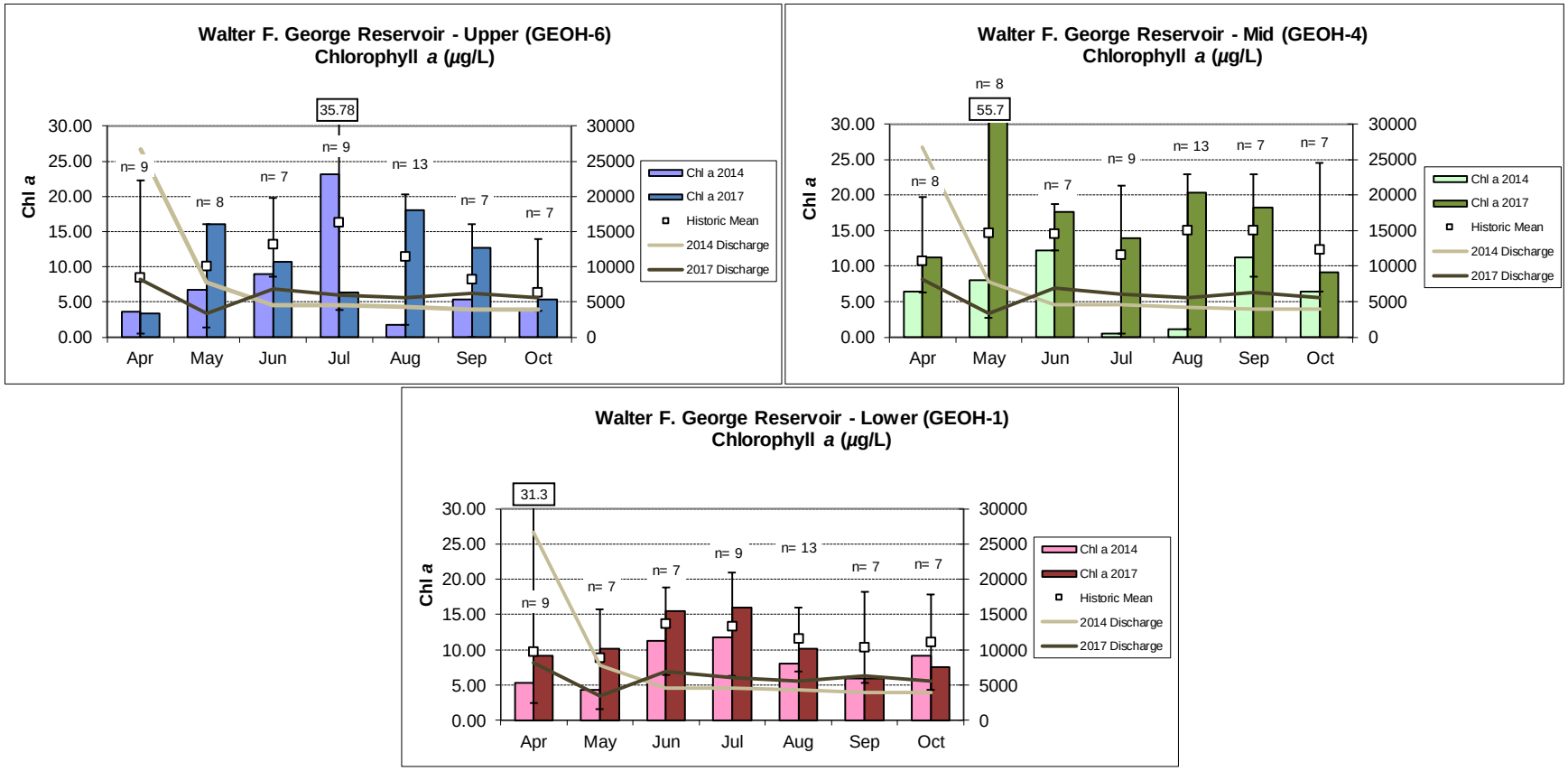
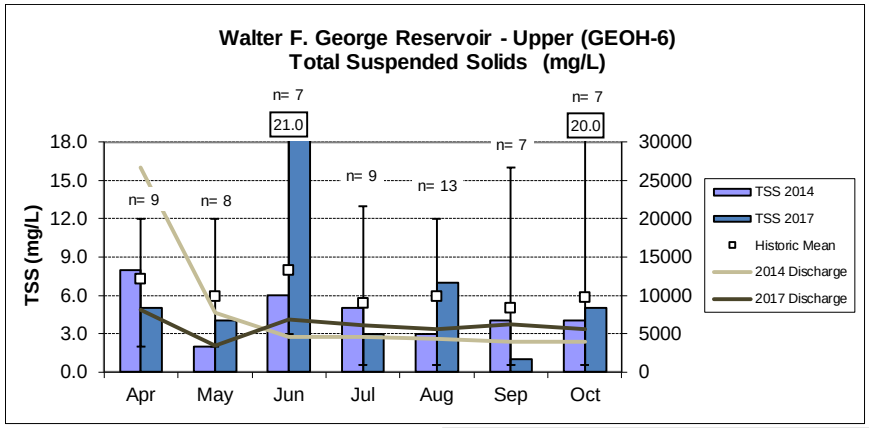
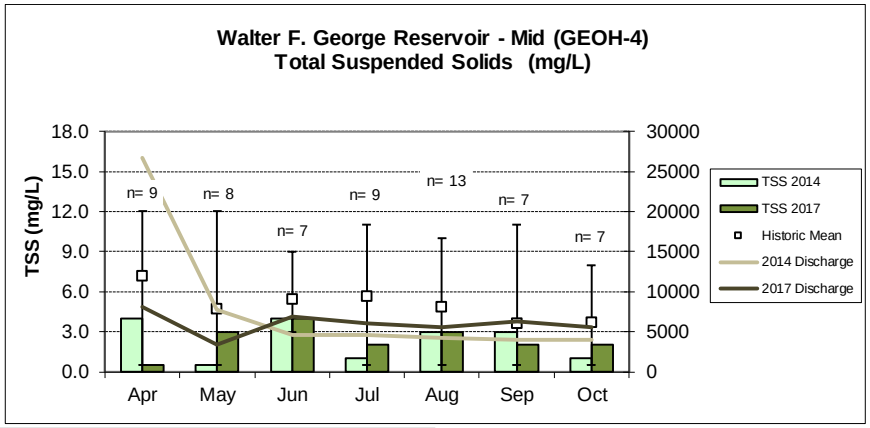


Figure 7. Monthly TSS concentrations measured in Walter F. George Reservoir, April-October 2014 and 2017 vs. average monthly discharge. Monthly discharge acquired from USACE at W.F. George Dam. Each bar graph depicts monthly changes in each station. The historic mean (1992-2017) and min/max range are also displayed for comparison. The "n" value equals the number of datapoints included in the monthly historic calculations.





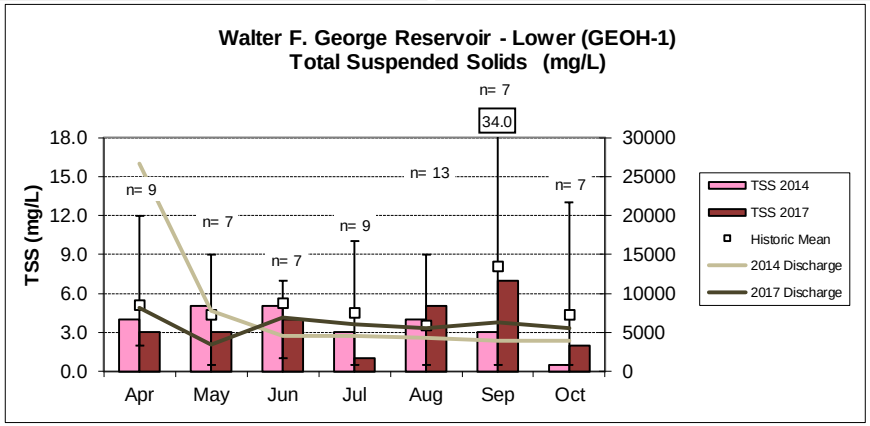
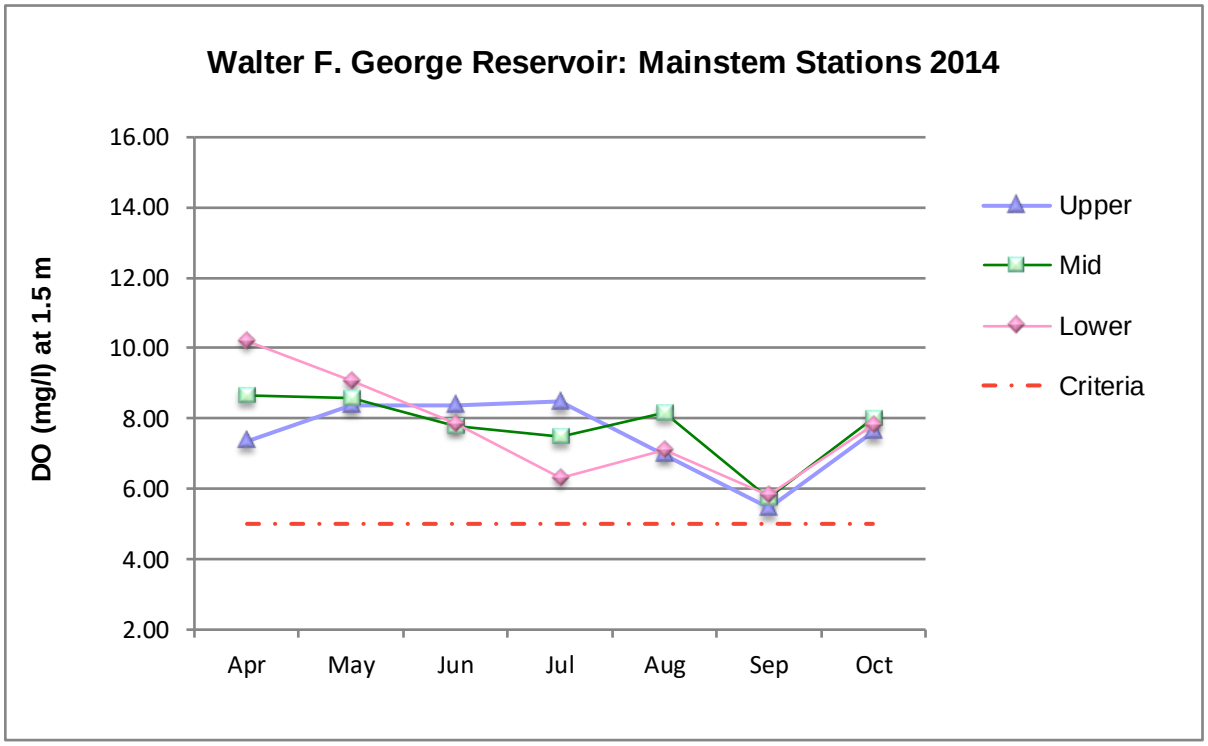


Table 2. Algal growth potential test results, Walter F. George Reservoir, 1999-2017 (expressed as mean Maximum Standing Crop (MSC) dry weights of Selenastrum capricornutum in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes; values below 20 mg/L MSC are considered protective of flowing streams and rivers. (Raschke and Schultz 1987).

Station	**Upper**		**Mid**		**Lower**	
	MSC	Limiting Nutrient	MSC	Limiting Nutrient	MSC	Limiting Nutrient
June 1999	7.24	Phosphorus	5.69	Phosphorus	2.08	Co-limiting
July 1999	12.06	Phosphorus	2.5	Phosphorus	1.38	Co-limiting
August 1999	31.67	Nitrogen	8.04	Phosphorus	2.19	Phosphorus
August 2004	6.46	**	3.29	Phosphorus	2.16	Co-limiting
August 2008	6.32	Phosphorus	3.56	Phosphorus	3.39	Phosphorus
August 2014	6.11	Phosphorus	3.34	Phosphorus	2.64	Phosphorus
August 2017	19.54	Phosphorus	*	*	*	*

*No AGPT sample collected at this location.
**The limiting nutrient status could not accurately be determined.

Figure 8. Monthly DO concentrations at 1.5 m (5 ft) for Walter F. George Reservoir stations collected April-October 2014. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).



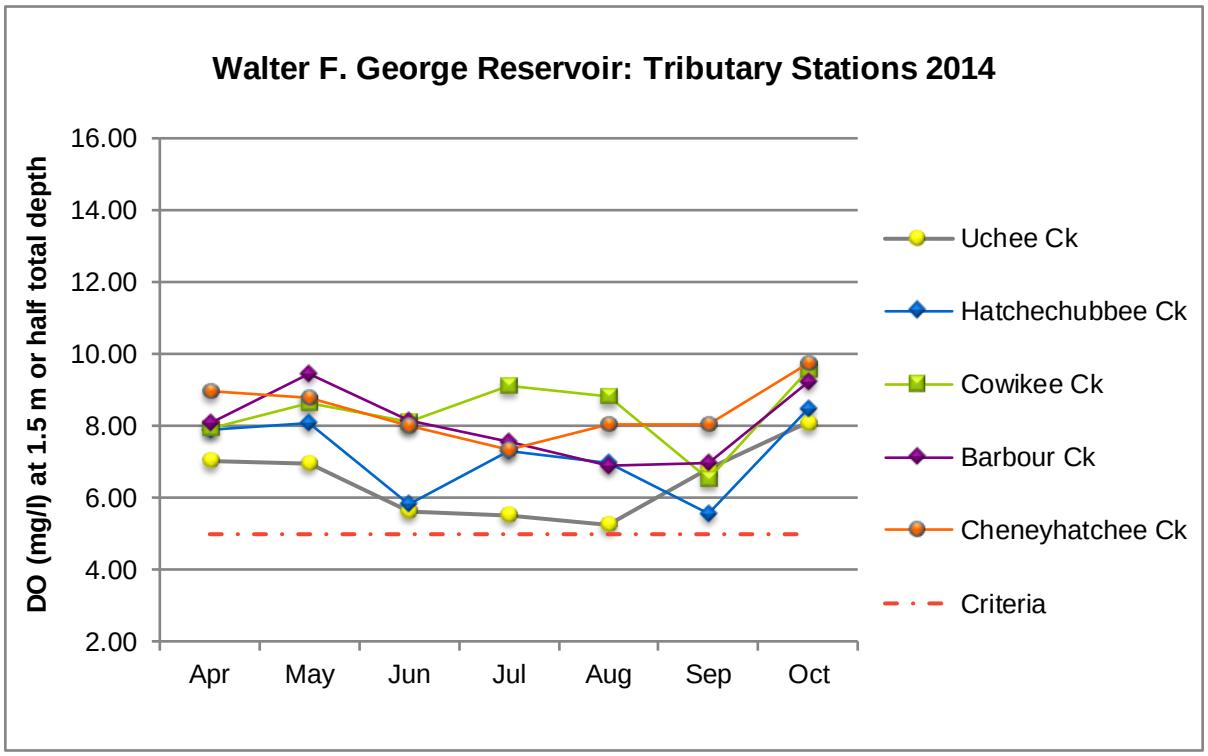
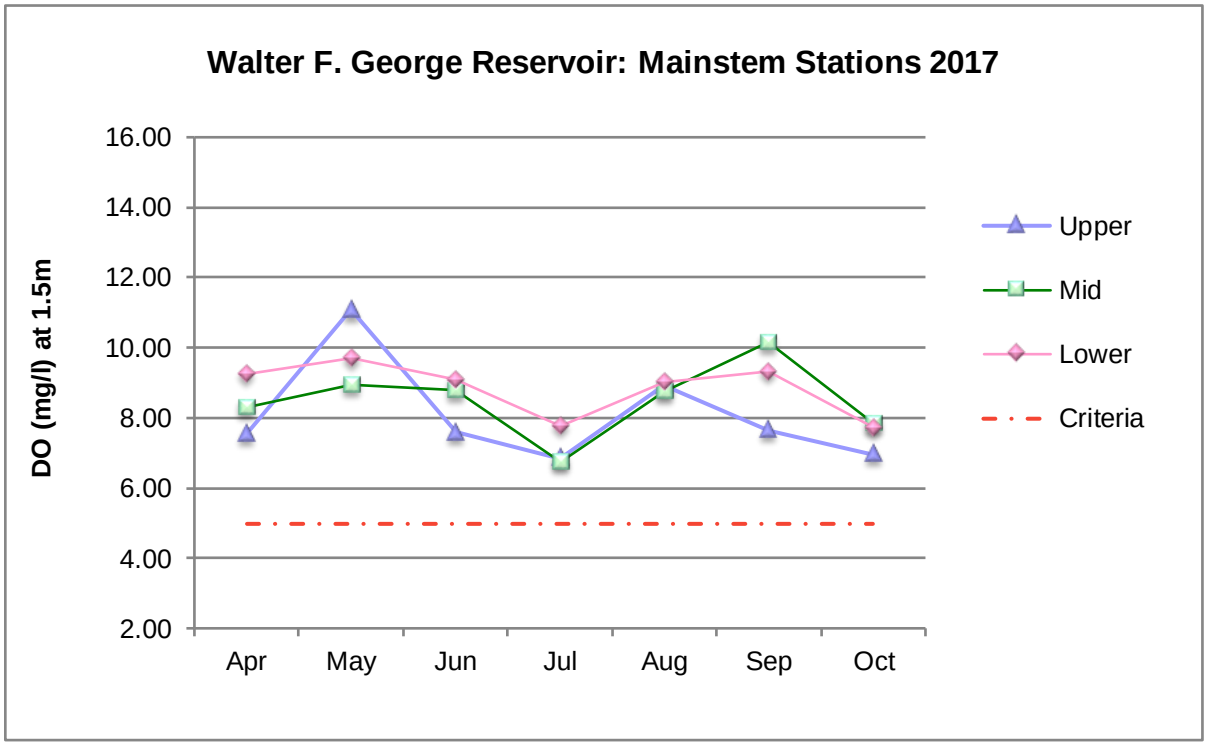


Figure 9. Monthly DO concentrations at 1.5 m (5 ft) for Walter F. George Reservoir stations collected April-October 2017. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth (ADEM 2005).



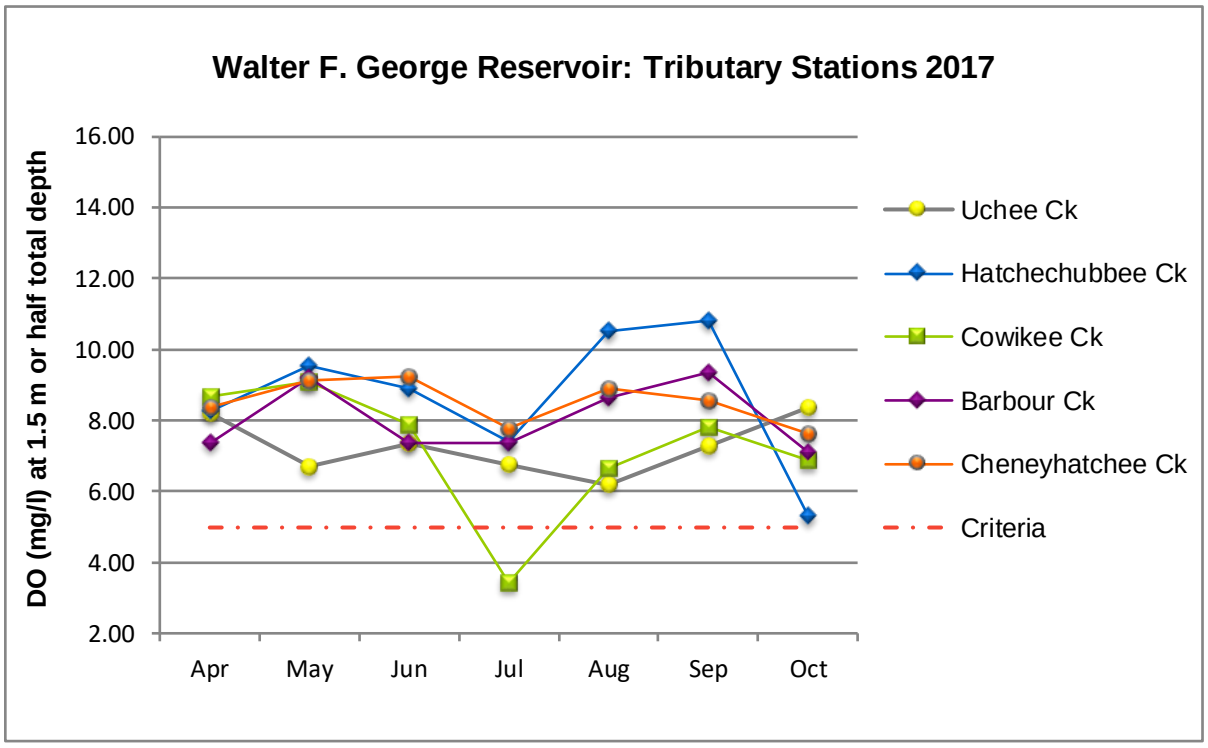


Figure 10. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the lower Walter F. George Reservoir station, April-October 2014.

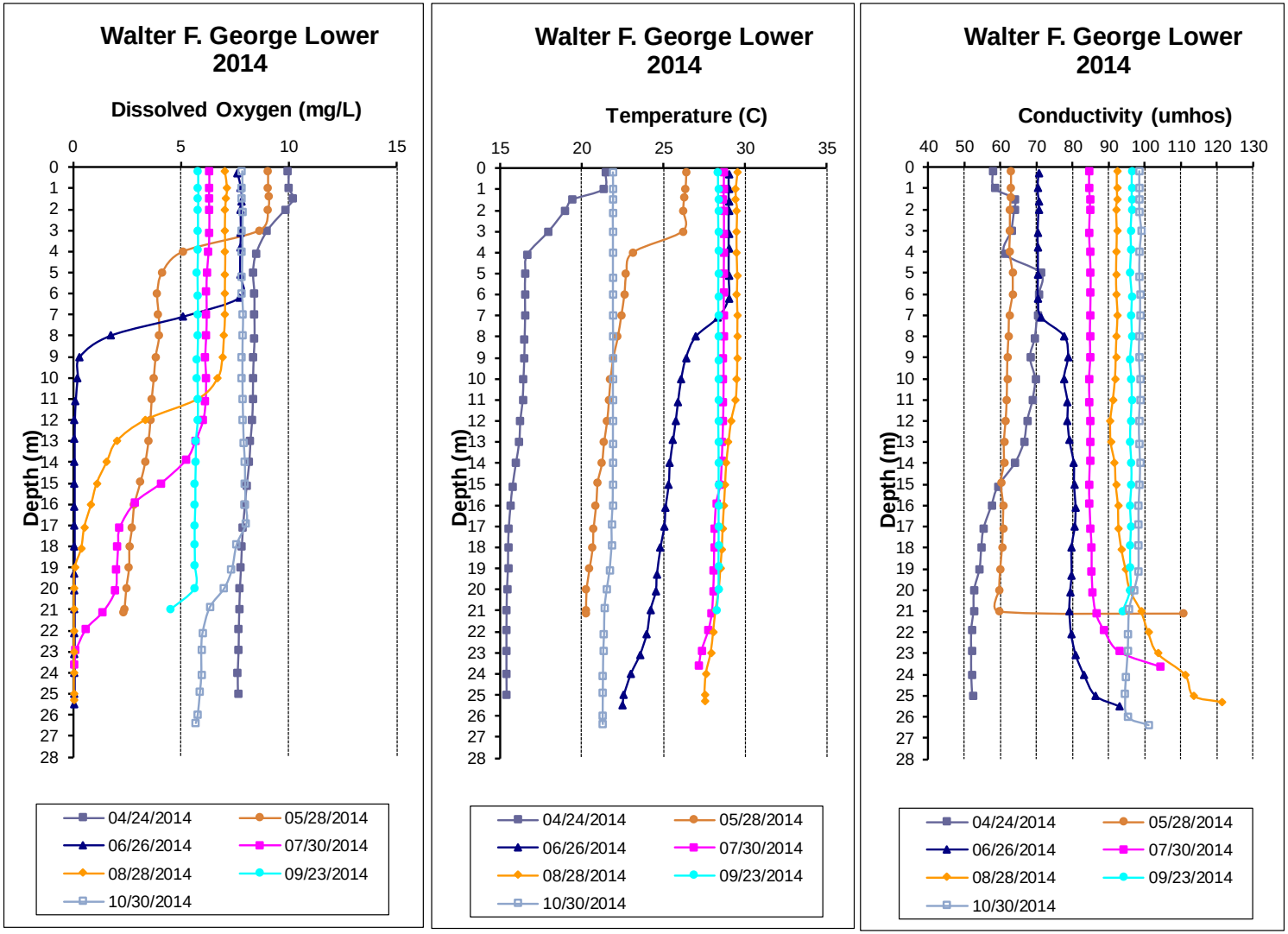


Figure 11. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the upper Walter F. George Reservoir station, April-October 2014.

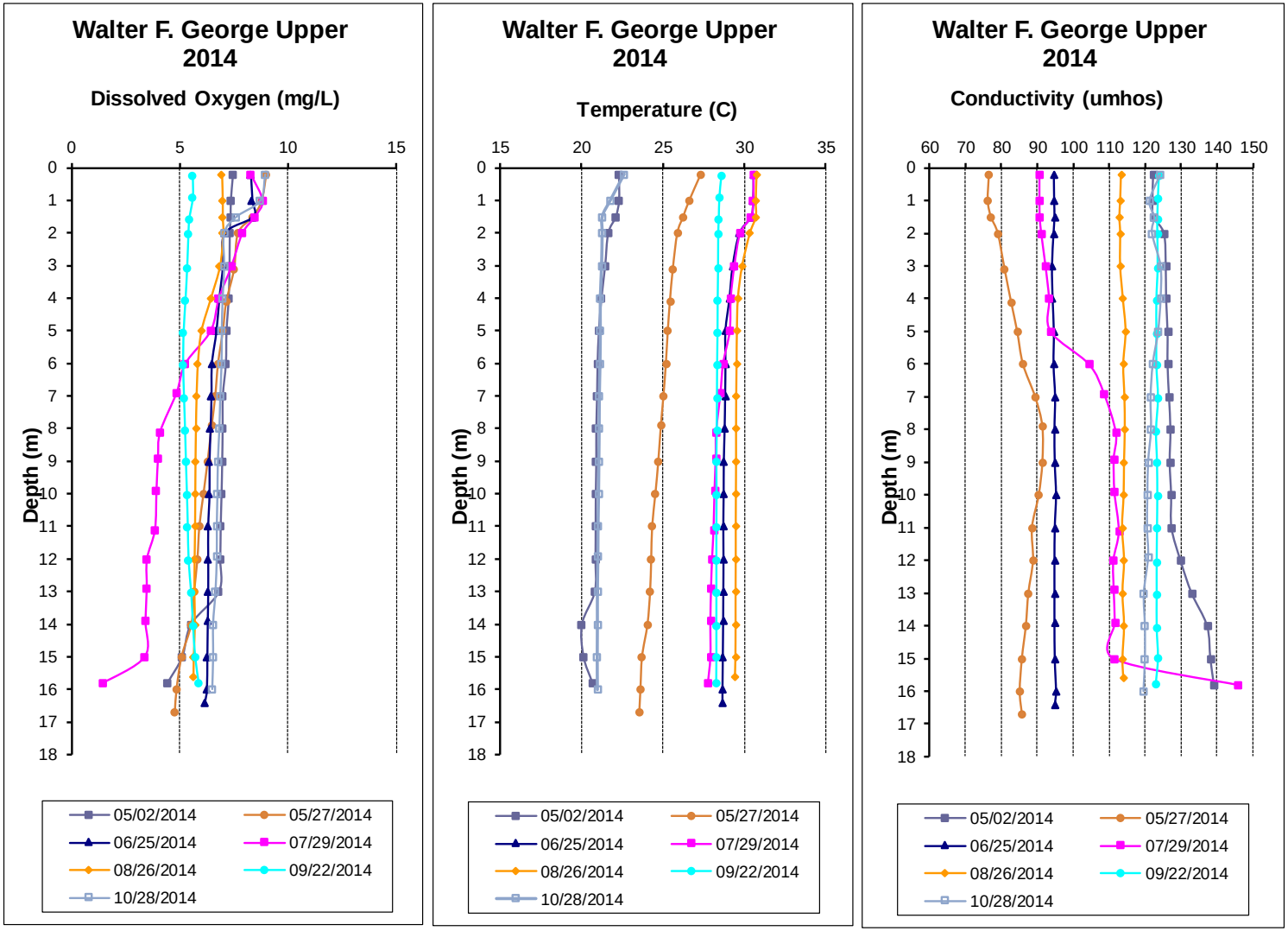


Figure 12. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the lower Walter F. George Reservoir station, April-October 2017.

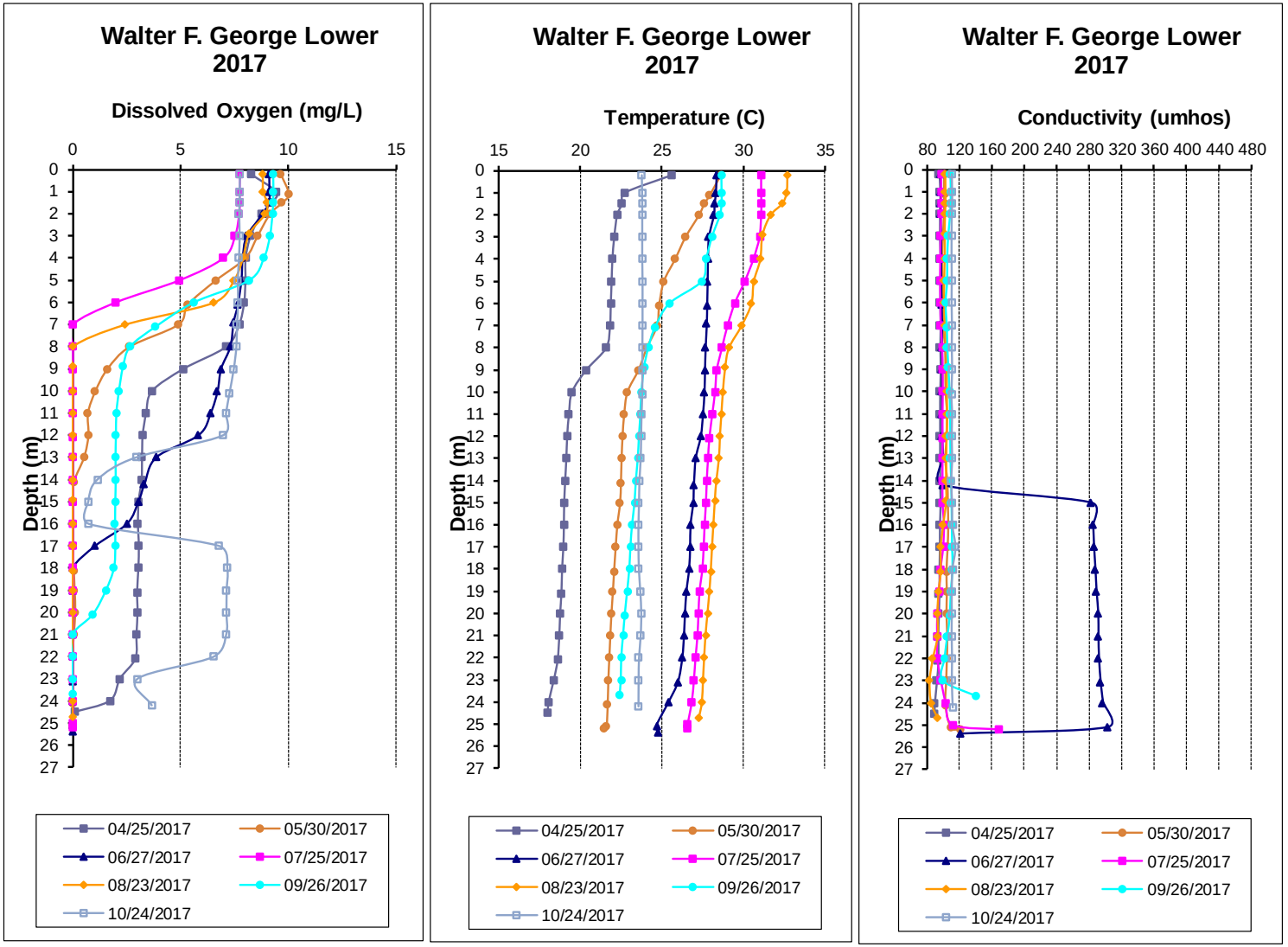


Figure 13. Monthly depth profiles of dissolved oxygen (mg/L), temperature (C) and conductivity (umhos) in the upper Walter F. George Reservoir station, April-October 2017.

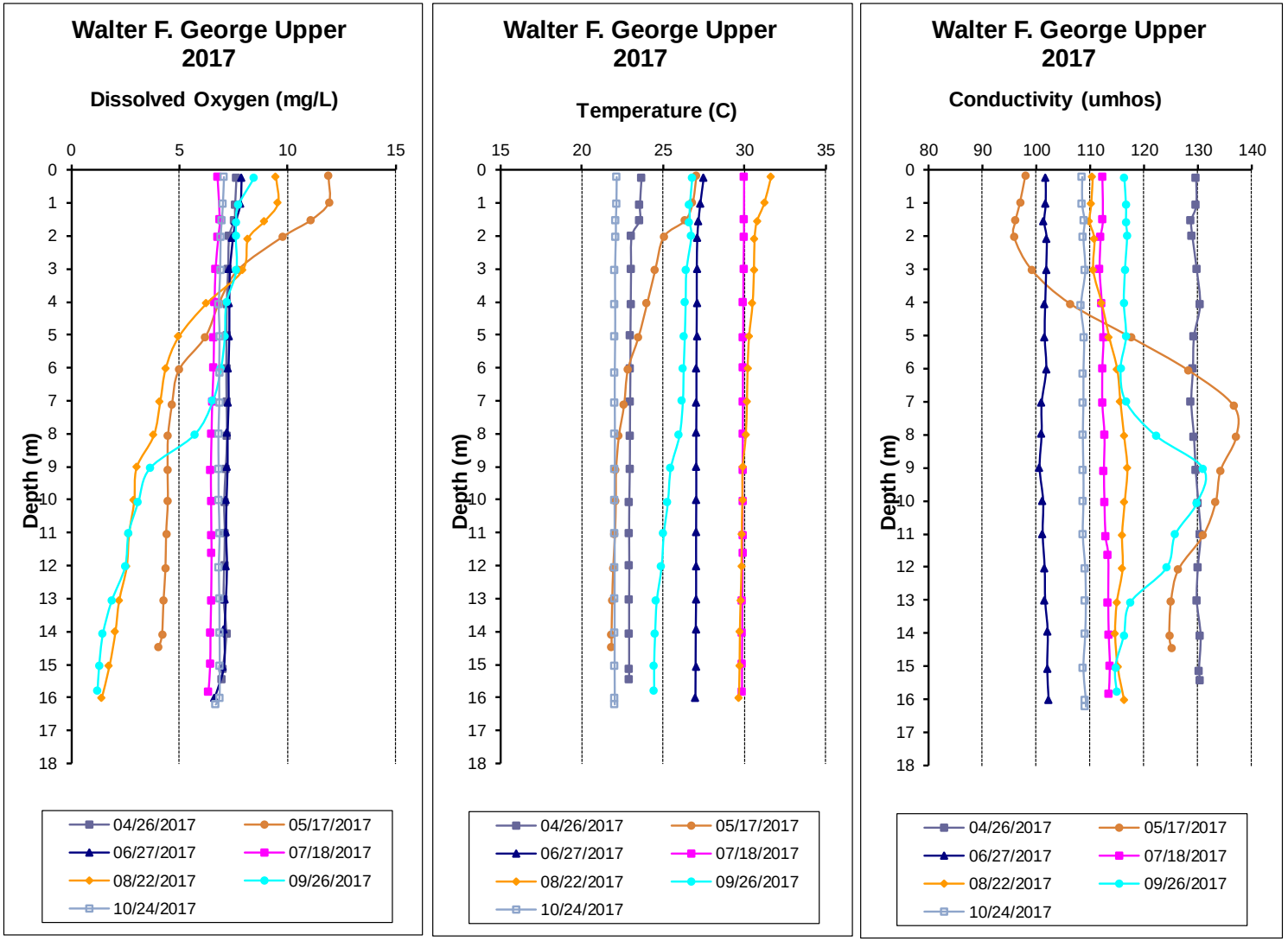
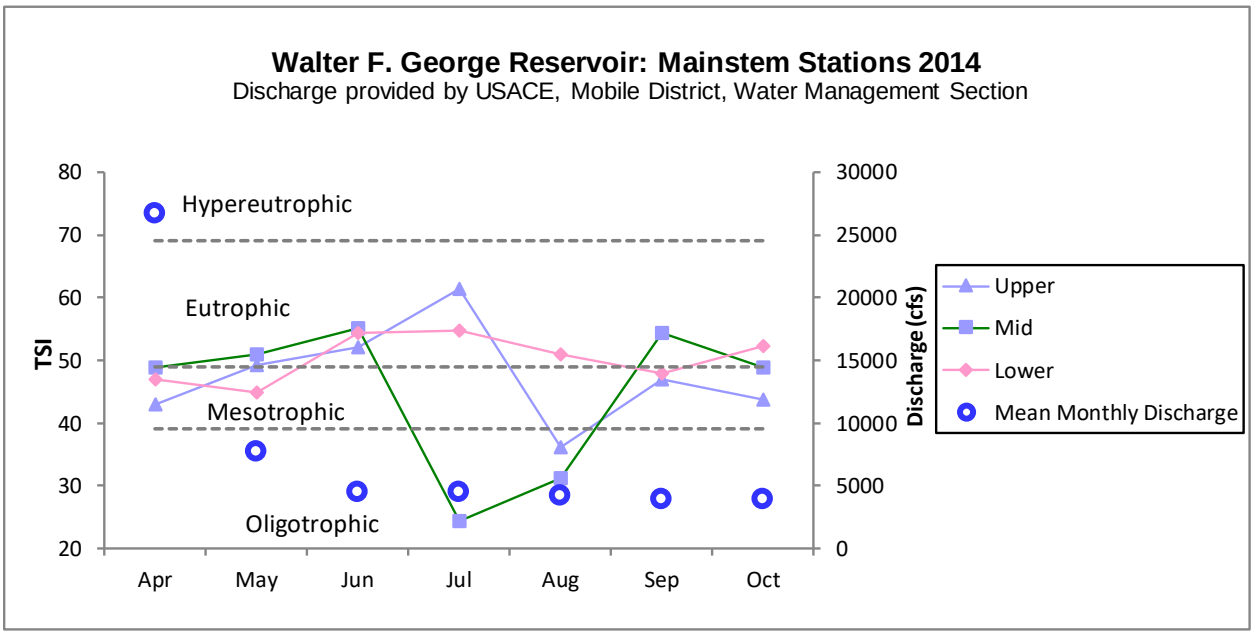


Figure 14. 2014 Monthly TSI values calculated for mainstem and tributary Walter F. George Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from USACE at W.F. George Dam.



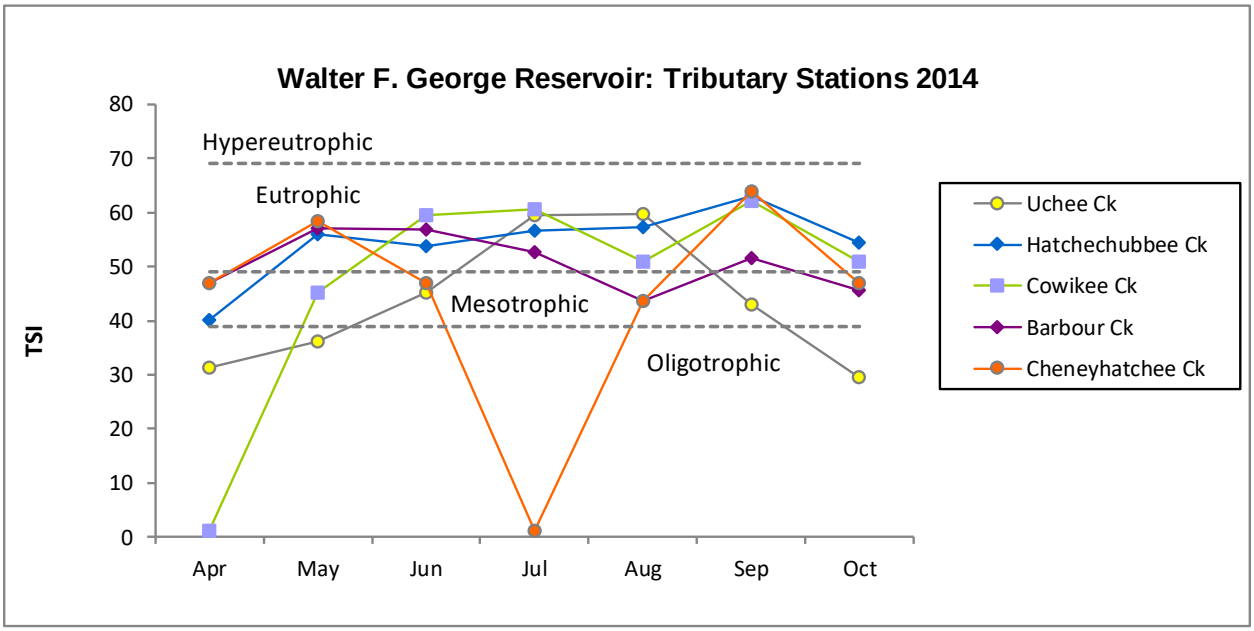
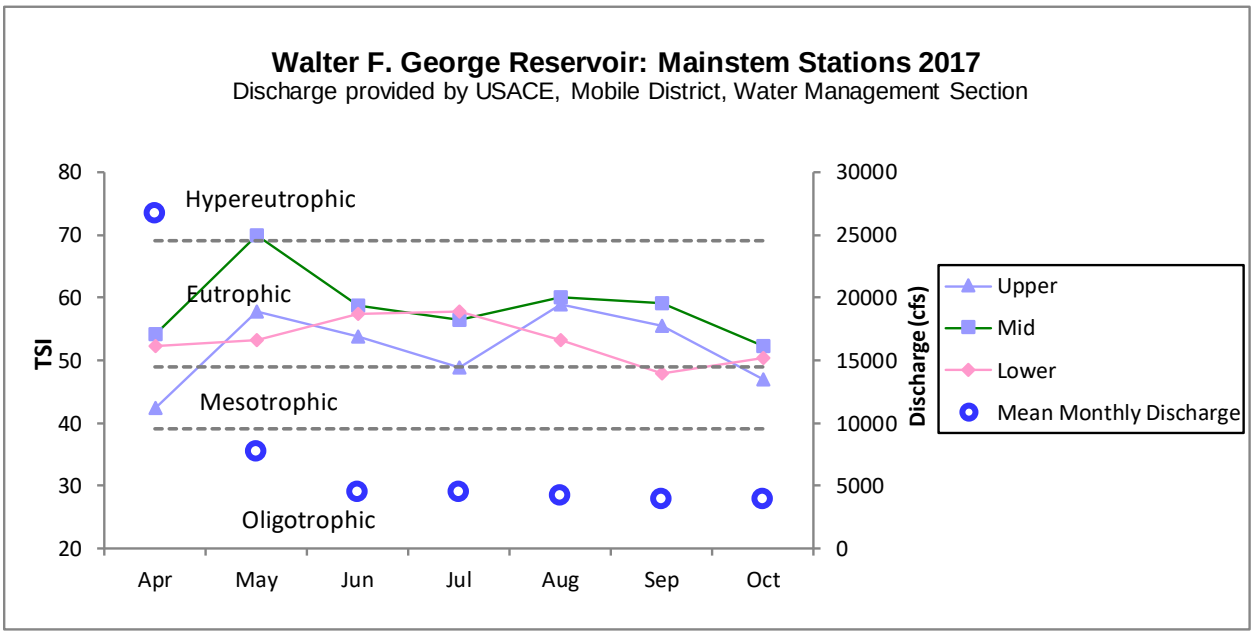
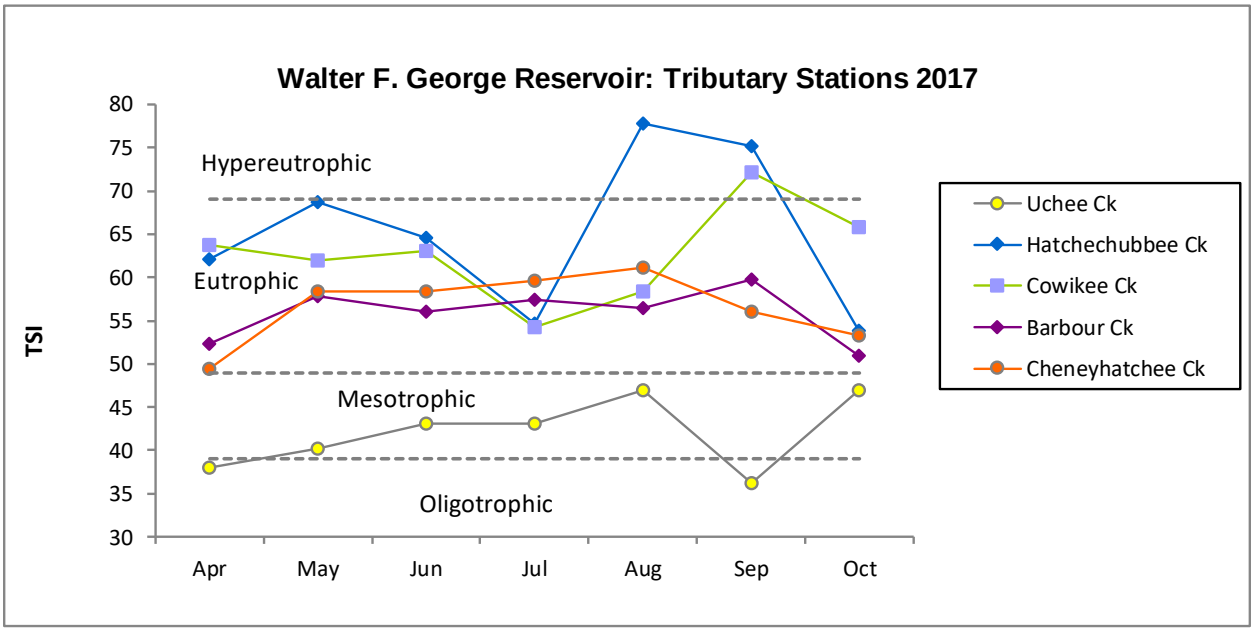


Figure 15. 2017 Monthly TSI values calculated for mainstem and tributary Walter F. George Reservoir stations using chl *a* concentrations and Carlson's Trophic State Index calculation. Monthly discharge acquired from USACE at W.F. George Dam.





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APPENDIX

Appendix Table 1. Summary of Walter F. George Reservoir water quality data collected April-October, 2014. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N	Min	Max	Med	Mean	SD
GEOH-1	**Physical**						
	Turbidity (NTU)	7	2.6	20.0	3.2	5.5	6.4
	Total Dissolved Solids (mg/L)	7	13.0	64.0	52.0	44.4	21.0
	Total Suspended Solids (mg/L)	7	< 1.0	5.0	4.0	3.5	1.6
	Hardness (mg/L)	4	15.3	22.7	19.0	19.0	4.2
	Alkalinity (mg/L)	7	13.3	27.8	24.7	22.3	6.1
	Photic Zone (m)	7	1.97	5.55	5.00	4.59	1.24
	Secchi (m)	7	0.76	2.27	2.10	1.82	0.55
	Bottom Depth (m)	7	21.0	26.4	25.0	24.0	2.2
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.116	0.003	0.034	0.053
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.011	0.338	0.038	0.103	0.122
	Total Kjeldahl Nitrogen (mg/L)	7	0.282	0.840	0.417	0.465	0.183
	Total Nitrogen (mg/L)[J]	7	0.319	1.178	0.484	0.568	0.284
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.005	0.004	0.004	0.001
	Total Phosphorus (mg/L)	7	0.013	0.029	0.019	0.020	0.006
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.9	7.5	5.4	5.4	1.3
	Biological						
	Chlorophyll a (mg/m³)	7	4.27	11.75	8.01	7.93	2.92
	E. coli (MPN/DL)[J]	3	< 1	1	1	1	0
GEOH-10	**Physical**						
	Turbidity (NTU)	8	3.7	59.4	5.6	12.1	19.1
	Total Dissolved Solids (mg/L)	7	45.0	93.0	61.0	68.7	17.4
	Total Suspended Solids (mg/L)	7	3.0	16.0	7.0	7.7	4.2
	Hardness (mg/L)	4	17.9	29.0	23.6	23.6	4.6
	Alkalinity (mg/L)	7	11.9	33.1	30.0	26.5	7.3
	Photic Zone (m)	7	0.84	4.26	3.06	3.00	1.11
	Secchi (m)	7	0.30	1.49	1.17	1.09	0.38
	Bottom Depth (m)	8	11.0	12.0	11.4	11.5	0.4
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.060	0.003	0.015	0.022
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.015	0.173	0.112	0.094	0.070
	Total Kjeldahl Nitrogen (mg/L)	7	0.437	0.956	0.589	0.634	0.164
	Total Nitrogen (mg/L)[J]	7	0.610	0.980	0.701	0.727	0.122
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.007	0.004	0.004	0.002
	Total Phosphorus (mg/L)	7	0.018	0.043	0.021	0.025	0.009
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	1.7	9.1	6.7	6.0	2.4
	Biological						
	Chlorophyll a (mg/m³)	7	< 0.10	24.92	8.01	12.27	9.45
	E. coli (MPN/DL)[J]	3	1	2	2	2	1

Appendix Table 1. 2014 (continued)

Station	Parameter	N	Min	Max	Med	Mean	SD
GEOH-12	**Physical**						
	Turbidity (NTU)	7	3.3	49.8	4.6	10.8	17.2
	Total Dissolved Solids (mg/L)	7	5.0	85.0	50.0	51.0	26.9
	Total Suspended Solids (mg/L)	7	3.0	14.0	6.0	7.0	3.8
	Hardness (mg/L)	4	20.2	24.8	22.7	22.6	2.0
	Alkalinity (mg/L)	7	14.7	31.4	27.1	25.3	5.4
	Photic Zone (m)	7	1.15	4.70	3.61	3.42	1.14
	Secchi (m)	7	0.34	1.76	1.32	1.27	0.48
	Bottom Depth (m)	7	7.4	10.2	9.4	9.3	1.0
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.006	0.074	0.003	0.014	0.026
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.024	0.174	0.144	0.116	0.061
	Total Kjeldahl Nitrogen (mg/L)	7	0.196	1.200	0.563	0.584	0.313
	Total Nitrogen (mg/L)	7	0.298	1.374	0.587	0.699	0.343
	Dissolved Reactive Phosphorus (mg/L)[J]	7	0.003	0.007	0.003	0.004	0.002
	Total Phosphorus (mg/L)	7	0.011	0.056	0.015	0.021	0.016
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.9	7.9	6.3	5.6	1.7
	Biological						
	Chlorophyll a (mg/m³)	7	3.81	14.95	8.54	8.80	4.60
	E. coli (MPN/DL)[J]	3	1	4	2	2	2
GEOH-13	**Physical**						
	Turbidity (NTU)	7	3.1	34.5	4.7	8.6	11.4
	Total Dissolved Solids (mg/L)	7	13.0	77.0	57.0	55.0	20.3
	Total Suspended Solids (mg/L)	7	3.0	12.0	6.0	5.7	3.1
	Hardness (mg/L)	4	11.1	23.9	20.2	18.8	5.7
	Alkalinity (mg/L)	7	8.8	27.2	25.6	22.4	6.6
	Photic Zone (m)	7	1.48	5.60	3.62	3.69	1.29
	Secchi (m)	7	0.37	2.14	1.53	1.44	0.60
	Bottom Depth (m)	7	7.5	9.5	8.2	8.4	0.7
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.068	0.003	0.017	0.025
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.026	0.214	0.124	0.120	0.072
	Total Kjeldahl Nitrogen (mg/L)[J]	7	0.146	1.200	0.445	0.484	0.336
	Total Nitrogen (mg/L)[J]	7	0.242	1.385	0.492	0.605	0.370
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.005	0.003	0.003	0.001
	Total Phosphorus (mg/L)	7	0.012	0.058	0.014	0.021	0.016
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.8	8.4	6.2	5.7	1.9
	Biological						
	Chlorophyll a (mg/m³)	7	< 0.10	30.26	5.34	9.60	10.50
	E. coli (MPN/DL)[J]	3	1	6	2	3	3

Appendix Table 1. 2014 (continued)

Station	Parameter	N	Min	Max	Med	Mean	SD
GEOH-16	**Physical**						
	Turbidity (NTU)	8	8.4	19.1	13.5	13.2	3.4
	Total Dissolved Solids (mg/L)	7	34.0	71.0	53.0	54.1	12.5
	Total Suspended Solids (mg/L)	7	5.0	14.0	11.0	10.0	3.2
	Hardness (mg/L)	4	15.4	17.6	16.6	16.5	0.9
	Alkalinity (mg/L)	7	12.7	15.9	14.7	14.4	1.4
	Photic Zone (m)	5	1.04	2.23	2.06	1.91	0.50
	Secchi (m)	5	0.60	0.96	0.70	0.73	0.14
	Bottom Depth (m)	8	2.6	3.9	2.8	3.0	0.5
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.050	0.005	0.014	0.019
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	0.004	0.456	0.038	0.096	0.161
	Total Kjeldahl Nitrogen (mg/L)	7	0.289	0.704	0.351	0.413	0.140
	Total Nitrogen (mg/L)[J]	7	0.327	1.160	0.379	0.509	0.295
	Dissolved Reactive Phosphorus (mg/L)[J]	7	0.004	0.012	0.005	0.007	0.003
	Total Phosphorus (mg/L)	7	0.027	0.051	0.033	0.035	0.008
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.6	5.1	4.5	4.3	0.6
	Biological						
	Chlorophyll a (mg/m³)	7	0.89	19.58	3.56	7.22	8.42
	E. coli (MPN/DL)	3	47	93	64	68	23
GEOH-4	**Physical**						
	Turbidity (NTU)	7	3.3	34.9	4.5	8.5	11.7
	Total Dissolved Solids (mg/L)	7	27.0	81.0	66.0	64.3	19.1
	Total Suspended Solids (mg/L)	7	< 1.0	4.0	3.0	2.4	1.5
	Hardness (mg/L)	4	14.1	24.5	21.0	20.2	5.0
	Alkalinity (mg/L)	7	12.0	29.7	27.1	24.7	6.3
	Photic Zone (m)	7	1.33	4.44	4.08	3.72	1.10
	Secchi (m)	7	0.42	2.03	1.51	1.40	0.51
	Bottom Depth (m)	7	12.5	20.4	20.0	18.0	3.7
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.125	0.003	0.037	0.057
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.160	0.376	0.253	0.247	0.069
	Total Kjeldahl Nitrogen (mg/L)	7	0.400	0.841	0.518	0.564	0.156
	Total Nitrogen (mg/L)	7	0.595	1.111	0.754	0.811	0.180
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.007	0.004	0.004	0.002
	Total Phosphorus (mg/L)	7	0.016	0.053	0.019	0.024	0.013
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	3.4	10.0	6.8	6.8	2.3
	Biological						
	Chlorophyll a (mg/m³)	7	0.53	12.21	6.41	6.55	4.51
	E. coli (MPN/DL)[J]	3	< 1	1	1	1	0

Appendix Table 1. 2014 (continued)

Station	Parameter	N	Min	Max	Med	Mean	SD
GEOH-6	**Physical**						
	Turbidity (NTU)	7	4.8	25.3	7.0	9.4	7.2
	Total Dissolved Solids (mg/L)	7	56.0	81.0	70.0	70.0	7.7
	Total Suspended Solids (mg/L)	7	2.0	8.0	4.0	4.6	2.0
	Hardness (mg/L)	4	16.2	25.8	21.7	21.4	4.1
	Alkalinity (mg/L)	7	14.7	29.3	24.6	24.6	5.3
	Photic Zone (m)	7	1.76	3.76	2.92	2.92	0.74
	Secchi (m)	7	0.51	1.15	1.08	1.01	0.22
	Bottom Depth (m)	7	15.6	16.7	16.0	16.1	0.4
	Chemical						
	Ammonia Nitrogen (mg/L)[J]	7	< 0.006	0.116	0.021	0.043	0.044
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.306	0.542	0.402	0.428	0.084
	Total Kjeldahl Nitrogen (mg/L)	7	0.331	0.793	0.542	0.536	0.156
	Total Nitrogen (mg/L)	7	0.637	1.206	0.944	0.964	0.185
	Dissolved Reactive Phosphorus (mg/L)[J]	7	0.003	0.012	0.005	0.007	0.004
	Total Phosphorus (mg/L)	7	0.022	0.038	0.026	0.028	0.005
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	4.4	9.8	6.7	7.2	2.0
	Biological						
	Chlorophyll a (mg/m³)	7	1.78	23.14	5.34	7.60	7.23
	E. coli (MPN/DL)[J]	3	1	1	1	1	0
GEOH-9	**Physical**						
	Turbidity (NTU)	7	4.3	34.4	6.4	10.6	10.7
	Total Dissolved Solids (mg/L)	7	< 1.0	105.0	67.0	62.1	34.8
	Total Suspended Solids (mg/L)	7	3.0	13.0	6.0	7.0	3.5
	Hardness (mg/L)	4	25.0	29.1	27.6	27.3	1.8
	Alkalinity (mg/L)[J]	7	21.1	32.2	26.5	26.9	4.5
	Photic Zone (m)	7	1.20	3.41	3.12	2.79	0.76
	Secchi (m)	7	0.44	1.28	1.09	1.02	0.27
	Bottom Depth (m)	7	5.3	7.4	6.3	6.4	0.7
	Chemical						
	Ammonia Nitrogen (mg/L)	7	< 0.006	0.085	0.003	0.030	0.037
	Nitrate+Nitrite Nitrogen (mg/L)	7	0.093	0.448	0.180	0.214	0.130
	Total Kjeldahl Nitrogen (mg/L)	7	0.303	0.918	0.465	0.546	0.232
	Total Nitrogen (mg/L)	7	0.475	1.240	0.672	0.760	0.272
	Dissolved Reactive Phosphorus (mg/L)[J]	7	< 0.003	0.005	0.004	0.004	0.001
	Total Phosphorus (mg/L)	7	0.015	0.024	0.020	0.021	0.003
	CBOD-5 (mg/L)[J]	7	< 2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7	2.5	9.5	6.7	6.3	2.2
	Biological						
	Chlorophyll a (mg/m³)	7	2.67	27.59	13.35	13.59	7.43
	E. coli (MPN/DL)[J]	2	< 1	2	1	1	1

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit

Appendix Table 2. Summary of Walter F. George Reservoir water quality data collected April-October, 2017. Minimum (min) and maximum (max) values calculated using minimum detection limits when results were less than this value. Median (med), mean, and standard deviation (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

Station	Parameter	N		Min	Max	Med	Mean	SD
GEOH-1	**Physical**							
	Turbidity (NTU)	7		2.2	5.0	3.4	3.4	0.8
	Total Dissolved Solids (mg/L)	7		41.0	73.0	55.0	57.7	10.5
	Total Suspended Solids (mg/L)	7		1.0	7.0	3.0	3.6	2.0
	Hardness (mg/L)	4		20.4	24.6	24.1	23.3	2.0
	Alkalinity (mg/L)	7		20.6	29.7	25.7	25.3	3.3
	Photic Zone (m)	7		4.73	6.41	5.71	5.66	0.66
	Secchi (m)	7		1.46	2.72	2.05	2.12	0.41
	Bottom Depth (m)	7		23.7	25.4	24.9	24.7	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.043	0.004	0.010	0.015
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7	<	0.004	0.309	0.012	0.084	0.115
	Total Kjeldahl Nitrogen (mg/L)	7		0.172	0.603	0.369	0.384	0.133
	Total Nitrogen (mg/L)[J]	7	<	0.177	0.724	0.405	0.468	0.189
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.004	0.002	0.002	0.001
	Total Phosphorus (mg/L)	7		0.011	0.018	0.016	0.015	0.002
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		7.5	8.6	7.7	7.8	0.4
	Biological							
	Chlorophyll a (mg/m³)	7		5.87	16.00	10.10	10.59	3.83
	E. coli (MPN/DL)[J]	4		1	1	1	1	0
GEOH-10	**Physical**							
	Turbidity (NTU)	7		4.4	8.6	5.2	5.8	1.6
	Total Dissolved Solids (mg/L)	7		50.0	73.0	62.0	59.4	8.1
	Total Suspended Solids (mg/L)	7		2.0	8.0	4.0	4.4	2.4
	Hardness (mg/L)	4		24.4	28.2	27.2	26.8	1.6
	Alkalinity (mg/L)	7		25.8	30.6	27.7	28.0	1.5
	Photic Zone (m)	7		2.37	3.48	2.88	2.93	0.39
	Secchi (m)	7		0.95	1.89	1.19	1.26	0.32
	Bottom Depth (m)	7		10.1	11.9	11.3	11.2	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.030	0.004	0.011	0.010
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.012	0.087	0.035	0.041	0.026
	Total Kjeldahl Nitrogen (mg/L)	7		0.457	0.861	0.776	0.705	0.156
	Total Nitrogen (mg/L)[J]	7		0.514	0.948	0.811	0.746	0.167
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.005	0.002	0.003	0.002
	Total Phosphorus (mg/L)	7		0.020	0.034	0.024	0.025	0.005
	CBOD-5 (mg/L)	7	<	2.0	2.9	2.1	1.8	0.8
	Chlorides (mg/L)	7		5.8	7.8	7.0	7.0	0.8
	Biological							
	Chlorophyll a (mg/m³)	7		11.20	69.40	27.60	30.77	18.91
	E. coli (MPN/DL)[J]	4	<	1	5	2	2	2

Appendix Table 2. 2017 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
GEOH-12	**Physical**							
	Turbidity (NTU)	7		3.9	9.4	4.5	6.0	2.4
	Total Dissolved Solids (mg/L)	7	<	1.0	70.0	63.0	51.9	24.8
	Total Suspended Solids (mg/L)	7		1.0	6.0	5.0	4.1	1.7
	Hardness (mg/L)	4		21.6	27.4	26.0	25.2	2.5
	Alkalinity (mg/L)	7		24.7	28.5	26.9	26.6	1.6
	Photic Zone (m)	7		2.70	4.22	3.52	3.49	0.52
	Secchi (m)	7		0.87	1.86	1.38	1.40	0.35
	Bottom Depth (m)	7		8.8	10.2	9.5	9.5	0.5
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.063	0.004	0.018	0.024
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.009	0.209	0.069	0.098	0.076
	Total Kjeldahl Nitrogen (mg/L)	7		0.289	0.731	0.417	0.427	0.155
	Total Nitrogen (mg/L)[J]	7		0.325	0.940	0.485	0.525	0.199
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.007	0.001	0.002	0.002
	Total Phosphorus (mg/L)	7		0.013	0.017	0.014	0.015	0.002
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.2	0.4
	Chlorides (mg/L)	7		6.8	8.4	7.7	7.6	0.5
	Biological							
	Chlorophyll a (mg/m³)	7		8.01	19.60	13.90	13.65	4.01
	E. coli (MPN/DL)[J]	4	<	1	1	1	1	0
GEOH-13	**Physical**							
	Turbidity (NTU)	7		3.9	7.4	4.4	5.4	1.5
	Total Dissolved Solids (mg/L)[J]	7		47.0	64.0	55.0	55.9	7.0
	Total Suspended Solids (mg/L)[J]	7		1.0	8.0	3.0	3.4	2.4
	Hardness (mg/L)	4		19.6	25.2	23.0	22.7	2.4
	Alkalinity (mg/L)	7		16.8	27.0	23.5	23.6	3.3
	Photic Zone (m)	7		2.89	4.46	3.74	3.64	0.63
	Secchi (m)	7		1.12	1.69	1.47	1.43	0.18
	Bottom Depth (m)	7		8.8	9.6	9.0	9.1	0.3
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.017	0.004	0.006	0.007
	Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.004	0.240	0.042	0.099	0.093
	Total Kjeldahl Nitrogen (mg/L)	7		0.189	0.789	0.452	0.451	0.185
	Total Nitrogen (mg/L)	7	<	0.231	0.831	0.547	0.550	0.202
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.007	0.001	0.002	0.002
	Total Phosphorus (mg/L)	7		0.012	0.019	0.014	0.014	0.002
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		6.6	8.5	7.8	7.6	0.7
	Biological							
	Chlorophyll a (mg/m³)	7		6.87	22.40	17.10	15.17	5.38
	E. coli (MPN/DL)[J]	4	<	1	1	1	1	0

Appendix Table 2. 2017 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
GEOH-16	**Physical**							
	Turbidity (NTU)	7		10.9	63.6	15.0	24.5	19.6
	Total Dissolved Solids (mg/L)	7		12.0	81.0	52.0	50.6	21.4
	Total Suspended Solids (mg/L)	7		3.0	52.0	7.0	16.3	17.3
	Hardness (mg/L)	4		12.5	21.1	17.9	17.4	3.6
	Alkalinity (mg/L)	7		10.0	20.1	15.7	15.1	3.5
	Photic Zone (m)	7		0.77	2.43	2.05	1.80	0.64
	Secchi (m)	7		0.22	1.21	0.78	0.81	0.36
	Bottom Depth (m)	7		2.0	3.0	2.5	2.6	0.3
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.049	0.014	0.015	0.017
	Nitrate+Nitrite Nitrogen (mg/L)[J]	7		0.004	0.116	0.049	0.061	0.038
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.077	0.391	0.277	0.242	0.119
	Total Nitrogen (mg/L)[J]	7	<	0.084	0.440	0.370	0.302	0.133
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.003	0.009	0.006	0.006	0.002
	Total Phosphorus (mg/L)	7		0.024	0.044	0.029	0.031	0.007
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		2.8	4.3	3.8	3.8	0.5
	Biological							
	Chlorophyll a (mg/m³)	7		1.78	5.34	3.56	3.48	1.43
	E. coli (MPN/DL)[J]	4		52	172	83	97	51
GEOH-4	**Physical**							
	Turbidity (NTU)	7		3.3	6.2	4.4	4.4	1.0
	Total Dissolved Solids (mg/L)	7	<	1.0	86.0	46.0	43.8	28.6
	Total Suspended Solids (mg/L)	7	<	1.0	4.0	2.0	2.4	1.1
	Hardness (mg/L)	4		19.8	26.4	25.8	24.4	3.1
	Alkalinity (mg/L)	7		22.3	28.6	26.3	25.6	2.2
	Photic Zone (m)	7		3.23	4.28	3.69	3.75	0.36
	Secchi (m)	7		1.35	2.05	1.40	1.55	0.30
	Bottom Depth (m)	7		18.9	20.3	19.6	19.6	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)[J]	7	<	0.004	0.017	0.004	0.006	0.006
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.064	0.489	0.138	0.204	0.162
	Total Kjeldahl Nitrogen (mg/L)	7		0.349	0.808	0.472	0.511	0.154
	Total Nitrogen (mg/L)	7		0.557	0.901	0.674	0.716	0.132
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.006	0.002	0.003	0.002
	Total Phosphorus (mg/L)	7		0.016	0.033	0.020	0.022	0.006
	CBOD-5 (mg/L)	7	<	2.0	2.0	1.0	1.0	0.0
	Chlorides (mg/L)	7		7.3	9.7	8.4	8.5	0.7
	Biological							
	Chlorophyll a (mg/m³)	7		9.08	55.70	17.60	20.85	15.88
	E. coli (MPN/DL)[J]	4	<	1	1	1	1	0

Appendix Table 2. 2017 (continued)

Station	Parameter	N		Min	Max	Med	Mean	SD
GEOH-6	**Physical**							
	Turbidity (NTU)	7		4.2	18.4	6.9	8.3	4.7
	Total Dissolved Solids (mg/L)	7		47.0	77.0	66.0	63.4	11.5
	Total Suspended Solids (mg/L)	7		1.0	21.0	5.0	6.6	6.6
	Hardness (mg/L)	4		23.0	27.7	24.8	25.0	2.0
	Alkalinity (mg/L)	7		21.8	27.4	25.8	25.6	1.9
	Photic Zone (m)	7		1.67	4.00	3.26	3.16	0.73
	Secchi (m)	7		0.65	1.50	1.16	1.15	0.31
	Bottom Depth (m)	7		14.4	16.2	15.8	15.7	0.6
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.004	0.079	0.004	0.023	0.034
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.229	0.834	0.430	0.454	0.199
	Total Kjeldahl Nitrogen (mg/L)	7	<	0.077	1.120	0.280	0.383	0.359
	Total Nitrogen (mg/L)	7	<	0.404	1.413	0.699	0.838	0.394
	Dissolved Reactive Phosphorus (mg/L)[J]	7		0.003	0.034	0.006	0.014	0.013
	Total Phosphorus (mg/L)	7		0.018	0.055	0.030	0.036	0.014
	CBOD-5 (mg/L)	7	<	2.0	2.2	1.0	1.2	0.5
	Chlorides (mg/L)	7		7.9	10.8	8.7	8.8	1.0
	Biological							
	Chlorophyll a (mg/m³)	7		3.34	18.00	10.70	10.36	5.57
	E. coli (MPN/DL)[J]	4		1	2	1	1	1
GEOH-9	**Physical**							
	Turbidity (NTU)	7		5.2	250.0	6.3	41.6	91.9
	Total Dissolved Solids (mg/L)	7		43.0	78.0	57.0	60.0	13.0
	Total Suspended Solids (mg/L)[J]	7		3.0	148.0	5.0	25.7	54.0
	Hardness (mg/L)	4		23.9	27.9	25.2	25.5	1.9
	Alkalinity (mg/L)	7		14.5	28.4	27.1	25.0	4.9
	Photic Zone (m)	7		0.32	2.93	2.58	2.33	0.92
	Secchi (m)	7		0.10	1.28	1.16	0.99	0.42
	Bottom Depth (m)	7		6.4	7.0	6.9	6.8	0.2
	Chemical							
	Ammonia Nitrogen (mg/L)	7	<	0.004	0.094	0.002	0.016	0.035
	Nitrate+Nitrite Nitrogen (mg/L)	7		0.097	0.460	0.154	0.196	0.121
	Total Kjeldahl Nitrogen (mg/L)	7		0.254	0.883	0.425	0.494	0.217
	Total Nitrogen (mg/L)	7		0.408	1.088	0.568	0.691	0.266
	Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.002	0.004	0.003	0.003	0.001
	Total Phosphorus (mg/L)	7		0.018	0.033	0.021	0.025	0.007
	CBOD-5 (mg/L)	7	<	2.0	3.5	2.6	2.4	1.0
	Chlorides (mg/L)	7		2.0	8.8	8.2	7.2	2.4
	Biological							
	Chlorophyll a (mg/m³)	7		10.70	123.00	32.00	49.33	43.31
	E. coli (MPN/DL)[J]	4		1	2	1	1	1

J=one or more of the values provided are estimated; < = Actual value is less than the detection limit