2007 WATER QUALITY MONITORING
F.E. WALTER RESERVOIR
WHITE HAVEN, PENNSYLVANIA

U.S. Army Corps of Engineers
Philadelphia District
Environmental Resources Branch

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2007 Water Quality Monitoring
F.E. Walter Reservoir
White Haven, Pennsylvania

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1.0 INTRODUCTION

1.1 DESCRIPTION OF F.E. WALTER RESERVOIR

The U.S. Army Corps of Engineers (USACE) manages F.E. Walter Reservoir located in northeastern Pennsylvania within the Delaware River Basin. F.E. Walter Reservoir is an integral part of the Lehigh River Flood Control Program. The authorized purpose of this project is flood control. The reservoir project was authorized for recreation and specifically white water recreation as part of Public Law 100-676, Section 6, dated November 17, 1988. Located about 9 miles southeast of Wilkes-Barre, PA, the reservoir dams a drainage area of 288 square miles. The dam can impound up to 35.8 billion gallons of floodwater. The primary surface water input into the reservoir is the Lehigh River as it flows west between Luzerne and Carbon Counties. Bear Creek, a secondary surface water input, enters the reservoir from the north. Tobyhanna Creek drains an area to the southeast and joins the Lehigh River near the headwaters of the reservoir. The reservoir is approximately 3 miles long and typically approximately 50 feet deep behind the dam when not operating for flood control or recreation. In an effort to maximize recreational potential in the reservoir and on the Lehigh River downstream, specifically recreational boating and fishing, the normal operating pool of 50 feet was raised an additional 65 feet in April of 2007. The additional storage was used to augment low flows in the Lehigh River downstream and increase the number of recreational boating releases throughout the summer recreation season.

1.2 PURPOSE OF THE MONITORING PROGRAM

Foremost, F.E. Walter Reservoir provides flood control to downstream communities on the Lehigh River. Additionally, the reservoir provides important habitat for fish, waterfowl, and other wildlife, and recreational opportunities through fishing and boating. Drinking water intakes exist at various locations on the Lehigh River downstream of the dam. Due to the broad range of uses and demands F.E. Walter Reservoir serves, the USACE monitors water quality and other aspects related to reservoir health primarily to ensure public health safety. Water quality monitoring results are compared to state water quality standards and used to diagnose other problems that commonly effect reservoir health such as nutrient enrichment and toxic loadings. This report summarizes the results of water quality monitoring at F.E. Walter Reservoir and its tributaries from May through November 2007.

1.3 ELEMENTS OF THE STUDY

The USACE, Philadelphia District, has been monitoring the water quality of F.E. Walter Reservoir since 1975. Over this time, yearly monitoring program designs have evolved to address new areas of concern such as health aspects of public drinking water, sediment contaminants within the reservoir basin, and a 2002 investigation of a hydrogen sulfide smell near the tail water of the dam. The 2007 monitoring program was similar to those in recent years with additional sampling to monitor water quality changes occurring within the reservoir and downstream as a result of modified operations. The major elements of the monitoring included:

- Monthly water quality and bacteria monitoring from May through November to evaluate compliance with the Pennsylvania state water quality standards. Sampling was postponed in the months of August and September due to sampling equipment failure and subsequent repair;

- Multiple unscheduled profile samples for temperature, dissolved oxygen, chlorophyll, pH and conductivity at the deepest station in the reservoir;

- Automated half-hour temperature recorders at five stations along the Lehigh River below the reservoir.

2.0 METHODS

2.1 PHYSICAL STRATIFICATION MONITORING

Physical stratification monitoring of the water column of F.E. Walter Reservoir was conducted five times between May and November 2007 at all stations (Table 2-1). Sampling was postponed in the months of August and September due to sampling equipment failure and subsequent repair delays. Physical stratification parameters included temperature, dissolved oxygen (DO), pH, Chlorophyll a, depth, turbidity, and conductivity. Monitoring was conducted at seven fixed stations located throughout the reservoir watershed (Fig. 2-1). Surface water quality was monitored at stations downstream (outfall discharge) of the reservoir (WA-1) and tributary upstream stations on Tobyhanna Creek (WA-3), the Lehigh River (WA-4), and Bear Creek (WA-5). Stratification monitoring was conducted within the reservoir at a reservoir tower station (WA-2), Bear Creek arm of the lake (WA-6), and Lehigh River arm of the lake (WA-7) with water quality measured at the surface to the bottom at 5-ft intervals. Stratification monitoring at station WA-2 and WA-1 were conducted a total of 11 times throughout the season from May through November to monitor the changes in water quality as a result of modified operations in 2007. All of the water quality monitoring was conducted with a calibrated YSI 6600 water quality meter.

In this report, water quality data recorded from stratification monitoring were compared to applicable water quality standards mandated by the Pennsylvania Department of Environmental Protection (PADEP Chapter 93). The standard for DO is a minimum concentration of 5 mg/L, and that for pH is an acceptable range from 6 to 9. All of the water quality data collected during physical stratification monitoring is summarized in Appendix A.

2.2 WATER COLUMN CHEMISTRY MONITORING

Water column chemistry monitoring was conducted five times at F.E. Walter Reservoir between May and November 2007 (Table 2-1). Sampling was postponed in the months of August and September due to sampling equipment failure and subsequent repair delays. Water samples were collected at the seven fixed stations throughout the reservoir drainage area (Fig. 2-1). Surface water samples were collected at stations downstream of the reservoir (WA-1) and upstream on Tobyhanna Creek (WA-3), the Lehigh River (WA-4), and Bear Creek (WA-5). Surface, middle, and bottom water samples were collected at the reservoir-body stations WA-2, WA-6, and WA-7. Surface water samples were collected by opening the sample containers approximately 1 foot below the water's surface. Middle and bottom samples were collected with a Van Dorn design water bottle sampler. All samples were placed on ice in a cooler and shipped to a certified laboratory for testing.

Water samples collected from surface, middle, and bottom depths were analyzed for ammonia, nitrite, nitrate, total Kjeldahl nitrogen (TKN), total phosphorus, diss./ortho-phosphate, soluble phosphorus, total dissolved solids (TDS), total suspended solids (TSS), biochemical oxygen demand (BOD), alkalinity, total organic carbon (TOC), total inorganic carbon (TIC), total carbon, and chlorophyll *a*. Table 2-2 summarizes the water quality parameters; laboratory method detection limits, state water quality standards, and allowable and achieved maximum hold times for each.

Table 2-1. F.E. Walter Reservoir water quality schedule for 2007 monitoring

Date of Sample Collection	(3) Physical Stratification Monitoring (WA-2 and WA-1)	Water Column Chemistry Monitoring (All Stations)	Trophic State Determination (WA-2)	Coliform Bacteria Monitoring (All Stations)	(4) Sediment Priority Pollutant Monitoring (WA-2)	(2) Lehigh Temperature Probes	(1) Drinking Water Monitoring
4 May	X					X	
24 May	**X**					X	
07 June	X					X	
14 June	X					X	
21 June	**X**					X	
29 June	X	X	X	X		X	
12 July	X					X	
19 July	**X**	X	X	X		X	
03 August	X	X	X	X		X	
11 October	**X**	X	X	X		X	
06 November	**X**	X	X	X			

(1) Drinking water samples are sampled quarterly by personnel at each reservoir.
(2) Lehigh River temperature probes continuously monitor river temperatures throughout the sampling period. They are periodically downloaded.
(3) Physical stratification monitoring is conducted at all stations during routine monthly sampling shown in bold.
(4) Sediment Sampling was not conducted in 2007 based on historic sampling results showing low probability of sediment contamination.

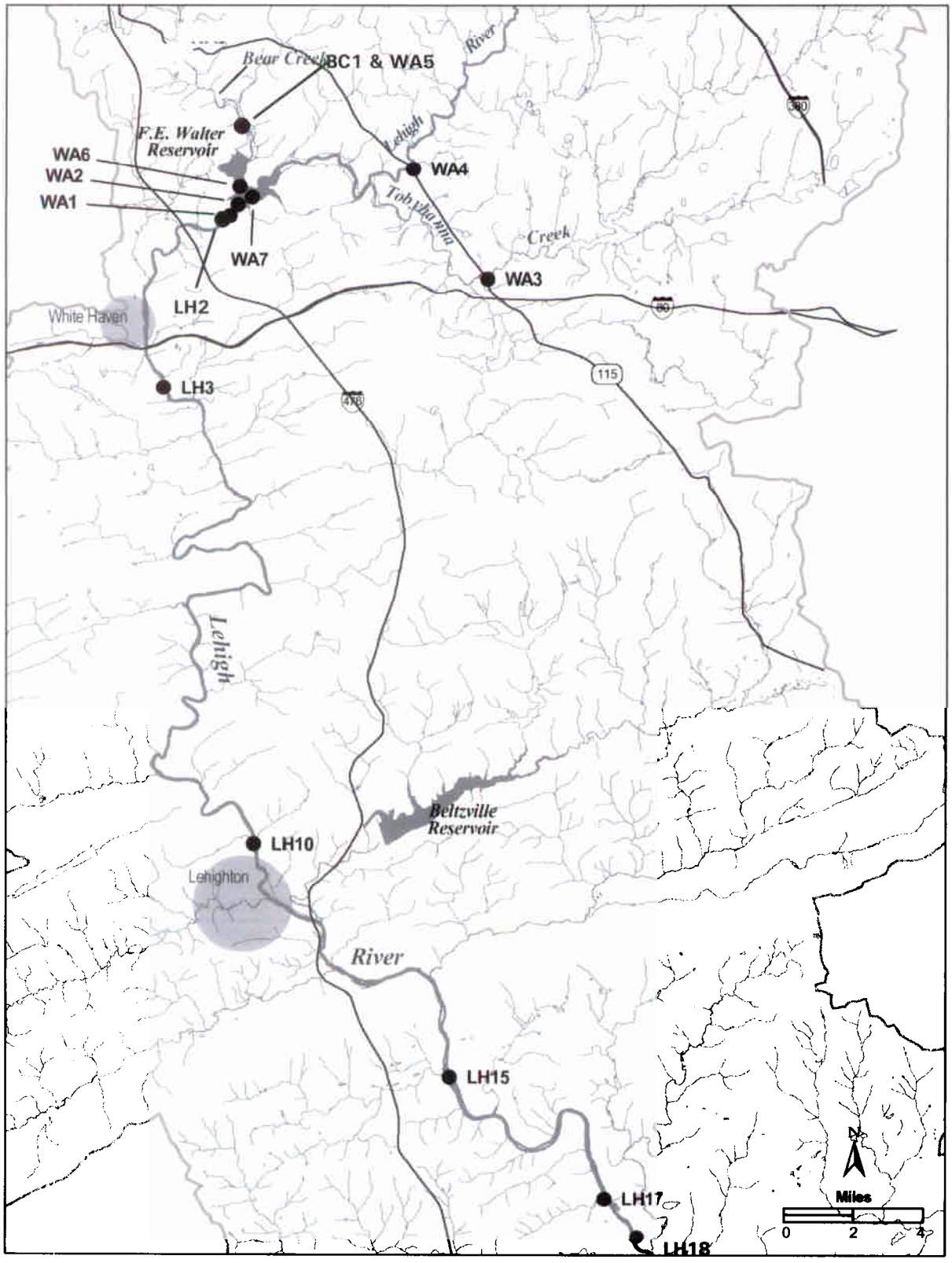

Figure 2-1. Location map for F.E. Walter Reservoir and Lehigh River temperature probe monitoring stations in 2007

Table 2-2. Water quality test methods, detection limits, state regulatory criteria, and sample holding times for water quality parameters monitored at F.E. Walter Reservoir in 2007

Parameter	Method	Detection Limit	PADEP Surface Water Quality Criteria	Allowable Hold Times (Days)	Maximum Hold Time Achieved (Days)
Alkalinity	SM18 2320B	5.0 mg/L	minimum 20 mg/L $CaCO_3$	14	(X)
Biochemical Oxygen Demand (BOD)	SM5210B	2.0 mg/L	None	2	
Total Phosphorus	MCAWW 365.1	0.002 mg/L	None	28	(X)
Diss./Ortho-Phosphate	300.0 A	0.014 mg/L	None	28	(X)
Soluble Phosphorus	4500-PE	0.034 mg/L	None	28	(X)
Total Organic Carbon	SW846 9060	1.0 mg/L	None	14	(X)
Total Inorganic Carbon	SW846 9060	1.0 mg/L	None	28	(X)
Total Carbon	SW846 9060	1.0 mg/L	None	28	(X)
* Chlorophyll *a*			None		
Total Kjeldahl Nitrogen	351.2	0.25 mg/L	None	28	(X)
Ammonia	MCAWW 350.1 Low L	0.004mg/L	Temperature and pH dependent	28	(X)
Nitrate	MCAWW 353.2	0.018 mg/L	Maximum 10 mg/L (nitrate + nitrite)	28	(X)
Nitrite	MCAWW 353.2	0.016 mg/L		28	(X)
Total Dissolved Solids	SM18 2540C	10 mg/L	Maximum 500 mg/L	7	(X)
Total Suspended Solids	SM18 2540D	1.7 mg/L	None	7	(X)

* Chlorophyll *a* samples were recorded using a YSI 6600 with a chlorophyll sensor.
** (X) Hold times acheived

2.3 TROPHIC STATE DETERMINATION

The trophic state of F.E. Walter Reservoir was determined by methods outlined by Carlson (1977). In general, this method calculates trophic state indices (TSIs) independently for total phosphorus and chlorophyll *a* concentrations, and secchi disk depth. Surface water measures of total phosphorus and chlorophyll *a* from chemistry monitoring were used independently in determining monthly TSI values. Secchi disk depth was measured only in surface waters in the reservoir-body. Trophic state determinations were made using criteria defined by Carlson (1977) and EPA (1983) and calculated only for Station WA-2 within the reservoir.

2.4 RESERVOIR BACTERIA MONITORING

Monitoring for coliform bacteria contaminants was conducted five times between May and November at F.E. Walter Reservoir. Surface water samples were collected in the same manner as for chemical parameter samples, and analyzed for total and fecal coliform and e-coli bacteria contamination. Table 2-3 presents the test methods, detection limits, PADEP standards, and sample holding times for the bacteria parameters monitored at F.E. Walter Reservoir in 2007. The bacteria analytical method was based on a membrane filtration technique. All of the samples were analyzed within their maximum allowable hold times.

Monthly coliform bacteria counts were compared to the PADEP single sample and swimming beach water quality standard for bacteria. The multiple beach sample standards is defined as a maximum geometric mean of 200 colonies/100-ml based on five samples collected on different days within a 30-day period. Application of this standard is not necessary at F.E. Walter because swimming and other human/water contact recreation is prohibited in the reservoir. However, it is used in evaluating the bacteria results.

Table 2-3. Water quality test methods, detection limits, PADEP water quality standards, and sample holding times for bacteria parameters monitored at F.E. Walter Reservoir in 2007

Parameter	Total coliform	Fecal coliform
Test method	SM 9222B	SM9222D
Detection limit	10 clns/100-mls	10 clns/100-ml
PADEP standard	-	Geometric mean less than 200 clns/100-ml (application of this standard is conservative because swimming is not permitted in the reservoir)
Maximum allowable holding time	30 hours	30 hours
Achieved holding time	< 30 hours	< 30 hours

2.5 LEHIGH WATER QUALITY MONITORING

Ambient water temperature was recorded every ½ hour with Onset Computer Corporation TidbiT^{tm} probes at five stations along the Lehigh River. The station locations were LH-2 (just below the F. E. Walter dam outfall), station LH-3 (Tannery Bridge located several miles downstream of the dam), LH-10 (Lehighton near the Lehighton water intake facility), LH-15 (Walnutport), and LH-18 near Catasauqua, PA just upstream of the Lehigh Rivers confluence with Hockendauqua Creek. Station LH-18 was newly established in 2007. A temperature probe located at the Treichlers Bridge over the Lehigh River was also lost during the early portion of the sampling season. Loss of this probe is assumed to be the result of vandalism.

3.0 RESULTS AND DISCUSSION

3.1 STRATIFICATION MONITORING

The following sections describe temporal and spatial patterns for the water quality parameters of temperature, dissolved oxygen (DO) and pH measured throughout the F.E. Walter Reservoir watershed during 2007. Additionally, patterns related to season and depths are described for station WA-2 located in the reservoir. Maximum depths for WA-2 vary between approximately 50 to 115 feet due to operations in 2007. All of the stratification data collected during the 2007 monitoring period is presented in Appendix A.

3.1.1 Temperature

Temperature is the primary influencing factor on water density, affects the solubility of many chemicals compounds, and can therefore influence the effect of pollutants on aquatic life. Increased temperatures elevate the metabolic oxygen demand, in conjunction with reduced oxygen solubility, and can impact many species. Vertical stratification patterns naturally occurring in lakes affect the distribution of dissolved and suspended compounds.

Temperature of the tributary surface waters (Stations WA-3, -4, and -5) of the F.E. Walter Reservoir watershed generally followed a similar pattern throughout the monitoring period. Temperatures increased throughout the summer and peaked during mid-July sampling at approximately 20.76 °C (Fig. 3-1). Downstream release (station WA-1) surface temperatures peaked in early August at approximately 21.49 °C. Temperatures in surface waters of the reservoir-body (station WA-2, -6, and -7) were generally warmer than in tributaries and downstream of the dam as a result of warming from the sun. In-lake reservoir surface temperatures peaked in early August at approximately 26.15 °C.

The water column of F.E. Walter Reservoir was stratified during most of the 2007 sampling season (Fig. 3-2). Due to operational changes in 2007, specifically the raising of the base pool level and recreational release operations, the temperature stratification within the reservoir was likely affected by bottom flood gate releases on various occasions during the season. As a result, lower and typically cooler bottom waters are withdrawn first, likely causing a disruption in stratification and accelerated depletion of cooler bottom waters. Overall, 2007 reservoir and release temperatures were lower than seen during operations in 2005 and 2006. This can be a result of numerous factors to include operating at a higher pool level, recreational release schedules, and meteorological conditions throughout the season.

3.1.2 Dissolved Oxygen

Dissolved oxygen (DO) is the measure of the amount of DO in water. Typically, DO concentrations in surface waters are less than 10 mg/L. Dissolved Oxygen concentrations are subject to diurnal and seasonal fluctuations that can be influenced, in part, by temperature, river discharge, and photosynthetic activity. Dissolved Oxygen is essential to the respiratory metabolism of most aquatic organisms. It affects the availability and solubility of nutrients and subsequently the productivity of aquatic ecosystems. Low levels of oxygen can facilitate the release of nutrients from bottom sediments.

In 2007, DO in the tributary surface waters (stations WA-3, -4, and -5) of F.E. Walter Reservoir remained relatively constant from May through October sampling with an increasing trend into November. This can be attributed to typically well oxygenated stream and river systems. Station WA-1 located downstream of F.E. Walter Reservoir also maintained a similar pattern. This can be attributed to the aeration of reservoir bottom waters as it passes through the conduit system of the dam.

The water column of F.E. Walter Reservoir was weakly stratified with respect to DO during most of the sampling season (Fig. 3-4). From May through mid-June and November the water column was relatively uniform with concentrations remaining fairly stable and typically above state criteria (5 mg/l) throughout the water column. The rest of the sampling season has shown a trend of decreasing or varying DO concentrations at greater depths in the water column. The lowest DO concentrations were recorded during the 19 July sampling event. Measurements below the state criteria were seen from mid-July into August.

The health of aquatic ecosystems can be impaired by low DO concentrations in the water column. Hypoxia, or conditions of DO concentrations less than 2 mg/L, is generally accepted as the threshold at which the most severe effects on biota occur. In late July of 2007, the bottom waters of F.E. Walter Reservoir experienced hypoxia or near hypoxic conditions (Fig. 3-4). Release water is re-aerated as it passes through the conduit system of the reservoir. As a result, water releases from the deeper portions of the reservoir containing lower DO concentration did not directly impact the Lehigh River downstream. DO concentrations downstream ranged from 8.21 mg/L to 11.71 mg/L throughout the sampling season.

3.1.3 pH

PH is the measure of the hydrogen –ion concentration in the water. A pH below 7 is considered acidic and a pH above 7 is basic. The pH scale is 0-14 with the lower numbers being more acidic and the higher numbers being more basic. High pH values tend to facilitate solubilization of ammonia, salts, and heavy metals. Low pH levels tend to

increase carbonic acid and carbon dioxide concentrations. Lethal effects of pH on aquatic life typically occur below pH 4.5 and above pH 9.5.

Measures of pH in tributary surface (WA-3, -4, and –5) waters of F.E. Walter Reservoir generally followed a similar pattern during 2007 and remained relatively constant or within a narrow range of values throughout the sampling season. The lowest pH level of 5.85 recorded during the sampling season occurred at station WA-5 during the November sampling.

On most monitoring dates in 2007, measures of pH within the lake were higher near the surface waters (Fig. 3-6). Likely, this is a result of increased algal productivity in the trophic zone of the lake (influenced by sun light and primary production). Measures of pH in the deeper portions of the water column of F.E. Walter Reservoir were routinely not in compliance with PADEP water quality standards. The water quality standard for pH is a range of acceptable measures between 6 and 9. Portions of the water column at station WA-2 was below the pH standard of 6.0 for all sampling dates except for October and November (Appendix A).

3.1.4 Conductivity

Conductivity is the measure of the ability of water to conduct electric current. The greater the content of ions in the water, then the more current the water can carry. Ions are dissolved metals and other dissolved materials. Specific conductivity can be used to estimate the total ion concentration of the water and is sometimes used as an alternative measure of dissolved solids. Natural waters are found to vary between .05 and 1.5 mS/cm.

Of the three tributary surface water stations (WA-3, -4, -5) sampled at F.E. Walter Reservoir, station WA-3S routinely had the highest conductivity measures (Appendix A). The maximum conductivity measure of 0.114 mS/cm was recorded at Station WA-3S in October. Conductivity was routinely lower upstream of the reservoir at station WA-5. In most months, conductivity measures were generally uniform throughout the water column, but showed a slight increasing trend deeper in the water column notably in August. Conductivity patterns in the water column at station WA-2 were at their lowest in November and July and at their highest levels in May and June.

3.2 WATER COLUMN CHEMISTRY MONITORING

Table 3-2 provides a summary of water column chemistry sampling for all stations and dates sampled at F.E. Walter Reservoir in 2007. The following sections describe the temporal, spatial, and depth related patterns for these water quality measures.

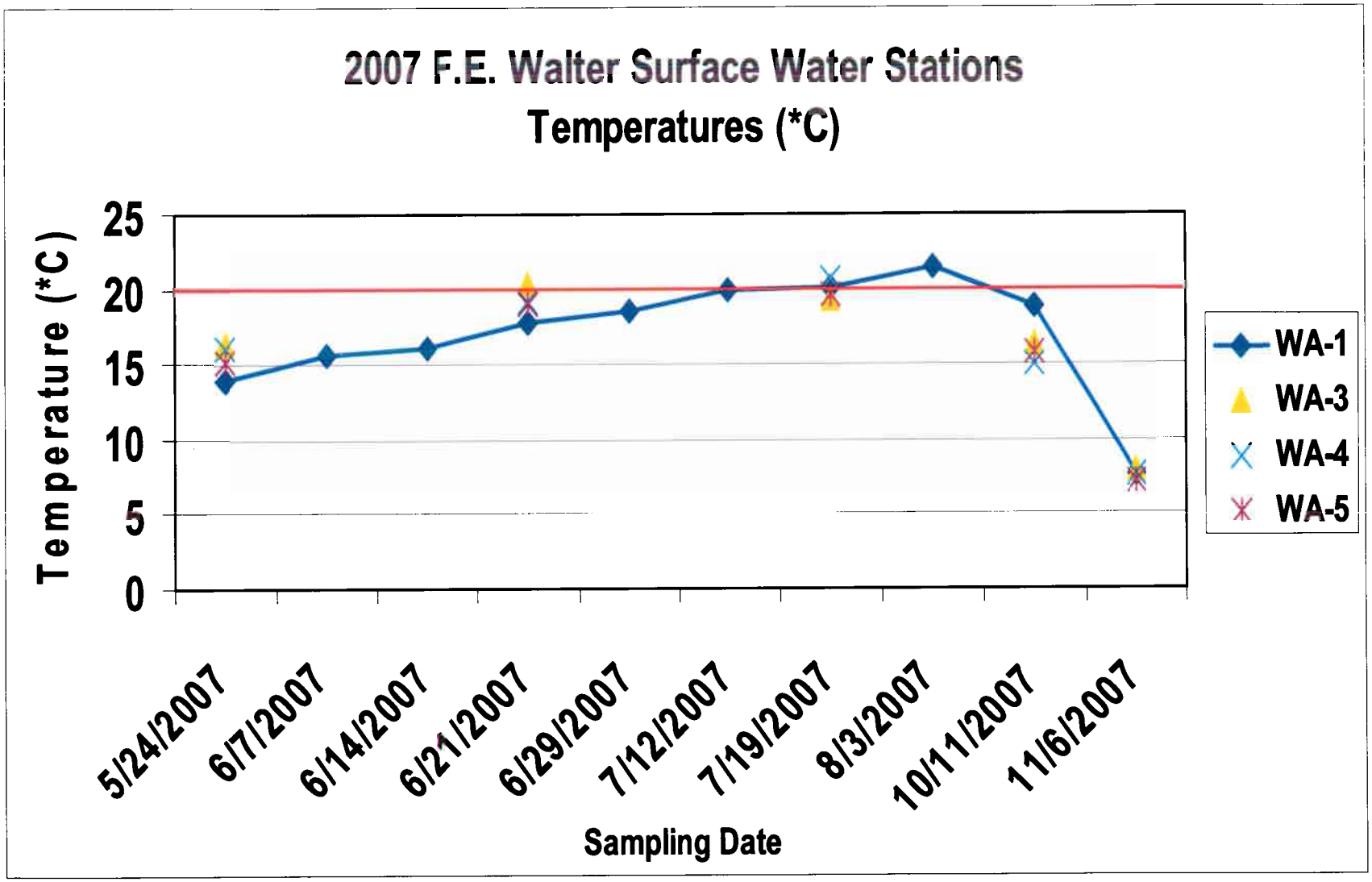

Figure 3-1. Temperature measured in tributary and release (WA-1) surface waters of F.E. Walter Reservoir during 2007. See Appendix A for a summary of the plotted values.

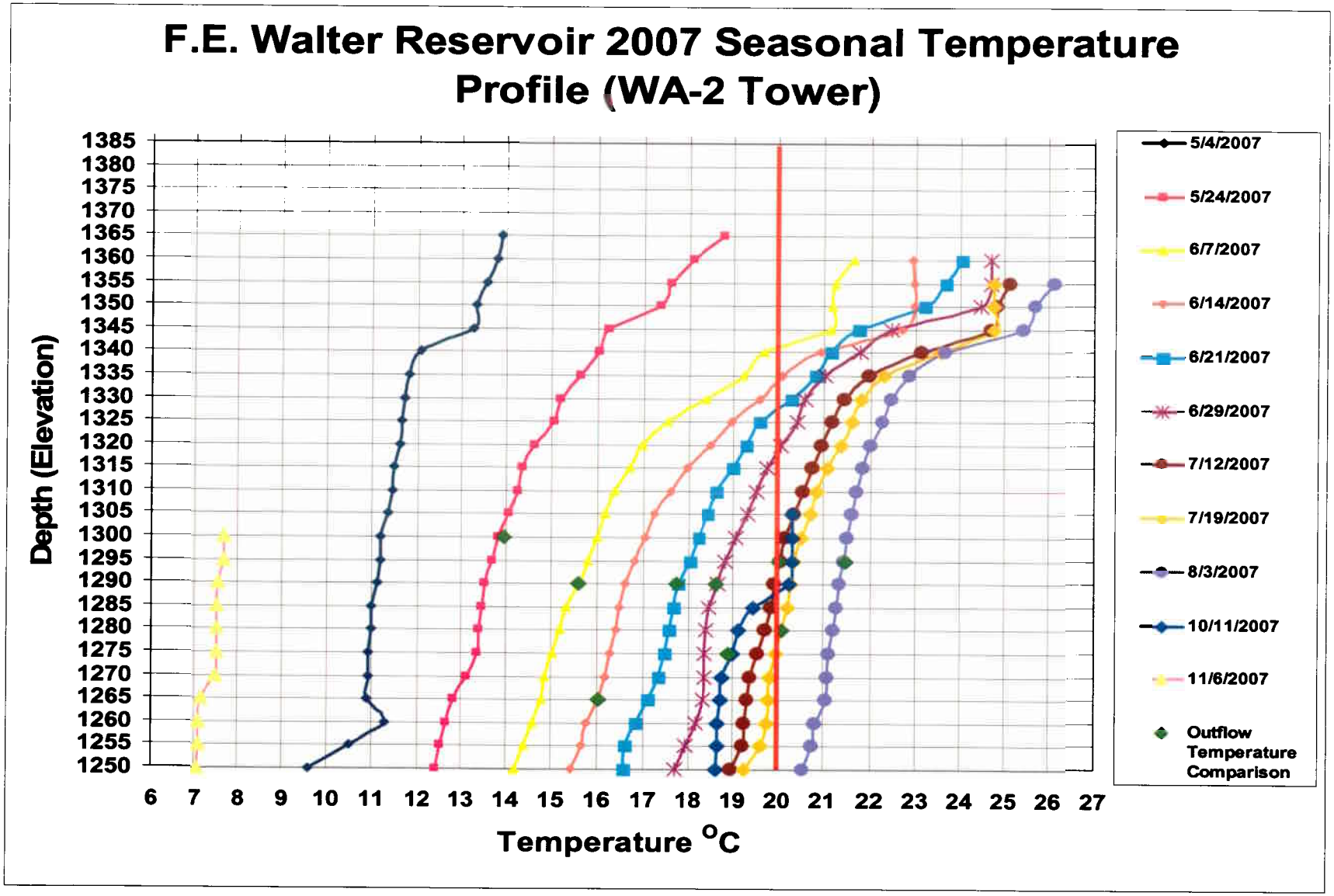

Figure 3-2. Stratification of temperature measured in the water column of F. E. Walter Reservoir at station WA-2 during 2007. See Appendix A for a summary of the plotted values.

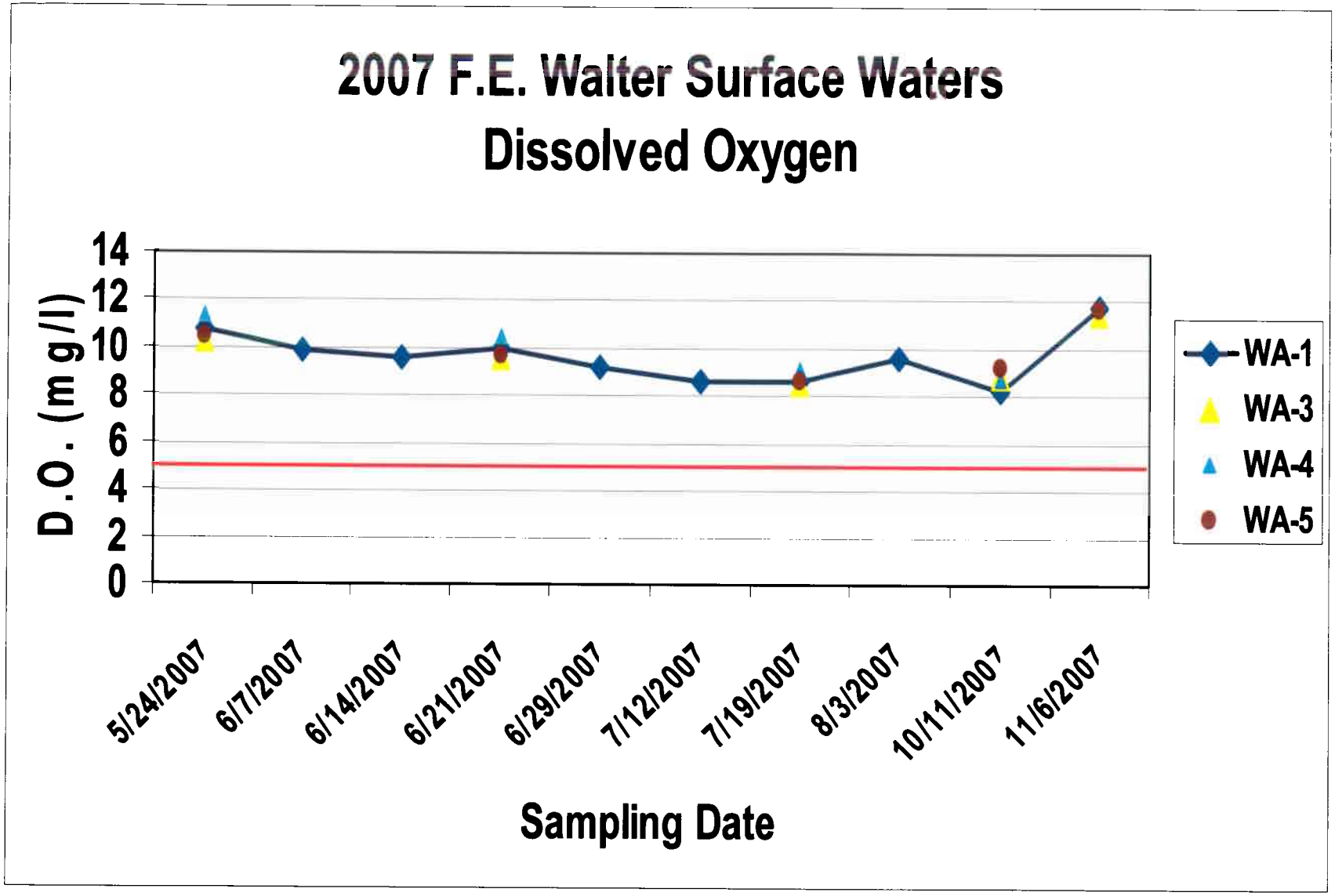

Figure 3-3. Dissolved oxygen measured in surface and release (WA-1) waters of F. E. Walter Reservoir during 2007. See Appendix A for a summary of the plotted valu.

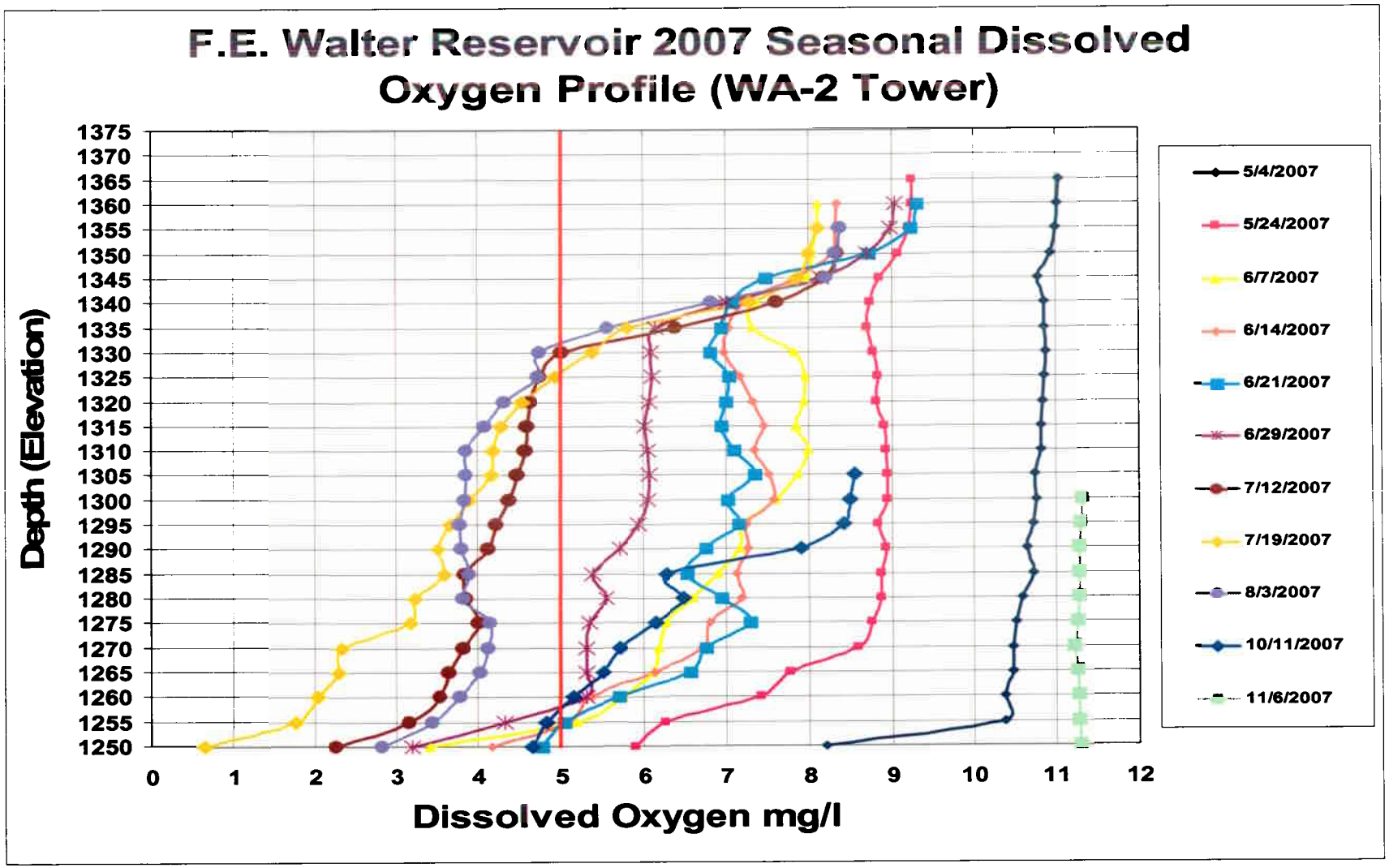

Figure 3-4. Dissolved oxygen measured in the water column of F.E. Walter Reservoir at station WA-2 during 2007. The PADEP water quality standard for DO is a minimum concentration of 5 mg/L. See Appendix A for a summary of the plotted values

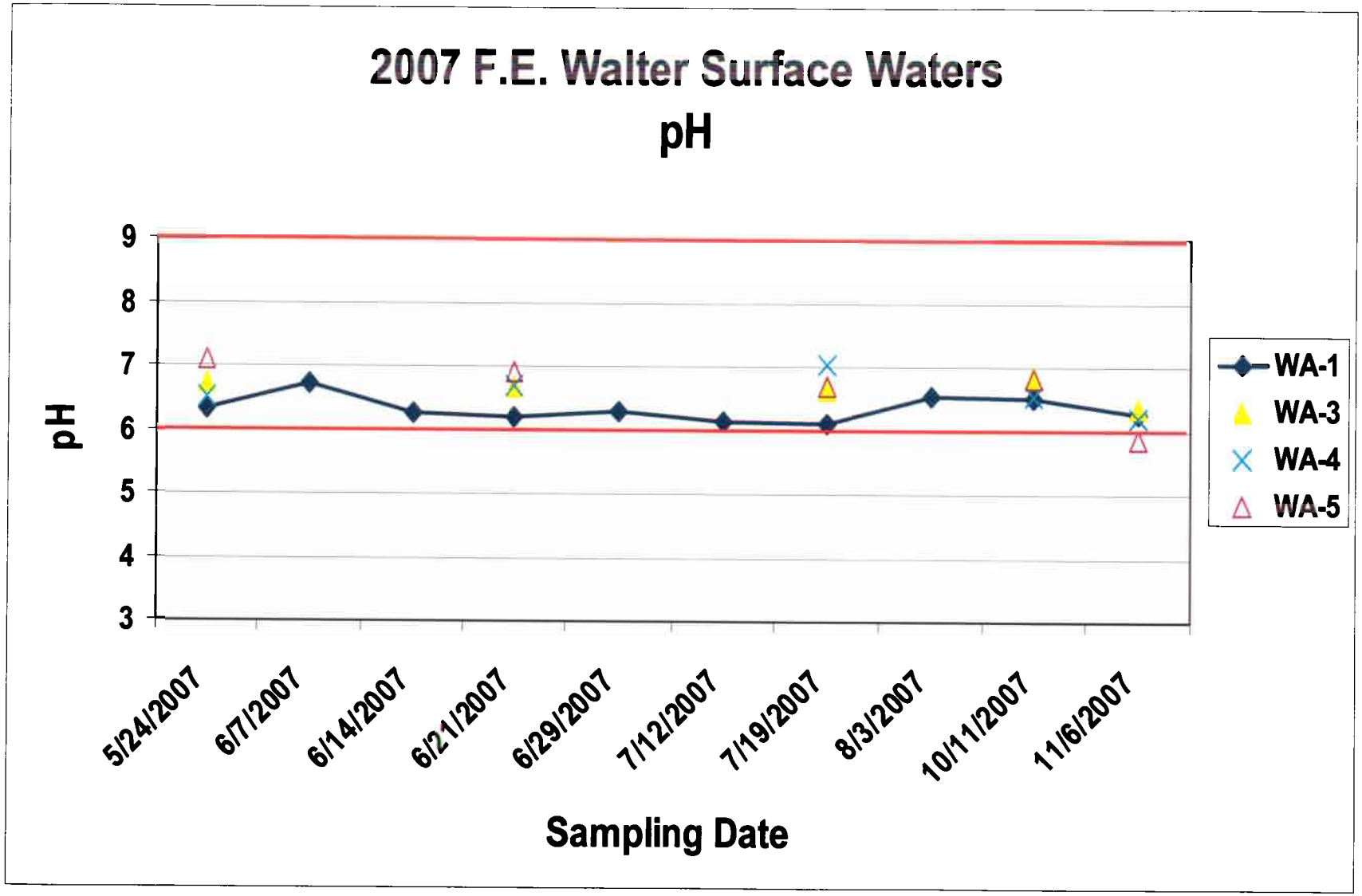

Figure 3-5. Measures of pH in tributary and release (WA-1) surface waters of F.E. Walter Reservoir during 2007. The PADEP water quality standard for pH is an acceptable range from 6 to 9. See Appendix A for a summary of the plotted values.

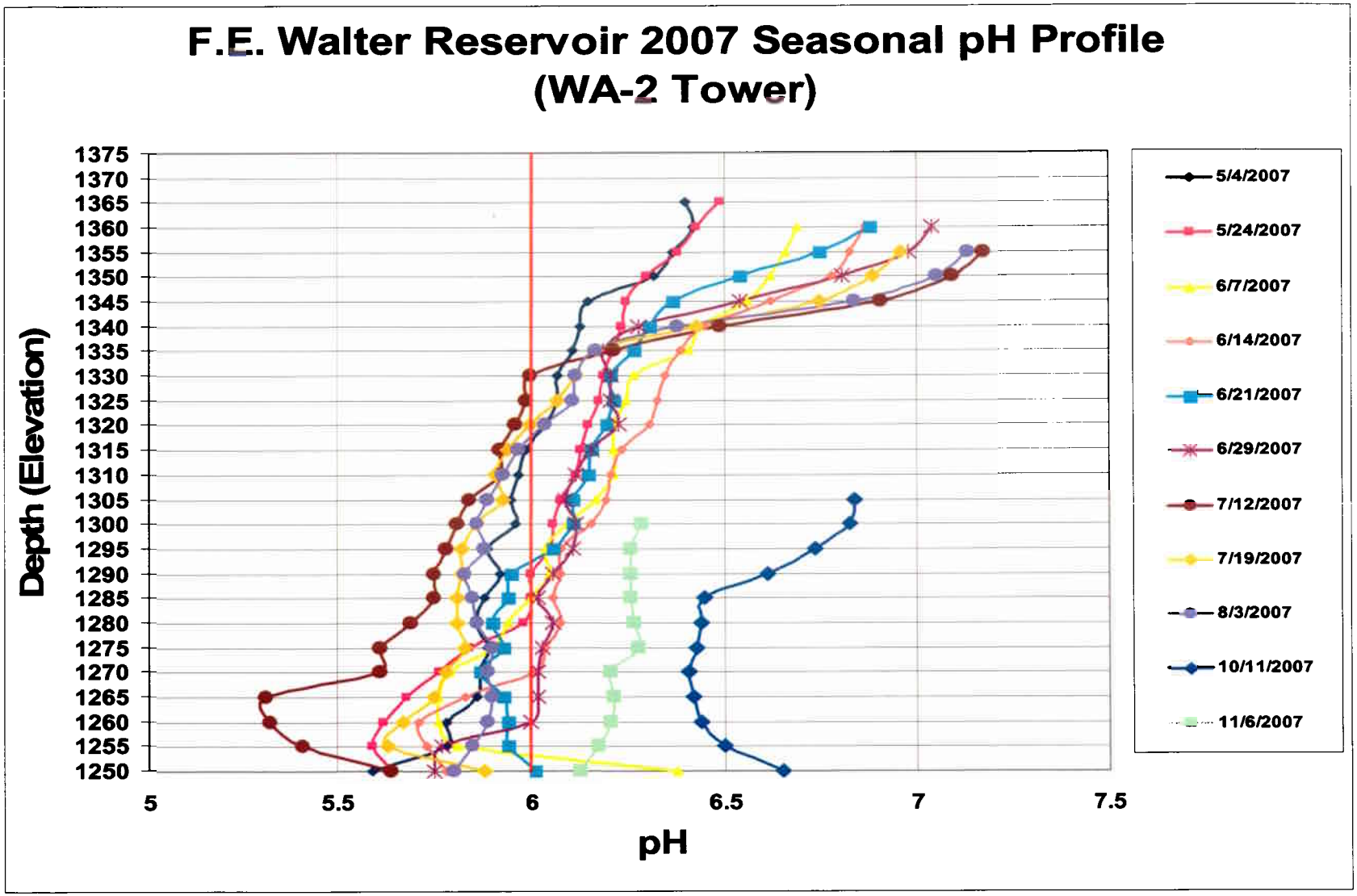

Figure 3-6. Stratification of pH measured in the water column of F.E. Walter Reservoir at station WA-2 during 2007. The PADEP water quality standard pH is an acceptable range from 6 to 9. See Appendix A for a summary of the plotted value.

Table 3-1. Summary of surface, middle, and bottom water quality monitoring data for F.E. Walter Reservoir in 2007

STATION	DATE		BOD		NO3		NO2		PO4	ALK	TDS		TIC		TKN	TOC		TP		DISS P		TSS		NH3
WA-1S	24 May	<	2	<	.018	<	.016	<	.034	5.8	52		1	<	.25	3		.012	<	0.014	<	1.7		0.064
	21-Jun	<	2	<	.018	<	.016	<	.034	6.8	49		2	<	.25	3		.014	<	0.014	<	1.7		0.131
	19-Jul	<	2		0.1	<	.016	<	.034	8.1	62		2	<	.25	3		.013	<	0.014		6		0.087
	11-Oct	<	2	<	.018	<	.016	<	.034	10.3	51		2	<	.25	3		.017	<	0.014		12		0.088
	6-Nov	<	2		0.1	<	.016	<	.034	6.8	81		1	<	.25	5		.010	<	0.014	<	1.7		0.042
Mean			2.0		.051		.016		.03	7.56	59.0		2		0.3	3.4		.013		0.014		4.6		0.1
Max.			2.0		.100		.016		.03	10.3	81.0		2		0.3	5.0		.017		0.014		12.0		0.1
Min.			2.0		.018		.016		.03	5.80	49.0		1		0.3	3.0		.010		0.014		1.7		0.0
Std. D			0.0		.045		0.00		.00	1.74	13.3		0.5		0.0	0.9		.002		0.000		4.5		0.0
No. of D			0		2		0		0	5	5		5		0	5		5		0		2		5
WA-2S	24 May	<	2	<	.018	<	.016	<	.034	5.6	56		1	<	.25	3		.0067	<	0.014	<	1.7		0.037
	21-Jun	<	2	<	.018	<	.016	<	.034	6.5	56		2	<	.25	3		.0069	<	0.014	<	1.7		0.054
	19-Jul	<	2	<	.018	<	.016	<	.034	11.0	58		1	<	.25	3		.0104	<	0.014	<	1.7		0.045
	11-Oct	<	2	<	.018	<	.016	<	.034	9.7	50		2	<	.25	3		.0123	<	0.014		5		0.047
	6-Nov	<	2		0.1	<	.016	<	.034	6.2	63	<	1	<	.25	5		.0074	<	0.014	<	1.7		0.057
Mean			2.0		.034		.016		0.03	7.80	56.6		1		0.3	3.4		.0087		0.014		2.4		0.05
Maximum			2.0		.100		.016		0.03	11.0	63.0		2		0.3	5.0		.0123		0.014		5.0		0.1
Minimum			2.0		.018		.016		0.03	5.60	50.0		1		0.3	3.0		.0067		0.014		1.7		0.0
Std. Dev			0.0		.037		.000		0.00	2.39	4.67		0.5		0.0	0.9		.0025		0.000		1.5		0.0
No. of D			0		1		0		0	5	5		4		0	5		5		0		1		5
WA-2M	24 May	<	2	<	.018	<	.016	<	.034	5.5	47		2	<	.25	3		.0091	<	0.014		4		0.043
	21-Jun	<	2	<	.018	<	.016	<	.034	7.3	50		2	<	.25	3		.0091	<	0.014		4		0.094
	19-Jul	<	2	<	.018	<	.016	<	.034	7.7	59		2	<	.25	3		.0126	<	0.014		6		0.109
	11-Oct	<	2	<	.018	<	.016	<	.034	10.3	55		2	<	.25	3		.0135	<	0.014	<	1.7		0.048
	6-Nov	<	2		0.1	<	.016		0.5	6.0	60		1		0.6	5		.0105	<	0.014	<	1.7		0.077
Mean			2.0		.034		.016		0.13	7.36	54.2		2		0.3	3.4		.0110		0.014		3.5		0.1
Maximum			2.0		.100		.016		0.50	10.3	60.0		2		0.6	5.0		.0135		0.014		6.0		0.1
Minimum			2.0		.018		.016		0.03	5.50	47.0		1		0.3	3.0		.0091		0.014		1.7		0.0
Std. Dev			0.0		.037		.000		0.21	1.88	5.63		0.4		0.2	0.89		.0020		0.000		1.8		0.0
No. of D			0		1		0		0	5	5		5		1	5		5		0		3		5

Table 3-1 continued. Summary of surface, middle, and bottom water quality monitoring data for F.E. Walter Reservoir in 2007

STATION	DATE		BOD		NO3		NO2		PO4		ALK		TDS		TIC		TKN		TOC		TP		DISS P		TSS		NH3
WA-2B	24 May	<	2		0.1	<	.016		0.56		5.6		45		2		1.0		5		.0928	<	0.014		240		0.151
	21-Jun	<	2	<	.018	<	.016	<	.034		7.9		47		3	<	.25		3		.0428	<	0.014		22		0.236
	19-Jul	<	2		0.1	<	.016	<	.034		9.2		74		2	<	.25		3		.0239	<	0.014		13		0.160
	11-Oct	<	2	<	.018	<	.016	<	.034		10.1		66		2	<	.25		3		.0396	<	0.014		20		0.225
	6-Nov	<	2		0.1	<	.016	<	.034		6.4		76		1	<	.25		5		.0132	<	0.014		5		0.045
Mean			2.0		.067		.016		0.14		7.84		61.6		2		0.4		3.8		.0425		0.014		60.0		0.2
Maximum			2.0		.100		.016		0.56		10.1		76.0		3		1.0		5.0		.0928		0.014		240		0.2
Minimum			2.0		.018		.016		0.03		5.60		45.0		1		0.3		3.0		.0132		0.014		5.0		0.0
Std. Dev			0.0		.045		.000		0.24		1.87		14.8		0.7		0.3		1.1		.0306		0.000		101		0.1
No. of D			0		3		0		1		5		5		5		1		5		5		0		5		5
WA-3S	24 May	<	2		0.1	<	.016	<	.034		6.2		59		2	<	.25		3		.0118	<	0.014		4		0.025
	21-Jun	<	2	<	.018	<	.016	<	.034		8.2		76		2	<	.25		4		.0134	<	0.014	<	1.7		0.073
	19-Jul	<	2	<	.018	<	.016	<	.034		10.2		59		2	<	.25		3		.0114	<	0.014	<	1.7		0.057
	11-Oct		2		0.1	<	.016	<	.034		12.5		74		2	<	.25		5		.0556	<	0.014		13		0.046
	6-Nov	<	2		0.1	<	.016	<	0.5		7.0		72		1		0.6		7		.0135	<	0.014	<	1.7		0.060
Mean			2.0		.067		.016		0.13		8.82		68.0		2		0.3		4.4		.0211		0.014		4.4		0.1
Maximum			2.0		.100		.016		0.50		12.5		76.0		2		0.6		7.0		.0556		0.014		13.0		0.1
Minimum			2.0		.018		.016		0.03		6.20		59.0		1		0.3		3.0		.0114		0.014		1.7		0.0
Std. Dev			0.0		.045		.000		0.21		2.55		8.34		0.4		0.2		1.7		.0193		0.000		4.9		0.0
No. of D			1		3		0		0		5		5		5		1		5		5		0		2		5
WA-4S	24 May	<	2	<	.018	<	.016	<	.034		8.2		46		2	<	.25		3		.0112	<	0.014	<	1.7		0.033
	21-Jun	<	2		0.1	<	.016	<	.034		10.7		51		3	<	.25		4		.0176	<	0.014	<	1.7		0.077
	19-Jul	<	2	<	.018	<	.016	<	.034		12.9		51		3	<	.25		2		.0174	<	0.014		8		0.046
	11-Oct		4	<	.018	<	.016	<	.034		27.8		54		6		1.0		5		.0526	<	0.014		5		0.226
	6-Nov	<	2	<	.018	<	.016	<	.034		7.5		59		1	<	.25		4		.0091	<	0.014	<	1.7		0.045
Mean			2.4		.034		.016		0.03		13.4		52.2		3		0.4		3.6		.0216		0.014		3.6		0.1
Maximum			4.0		.100		.016		0.03		27.8		59.0		6		1.0		5.0		.0526		0.014		8.0		0.2
Minimum			2.0		.018		.016		0.03		7.50		46.0		1		0.3		2.0		.0091		0.014		1.7		0.0
Std. Dev			0.9		.037		.000		0.00		8.32		4.76		1.9		0.3		1.1		.0177		0.000		2.8		0.1
No. of D			1		1		0		0		5		5		5		1.0		5		5		0		2		5

Table 3-1 continued. Summary of surface, middle, and bottom water quality monitoring data for F.E. Walter Reservoir in 2007

STATION	DATE		BOD		NO3		NO2		PO4		ALK		TDS		TIC		TKN		TOC		TP		DISS P		TSS		NH3
WA-5S	24 May	<	2	<	.018	<	.016	<	.034	<	5.0		46	<	1	<	.25		2		.0076	<	0.014		4		0.035
	21-Jun	<	2	<	.018	<	.016	<	.034	<	5.0		51	<	1	<	.25		3		.0084	<	0.014	<	1.7		0.062
	19-Jul	<	2	<	.018	<	.016	<	.034	<	5.0		80	<	1	<	.25		2		.0053	<	0.014	<	1.7		0.056
	11-Oct	<	2	<	.018	<	.016	<	.034		5.4		48	<	1	<	.25		3		.0071	<	0.014	<	1.7		0.045
	6-Nov	<	2	<	.018	<	.016	<	.034	<	5.0		31	<	1	<	.25		3		.0060	<	0.014		4		0.047
Mean			2.0		.018		.016		0.03		5.08		51.2		1		0.3		2.6		.0069		0.014		2.6		0.0
Maximum			2.0		.018		.016		0.03		5.40		80.0		1		0.3		3.0		.0084		0.014		4.0		0.1
Minimum			2.0		.018		.016		0.03		5.00		31.0		1		0.3		2.0		.0053		0.014		1.7		0.0
Std. Dev			0.0		.000		.000		0.00		0.18		17.9		0.0		0.0		0.5		.0012		0.000		1.3		0.0
No. of D			0		0		0		0		1		5		0		0		5		5		0		2		5
WA-6S	24 May	<	2	<	.018	<	.016	<	.034		5.7		55		1	<	.25		3		.0069	<	0.014	<	1.7		0.031
	21-Jun	<	2	<	.018	<	.016	<	.034		6.6		52		2	<	.25		3		.0081	<	0.014	<	1.7		0.070
	19-Jul	<	2	<	.018	<	.016	<	.034		7.7		54		1	<	.25		3		.0063	<	0.014	<	1.7		0.035
	11-Oct	<	2	<	.018	<	.016	<	.034		11.3		52		2	<	.25		3		.0115	<	0.014	<	1.7		0.044
	6-Nov	<	2	<	.018	<	.016	<	.034		5.5		41		1		0.5		4		.0095	<	0.014	<	1.7		0.046
Mean			2.0		.018		.016		0.03		7.36		50.8		1		0.3		3.2		.0085		0.014		1.7		0.0
Maximum			2.0		.018		.016		0.03		11.3		55.0		2		0.5		4.0		.0115		0.014		1.7		0.1
Minimum			2.0		.018		.016		0.03		5.50		41.0		1		0.3		3.0		.0063		0.014		1.7		0.0
Std. Dev			0.0		.000		.000		0.00		2.37		5.63		0.5		0.1		0.4		.0021		0.000		0.0		0.0
No. of D			0		0		0		0		5		5		5		1		5		5		0		0		5
WA-6M	24 May	<	2	<	.018	<	.016	<	.034	<	5.0		43		1	<	.25		3		.0102	<	0.014		7		0.048
	21-Jun	<	2	<	.018	<	.016	<	.034		6.8		50		2	<	.25		3		.0096	<	0.014	<	1.7		0.136
	19-Jul	<	2	<	.018	<	.016	<	.034		9.1		55		2	<	.25		3		.0115	<	0.014	<	1.7		0.096
	11-Oct	<	2	<	.018	<	.016	<	.034		9.3		53		2	<	.25		3		.0142	<	0.014	<	1.7		0.043
	6-Nov	<	2	<	.018	<	.016		0.5		5.6		39	<	1	<	.25		4		.0074	<	0.014	<	1.7		0.049
Mean			2.0		.018		.016		0.13		7.16		48.0		2		0.3		3.2		.0106		0.014		2.8		0.1
Maximum			2.0		.018		.016		0.50		9.30		55.0		2		0.3		4.0		.0142		0.014		7.0		0.1
Minimum			2.0		.018		.016		0.03		5.00		39.0		1		0.3		3.0		.0074		0.014		1.7		0.0
Std. Dev			0.0		.000		0.00		0.21		1.97		6.78		0.5		0.0		0.4		.0025		0.000		2.4		0.0
No. of D			0		0		0		1		4		5		4		0		5		5		0		1		5

Table 3-1 continued. Summary of surface, middle, and bottom water quality monitoring data for F.E. Walter Reservoir in 2007

STATION	DATE		BOD		NO3		NO2		PO4		ALK		TDS		TIC		TKN		TOC		TP		DISS P		TSS		NH3
WA-6B	24 May	<	2		0.1	<	.016		0.58		6.5		58		2		0.8		4		.0971	<	0.014		110		0.091
	21-Jun	<	2	<	.018	<	.016	<	.034		6.5		49		2	<	.25		3		.0071	<	0.014	<	1.7		0.130
	19-Jul	<	2		0.1	<	.016	<	.034		8.3		17.3		2	<	.25		3		.0135	<	0.014	<	1.7		0.066
	11-Oct	<	2	<	.018	<	.016	<	.034		10.2		57		2	<	.25		3		.0186	<	0.014	<	1.7		0.051
	6-Nov	<	2	<	.018	<	.016	<	.034		6.6		44		1	<	.25		5		.0456	<	0.014		37		0.048
Mean			2.0		.051		.016		0.14		7.62		45.1		2		0.4		3.6		.0364		0.014		30.4		0.1
Maximum			2.0		.100		.016		0.58		10.2		58.0		2		1		5.0		.0971		0.014		110.		0.1
Minimum			2.0		.018		.016		0.03		6.50		17.3		1		0.3		3.0		.0071		0.014		1.7		0.0
Std. Dev			0.0		.045		.000		0.24		1.63		16.7		0.4		0.2		0.9		.0370		0.000		47.0		0.0
No. of D			0		2		0		1		5		5		5		1		5		5		0		2		5
WA-7S	24 May	<	2	<	.018	<	.016	<	.034		5.6		62		1	<	.25		3		.0081	<	0.014	<	1.7		0.038
	21-Jun	<	2	<	.018	<	.016	<	.034		7.4		54		2	<	.25		3		.0096	<	0.014	<	1.7		0.082
	19-Jul	<	2	<	.018	<	.016	<	.034		8.1		61		2	<	.25		3		.0084	<	0.014		4		0.039
	11-Oct	<	2	<	.018	<	.016	<	.034		10.2		57		2	<	.25		3		.0111	<	0.014		4		0.045
	6-Nov	<	2	<	.018	<	.016	<	.034		7.4		45		1	<	.25		5		.0093	<	0.014		5		0.048
Mean			2.0		.018		.016		0.03		7.74		55.8		2		0.3		3.4		.0093		0.014		3.3		0.1
Maximum			2.0		.018		.016		0.03		10.2		62.0		2		0.3		5.0		.0111		0.014		5.0		0.1
Minimum			2.0		.018		.016		0.03		5.60		45.0		1		0.3		3.0		.0081		0.014		1.7		0.0
Std. Dev			0.0		.000		.000		0.00		1.66		6.83		0.5		0.0		0.9		.0012		0.000		1.5		0.0
No. of D			0		0		0		0		5		5		5		0		5		5		0		3		5
WA-7M	24 May	<	2	<	.018	<	.016	<	.034		5.5		50		2		0.8		3		.0096	<	0.014	<	1.7		0.051
	21-Jun	<	2	<	.018	<	.016	<	.034		8.9		54		2	<	.25		3		.0099	<	0.014	<	1.7		0.120
	19-Jul	<	2	<	.018	<	.016	<	.034		7.9		63	<	1	<	.25		3		.0095	<	0.014	<	1.7		0.111
	11-Oct	<	2	<	.018	<	.016	<	.034		17.2		48		2	<	.25		3		.0137	<	0.014	<	1.7		0.047
	6-Nov	<	2	<	.018	<	.016	<	.034		7.7		49	<	1	<	.25		5		.0084	<	0.014	<	1.7		0.032
Mean			2.0		.018		.016		0.03		9.44		52.8		2		0.4		3.4		.0102		0.014		1.7		0.1
Maximum			2.0		.018		.016		0.03		17.2		63.0		2		0.8		5.0		.0137		0.014		1.7		0.1
Minimum			2.0		.018		.016		0.03		5.50		48.0		1		0.3		3.0		.0084		0.014		1.7		0.0
Std. Dev			0.0		.000		.000		0.00		4.51		6.14		0.5		0.2		0.9		.0020		0.000		0.0		0.0
No. of D			0		0		0		0		5		5		3		1		5		5		0		0		5

Table 3-1 continued. Summary of surface, middle, and bottom water quality monitoring data for F.E. Walter Reservoir in 2007

STATION	DATE		BOD		NO3		NO2		PO4	ALK	TDS		TIC		TKN		TOC		TP		DISS P		TSS		NH3
WA-7B	24 May	<	2		0.1	<	.016	<	.034	8.5	58		2	<	.25		3		.0462	<	0.014		53		0.094
	21-Jun	<	2	<	.018	<	.016	<	.034	8.7	68		3		0.5		3		.0132	<	0.014		17		0.126
	19-Jul	<	2	<	.018	<	.016	<	.034	10.0	62		2		0.7		3		.0829	<	0.014		66		0.169
	11-Oct	<	2	<	.018	<	.016	<	.034	11.2	54		2		0.8		5		.2330	<	0.014		62		0.056
	6-Nov	<	2	<	.018	<	.016	<	.034	7.4	45		1	<	.25		5		.0085	<	0.014		29		0.037
Mean			2.0		.034		.016		0.03	9.16	57.4		2		0.5		3.8		.0768		0.014		45.4		0.1
Maximum			2.0		.100		.016		0.03	11.2	68.0		3		0.8		5.0		.2330		0.014		66.0		0.2
Minimum			2.0		.018		.016		0.03	7.40	45.0		1		0.3		3.0		.0085		0.014		17.0		0.0
Std. Dev			0.0		.037		.000		0.00	1.47	8.65		0.7		0.3		1.1		.0923		0.000		21.4		0.1
No. of D			0		1		0		0	5	5		5		3		5		5		0		5		5

3.2.1 Ammonia

Total Ammonia is a measure of the most reduced inorganic form of nitrogen in water and includes dissolved ammonia and the ammonium ion. Ammonia is a small component of the nitrogen cycle but is an essential plant nutrient, it contributes to the trophic status of a water body. Excess ammonia contributes to eutrophication of water bodies. This can result in excessive algal growths and impacts on recreation and drinking water supplies. In high concentrations, ammonia is toxic to aquatic life.

Ammonia in the water column of F.E. Walter Reservoir was consistently low throughout the monitoring period. Measures of ammonia ranged from a high measure of 0.236 mg/L at station WA-2B on 21 June to a low measure of 0.025 mg/L at station WA-3S on 24 May (Table 3-1). F.E. Walter Reservoir was in compliance with the PADEP water quality standard for ammonia during 2007. The water quality standard of ammonia is dependent on temperature and pH (Table 3-2). Throughout the monitoring period, all measures of ammonia were less than their respective criteria values.

Table 3-2. PADEP ammonia nitrogen criteria (Pennsylvania Code, Title 25 1984). Specific ammonia criteria dependent on temperature and pH.

PH	0 °C	5 °C	10 °C	15 °C	20 °C	25 °C	30 °C
6.50	25.5	25.5	25.5	17.4	12.0	8.4	5.9
6.75	23.6	23.6	23.6	16.0	11.1	7.7	5.5
7.00	20.6	20.6	20.6	14.0	9.7	6.8	4.8
7.25	16.7	16.7	16.7	11.4	7.8	5.5	3.9
7.50	12.4	12.4	12.4	8.5	5.9	4.1	2.9
7.75	8.5	8.5	8.5	5.8	4.0	2.8	2.0
8.00	5.5	5.5	5.5	5.8	4.0	2.8	2.0
8.25	3.4	3.4	3.4	2.3	1.6	1.2	0.9
8.50	2.0	2.0	2.0	1.4	1.0	0.7	0.6
8.75	1.2	1.2	1.2	0.9	0.6	0.5	0.4
9.00	0.8	0.8	0.8	0.5	0.4	0.3	0.3

3.2.2 Nitrite and Nitrate

Nitrite is a measure of a form of nitrogen that occurs as an intermediate in the nitrogen cycle. It is unstable and can rapidly be oxidized to nitrate or reduced to nitrogen gas. Nitrite is a source of nutrients for plants and can be toxic to aquatic life in relatively low concentrations. Concentrations of nitrite at F.E. Walter Reservoir were consistently low during 2007. Concentrations of nitrite measured at all stations and all depths were less than the method detection limit of 0.016-mg/L for the entire monitoring period (Table 3-1).

Nitrate is the measure of the most oxidized and stable form of nitrogen. It is the principal form of combined nitrogen in natural waters. Nitrate is the primary form of nitrogen used by plants as a nutrient to stimulate plant growth. Nitrate was also consistently low at F.E. Walter Reservoir during 2007. For all stations and depths, concentrations ranged from less than the method detection limit of 0.018 mg/L to 0.10 mg/L.

In 2007, F.E. Walter Reservoir was in compliance with the PADEP water quality standard for nitrogen. The water quality standard for nitrogen is a summed concentration of nitrite and nitrate of less than 10-mg/L. Throughout the monitoring period, the summed concentrations for each station were well below this standard. The maximum summed concentration for any one sampling station did not exceed 0.116 mg/L

3.2.3 Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen that includes ammonia. Organic nitrogen is not immediately available for biological activity and is therefore not available for plant growth until decomposition to an inorganic form occurs. TKN in the water column of F.E. Walter Reservoir was low during 2007 (Table 3-1). Concentrations measured at all reservoir stations ranged from below the detection limit of 0.25 mg/L (at most stations and depths) to a maximum measure of 1.00 mg/L at stations WA-4S on 11 October and WA-2B on 24 May.

3.2.4 Total Phosphorus

Total phosphorus is a measure of both organic and inorganic forms of phosphorus. It is an essential plant nutrient and is often the most limiting nutrient to plant growth in freshwater systems. Inputs of phosphorus are the prime contributing factors to eutrophication in most freshwater systems. Phosphorus bound to bottom sediments in lakes can be released when oxygen levels are depleted in bottom waters. This phosphorus then becomes available for plant growth.

EPA guidance for nutrient criteria in lakes and reservoirs suggests a maximum concentration for total phosphorus of 0.01-mg/L (EPA 2000). Lakes and reservoirs exceeding this concentration are more likely to experience algal bloom problems during the growing season. Concentrations of total phosphorus were slightly elevated at many of the reservoir sampling stations throughout the sampling season (Table 3-1). Surface waters of the reservoir lake body routinely had the lowest concentrations. This may be attributed to its uptake during algal photosynthesis. The highest concentrations of total phosphorus were seen in the deeper waters of the reservoir with a maximum concentration of 0.233 mg/L measured in the 11 October bottom water sample at station WA-7. These higher concentrations may be attributed to phosphorus sediment release. The lowest measured

concentration of 0.005 mg/L was seen in the 19 July tributary surface water station WA-5S.

3.2.5 Dissolved Phosphorus

Dissolved or soluble phosphorus in the water column of F.E. Walter Reservoir remained consistently low during 2007. Concentrations at all stations and depths during the sampling season were below the detection limit of 0.014 mg/L (Table 3-1). In freshwater environments, dissolved phosphorus is usually a limiting nutrient and is utilized by freshwater plants and algae during photosynthesis.

3.2.6 Dissolved Phosphate

Dissolved Phosphate (Orthophosphate) is a measure of the inorganic oxidized form of soluble phosphorus. This form of phosphorus is the most readily available for uptake during photosynthesis. In 2007, concentrations of dissolved phosphate were generally near or below the detection limit of 0.034 mg/L at most stations and depths. The highest concentration of 0.58 mg/L was recorded on 24 May in the bottom waters of station WA-6.

3.2.7 Total Dissolved Solids

Total dissolved solids (TDS) is a measure of the amount of filterable dissolved material in the water. Dissolved salts such as sulfate, magnesium, chloride, and sodium contribute to elevated levels. TDS in the lake and tributary stations of F.E. Walter Reservoir remained relatively constant and low during 2007. Concentrations at all stations and depths averaged 54-mg/L over the monitoring period while ranging from 17.3 to 81 mg/L (Table 3-1). The highest mean seasonal concentration of 68 mg/L was seen at the upstream surface tributary station WA-3S. F.E. Walter Reservoir and its tributaries were in compliance with the PADEP water quality standard for total dissolved solids during 2007. The water quality standard is a maximum concentration of 500-mg/L.

3.2.8 Total Suspended Solids

Total suspended solids (TSS) is a measure of the amount of non-filterable particulate matter that is suspended within the water column. High concentrations increase the turbidity of the water and can hinder photosynthetic activity, result in damage to fish gills, and cause impairment to spawning habitat (smothering). TSS measures in the water column of F.E. Walter Reservoir were consistently low in 2007 with many samples less then the detection limit of 1.7 mg/L. Overall concentrations at all stations and depths ranged from less than the detection limit to an isolated 240 mg/L concentration (Table 3-1) in the bottom waters at Station WA-2. This is likely due to contamination of sediment in the sampling apparatus during lake bottom water sample collection.

3.2.9 Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a test to measure biodegradable organic matter concentrations in a water sample. It measures the rate of oxygen uptake by organisms in the water sample over a period of time. It is an indicator of the quality of a water body and the degree of pollution by biodegradable organic matter is therefore inferred. Measurements of 5-day Biochemical oxygen demand (BOD) in F.E. Walter Reservoir and tributary stations were below the detection limit of 2.0 mg/L except for one sample. A measure of 4.0 mg/L was recorded at the tributary surface water station WA-4S during the 11 October sampling event.

3.2.10 Alkalinity

Alkalinity is a measure of the acid-neutralizing capacity of water. Waters that have high alkalinity values are considered undesirable because of excessive hardness and high concentrations of sodium salts. Water with low alkalinity has little capacity to buffer acidic inputs and is susceptible to acidification (low pH). The PADEP standard is a minimum concentration of 20-mg/L $CaCO_3$ except where natural conditions are less.

Alkalinity measurements in the waters of F.E. Walter Reservoir were routinely low during 2007. Concentrations measured at all stations and depths averaged 8.2 mg/L throughout the monitoring period (Table 3-1). The greatest concentration of 27.8 mg/L was measured during the 11 October sampling event in the tributary surface waters at Station WA-4S. Concentrations that measured less than the detection limit of 5.0 mg/L occurred throughout the sampling season at tributary surface water station WA-5S. The natural alkalinity of water is largely dependent on the underlying geology and soils within the surrounding watershed. The low alkalinity measured at F.E. Walter Reservoir probably results from the regional geology, which is primarily sandstone and shale (Van Diver 1990).

3.2.11 Total Inorganic and Organic Carbon

Total organic carbon (TOC) is a measure of the dissolved and particulate organic carbon in water. The bulk of organic carbon in water is composed of humic substances and partly degraded animal and plant materials. High levels of organic carbon coincide with a lowering of dissolved oxygen concentrations. Total inorganic carbon (TIC) is a measure of the sum of carbonates, bicarbonates, and carbonic acid. The relative amount of each of these is dependent on the pH of the water. The inorganic forms of carbon are part of the carbon cycle. The bicarbonate ions serve as the main buffer in freshwater systems and provide carbon dioxide for photosynthesis. Carbon is a nutrient required for biological processes.

Total inorganic carbon (TIC) and total organic carbon (TOC) were measured in the water column and tributaries of F.E. Walter Reservoir (Table 3-1). Concentrations of TIC at

all stations and depths ranged from 6.0 mg/L to less than the method detection limit of 1.0 mg/L. Additionally, concentrations of TOC at all stations and depths ranged from 7.0 mg/L to 2.0 mg/L. Total carbon is the sum of TIC and TOC. Total carbon in the waters of F.E. Walter Reservoir at all stations and depths ranged from 3.0 mg/L to 11.0 mg/L. The highest single measured concentration of 11.0 mg/L was in the tributary surface water station WA-4S on 11 October.

3.2.12 Chlorophyll *a*

Chlorophyll a is the measure of the plant chlorophyll a primary pigment which helps plants get energy from light. It is found in most plants, algae, and cyanobacteria. Chlorophyll a measures increase in relation to algal densities in a water body. For the most part, chlorophyll *a* was low in the waters of F.E. Walter Reservoir during 2007 (Appendix A). Concentrations at all stations and depths had a value range of 0.0 ug/L to 10.3 ug/L throughout the monitoring season. The highest single surface water concentration of 10.3 ug/L was measured at station WA-2 on 11 October. The lowest single measured concentration of 1.1 ug/L was taken at station WA-2 on 29 June.

3.3 TROPHIC STATE DETERMINATION

Carlson's (1977) trophic state index (TSI) is a method of expressing the extent of eutrophication of a lake, quantitatively. The trophic state analysis calculates separate indices for eutrophication based on measures of total phosphorus, chlorophyll *a*, and secchi disc depth. Index values for each parameter range on the same scale from 0 (least enriched) to 100 (most enriched). The resulting indices can also be compared to qualitative threshold values that correspond to levels of eutrophication. Classification of F.E. Walter Reservoir was based on a single sample each month during the sampling season. It is important to note that variability in measurements not captured between sampling events and the resulting classification can occur. Figure 3-9 graphically shows this potential variability between samples.

TSIs calculated for measures of Total Phosphorus classified F.E. Walter Reservoir as oligotrophic in May, June, July, October, and November with TSI values of 32.2, 32.2, 37.4, 39.9, and 37.4 respectively. TSIs calculated for measures of secchi disk depth classified F.E. Walter Reservoir as mesotrophic throughout the sampling season with values ranging from 40.2 to 48. TSIs calculated for measures of chlorophyll *a* classified F.E. Walter Reservoir as oligotrophic in May (34), eutrophic in October (53), and mesotrophic in November (43.8).

Carlson (1977) warned against averaging TSI values estimated for different parameters, and instead suggested giving priority to chlorophyll a during the summer and to phosphorus in the spring, fall, and winter. With this in mind, and based on the pattern of TSI values for secchi disk depth, chlorophyll a and Total Phosphorus, F.E. Walter Reservoir was mesotrophic during summer and oligotrophic in spring and fall of 2007.

The EPA (1983) also provides criteria for classifying the trophic conditions of lakes of the North Temperate Zone based on concentrations of total phosphorus, chlorophyll *a*, and secchi disk depth (Table 3-3). Taking into account the general agreement between the EPA classifications with that of the TSIs, the trophic condition of F.E. Walter Reservoir was mesotrophic during summer and early fall and oligotrophic in spring and late fall of 2007.

Table 3-3. EPA trophic classification criteria and average monthly measures for F.E. Walter Reservoir in 2007

Water Quality Variable	Oligo-trophic	Meso-trophic	Eutrophic	24 May	21 June	19 July	11 Oct.	06 Nov.
Total phos. (ppb)	<10	10-20	>20	7	7	10	12	7
Chlorophyll a (ppb)	<4	4-10	>10	1.70	Error	Error	9.83	3.87
Secchi depth (m)	>4	2-4	<2	3.95	2.75	3.45	2.70	2.30
NM = not measured								

3.4 RESERVOIR BACTERIA MONITORING

Three forms of coliform bacteria contamination were monitored in the tributary and lake surface waters at F.E. Walter Reservoir during 2007 including total and fecal coliform (Table 3-4). Total coliform includes *Escherica coli* (*E. coli*) and related bacteria that are associated with fecal discharges. Fecal coliform bacteria are a subgroup of the total coliform and are normally associated with waste derived from human and other warm-blooded animals. Total coliform contamination was high at F.E. Walter Reservoir during 2007. Total coliform measures ranged from 26-clns/100-ml to greater than the detection limit of 2400 clns/100-ml. Fecal coliform contamination at F.E. Walter Reservoir during 2007 ranged from less than the detection limit of 1-clns/100-ml to 530-clns/100-ml throughout the monitoring period. Coliform bacteria levels were low at F.E. Walter Reservoir with respect to PADEP water quality standards throughout the monitoring period. For waters with contact recreation, the water quality standard for bacteria contamination is a geometric mean of less than 200 colonies/100-ml. At no point did the geometric means approach the PADEP water contact recreation standard. Water contact recreation is not permitted at F.E. Walter Reservoir.

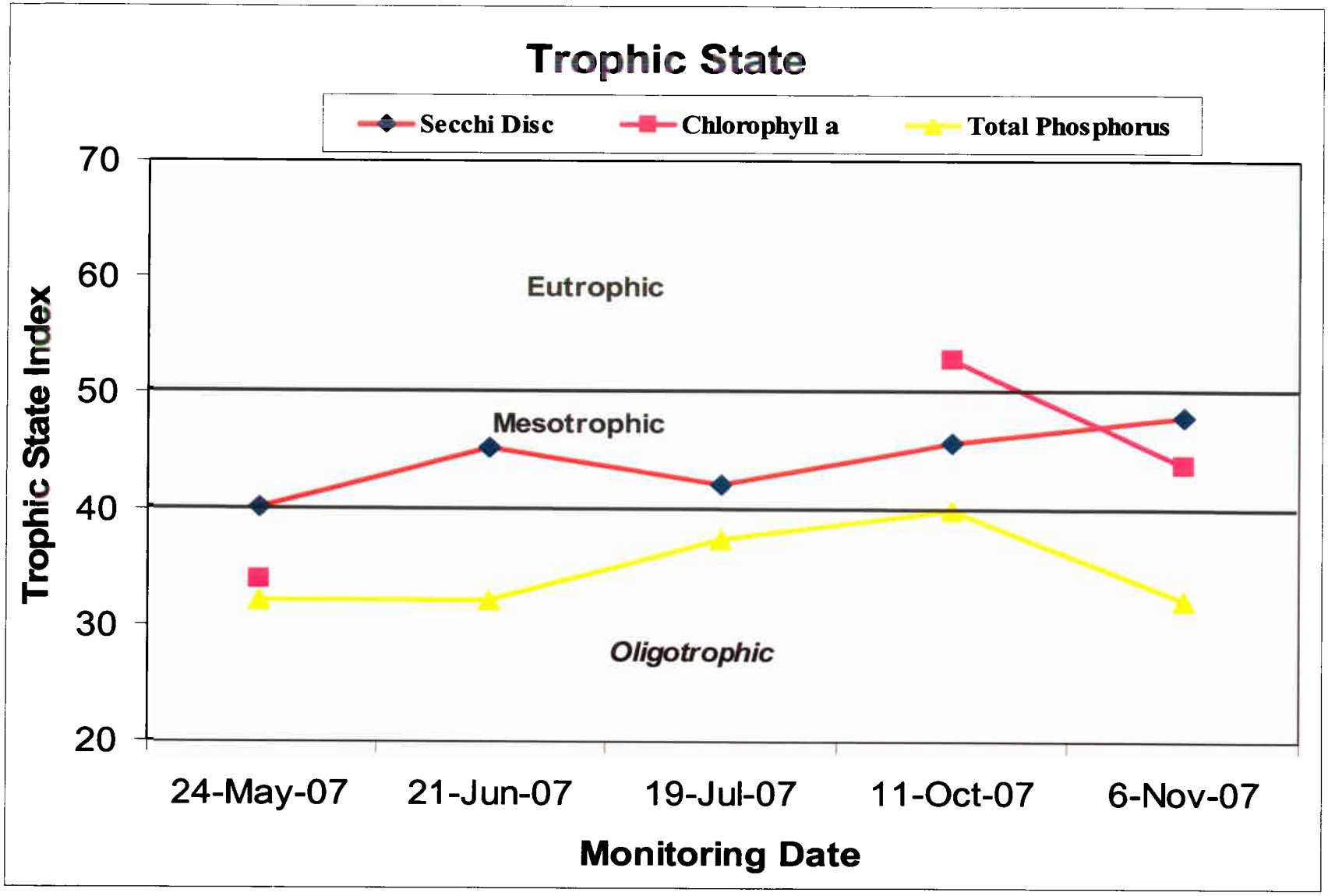

Figure 3-7. Carlson Trophic state indices calculated from secchi disk depth, concentrations of chlorophyll a and Total Phosphorus measured in surface waters of F.E. Walter Reservoir at Station WA-2 during 2007

Table 3-4. Bacteria counts (colonies/100 ml) at Walter Reservoir during 2007.

STATION	DATE	Total Coliform		Fecal Coliform		Escherichia coli	
WA-1S	24-May		410	<	2		1
	21-Jun		1,200		22		14
	19-Jul		690	<	1	<	1
	11-Oct	>	2,400		160		150
	6-Nov		1,000		18		11
WA-2S	24-May		40		2		
	21-Jun		690	<	1	<	1
	19-Jul	>	2,400		26		24
	11-Oct		770		8		8
	6-Nov		870		18		14
WA-3S	24-May	>	2,400		2		2
	21-Jun	>	2,400		34		29
	19-Jul						
	11-Oct	>	2,400		500		490
	6-Nov		2,000		20		16
WA-4S	24-May	>	2,400		12		10
	21-Jun	>	2,400		51		42
	19-Jul	>	2,400		67		60
	11-Oct	>	2,400		530		520
	6-Nov		1,300		18		18
WA-5S	24-May		2,400		4		3
	21-Jun	>	2,400	>	60		20
	19-Jul		2,000		43		44
	11-Oct	>	2,400		290		210
	6-Nov		980		10		10
WA-6S	24-May		26	<	2		
	21-Jun		1,200	<	1	<	1
	19-Jul		190	<	1	<	1
	11-Oct		1,300		52		35
	6-Nov		920		12		12
WA-7S	24-May		27	<	2		
	21-Jun		920	<	1	<	1
	19-Jul		360	<	1	<	1
	11-Oct		1,200		46		44
	6-Nov		1,100		18		10

3.5 TEMPERATURE PROBE MONITORING

In-situ TidbiT™ temperature probes were deployed at five Lehigh River monitoring stations to continuously record surface water temperatures in ½ hour increments over the sampling period from May through October 2007. Station WA1 (LH-2) was located just downstream of the F. E. Walter dam outfall (Fig. 3-8). Station LH-3 was located at Tannery Bridge near White Haven, PA (Fig. 3-9). Station LH-10 was located near the Lehighton water intake structure in Lehighton, PA (Fig. 3-10). Station LH-15 was located near the Walnutport USGS gauging station in Walnutport, PA (Fig. 3-11). Station LH-18 was established in 2007 on the Lehigh River near Catasauqua, PA just upstream of the confluence with the Hockendauqua Creek (Fig. 3-12).

The Commonwealth of Pennsylvania provides water temperature standards that are based on a particular water body's protected use (Pennsylvania Code, Title 25, Chapter 93 2001). Stations LH-2 and LH-3 are classified as a High Quality-Cold Water Fishes (HQ-CWF) by PADEP. Pennsylvania Department of Environmental Protection defines Cold Water Fishes as the *"maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a coldwater habitat"*. The maximum temperature criterion for this reach of the Lehigh River is 66 degrees Fahrenheit (18.87 degrees Celsius) from 01 July through 30 August. From early July through August of 2007, the temperatures recorded in this section (LH-2 and LH-3) of the river routinely exceeded the HQ-CWF criterion. The maximum temperatures recorded during the monitoring period were 72.34 °F (22.41 °C) at LH-2 and 79.74 °F (°C 26.52) at LH-3.

Stations LH-10, LH-15, and LH-18 are with a section of the river classified a Trout Stocking Fishery (TSF). Pennsylvania Department of Environmental Protection defines Trout Stocking as the *"maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat"*. The maximum temperature criterion for this reach of the Lehigh River varies during the season from 70 °F (21.1 °C) from 01 June through 15 June; 72 °F (22.2 °C) from 16 June through 30 June; 74 °F (23.3 °C) from 01 July through 31 July; 80 °F (26.6 °C) from 01 August through 15 August; and 87 °F (30.5 °C) from 16 August through 30 August. Except for the time period between mid and late August at each station, stations LH-10, LH-15, and LH-18 routinely exceeded the TSF criterion in 2007. The maximum temperature recorded during the monitoring period at LH-10, LH-15, and LH-18 was 81.45 °F (27.44 °C), 84.31 °F (29.03 °C) and 86.18 °F (30.10 °C), respectively.

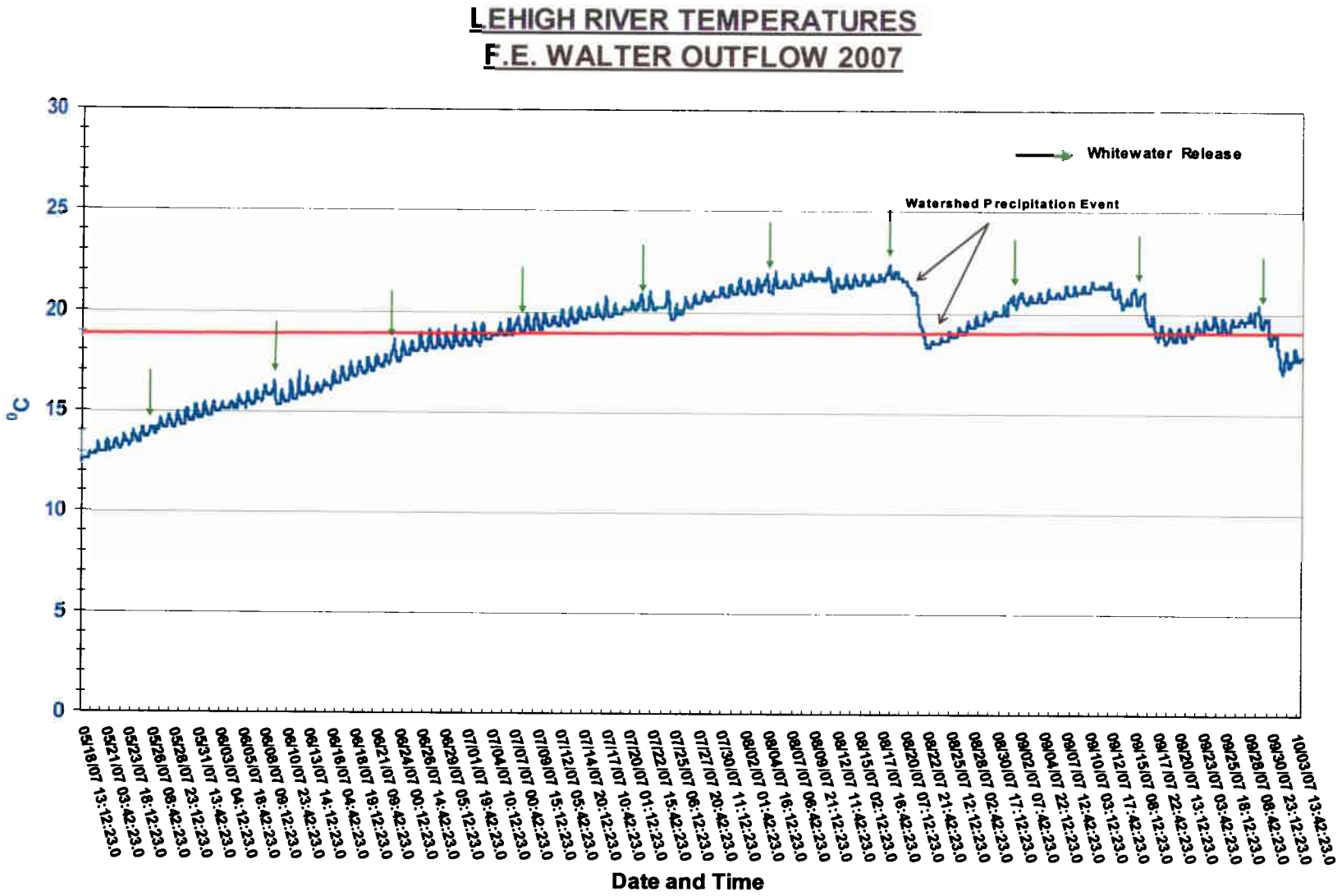

Figure 3-8. In-situ temperature measured in surface waters of Lehigh River immediately downstream of F.E. Walter Reservoir (LH_2) during 2007.

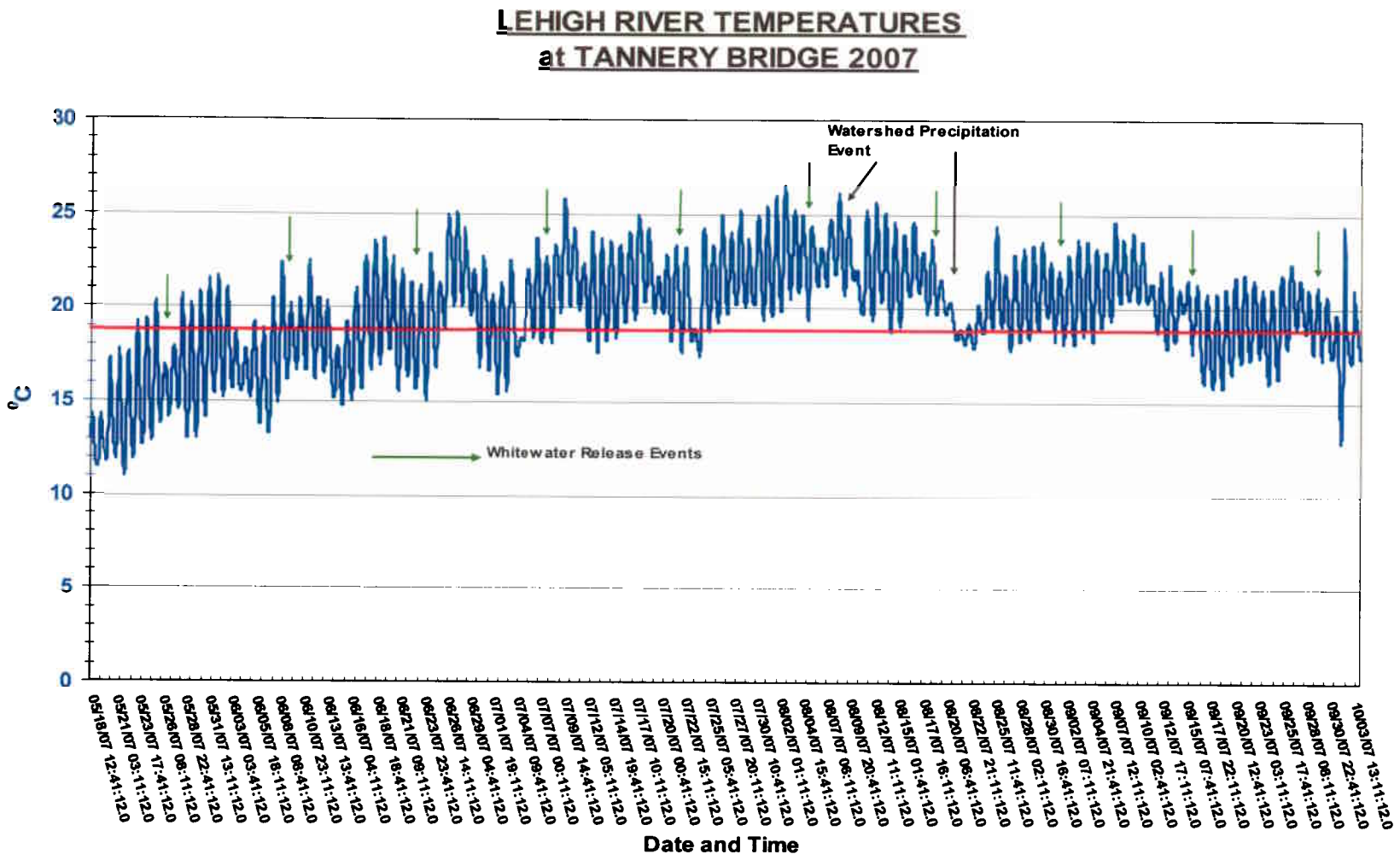

Figure 3-9. In-situ temperature measured in surface waters of Lehigh River at Tannery Bridge (LH-3) near White Haven, PA during 2007.

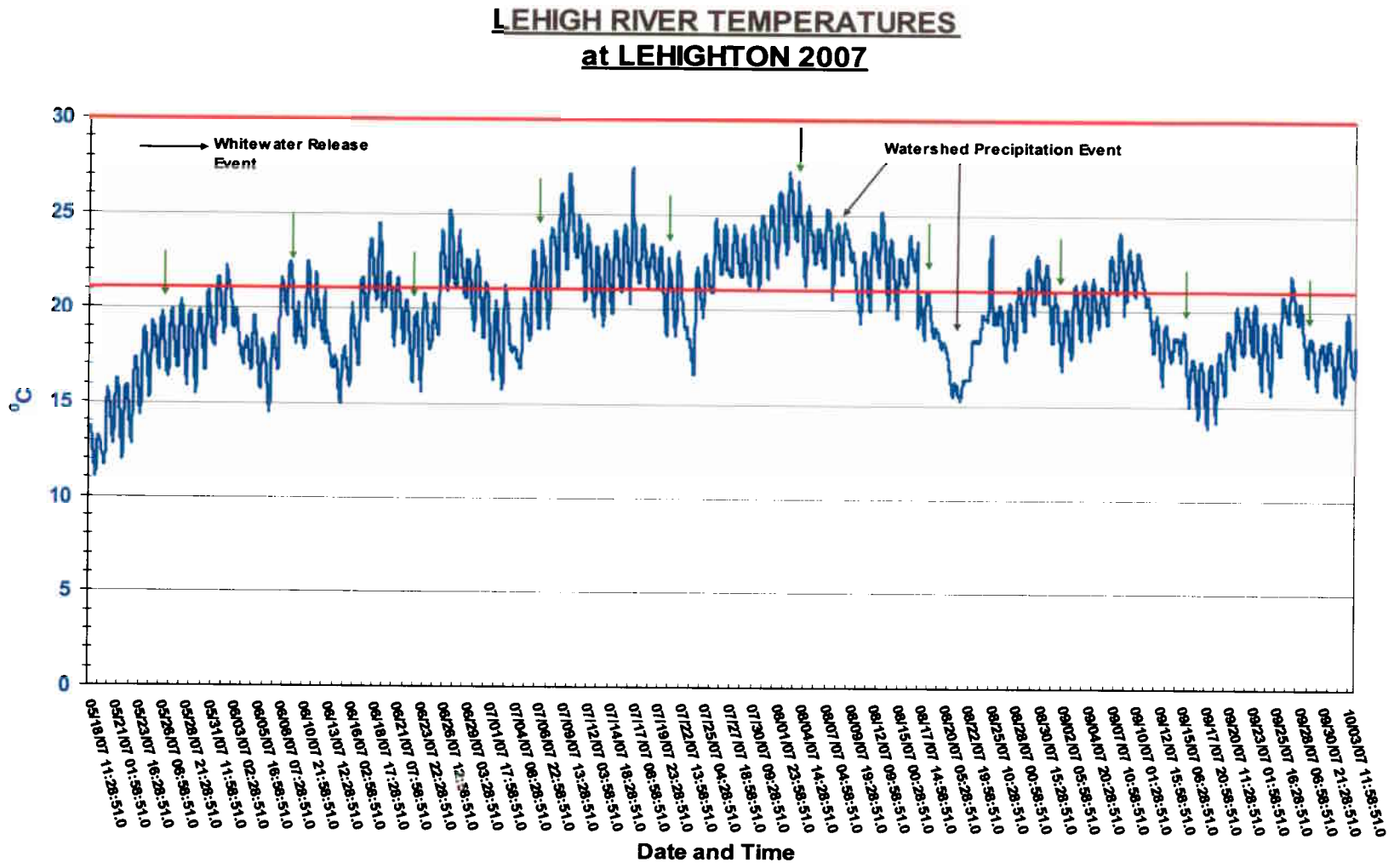

Figure 3-10. In-situ temperature measured in surface waters of Lehigh River near Lehighton (LH-10), PA during 2007.

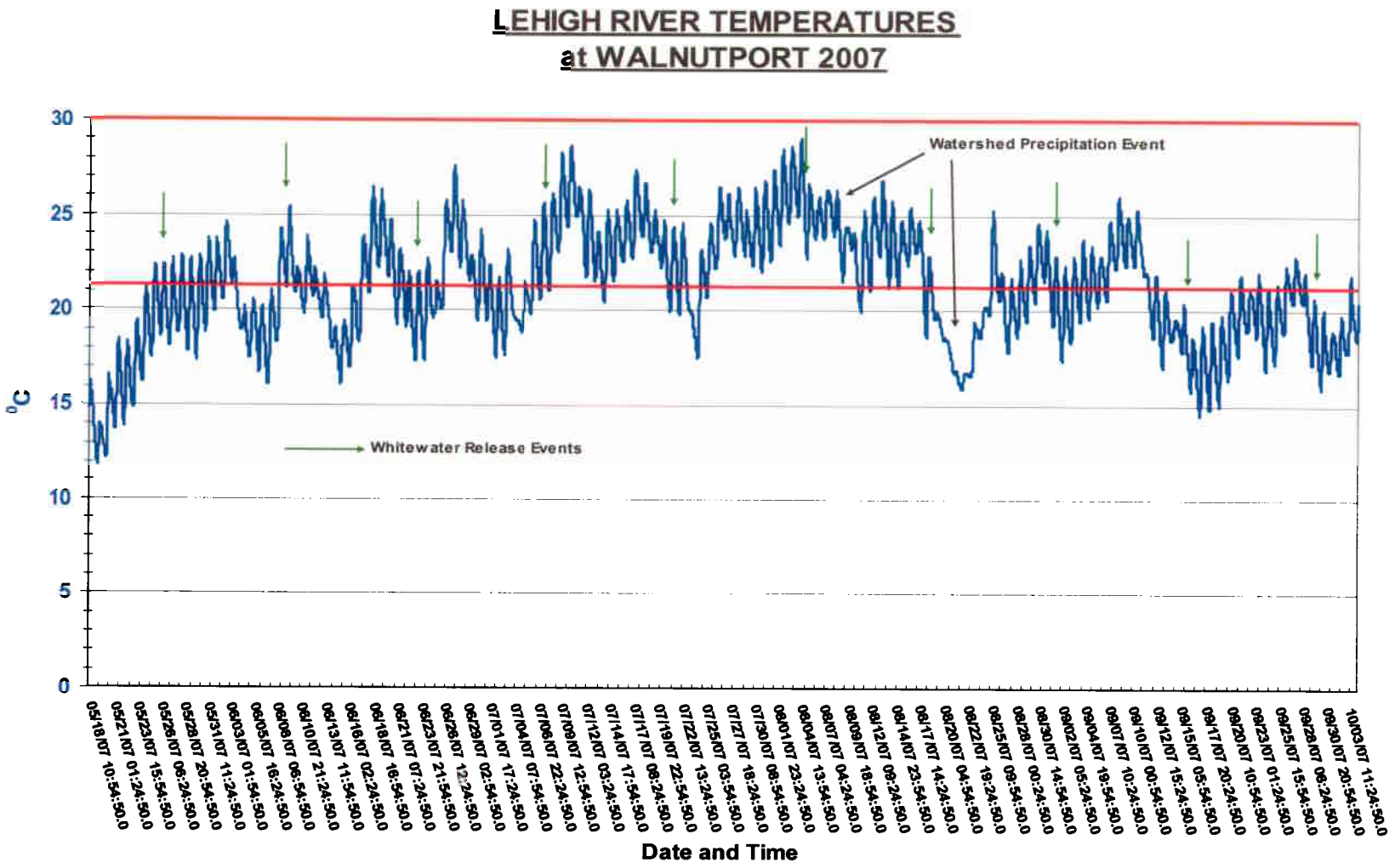

Figure 3-11. In-situ temperature measured in surface waters of Lehigh River near Walnutport (LH-15), PA during 2007.

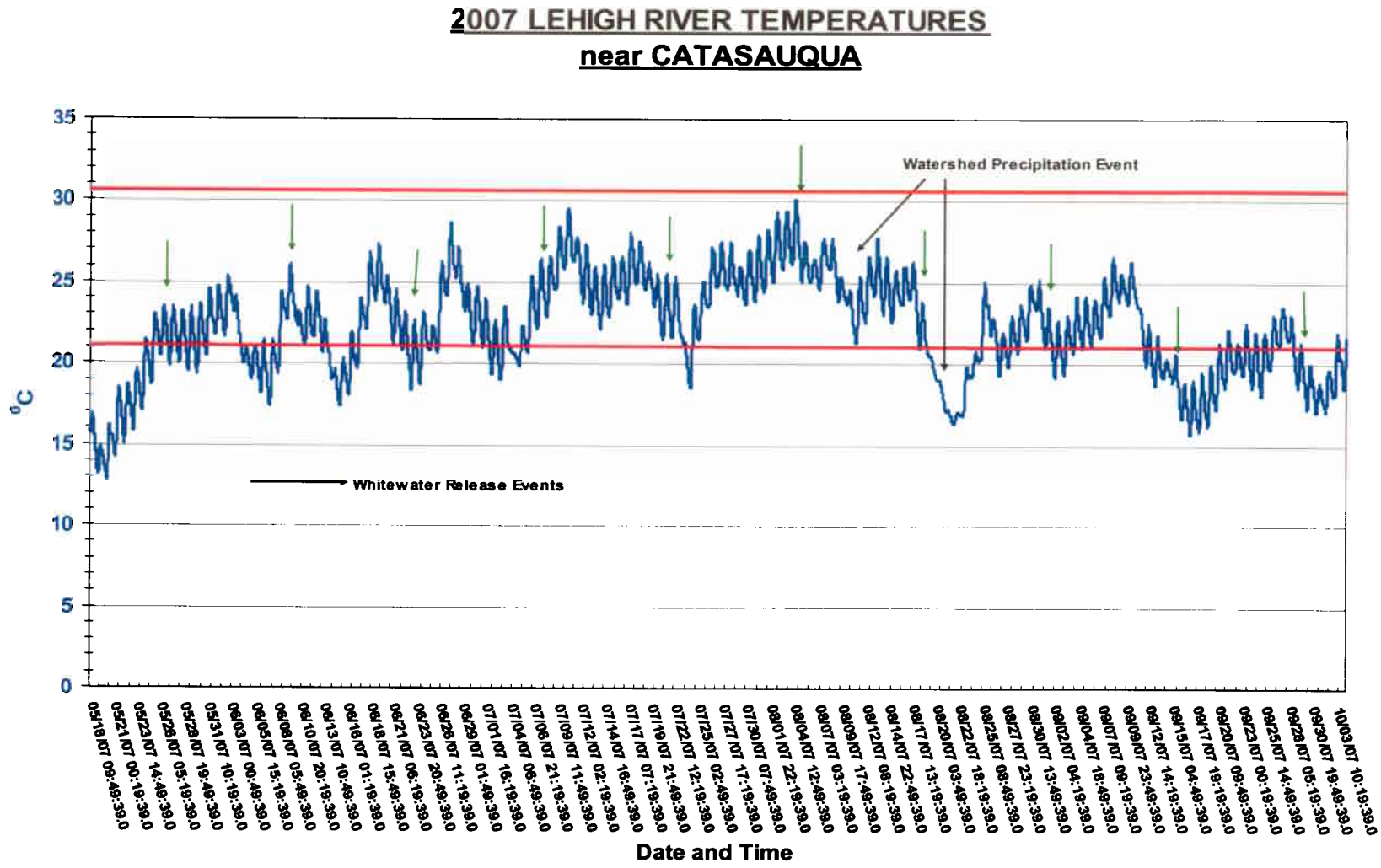

Figure 3-12. In-situ temperature measured in surface waters of Lehigh River near Catasauqua, PA during 2007.

4.0 REFERENCES

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APPENDIX A

STRATIFICATION DATA TABLES

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
	5/24/2007	14:45:49	0	13.99	104.7	10.79	0.073	6.31	6.2	1.6
	6/7/2007	9:06:08	0	15.61	99	9.85	0.073	6.71	4.1	1
WA-1	6/14/2007	9:00:10	0	16.03	97.7	9.64	0.075	6.26	5.8	1.3
Outfall	6/21/2007	12:10:07	0	17.72	105.1	10.01	0.078	6.2	8	1
	6/29/2007	10:45:49	0	18.61	98.3	9.19	0.083	6.28	5.9	**42.8**
	7/12/2007	12:51:19	0	20.01	95.2	8.65	0.087	6.13	5.5	**380.4**
	7/19/2007	12:31:27	0	20.08	94.6	8.58	0.082	6.1	**0.1**	**-1.1**
	8/3/2007	10:27:42	0	21.49	108.9	9.62	0.084	6.53	**0**	**0**
	10/11/2007	13:06:17	0	18.89	88.3	8.21	0.088	6.5	16	3.7
	11/6/2007	11:40:55	0	7.6	98	11.71	0.059	6.27	7.1	2.8
		11:05:00	0	13.9	106.8	11.03	0.067	6.4	**-0.4**	2.2
		11:04:17	5	13.81	106.5	11.02	0.067	6.42	**-0.4**	3.2
		11:02:48	10	13.56	105.8	11	0.067	6.37	**-0.3**	3.1
		11:01:25	15	13.33	104.6	10.94	0.067	6.32	**-0.4**	3.8
		11:00:30	20	13.27	103	10.79	0.067	6.15	**-0.3**	3
		10:59:37	25	12.07	101	10.87	0.066	6.13	**-0.2**	2.8
		10:58:52	30	11.83	100.5	10.87	0.066	6.11	**-0.2**	2.2
WA-2		10:57:44	35	11.71	100.3	10.88	0.066	6.07	**-0.2**	2.9
		10:56:58	40	11.66	99.9	10.86	0.066	6.07	**-0.2**	2.9
Lake		10:56:16	45	11.6	99.8	10.85	0.066	6.04	**-0.1**	2
Tower	5/4/2007	10:55:39	50	11.48	99.3	10.83	0.066	5.99	**-0.2**	2.1
		10:55:11	55	11.45	99.1	10.82	0.066	5.97	**-0.2**	2.7
		10:54:14	60	11.34	98.1	10.74	0.067	5.95	**-0.2**	2.8
		10:53:54	65	11.19	98	10.76	0.066	5.96	**-0.2**	3
		10:52:46	70	11.18	97.7	10.73	0.066	5.89	**-0.2**	2.4
		10:51:45	75	11.12	97	10.66	0.067	5.92	**-0.2**	2.3
		10:51:15	80	10.97	97.2	10.72	0.068	5.88	**-0.2**	2.6
		10:49:05	85	11	96.1	10.6	0.065	5.86	**-0.1**	2.4
		10:48:05	90	10.92	95.2	10.52	0.069	5.89	**-0.2**	2.5
		10:47:16	95	10.91	95	10.49	0.067	5.87	**-0.2**	2.4
		10:46:06	100	10.9	94.9	10.49	0.068	5.86	**-0.2**	2.3
		10:44:48	105	11.27	94.7	10.38	0.065	5.78	**-0.2**	2.3
		10:41:48	110	10.5	94.7	10.38	0.065	5.78	**-0.2**	2.3
		10:38:54	115	9.59	71.9	8.2	0.068	5.59	**18**	1
		12:50:06	0	18.8	99.2	9.24	0.072	6.49	0.4	1.4
		12:48:58	5	18.1	97.9	9.25	0.072	6.43	0.3	1.4
		12:48:09	10	17.61	96.5	9.21	0.072	6.38	-0.1	2.3
		12:47:12	15	17.35	94.7	9.08	0.072	6.3	0.2	1.3
WA-2		12:46:09	20	16.23	90	8.84	0.07	6.25	0.7	1.5
	5/24/2007	12:45:18	25	16.04	88.6	8.74	0.071	6.24	0.3	1.3
Lake		12:44:22	30	15.63	87.4	8.69	0.072	6.22	0	1.5
Tower		12:43:21	35	15.19	87.4	8.77	0.074	6.19	0	2.1
Secchi		12:42:27	40	15.07	87.7	8.83	0.073	6.18	0.4	1.3
3.95 M		12:41:16	45	14.65	86.8	8.81	0.074	6.15	0.2	1.5
		12:39:36	50	14.37	87.1	8.9	0.07	6.13	0.4	1.2
		12:38:40	55	14.26	87.2	8.93	0.075	6.12	0.5	1.8
		12:37:54	60	14.09	87	8.95	0.074	6.08	0.3	1.7

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
		12:37:08	65	13.83	86.5	8.95	0.074	6.06	0.5	1.8
		12:36:10	70	13.72	85.2	8.83	0.074	6.05	0.6	1.6
		12:34:26	75	13.53	85.7	8.92	0.07	6	0.9	2.2
		12:33:20	80	13.46	85	8.87	0.071	6	0.8	1.3
	5/24/2007	12:31:59	85	13.42	85	8.87	0.072	5.98	1.2	1.7
	Cont.	12:29:57	90	13.38	83.8	8.76	0.073	5.84	1.7	1
		12:28:18	95	13.14	81.6	8.58	0.072	5.76	1.5	1.7
		12:26:44	100	12.85	73.5	7.77	0.073	5.68	3.6	1.5
		12:24:53	105	12.69	70	7.43	0.073	5.62	6.1	1.6
		12:23:20	110	12.53	58.9	6.27	0.073	5.59	**23.3**	1.9
		12:22:18	115	12.44	55.4	5.91	0.073	5.64	**51.7**	1.8
		10:29:21	0	21.66	92.1	8.11	0.077	6.69	1.4	1.6
		10:27:06	5	21.24	91.3	8.1	0.077	6.66	1.6	1.7
		10:25:53	10	21.17	90.5	8.04	0.077	6.62	1.5	1.8
		10:24:49	15	21.14	89.5	7.96	0.077	6.56	1.4	1.6
		10:23:30	20	19.68	80.4	7.36	0.081	6.44	0.9	-0.4
		10:21:23	25	19.21	79.4	7.33	0.082	6.41	1.4	1.5
WA-2		10:20:03	30	18.4	83.3	7.82	0.075	6.27	0.7	1.7
		10:18:58	35	17.53	83.1	7.95	0.073	6.25	0.4	1.3
Lake		10:17:00	40	16.96	82.1	7.94	0.072	6.22	0.6	1.5
Tower		10:15:49	45	16.69	80.6	7.84	0.073	6.22	0.4	1.4
	6/7/2007	10:14:20	50	16.37	81.7	8	0.072	6.22	0.4	0.9
		10:12:44	55	16.18	80	7.87	0.072	6.17	0.2	1
		10:11:21	60	16	77.3	7.62	0.072	6.1	0.4	1.5
		10:09:49	65	15.8	72.8	7.22	0.072	6.04	0.7	1.1
		10:08:43	70	15.62	72	7.17	0.073	6.05	0.7	1.3
		10:06:54	75	15.35	69.1	6.92	0.074	6	1.4	1
		10:05:19	80	15.21	65.7	6.6	0.074	5.94	1.9	1.1
		10:04:10	85	15.03	62.5	6.29	0.076	5.9	2.5	0.8
		10:01:18	90	14.86	61.2	6.19	0.076	5.79	3.1	1.2
		10:00:16	95	14.8	60.4	6.11	0.076	5.76	3.8	0.9
		9:59:02	100	14.61	56.7	5.76	0.076	5.76	6.7	1.4
		9:57:34	105	14.42	50.7	5.18	0.076	5.81	**16.2**	1.1
		9:54:34	110	14.21	33.4	3.42	0.078	6.38	**175.2**	**3.8**
		10:11:22	0	22.96	97	8.33	0.078	6.87	1	1.9
		10:10:14	5	22.98	97	8.32	0.078	6.83	1.3	2
		10:09:30	10	22.98	96.5	8.28	0.078	6.78	1.3	2.2
WA-2		10:08:19	15	22.72	90.9	7.84	0.078	6.62	1.6	1.3
Lake		10:06:37	20	20.92	81.1	7.24	0.078	6.45	1	1.8
Tower	6/14/2007	10:05:28	25	20.1	77.7	7.05	0.08	6.39	1.2	1.2
		10:04:15	30	19.6	76.2	6.98	0.08	6.35	1	1.8
		10:03:06	35	18.96	77.2	7.17	0.078	6.33	0.8	1
		10:01:33	40	18.51	78.1	7.32	0.078	6.31	0.4	1.6
		9:59:59	45	17.95	78.7	7.46	0.077	6.24	0.6	1.3
		9:59:11	50	17.6	76.9	7.34	0.075	6.21	0.5	0.9
		9:58:10	55	17.22	78.2	7.52	0.074	6.2	0.2	1.5
		9:56:59	60	17.03	78.4	7.57	0.073	6.16	0.2	1.4

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
		9:55:28	65	16.8	74.8	7.25	0.073	6.08	0.4	1.3
		9:54:16	70	16.59	74.6	7.27	0.073	6.08	0.7	1.2
		9:52:38	75	16.47	73.1	7.14	0.073	6.06	0.9	1.4
		9:51:33	80	16.39	73.6	7.2	0.073	6.08	0.7	-0.2
	6/14/2007	9:50:04	85	16.27	69.4	6.81	0.073	6.04	1.6	1.8
	Cont.	9:48:45	90	16.17	68.4	6.73	0.074	6.01	1.6	0.8
		9:47:04	95	16.05	62.3	6.14	0.076	5.83	2.1	0.8
		9:44:29	100	15.76	54	5.36	0.077	5.71	6.6	0.7
		9:43:16	105	15.68	51.1	5.07	0.077	5.73	6.2	1.1
		9:41:44	110	15.44	41.9	4.18	0.077	5.78	**27.4**	1.4
		13:36:41	0	24.05	110.6	9.3	0.079	6.88	1.1	**104.4**
		13:35:38	5	23.68	109	9.23	0.079	6.75	1.3	**37.5**
		13:34:28	10	23.22	102.1	8.72	0.079	6.54	1.6	**-1**
		13:33:15	15	21.76	85.3	7.49	0.081	6.37	1.5	**65**
		13:31:17	20	21.16	79.7	7.08	0.083	6.31	1	**87.9**
		13:29:49	25	20.82	77.7	6.95	0.082	6.27	1	**36.3**
		13:28:32	30	20.3	75.5	6.82	0.081	6.21	0.8	**49.3**
		13:27:14	35	19.59	76.8	7.04	0.083	6.22	0.6	**93.7**
		13:25:58	40	19.3	76	7	0.082	6.2	0.7	**122.2**
WA-2		13:24:17	45	18.99	75	6.95	0.082	6.16	0.8	**21.6**
	6/21/2007	13:23:28	50	18.64	76	7.1	0.082	6.15	0.7	**75.2**
Lake		13:22:04	55	18.44	78.3	7.35	0.079	6.11	0.5	**42.6**
Tower		13:20:45	60	18.23	74.6	7.03	0.081	6.11	0.6	**102.1**
		13:18:46	65	18.03	75.6	7.15	0.079	6.06	0.6	**40.3**
Secchi		13:17:06	70	17.75	71.1	6.76	0.076	5.95	1	**0.6**
2.75 M		13:16:03	75	17.66	68.5	6.53	0.077	5.94	2.3	**74.1**
		13:13:09	80	17.55	72.7	6.95	0.077	5.9	2.7	**3.6**
		13:10:59	85	17.47	76.2	7.29	0.078	5.93	1.1	**0.8**
		13:09:37	90	17.34	70.4	6.76	0.078	5.87	2.1	**-1.9**
		13:08:20	95	17.1	68.1	6.57	0.079	5.93	2.3	**10.3**
		13:07:03	100	16.82	58.7	5.69	0.08	5.94	6.4	**4.6**
		13:06:12	105	16.6	51.7	5.04	0.081	5.94	**13.7**	**19.9**
		13:04:49	110	16.56	48.8	4.76	0.081	6.01	**19.8**	**2.8**
		9:51:54	0	24.7	108.9	9.04	0.082	7.04	0.9	1.1
		9:50:29	5	24.71	108.1	8.98	0.082	6.98	1.3	0
		9:49:08	10	24.49	104.3	8.7	0.081	6.81	1.8	0.7
		9:48:12	15	22.49	94.1	8.15	0.08	6.54	1.1	0.2
		9:46:50	20	21.77	79.9	7.02	0.08	6.28	0.9	-0.1
WA-2		9:45:42	25	21.03	69	6.15	0.082	6.19	0.6	0.3
	6/29/2007	9:44:31	30	20.59	67.8	6.09	0.083	6.21	0.4	0.3
Lake		9:43:06	35	20.42	67.9	6.12	0.084	6.21	0.8	0.4
Tower		9:42:26	40	20.04	66.9	6.07	0.083	6.23	0.4	0
		9:41:07	45	19.77	65.9	6.01	0.084	6.16	0.3	2.3
		9:39:12	50	19.54	66	6.06	0.083	6.12	0.8	1.3
		9:38:05	55	19.33	65.9	6.07	0.083	6.09	0.4	0.3
		9:37:04	60	19.06	65.3	6.05	0.083	6.12	0.2	1.9
		9:35:34	65	18.84	63.8	5.94	0.084	6.11	0.7	1.3

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
		9:33:17	70	18.67	61.1	5.71	0.083	6.06	0.9	0.9
		9:31:47	75	18.47	57.3	5.37	0.082	6.02	1.6	1.1
WA-2		9:29:37	80	18.41	59	5.54	0.083	6.06	1.6	0.5
		9:28:19	85	18.37	56.9	5.34	0.083	6.03	2.5	-0.4
Lake	6/29/2007	9:26:55	90	18.35	56.4	5.3	0.084	6.02	2.3	0.6
Tower	Cont.	9:25:37	95	18.32	56.4	5.3	0.084	6.02	2.9	1.8
		9:24:19	100	18.17	56.2	5.3	0.084	6	3.8	2.2
		9:22:34	105	17.93	45.6	4.32	0.084	5.77	8.5	2.8
		9:21:24	110	17.7	33.7	3.21	0.086	5.75	**25.3**	1.2
		12:07:37	0	25.14	101.6	8.37	0.084	7.17	1.1	**-1.4**
		12:06:04	5	24.84	100.6	8.34	0.084	7.09	1.4	**-2.9**
		12:04:31	10	24.7	98.5	8.18	0.084	6.91	1.1	**-2.5**
		12:03:25	15	23.13	89.1	7.62	0.082	6.49	1.4	**-2.5**
		12:00:28	20	21.98	73.1	6.39	0.082	6.22	0.9	**6.7**
		11:59:19	25	21.44	56.8	5.02	0.083	6	0.5	**2.6**
		11:58:25	30	21.17	53.5	4.75	0.083	5.99	1.3	**-0.5**
		11:57:06	35	20.95	52	4.64	0.084	5.96	0.5	**-1**
WA-2		11:55:35	40	20.74	51.3	4.6	0.083	5.92	-0.2	**2.2**
Lake	7/12/2007	11:53:43	45	20.56	50.9	4.57	0.084	5.92	0.5	**-1.4**
Tower		11:52:14	50	20.36	49.6	4.48	0.084	5.84	0.2	**-3.3**
		11:51:19	55	20.16	48.4	4.38	0.084	5.81	0.8	**-1.3**
		11:49:41	60	20.04	46.5	4.23	0.083	5.78	0.5	**-3.1**
		11:48:14	65	19.93	45.4	4.14	0.082	5.75	1.3	**-3**
		11:47:01	70	19.86	42.4	3.86	0.084	5.75	1.6	**-2.9**
		11:45:31	75	19.73	42.5	3.88	0.084	5.69	1.8	**-3.1**
		11:43:35	80	19.57	44	4.03	0.085	5.61	2.1	**-2.3**
		11:42:30	85	19.4	41.8	3.84	0.087	5.61	4.8	**-2.7**
		11:41:19	90	19.33	39.8	3.67	0.087	5.31	3.5	**-2.4**
		11:40:21	95	19.26	38.5	3.55	0.088	5.32	4.4	**-2.7**
		11:39:29	100	19.21	34.3	3.17	0.088	5.41	6.3	**-3.2**
		11:38:23	105	18.95	24.3	2.26	0.089	5.64	**16.1**	**-3.1**
		10:49:25	0	24.79	97.6	8.1	0.08	6.96	**-6.2**	**0.1**
		10:48:22	5	24.77	96.3	7.99	0.08	6.89	**-7.7**	**-1.9**
		10:47:26	10	24.76	94.8	7.87	0.08	6.75	**-8**	**-0.3**
		10:46:28	15	23.57	86	7.3	0.079	6.43	**-4.4**	**-1.6**
WA-2		10:45:35	20	22.33	66.8	5.81	0.078	6.17	**-5.9**	**-0.5**
		10:44:35	25	21.8	61.3	5.38	0.078	6.12	**384.7**	**-47.8**
Lake		10:43:13	30	21.63	55.9	4.93	0.078	6.07	**72.1**	**-83.7**
Tower		10:42:05	35	21.4	51.2	4.53	0.079	6	**606.2**	**-99.9**
		10:40:49	40	21.1	48.2	4.29	0.08	5.94	**115.8**	**-99.9**
Secchi	7/19/2007	10:39:54	45	20.85	47	4.2	0.08	5.91	**1512.3**	**-99.9**
3.45 M		10:39:16	50	20.73	46.5	4.17	0.081	5.93	**502**	**-99.9**
		10:37:48	55	20.51	43.5	3.91	0.08	5.86	**-8.6**	**-93.1**
		10:36:40	60	20.37	40.9	3.69	0.08	5.82	**-8.9**	**-12.6**
		10:35:13	65	20.3	39.2	3.54	0.08	5.82	**-2**	**-33.9**
		10:34:26	70	20.21	39.7	3.6	0.08	5.81	**-9.1**	**-39.7**
		10:32:11	75	20.08	35.7	3.24	0.081	5.81	**-8.7**	**-11.7**

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
		10:31:06	80	19.96	35	3.19	0.081	5.83	**8.8**	**-2.6**
		10:29:44	85	19.82	25.5	2.33	0.083	5.78	**350.6**	**-17**
	7/19/2007	10:28:37	90	19.78	25.1	2.29	0.083	5.75	**25.8**	**-9.7**
	Cont.	10:26:53	95	19.75	22.2	2.03	0.084	5.67	**23.3**	**-6.7**
		10:25:34	100	19.62	19.2	1.76	0.084	5.63	**29.9**	**-5.9**
		10:23:26	105	19.26	7.2	0.66	0.09	5.88	**41.3**	**-66.4**
		9:49:41	0	26.15	103.6	8.38	0.082	7.13	x	x
		9:48:26	5	25.71	101.9	8.31	0.083	7.05	x	x
		9:47:25	10	25.43	100.1	8.2	0.082	6.84	x	x
		9:46:15	15	23.67	80.6	6.83	0.081	6.38	x	x
		9:44:55	20	22.88	64.7	5.56	0.081	6.17	x	x
		9:43:48	25	22.49	54.8	4.75	0.081	6.12	x	x
		9:42:49	30	22.27	54.2	4.72	0.082	6.11	x	x
WA-2		9:41:39	35	22.02	49.4	4.32	0.082	6.04	x	x
		9:40:31	40	21.84	46.9	4.11	0.082	5.97	x	x
Lake		9:39:25	45	21.72	44.2	3.88	0.08	5.93	x	x
Tower	8/3/2007	9:38:28	50	21.61	43.9	3.87	0.081	5.89	x	x
		9:37:26	55	21.52	43.7	3.86	0.082	5.86	x	x
		9:36:29	60	21.44	42.9	3.79	0.08	5.88	x	x
		9:35:22	65	21.36	43.1	3.82	0.082	5.83	x	x
		9:34:28	70	21.28	44.2	3.92	0.083	5.85	x	x
		9:33:25	75	21.21	43.3	3.84	0.083	5.86	x	x
		9:32:13	80	21.12	46.6	4.15	0.083	5.9	x	x
		9:31:07	85	21.1	46.4	4.13	0.085	5.89	x	x
		9:30:20	90	21.06	45.5	4.05	0.085	5.9	x	x
		9:29:06	95	20.81	42.3	3.79	0.085	5.89	x	x
		9:25:25	100	20.75	38.5	3.45	0.086	5.85	x	x
		9:24:01	105	20.56	31.4	2.82	0.086	5.8	x	x
		11:23:51	0	20.32	94.6	8.55	0.084	6.84	5.4	10.3
		11:23:06	5	20.32	93.9	8.49	0.084	6.83	5.5	9.3
WA-2		11:21:40	10	20.31	93.1	8.41	0.084	6.74	5.5	9.9
		11:20:24	15	20.24	87.3	7.9	0.085	6.61	5.8	10.1
Lake		11:19:17	20	19.46	68.4	6.28	0.087	6.45	8.1	3.2
Tower	10/11/2007	11:18:02	25	19.11	70.2	6.49	0.089	6.44	9.9	2.6
		11:16:43	30	19	66.4	6.16	0.088	6.43	10.6	2.5
Secchi		11:15:29	35	18.77	61.3	5.71	0.088	6.41	13.5	2.5
2.70 M		11:14:17	40	18.73	59	5.5	0.088	6.42	16.6	2.9
		11:13:01	45	18.66	55	5.14	0.088	6.44	21.6	2.6
		11:11:14	50	18.65	51.6	4.82	0.088	6.5	25.2	2.7
		11:09:49	52	18.61	49.8	4.66	0.088	6.65	**40**	3.9
		12:56:57	0	7.7	94.8	11.31	0.06	6.29	6.1	4
WA-2		12:56:08	5	7.69	94.7	11.3	0.061	6.26	6.3	3.7
	11/6/2007	12:54:51	10	7.57	94.2	11.28	0.059	6.26	6.6	3.9
Lake		12:54:03	15	7.54	94.1	11.27	0.059	6.26	6.6	3.6
Tower		12:52:58	20	7.54	94.1	11.27	0.06	6.27	6.4	3.6
		12:52:05	25	7.53	93.9	11.25	0.06	6.28	6.4	3.5

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
Secchi 2.30 M	11/6/2007 Cont.	12:50:59	30	7.5	93.7	11.23	0.06	6.21	6.6	3.8
		12:50:00	35	7.17	93.1	11.26	0.061	6.22	24.5	3.8
		12:49:07	40	7.11	93.2	11.28	0.061	6.21	8.7	3.8
		12:48:24	45	7.1	93.2	11.28	0.061	6.18	8.5	3.7
		12:47:44	50	7.07	93.3	11.3	0.062	6.13	**100.7**	**7.8**
WA-3 Tobyhanna Creek Upstream	5/24/2007	11:14:16	0	16.41	105.3	10.31	0.093	6.72	1	2
	6/21/2007	11:39:33	0	20.36	105.9	9.56	0.098	6.66	3.2	0.7
	7/19/2007	12:58:17	0	19.27	92.2	8.51	0.096	6.62	**10.8**	**-1.8**
	10/11/2007	14:08:49	0	16.45	89.7	8.77	0.114	6.86	19.1	5.8
	11/6/2007	11:17:21	0	8.04	97	11.48	0.079	6.34	6.4	4.4
WA-4 Lehigh River Upstream	5/24/2007	11:01:58	0	16.09	114.8	11.31	0.07	6.5	1.4	1.6
	6/21/2007	11:18:09	0	19.17	113.3	10.47	0.083	6.7	1.9	-0.5
	7/19/2007	13:12:04	0	20.76	101.5	9.09	0.079	7.03	**155.4**	**-0.6**
	10/11/2007	13:53:26	0	15.03	86.5	8.71	0.074	6.54	21.3	6.5
	11/6/2007	11:02:25	0	7.65	99.1	11.84	0.06	6.2	5.9	3.1
WA-5 Bear Creek Upstream	5/24/2007	10:38:55	0	15.13	104.5	10.51	0.065	7.08	1.2	1.3
	6/21/2007	10:47:59	0	19.03	105	9.73	0.086	6.92	2	-5.6
	7/19/2007	9:43:32	0	19.69	94.3	8.63	0.099	6.69	**-7.4**	**-26**
	10/11/2007	13:28:30	0	15.79	92.8	9.2	0.082	6.81	5.8	1.9
	11/6/2007	10:43:50	0	7.2	96.8	11.69	0.05	5.85	6.5	2
WA-6 Bear Creek Lake Arm	5/24/2007	13:51:50	0	20.84	102.6	9.18	0.073	6.55	0.3	1.7
		13:50:21	5	18.37	98.5	9.25	0.072	6.45	0.3	1.9
		13:49:12	10	17.7	96.3	9.17	0.072	6.38	0.5	2
		13:48:13	15	17.02	93.3	9.01	0.072	6.3	-0.4	1.5
		13:47:26	20	16.62	91.2	8.89	0.071	6.23	0.3	1.9
		13:46:50	25	16.06	90.1	8.88	0.07	6.18	0.8	2
		13:45:39	30	15.51	87.5	8.73	0.071	6.04	0.7	1.4
		13:44:56	35	15.08	87	8.75	0.07	5.99	0.5	1.5
		13:44:12	40	14.85	86.7	8.77	0.068	5.97	0.5	1
		13:43:29	45	14.6	86.5	8.8	0.067	5.92	1.3	1.3
		13:43:07	50	14.52	86.6	8.82	0.067	5.98	0.5	1.7
		13:42:33	55	14.36	86.2	8.82	0.07	6.01	0.7	1.2
		13:41:48	60	14.05	85.2	8.77	0.067	6.06	1.3	0.9
		13:40:50	65	13.72	84.5	8.76	0.074	6.15	1.7	1.7
		13:40:06	70	13.59	85	8.84	0.073	6.24	1.6	1.4
		13:39:24	75	13.45	84.5	8.82	0.076	6.27	1.4	1.2
		13:38:46	80	13.3	83.2	8.7	0.075	6.31	1.5	1.1
		13:37:47	85	13.1	81.1	8.52	0.075	6.37	**2.9**	1.1

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
WA-6 Bear Creek Lake Arm	6/21/2007	14:39:29	0	25.38	112.3	9.22	0.08	6.89	1.2	**-8.1**
		14:38:34	5	23.76	108.3	9.16	0.079	6.74	1.4	**-7.6**
		14:37:54	10	23.35	104.3	8.88	0.079	6.62	1.8	**-7.4**
		14:36:14	15	22.29	90.6	7.88	0.078	6.23	0.9	**-8**
		14:35:14	20	21.21	76.9	6.82	0.08	6.15	1.2	**-7.3**
		14:34:31	25	20.58	74.5	6.69	0.079	6.13	1.7	**-7.2**
		14:33:52	30	20.22	73.9	6.69	0.08	6.09	1.1	**-7.2**
		14:31:54	35	19.84	75.2	6.85	0.084	6.1	0.8	**-7.3**
		14:31:10	40	19.34	73.2	6.74	0.079	6.02	1	**-7.2**
		14:30:29	45	19.02	74.1	6.87	0.085	6.05	1.3	**-6.9**
		14:29:26	50	18.7	74.7	6.97	0.085	6	1.3	**-6.7**
		Missed	**Missed**	**Missed**	**Missed**	**Missed**	**Missed**	**Missed**	**Missed**	**Missed**
		14:28:33	60	18.36	75.4	7.09	0.081	6.01	1.1	**-6.2**
		14:27:49	65	18.11	76.8	7.26	0.079	6.07	0.5	**-6.6**
		14:26:28	70	17.84	77.5	7.36	0.078	6.1	0.8	**-4.2**
		14:25:14	75	17.64	72.5	6.92	0.078	6.15	1.4	**-7**
		14:24:06	80	17.41	69.7	6.68	0.079	6.23	2.9	**-7.1**
WA-6 Bear Creek Lake Arm	7/19/2007	11:14:53	0	24.93	98.4	8.14	0.08	6.95	**-2.3**	**-0.2**
		11:13:49	5	24.9	97	8.03	0.08	6.8	**-2.8**	**0**
		11:12:55	10	24.6	93.6	7.79	0.08	6.64	**36.2**	**-10.4**
		11:11:56	15	23.67	76.5	6.48	0.081	6.31	**-7**	**-17.4**
		11:11:04	20	22.48	63.1	5.47	0.079	6.11	**-6.8**	**-23.8**
		11:10:25	25	21.97	59.4	5.2	0.078	6.05	**-7**	**-28.4**
		11:09:31	30	21.59	51.7	4.56	0.079	5.97	**-9.1**	**-42.9**
		11:08:33	35	21.28	47.4	4.2	0.079	5.91	**7.9**	**-99.9**
		11:07:33	40	21.07	43	3.83	0.079	5.87	**-7.3**	**-11.4**
		11:06:15	45	20.9	41.8	3.74	0.079	5.81	**10.1**	**-8.8**
		11:05:31	50	20.69	43.6	3.91	0.08	5.87	**-6.1**	**-7.9**
		11:04:27	55	20.47	37.7	3.39	0.08	5.78	**0.9**	**-4.8**
		11:03:36	60	20.32	42.4	3.83	0.081	5.86	**-4.5**	**-1.7**
		11:02:35	65	20.24	40.3	3.65	0.081	5.86	**-8**	**-16.1**
		11:01:27	70	20.12	36.5	3.31	0.082	5.86	**-7.1**	**-56.8**
		11:00:19	75	19.98	32.7	2.97	0.082	5.89	**-7.7**	**-2.4**
WA-6 Bear Creek Lake Arm	10/11/2007	12:03:07	0	20.17	89	8.07	0.086	6.7	6.2	7.7
		12:02:17	5	20.21	87.7	7.94	0.086	6.68	6.2	8
		12:00:56	10	19.92	79.4	7.23	0.088	6.58	6.5	3.3
		11:59:11	15	19.58	73.7	6.76	0.085	6.53	7.1	2.9
		11:57:37	20	19.32	80.3	7.4	0.089	6.63	14.1	3.3
		11:56:34	22	19.21	78.4	7.24	0.089	6.61	51.5	3.6
WA-6 Bear Creek Lake Arm	11/6/2007	13:43:11	0	7.75	94.8	11.29	0.056	6.23	6.3	2.9
		13:42:09	5	7.77	94.8	11.29	0.056	6.26	6.3	3.1
		13:41:02	10	7.77	94.7	11.28	0.056	6.3	6.4	3.1
		13:39:25	15	7.77	94.7	11.28	0.056	6.36	6.4	3.4
		13:38:11	20	7.7	94.4	11.27	0.057	6.45	6.9	3.5
		13:36:59	25	7.58	94.9	11.35	0.064	6.47	8	3.9

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
WA-7 Lehigh Lake Arm	5/24/2007	13:27:46	0	19.93	100.9	9.18	0.073	6.48	0.2	1.8
		13:26:57	5	18.38	99.1	9.31	0.074	6.45	0.6	1.8
		13:26:14	10	17.63	96.1	9.16	0.073	6.41	0.4	2.1
		13:25:37	15	17.16	94.2	9.07	0.072	6.39	0.2	1.7
		13:24:26	20	16.58	91.2	8.89	0.071	6.31	0.6	2.4
		13:23:51	25	16.17	89.2	8.77	0.071	6.3	-0.2	2
		13:22:48	30	15.38	87	8.7	0.075	6.28	0.3	1.8
		13:22:06	35	14.98	86.4	8.71	0.075	6.3	0.7	1.4
		13:20:18	40	14.78	87.4	8.85	0.075	6.25	0.6	1.3
		13:19:30	45	14.66	88	8.94	0.077	6.26	0.6	1.7
		13:18:56	50	14.5	87.7	8.94	0.076	6.29	0.5	1.8
		13:18:07	55	14.28	88	9.01	0.077	6.32	0.4	1.6
		13:17:27	60	14.08	87.9	9.05	0.077	6.38	0.8	2.4
		13:16:44	65	13.92	87.6	9.04	0.076	6.41	0.8	2.2
		13:16:05	70	13.69	87.2	9.04	0.078	6.45	1.4	2
		13:15:29	75	13.55	85.3	8.88	0.079	6.47	3.9	1.5
		13:14:42	80	13.45	81.8	8.54	0.079	6.5	**19.8**	2.2
WA-7 Lehigh Lake Arm	6/21/2007	14:06:33	0	24.31	110.5	9.25	0.079	6.89	1.4	**-7.9**
		14:05:33	5	24.18	109.1	9.15	0.079	6.77	1	**-7.8**
		14:04:45	10	23.5	103.6	8.81	0.08	6.62	2.3	**-7.3**
		14:02:23	15	21.84	85.4	7.49	0.083	6.37	2.1	**-4.3**
		14:01:43	20	21.18	79.3	7.04	0.082	6.33	1.6	**-6.3**
		14:00:46	25	20.61	77.3	6.94	0.083	6.34	1.3	**-6.3**
		13:59:18	30	20.25	76.7	6.94	0.085	6.3	1.1	**-6.7**
		13:58:26	35	19.93	76.2	6.93	0.085	6.26	1.3	**-6.7**
		13:57:40	40	19.54	76.1	6.98	0.086	6.23	1.8	**-4**
		13:56:51	45	19.1	75.4	6.98	0.087	6.18	2.1	**-6.3**
		13:56:05	50	18.89	73.1	6.8	0.087	6.17	2.9	**-4.3**
		13:54:32	55	18.58	72.6	6.79	0.087	6.11	4	**-6**
		13:53:34	60	18.15	71.5	6.75	0.087	6.1	3.7	**-3.1**
		13:52:31	65	17.99	70.6	6.69	0.087	6.13	3.7	**-5.2**
		13:51:22	70	17.67	70.6	6.73	0.085	6.17	2.7	**-3.7**
		13:49:34	75	17.39	67.7	6.49	0.083	6.21	3.9	**16.6**

2007 F.E. Walter Water Quality Profiles

Station	Date	Time	Depth	Temp	DO	DO	SpCond	pH	Turbidity +	Chloro.
	M/D/Y	hh:mm:ss	ft	C	%	mg/L	mS/cm		NTU	ug/L
WA-7 Lehigh Lake Arm	7/19/2007	11:44:54	0	24.98	98.2	8.12	0.082	6.9	**403.3**	**-76.3**
		11:44:03	5	24.89	96.8	8.02	0.082	6.82	**332.4**	**-29.4**
		11:43:05	10	24.41	94.3	7.88	0.08	6.66	**-0.4**	**-5.2**
		11:42:08	15	23.7	89.1	7.54	0.079	6.5	**-3.9**	**0**
		11:40:36	20	22.64	62.5	5.4	0.08	6.16	**-5.1**	**-1.8**
		11:39:23	25	21.93	61.4	5.37	0.079	6.12	**208.2**	**0.1**
		11:37:54	30	21.61	48.4	4.26	0.081	6.03	**-2.2**	**0.2**
		11:36:52	35	21.3	45.7	4.05	0.083	6	**20.3**	**-2.5**
		11:35:50	40	21.06	47.2	4.2	0.081	5.93	**33.2**	**0.5**
		11:34:44	45	20.87	39.6	3.54	0.085	5.95	**1011.6**	**-2**
		11:33:38	50	20.7	37.9	3.4	0.085	5.91	**167.2**	**-2.3**
		11:32:48	55	20.53	36.7	3.31	0.085	5.9	**-8.8**	**-20.4**
		11:31:58	60	20.37	32.9	2.97	0.085	5.92	**-2.4**	**-26.6**
		11:30:32	65	20.26	29.7	2.68	0.085	5.91	**85**	**-16.6**
		11:29:47	70	20.08	26.9	2.44	0.084	5.94	**58.9**	**-34.7**
		11:28:29	75	19.6	12.5	1.15	0.125	6.16	**15.8**	**-33.4**
WA-7 Lehigh Lake Arm	10/11/2007	11:42:19	0	20.25	92.6	8.38	0.086	6.96	5.9	6.3
		11:41:34	5	20.24	92.5	8.36	0.086	6.97	5.8	6.2
		11:39:51	10	19.93	90	8.19	0.089	6.92	7	4.4
		11:38:41	15	19.12	89.6	8.29	0.09	6.83	6.8	4.5
		11:37:40	20	17.27	87.8	8.43	0.093	6.83	**20.4**	4.3
		11:36:38	22	17.21	87.7	8.44	0.093	6.88	**46.5**	**13.3**
WA-7 Lehigh Lake Arm	11/6/2007	13:19:49	0	7.63	94.3	11.27	0.066	6.49	6.9	3.9
		13:18:33	5	7.61	94.2	11.26	0.066	6.52	6.8	6.1
		13:17:36	10	7.59	94.2	11.26	0.066	6.51	6.6	6.2
		13:16:44	15	7.56	94	11.26	0.066	6.51	6.6	6.1
		13:15:41	21	7.54	93.7	11.22	0.066	6.5	**60.7**	7.1