

2007

WAPPAPELLO LAKE

WATER QUALITY

REPORT



U.S. ARMY CORPS OF ENGINEERS, ST. LOUIS DISTRICT
ENVIRONMENTAL QUALITY SECTION – WATER QUALITY

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WATER QUALITY MONITORING PROGRAM

1.0 GENERAL OVERVIEW

This report summarizes water quality activities of the St. Louis District for Fiscal Year 2007 in accordance with ER 1110-2-8154 Water Quality & Environmental management for Corps Civil Works Projects and ETL 1110-2-362 Environmental Engineering Initiatives for Water Management.

Water quality monitoring remains one of the Sections major responsibilities in the area of environmental stewardship. The objective is to maintain a reasonable environmental monitoring program for the Mississippi River and the 5 lakes under the St. Louis District's control. The District's reservoirs consist of Mark Twain and Wappapello Lakes in Missouri, and Shelbyville, Carlyle and Rend Lakes in Illinois. Water quality sampling is conducted within the lakes and their tributaries to establish trend analysis and maintain water quality at or above state and federal regulations.

The main objective is to provide technical expertise of an environmental nature to all Corps elements requesting assistance in accordance with ER 1110-2-8154. This would include updating the water quality management priorities for the district's projects to ensure water quality meets the state and federal regulations, for protection of human health and the environment, and for the safety and economic welfare of those at Corps projects. Ongoing goals include ensuring that downstream water quality meets all state and federal regulations, is suitable for aquatic and human life, and continue to evaluate trend analysis in relation to baseline conditions at all projects.

Water quality data is provided to the Missouri Department of Natural Resources (MDNR) to be used as a screening mechanism for the Missouri Water Quality Report which is required every two years by the Clean Water Act Sections 303(d) and 305(b). MDNR does not routinely monitor Wappapello Lake, however the University of Missouri-Columbia has been taking 4 samples per year in the forebay at the lake since 1989.

The National Water Quality Inventory Report to Congress (305(b) report) is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. This document characterizes our water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect our waters.

Under Section 303(d) of the 1972 Clean Water Act, states, territories and authorized tribes are required to develop a list of water quality limited segments. These waters on the list do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for water on the lists and develop action plans, called as Total Maximum Daily Loads (TMDL), to improve water quality.

The 2004 water quality report compiled by the Missouri Department of Natural Resources listed the upper St. Francis River near Farmington, Saline and Big Creeks impaired. The St. Francis is impaired by Biochemical Oxygen Demand (BOD), and ammonia. Saline and Big Creek are impaired by Nickel, and Lead. Wappapello Lake is listed as eutrophic. Continued monitoring of the lake and its tributaries is vital in assisting the future assessment of the lake for these and other possible impairments. The water quality monitoring program represents the single metric that encompasses the overall health of the watershed as it is a direct measure of how well the environmental stewardship programs are working.

1.1 INTRODUCTION

Wappapello Lake is located in southeastern Missouri and is primarily utilized as a recreational lake. The surrounding lands are residential with little agricultural use due to the terrain.

Nestled in the foothills of the Ozark Mountains, Wappapello Lake offers activities for all walks of life. Over 44,000 acres of public lands and water welcome hunting, fishing, swimming, boating, camping and picnicking. Interpretation of the natural resources through trails, Visitor Center exhibits and various programs highlight the natural beauty found in Southeast Missouri.

The operating purposes of Wappapello Lake are fishing, hunting and other wildlife activities as well as recreation uses, such as boating and swimming. The area around the lake has camping sites and nature trails. The water quality management program for the lake includes monitoring baseline parameters and ecological trends as well as investigating problem areas to keep the lake within state and federal standards.

The water quality monitoring program was conducted during 2007 at five lake sites to assure that safe conditions were maintained for human recreation, wildlife and aquatic life. One of the five sites was selected as a quality control duplicate site during each sampling event and was denoted as WAP-15. Four water quality and one sediment sampling event took place from June through August 2007. Sediment samples were taken at sites Wap-2, Wap-5, and Wap-6. The locations of the 5 sampling sites are depicted on the lake map in Figure 1.

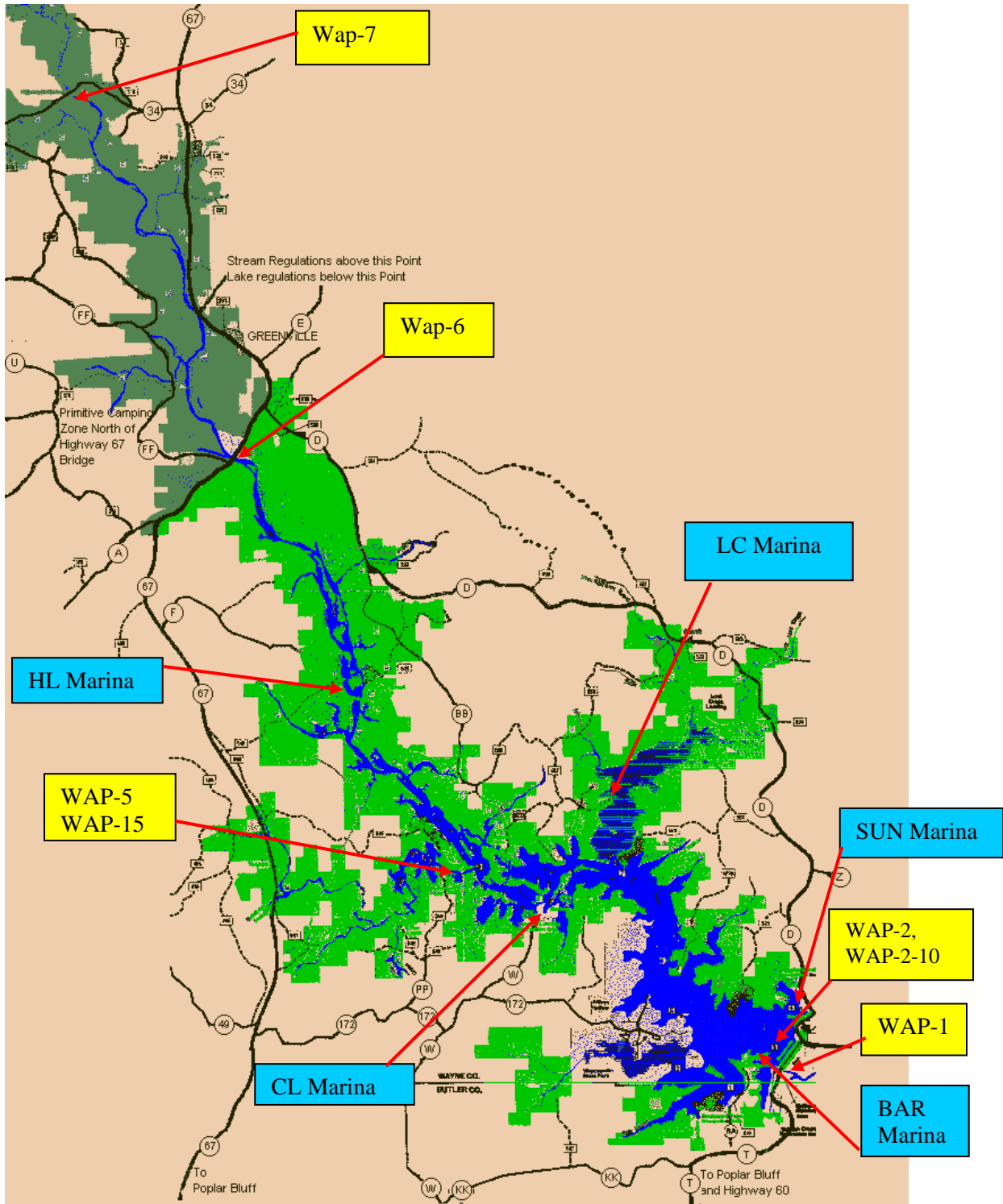


Figure 1
Location of sample sites

2.0 WATER QUALITY ASSESSMENT CRITERIA

2.1 Water Quality

The water quality assessment criteria were based upon the State of Missouri regulatory limits for certain contaminants, which has been generally accepted criteria for sustaining adequate aquatic plant and animal growth. The samplings and analysis which were conducted at the Wappapello Lake sites reflect the minimal set of parameters needed to analyze the current status of water quality for the Wappapello Lake system.

The following parameters were analyzed in the Fiscal Year 2007 samplings at Wappapello Lake: Total Organic Carbon (TOC), iron, manganese, ammonia-nitrogen, nitrate-nitrogen, orthophosphate, total phosphate, Total Suspended Solids (TSS), Total Volatile Suspended Solids (TVSS), fecal coliform, pH, temperature, dissolved oxygen, specific conductance, oxidation-reduction potential (ORP), chlorophyll, and pheophytin-a. In addition sediment samples were taken at the 3 lake sites and analyzed for metals, TKN, phosphates, nitrogen, solids, TOC, and pesticides.

The Missouri Department of Natural Resources, Code of State Regulations, Division 20, Chapter 7 classifies water quality criteria based on designated usage. These standards are used to determine the aquatic water quality of the lake. Table 2.1 provides a listing of the regulatory limits for the parameters analyzed where a limit has been established.

PARAMETER	LIMIT
Temperature	20.5°C - 33°C (68°F - 90°F)
Ammonia Nitrogen	< 15 mg/L
Nitrate Nitrogen	10 mg/L
Iron	1.0 mg/L (Aquatic Life)
Manganese	0.05 mg/L (Drinking Water & GW)
Phosphorous as Phosphate	0.05 mg/L
Fecal Coliform	< 200 colonies/100 ml (geometric mean)
pH	Range: 6.5 to 9.0
DO	> 5.0 mg/L
Atrazine	0.003 mg/L (Drinking Water Standard)
Alachlor	0.002 mg/L (Drinking Water Standard)

Nitrogen is an essential component of proteins, genetic material, chlorophyll, and other key organic molecules. All organisms require nitrogen in order to survive. Nitrogen exists in several forms. These forms include gaseous nitrogen (N₂), nitrites (NO₂), nitrate (NO₃), ammonia nitrogen (NH₃-N), and ammonium (NH₄). Ammonia can be toxic to fish and other aquatic organisms at certain levels. Unlike ammonia, ammonium (NH₄) is not toxic to aquatic

organisms and is readily available for uptake by plankton and macrophytes. Nitrogen levels have increased as human activities have accelerated the rate of fixed nitrogen being put into circulation. High nitrogen levels can cause eutrophication. Eutrophication increases biomass of phytoplankton, decrease water transparency, and causes oxygen depletion. Ammonia nitrogen is monitored so that the effects on fish spawning, hatching, growth rate and pathologic changes in gills, liver and kidney tissue can be related to the detected levels of ammonia nitrogen. Nitrate-nitrogen degrades to nitrite or produces ammonia which has a detrimental effect on aquatic life and, therefore, has been monitored to assure levels are below the regulatory "safe" limit.

Phosphate has been analyzed as phosphorus and has been monitored due to the potential for uptake by nuisance algae. Levels of phosphate can indicate the potential for rapid growth of algae (algae bloom) which can cause serious oxygen depletion during the algae decay process. Phosphorous is typically the limiting nutrient in a water body. Therefore, addition of phosphorous to the ecosystem stimulates the growth of plants and algae. Phosphorous is delivered to lakes and streams by way of storm water runoff from agricultural fields, residential property, and construction sites. Other sources of phosphorous are anaerobic decomposition of organic matter, leaking sewer systems, waterfowl, and point source pollution. The general standard for phosphorous in lake water is 0.05mg/L. Dissolved phosphorous also called orthophosphorous is generally found in much smaller concentrations than total phosphorous and is readily available for uptake. For this reason dissolved phosphorous concentrations are variable and difficult to use as an indicator of nutrient availability.

The metals manganese and iron are nutrients for both plants and animals. Living organisms require trace amounts of metals. However, excessive amounts can be harmful to the organism. Heavy metals exist in surface waters in three forms, colloidal, particulate, and dissolved. Water chemistry determines the rate of adsorption and desorption of metals to and from sediment. Metals are desorbed from the sediment if the water experiences increases in salinity, decreases in redox potential, or decreases in pH. Metals in surface waters can be from natural or human sources. Currently human sources contribute more metals than natural sources. Metals levels in surface water may pose a health risk to humans and the environment.

Photosynthetic activity can be hindered by the levels of total suspended solids. Total suspended solids concentrations, which cause the photosynthetic activity to be reduced by more than 10% from the seasonably established norm, can have a detrimental effect on aquatic life. Soil particles, organic material, and other debris comprise suspended solids in the water column. Secchi disk measurements are inverse to suspended solid measurements. As the total suspended solids (TSS) increase, the secchi disk depth or water transparency decreases. Total suspended solids can be an important indicator of the type and degree of turbidity. TSS measurements represent a combination of organic (volatile) and inorganic (non-volatile) particles in the water. In order to more accurately determine the types and amounts of suspended solids, volatile suspended solids (VSS) are analyzed. VSS concentration represents the organic portion of the total suspended solids. Organic material often includes plankton and additional plant and animal debris that is present in water. Total volatile solids indicate the presence of organics in suspension and, therefore, show additional demand levels of oxygen.

Chlorophyll and pheophytin-a are monitored to provide indicators of algae growth and,

therefore, potential oxygen depletion activity. Chlorophyll is measured in lakes to estimate the type and amount of algal productivity in the water column. Chlorophyll a is present in green algae, blue-green algae, and in diatoms. Chlorophyll a is often used to indicate the degree of eutrophication. Chlorophyll b and c are used to estimate the extent of algal diversity and productivity. Chlorophyll b is common in green algae and is used as an auxiliary pigment for photosynthesis. Chlorophyll c is most common in diatom species and serves as an auxiliary pigment. Algal productivity and diversity can be determined by the concentrations of the individual pigments. For example high concentrations of chlorophyll a and b would indicate that green algae is abundant. High concentrations of chlorophyll a would indicate abundance of blue-green algae and concentrations of chlorophyll a and c would indicate diatoms are the dominant species. Chlorophyll production is currently being connected with hypoxia.

Fecal coliform bacteria is monitored for the protection of human health as it relates to full body contact of recreational waters. People can be exposed to disease-causing organisms, such as bacteria, viruses and protozoa in beach and recreational waters mainly through accidental ingestion of contaminated water or through skin contact. These organisms, called pathogens, usually come from the feces of humans and other warm-blooded animals. If taken into the body, pathogens can cause various illnesses and on rare occasions, even death. Waterborne illnesses include diseases resulting from bacteria infection such as cholera, salmonellosis, and gastroenteritis, viral infections such as hepatitis, gastroenteritis, and intestinal diseases, and protozoan infections such as amebic dysentery and giardiasis. The most commonly monitored recreational water indicator organisms are fecal coliform, *Escherichia coli*, (*E. coli*) and enterococci. Fecal coliform are bacteria that live in the intestinal tracts of warm-blooded animals. The standard for fecal coliform is less than a geometric mean of 200 colonies per 100ml of sample water. Fecal coliform was originally recommended in 1968 by the Federal Water Pollution Control Administration (predecessor to EPA) as an effective water quality indicator organism for recreational waters. Recent studies indicate that fecal coliform show less correlation to illness than other indicator organisms such as *E. coli* and enterococci. The Environmental Protection Agency (EPA) currently recommends *E. coli* or enterococci as an indicator organism for fresh waters. Although *E. coli* and enterococci are more costly they may become the standard in the near future.

Atrazine and Alachlor herbicides are commonly used agricultural chemicals which can be readily transported by rainfall runoff. Both compounds are suspected of causing cancer and, therefore, were monitored for the protection of human and aquatic health. Organic compounds include many pesticides. A pesticide can be any substance that is intended to prevent, destroy, repel, or mitigate any pest. This includes insecticides, herbicides, fungicides, fumigants, algaecides and other substances. Herbicides which are pesticides used to kill vegetation are the most widely used and sampled. Ten of the most frequently used herbicides and detected in water are Atrazine, Metolachlor, Alachlor, 2,4-D, Trifluralin, Glyphosate, Dicamba, Cyanazine, Simazine, and 2,4,5-T. Two of the most widely used pesticides are Atrazine and Alachlor. Atrazine is a preemergence or postemergence herbicide use to control broadleaf weeds and annual grasses. Atrazine is most commonly detected in ground and surface water due to its wide use, and its ability to persist in soil and move in water. Alachlor is a Restricted Use Pesticide (RUP) due to the potential to contaminate groundwater. The drinking water standard for Atrazine is 0.003mg/L and 0.002 mg/L for Alachlor.

Temperature, dissolved oxygen and pH are monitored for the protection of aquatic life. Temperature is important because it controls several aspects of water quality. Colder water hold more dissolved oxygen which is required by aquatic organisms. Plants grow more rapidly and use more oxygen in warmer water. Decomposition of organic matter which uses oxygen is accelerated in warmer water. Temperature can also determine the availability of toxic compounds such as ammonia. Since aquatic organisms are cold blooded, water temperature regulates their metabolism and ability to survive. The number and kinds of organisms that are found in streams or lakes is directly related to temperature. Certain organisms require a specific temperature range, such as trout, which require water temperatures below 20°C. Most aquatic organisms require a minimum concentration of dissolved oxygen to survive. In spring, surface waters of the lake mix with the water below through wind and thermal action. This mixing diminishes as the upper layer of water becomes warmer and less dense. Solar insolation during the summer months stratifies the lake into three zones. The upper warmer water zone is called the epilimnion and the lower cooler water zone is called the hypolimnion. The epilimnion and the hypolimnion zones are divided by a transition zone known as the metalimnion. The thermocline located within the metalimnion exhibits a rapid change in water temperature. During the summer months the hypolimnion may become anaerobic. In this anaerobic zone, chemical reduction of iron and manganese, or the production of methane and sulfides can occur. Iron rapidly oxidizes in aerobic environments, but manganese oxidizes slowly and can remain in the reduced state for long distances down stream even in aerobic environments. The degree of acidity of water is measured by a logarithmic scale ranging from 0 to 14 and is known as the pH scale. A reading of 7 indicates neutrality and readings below seven are acidic and above are alkaline. Most Missouri lakes range from 6 to 9 on the pH scale. The buffering capacity of water is the ability to neutralize acid better known as alkalinity. A high alkalinity concentration indicates an increased ability to neutralize pH and resist changes, whereas a low alkalinity concentration indicates that a water body is vulnerable to changes in pH.

Conductivity is a measure of a water's ability to conduct an electrical current. The ability to carry a current is often driven by the dissolved materials present in a water column. These materials can include dissolved ions and other materials in the water and thus are directly proportional to the concentration of total dissolved solids (TDS) present in the water column. Typically TDS concentrations represent 50-60% of the conductivity measurements. Conductivity is also affected by water temperature. The warmer the water, the higher the conductivity. Conductivity in streams and rivers is affected by the geology of the area. Streams running through granite areas tend to have lower conductivity due to granite being composed of inert material, materials that do not ionize or dissolve into ionic compounds in water. On the other hand streams that run through areas of limestone or clay soils tend to have higher conductivity readings because of the presence of materials that ionize. Conductivity is useful as a general measure of water quality. A stream tends to have a relatively constant range of conductivity that once established can be used as a baseline. Significant changes either high or low might indicate a source of pollution has been introduced into the water. The pollution source could be a treatment plant which raises the conductivity or an oil spill which would lower the conductivity.

Redox or Oxidation-Reduction Potential (ORP) is a measurement to oxidize materials.

Oxidation involves an exchange of electrons between 2 atoms. The atom that loses an electron is oxidized and the one that gains an electron is reduced. ORP sensors measure the electrochemical potential between the solution and a reference electrode. Readings are expressed in millivolts with positive readings indicating increased oxidizing potential and negative readings being increased reduction. The ORP probe is essentially a millivolt meter, measuring the voltage across 2 electrodes with the water in between. ORP values are used much like pH values to determine water quality. While pH readings characterize the state of a system relative to the receiving or donating hydrogen ions (base or acid), ORP readings characterize the relative state of losing or gaining electrons. The conversion of ammonia (NH₃) requires an oxidating environment to convert it into nitrites (NO₂) and nitrates (NO₃). Ammonia levels as low as 0.002mg/L can be harmful to fish. Generally ORP readings above 400mV are harmful to aquatic life. However, ORP is a non-specific measurement which is a reflection of a combination of effects of all the dissolved materials in the water. Therefore, the measurement of ORP in relatively clean water has only limited utility unless a predominant redox-active material is known to be present.

Water clarity is intuitively used by the public to judge water quality. Secchi depth has been used for many years as a limnological characterization tool for characterizing water clarity. Secchi depth is a measure of light penetration into a waterbody and is a function of the absorption and scattering of light in the water. There are three characteristics of water which affect the penetration of light. The three factors are the color of water, amount of phytoplankton in the water column, and amount of inorganic material in the water column. Secchi depth integrates the combined impacts of all the factors which influence water clarity. Water transparency was measured using a Secchi disk. Secchi disk readings were taken at all lake sites.

2.2 Sediment

In accordance with EM-1110-2-1201, sediment samples should be taken to monitor and assess potential impacts to aquatic and human health. To assess ecological risk, sample values were compared against toxicity information published in the National Oceanic Atmospheric Administrations (NOAA) Screening Quick Reference Tables (SQRT) or similar references for ecological receptors in freshwater sediment. Without standards or other widely applicable numerical tools, NOAA scientists found it difficult to estimate the possible toxicological significance of chemical concentrations in sediment. Therefore, numerical sediment quality guidelines (SQG's) were developed as informal, interpretive tools. The SQGs were not promulgated as regulatory standards, but rather as informal, non-regulatory guidelines for interpreting chemical data from analyses of sediments. For potential ecological risk from inorganic contaminants, seven metals are typically of "most concern" with regards to fish and wildlife: Arsenic, Copper, Cadmium, Selenium, Mercury, Lead, and Zinc. Avian species are thought to be particularly sensitive to arsenic, but is also considered a carcinogenic, mutagenic, and teratogenic contaminant in a variety of species in elevated doses over time. Avian species are also known to be particularly sensitive to lead in the environment with effects ranging from mortality, reduced growth and reproductive output, behavior changes, blood chemistry alterations, and lesions of major organs. Finally, the embryo stages in fish and avian species are known to be the most sensitive life stage to selenium effecting reproductive success.

It is recommended that the next round of sediment samples focus on organochlorines in freshwater sediment to assess potential chronic aquatic impacts (e.g. aldrin, chlordane, endrin, endosulfan, DDT, methoxychlor).

For potential human health risk, there are no known values in Missouri for sediments. While not a direct correlation, sample results were compared against Missouri Risk Based Corrective Action (MRBCA) lowest default target levels for all soil types and exposure pathways for soils.

3.0 SUMMARY OF MONITORING RESULTS

3.1 Water Quality Summary

The seasonal change brought on gradual lake stratification during the summer months. Fecal coli are sampled at the marinas to ensure that the marina areas are not being contaminated by boats with restroom facilities. Bacteria levels for all the marinas were below the Missouri standard of 200 colonies/100ml of sample. We currently do not take enough samples in a month to calculate a geometric mean, so we mainly look at a high mark of 200 colonies/100ml of sample to trigger additional investigations. All samples were well below the 200 colonies except the Lost Creek sample on August 21, 2007 which was 198.

Total iron and total manganese are sampled above the dam near the bottom of the channel (WAP-2-10), and in the spillway area (WAP-1). As was previously stated living organisms require trace amounts of metals, however excessive amounts can be harmful to the organism. Iron exceeded the Missouri Water Quality Standard at site WAP-2-10 for the June and August sampling events. Iron cycling is a function of oxidation-reduction processes. This elevated level of iron near the bottom of the lake is not detrimental to the overall lake system at this time. Iron oxidizes relatively rapidly (minutes to hours); therefore any iron released through the spillway will normally be oxidized in a short period of time. Missouri's standard for manganese is for drinking water and groundwater. Missouri does not have a manganese standard for aquatic life. According to MDNR elevated levels of manganese are common due to the geologic nature of the area.

Nitrogen and phosphates are sampled at all sites. The 2007 phosphate results at all sites exceeded or nearly exceeded the 0.05 mg/L standard. Because phosphorous in water is not considered directly toxic to humans and animals no drinking water standards have been established for phosphorous. However, phosphorous can cause health threats through the stimulation of toxic algal blooms and the resulting oxygen depletion. However, nitrates can pose a threat to human and animal health. Nitrate in water is toxic at high levels and has been linked to toxic effects of livestock and to blue baby disease (methemoglobinemia) in infants. The Maximum Contaminant Level (MCL) for nitrate-N in drinking water is 10mg/L to protect babies 3 to 6 months of age. The Missouri Water Quality Standard for ammonia nitrogen (NH₃-N) is 15mg/L. The increased levels of phosphate in combination with nitrogen and other lake conditions, such as temperature, pH and stagnant lake conditions, can lead to increased algae growth. Eutrophication is currently the most widespread water quality problem in the U.S. and many other countries. Restoration of eutrophic waters requires the reduction of nonpoint inputs

of phosphorous and nitrogen. The resulting detrimental effects of algae toxins and oxygen depletion could result in health problems for fish and other aquatic species as well as land animals utilizing the water supply. There were no signs of any of these effects throughout 2007.

Chlorophyll *a* was sampled at 3 sites, WAP-2, WAP-5, WAP-6 and WAP15. WAP-15 is a duplicate sample of WAP-5. Chlorophyll *a* is a green pigment found in plants. Chlorophyll *a* concentrations are an indicator of phytoplankton abundance and biomass. They can be an effective measure of trophic status, and used as a measure of water quality. High levels often indicate poor water quality and low levels suggest good conditions. However, elevated levels are not necessarily bad. It is the long term persistence of elevated levels that is the problem. It is natural for chlorophyll *a* levels to fluctuate over time. Chlorophyll *a* tends to be higher after storm events and during the summer months when water temperatures and light levels are elevated. Chlorophyll can reduce the clarity of the water and the amount of oxygen available to other organisms. Missouri does not currently have a standard for chlorophyll. The data indicates a normal increase in chlorophyll levels during the warmer summer months, which is not a concern.

Due to the limited amount of agriculture in the Wappapello watershed and the government chemical restrictions on the use of Atrazine and Alachlor on leased cropland, these chemicals were not sampled.

Total Suspended Solids (TSS) and Total Volatile Suspended Solids (TVSS) samples are collected at all sites. Solids can affect water quality by increasing temperature through the absorption of sunlight by the particles in the water, which also effects the clarity of the water. This can then effect the amount of oxygen in the water. Missouri does not currently have a standard for TSS or TVSS.

Total Organic Carbon (TOC) is collected at all sites. TOC is an indicator of the organic character of water. The larger the carbon or organic content, the more oxygen is consumed. TOC tends to be higher in the summer months which may be a result of plant material, which had grown all summer and begins to decay. Missouri does not currently have a standard for TOC.

Temperature and dissolved oxygen levels were taken at all sites. Measurements were taken at 1 meter intervals at the lake sites. During the summer months the lake stratifies and a boundary is formed between the upper warmer water and the lower cooler water. This transition area is known as the thermocline, the area where the temperature drops significantly. Oxygen levels can also change drastically as a function of depth. This area where the oxygen level significantly drops is called the oxycline. The depth of the thermocline and oxycline can have an effect on the aquatic organisms. Occasionally the thermocline and oxycline are at or near the same depth.

PH is taken at all sites and at 1 meter intervals at lake sites. All sites except site 2 were within the 6 to 9 pH range. The increase at site 2 in June may have a correlation to the increase levels of manganese during this same time period.

Conductivity and redox are taken at all sites and at 1 meter intervals at lake sites. Missouri does not currently have a standard for conductivity or redox. A malfunctioning probe on the sonde produced extremely negative readings during the August sampling event.

The monitoring program for Wappapello Lake during Fiscal Year 2007 revealed good water quality when compared to limits established by the Missouri Department of Natural Resources for general use, secondary contact, and indigenous aquatic life. Nutrient runoffs were primary concerns for the lake's water quality. Better land management practices, erosion control and buffering zones are methods used to reduce such contaminants from entering the lake. The St. Louis District personnel have been working continuously with lake personnel, area communities and other agencies in the implementation of educational programs and implementation planning to bring about the use of better management techniques to improve the lake's water quality.

3.2 Sediment Summary

Arsenic and selenium were detected above ecological thresholds at all 3 sites. Lead was detected above ecological thresholds at sites 2 and 5. These levels warrant further monitoring considerations in front and below the dam. The source of these contaminants has not been established, though all occur naturally in rocks and can be widespread in the environment; anthropogenic sources can include industrial and agricultural operations. Background concentrations of total metals were not determined as no data was readily available for concentrations of inorganic chemicals in background soils or sediments for Missouri. Whether ubiquitous (naturally occurring) or anthropogenic (man made) in nature, continued investigation appears warranted based on levels present and ecological risk potential, particularly in the area of the dam where contaminants may collect and be released down stream. For potential ecological risk from organic contaminants, the organophosphates (particularly atrazine and chloropyrifos) were below laboratory reporting limits.

For potential human health risk, there are no know values in Missouri for sediments. While not a direct correlation, sample results were compared against Missouri Risk Based Corrective Action (MRBCA) lowest default target levels for all soil types and exposure pathways for soils. Arsenic, and lead exceeded MRBCA levels at all sites which provides additional justification for continued sediment monitoring for inorganics.

4.0 PLANNED 2008 STUDIES

The Wappapello Lake water quality monitoring program will continue in Fiscal Year 2008 on a limited basis. Because of budgetary constraints the number of sampling events will be cut drastically. Reducing the number of sampling events will limit the value of a trend analysis. Sampling events are planned to be conducted between May and August in 2008. Wappapello Lake is a high usage recreational lake. The monitoring of water quality is imperative to assure the water quality is within acceptable limits for the designated usage.

The sampling sites include the following: WAP-1 Spillway, WAP-2 lake side of dam,

WAP-5 Otter Creek, WAP-6 Greenville, WAP-7 Hwy 34 bridge and all 5 marinas. This combination of sites effectively represents the incoming contaminants and their effects on the lake.

APPENDIX A

DATA

LAB DATA

Sediment Samples

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-2	07/24/2007	S	96	U	ug/kg	Acetochlor	96
Wap-2	07/24/2007	S	96	U	ug/kg	Alachlor	96
Wap-2	07/24/2007	S	8		mg/kg	Arsenic, Total	7
Wap-2	07/24/2007	S	96	U	ug/kg	Atrazine	96
Wap-2	07/24/2007	S	190		mg/kg	Barium, Total	3
Wap-2	07/24/2007	S	27	U	mg/kg	Boron, Total	27
Wap-2	07/24/2007	S	165	U	ug/kg	Bromacil	165
Wap-2	07/24/2007	S	96	U	ug/kg	Butachlor	96
Wap-2	07/24/2007	S	1.4	U	mg/kg	Cadmium, Total	1.4
Wap-2	07/24/2007	S	96	U	ug/kg	Chlorpyrifos	96
Wap-2	07/24/2007	S	21.1		mg/kg	Chromium, Total	2.7
Wap-2	07/24/2007	S	25		mg/kg	Copper, Total	5
Wap-2	07/24/2007	S	96	U	ug/kg	Cyanazine	96
Wap-2	07/24/2007	S	26200		mg/kg	Iron, Total	27
Wap-2	07/24/2007	S	167		mg/kg	Lead, Total	5
Wap-2	07/24/2007	S	2000		mg/kg	Manganese, Total	2.7
Wap-2	07/24/2007	S	0.48	U	mg/kg	Mercury, Total	0.48
Wap-2	07/24/2007	S	96	U	ug/kg	Metolachlor	96
Wap-2	07/24/2007	S	96	U	ug/kg	Metribuzin	96
Wap-2	07/24/2007	S	63.8		%	Moisture	0.1
Wap-2	07/24/2007	S	96	U	ug/kg	Molinate	96
Wap-2	07/24/2007	S	32		mg/kg	Nickel, Total	5
Wap-2	07/24/2007	S	13.9	U	mg/kg	Nitrate-N	13.9
Wap-2	07/24/2007	S	96	U	ug/kg	Pendimethalin(Prowl)	96
Wap-2	07/24/2007	S	684		mg/kg	Phosphorus, Total	27
Wap-2	07/24/2007	S	165	U	ug/kg	Prometon	165
Wap-2	07/24/2007	S	96	U	ug/kg	Propachlor	96
Wap-2	07/24/2007	S	14	U	mg/kg	Selenium, Total	14
Wap-2	07/24/2007	S	1.4	U	mg/kg	Silver, Total	1.4
Wap-2	07/24/2007	S	96	U	ug/kg	Simazine	96
Wap-2	07/24/2007	S	2380		mg/kg	Total Kjeldahl Nitrogen	41.5

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-2	07/24/2007	S	19700		mg/kg	Total Organic Carbon (TOC)	2620
Wap-2	07/24/2007	S	36.2		%	Total Solids	0.1
Wap-2	07/24/2007	S	96	U	ug/kg	Trifluralin	96
Wap-2	07/24/2007	S	77		mg/kg	Zinc, Total	5
Wap-5	07/24/2007	S	81	U	ug/kg	Acetochlor	81
Wap-5	07/24/2007	S	81	U	ug/kg	Alachlor	81
Wap-5	07/24/2007	S	8		mg/kg	Arsenic, Total	3
Wap-5	07/24/2007	S	81	U	ug/kg	Atrazine	81
Wap-5	07/24/2007	S	181		mg/kg	Barium, Total	1
Wap-5	07/24/2007	S	11	U	mg/kg	Boron, Total	11
Wap-5	07/24/2007	S	138	U	ug/kg	Bromacil	138
Wap-5	07/24/2007	S	81	U	ug/kg	Butachlor	81
Wap-5	07/24/2007	S	0.6	U	mg/kg	Cadmium, Total	0.6
Wap-5	07/24/2007	S	81	U	ug/kg	Chlorpyrifos	81
Wap-5	07/24/2007	S	19.3		mg/kg	Chromium, Total	1.1
Wap-5	07/24/2007	S	17		mg/kg	Copper, Total	2
Wap-5	07/24/2007	S	81	U	ug/kg	Cyanazine	81
Wap-5	07/24/2007	S	21600		mg/kg	Iron, Total	11
Wap-5	07/24/2007	S	81		mg/kg	Lead, Total	2
Wap-5	07/24/2007	S	926		mg/kg	Manganese, Total	1.1
Wap-5	07/24/2007	S	0.44	U	mg/kg	Mercury, Total	0.44
Wap-5	07/24/2007	S	81	U	ug/kg	Metolachlor	81
Wap-5	07/24/2007	S	81	U	ug/kg	Metribuzin	81
Wap-5	07/24/2007	S	58.0		%	Moisture	0.1
Wap-5	07/24/2007	S	81	U	ug/kg	Molinate	81
Wap-5	07/24/2007	S	23		mg/kg	Nickel, Total	2
Wap-5	07/24/2007	S	11.9	U	mg/kg	Nitrate-N	11.9
Wap-5	07/24/2007	S	81	U	ug/kg	Pendimethalin(Prowl)	81
Wap-5	07/24/2007	S	498		mg/kg	Phosphorus, Total	23
Wap-5	07/24/2007	S	138	U	ug/kg	Prometon	138
Wap-5	07/24/2007	S	81	U	ug/kg	Propachlor	81
Wap-5	07/24/2007	S	6	U	mg/kg	Selenium, Total	6
Wap-5	07/24/2007	S	0.6	U	mg/kg	Silver, Total	0.6

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-5	07/24/2007	S	81	U	ug/kg	Simazine	81
Wap-5	07/24/2007	S	1700		mg/kg	Total Kjeldahl Nitrogen	35.7
Wap-5	07/24/2007	S	15200		mg/kg	Total Organic Carbon (TOC)	2740
Wap-5	07/24/2007	S	42.0		%	Total Solids	0.1
Wap-5	07/24/2007	S	81	U	ug/kg	Trifluralin	81
Wap-5	07/24/2007	S	61		mg/kg	Zinc, Total	2
Wap-6	07/24/2007	S	43	U	ug/kg	Acetochlor	43
Wap-6	07/24/2007	S	43	U	ug/kg	Alachlor	43
Wap-6	07/24/2007	S	5		mg/kg	Arsenic, Total	2
Wap-6	07/24/2007	S	43	U	ug/kg	Atrazine	43
Wap-6	07/24/2007	S	20		mg/kg	Barium, Total	0.8
Wap-6	07/24/2007	S	8	U	mg/kg	Boron, Total	8
Wap-6	07/24/2007	S	73	U	ug/kg	Bromacil	73
Wap-6	07/24/2007	S	43	U	ug/kg	Butachlor	43
Wap-6	07/24/2007	S	0.4	U	mg/kg	Cadmium, Total	0.4
Wap-6	07/24/2007	S	43	U	ug/kg	Chlorpyrifos	43
Wap-6	07/24/2007	S	11.5		mg/kg	Chromium, Total	0.8
Wap-6	07/24/2007	S	4		mg/kg	Copper, Total	2
Wap-6	07/24/2007	S	43	U	ug/kg	Cyanazine	43
Wap-6	07/24/2007	S	10000		mg/kg	Iron, Total	8
Wap-6	07/24/2007	S	26		mg/kg	Lead, Total	2
Wap-6	07/24/2007	S	202		mg/kg	Manganese, Total	0.8
Wap-6	07/24/2007	S	0.23	U	mg/kg	Mercury, Total	0.23
Wap-6	07/24/2007	S	43	U	ug/kg	Metolachlor	43
Wap-6	07/24/2007	S	43	U	ug/kg	Metribuzin	43
Wap-6	07/24/2007	S	19.8		%	Moisture	0.1
Wap-6	07/24/2007	S	43	U	ug/kg	Molinate	43
Wap-6	07/24/2007	S	7		mg/kg	Nickel, Total	2
Wap-6	07/24/2007	S	6.2	U	mg/kg	Nitrate-N	6.2
Wap-6	07/24/2007	S	43	U	ug/kg	Pendimethalin(Prowl)	43
Wap-6	07/24/2007	S	95		mg/kg	Phosphorus, Total	12
Wap-6	07/24/2007	S	73	U	ug/kg	Prometon	73
Wap-6	07/24/2007	S	43	U	ug/kg	Propachlor	43
Wap-6	07/24/2007	S	4	U	mg/kg	Selenium, Total	4

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-6	07/24/2007	S	0.4	U	mg/kg	Silver, Total	0.4
Wap-6	07/24/2007	S	43	U	ug/kg	Simazine	43
Wap-6	07/24/2007	S	75.9		mg/kg	Total Kjeldahl Nitrogen	18.7
Wap-6	07/24/2007	S	668		mg/kg	Total Organic Carbon (TOC)	483
Wap-6	07/24/2007	S	80.2		%	Total Solids	0.1
Wap-6	07/24/2007	S	43	U	ug/kg	Trifluralin	43
Wap-6	07/24/2007	S	15		mg/kg	Zinc, Total	2

Lab Data Water Samples

Wap-1	06/26/2007	WT	0.22		mg/L	Ammonia-nitrogen, Total	0.10
Wap-15	06/26/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-2	06/26/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-2-10	06/26/2007	WT	0.48		mg/L	Ammonia-nitrogen, Total	0.10
Wap-5	06/26/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-6	06/26/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-7	06/26/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-1	07/24/2007	WT	0.13		mg/L	Ammonia-nitrogen, Total	0.10
Wap-15	07/24/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-2	07/24/2007	WT	0.15	U	mg/L	Ammonia-nitrogen, Total	0.15
Wap-2-10	07/24/2007	WT	0.74		mg/L	Ammonia-nitrogen, Total	0.10
Wap-5	07/24/2007	WT	0.10		mg/L	Ammonia-nitrogen, Total	0.10
Wap-6	07/24/2007	WT	0.18		mg/L	Ammonia-nitrogen, Total	0.10
Wap-7	07/24/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-1	08/21/2007	WT	0.91		mg/L	Ammonia-nitrogen, Total	0.10
Wap-15	08/21/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-2	08/21/2007	WT	0.15		mg/L	Ammonia-nitrogen, Total	0.10
Wap-2-10	08/21/2007	WT	1.11		mg/L	Ammonia-nitrogen, Total	0.10
Wap-5	08/21/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-6	08/21/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-7	08/21/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-1	09/18/2007	WT	0.24		mg/L	Ammonia-nitrogen, Total	0.10
Wap-15	09/18/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-2	09/18/2007	WT	0.13		mg/L	Ammonia-nitrogen, Total	0.10
Wap-2-10	09/18/2007	WT	0.47		mg/L	Ammonia-nitrogen, Total	0.10
Wap-5	09/18/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-6	09/18/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-7	09/18/2007	WT	0.10	U	mg/L	Ammonia-nitrogen, Total	0.10
Wap-15	06/26/2007	WT	0.01		mg/m3	Chlorophyll a	
Wap-2	06/26/2007	WT	1.76		mg/m3	Chlorophyll a	
Wap-5	06/26/2007	WT	1.25		mg/m3	Chlorophyll a	
Wap-6	06/26/2007	WT	0.01		mg/m3	Chlorophyll a	
Wap-15	07/24/2007	WT	3.96		mg/m3	Chlorophyll a	
Wap-2	07/24/2007	WT	9.35		mg/m3	Chlorophyll a	
Wap-5	07/24/2007	WT	3.92	mg/m3		Chlorophyll a	
Wap-6	07/24/2007	WT	1.33		mg/m3	Chlorophyll a	
Wap-15	08/21/2007	WT	4.13		mg/m3	Chlorophyll a	
Wap-2	08/21/2007	WT	7.56		mg/m3	Chlorophyll a	
Wap-5	08/21/2007	WT	5.53		mg/m3	Chlorophyll a	
Wap-6	08/21/2007	WT	0.66		mg/m3	Chlorophyll a	
Wap-15	09/18/2007	WT	2.74		mg/m3	Chlorophyll a	
Wap-2	09/18/2007	WT	8.85		mg/m3	Chlorophyll a	
Wap-5	09/18/2007	WT	2.76		mg/m3	Chlorophyll a	
Wap-6	09/18/2007	WT	1.2		mg/m3	Chlorophyll a	
Wap-1	06/26/2007	WT	0.44		mg/L	Iron, Total	0.03
Wap-2-10	06/26/2007	WT	1.72		mg/L	Iron, Total	0.03
Wap-1	07/24/2007	WT	0.22		mg/L	Iron, Total	0.03
Wap-2-10	07/24/2007	WT	0.44		mg/L	Iron, Total	0.03

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-1	08/21/2007	WT	0.44		mg/L	Iron, Total	0.03
Wap-2-10	08/21/2007	WT	1.51		mg/L	Iron, Total	0.03
Wap-1	09/18/2007	WT	0.24		mg/L	Iron, Total	0.03
Wap-2-10	09/18/2007	WT	0.25		mg/L	Iron, Total	0.03
Wap-1	06/26/2007	WT	1.68		mg/L	Manganese, Total	0.002
Wap-2-10	06/26/2007	WT	3.52		mg/L	Manganese, Total	0.002
Wap-1	07/24/2007	WT	0.508		mg/L	Manganese, Total	0.002
Wap-2-10	07/24/2007	WT	4.28		mg/L	Manganese, Total	0.002
Wap-1	08/21/2007	WT	2.23		mg/L	Manganese, Total	0.002
Wap-2-10	08/21/2007	WT	3.48		mg/L	Manganese, Total	0.002
Wap-1	09/18/2007	WT	0.318		mg/L	Manganese, Total	0.002
Wap-2-10	09/18/2007	WT	0.987		mg/L	Manganese, Total	0.002
Wap-1	06/26/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-15	06/26/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2	06/26/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2-10	06/26/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-5	06/26/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-6	06/26/2007	WT	0.22		mg/L	Nitrate-N	0.20
Wap-7	06/26/2007	WT	0.2		mg/L	Nitrate-N	0.20
Wap-1	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-15	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2-10	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-5	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-6	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-7	07/24/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-1	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-15	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-2	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2-10	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-5	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-6	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-7	08/21/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-1	09/18/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-15	09/18/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2	09/18/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-2-10	09/18/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-5	09/18/2007	WT	0.2	U	mg/L	Nitrate-N	0.20
Wap-6	09/18/2007	WT	0.4		mg/L	Nitrate-N	0.20
Wap-7	09/18/2007	WT	0.46		mg/L	Nitrate-N	0.20
Wap-1	06/26/2007	WT	0.04		mg/L	Orthophosphate	0.02
Wap-15	06/26/2007	WT	0.42		mg/L	Orthophosphate	0.02
Wap-2	06/26/2007	WT	0.04		mg/L	Orthophosphate	0.02
Wap-2-10	06/26/2007	WT	0.06		mg/L	Orthophosphate	0.02
Wap-5	06/26/2007	WT	0.04		mg/L	Orthophosphate	0.02
Wap-6	06/26/2007	WT	0.06		mg/L	Orthophosphate	0.02
Wap-7	06/26/2007	WT	0.05		mg/L	Orthophosphate	0.02
Wap-1	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-15	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2-10	07/24/2007	WT	0.02		mg/L	Orthophosphate	0.02
Wap-5	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-6	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-7	07/24/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-1	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-15	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2-10	08/21/2007	WT	0.07		mg/L	Orthophosphate	0.02
Wap-5	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-6	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-7	08/21/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-1	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-15	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-2-10	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-5	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-6	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-7	09/18/2007	WT	0.02	U	mg/L	Orthophosphate	0.02
Wap-15	06/26/2007	WT			mg/m3	Pheophytin	
Wap-2	06/26/2007	WT			mg/m3	Pheophytin	
Wap-5	06/26/2007	WT			mg/m3	Pheophytin	
Wap-6	06/26/2007	WT			mg/m3	Pheophytin	
Wap-15	07/24/2007	WT	15.94		mg/m3	Pheophytin	
Wap-2	07/24/2007	WT	44.58		mg/m3	Pheophytin	
Wap-5	07/24/2007	WT	14.95	mg/m3		Pheophytin	
Wap-6	07/24/2007	WT	3.83		mg/m3	Pheophytin	
Wap-15	08/21/2007	WT	54.06		mg/m3	Pheophytin	
Wap-2	08/21/2007	WT	46.51		mg/m3	Pheophytin	
Wap-5	08/21/2007	WT	47.45		mg/m3	Pheophytin	
Wap-6	08/21/2007	WT	7.52		mg/m3	Pheophytin	
Wap-15	09/18/2007	WT	15		mg/m3	Pheophytin	
Wap-2	09/18/2007	WT	50.5		mg/m3	Pheophytin	
Wap-5	09/18/2007	WT	21.7		mg/m3	Pheophytin	
Wap-6	09/18/2007	WT	5.79		mg/m3	Pheophytin	
Wap-1	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-15	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2-10	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-5	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-6	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-7	06/26/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-1	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-15	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2-10	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-5	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-6	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-7	07/24/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-1	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-15	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2-10	08/21/2007	WT	0.12		mg/L	Phosphorus, Total	0.10
Wap-5	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-6	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-7	08/21/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-1	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-15	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-2-10	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-5	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-6	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-7	09/18/2007	WT	0.1	U	mg/L	Phosphorus, Total	0.10
Wap-1	06/26/2007	WT	3.8		mg/L	Total Organic Carbon (TOC)	2.0
Wap-15	06/26/2007	WT	4.3		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2	06/26/2007	WT	3.3		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2-10	06/26/2007	WT	4		mg/L	Total Organic Carbon (TOC)	1.0
Wap-5	06/26/2007	WT	4		mg/L	Total Organic Carbon (TOC)	1.0
Wap-6	06/26/2007	WT	2.5		mg/L	Total Organic Carbon	1.0

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-7	06/26/2007	WT	3.6		mg/L	Total Organic Carbon (TOC)	1.0
Wap-1	07/24/2007	WT	5.4		mg/L	Total Organic Carbon (TOC)	2.0
Wap-15	07/24/2007	WT	3.8		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2	07/24/2007	WT	6		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2-10	07/24/2007	WT	2.6		mg/L	Total Organic Carbon (TOC)	1.0
Wap-5	07/24/2007	WT	3.7		mg/L	Total Organic Carbon (TOC)	1.0
Wap-6	07/24/2007	WT	1.6		mg/L	Total Organic Carbon (TOC)	1.0
Wap-7	07/24/2007	WT	1.7		mg/L	Total Organic Carbon (TOC)	1.0
Wap-1	08/21/2007	WT	5.7		mg/L	Total Organic Carbon (TOC)	4.0
Wap-15	08/21/2007	WT	5.1		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2	08/21/2007	WT	5.9		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2-10	08/21/2007	WT	2.3		mg/L	Total Organic Carbon (TOC)	1.0
Wap-5	08/21/2007	WT	6		mg/L	Total Organic Carbon (TOC)	1.0
Wap-6	08/21/2007	WT	2.2		mg/L	Total Organic Carbon (TOC)	1.0
Wap-7	08/21/2007	WT	1.3		mg/L	Total Organic Carbon (TOC)	1.0
Wap-1	09/18/2007	WT	6.2		mg/L	Total Organic Carbon (TOC)	2.0
Wap-15	09/18/2007	WT	4.7		mg/L	Total Organic Carbon (TOC)	1.0
Wap-2	09/18/2007	WT	5		mg/L	Total Organic Carbon (TOC)	1.0

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-2-10	09/18/2007	WT	4.5		mg/L	Total Organic Carbon (TOC)	1.0
Wap-5	09/18/2007	WT	5		mg/L	Total Organic Carbon (TOC)	1.0
Wap-6	09/18/2007	WT	2.5		mg/L	Total Organic Carbon (TOC)	1.0
Wap-7	09/18/2007	WT	2.8		mg/L	Total Organic Carbon (TOC)	1.0
Wap-1	06/26/2007	WT	12		mg/L	Total Suspended Solids	5
Wap-15	06/26/2007	WT	11		mg/L	Total Suspended Solids	5
Wap-2	06/26/2007	WT	6		mg/L	Total Suspended Solids	5
Wap-2-10	06/26/2007	WT	13		mg/L	Total Suspended Solids	5
Wap-5	06/26/2007	WT	11		mg/L	Total Suspended Solids	5
Wap-6	06/26/2007	WT	14		mg/L	Total Suspended Solids	5
Wap-7	06/26/2007	WT	11		mg/L	Total Suspended Solids	5
Wap-1	07/24/2007	WT	16		mg/L	Total Suspended Solids	5
Wap-15	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-2	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-2-10	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-5	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-6	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-7	07/24/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-1	08/21/2007	WT	12		mg/L	Total Suspended Solids	5
Wap-15	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-2	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-2-10	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-5	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-6	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-7	08/21/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-1	09/18/2007	WT	14		mg/L	Total Suspended Solids	5
Wap-15	09/18/2007	WT	9		mg/L	Total Suspended Solids	5
Wap-2	09/18/2007	WT	14		mg/L	Total Suspended Solids	5
Wap-2-10	09/18/2007	WT	13		mg/L	Total Suspended Solids	5

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-5	09/18/2007	WT	10		mg/L	Total Suspended Solids	5
Wap-6	09/18/2007	WT	5	U	mg/L	Total Suspended Solids	5
Wap-7	09/18/2007	WT	5		mg/L	Total Suspended Solids	5
Wap-1	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-15	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-2	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-2-10	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-5	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-6	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-7	06/26/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-1	07/24/2007	WT	10		mg/L	Volatile Suspended Solids	5
Wap-15	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-2	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-2-10	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-5	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-6	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-7	07/24/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-1	08/21/2007	WT	11		mg/L	Volatile Suspended Solids	5
Wap-15	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-2	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
Wap-2-10	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-5	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-6	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-7	08/21/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-1	09/18/2007	WT	8		mg/L	Volatile Suspended Solids	5
Wap-15	09/18/2007	WT	7		mg/L	Volatile Suspended Solids	5
Wap-2	09/18/2007	WT	10		mg/L	Volatile Suspended Solids	5
Wap-2-10	09/18/2007	WT	5		mg/L	Volatile Suspended Solids	5
Wap-5	09/18/2007	WT	10		mg/L	Volatile Suspended Solids	5
Wap-6	09/18/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
Wap-7	09/18/2007	WT	5	U	mg/L	Volatile Suspended Solids	5
WAP-BAR-MAR	06/26/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-BAR-MAR	07/24/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-BAR-MAR	08/21/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-CL-MAR	06/26/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-CL-MAR	07/24/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-CL-MAR	08/21/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-HL-MAR	06/26/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-HL-MAR	07/24/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-HL-MAR	08/21/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-LC-MAR	06/26/2007	WT	10		cfu/100ml	Fecal Coliform	

Site	Sample date	Matrix	Result	Qualifier	Unit	Analyte Name	Reporting_Limit
WAP-LC-MAR	07/24/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-LC-MAR	08/21/2007	WT	198		cfu/100ml	Fecal Coliform	
WAP-SUN-MAR	06/26/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-SUN-MAR	07/24/2007	WT	10		cfu/100ml	Fecal Coliform	
WAP-SUN-MAR	08/21/2007	WT	10		cfu/100ml	Fecal Coliform	

FIELD DATA

Site	Date	Depth	H2OTemp	Redox	Cond	D.O.%	D.O.(mg/L)	pH	Time	Seechi	Air Temp
WAP 7	6/26/2007	1/0/1900	24.99	327	186	74.2	6.02	7.58	950		82
WAP 6	6/26/2007	0.32	27.12	322	230	80.2	6.27	7.66	1019	18	
6	6/26/2007	1.08	26.67	325	230	76.8	5.98	7.65	1020		
6	6/26/2007	2	26.3	324	229	74.8	5.92	7.63	1022		
6	6/26/2007	3	21.03	336	243	68.8	6.08	7.42	1023		
WAP 5	6/26/2007	0.3	30.59	296	187	115.7	8.45	8.14	1057	17	84
5	6/26/2007	1	29.77	315	198	95.6	6.51	7.6	1059		
5	6/26/2007	2	27.84	330	226	4.6	0.31	7.31	1100		
5	6/26/2007	3	25.43	51	207	1.8	0.15	7.15	1102		
WAP 2	6/26/2007	0.34	31.19	227	160.7	131.3	9.53	8.65	1200	28	84
2	6/26/2007	1	29.93	232	160	116.6	8.81	8.43	1201		
2	6/26/2007	2	28.75	267	164	76.8	5.63	7.82	1202		
2	6/26/2007	3	25.73	266	206	4.4	0.32	7.27	1204		
2	6/26/2007	4	23.76	138	223	0.17	2.1	7.21	1205		
2	6/26/2007	5	21.15	69	234	1.6	0.14	7.16	1207		
2	6/26/2007	6	20.21	39	236	1.4	0.13	7.14	1208		
2	6/26/2007	7	19.88	14	236	1.3	0.12	7.14	1209		
2	6/26/2007	8	19.56	-4	223	1.2	0.11	7.15	1210		
2	6/26/2007	9	19.06	-17	232	1.2	0.11	7.18	1211		
WAP 1	6/26/2007	0.85	25.98	171	199	95.3	7.57	7.56	1334		89
7	7/24/2007	0.5	24.95	327	271.1	88.8	7.18	7.68	956		82
6	7/24/2007	0.9	26.01	274	287	110	87.4	7.87	1352	32	
6	7/24/2007	1.5	21.76	328	275.9	81.6	7.01	7.4			
6	7/24/2007	2	17.9	304	270	61.1	5.64	7.26			
6	7/24/2007	3	16.86	309	272	49.4	4.65	7.19			

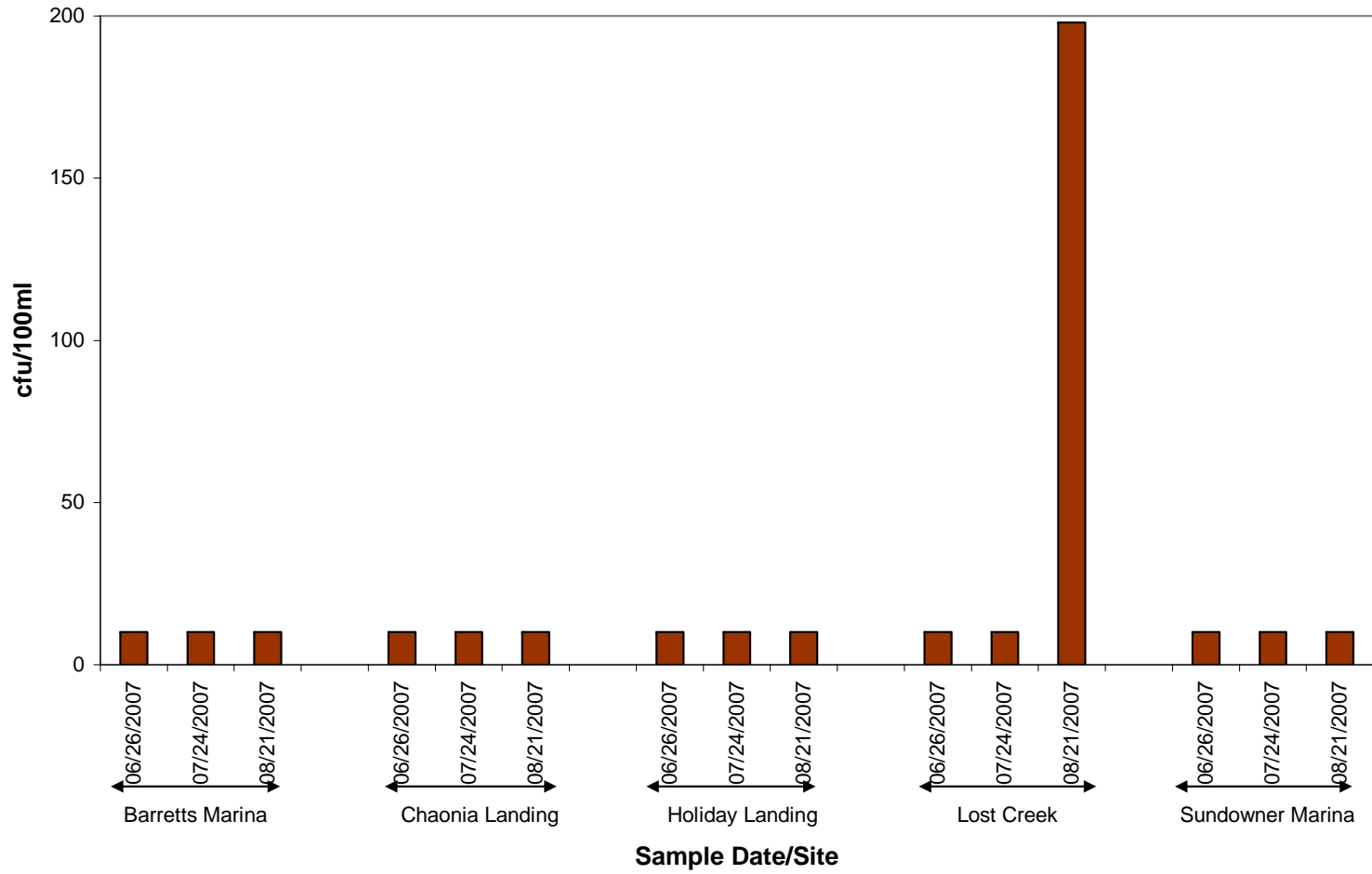
Site	Date	Depth	H2OTemp	Redox	Cond	D.O.%	D.O.(mg/L)	pH	Time	Seechi	Air Temp
5	7/24/2007	1.15	26.96	291	221	88	6.91	8.04	1120	15	
5	7/24/2007	2.14	26.8	295	221	85.1	6.46	7.86			
5	7/24/2007	3.17	26.1	296	225	80.3	6.41	7.9			
2	7/24/2007	1	27.69	236	178	120	8.9	8.72	1210	16	
2	7/24/2007	2	27.2	275	180	90	6.9	8.56			
2	7/24/2007	3	27.04	279	182	77.5	6.02	8.49			
2	7/24/2007	4	26.9	277	182	78.2	6.05	8.49			
2	7/24/2007	5	24.89	130	248	4.3	0.3	7.3			
1	7/24/2007	0.2	27.36	214	186	93.1	7.21	8.4	1245		
7	8/21/2007	0.33	26.84	307	270	76.1	6.01	7.42	933		
6	8/21/2007	0.3	27.97	297	285	93.4	7.23	7.7	1015	36	
6	8/21/2007	1	36.38	306	284.7	72.2	5.71	7.41			
6	8/21/2007	2	19.49	319	279	61	5.53	7.15			
6	8/21/2007	3	17.81	324	280	50.6	4.73	7.06			
5	8/21/2007	0.24	29.98	261	228.9	108.7	7.82	8.51	1051	10	
5	8/21/2007	1	28.98	281	233	57	4.26	7.95			
5	8/21/2007	2	28.49	281	233	58.7	4.5	7.96			
5	8/21/2007	3	27.98	285	233	53.5	4.12	7.83			
2	8/21/2007	0.25	29.5	249	188	101	7.64	8.68	1146	12	
2	8/21/2007	1	29.28	253	189	85.8	6.53	8.56			
2	8/21/2007	2	28.85	263	191	59.8	4.57	8.28			
2	8/21/2007	3	28.8	267	192	54.8	4.18	8.16			
2	8/21/2007	4	28.68	268	193	53.5	4.09	8.13			
2	8/21/2007	5	23.97	-29	296	3.5	0.28	7.07			
2	8/21/2007	6	22.18	-67	307	1.9	0.16	6.97			
2	8/21/2007	7	21.49	-80	310	1.5	0.13	6.91			
2	8/21/2007	8	21.31	-89	313	1.4	0.12	6.87			
2	8/21/2007	9	20.74	-88	334	1.3	0.11	6.76			

Site	Date	Depth	H2OTemp	Redox	Cond	D.O.%	D.O.(mg/L)	pH	Time	Seechi	Air Temp
1	8/21/2007	0.49	27.86	176	241.5	64.5	4.99	7.48	1300		
7	9/18/2007	0.57	21.55	253	266	92.4	8.06	7.55	1040		
6	9/18/2007	0.23	22.56	240	261	111.5	9.55	7.83	1113	42	
6	9/18/2007	1.3	21.62	244	261	108.2	9.38	7.77			
6	9/18/2007	2.19	19.91	253	267	96.4	8.63	7.53			
6	9/18/2007	3.15	17.58	261	271	83.9	7.9	7.36			
5	9/18/2007	0.26	24.75	213	199	132.6	10.9	8.53	1150	15	
5	9/18/2007	1	24.05	216	201	127	10.6	8.44			
5	9/18/2007	2	22.45	250	242	55.8	4.69	7.49			
5	9/18/2007	3	22.04	257	244	38.6	3.26	7.38			
2	9/18/2007	0.29	24.5	221	219	107.8	8.9	8.39	1234	16	
2	9/18/2007	1	23.37	343	229.4	59.4	4.77	7.68			
2	9/18/2007	2	23.26	248	231.6	48	4.04	7.59			
2	9/18/2007	3	23.08	249	231	46.9	3.97	7.56			
2	9/18/2007	4	22.99	250	233	43.2	3.63	7.5			
2	9/18/2007	5	22.95	253	238	33.9	2.89	7.43			
2	9/18/2007	6	22.92	255	243	27.9	2.32	7.38			
2	9/18/2007	7	22.9	256	246	16.4	1.37	7.34			
2	9/18/2007	8	22.88	257	252	5.1	0.41	7.26			
2	9/18/2007	9	21.66	-21	383	1.2	0.16	6.99			
1	9/18/2007	0.51	23.71	118	231	91.4	7.65	7.76	1311		

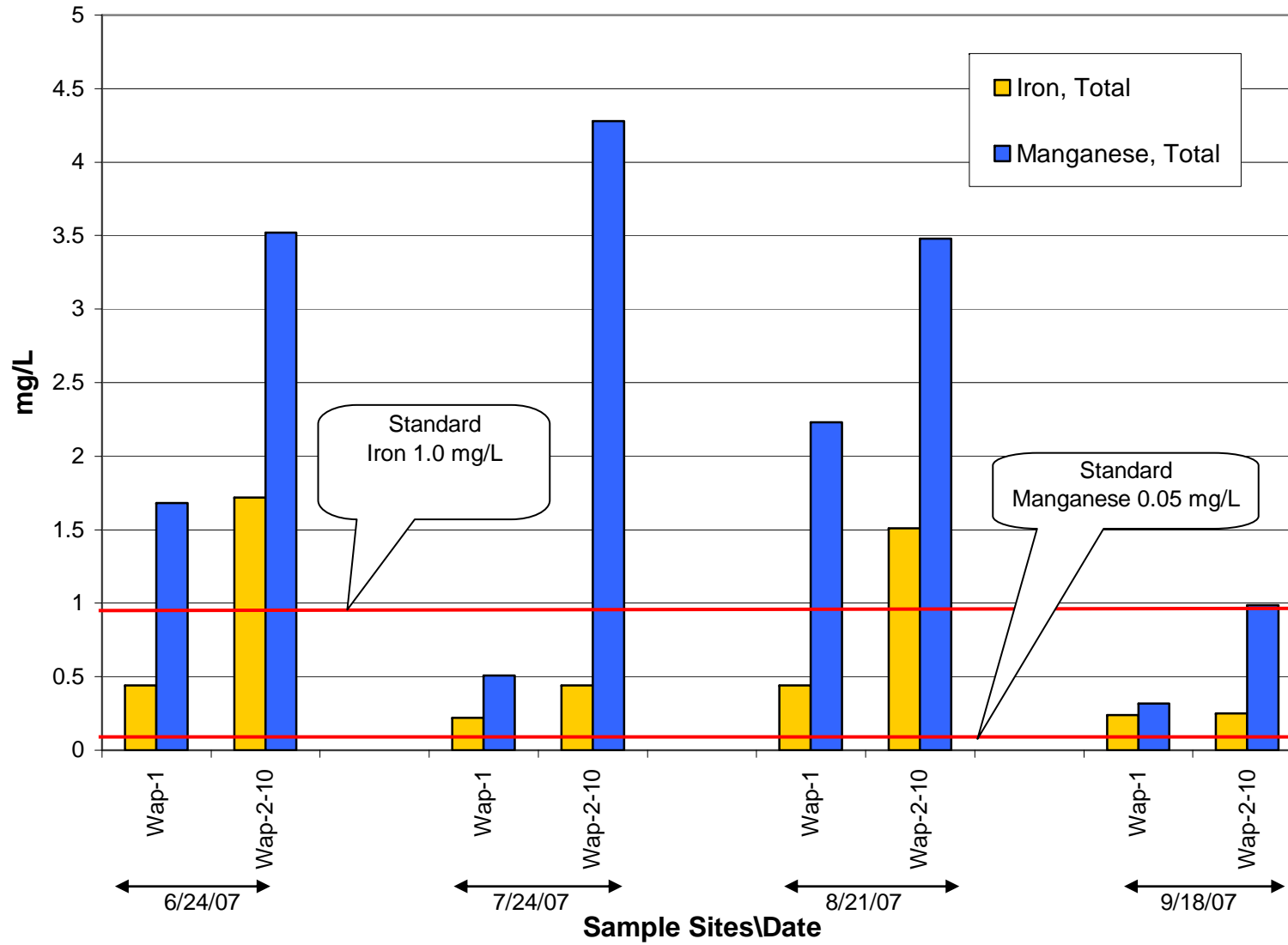
APPENDIX B

LAB DATA GRAPHS

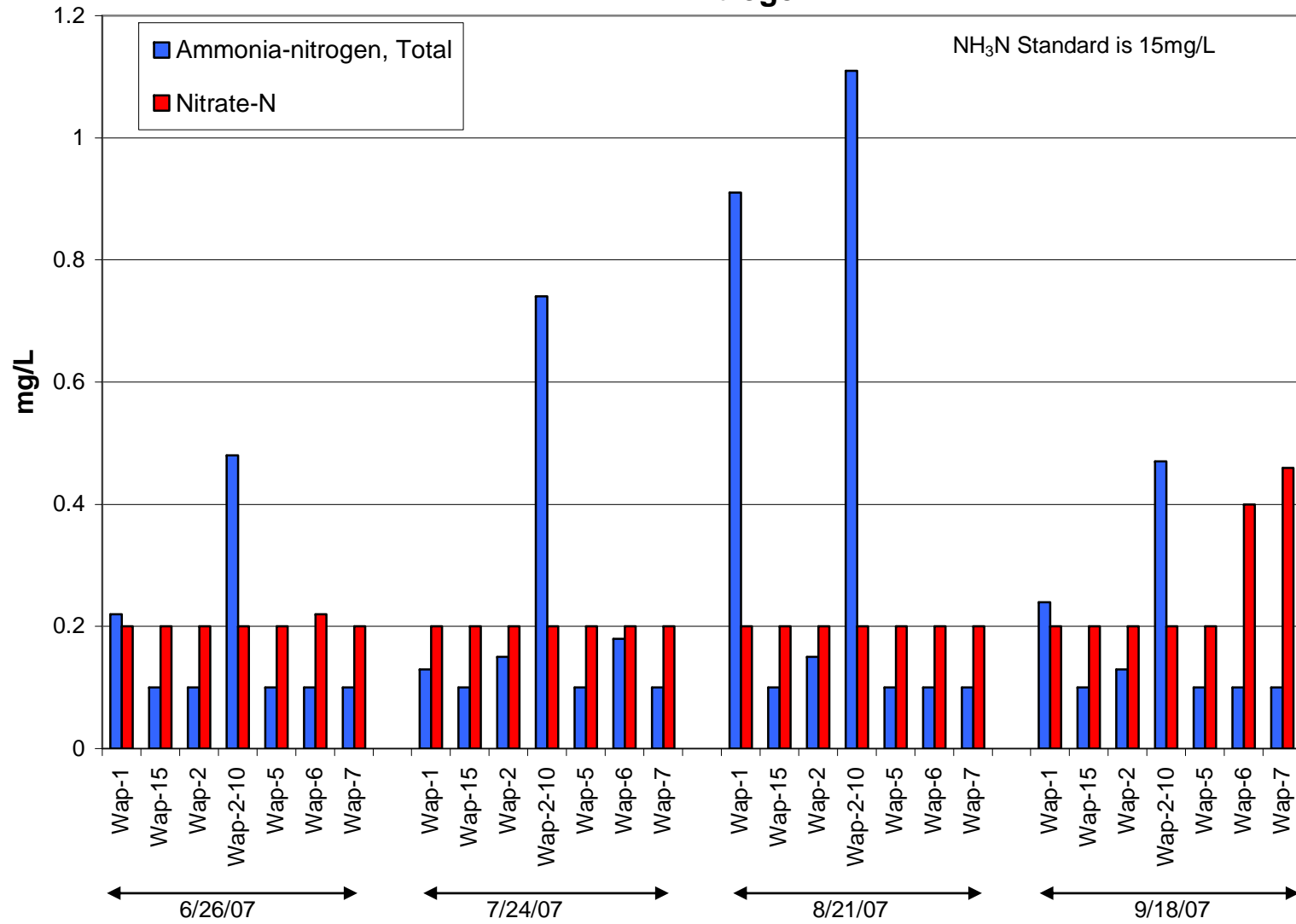
Fecal Coliform



Metals

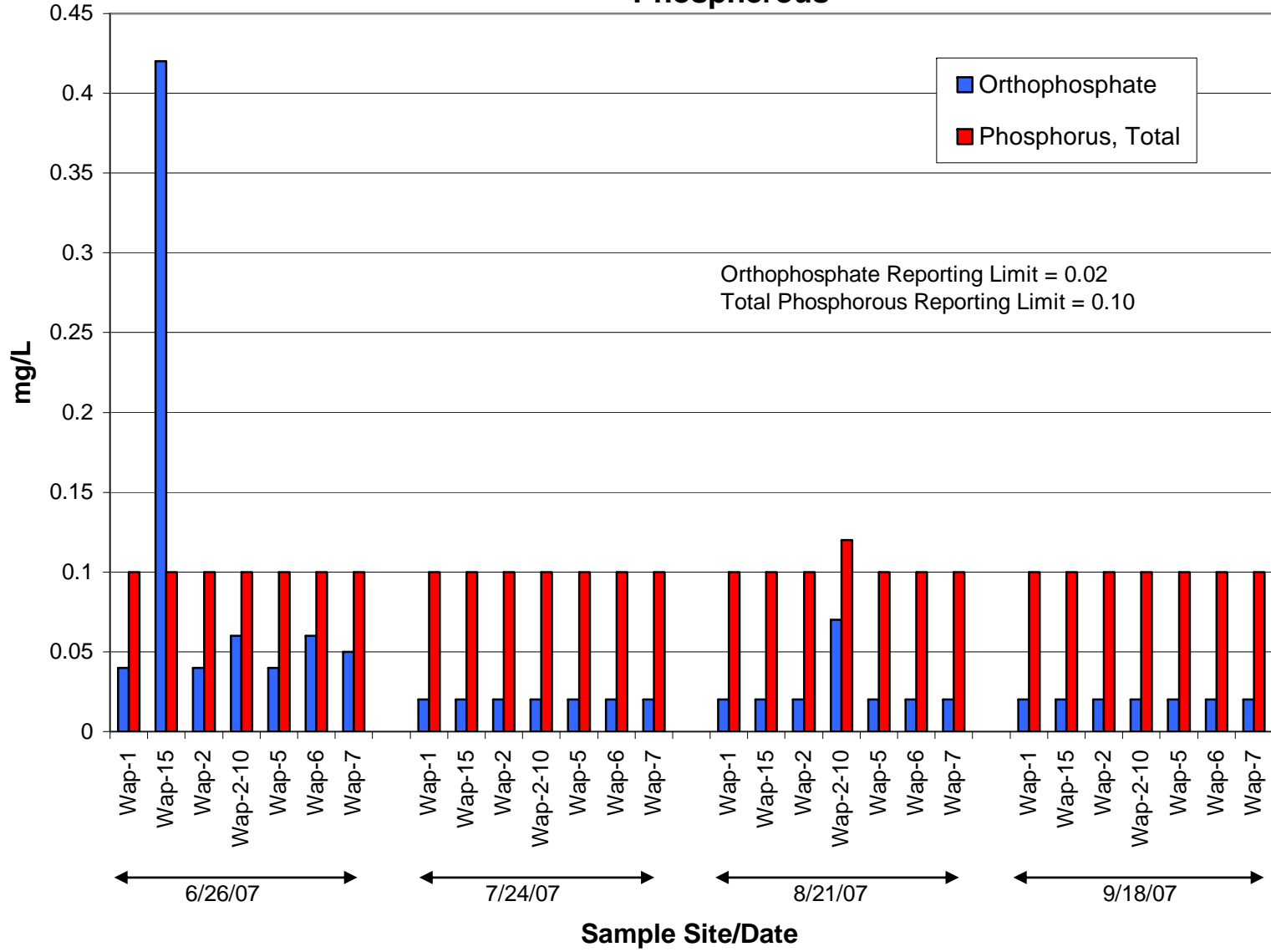


Nitrogen

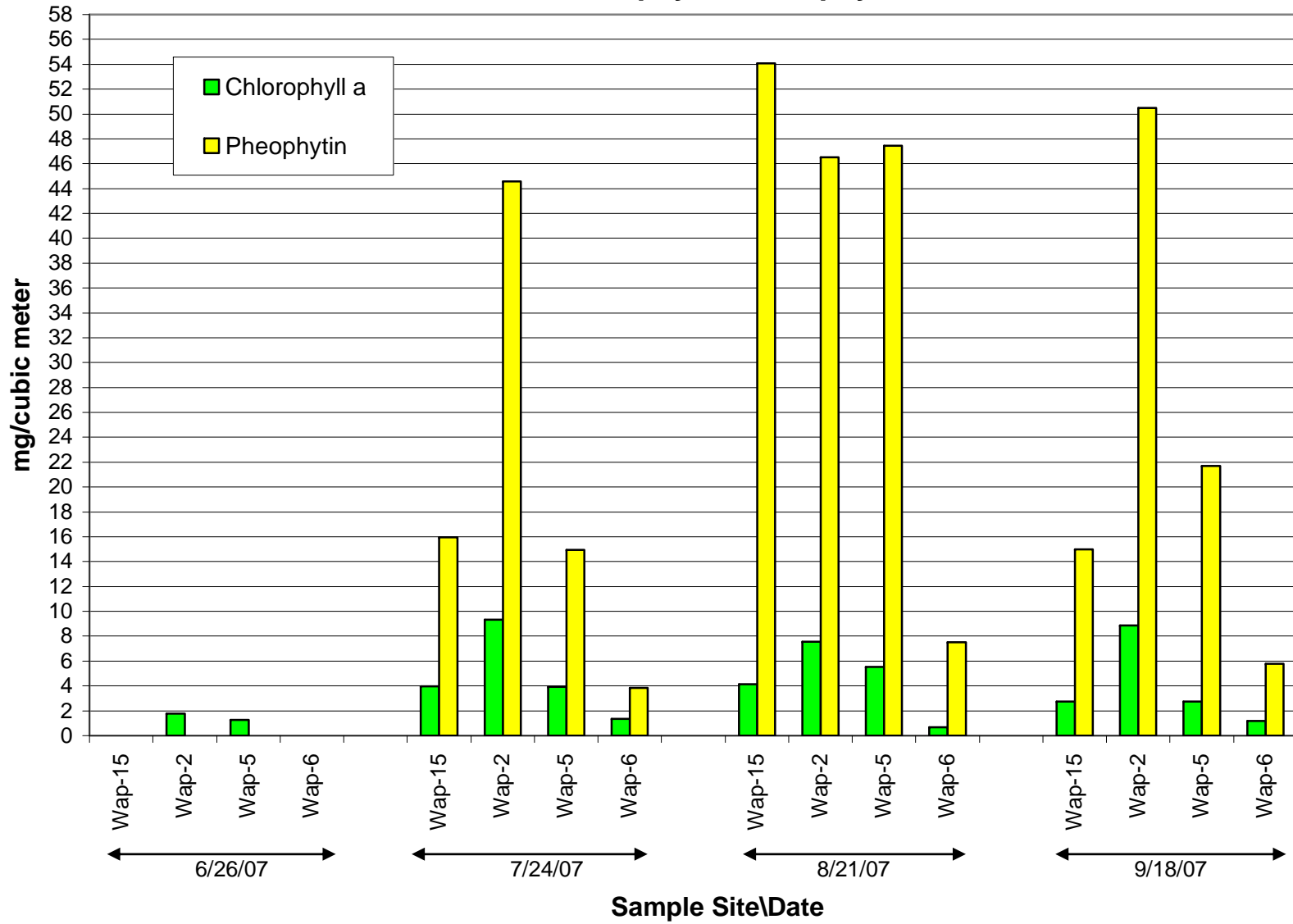


Sample Site/Date

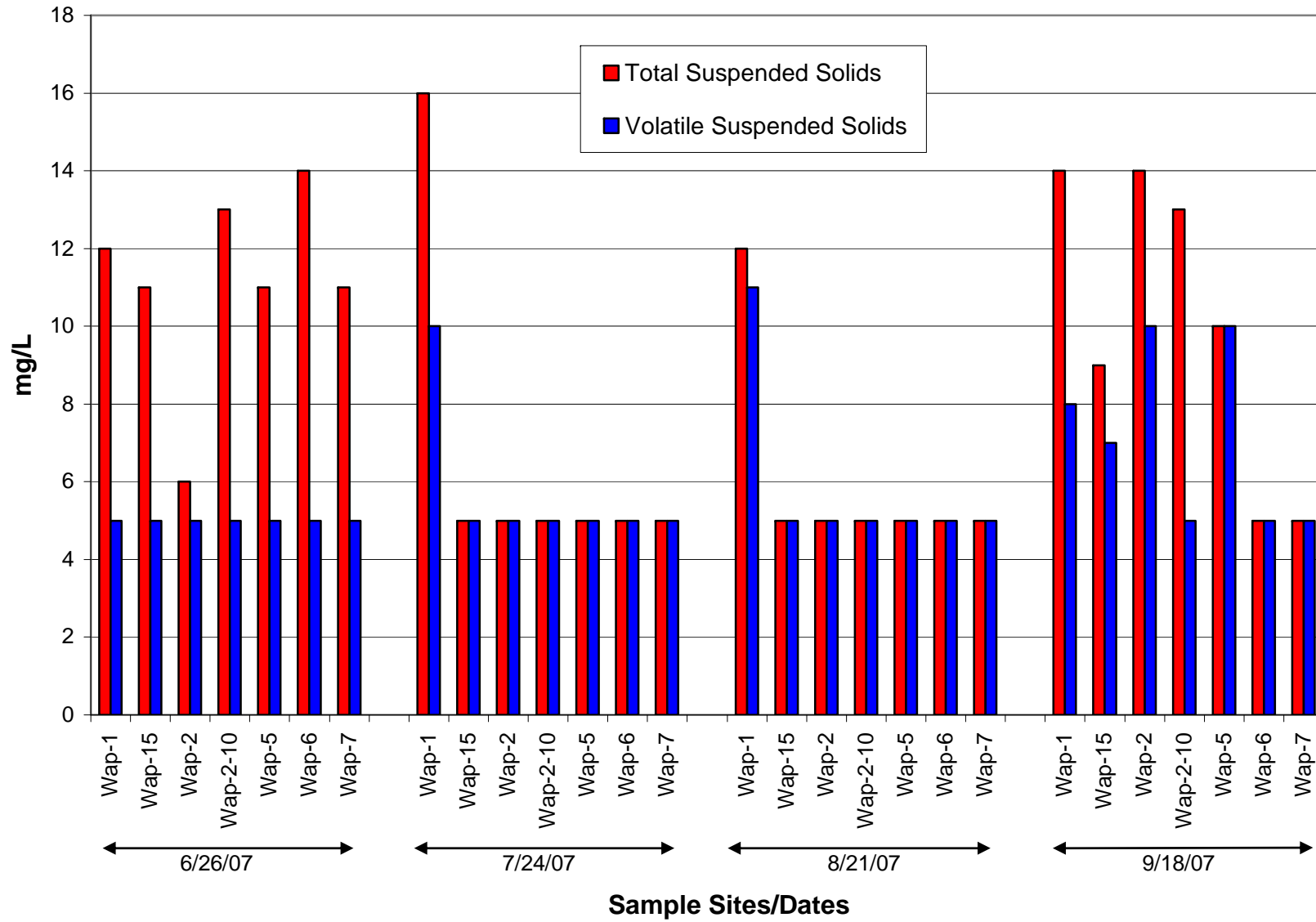
Phosphorous



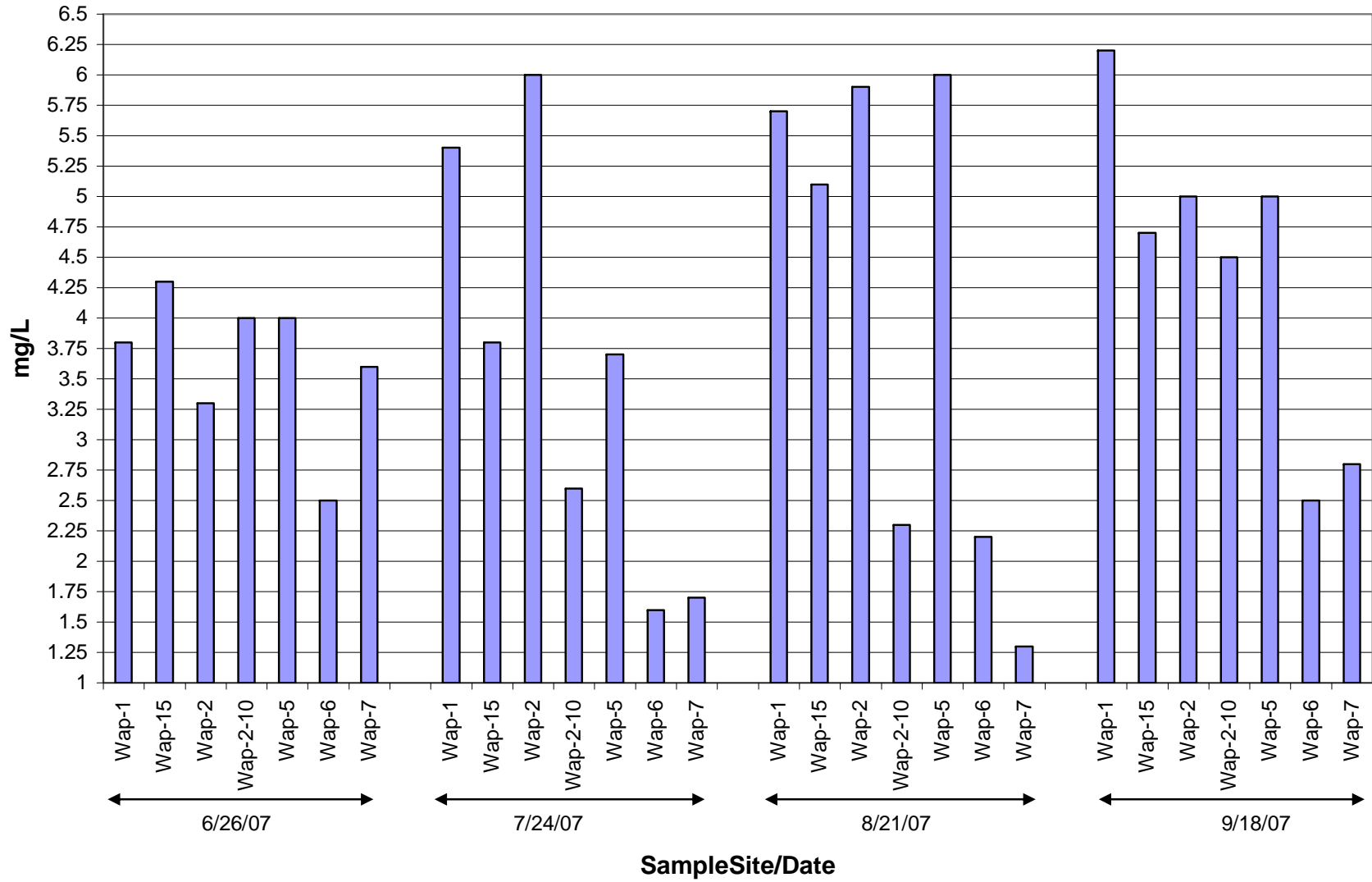
Chlorophyll & Pheophytin



Suspended Solids



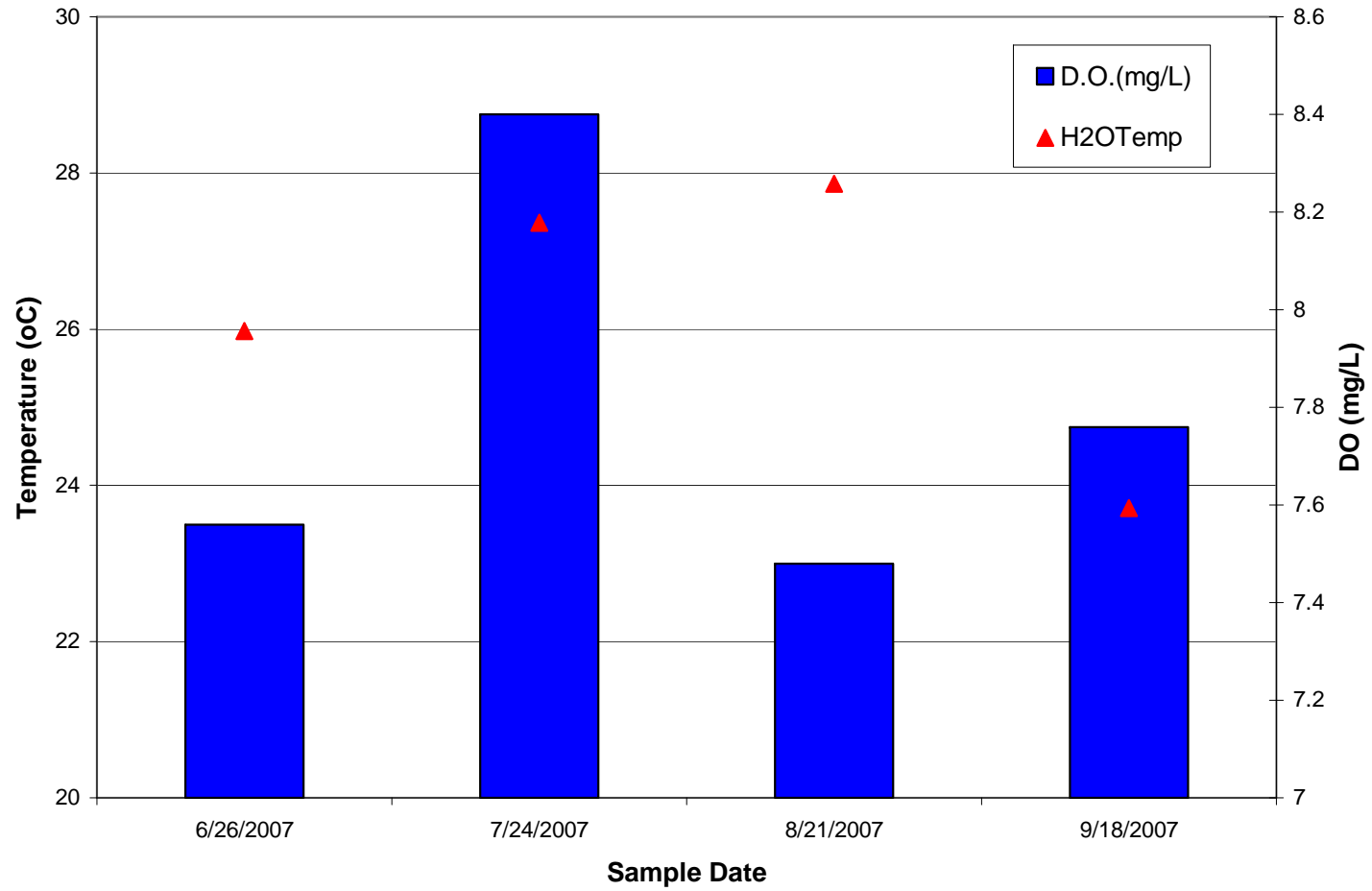
Total Organic Carbon (TOC)



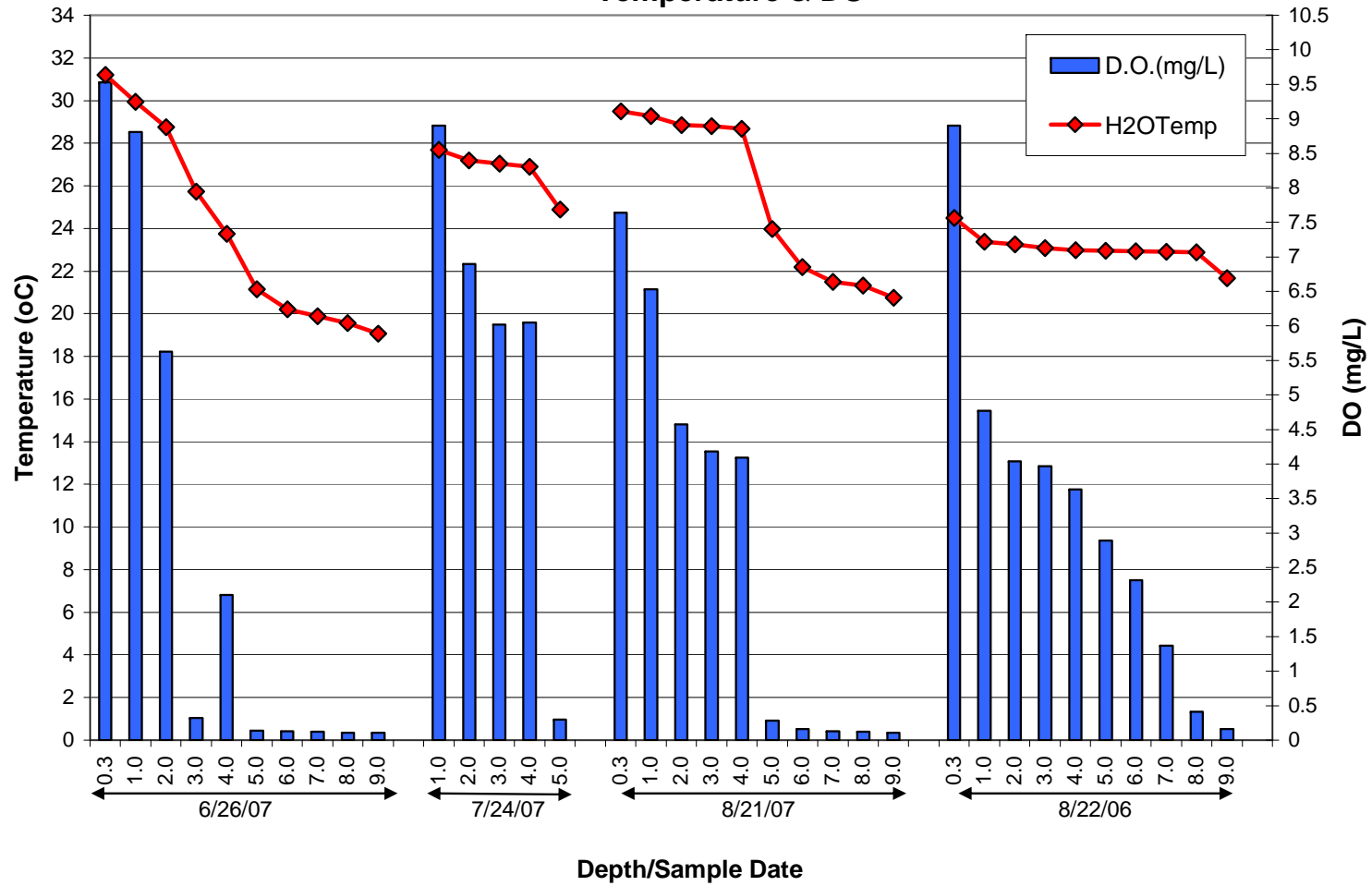
APPENDIX C

FIELD DATA GRAPHS

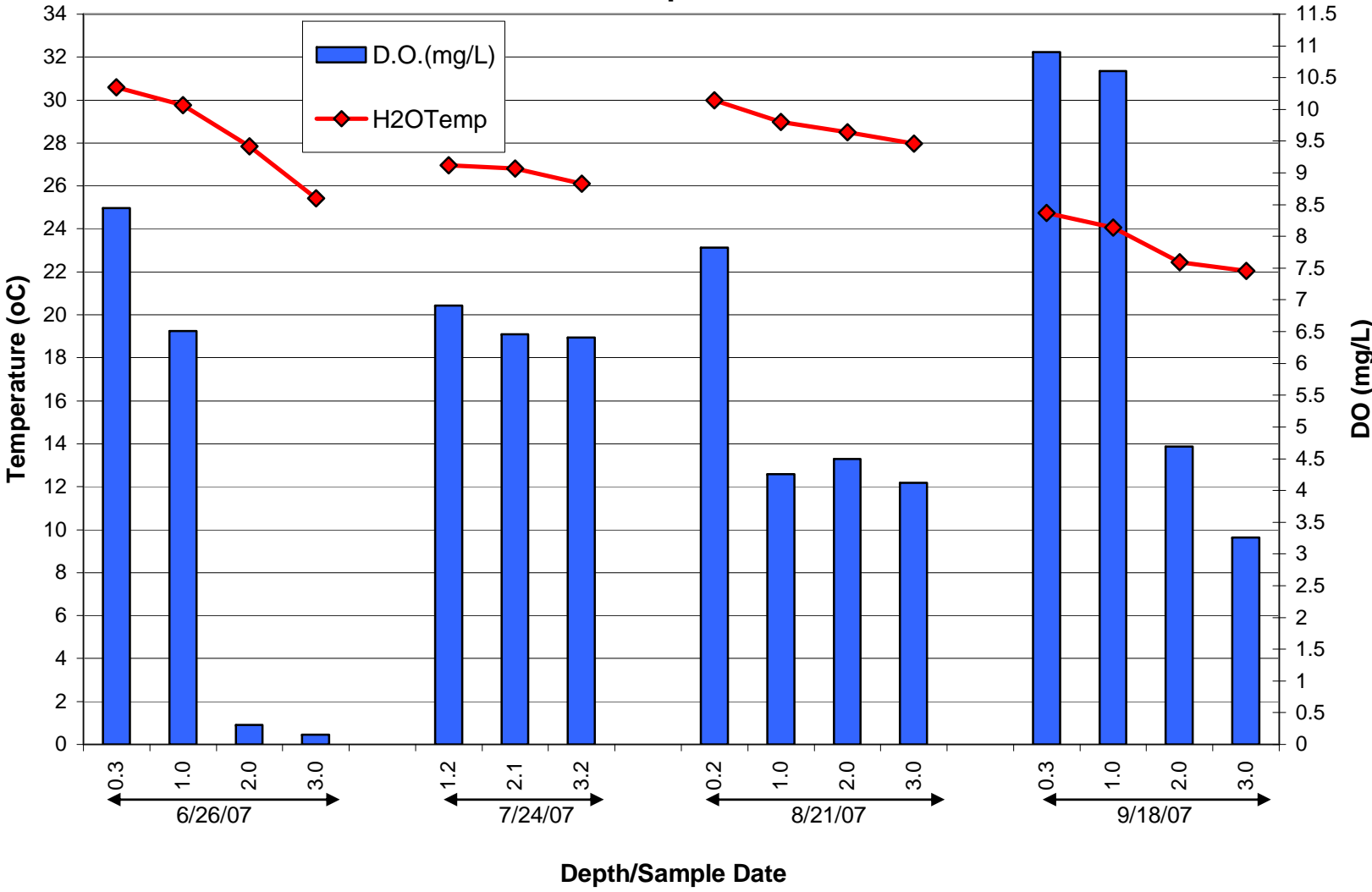
Site 1 Spillway Temperature & DO



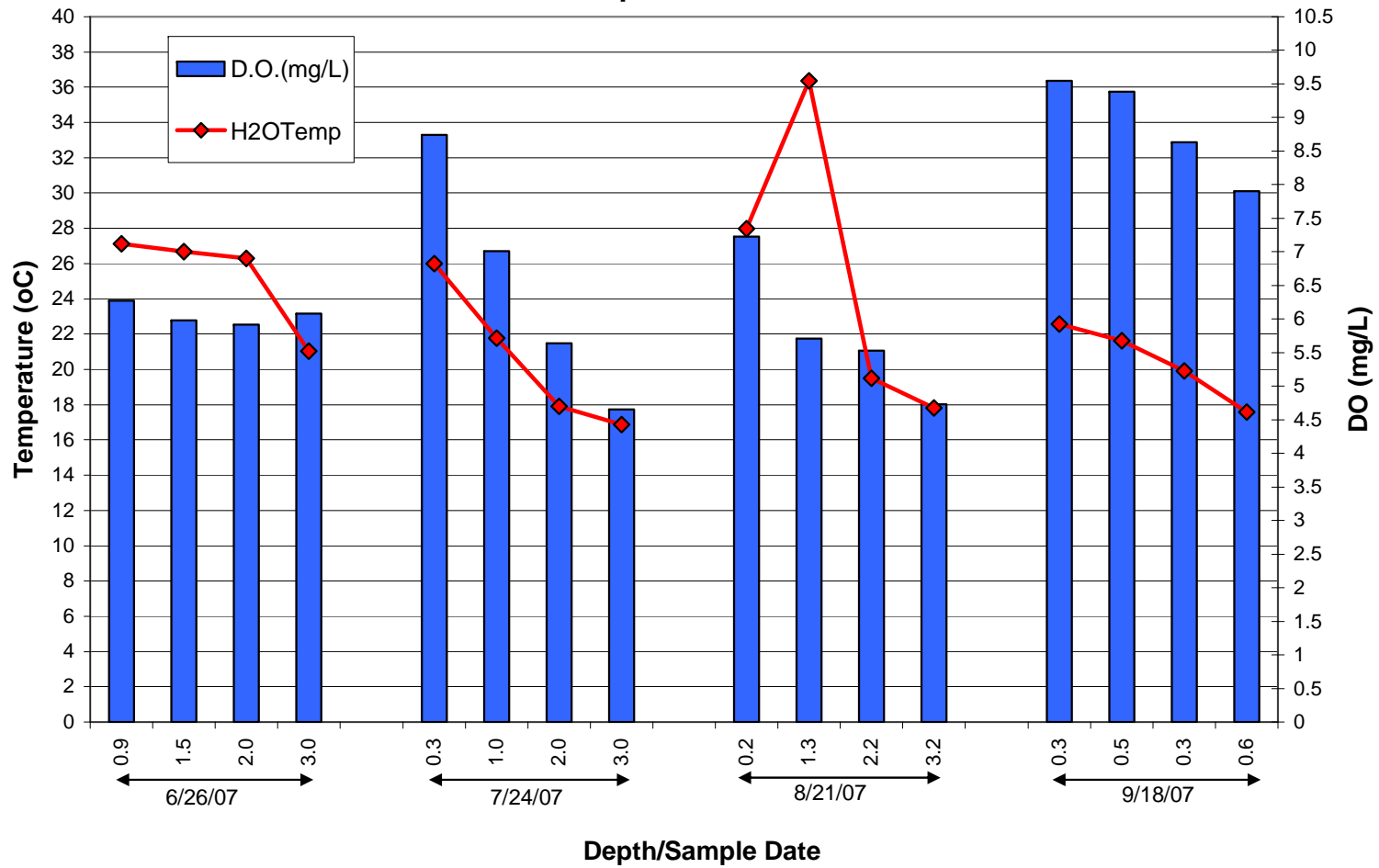
Site 2 Lake Side of Dam Temperature & DO



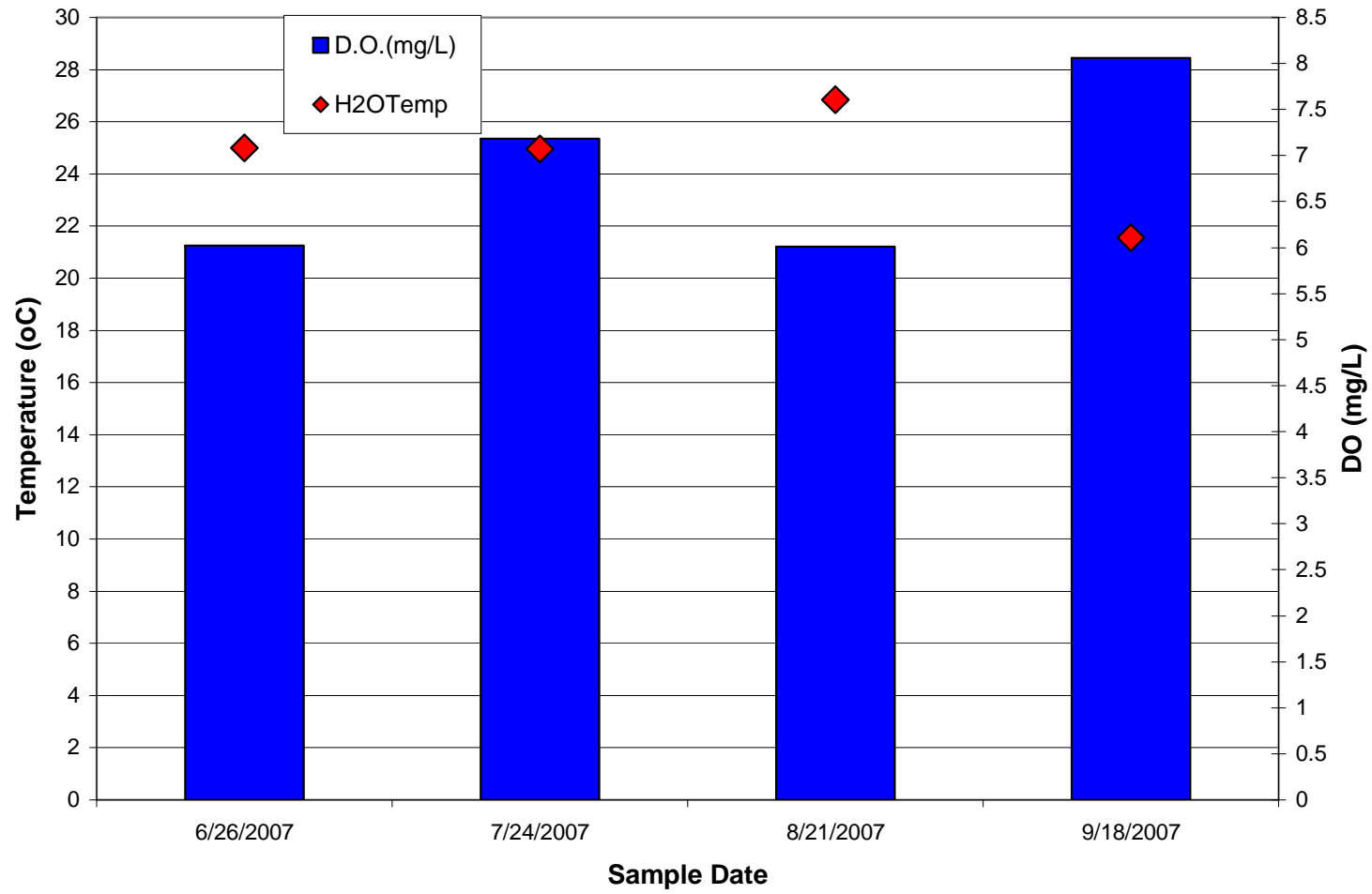
Site 5 Otter Creek Temperature & DO



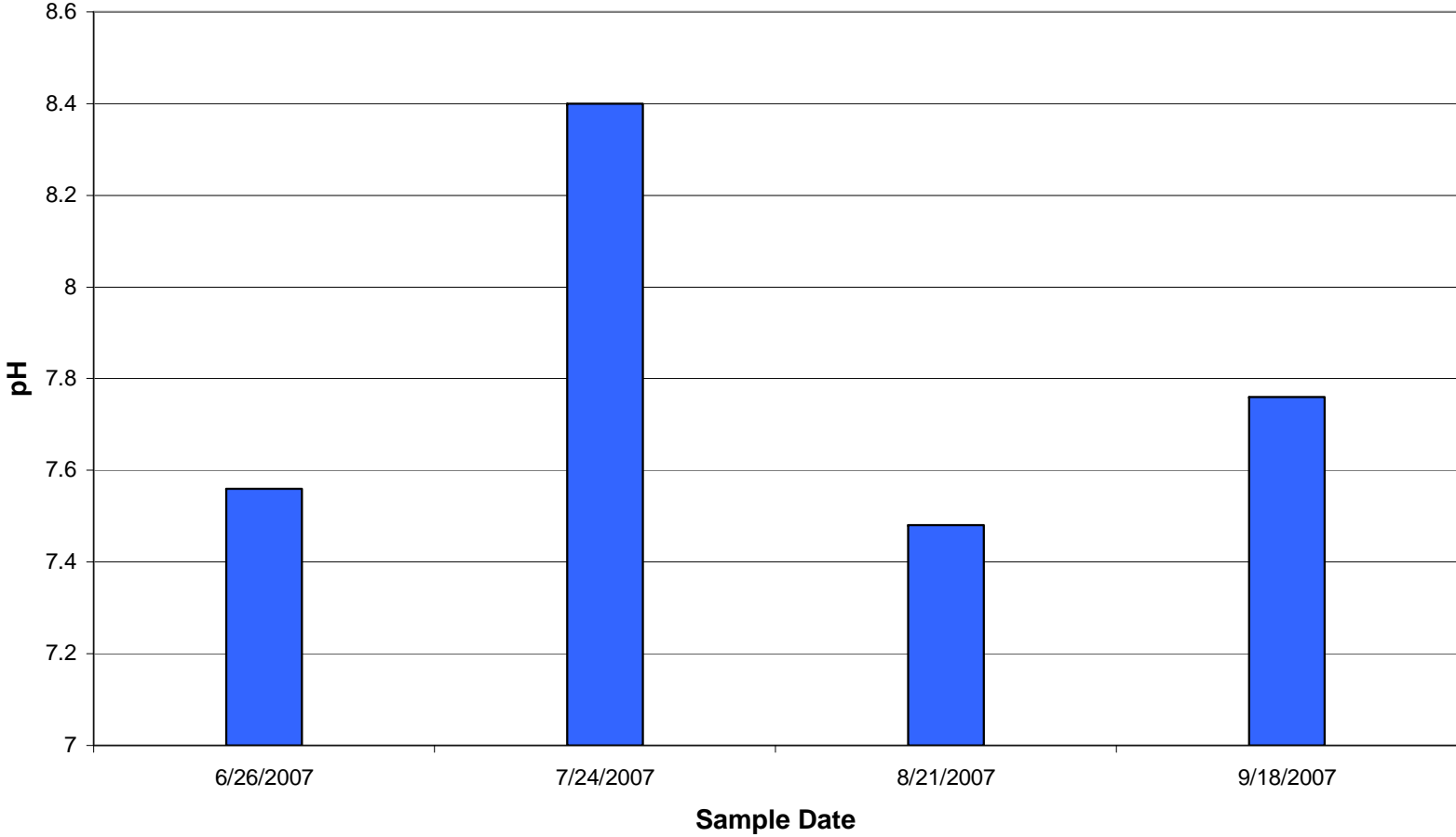
Site 6 Greenville Temperature & DO



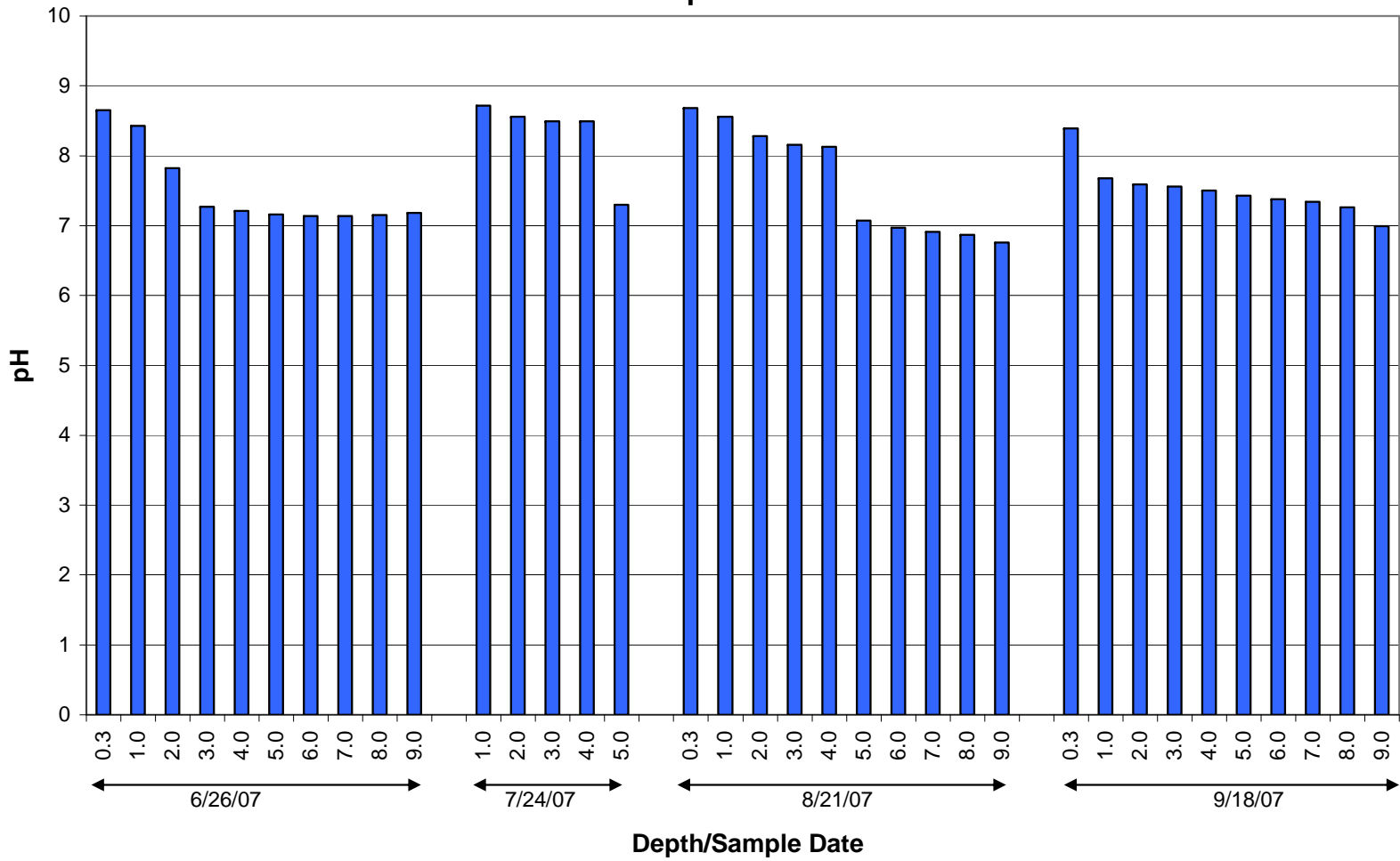
Site 7 Hwy 34 Bridge Temperature & DO



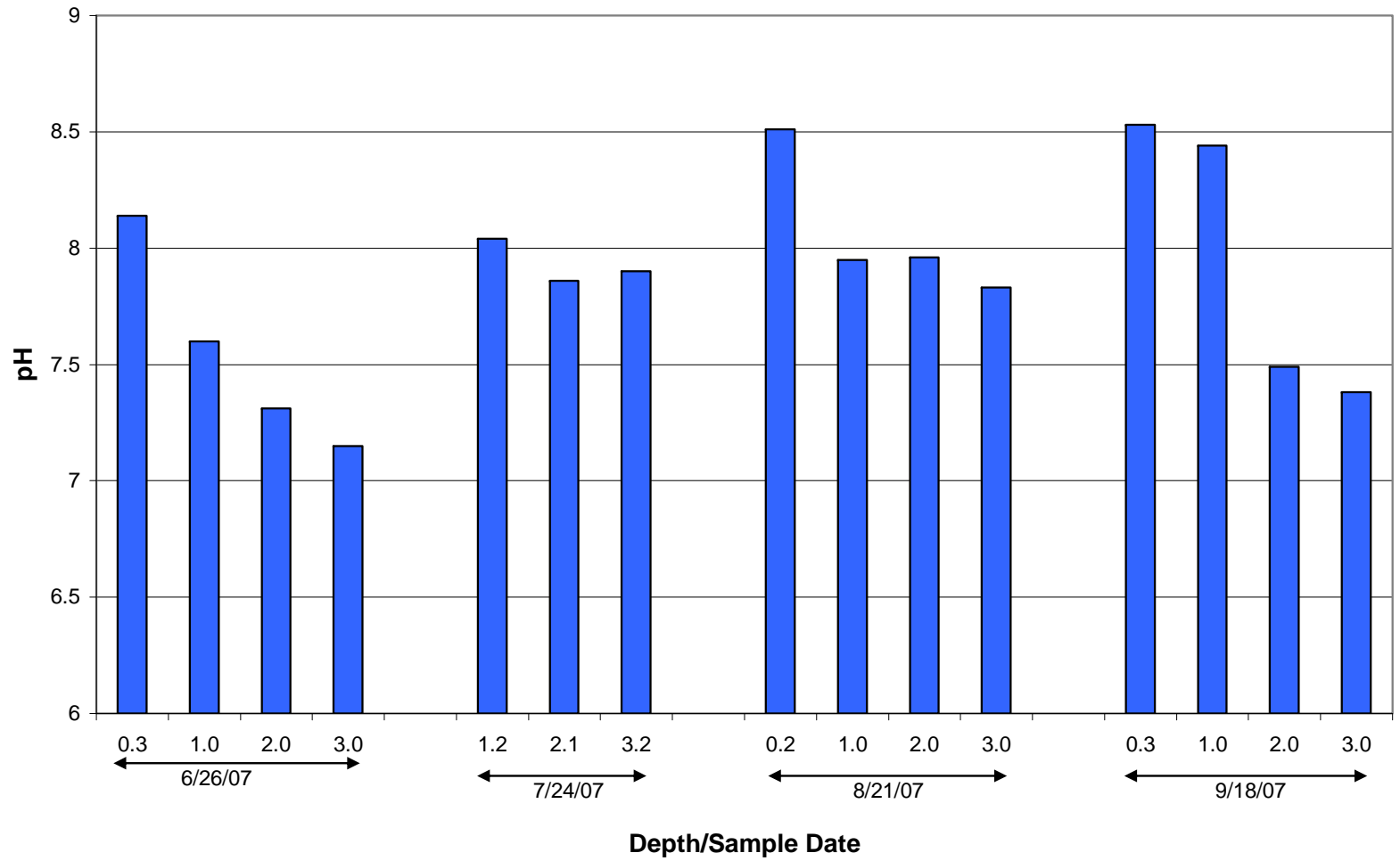
**Site 1 Spillway
pH**



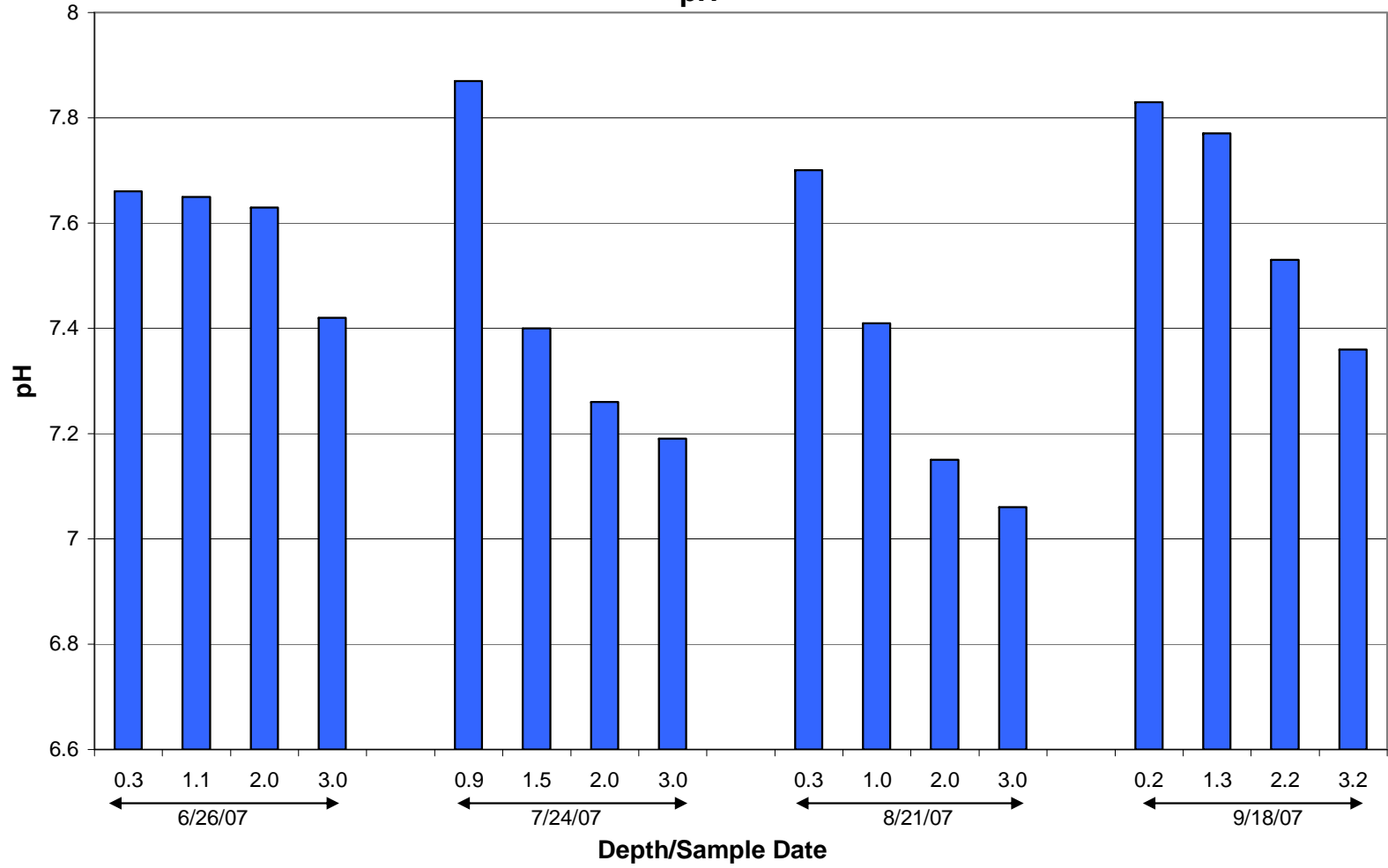
Site 2 Lake Side of Dam pH



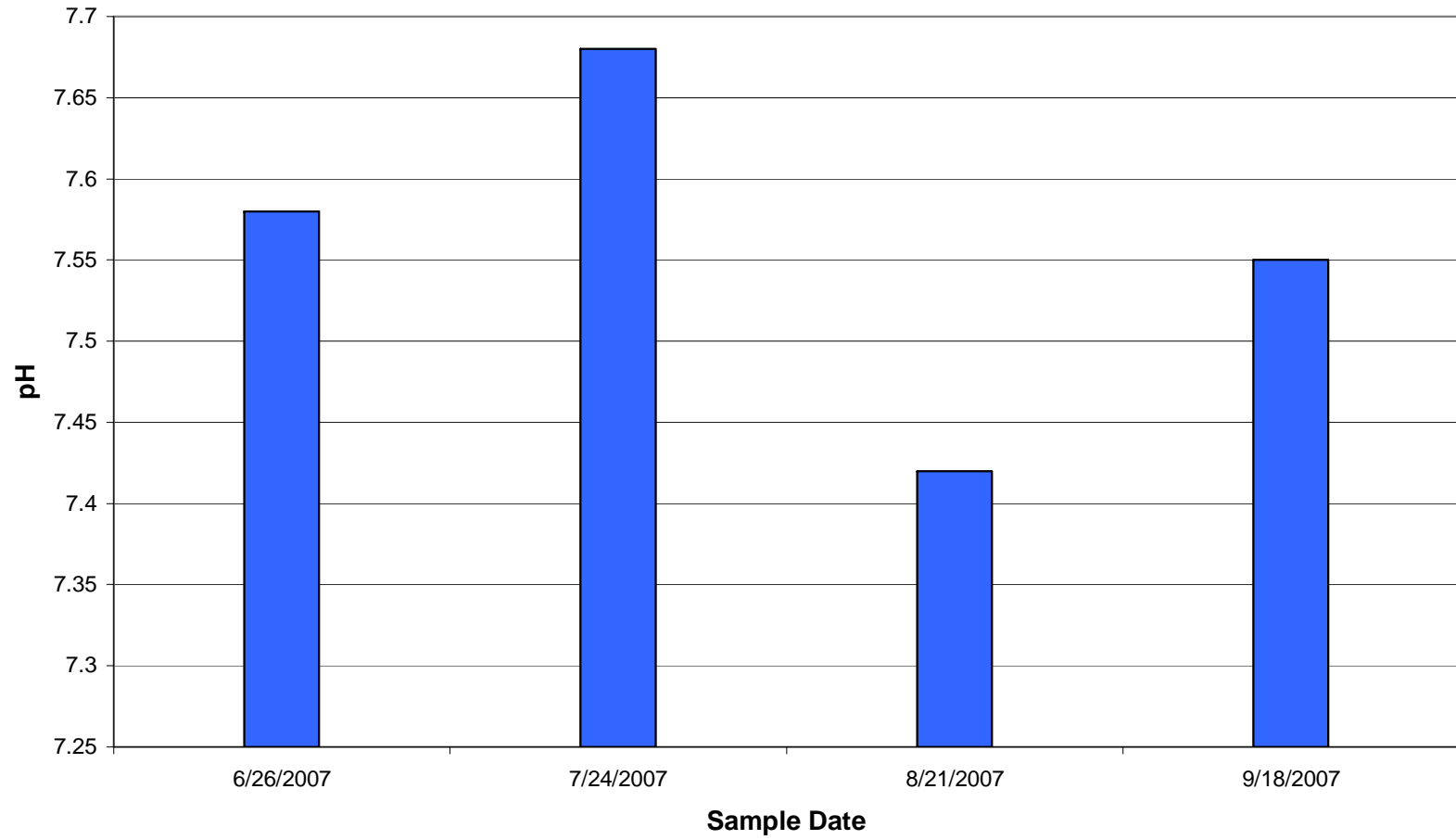
Site 5 otter Creek pH



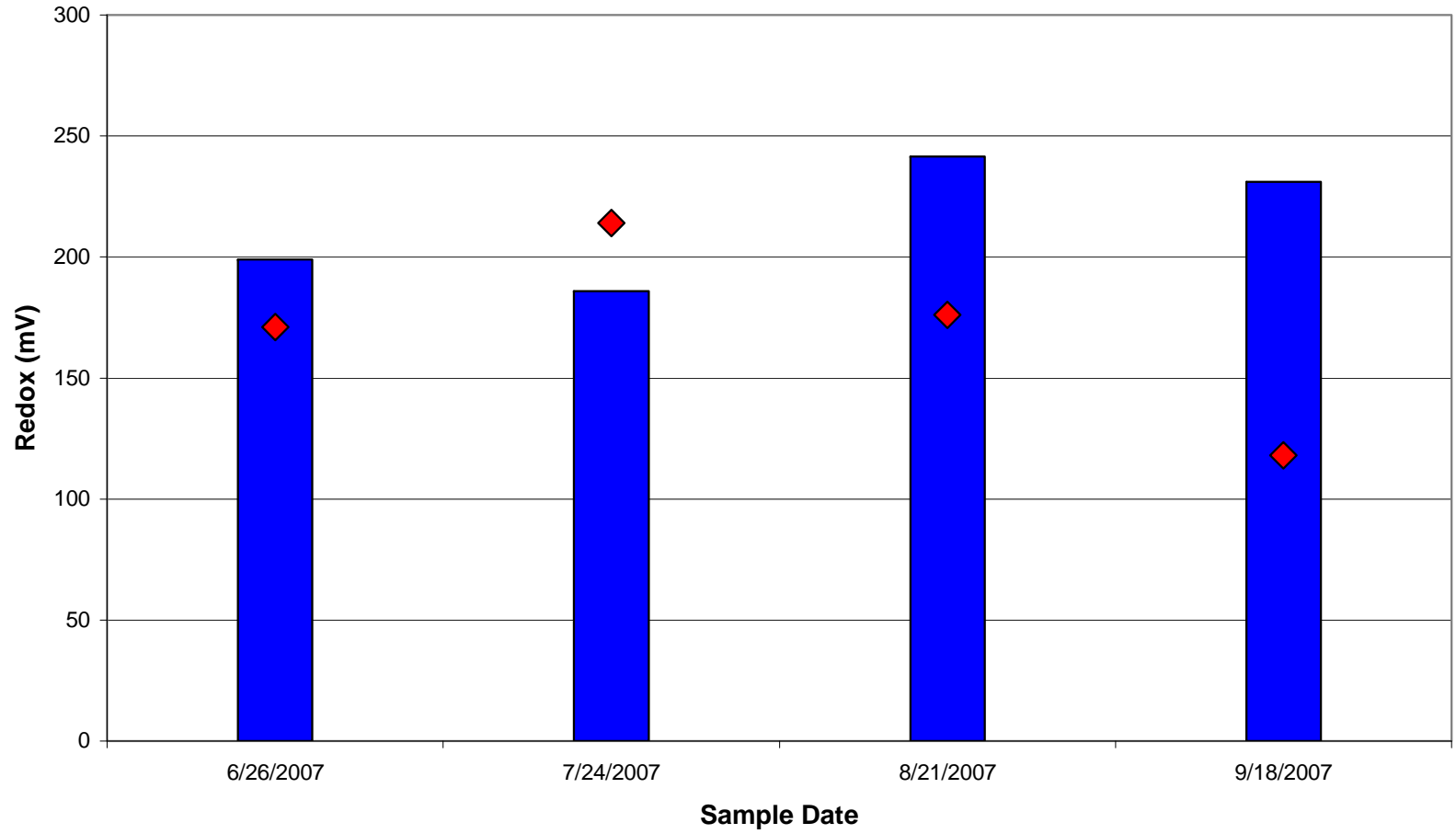
Site 6 Greenville pH



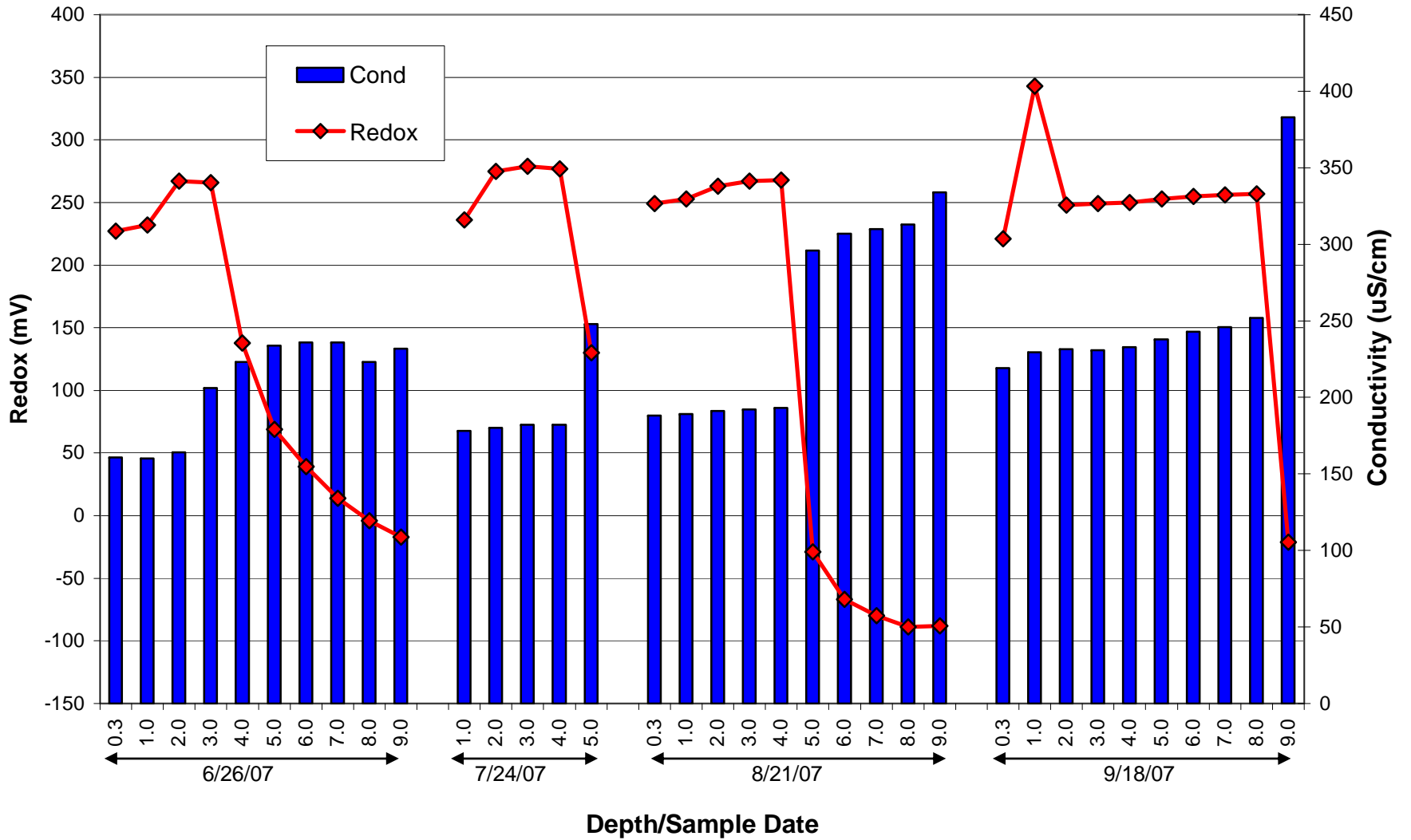
**Site 7 Hwy 34 Bridge
pH**



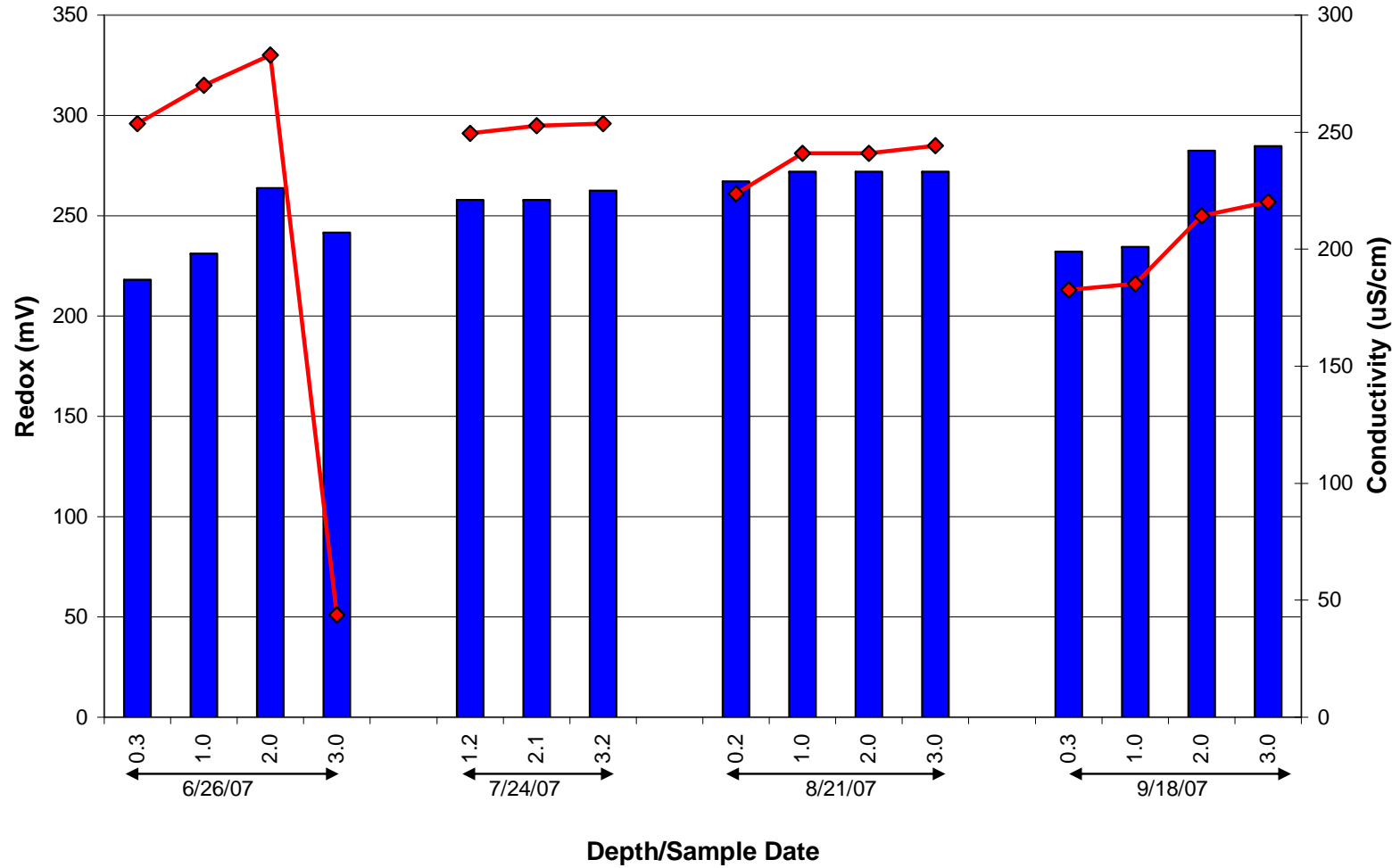
Site 1 Spillway Redox & Conductivity



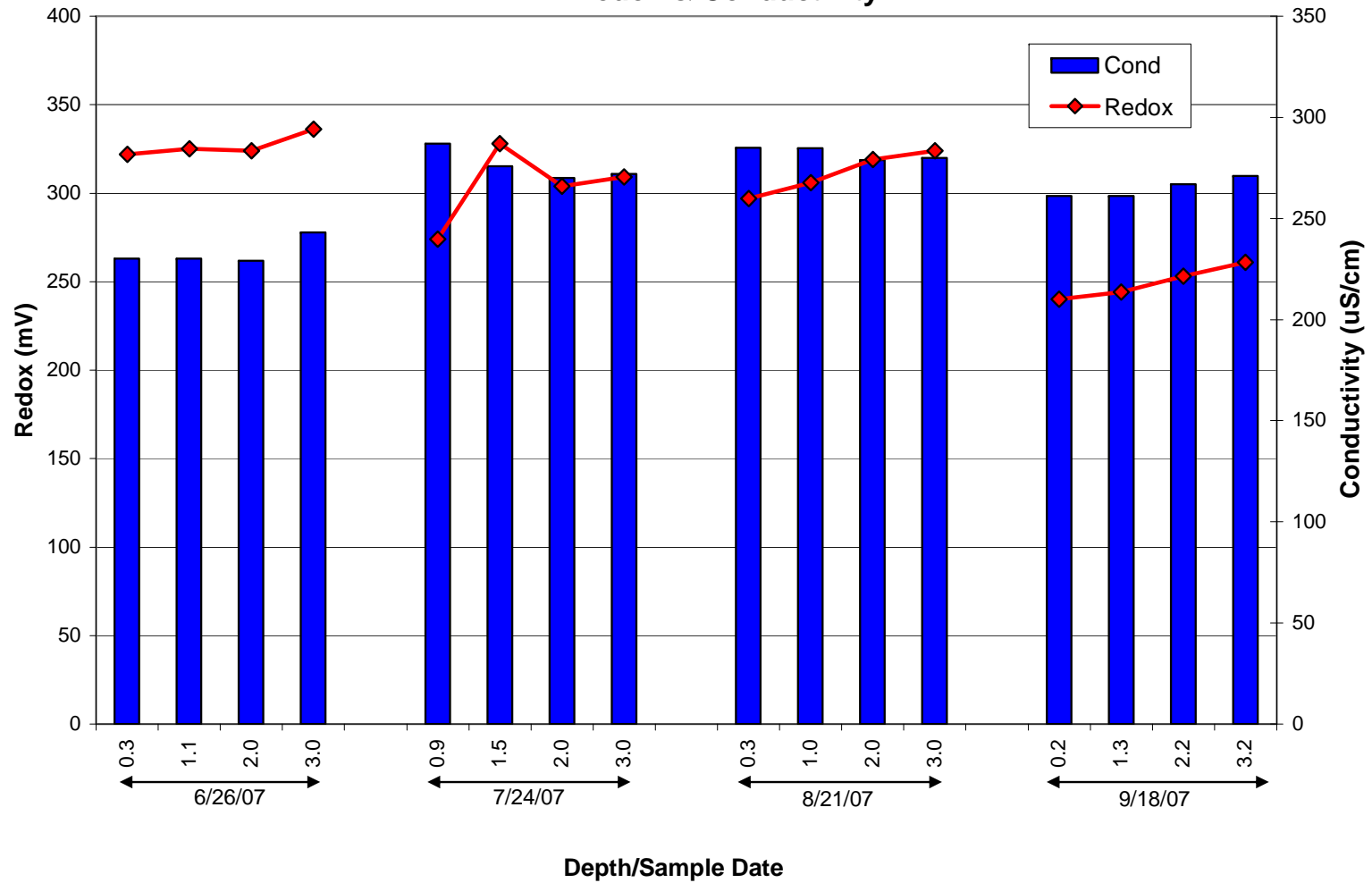
Site 2 Lake Side of Dam Redox & Conductivity



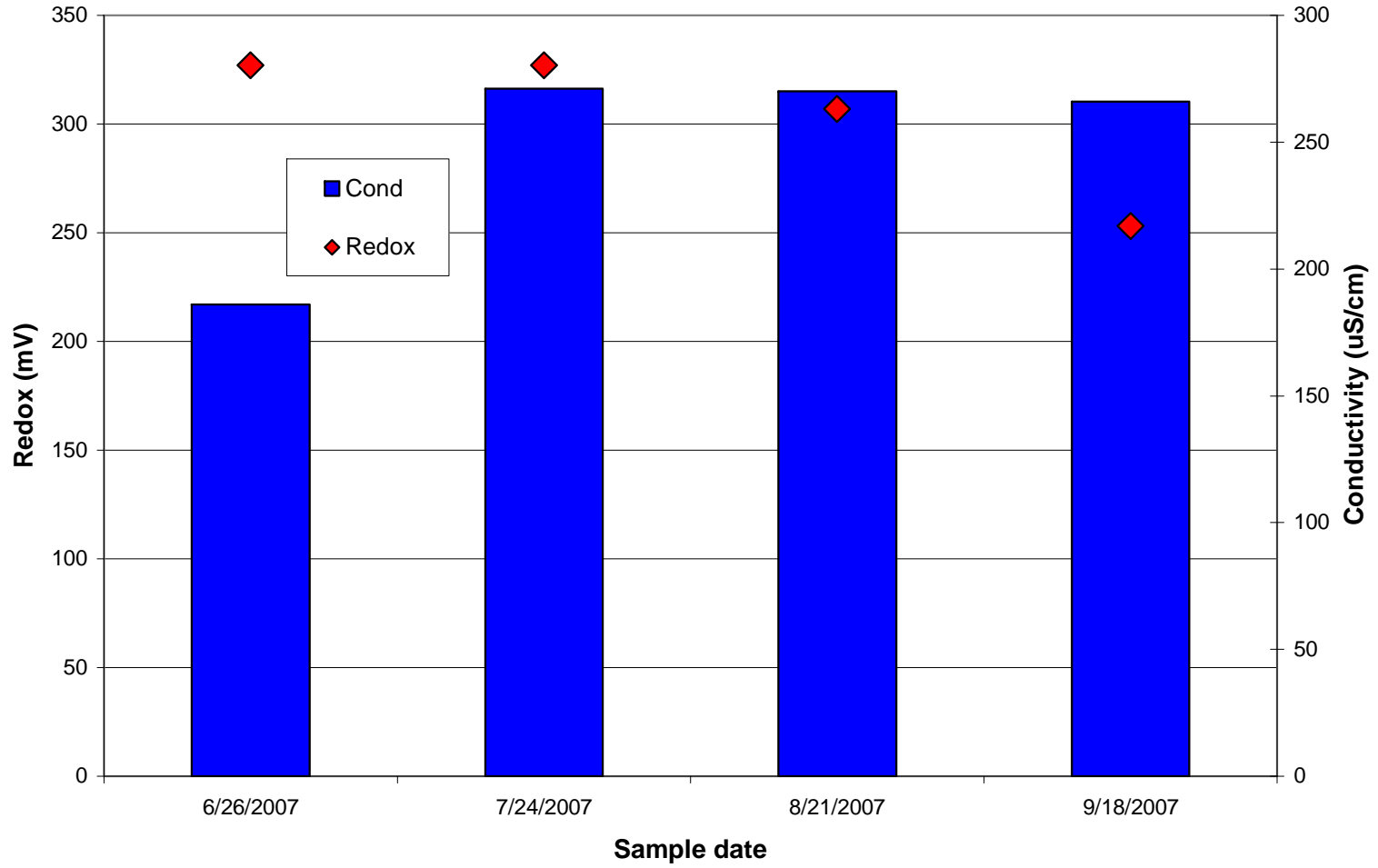
Site 5 Otter Creek Redox & Conductivity



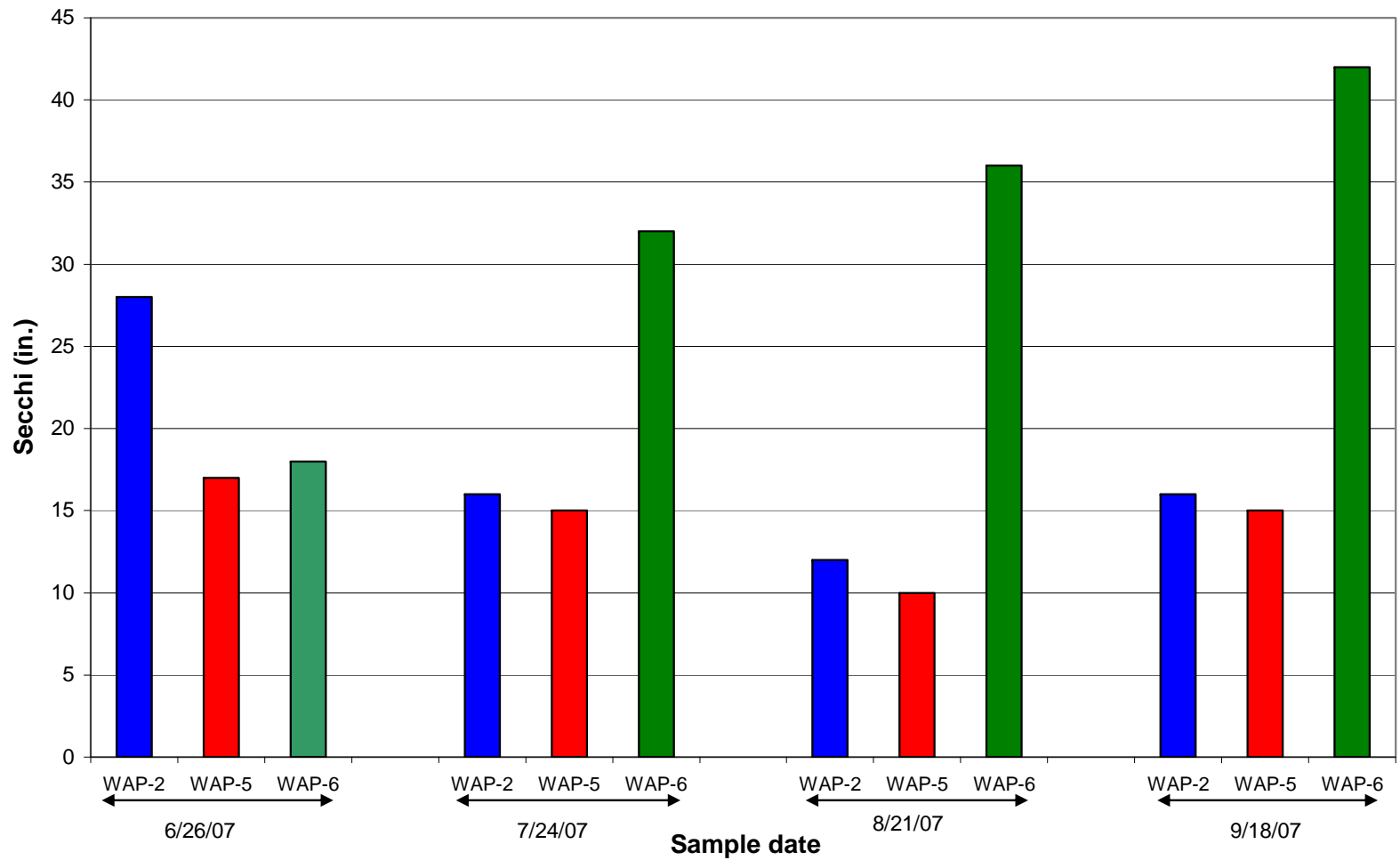
Site 6 Greenville Redox & Conductivity



Site 7 Hwy 34 Bridge Redox & Conductivity



Secchi(in)



APPENDIX D

Lakes of Missouri Volunteer Monitoring Data

Lakes of Missouri Volunteer Program (LMVP) Data

Lake Name	Date	Julian	Site	Temp (°F)	Secchi (in.)	TP (ug/L)	TN (ug/L)	CHL (ug/L)	NVSS (mg/L)	Lat	Long
Wappapello	5/10/07	130	1	70	59	23	310	8.4	1.5	36.9337	-90.2833
Wappapello	6/1/07	152	1	80	63	24	350	13.1	1.1	36.9337	-90.2833
Wappapello	6/29/07	180	1	84	18	32	560	30.8	6.4	36.9337	-90.2833
Wappapello	8/9/07	221	1	89	20	68	1100	75.4	3.1	36.9337	-90.2833
Wappapello	5/10/07	130	2	70	59	40	500	18.2	6.4	37.0207	-90.3069
Wappapello	6/1/07	152	2	79	62	27	400	12.7	2.4	37.0207	-90.3069
Wappapello	6/29/07	180	2	82	17	53	800	54.4	10.3	37.0207	-90.3069
Wappapello	8/9/07	221	2	91	25	97	1380	102.6	6.3	37.0207	-90.3069
Wappapello	5/10/07	130	3	70	59	83	690	6.2	38.1	37.1945	-90.5037
Wappapello	6/1/07	152	3	73		12	200	6.2	4.1	37.1945	-90.5037
Wappapello	6/29/07	180	3	73		20	270	4.1	7.5	37.1945	-90.5037
Wappapello	8/9/07	221	3	85		15	200	6	4.1	37.1945	-90.5037

Site 1 - Above Dam

Site 2 - Lost Creek Arm

Site 3 – Hwy 34 Bridge