2018

WAPPAPELLO LAKE

WATER QUALITY

REPORT

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

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Executive Summary

The purpose of this report is to provide an annual analysis of the water quality in the lake for the past year. Wappapello Lake is located on the upper St. Francis River in Wayne County, Missouri. The dam is located at river mile 213.2, 16 miles northeast of Poplar Bluff, Missouri, and regulates the drainage of 1,310 square miles. The area consists mainly of rugged upland terrain. Approximately 45% of the watershed upstream of the lake is included within the boundaries of the Mark Twain Forest and about 20% is privately owned woodland. Approximately 11% is used for the production of crops which consists of hay, small grains, and corn. Eight percent is used as pasture and the remaining 16% consists of roads, lakes, railroads and urban areas. The lake levels range from 31,100 acre-feet of water which covers 5,200 acres at conservation pool to 613,300 acre-feet which cover 23,200 acres at flood pool. Wappapello Dam and lake was authorized for downstream flood control by the Flood Control Act of 1936.

All sampling sites met the appropriate state standards during 2018 with the exception of dissolved oxygen, pH, phosphorous, total suspended solids, E. coliform, iron, and manganese. Phosphorous levels at the lake sites except site 6 have exceeded the state standard on a routine basis, however in 2018 most samples collected at most sites exceeded state standards. The tail water phosphorus levels were slightly lower than the lake sites. The project area has little pollution potentials at present time, no major form of degradation to the lake or streams is apparent. Constant water quality monitoring will continue to check future degradation of the watershed.

WATER QUALITY MONITORING PROGRAM

1.1 GENERAL OVERVIEW

This report summarizes water quality activities of the St. Louis District for Fiscal Year 2017 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 to 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 to 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 Lakes of Missouri Volunteer Program (LMVP) in cooperation with the University of Missouri-Columbia has been taking samples at 3 sites since 1989. The LMVP only analyze for Nutrients and Chlorophyll. The LMVP did not sample in 2017 or 2018. See appendix D for 2016 data.

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 Total Maximum Daily Loads (TMDL), to improve water quality.

The 2018 Missouri Department of Natural Resources 303(d) lists the upper St. Francis River as impaired for temperature. 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.

1.2 INTRODUCTION

Wappapello Lake is located on the upper St. Francis River in southeastern Missouri and is primarily utilized as a recreational lake. Lake Wappapello is an 8,400 acre reservoir located in Wayne County, with the southern arms reaching into Butler County. Construction of this lake began in September of 1938 and was completed in June 1941. Approximately 71% of Lake Wappapello's, 1,310 square mile watershed is forested and 21% is covered by grassland. The surrounding lands are residential with little agricultural use due to the steep 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 authorized purposes of Wappapello Lake are to provide flood control for the St. Francis River and its tributaries, and to provide and manage recreation, and fish and wildlife conservation on project lands and waters. 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 ensure that federal and state regulations are met.

The water quality monitoring program was conducted during 2018 at five sites to assure that safe conditions were maintained for human recreation, wildlife, and aquatic life. 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 4 marinas. 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 sampling events took place during 2018, between March and September. The locations of the five sampling sites are depicted on the lake map in Figure 1.

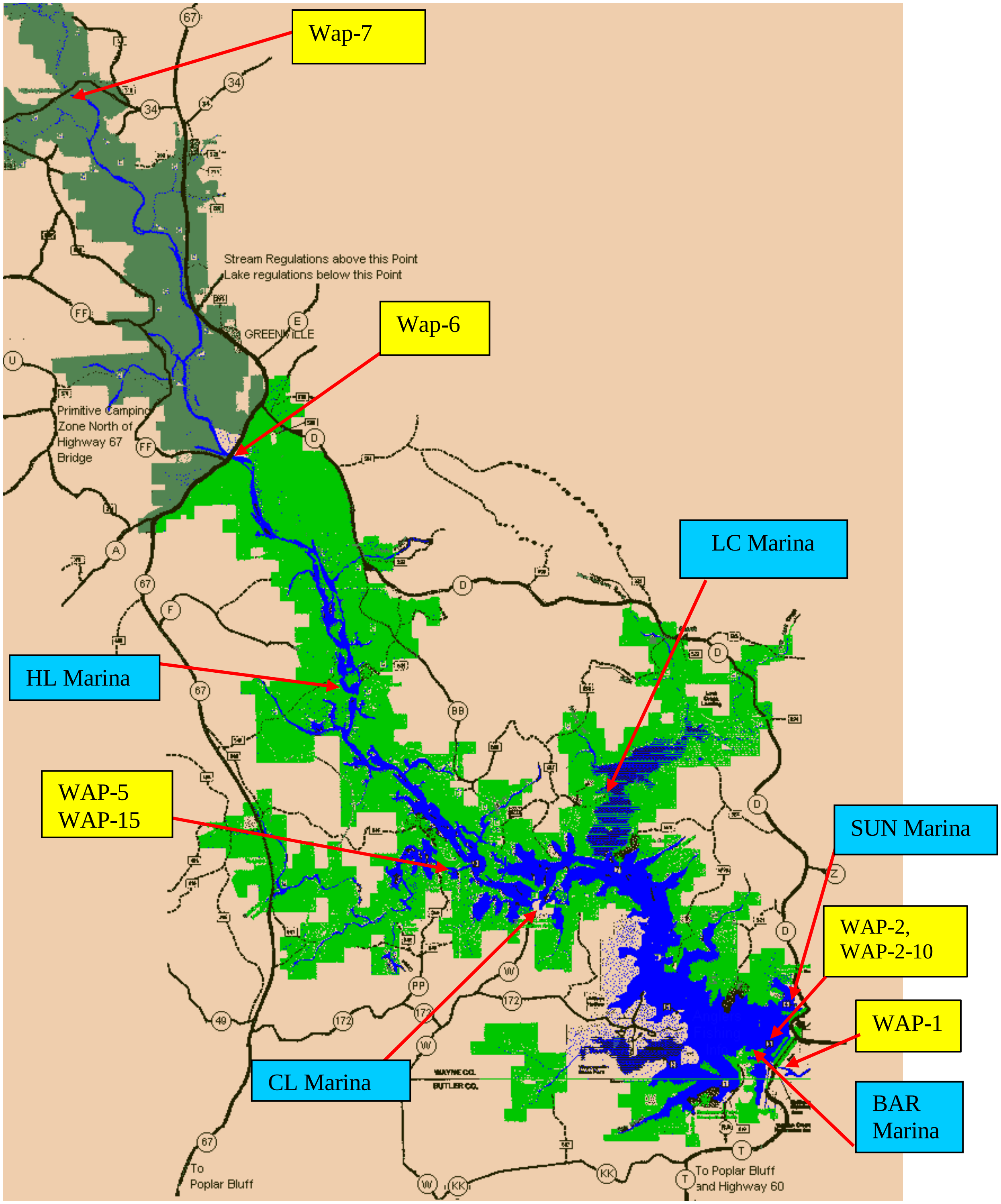


Figure 1
Location of sample sites

2.1 WATER QUALITY ASSESSMENT CRITERIA

2.2 Water Quality

The water quality assessment criteria, which has been generally accepted criteria for sustaining adequate aquatic plant and animal growth were based upon the State of Missouri regulatory limits for certain contaminants. 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 2018 sampling 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), Escherichia coliform (E. coli), pH, temperature, dissolved oxygen, specific conductance, oxidation-reduction potential (ORP), chlorophyll, and pheophytin-a.

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 where a limit has been established for the parameters analyzed.

TABLE 2.1

State of Missouri
Water Quality Standards

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
E. Coli	Missouri standard is 235 E. coli per 100ml for single sample or 126 for geometric
pH	Range: 6.5 to 9.0
DO	> 5.0 mg/L
Atrazine	0.003 mg/L[1]; 82ug/L[2]; 9ug/L[3]
Alachlor	0.002 mg/L (Drinking Water
Conductivity	1,700 *u*S/cm≈TDS of 1,000 mg/L
Total Suspended Solids (TSS)	116mg/L(streams); ≥12mg/L Lakes
Cyanazine	370ug/L Acute; 30ug/L Chronic
Metolachlor	1.7mg/L Acute
Simazine	4.0ug/L [1]
Trifluralin	26ug/L Acute; 1.1ug/L Chronic

[1] Drinking Water Standard
[2] Acute
[3] Chronic

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 (N_2), nitrites (NO_2), nitrate (NO_3), ammonia nitrogen (NH_3-N), and ammonium (NH_4). 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, decreases 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 ortho- phosphorous 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 total suspended solids (TSS) increases, 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 volatile suspended solids (VSS), that consist of organic material and nonvolatile suspended solids (NVSS) which are comprised of inorganic mineral particles in the water. In order to more accurately determine the types and amounts of 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 are present in water. Total volatile solids indicate the presence of organics in suspension; and therefore, show additional demand levels of oxygen. The state standard for TSS is 116 mg/L for streams and 12 mg/L for lakes. Missouri does not currently have a standard for TVSS. However, IEPA suggests that NVSS above 15mg/L could highly impair recreational lake use. A NVSS of 3 to 7mg/L might cause slight impairment.

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.

Escherichia coliform (E. coli) 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 bacterial infection such as cholera, salmonellosis, and gastroenteritis, viral infections such as hepatitis, gastroenteritis, and intestinal diseases, and protozoan infections such as amoebic 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. More recent studies indicate that fecal coliform show less correlation to illness than other indicator organisms such as E. coli and enterococci. The EPA currently recommends E. coli or enterococci as an indicator organism for fresh waters. Since 2009 the St. Louis District has been using E. coli as the standard indicator.

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 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 0.003 mg/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 holds 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^{o}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 insulation 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 downstream even in aerobic environments. The degree of acidity of water is measured by a logarithmetic 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 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. Conductivity is proportional to water temperature. 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. Positive readings indicate increased oxidizing potential and negative readings 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 (NH_3) requires an oxidating environment to convert it into nitrites (NO_2) and nitrates (NO_3). 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 water body 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: (1) color of water, (2) amount of phytoplankton in the water column, and (3) amount of inorganic material in the water column. Secchi depth integrates the combined impacts of all three of these factors. Water transparency was measured using a Secchi disk. Secchi disk readings were taken at all lake sites.

2.3 Sediment

In accordance with EM-1110-2-1201, sediment samples should be taken to monitor and assess potential impacts to aquatic and human health. 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, which is 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 to selenium affecting reproductive success. For potential human health risk, there are no known values in Missouri for sediments. While not a direct correlation, sample results are compared against Missouri Risk Based Corrective Action (MRBCA) lowest default target levels for all soil types and exposure pathways for soils.

3.1 <u>SUMMARY OF MONITORING RESULTS</u>

3.2 Water Quality Summary

The monitoring program for Wappapello Lake during Fiscal Year 2018 revealed overall good water quality when compared to limits established by the MDNR for general use, secondary contact, and indigenous aquatic life. Nutrient and sediment runoffs are 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.

E. 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 State old standard of 235/100ml. We currently do not take enough samples in a month to calculate a geometric mean, so we mainly look at a high mark of 235/100ml of sample to trigger additional investigations. E. coli beach sample results were received from the project office and incorporated into this report. The project office collects beach samples once a week during the recreation season. All swimming beach E. coli samples were below the state standard except for Rockwood on August 13 and Peoples on September 10. Both subsequent bacteria samples for Rockwood and Peoples beaches were within the standard. Beach data is located in Appendix E.

Total iron and total manganese are sampled above the dam near the bottom of the original river channel (WAP-2-10), and just downstream of the outlet area (WAP-1). As was previously stated living organisms require trace amounts of metals, however excessive amounts can be harmful to the organism. Iron cycling is a function of oxidation-reduction processes. Elevated iron levels above the standard of 1.0 mg/L were detected on March 14 at sites WAP-1 and WAP-2-10 and on July 26 and September 27 at WAP-2-10. This elevated level of iron near the bottom of the lake is not immediately detrimental to the overall lake system. Iron oxidizes relatively rapidly (minutes to hours); therefore any iron released through the outlet will normally be oxidized in a short period of time as can be seen from the significant reduction of iron in the outlet. Elevated manganese levels above the standard of 0.05 mg/L were detected at sites WAP-1 and at WAP-2-10 for all sampling events. 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.

Phosphorus and nitrogen are sampled at all sites. All sites exceeded the 0.05 mg/L phosphorous standard except for WAP-6 and WAP-7 on March 14 and July 26 and WAP-2 on May 23. 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. 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 (NH_3-N) is 15mg/L. 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 2018. Nitrogen levels did not exceed the state standard during 2018. In 2018 nitrogen levels were comparable in the lake and the tail water, but highest upstream at site 7. Phosphorus levels were comparable in the lake and tail water, but greater than upstream at site 7.

Chlorophyll *a* was sampled at 3 sites, WAP-2, WAP-5, WAP-6. 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 can indicate a 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. Chlorophyll is monitored to provide indicators of algae growth and therefore, potential oxygen depletion activity. Chlorophyll concentrations and cyanobacteria cell counts serve as proxies for the actual presence of algal toxins. Exposure to cyanobacteria or their toxins may produce allergic reactions such as skin rashes, eye irritations, respiratory symptoms, and in some cases more severe health effects. Microcystin is currently believed to be the most common cyanotoxin in lakes. EPA's current guidance as of December 2016 for recreational Ambient Water Quality Criteria (AWQC) for Cyanotoxins is 4ug/L for microcystins and 8ug/L for Cylindrospermopsin. According to the World Health Organization levels of chlorophyll 50 mg/cu m and greater are considered to create moderate risk. Missouri does not currently have a standard for chlorophyll. Wappapello Lake was in the moderate risk of exposure category for chlorophyll compared to the WHO recommendation in late summer with levels at WAP-2 reaching 79.5 mg/cu m on July 26 and 56.6 mg/cu m on September 27. 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 historical non-detection of pesticides, these chemicals have not been sampled for since 1999.

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 affects the clarity of the water. This can then affect the amount of oxygen in the water. Missouri does not currently have a standard for TVSS. The TSS standard for streams is 116 mg/L and 12 mg/L for lakes. The following lake sites exceeded the standard: WAP-5 on all sample dates and WAP-2 on September 27. Suspended solids decreased below the dam. The lake allows the sediments to drop out of the water column before they are expelled downstream. This results in improved water quality downstream.

Total Organic Carbon (TOC) is collected at all sites. TOC levels were fairly consistent at the lake sites with the caveat that WAP-2 was slightly higher in May and July. 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 decaying plant material. 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 may stratify forming a boundary 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. The state standard for temperature was not exceeded in 2018. Dissolved oxygen fell below the standard of 5 mg/L at site WAP-5, Lost Creek Marina, and Chaonia Landing on July 26, and at Sundowner Marina on September 27. All of these exceedences were between 4 and 5 mg/L of dissolved oxygen.

PH is taken at all sites and at 1 meter intervals at lake sites. All surface water samples for all sites were within the 6.5 to 9 pH state standard except for WAP-2, Barrett's Marina, Lost Creek Marina, and Sundowner's Marina on July 26. The pH for the lake sites at the lower depths trended downwardly as shown in Appendix C.

Conductivity and redox are taken at all sites and at 1 meter intervals at lake sites.
Missouri recommends 1,700*u*S/cm ≈TDS of 1,000mg/L standard for conductivity. No site exceeded this recommendation. Missouri does not currently have a standard for redox.

Water coming into the lake is very clear, as evidenced by the secchi disk readings for WAP-6 with depths ranging from 24 to 57 inches. As in previous years WAP-5, in the Otter Creek portion, has the lowest clarity probably due to the bank composition. Secchi readings at the dam were deepest on May 23 with a depth of 38 inches, but were otherwise comparable to WAP-5.

3.3 Sediment Summary

Sediment sampling was conducted at sites WAP-2, WAP-5, and WAP-6 on July 26, 2018. Ideally sediment sampling would be conducted every 5 years if funding is available, but was last conducted in 2007. Discrete sediment samples were collected using a ponar dredge. The following parameters were analyzed for: pesticides (same suite as water samples), arsenic, barium, boron, cadmium, chromium, copper, iron, manganese, lead, mercury, nickel, selenium, silver, zinc, total organic carbon, kjeldahl nitrogen, nitrate nitrogen, and total phosphorus. Missouri does not have human health standards for sediment, therefore test results were compared to lowest default target levels referenced in Missouri Risk-Based Corrective Action (MRBCA) table B-1. In addition, metal concentrations were compared to consensus based concentrations as related to sediment dwelling organisms taken from *Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems* (MacDonald et al.). Two reference criteria were used from this paper; Threshold effect concentration (TEC) and Probable effect concentration (PEC). TEC, as defined, 'represents the concentration below which adverse effects are expected to occur only rarely'. PEC, as defined, 'represents the concentration above which adverse effects are expected to occur frequently'. As with any environmental sampling, results only apply to the specific locations where the sample was taken from. A more comprehensive sampling design may lead to different overall results. Although, these samples represent only a snapshot in space and time of sediment in Wappapello Lake, the data is useful in establishing baselines for future assessments. All pesticides tested for were below the detection limits.

In Table 3.2 the 2018 sediment results are compared to samples taken in 2007. For this comparison, all results labeled ND were below detection limits (not detected). All red text indicates the result exceeds the reference MRBCA and TEC/PEC reference levels.

Table 3.2 Sediment Comparison

Site #	Parameter	2018 Result	2007 Result	Units
WAP-2	Alachlor	ND	ND	UG/KG
WAP-5	Alachlor	ND	ND	UG/KG
WAP-6	Alachlor	ND	ND	UG/KG
WAP-2	Arsenic	10.7	8	MG/KG
WAP-5	Arsenic	8.80	8	MG/KG
WAP-6	Arsenic	4.35	5	MG/KG
WAP-2	Atrazine	ND	ND	UG/KG
WAP-5	Atrazine	ND	ND	UG/KG
WAP-6	Atrazine	ND	ND	UG/KG
WAP-2	Barium	211	190	MG/KG
WAP-5	Barium	144	181	MG/KG
WAP-6	Barium	43.8	20	MG/KG
WAP-2	Boron	ND	ND	MG/KG
WAP-5	Boron	ND	ND	MG/KG
WAP-6	Boron	ND	ND	MG/KG
WAP-2	Cadmium	0.641	ND	MG/KG
WAP-5	Cadmium	0.406	ND	MG/KG
WAP-6	Cadmium	ND	ND	MG/KG
WAP-2	Chlorpyrifos	ND	ND	UG/KG
WAP-5	Chlorpyrifos	ND	ND	UG/KG
WAP-6	Chlorpyrifos	ND	ND	UG/KG
WAP-2	Chromium	21.4	21.1	MG/KG
WAP-5	Chromium	13.3	19.3	MG/KG
WAP-6	Chromium	10.3	11.5	MG/KG
WAP-2	Copper	24.0	25	MG/KG
WAP-5	Copper	13.6	17	MG/KG
WAP-6	Copper	5.98	4	MG/KG
WAP-2	Cyanazine	ND	ND	UG/KG
WAP-5	Cyanazine	ND	ND	UG/KG
WAP-6	Cyanazine	ND	ND	UG/KG
WAP-2	Iron	26100	26200	MG/KG

WAP-5	Iron	16300	21600	MG/KG
WAP-6	Iron	8650	10000	MG/KG
WAP-2	Kjeldahl nitrogen	2380	2380	MG/KG
WAP-5	Kjeldahl nitrogen	1270	1700	MG/KG
WAP-6	Kjeldahl nitrogen	449	75.9	MG/KG
WAP-2	Lead	181	167	MG/KG
WAP-5	Lead	76.4	81	MG/KG
WAP-6	Lead	82.6	26	MG/KG
WAP-2	Manganese	1940	2000	MG/KG
WAP-5	Manganese	969	926	MG/KG
WAP-6	Manganese	701	202	MG/KG
WAP-2	Mercury	ND	ND	MG/KG
WAP-5	Mercury	ND	ND	MG/KG
WAP-6	Mercury	ND	ND	MG/KG
WAP-2	Metolachlor	ND	ND	UG/KG
WAP-5	Metolachlor	ND	ND	UG/KG
WAP-6	Metolachlor	ND	ND	UG/KG
WAP-2	Metribuzin	ND	ND	UG/KG
WAP-5	Metribuzin	ND	ND	UG/KG
WAP-6	Metribuzin	ND	ND	UG/KG
WAP-2	Nickel	30.2	32	MG/KG
WAP-5	Nickel	18.3	23	MG/KG
WAP-6	Nickel	8.27	7	MG/KG
WAP-2	Nitrate-N	ND	ND	MG/KG
WAP-5	Nitrate-N	ND	ND	MG/KG
WAP-6	Nitrate-N	ND	ND	MG/KG
WAP-2	Pendimethalin	ND	ND	UG/KG
WAP-5	Pendimethalin	ND	ND	UG/KG
WAP-6	Pendimethalin	ND	ND	UG/KG
WAP-2	Phosphorus, total	750	684	MG/KG
WAP-5	Phosphorus, total	462	498	MG/KG
WAP-6	Phosphorus, total	226	95	MG/KG
WAP-2	Selenium	ND	ND	MG/KG
WAP-5	Selenium	ND	ND	MG/KG
WAP-6	Selenium	ND	ND	MG/KG
WAP-2	Silver	ND	ND	MG/KG
WAP-5	Silver	ND	ND	MG/KG
WAP-6	Silver	ND	ND	MG/KG
WAP-2	Total Organic Carbon	19000	19700	MG/KG
WAP-5	Total Organic Carbon	13000	15200	MG/KG
WAP-6	Total Organic Carbon	4500	668	MG/KG
WAP-2	Trifluralin	ND	ND	UG/KG
WAP-5	Trifluralin	ND	ND	UG/KG
WAP-6	Trifluralin	ND	ND	UG/KG
WAP-2	Zinc	83.5	77	MG/KG
WAP-5	Zinc	50.9	61	MG/KG
WAP-6	Zinc	20.4	15	MG/KG

Metals were compared to the background soil concentrations listed in MRBCA. The following were above the MRBCA criteria: arsenic, barium, chromium, and lead. All metal concentrations in 2018 were similar to 2007 levels at Wappapello (with a few exceptions) as well as levels at other lakes in the St. Louis District. Boron, mercury, selenium and silver were not detected. When compared to the consensus based TEC's (referenced above) arsenic, nickel, and lead were found to be above the criterion as described below. Lead was the only metal which exceeded the PEC criterion at site WAP-2 in 2007 and 2018. All other metal concentrations were less than this criteria. Arsenic exceeded the TEC level (9.79 mg/kg) at site 2 with a concentration of 10.7 mg/kg in 2018. Lead concentrations were higher than the TEC level (35.8 mg/kg) at all sites in both years except for site 6 in 2007. Nickel exceeded the TEC level (22.7 mg/kg) at site 2 in 2018 and sites 2 and 5 in 2007.

Nutrients nitrate-nitrogen, Kjeldahl nitrogen, and total phosphorus were analyzed for in 2018. There are no nutrient level comparison standards in the above references. Nitrate-nitrogen was not detected in both 2018 and 2007 sampling events. Kjeldahl nitrogen and phosphorus levels were slightly higher at site 6 in 2018 than 2007. Otherwise nutrient levels were comparable between the two sample years. Nutrient levels trended upwards from the upper lake to the dam site.

Total organic carbon (TOC) was also analyzed for in 2018. TOC levels were comparable between the two sample years with an upward trend going downstream. Levels were highest at near the dam at site 2 (19,000 mg/kg in 2018 and 19,700 mg/kg in 2007). TOC at site 6 was much higher in 2018 (4500 mg/kg) than in 2007 (668 mg/kg).

4.0 PLANNED 2019 STUDIES

The Wappapello Lake water quality monitoring program will continue in Fiscal Year 2019. As in the previous year, there will be 4 water sampling events in 2018. The greater number of sampling events there are, the better the ability to evaluate water quality trends, to better defend project operations (lake levels, releases, maintenance projects, construction projects, etc.), to better confirm that state water quality standards are met, and to better confirm that human health and safety are adequately protected. As with any record keeping or data analysis, the greater the sample size, the more reliable the findings. 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 4 marinas. This combination of sites effectively represents the incoming contaminants and their effects on the lake.

APPENDIX A

DATA

LAB DATA

Water Samples

Site #	Collection Date	Parameter	Flag	Reported Result	MDL	PQL	Units
WAP-15	3/14/2018	Chlorophyll-a		7.70	1.00	1.00	MG/CU.M.
	5/23/2018	Chlorophyll-a		23.90	1.00	1.00	MG/CU.M.
	7/26/2018	Chlorophyll-a		37.60	1.00	1.00	MG/CU.M.
	9/27/2018	Chlorophyll-a		44.90	1.00	1.00	MG/CU.M.
WAP-2	3/14/2018	Chlorophyll-a		9.40	1.00	1.00	MG/CU.M.
	5/23/2018	Chlorophyll-a		7.70	1.00	1.00	MG/CU.M.
	7/26/2018	Chlorophyll-a		79.50	1.00	1.00	MG/CU.M.
	9/27/2018	Chlorophyll-a		56.60	1.00	1.00	MG/CU.M.
WAP-5	3/14/2018	Chlorophyll-a		6.40	1.00	1.00	MG/CU.M.
	5/23/2018	Chlorophyll-a		27.10	1.00	1.00	MG/CU.M.
	7/26/2018	Chlorophyll-a		38.40	1.00	1.00	MG/CU.M.
	9/27/2018	Chlorophyll-a		23.50	1.00	1.00	MG/CU.M.
WAP-6	3/14/2018	Chlorophyll-a		1.50	1.00	1.00	MG/CU.M.
	5/23/2018	Chlorophyll-a		6.80	1.00	1.00	MG/CU.M.
	7/26/2018	Chlorophyll-a		5.60	1.00	1.00	MG/CU.M.
	9/27/2018	Chlorophyll-a		3.40	1.00	1.00	MG/CU.M.
BAR-MARINA	5/23/2018	E. Coliform		20.00	1.00	1.00	COL/100 ML
	7/26/2018	E. Coliform		12.00	1.00	1.00	COL/100 ML
	9/27/2018	E. Coliform		100.00	1.00	1.00	COL/100 ML
CL-MARINA	5/23/2018	E. Coliform		32.00	1.00	1.00	COL/100 ML
	7/26/2018	E. Coliform		68.00	1.00	1.00	COL/100 ML
	9/27/2018	E. Coliform		13.00	1.00	1.00	COL/100 ML
LC-MARINA	5/23/2018	E. Coliform		21.00	1.00	1.00	COL/100 ML
	7/26/2018	E. Coliform		41.00	1.00	1.00	COL/100 ML
	9/27/2018	E. Coliform		9.00	1.00	1.00	COL/100 ML
SUN MARINA	5/23/2018	E. Coliform		24.00	1.00	1.00	COL/100 ML
	7/26/2018	E. Coliform		22.00	1.00	1.00	COL/100 ML

	9/27/2018	E. Coliform		18.00	1.00	1.00	COL/100 ML
WAP-1	3/14/2018	Iron		1.06	0.05	0.10	MG/L
	5/23/2018	Iron		0.43	0.05	0.10	MG/L
	7/26/2018	Iron		0.29	0.05	0.10	MG/L
	9/27/2018	Iron		0.54	0.04	0.05	MG/L
WAP-2-10	3/14/2018	Iron		1.02	0.05	0.10	MG/L
	5/23/2018	Iron		0.70	0.05	0.10	MG/L
	7/26/2018	Iron		1.79	0.05	0.10	MG/L
	9/27/2018	Iron		3.82	0.04	0.05	MG/L
WAP-1	3/14/2018	Manganese		0.10	0.01	0.01	MG/L
	5/23/2018	Manganese		0.34	0.01	0.01	MG/L
	7/26/2018	Manganese		0.26	0.01	0.01	MG/L
	9/27/2018	Manganese		0.22	0.00	0.01	MG/L
WAP-2-10	3/14/2018	Manganese		0.10	0.01	0.01	MG/L
	5/23/2018	Manganese		2.45	0.01	0.01	MG/L
	7/26/2018	Manganese		9.78	0.01	0.01	MG/L
	9/27/2018	Manganese		0.91	0.00	0.01	MG/L
WAP-1	3/14/2018	Nitrate-N		0.39	0.04	0.04	MG/L
	5/23/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N		0.04	0.02	0.02	MG/L
WAP-15	3/14/2018	Nitrate-N		0.53	0.04	0.04	MG/L
	5/23/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
WAP-2	3/14/2018	Nitrate-N		0.42	0.04	0.04	MG/L
	5/23/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N	J	0.02	0.02	0.02	MG/L
WAP-2-10	3/14/2018	Nitrate-N		0.30	0.04	0.04	MG/L
	5/23/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
WAP-5	3/14/2018	Nitrate-N		0.54	0.04	0.04	MG/L
	5/23/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L

WAP-6	3/14/2018	Nitrate-N		0.49	0.04	0.04	MG/L
	5/23/2018	Nitrate-N		0.38	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N		0.17	0.02	0.02	MG/L
WAP-7	3/14/2018	Nitrate-N		0.54	0.04	0.04	MG/L
	5/23/2018	Nitrate-N		0.35	0.02	0.02	MG/L
	7/26/2018	Nitrate-N	<	0.02	0.02	0.02	MG/L
	9/27/2018	Nitrate-N		0.23	0.02	0.02	MG/L
WAP-1	3/14/2018	Nitrogen, ammonia		0.05	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia		0.35	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.09	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia		0.05	0.02	0.03	MG/L
WAP-15	3/14/2018	Nitrogen, ammonia		0.06	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.08	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
WAP-2	3/14/2018	Nitrogen, ammonia		0.07	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.06	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia		0.09	0.02	0.03	MG/L
WAP-2-10	3/14/2018	Nitrogen, ammonia		0.21	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia		0.27	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		2.20	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia		0.21	0.02	0.03	MG/L
WAP-5	3/14/2018	Nitrogen, ammonia		0.03	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia		0.15	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.05	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
WAP-6	3/14/2018	Nitrogen, ammonia	J	0.03	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia		0.20	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.09	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
WAP-7	3/14/2018	Nitrogen, ammonia		0.06	0.02	0.03	MG/L
	5/23/2018	Nitrogen, ammonia		0.03	0.02	0.03	MG/L
	7/26/2018	Nitrogen, ammonia		0.05	0.02	0.03	MG/L
	9/27/2018	Nitrogen, ammonia	<	0.02	0.02	0.03	MG/L
WAP-15	3/14/2018	Pheophytin-a		1.60	1.00	1.00	MG/CU.M.

	5/23/2018	Pheophytin-a		4.60	1.00	1.00	MG/CU.M.
	7/26/2018	Pheophytin-a		5.50	1.00	1.00	MG/CU.M.
	9/27/2018	Pheophytin-a		9.70	1.00	1.00	MG/CU.M.
WAP-2	3/14/2018	Pheophytin-a		2.30	1.00	1.00	MG/CU.M.
	5/23/2018	Pheophytin-a		1.10	1.00	1.00	MG/CU.M.
	7/26/2018	Pheophytin-a		6.10	1.00	1.00	MG/CU.M.
	9/27/2018	Pheophytin-a		11.40	1.00	1.00	MG/CU.M.
WAP-5	3/14/2018	Pheophytin-a		1.60	1.00	1.00	MG/CU.M.
	5/23/2018	Pheophytin-a		4.80	1.00	1.00	MG/CU.M.
	7/26/2018	Pheophytin-a		6.40	1.00	1.00	MG/CU.M.
	9/27/2018	Pheophytin-a		5.70	1.00	1.00	MG/CU.M.
WAP-6	3/14/2018	Pheophytin-a	<	1.00	1.00	1.00	MG/CU.M.
	5/23/2018	Pheophytin-a	<	1.00	1.00	1.00	MG/CU.M.
	7/26/2018	Pheophytin-a		1.30	1.00	1.00	MG/CU.M.
	9/27/2018	Pheophytin-a	<	1.00	1.00	1.00	MG/CU.M.
WAP-1	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.02	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
WAP-15	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-	J	0.01	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
WAP-2	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.01	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
WAP-2-10	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.02	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-		0.07	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
WAP-5	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.01	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
WAP-6	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.05	0.01	0.01	MG/L

	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-		0.02	0.01	0.01	MG/L
WAP-7	3/14/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	5/23/2018	Phosphorus, ortho-		0.04	0.01	0.01	MG/L
	7/26/2018	Phosphorus, ortho-	<	0.01	0.01	0.01	MG/L
	9/27/2018	Phosphorus, ortho-		0.03	0.01	0.01	MG/L
WAP-1	3/14/2018	Phosphorus, total		0.11	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.09	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.10	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.15	0.01	0.01	MG/L
WAP-15	3/14/2018	Phosphorus, total		0.10	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.13	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.15	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.23	0.01	0.01	MG/L
WAP-2	3/14/2018	Phosphorus, total		0.09	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.05	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.08	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.13	0.01	0.01	MG/L
WAP-2-10	3/14/2018	Phosphorus, total		0.11	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.13	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.27	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.55	0.01	0.01	MG/L
WAP-5	3/14/2018	Phosphorus, total		0.10	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.13	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.14	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.23	0.01	0.01	MG/L
WAP-6	3/14/2018	Phosphorus, total		0.03	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.10	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.03	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.07	0.01	0.01	MG/L
WAP-7	3/14/2018	Phosphorus, total		0.02	0.01	0.01	MG/L
	5/23/2018	Phosphorus, total		0.09	0.01	0.01	MG/L
	7/26/2018	Phosphorus, total		0.04	0.01	0.01	MG/L
	9/27/2018	Phosphorus, total		0.12	0.01	0.01	MG/L
WAP-1	3/14/2018	Solids, total suspended		18.50	2.50	2.50	MG/L
	5/23/2018	Solids, total suspended		17.10	2.86	2.86	MG/L
	7/26/2018	Solids, total suspended		11.60	4.00	4.00	MG/L

	9/27/2018	Solids, total suspended		17.30	6.67	6.67	MG/L
WAP-15	3/14/2018	Solids, total suspended		14.00	2.50	2.50	MG/L
	5/23/2018	Solids, total suspended		18.00	4.00	4.00	MG/L
	7/26/2018	Solids, total suspended		23.60	4.00	4.00	MG/L
	9/27/2018	Solids, total suspended		27.30	6.67	6.67	MG/L
WAP-2	3/14/2018	Solids, total suspended		9.60	1.33	1.33	MG/L
	5/23/2018	Solids, total suspended		5.20	2.00	2.00	MG/L
	7/26/2018	Solids, total suspended		10.00	4.00	4.00	MG/L
	9/27/2018	Solids, total suspended		20.70	6.67	6.67	MG/L
WAP-2-10	3/14/2018	Solids, total suspended		18.50	2.50	2.50	MG/L
	5/23/2018	Solids, total suspended		26.40	4.00	4.00	MG/L
	7/26/2018	Solids, total suspended		29.60	4.00	4.00	MG/L
	9/27/2018	Solids, total suspended		96.70	6.67	6.67	MG/L
WAP-5	3/14/2018	Solids, total suspended		13.80	1.82	1.82	MG/L
	5/23/2018	Solids, total suspended		20.80	4.00	4.00	MG/L
	7/26/2018	Solids, total suspended		24.00	4.00	4.00	MG/L
	9/27/2018	Solids, total suspended		27.30	6.67	6.67	MG/L
WAP-6	3/14/2018	Solids, total suspended		6.00	1.25	1.25	MG/L
	5/23/2018	Solids, total suspended		9.20	2.00	2.00	MG/L
	7/26/2018	Solids, total suspended		4.67	2.22	2.22	MG/L
	9/27/2018	Solids, total suspended		6.67	6.67	6.67	MG/L
WAP-7	3/14/2018	Solids, total suspended		2.67	1.11	1.11	MG/L
	5/23/2018	Solids, total suspended		7.40	2.00	2.00	MG/L
	7/26/2018	Solids, total suspended		7.11	2.22	2.22	MG/L
	9/27/2018	Solids, total suspended		6.67	6.67	6.67	MG/L
WAP-1	3/14/2018	Solids, Volaltile Suspended		2.75	2.50	2.50	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	2.86	2.86	2.86	MG/L
	7/26/2018	Solids, Volaltile Suspended		5.20	4.00	4.00	MG/L
	9/27/2018	Solids, Volaltile Suspended	<	6.67	6.67	6.67	MG/L
WAP-15	3/14/2018	Solids, Volaltile Suspended	<	2.50	2.50	2.50	MG/L
	5/23/2018	Solids, Volaltile Suspended		4.40	4.00	4.00	MG/L
	7/26/2018	Solids, Volaltile Suspended		6.00	4.00	4.00	MG/L
	9/27/2018	Solids, Volaltile Suspended		8.00	6.67	6.67	MG/L
WAP-2	3/14/2018	Solids, Volaltile Suspended		1.60	1.33	1.33	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	2.00	2.00	2.00	MG/L
	7/26/2018	Solids, Volaltile Suspended		6.00	4.00	4.00	MG/L
	9/27/2018	Solids, Volaltile Suspended	<	6.67	6.67	6.67	MG/L

WAP-2-10	3/14/2018	Solids, Volaltile Suspended		3.50	2.50	2.50	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
	7/26/2018	Solids, Volaltile Suspended		10.40	4.00	4.00	MG/L
	9/27/2018	Solids, Volaltile Suspended		13.30	6.67	6.67	MG/L
WAP-5	3/14/2018	Solids, Volaltile Suspended		2.18	1.82	1.82	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
	7/26/2018	Solids, Volaltile Suspended		5.60	4.00	4.00	MG/L
	9/27/2018	Solids, Volaltile Suspended	<	6.67	6.67	6.67	MG/L
WAP-6	3/14/2018	Solids, Volaltile Suspended	<	1.25	1.25	1.25	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	2.00	2.00	2.00	MG/L
	7/26/2018	Solids, Volaltile Suspended	<	2.22	2.22	2.22	MG/L
	9/27/2018	Solids, Volaltile Suspended	<	6.67	6.67	6.67	MG/L
WAP-7	3/14/2018	Solids, Volaltile Suspended	<	1.11	1.11	1.11	MG/L
	5/23/2018	Solids, Volaltile Suspended	<	2.00	2.00	2.00	MG/L
	7/26/2018	Solids, Volaltile Suspended	<	2.22	2.22	2.22	MG/L
	9/27/2018	Solids, Volaltile Suspended	<	6.67	6.67	6.67	MG/L
WAP-1	3/14/2018	Total Organic Carbon		2.50	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	2.80	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		4.50	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		3.80	0.50	1.00	MG/L
WAP-15	3/14/2018	Total Organic Carbon		2.20	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	3.80	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		4.20	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		4.40	0.50	1.00	MG/L
WAP-2	3/14/2018	Total Organic Carbon		2.30	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	6.60	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		5.10	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		3.60	0.50	1.00	MG/L
WAP-2-10	3/14/2018	Total Organic Carbon		2.50	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	3.60	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		4.90	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		3.80	0.50	1.00	MG/L
WAP-5	3/14/2018	Total Organic Carbon		2.40	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	3.80	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		3.80	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		4.30	0.50	1.00	MG/L
WAP-6	3/14/2018	Total Organic Carbon		1.20	0.50	1.00	MG/L

	5/23/2018	Total Organic Carbon	B	4.10	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		2.20	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		1.90	0.50	1.00	MG/L
WAP-7	3/14/2018	Total Organic Carbon		1.20	0.50	1.00	MG/L
	5/23/2018	Total Organic Carbon	B	4.10	0.50	1.00	MG/L
	7/26/2018	Total Organic Carbon		1.90	0.50	1.00	MG/L
	9/27/2018	Total Organic Carbon		2.70	0.50	1.00	MG/L

J indicates an estimated value between Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) < Indicates non detect (ND). B indicates that the analyte was found in the blank as well as the sample which, in turn, signifies a probable blank contamination.

Sediment Data

Site	Parameter	Flag	Reported Result	MDL	PQL	Units	Collection Date
WAP-15	Arsenic		7.80	0.544	1.09	MG/KG	7/26/2018
WAP-2	Arsenic		10.7	0.961	1.92	MG/KG	7/26/2018
WAP-5	Arsenic		8.80	0.529	1.06	MG/KG	7/26/2018
WAP-6	Arsenic		4.35	0.413	0.825	MG/KG	7/26/2018
WAP-15	Barium		138	1.81	3.63	MG/KG	7/26/2018
WAP-2	Barium		211	3.20	6.41	MG/KG	7/26/2018
WAP-5	Barium		144	1.76	3.53	MG/KG	7/26/2018
WAP-6	Barium		43.8	1.38	2.75	MG/KG	7/26/2018
WAP-15	Boron	<	5.44	5.44	10.9	MG/KG	7/26/2018
WAP-2	Boron	<	9.61	9.61	19.2	MG/KG	7/26/2018
WAP-5	Boron	<	5.29	5.29	10.6	MG/KG	7/26/2018
WAP-6	Boron	<	4.13	4.13	8.25	MG/KG	7/26/2018
WAP-15	Cadmium	J	0.381	0.363	0.726	MG/KG	7/26/2018
WAP-2	Cadmium	J	0.641	0.641	1.28	MG/KG	7/26/2018
WAP-5	Cadmium	J	0.406	0.353	0.706	MG/KG	7/26/2018
WAP-6	Cadmium	<	0.275	0.275	0.550	MG/KG	7/26/2018
WAP-15	Chromium		13.1	0.907	1.81	MG/KG	7/26/2018
WAP-2	Chromium		21.4	1.60	3.20	MG/KG	7/26/2018
WAP-5	Chromium		13.3	0.882	1.76	MG/KG	7/26/2018
WAP-6	Chromium		10.3	0.688	1.38	MG/KG	7/26/2018
WAP-15	Copper		13.4	1.81	3.63	MG/KG	7/26/2018
WAP-2	Copper		24.0	3.20	6.41	MG/KG	7/26/2018
WAP-5	Copper		13.6	1.76	3.53	MG/KG	7/26/2018
WAP-6	Copper		5.98	1.38	2.75	MG/KG	7/26/2018
WAP-15	Iron		15800	9.07	18.1	MG/KG	7/26/2018
WAP-2	Iron		26100	16.0	32.0	MG/KG	7/26/2018
WAP-5	Iron		16300	8.82	17.6	MG/KG	7/26/2018
WAP-6	Iron		8650	6.88	13.8	MG/KG	7/26/2018
WAP-15	Kjeldahl nitrogen		1240	118	124	MG/KG	7/26/2018
WAP-2	Kjeldahl nitrogen		2380	306	322	MG/KG	7/26/2018

WAP-5	Kjeldahl nitrogen		1270	182	192	MG/KG	7/26/2018
WAP-6	Kjeldahl nitrogen		449	83.6	88.0	MG/KG	7/26/2018
WAP-15	Lead		71.8	0.544	1.09	MG/KG	7/26/2018
WAP-2	Lead		181	0.961	1.92	MG/KG	7/26/2018
WAP-5	Lead		76.4	0.529	1.06	MG/KG	7/26/2018
WAP-6	Lead		82.6	0.413	0.825	MG/KG	7/26/2018
WAP-15	Manganese		798	0.907	1.81	MG/KG	7/26/2018
WAP-2	Manganese		1940	1.60	3.20	MG/KG	7/26/2018
WAP-5	Manganese		969	0.882	1.76	MG/KG	7/26/2018
WAP-6	Manganese		701	0.688	1.38	MG/KG	7/26/2018
WAP-15	Mercury	<	0.151	0.151	0.377	MG/KG	7/26/2018
WAP-2	Mercury	<	0.264	0.264	0.661	MG/KG	7/26/2018
WAP-5	Mercury	<	0.154	0.154	0.384	MG/KG	7/26/2018
WAP-6	Mercury	<	0.112	0.112	0.281	MG/KG	7/26/2018
WAP-15	Nickel		17.7	2.72	5.44	MG/KG	7/26/2018
WAP-2	Nickel		30.2	4.81	9.61	MG/KG	7/26/2018
WAP-5	Nickel		18.3	2.65	5.29	MG/KG	7/26/2018
WAP-6	Nickel		8.27	2.06	4.13	MG/KG	7/26/2018
WAP-15	Nitrate-N	<	3.50	3.50	3.50	MG/KG	7/26/2018
WAP-2	Nitrate-N	<	5.67	5.67	5.67	MG/KG	7/26/2018
WAP-5	Nitrate-N	<	3.31	3.31	3.31	MG/KG	7/26/2018
WAP-6	Nitrate-N	<	2.58	2.58	2.58	MG/KG	7/26/2018
WAP-15	Phosphorus, total		443	2.86	3.57	MG/KG	7/26/2018
WAP-2	Phosphorus, total		750	8.95	11.2	MG/KG	7/26/2018
WAP-5	Phosphorus, total		462	2.95	3.68	MG/KG	7/26/2018
WAP-6	Phosphorus, total		226	1.59	1.98	MG/KG	7/26/2018
WAP-15	Selenium	<	0.907	0.907	1.81	MG/KG	7/26/2018
WAP-2	Selenium	<	1.60	1.60	3.20	MG/KG	7/26/2018
WAP-5	Selenium	<	0.882	0.882	1.76	MG/KG	7/26/2018
WAP-6	Selenium	<	0.688	0.688	1.38	MG/KG	7/26/2018
WAP-15	Silver	<	0.907	0.907	1.81	MG/KG	7/26/2018
WAP-2	Silver	<	1.60	1.60	3.20	MG/KG	7/26/2018
WAP-5	Silver	<	0.882	0.882	1.76	MG/KG	7/26/2018
WAP-6	Silver	<	0.688	0.688	1.38	MG/KG	7/26/2018
WAP-15	Total Organic Carbon		12000	3000	5000	MG/KG	7/26/2018
WAP-2	Total Organic Carbon		19000	3000	5000	MG/KG	7/26/2018

WAP-5	Total Organic Carbon		13000	3000	5000	MG/KG	7/26/2018
WAP-6	Total Organic Carbon		4500	600	1000	MG/KG	7/26/2018
WAP-15	Zinc		49.0	0.907	1.81	MG/KG	7/26/2018
WAP-2	Zinc		83.5	1.60	3.20	MG/KG	7/26/2018
WAP-5	Zinc		50.9	0.882	1.76	MG/KG	7/26/2018
WAP-6	Zinc		20.4	0.688	1.38	MG/KG	7/26/2018
WAP-15	Alachlor	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Alachlor	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Alachlor	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Alachlor	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Atrazine	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Atrazine	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Atrazine	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Atrazine	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Chlorpyrifos	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Chlorpyrifos	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Chlorpyrifos	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Chlorpyrifos	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Cyanazine	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Cyanazine	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Cyanazine	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Cyanazine	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Metolachlor	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Metolachlor	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Metolachlor	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Metolachlor	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Metribuzin	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Metribuzin	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Metribuzin	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Metribuzin	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Pendimethalin	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Pendimethalin	<	22.7	22.7	22.7	UG/KG	7/26/2018
WAP-5	Pendimethalin	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Pendimethalin	<	9.53	9.53	9.53	UG/KG	7/26/2018
WAP-15	Trifluralin	<	12.8	12.8	12.8	UG/KG	7/26/2018
WAP-2	Trifluralin	<	22.7	22.7	22.7	UG/KG	7/26/2018

WAP-5	Trifluralin	<	13.1	13.1	13.1	UG/KG	7/26/2018
WAP-6	Trifluralin	<	9.53	9.53	9.53	UG/KG	7/26/2018

J indicates an estimated value between Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) < Indicates non detect (ND).

Marina E. coli

Site	Date Collected	Result	Qualifier	Unit
BAR-MARINA	5/23/2018	20.00		COL/100 ML
	7/26/2018	12.00		COL/100 ML
	9/27/2018	100.00		COL/100 ML
CL-MARINA	5/23/2018	32.00		COL/100 ML
	7/26/2018	68.00		COL/100 ML
	9/27/2018	13.00		COL/100 ML
LC-MARINA	5/23/2018	21.00		COL/100 ML
	7/26/2018	41.00		COL/100 ML
	9/27/2018	9.00		COL/100 ML
SUN MARINA	5/23/2018	24.00		COL/100 ML
	7/26/2018	22.00		COL/100 ML
	9/27/2018	18.00		COL/100 ML

FIELD DATA

Site	Date	Depth	Water Temp (oC)	Redox (mv)	Cond (uS)	DO %	DO mg/l	pH	Time	Seechi (in)	Total Depth (ft)
WAP-1	3/14/2018	0.9	8.9	185.8	135.4	106.4	12.3	8.0	12:00		
WAP-1	5/23/2018	1.0	24.6	44.6	142.6	96.4	8.0	7.5	10:58		
WAP-1	7/26/2018	1.0	28.8		211.9	88.9	6.9		10:40		
WAP-1	9/27/2018	1.2	23.7	382.9	242.8	91.5	7.7	8.3	13:22		
WAP-2	3/14/2018	0.0	9.9	130.2	134.4	99.9	11.3	7.9	11:04	16	11
WAP-2	3/14/2018	1.2	8.8	131.5	133.8	95.9	11.1	7.9	11:05		
WAP-2	3/14/2018	2.2	8.6	142.1	133.9	93.2	10.9	7.7	11:09		
WAP-2	3/14/2018	3.1	8.6	148.9	134.0	93.3	10.9	7.6	11:10		
WAP-2	5/23/2018	0.0	27.5	213.0	136.8	125.7	9.9	8.1	11:34	38	30
WAP-2	5/23/2018	1.2	26.3	223.6	135.8	117.2	9.5	7.8	11:35		
WAP-2	5/23/2018	2.2	23.6	248.2	152.3	35.0	3.0	6.9	11:36		
WAP-2	5/23/2018	3.2	22.6	253.7	160.4	15.1	1.3	6.6	11:36		
WAP-2	5/23/2018	4.3	22.1	255.3	168.7	10.0	0.9	6.5	11:37		
WAP-2	5/23/2018	5.1	21.6	255.7	168.1	6.0	0.5	6.4	11:37		
WAP-2	5/23/2018	6.1	21.2	255.4	163.5	2.6	0.2	6.4	11:38		
WAP-2	5/23/2018	7.1	20.3	252.5	153.3	1.7	0.2	6.4	11:38		
WAP-2	5/23/2018	8.1	19.3	117.0	155.8	1.3	0.1	6.4	11:39		
WAP-2	7/26/2018	0.0	29.4	-68.6	207.7	106.5	8.1	9.3	11:13	15	9
WAP-2	7/26/2018	1.0	28.8	-43.9	209.2	88.7	6.8	8.9	11:13		
WAP-2	7/26/2018	2.1	28.6	-35.9	209.7	79.8	6.2	8.6	11:14		
WAP-2	7/26/2018	3.1	28.6	-31.1	210.5	72.8	5.6	8.5	11:15		
WAP-2	7/26/2018	4.1	28.4	-33.1	211.7	57.4	4.5	8.2	11:16		
WAP-2	7/26/2018	5.1	28.1	-37.3	215.4	28.1	2.2	7.7	11:17		
WAP-2	7/26/2018	6.0	27.9	-44.4	217.8	16.1	1.3	7.5	11:17		
WAP-2	7/26/2018	6.9	27.1	-146.5	245.3	3.2	0.3	7.4	11:18		

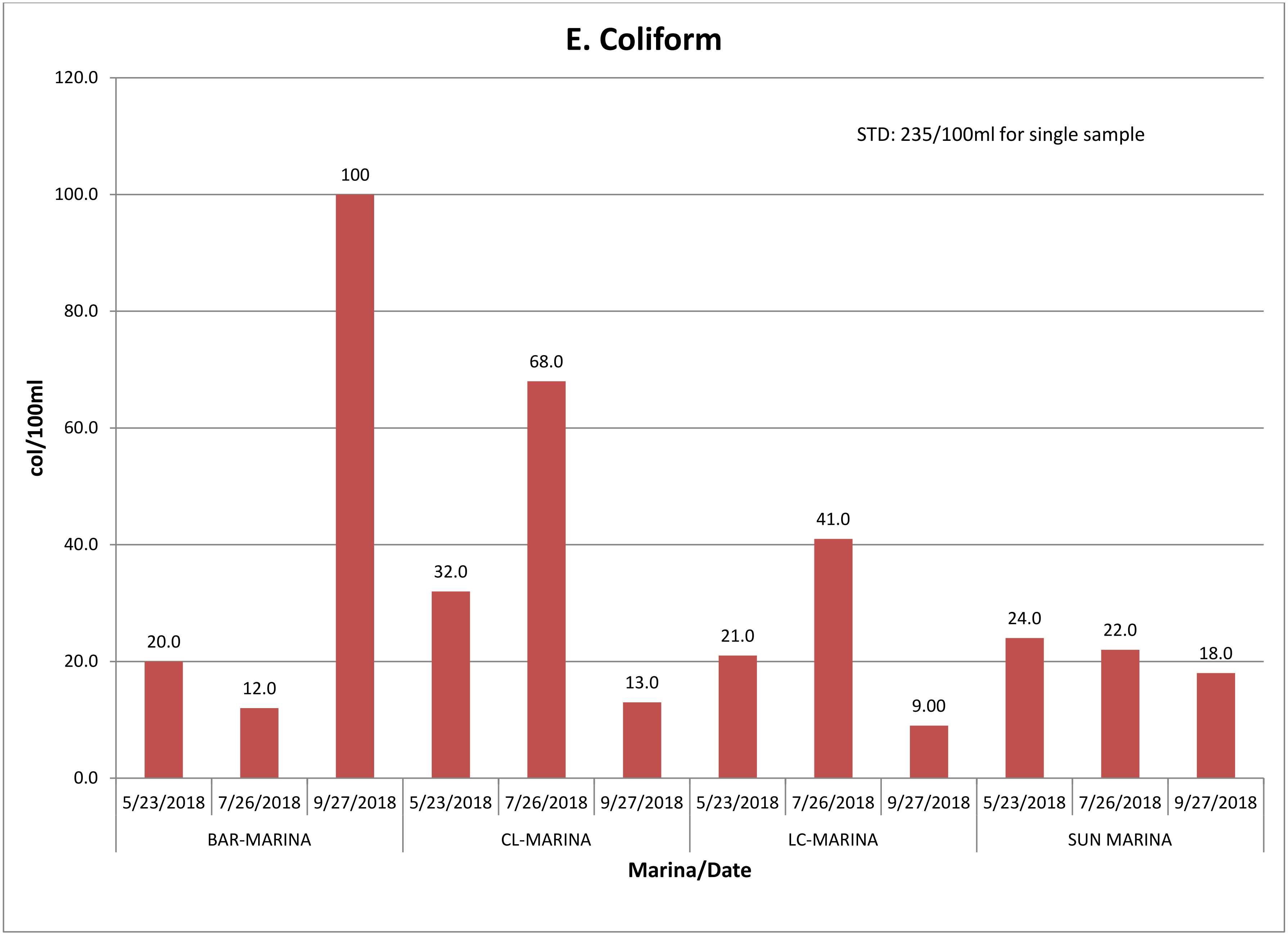
WAP-2	7/26/2018	8.0	25.1	-202.9	308.6	2.0	0.2	7.3	11:18		
WAP-2	7/26/2018	9.1	24.1	-217.8	327.8	1.7	0.1	7.2	11:19		
WAP-2	9/27/2018	0.0	23.8	161.7	242.8	80.0	6.8	8.3	12:37	12	32
WAP-2	9/27/2018	1.0	23.7	154.0	243.3	73.2	6.2	8.2	12:36		
WAP-2	9/27/2018	2.0	23.7	144.5	243.4	70.9	6.0	8.2	12:35		
WAP-2	9/27/2018	3.0	23.7	128.4	243.4	70.3	6.0	8.2	12:33		
WAP-2	9/27/2018	4.0	23.7	119.4	243.4	70.0	5.9	8.2	12:33		
WAP-2	9/27/2018	5.2	23.7	109.4	243.4	69.6	5.9	8.2	12:32		
WAP-2	9/27/2018	6.0	23.7	87.3	243.4	68.9	5.8	8.2	12:31		
WAP-2	9/27/2018	6.9	23.7	75.5	243.5	68.9	5.8	8.2	12:31		
WAP-2	9/27/2018	8.1	23.7	49.9	243.3	68.2	5.8	8.1	12:30		
WAP-2	9/27/2018	9.1	23.6	22.6	244.1	63.9	5.4	8.0	12:29		
WAP-2	9/27/2018	9.5	23.6	-8.7	244.7	61.4	5.2	7.9	12:28		
WAP-5	3/14/2018	0.0	8.4	140.5	85.1	99.6	11.7	7.8	9:51	18	11
WAP-5	3/14/2018	1.0	7.7	139.6	85.8	97.5	11.6	7.8	9:51		
WAP-5	3/14/2018	2.0	7.4	146.4	89.0	94.7	11.4	7.6	9:52		
WAP-5	3/14/2018	3.1	7.4	158.9	89.6	93.7	11.2	7.3	9:52		
WAP-5	5/23/2018	0.1	26.9	163.5	123.4	122.5	9.8	7.6	10:22	12	11
WAP-5	5/23/2018	1.0	24.7	183.4	170.7	79.1	6.6	7.3	10:24		
WAP-5	5/23/2018	2.1	22.9	194.7	199.3	41.5	3.6	7.1	10:24		
WAP-5	5/23/2018	3.0	22.1	204.1	201.0	6.6	0.6	6.9	10:25		
WAP-5	7/26/2018	0.1	28.8	6.5	242.7	71.5	5.5	8.1	10:13	15	9
WAP-5	7/26/2018	1.1	28.2	-5.4	238.6	56.9	4.4	7.9	10:13		
WAP-5	7/26/2018	2.4	27.8	-19.9	239.3	37.0	2.9	7.8	10:14		
WAP-5	7/26/2018	2.9	27.7	-84.0	243.5	7.4	0.6	7.5	10:14		
WAP-5	9/27/2018	0.9	23.3	102.9	237.3	67.0	5.7	8.0	11:01	12	10
WAP-5	9/27/2018	2.1	23.1	64.2	236.7	73.7	6.3	8.2	11:00		
WAP-5	9/27/2018	2.9	22.9	22.8	236.4	71.0	6.1	8.1	11:00		
WAP-6	3/14/2018	0.0	7.4	129.5	191.4	94.4	11.3	7.4	8:47	57	12
WAP-6	3/14/2018	1.2	7.4	132.8	191.4	94.0	11.3	7.4	8:48		
WAP-6	3/14/2018	2.1	7.4	132.9	191.4	93.8	11.3	7.4	8:49		
WAP-6	3/14/2018	3.1	7.4	132.8	191.4	93.8	11.3	7.4	8:49		

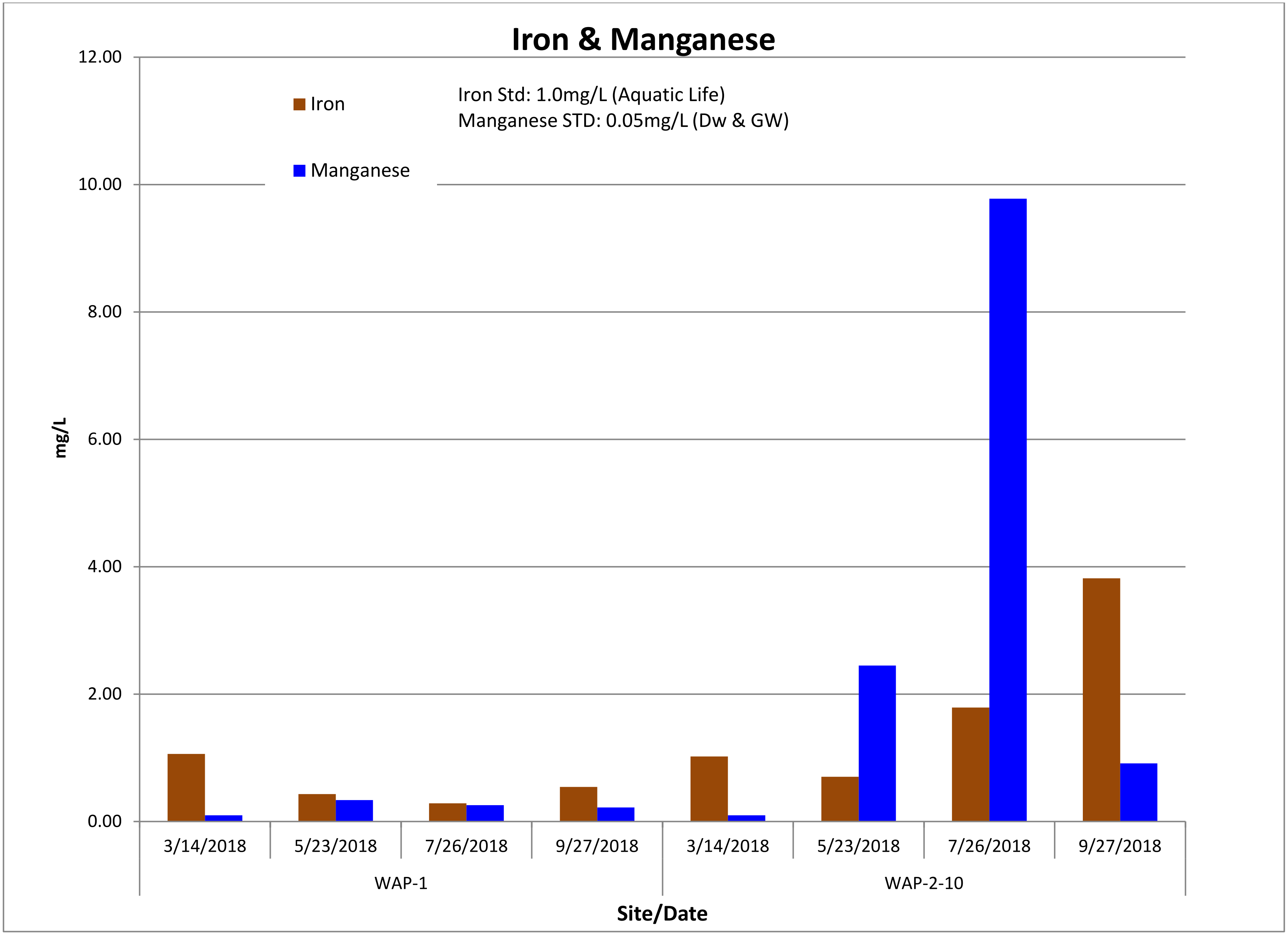
WAP-6	5/23/2018	0.1	23.7	185.4	178.4	75.6	6.4	7.3	9:47	24	12
WAP-6	5/23/2018	1.0	23.6	186.8	178.2	74.6	6.3	7.4	9:48		
WAP-6	5/23/2018	2.1	23.5	188.8	178.3	74.4	6.3	7.4	9:48		
WAP-6	5/23/2018	3.1	23.3	191.2	178.5	74.3	6.3	7.4	9:49		
WAP-6	5/23/2018	3.7	23.0	196.1	178.7	73.9	6.3	7.3	9:49		
WAP-6	7/26/2018	0.0	27.3	198.9	267.3	89.9	7.1	8.1	9:23	41	14
WAP-6	7/26/2018	1.0	27.1	183.3	267.7	87.2	6.9	8.0	9:23		
WAP-6	7/26/2018	2.2	18.6	165.4	274.2	65.4	6.1	7.6	9:24		
WAP-6	7/26/2018	3.0	17.2	168.5	273.9	57.6	5.5	7.4	9:25		
WAP-6	9/27/2018	1.1	22.4	359.8	265.8	79.8	6.9	7.9	10:01	40	12
WAP-6	9/27/2018	2.2	19.3	362.4	270.2	69.6	6.4	7.6	10:01		
WAP-6	9/27/2018	3.0	17.5	362.4	266.3	64.0	6.1	7.4	10:00		
WAP-6	9/27/2018	3.3	17.4	359.9	267.1	54.9	5.3	7.4	9:59		
WAP-7	3/14/2018	0.3	7.1	133.5	185.9	95.3	11.6	7.7	8:05		
WAP-7	5/23/2018	0.5	23.5	116.6	172.8	83.6	7.1	7.5	10:03		
WAP-7	7/26/2018	0.5	26.7		264.4	77.5	6.2		9:36		
WAP-7	9/27/2018	0.1	21.8	362.4	243.3	82.8	7.3	8.0	9:28		
BAR MAR	5/23/2018	1.0	27.6	133.5	135.0	121.7	9.6	8.5	11:56		
BAR MAR	7/26/2018	0.1	29.6	10.0	205.8	117.1	8.9	9.1	11:41		
BAR MAR	7/26/2018	0.1	29.6	10.0	205.8	117.1	8.9	9.1	11:41		
BAR MAR	7/26/2018	1.1	29.2	-6.9	207.1	100.6	7.7	8.8	11:41		
BAR MAR	7/26/2018	1.1	29.2	-6.9	207.1	100.6	7.7	8.8	11:41		
BAR MAR	7/26/2018	2.0	29.1	-11.4	208.6	85.1	6.5	8.6	11:42		
BAR MAR	7/26/2018	2.0	29.1	-11.4	208.6	85.1	6.5	8.6	11:42		
BAR MAR	9/27/2018	1.2	23.6	368.5	243.8	65.8	5.6	8.1	12:59		
BAR MAR	9/27/2018	2.4	23.5	365.1	243.3	68.9	5.9	8.2	12:58		
CL MAR	7/26/2018	0.2	29.2	-34.3	250.3	63.3	4.9	8.1	10:37		
CL MAR	7/26/2018	0.2	29.2	-34.3	250.3	63.3	4.9	8.1	10:37		
CL MAR	7/26/2018	1.0	29.1	-17.9	250.3	55.5	4.3	7.9	10:38		
CL MAR	7/26/2018	1.0	29.1	-17.9	250.3	55.5	4.3	7.9	10:38		
CL MAR	7/26/2018	2.0	28.7	-8.1	251.3	32.8	2.5	7.6	10:39		
CL MAR	7/26/2018	2.0	28.7	-8.1	251.3	32.8	2.5	7.6	10:39		

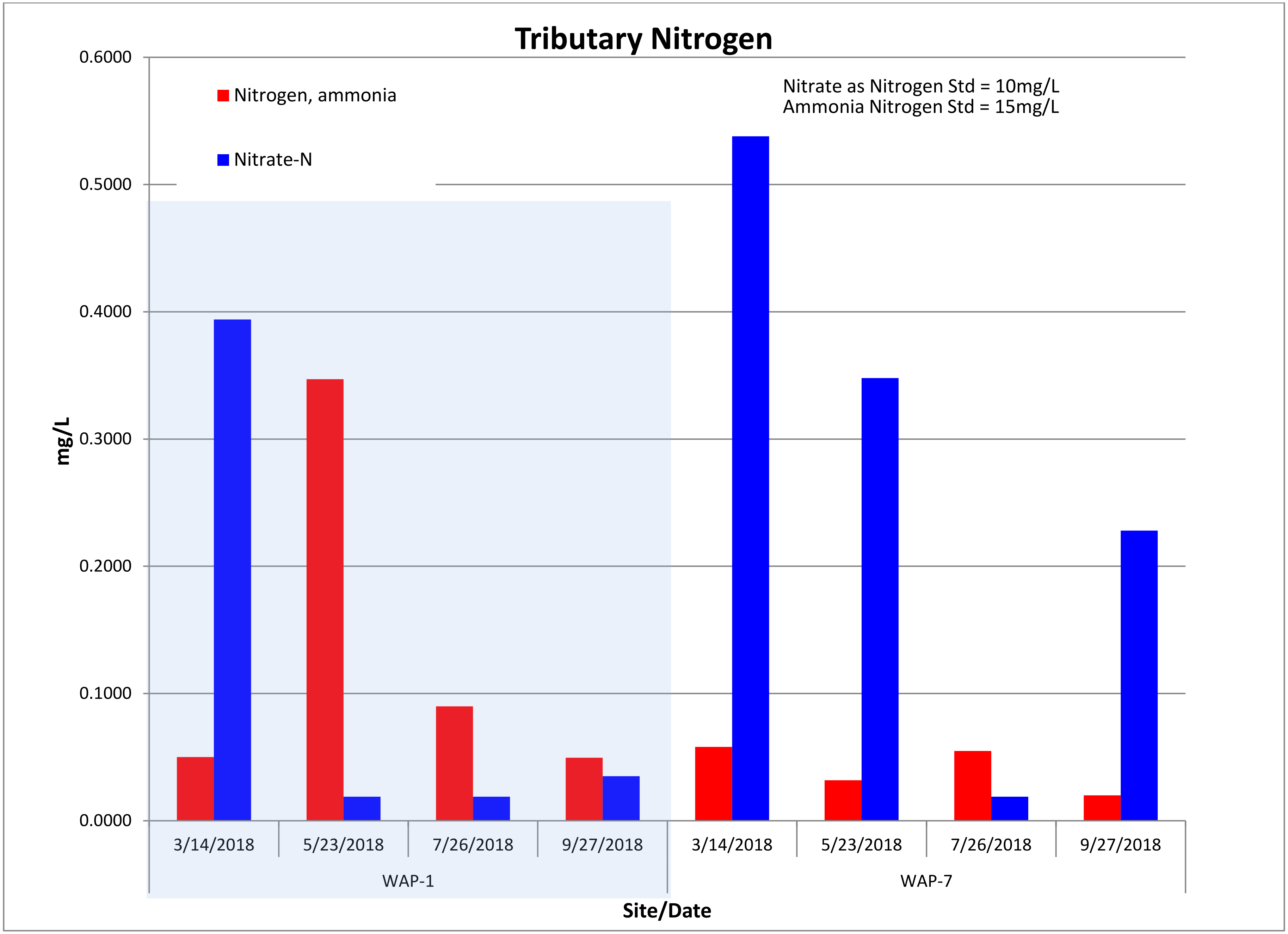
CL MAR	7/26/2018	2.4	28.3	-20.7	252.7	7.7	0.6	7.4	10:39		
CL MAR	7/26/2018	2.4	28.3	-20.7	252.7	7.7	0.6	7.4	10:39		
CL MAR	9/27/2018	1.0	23.3	115.9	218.7	82.6	7.0	8.2	10:49		
CL MAR	9/27/2018	2.2	23.1	92.9	218.5	79.5	6.8	8.0	10:48		
CL MAR	9/27/2018	3.1	22.8	2.2	235.9	72.9	6.3	8.1	10:58		
LC MAR	5/23/2018	0.0	27.6	151.6	122.6	118.3	9.3	8.3	10:51		
LC MAR	7/26/2018	0.0	29.1	-19.5	203.9	118.0	9.1	9.0	10:51		
LC MAR	7/26/2018	0.0	29.1	-19.5	203.9	118.0	9.1	9.0	10:51		
LC MAR	7/26/2018	0.9	28.6	-35.7	208.3	56.1	4.4	8.0	10:52		
LC MAR	7/26/2018	0.9	28.6	-35.7	208.3	56.1	4.4	8.0	10:52		
LC MAR	9/27/2018	0.1	22.8	123.6	225.4	77.6	6.7	8.1	11:22		
LC MAR	9/27/2018	0.2	22.8	123.1	225.6	76.3	6.6	8.1	11:21		
LC MAR	9/27/2018	0.6	22.8	90.6	226.1	73.7	6.3	8.1	11:22		
SUN MAR	5/23/2018	1.1	25.9	152.1	134.1	101.5	8.3	8.2	12:05		
SUN MAR	7/26/2018	0.0	29.3	65.4	207.7	111.7	8.5	9.3	12:00		
SUN MAR	7/26/2018	0.0	29.3	65.4	207.7	111.7	8.5	9.3	12:00		
SUN MAR	7/26/2018	1.1	28.8	66.8	208.7	96.5	7.5	9.0	12:00		
SUN MAR	7/26/2018	1.1	28.8	66.8	208.7	96.5	7.5	9.0	12:00		
SUN MAR	7/26/2018	2.0	28.4	77.6	211.5	68.8	5.3	8.5	12:01		
SUN MAR	7/26/2018	2.0	28.4	77.6	211.5	68.8	5.3	8.5	12:01		
SUN MAR	7/26/2018	2.5	28.4	76.1	212.6	58.9	4.6	8.3	12:01		
SUN MAR	7/26/2018	2.5	28.4	76.1	212.6	58.9	4.6	8.3	12:01		
SUN MAR	9/27/2018	1.2	24.1	97.4	244.2	56.4	4.7	8.0	12:21		
SUN MAR	9/27/2018	2.0	23.9	48.4	243.8	56.0	4.7	8.0	12:20		

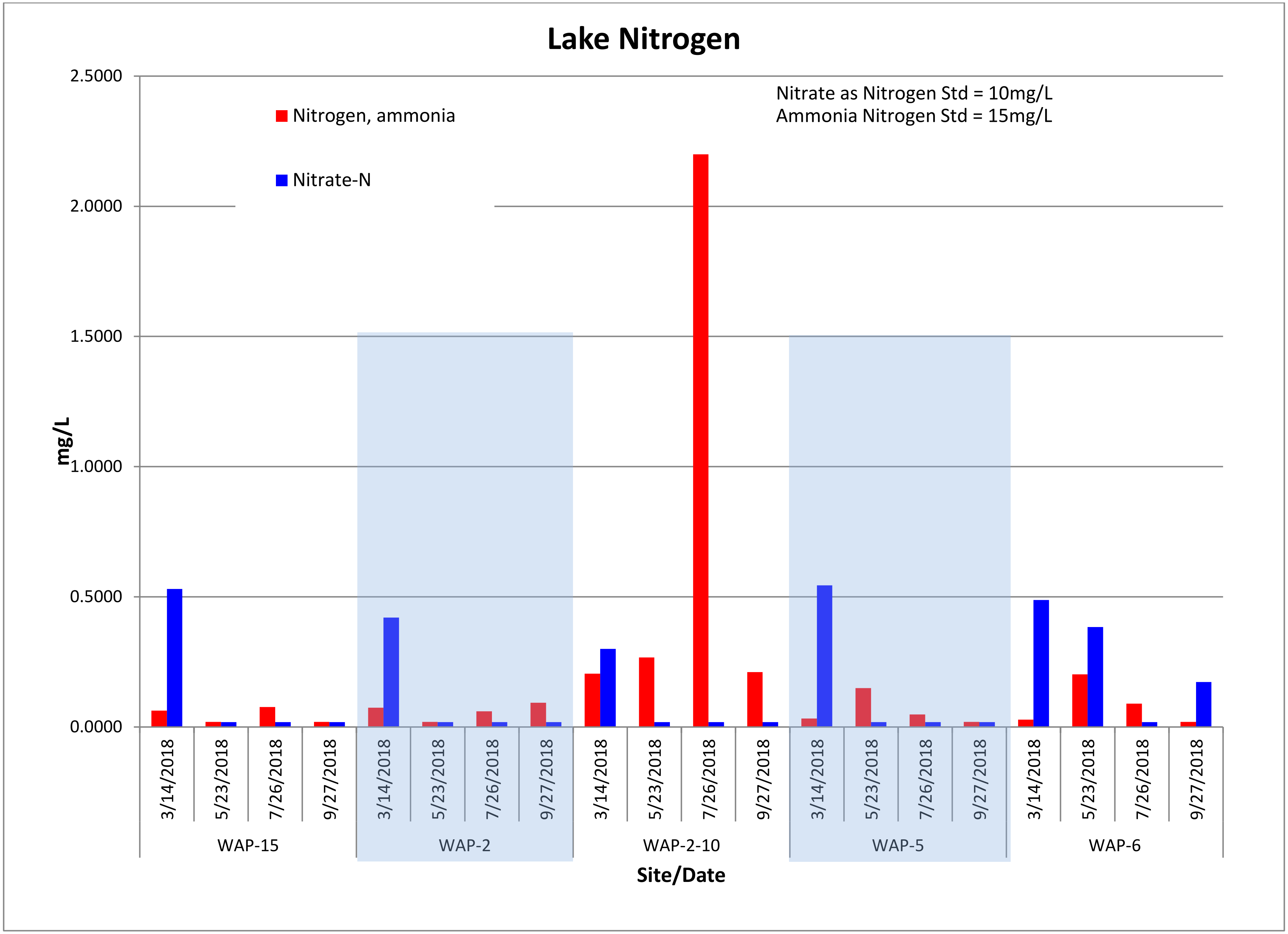
APPENDIX B

LAB
GRAPHS

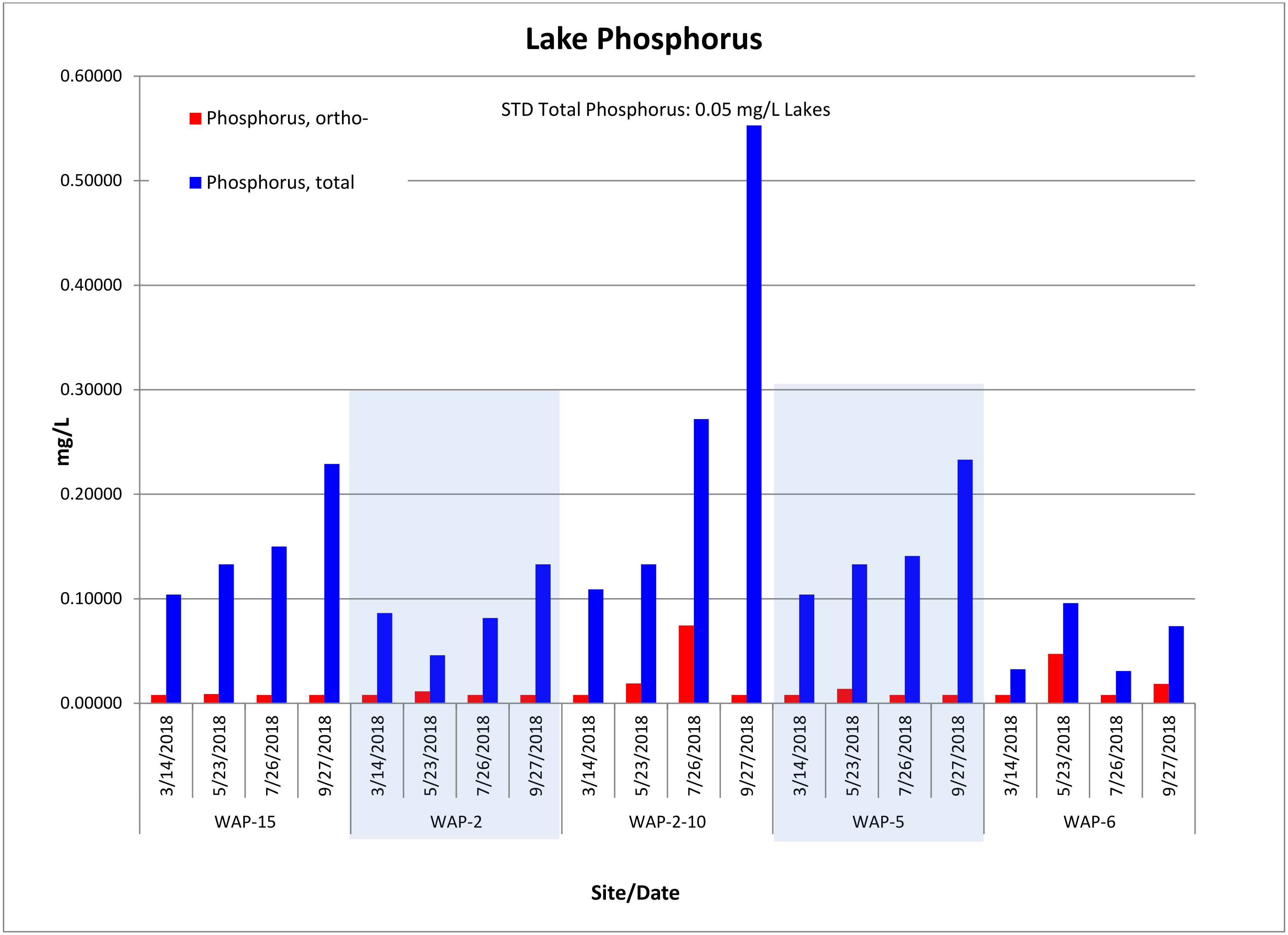

E. Coliform
STD: 235/100ml for single sample
col/100ml
120.0
100.0
80.0
60.0
40.0
20.0
0.0
20.0
12.0
100
32.0
68.0
13.0
21.0
41.0
9.00
24.0
22.0
18.0
5/23/2018
7/26/2018
9/27/2018
BAR-MARINA
CL-MARINA
LC-MARINA
SUN MARINA
Marina/Date


Iron & Manganese
12.00
10.00
8.00
6.00
4.00
2.00
0.00
mg/L
Iron
Manganese
Iron Std: 1.0mg/L (Aquatic Life)
Manganese STD: 0.05mg/L (Dw & GW)
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
WAP-2-10
Site/Date

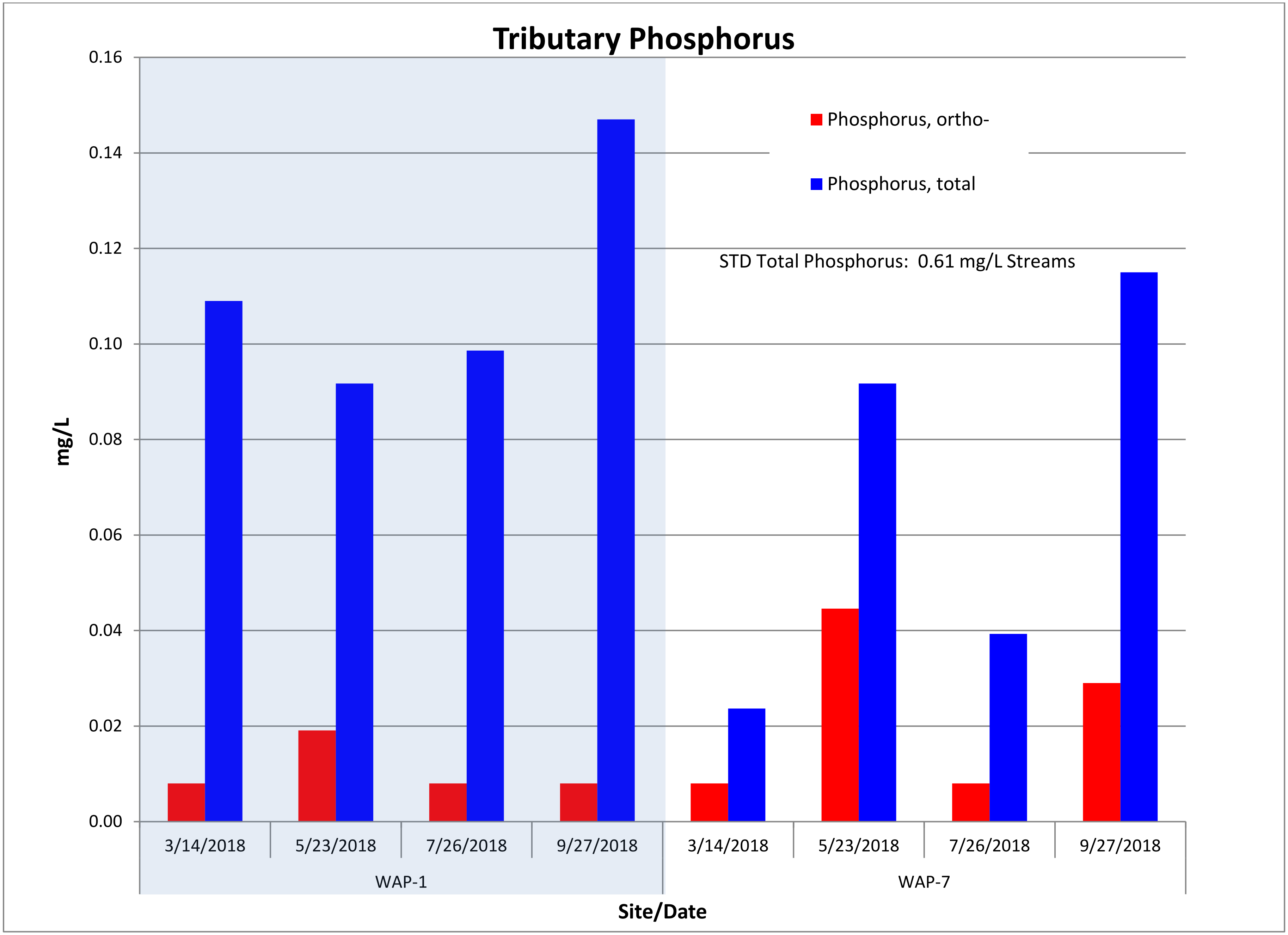

Tributary Nitrogen
Nitrogen, ammonia
Nitrate-N
Nitrate as Nitrogen Std = 10mg/L
Ammonia Nitrogen Std = 15mg/L
mg/L
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-7
Site/Date



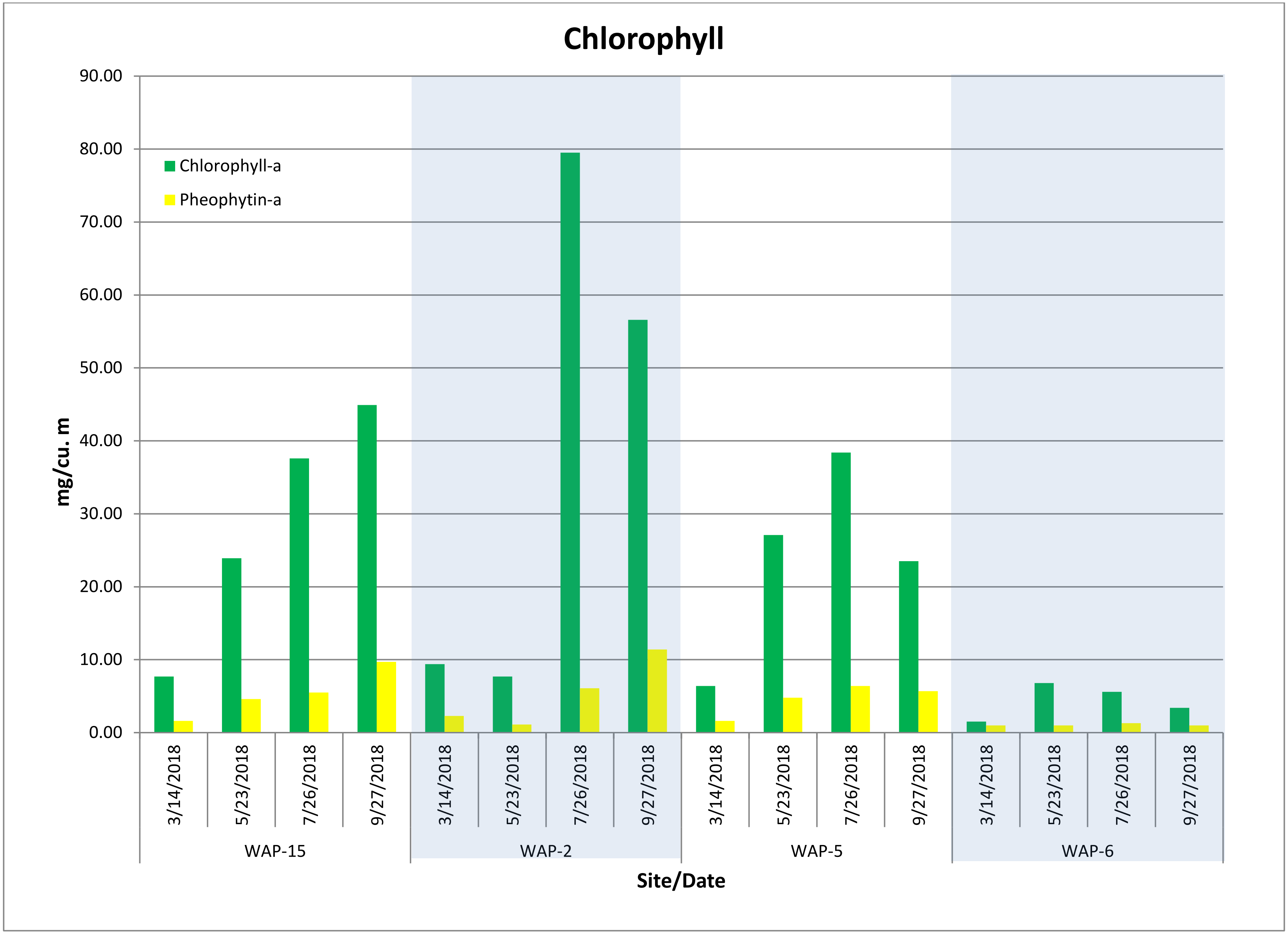
Lake Nitrogen
Nitrogen, ammonia
Nitrate-N
Nitrate as Nitrogen Std = 10mg/L
Ammonia Nitrogen Std = 15mg/L
mg/L
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-15
WAP-2
WAP-2-10
WAP-5
WAP-6
Site/Date

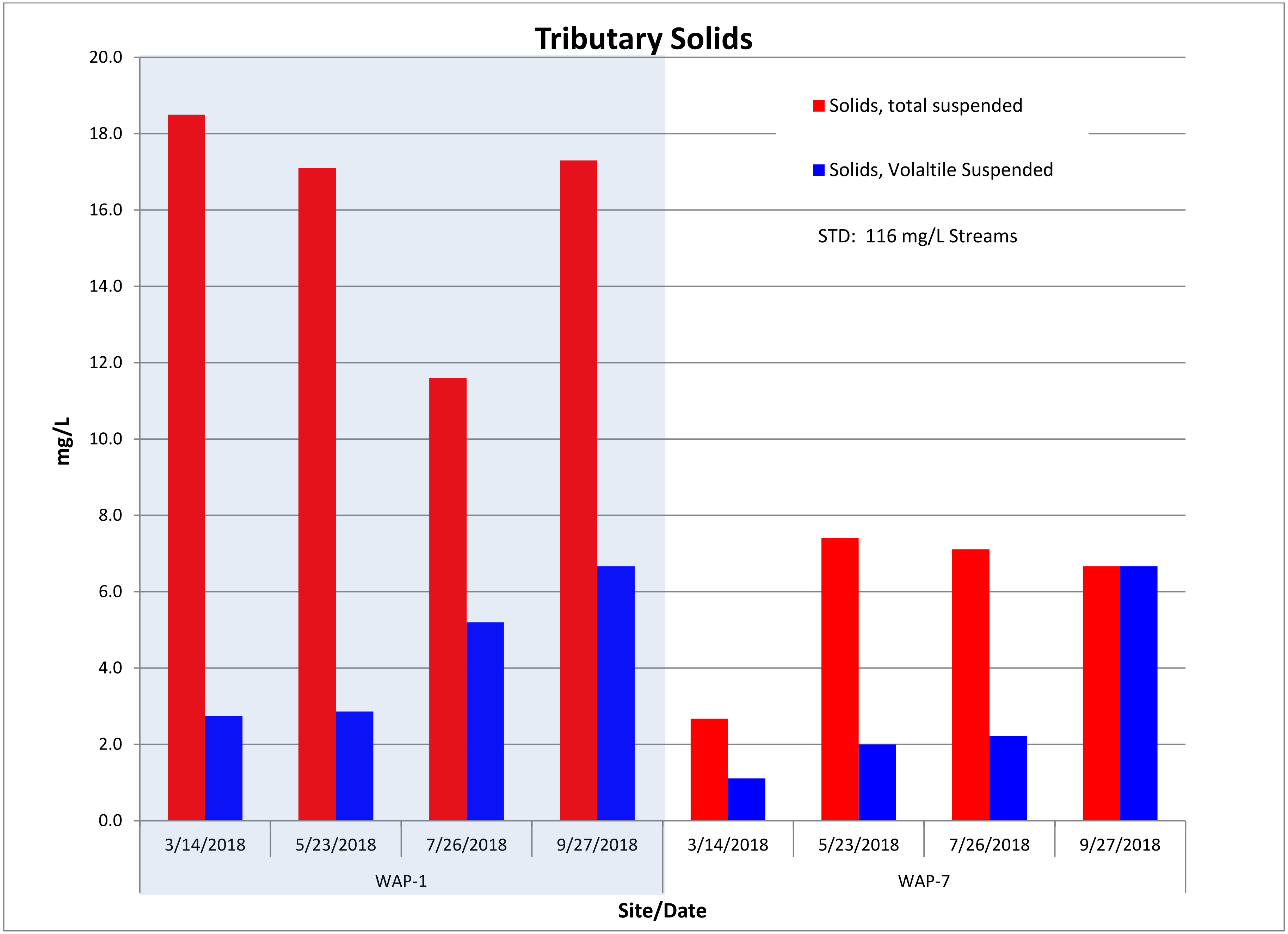


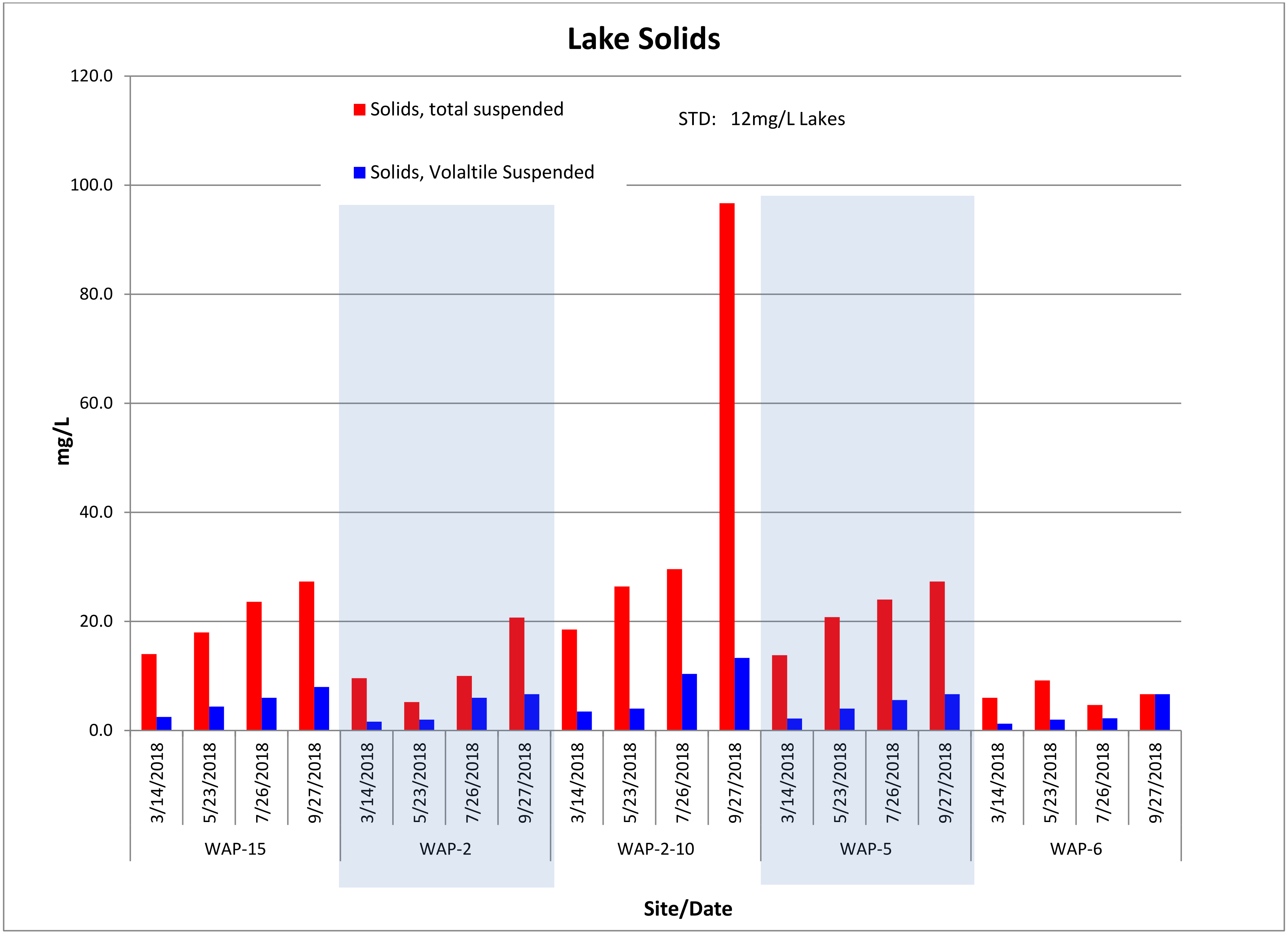
Lake Phosphorus
0.60000
0.50000
0.40000
0.30000
0.20000
0.10000
0.00000
mg/L
Phosphorus, ortho-
Phosphorus, total
STD Total Phosphorus: 0.05 mg/L Lakes
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-15
WAP-2
WAP-2-10
WAP-5
WAP-6
Site/Date

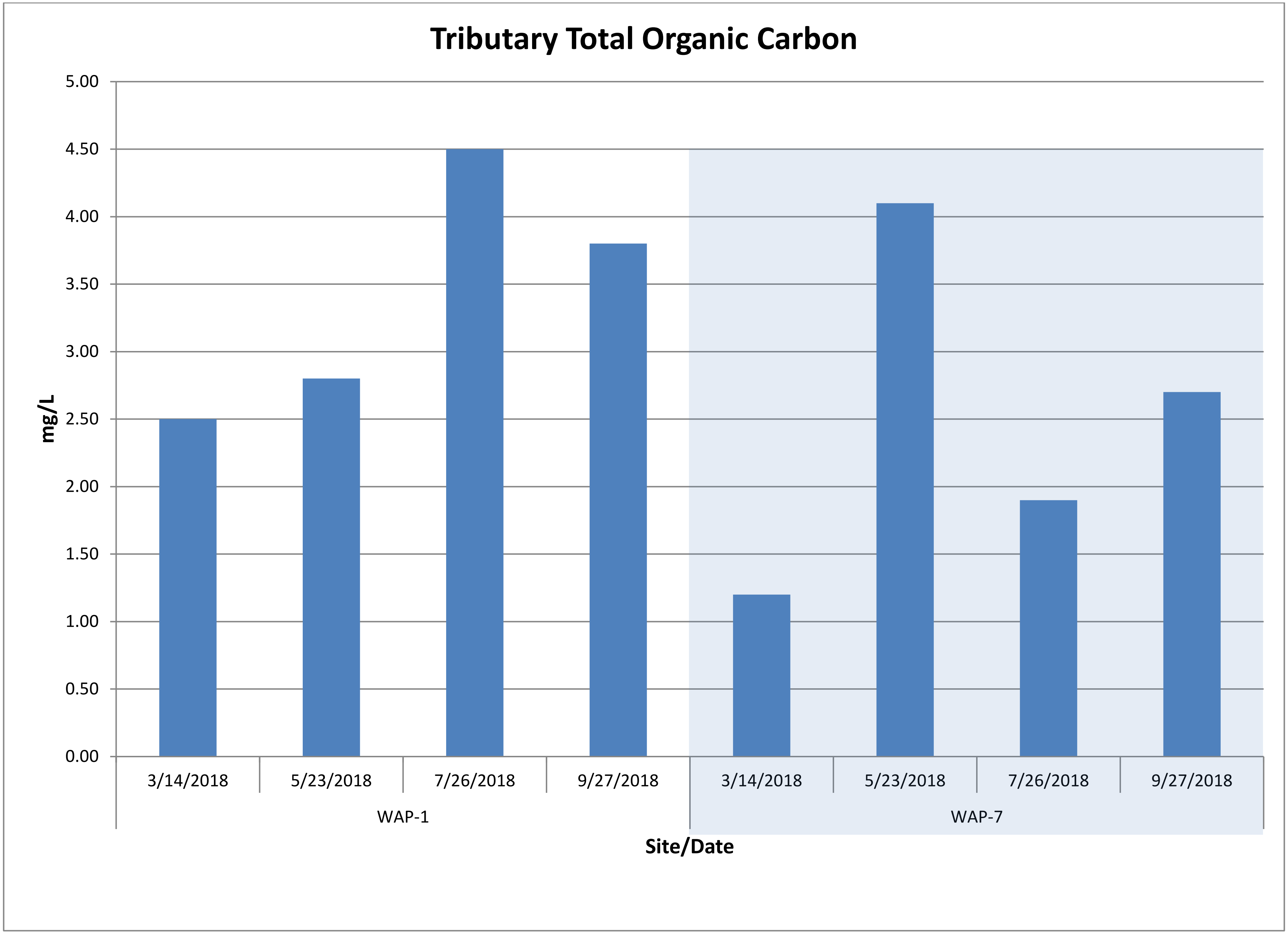


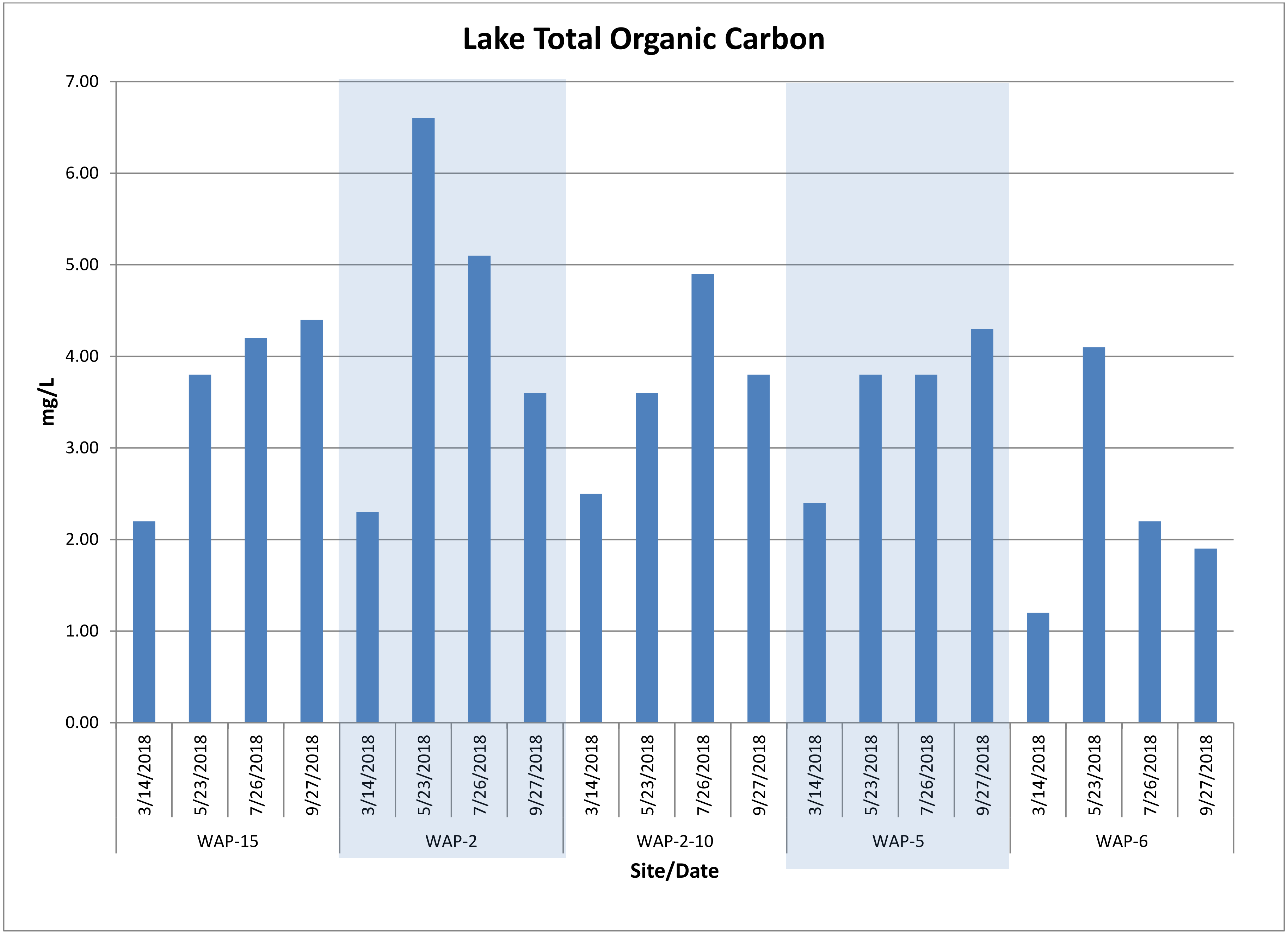
Tributary Phosphorus
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
mg/L
Phosphorus, ortho-
Phosphorus, total
STD Total Phosphorus: 0.61 mg/L Streams
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-7
Site/Date


Chlorophyll
Chlorophyll-a
Pheophytin-a
mg/cu. m
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-15
WAP-2
WAP-5
WAP-6
Site/Date

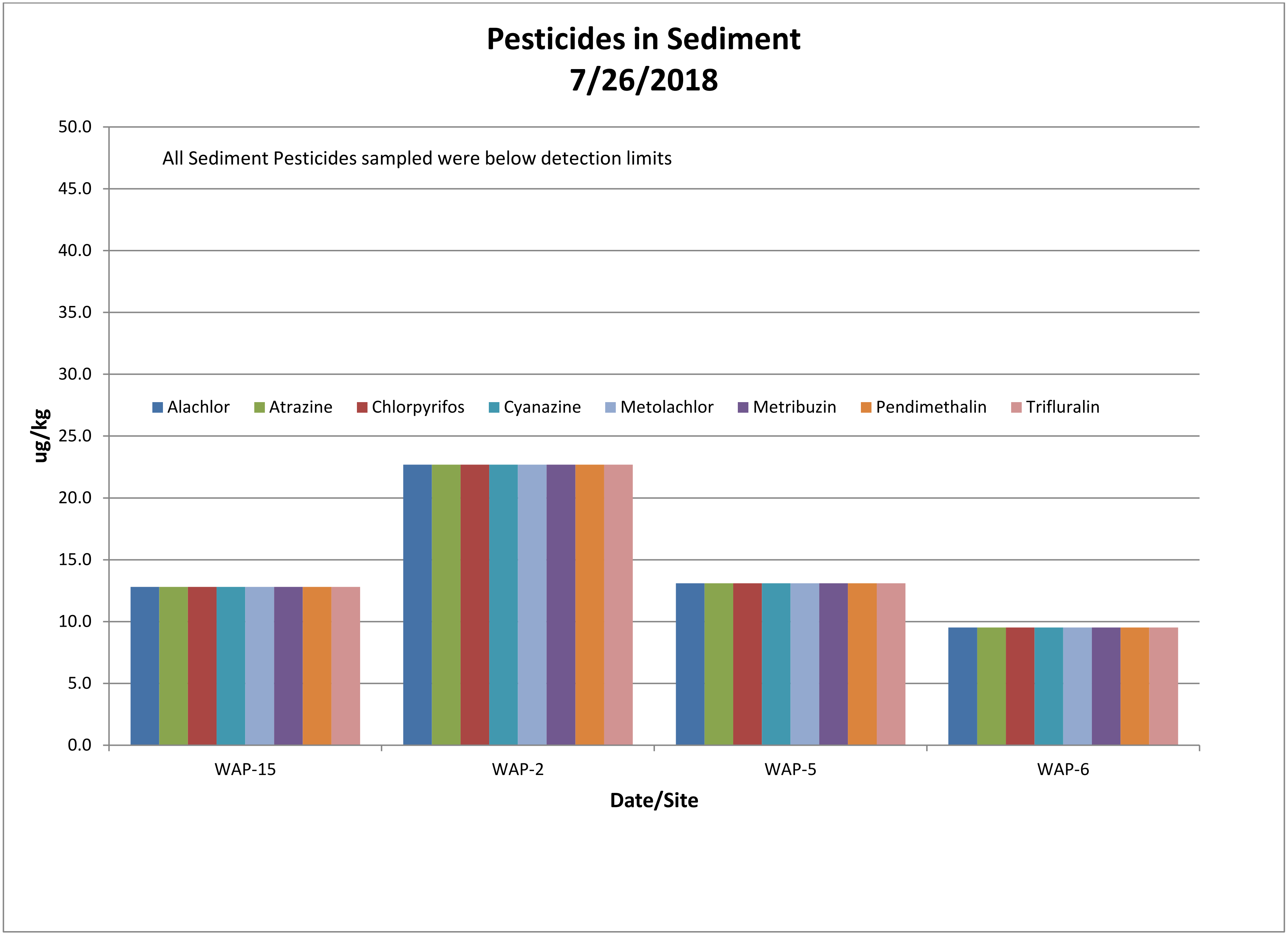

Tributary Solids
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
mg/L
Solids, total suspended
Solids, Volaltile Suspended
STD: 116 mg/L Streams
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
WAP-7
Site/Date

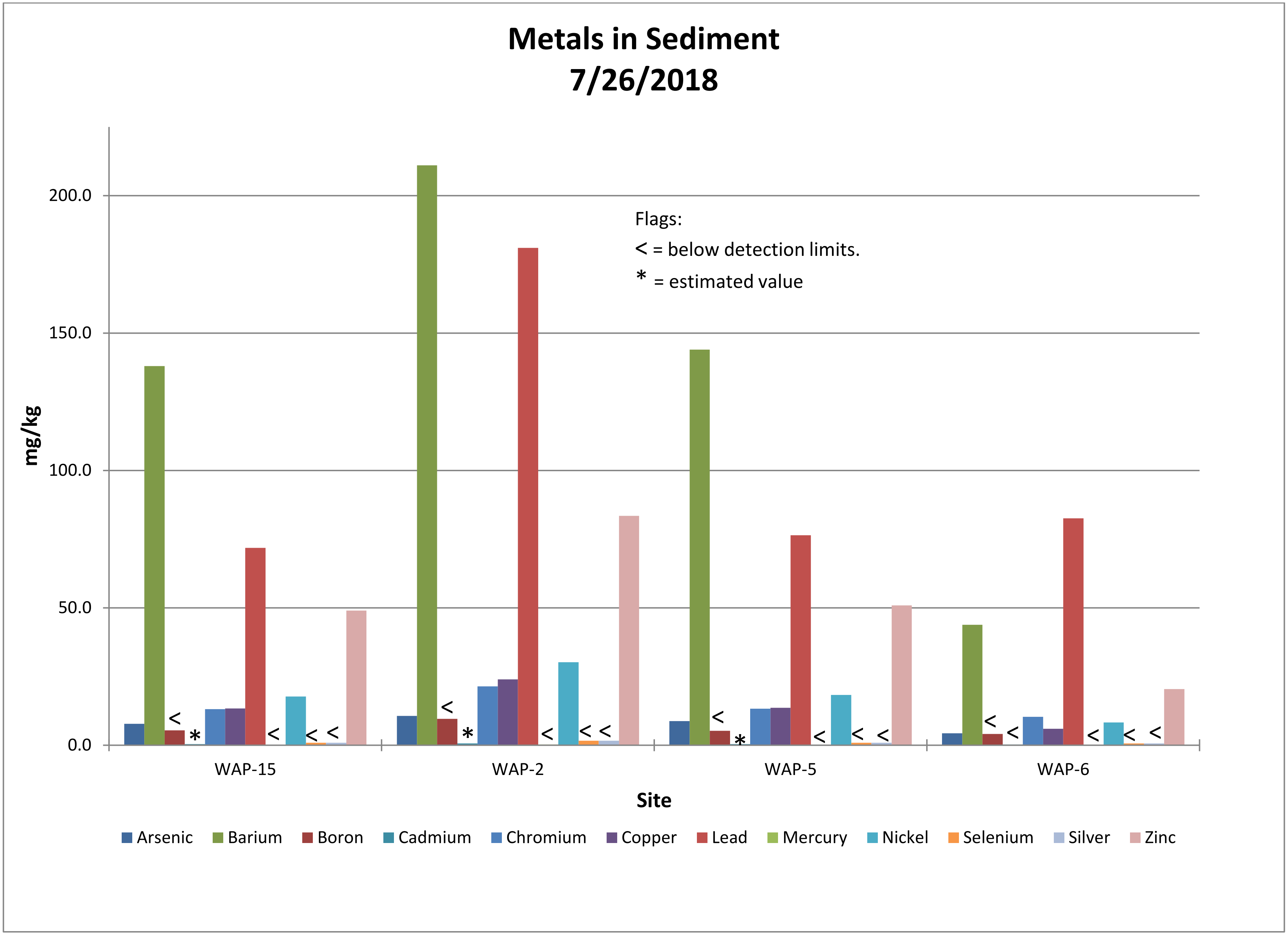

Lake Solids
Solids, total suspended
Solids, Volaltile Suspended
STD: 12mg/L Lakes
mg/L
120.0
100.0
80.0
60.0
40.0
20.0
0.0
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-15
WAP-2
WAP-2-10
WAP-5
WAP-6
Site/Date

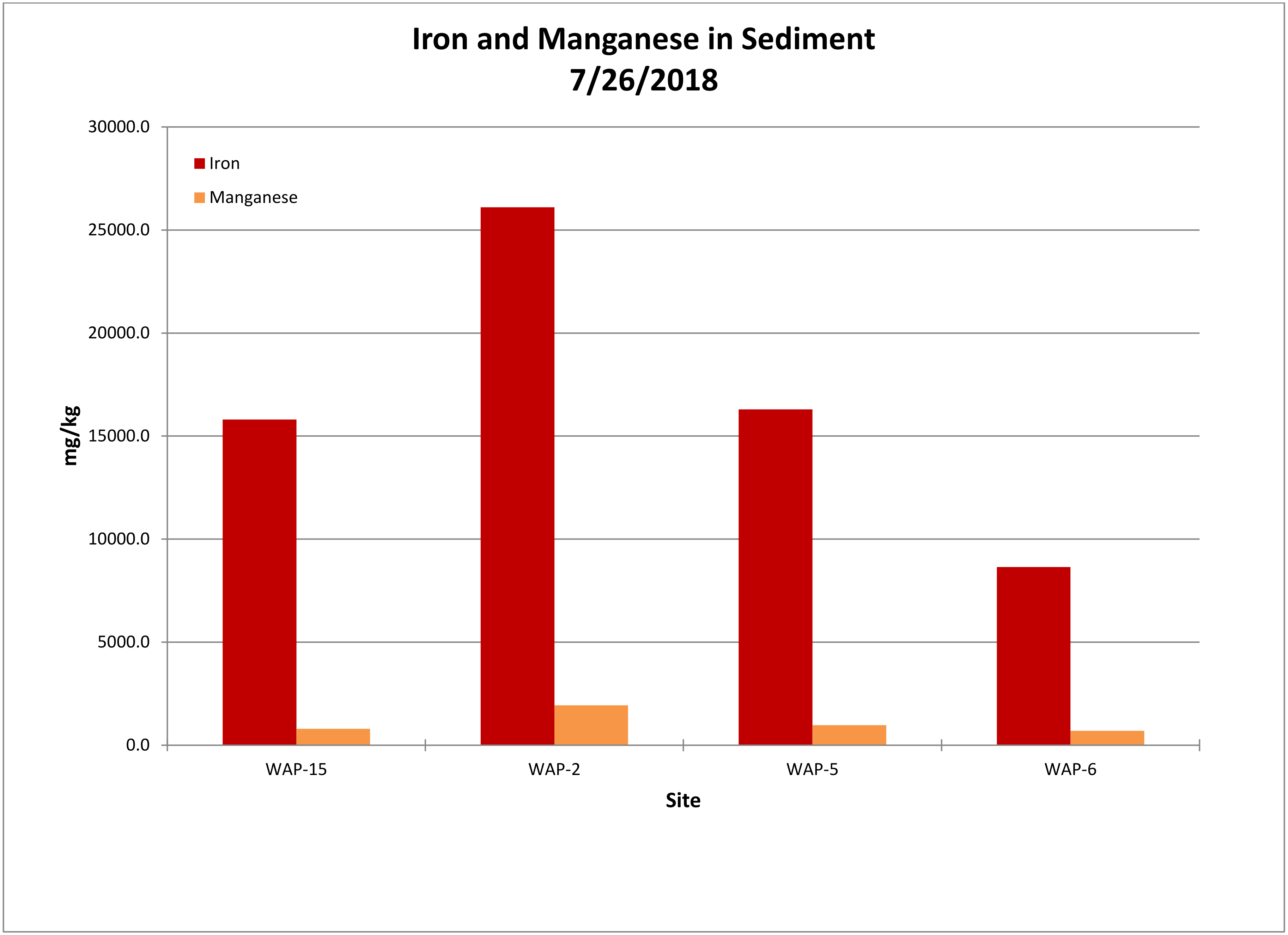

Tributary Total Organic Carbon
mg/L
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
WAP-7
Site/Date



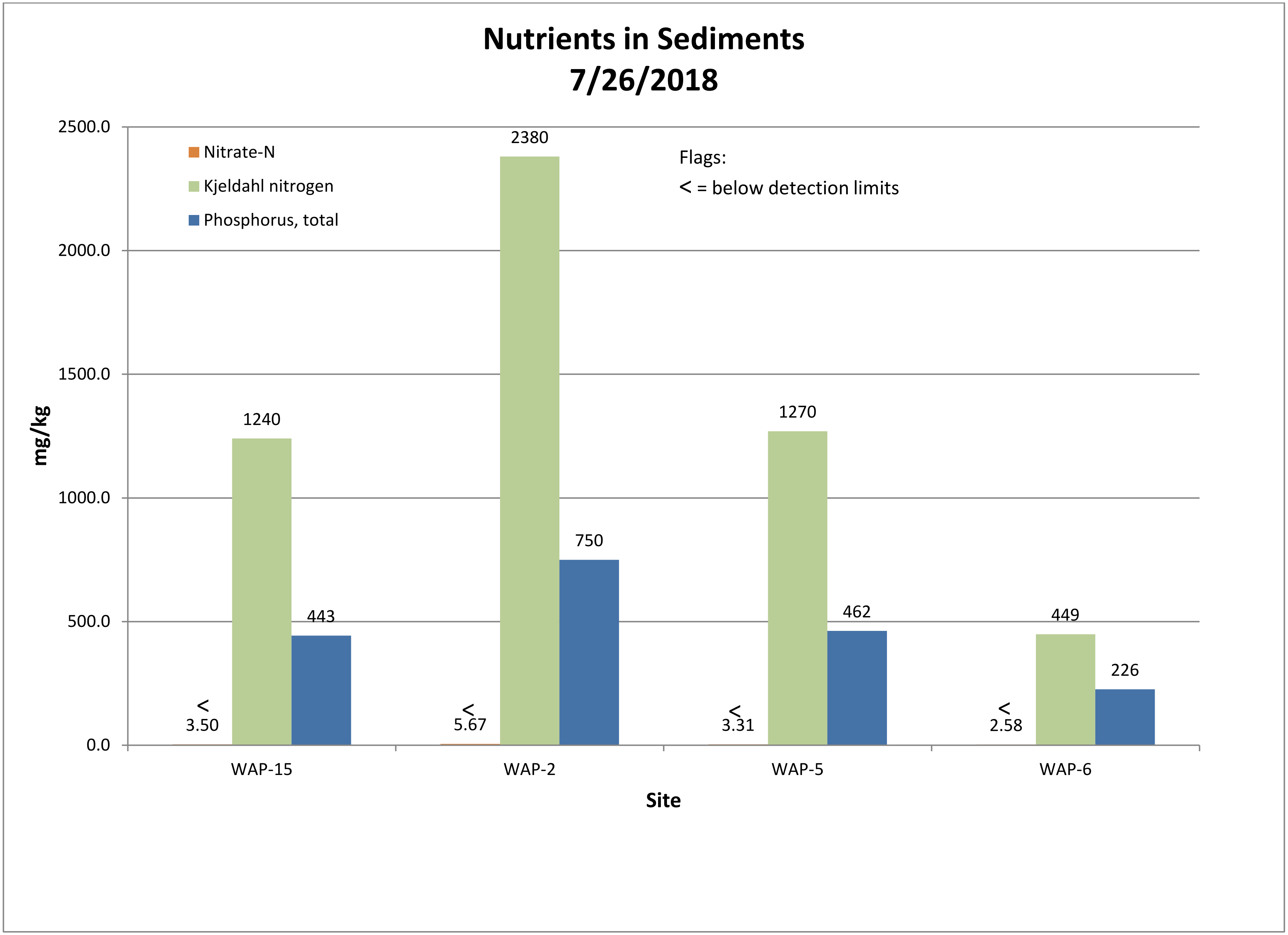
Lake Total Organic Carbon
mg/L
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-15
WAP-2
WAP-2-10
WAP-5
WAP-6
Site/Date

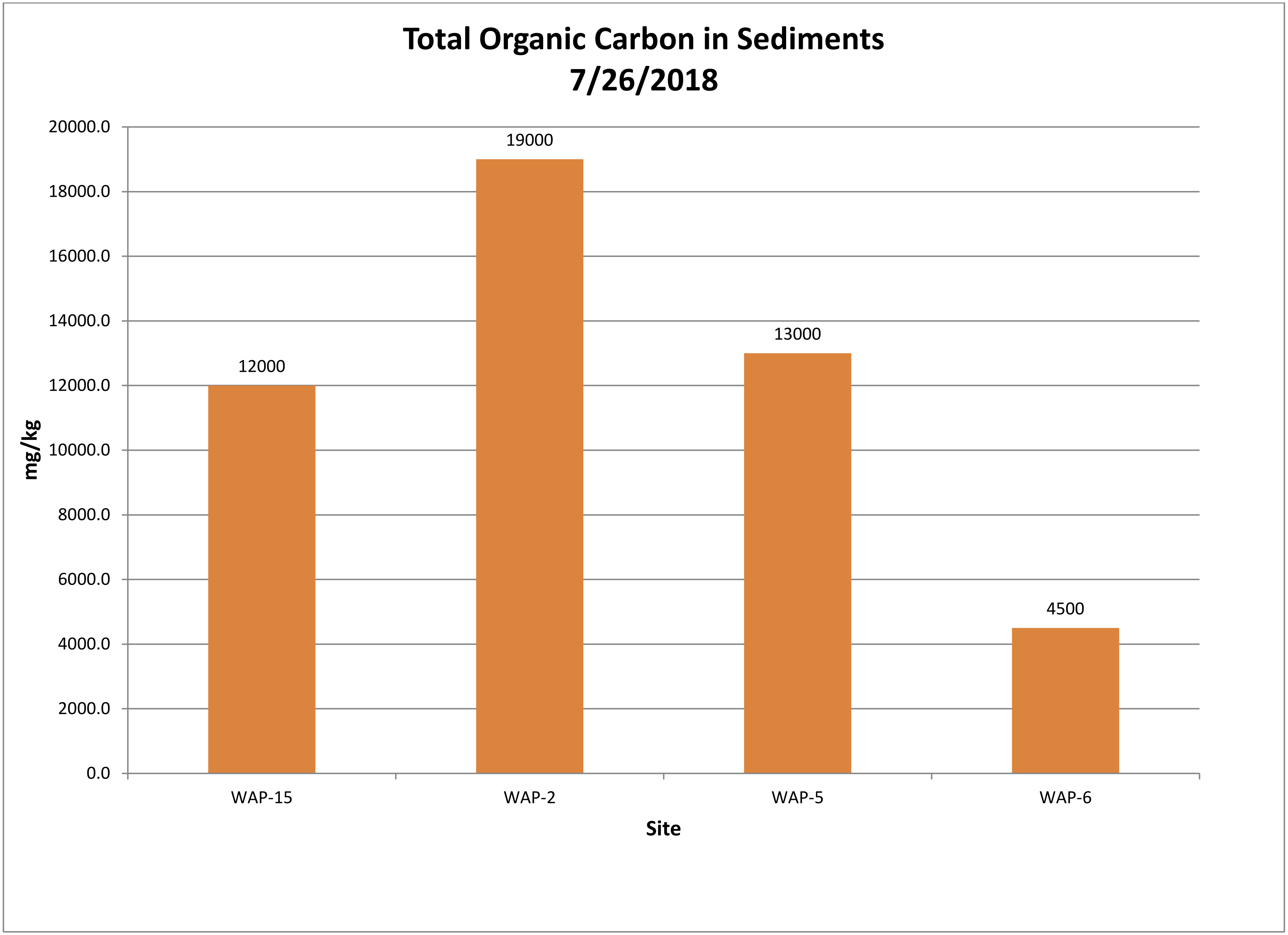

Pesticides in Sediment
7/26/2018
All Sediment Pesticides sampled were below detection limits
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
ug/kg
Alachlor
Atrazine
Chlorpyrifos
Cyanazine
Metolachlor
Metribuzin
Pendimethalin
Trifluralin
WAP-15
WAP-2
WAP-5
WAP-6
Date/Site


Metals in Sediment
7/26/2018
mg/kg
200.0
150.0
100.0
50.0
0.0
Flags:
< = below detection limits.
* = estimated value
WAP-15
WAP-2
WAP-5
WAP-6
Site
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Zinc



Iron and Manganese in Sediment
7/26/2018
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
mg/kg
Iron
Manganese
WAP-15
WAP-2
WAP-5
WAP-6
Site

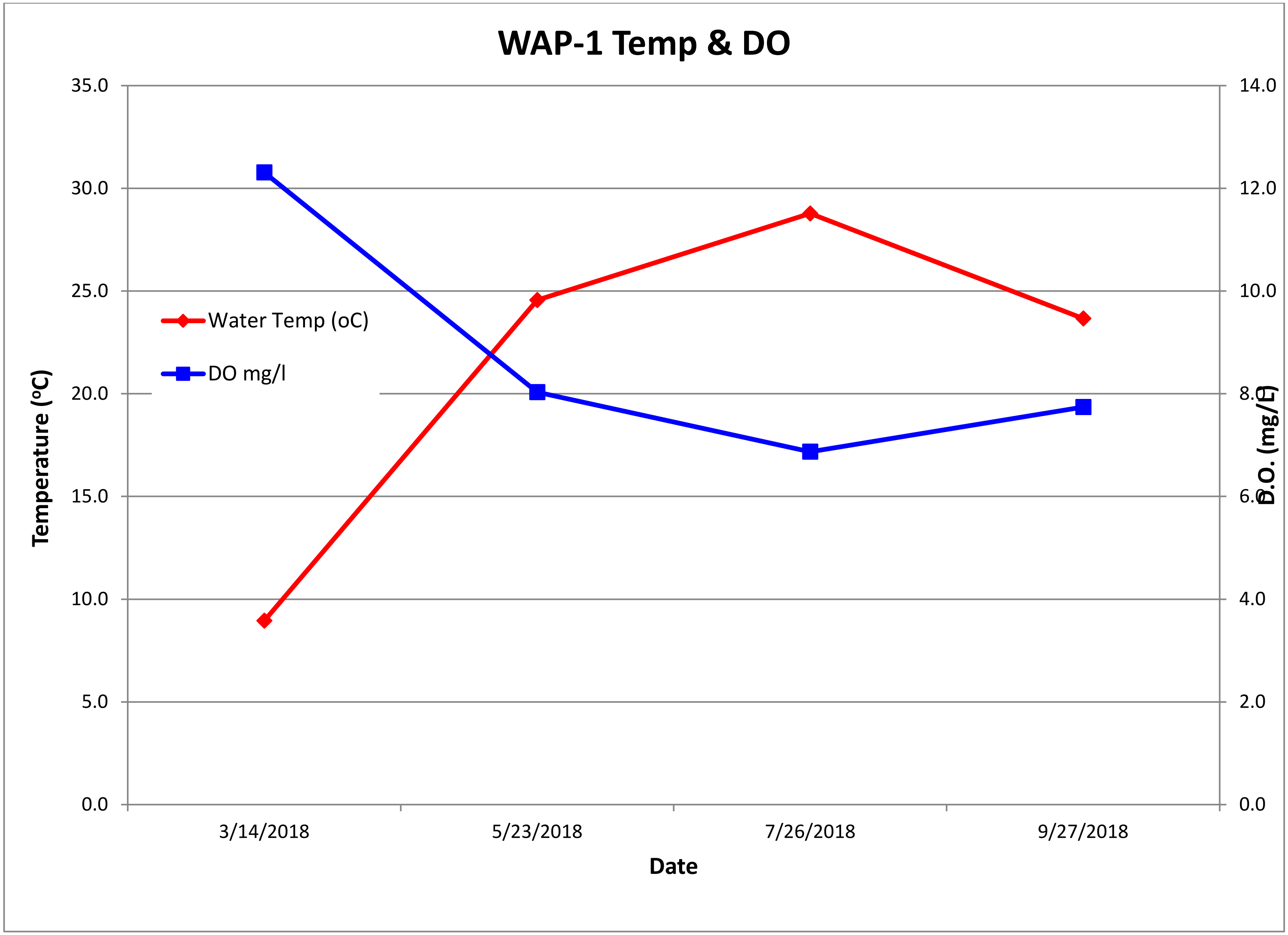

Nutrients in Sediments
7/26/2018
2500.0
2000.0
1500.0
1000.0
500.0
0.0
mg/kg
Nitrate-N
Kjeldahl nitrogen
Phosphorus, total
Flags:
< = below detection limits
2380
1240
1270
750
443
462
449
226
<
3.50
<
5.67
<
3.31
<
2.58
WAP-15
WAP-2
WAP-5
WAP-6
Site



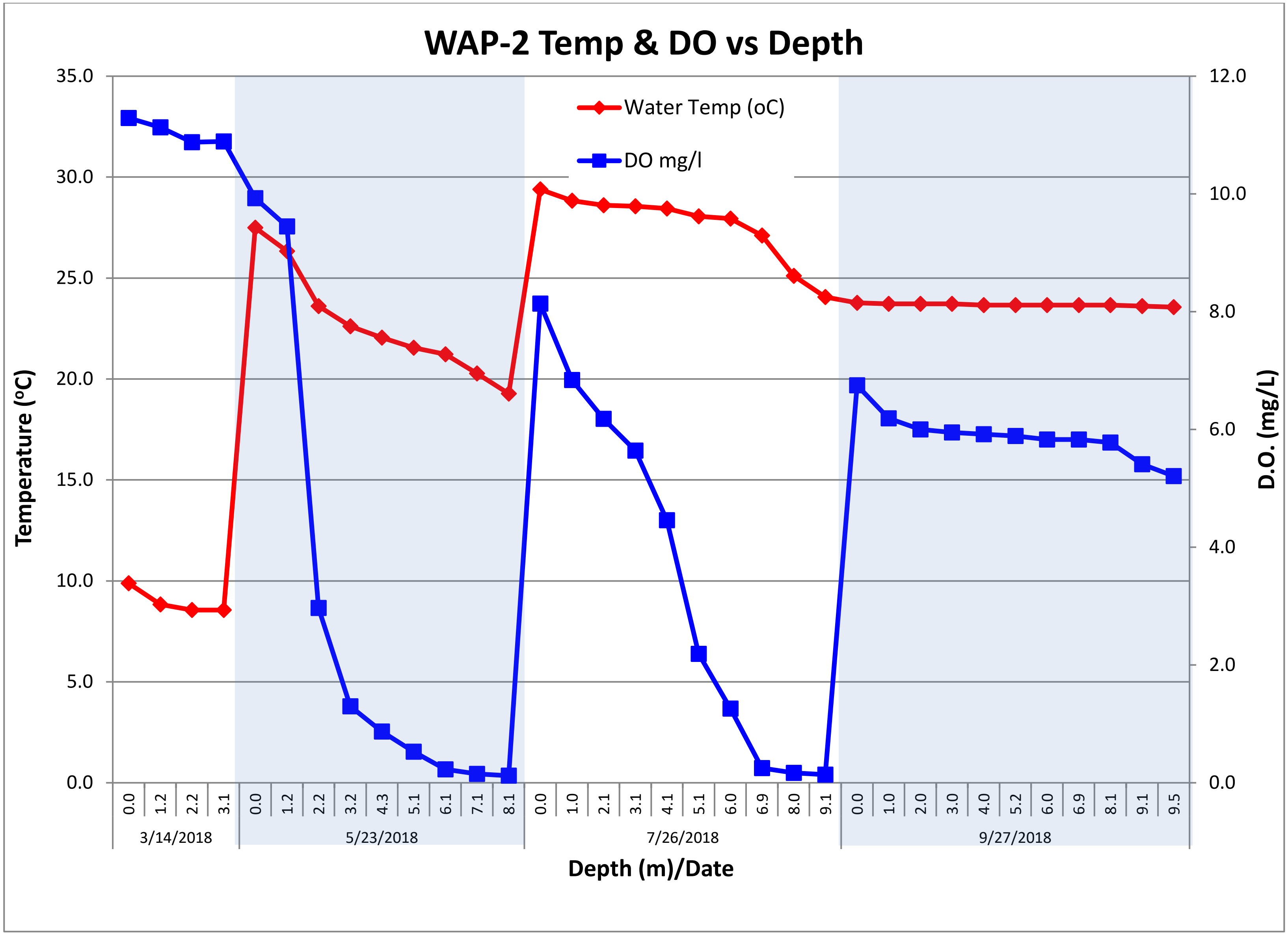
Total Organic Carbon in Sediments
7/26/2018
mg/kg
20000.0
18000.0
16000.0
14000.0
12000.0
10000.0
8000.0
6000.0
4000.0
2000.0
0.0
12000
19000
13000
4500
WAP-15
WAP-2
WAP-5
WAP-6
Site

APPENDIX C

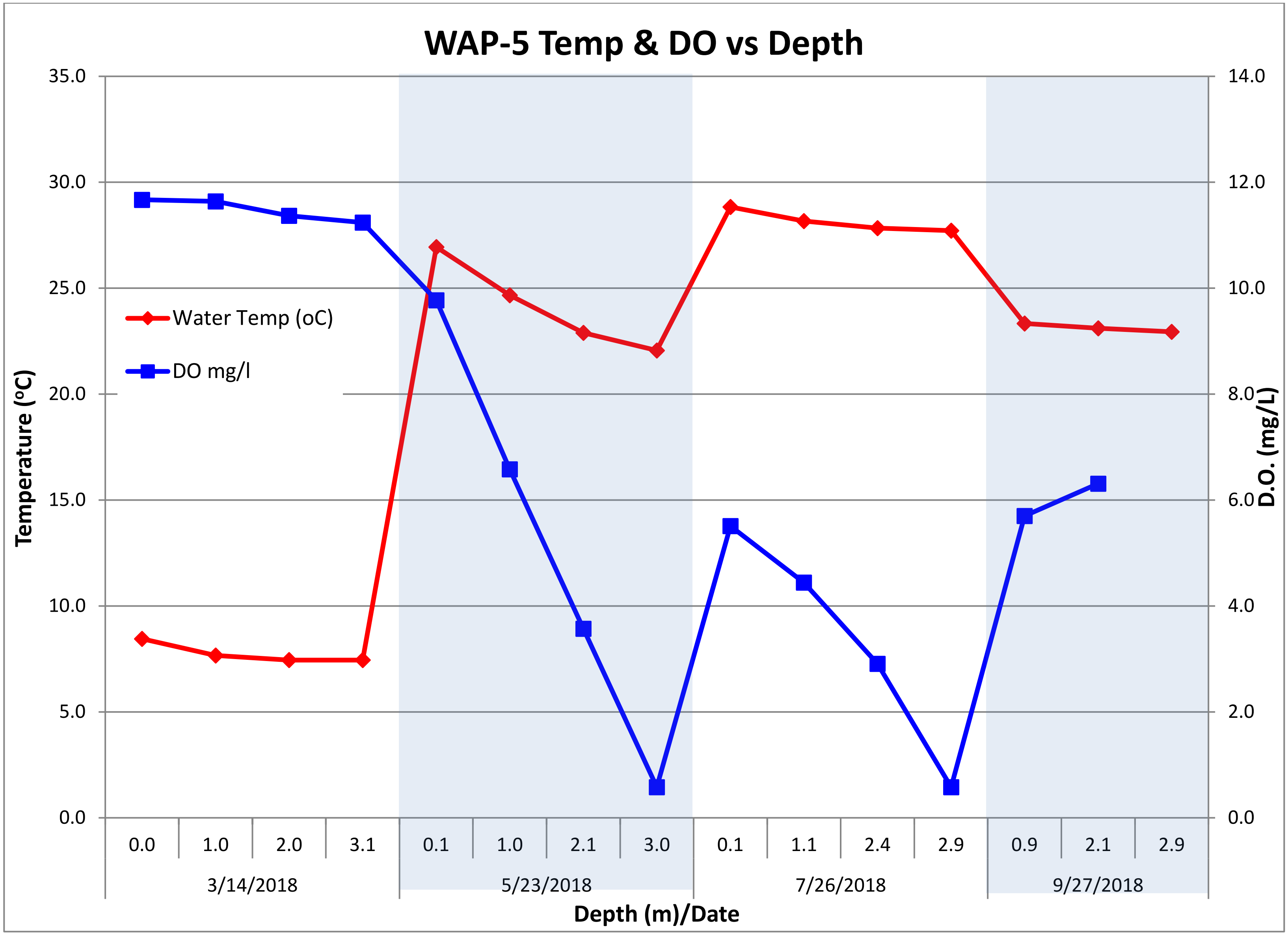
FIELD
GRAPHS

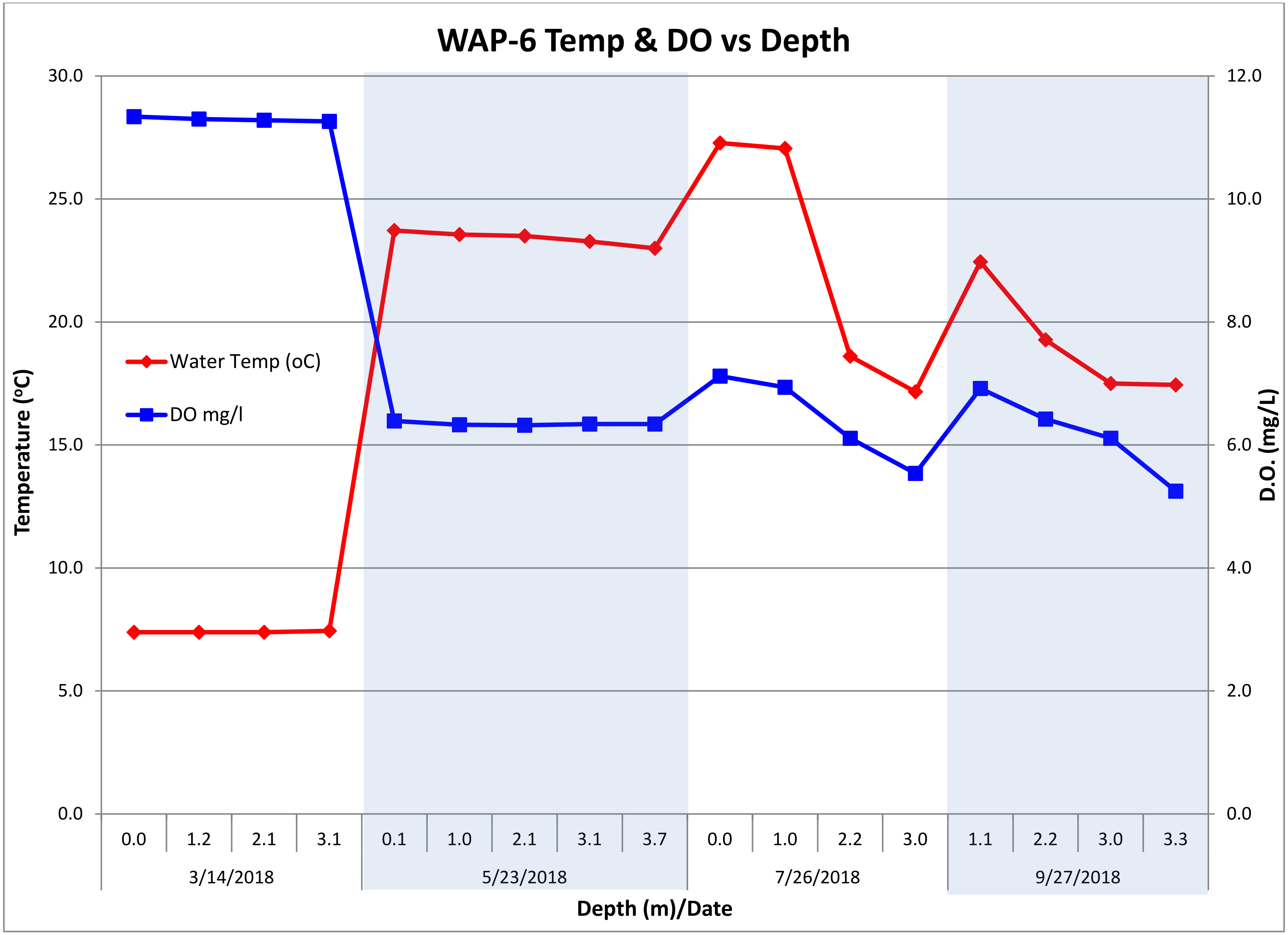


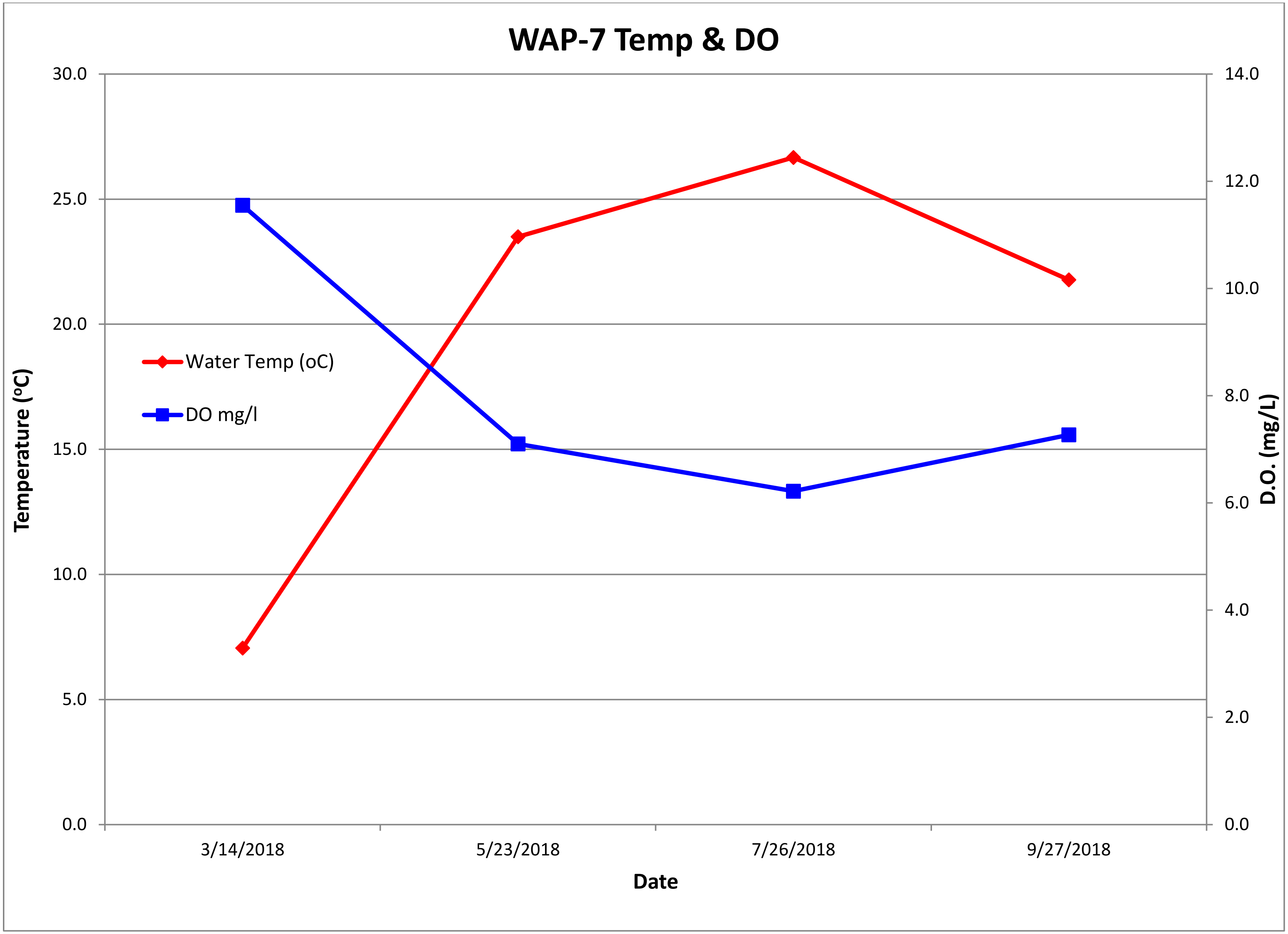
WAP-1 Temp & DO
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Temperature (ºC)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
D.O. (mg/L)
Water Temp (oC)
DO mg/l
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Date



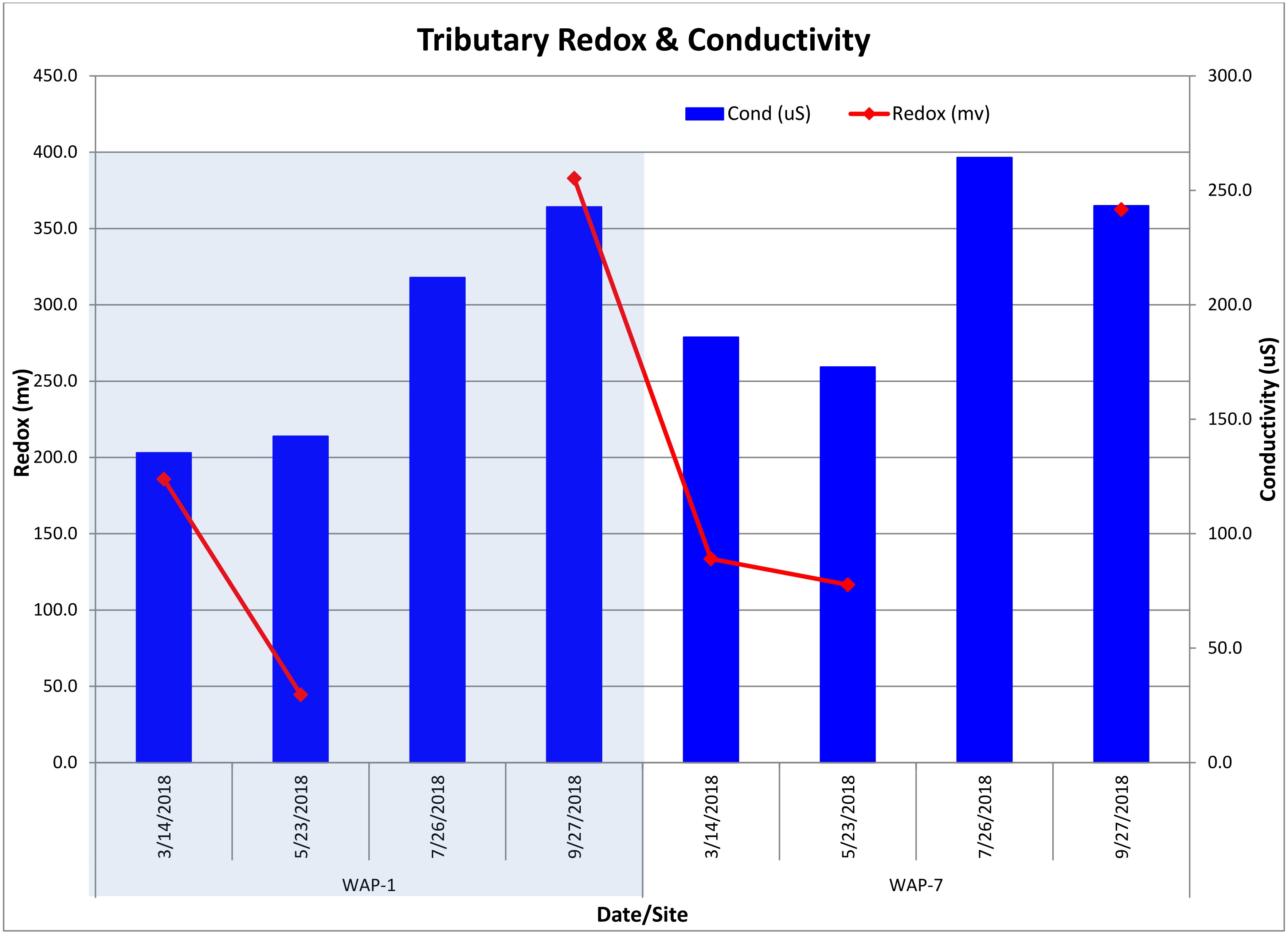
WAP-2 Temp & DO vs Depth
Water Temp (oC)
DO mg/l
Temperature (ºC)
D.O. (mg/L)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0 1.2 2.2 3.1
3/14/2018
0.0 1.2 2.2 3.2 4.3 5.1 6.1 7.1 8.1
5/23/2018
0.0 1.0 2.1 3.1 4.1 5.1 6.0 6.9 8.0 9.1
7/26/2018
0.0 1.0 2.0 3.0 4.0 5.2 6.0 6.9 8.1 9.1 9.5
9/27/2018
Depth (m)/Date


WAP-5 Temp & DO vs Depth
Water Temp (oC)
DO mg/l
Temperature (ºC)
D.O. (mg/L)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0 1.0 2.0 3.1
3/14/2018
0.1 1.0 2.1 3.0
5/23/2018
0.1 1.1 2.4 2.9
7/26/2018
0.9 2.1 2.9
9/27/2018
Depth (m)/Date

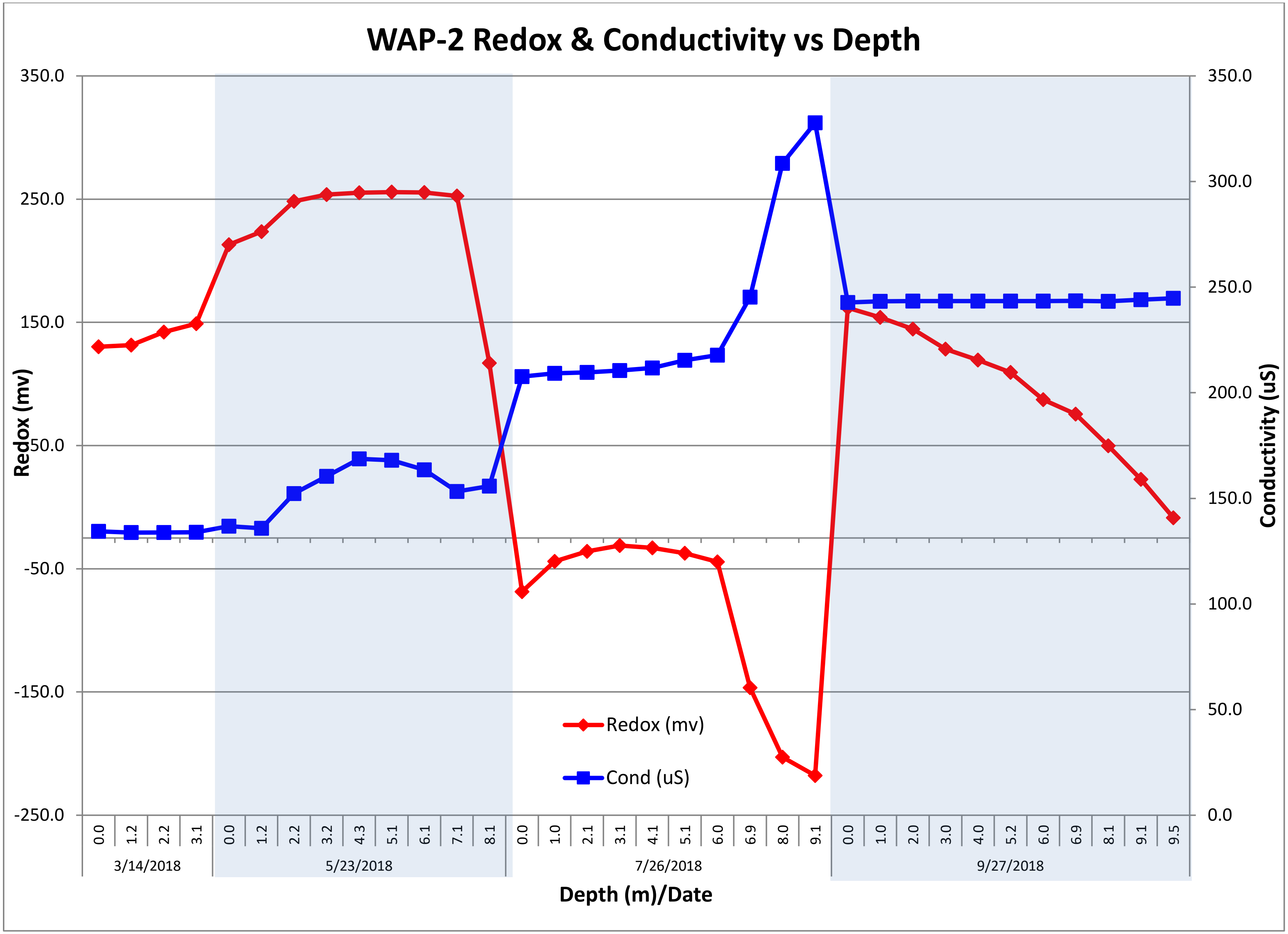

WAP-6 Temp & DO vs Depth
Temperature (°C)
D.O. (mg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Water Temp (oC)
DO mg/l
0.0 1.2 2.1 3.1 0.1 1.0 2.1 3.1 3.7 0.0 1.0 2.2 3.0 1.1 2.2 3.0 3.3
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Depth (m)/Date

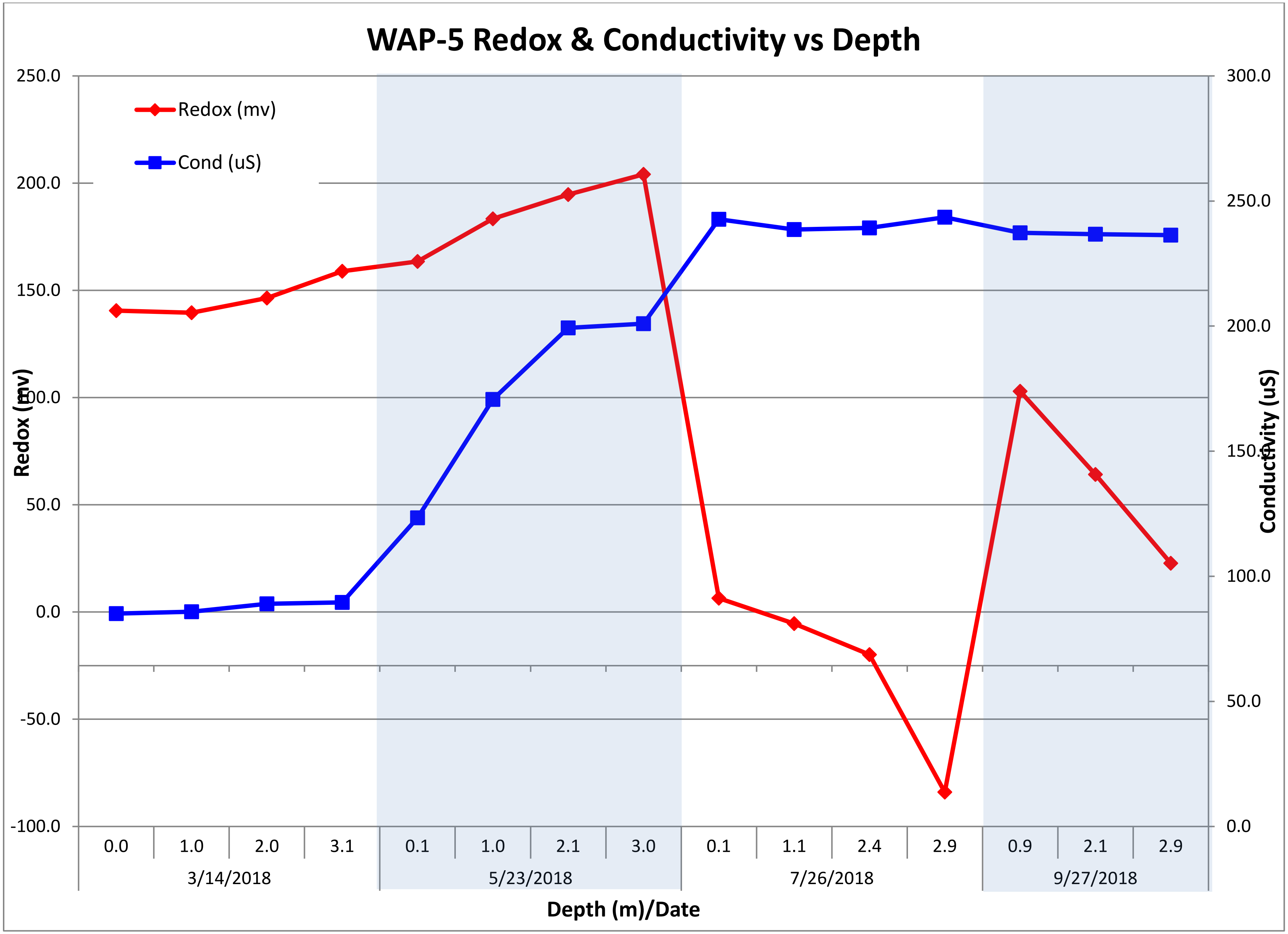


WAP-7 Temp & DO
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Temperature (ºC)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
D.O. (mg/L)
Water Temp (oC)
DO mg/l
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Date

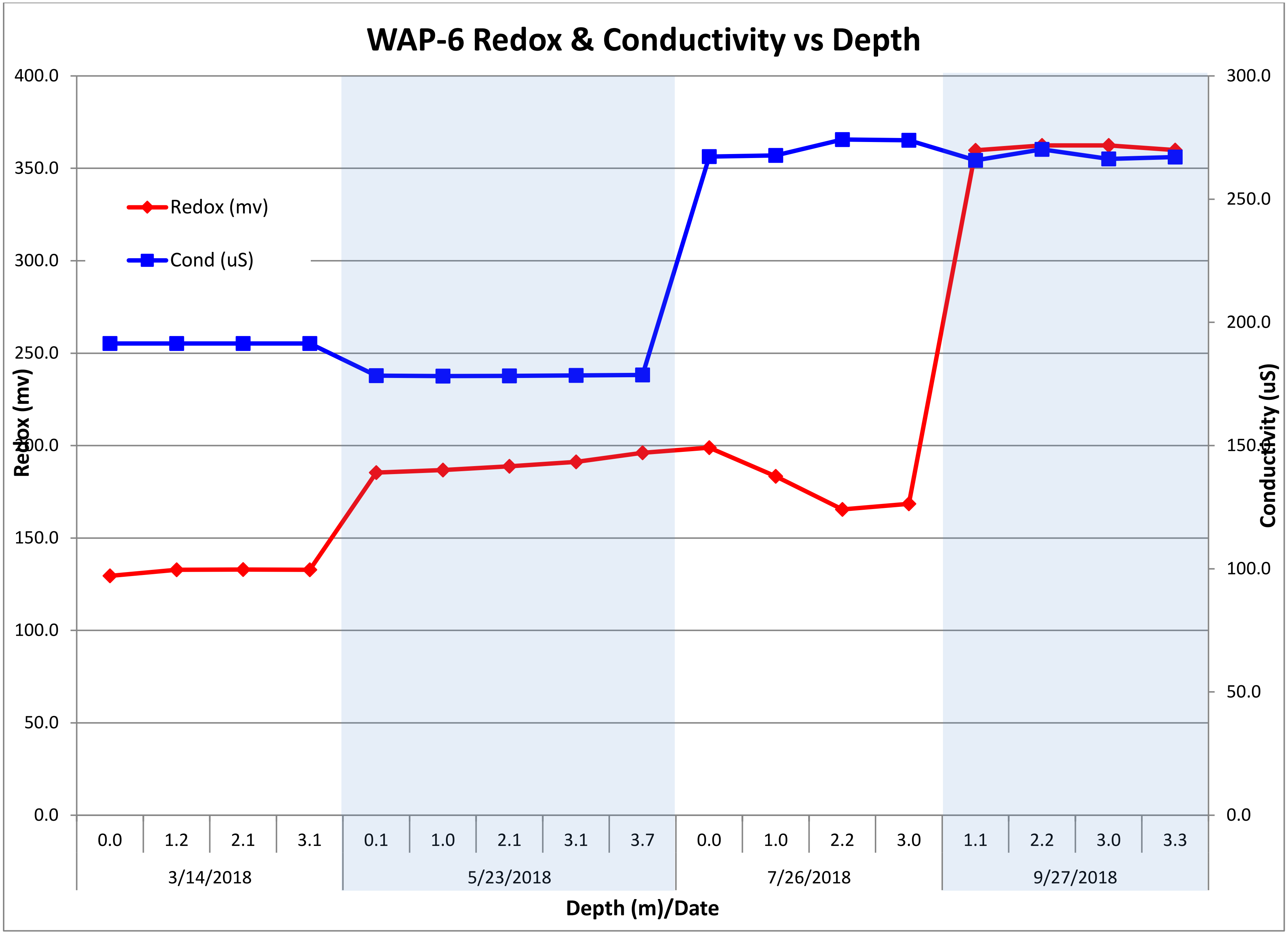


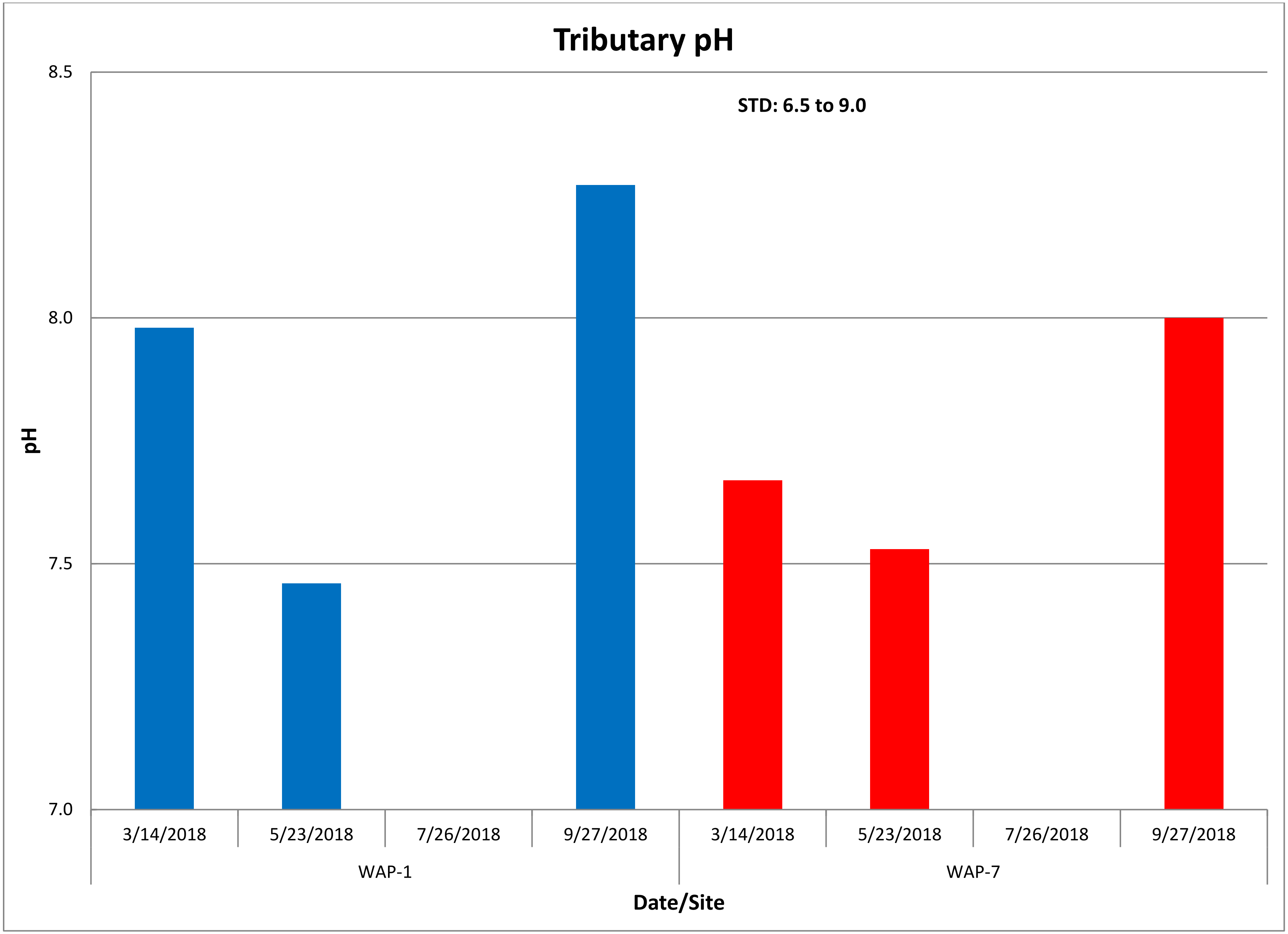
Tributary Redox & Conductivity
Cond (uS)
Redox (mv)
Redox (mv)
Conductivity (uS)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
WAP-7
Date/Site

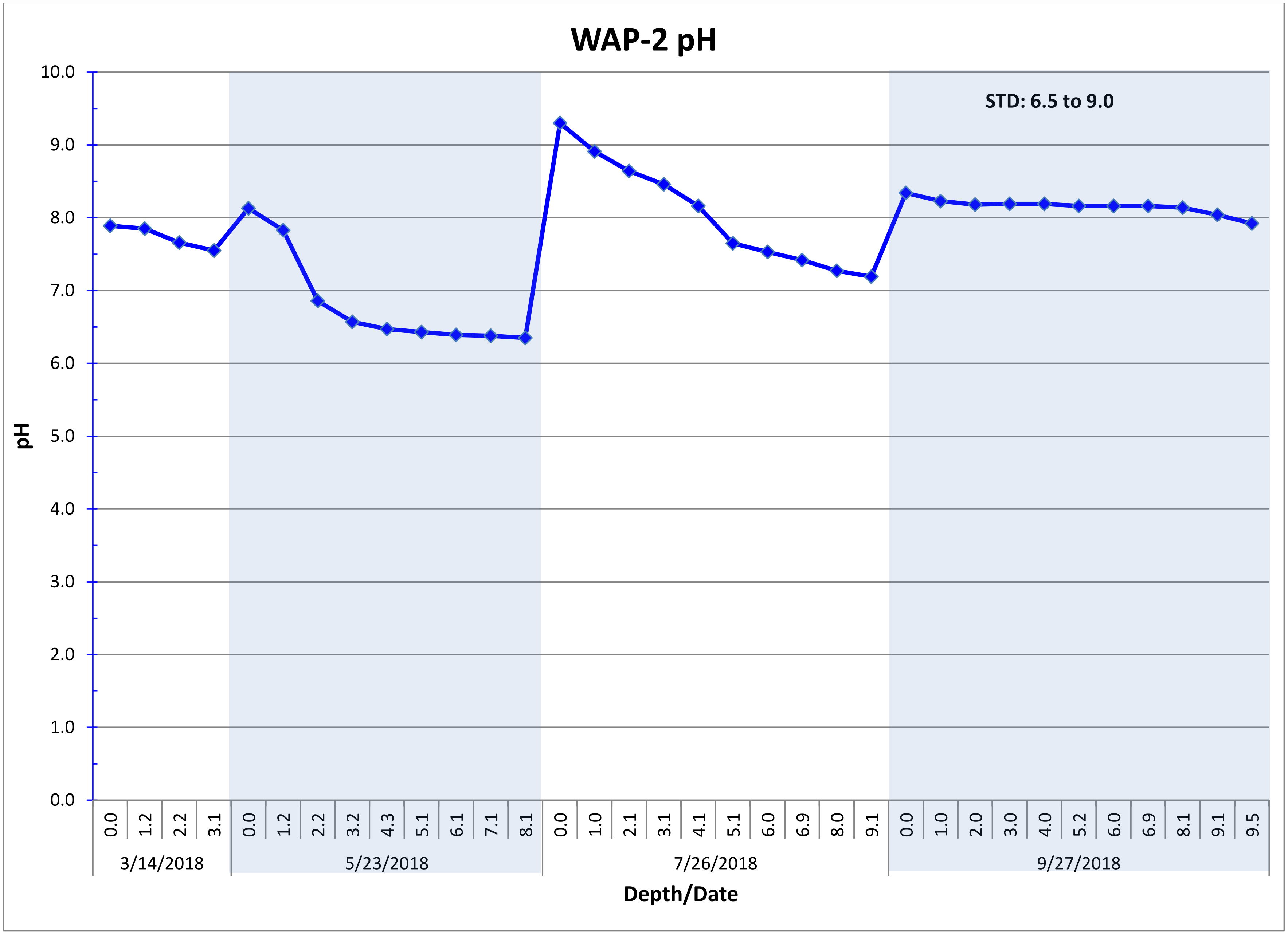

WAP-2 Redox & Conductivity vs Depth
Redox (mv)
Conductivity (uS)
350.0
250.0
150.0
50.0
-50.0
-150.0
-250.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Redox (mv)
Cond (uS)
0.0 1.2 2.2 3.1
3/14/2018
0.0 1.2 2.2 3.2 4.3 5.1 6.1 7.1 8.1
5/23/2018
0.0 1.0 2.1 3.1 4.1 5.1 6.0 6.9 8.0 9.1
7/26/2018
0.0 1.0 2.0 3.0 4.0 5.2 6.0 6.9 8.1 9.1 9.5
9/27/2018
Depth (m)/Date

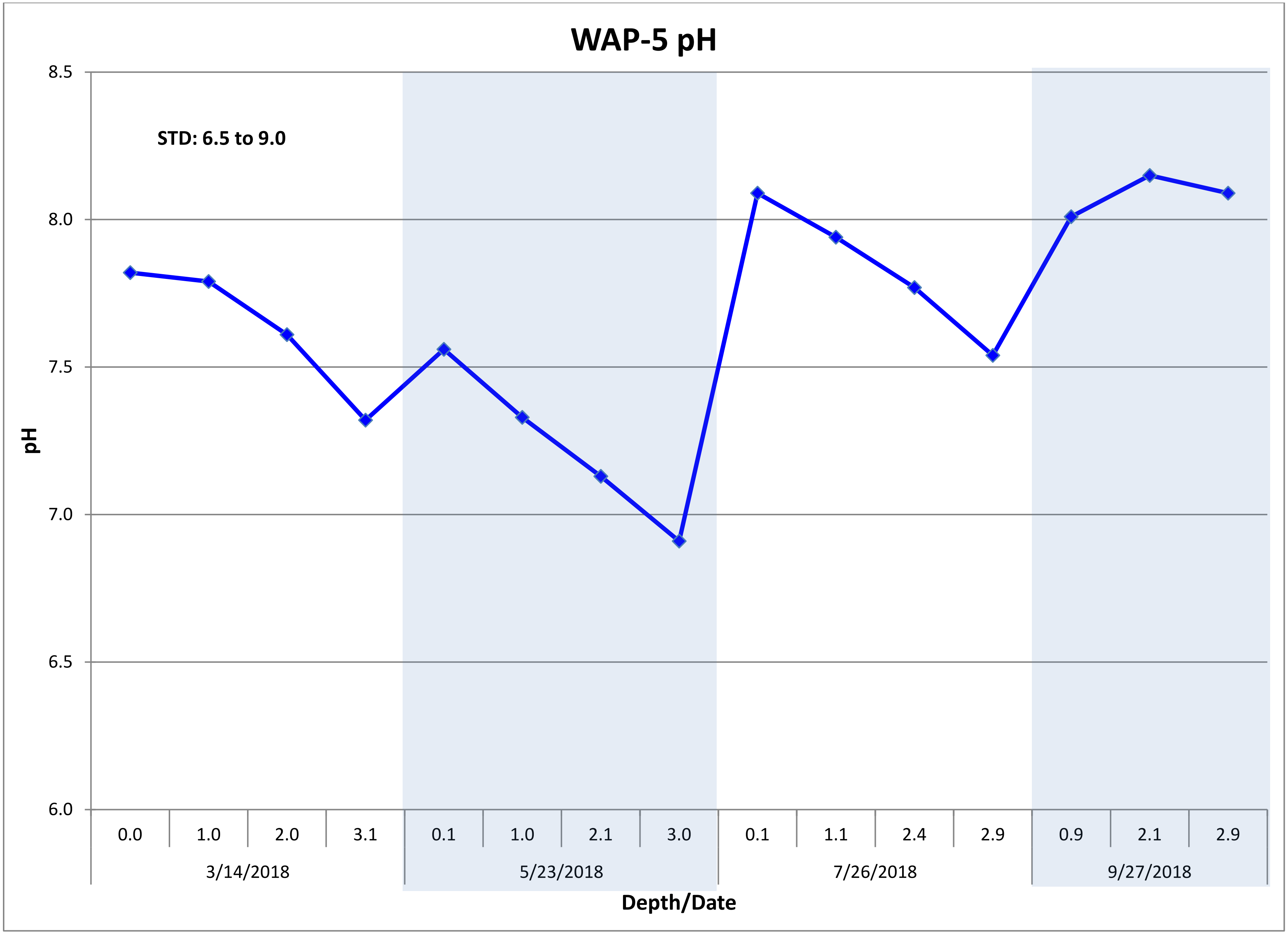


WAP-5 Redox & Conductivity vs Depth
Redox (mv)
Cond (uS)
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Redox (mv)
Conductivity (uS)
0.0
1.0
2.0
3.1
0.1
1.0
2.1
3.0
0.1
1.1
2.4
2.9
0.9
2.1
2.9
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Depth (m)/Date

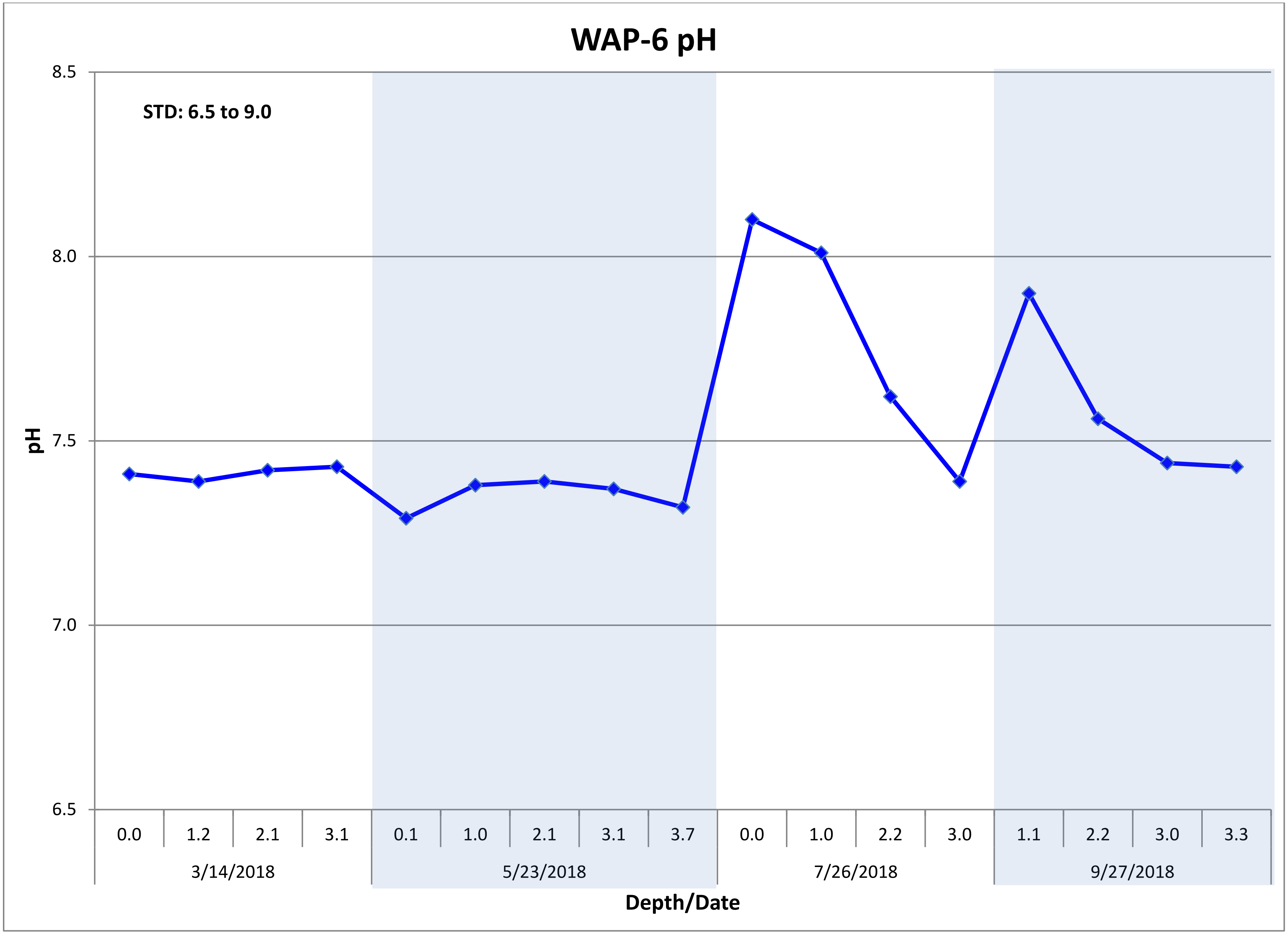

WAP-6 Redox & Conductivity vs Depth
Redox (mv)
Cond (uS)
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Redox (mv)
Conductivity (uS)
0.0
1.2
2.1
3.1
0.1
1.0
2.1
3.1
3.7
0.0
1.0
2.2
3.0
1.1
2.2
3.0
3.3
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Depth (m)/Date


Tributary pH
STD: 6.5 to 9.0
8.5
8.0
7.5
7.0
pH
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-1
WAP-7
Date/Site

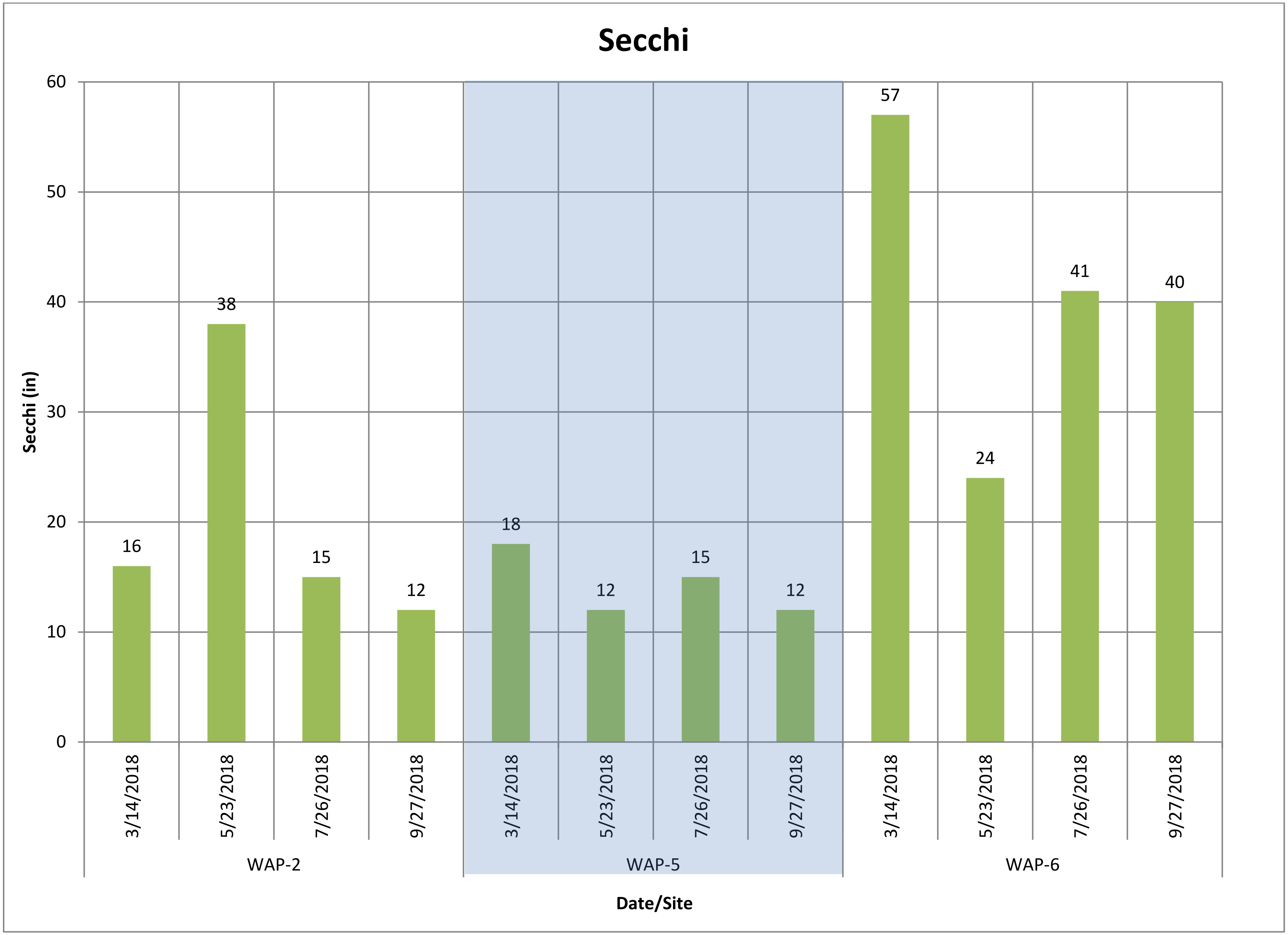

WAP-2 pH
STD: 6.5 to 9.0
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0 1.2 2.2 3.1
3/14/2018
0.0 1.2 2.2 3.2 4.3 5.1 6.1 7.1 8.1
5/23/2018
0.0 1.0 2.1 3.1 4.1 5.1 6.0 6.9 8.0 9.1
7/26/2018
0.0 1.0 2.0 3.0 4.0 5.2 6.0 6.9 8.1 9.1 9.5
9/27/2018
Depth/Date



WAP-5 pH
STD: 6.5 to 9.0
pH
8.5
8.0
7.5
7.0
6.5
6.0
0.0
1.0
2.0
3.1
0.1
1.0
2.1
3.0
0.1
1.1
2.4
2.9
0.9
2.1
2.9
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Depth/Date



WAP-6 pH
STD: 6.5 to 9.0
8.5
8.0
7.5
7.0
6.5
pH
0.0
1.2
2.1
3.1
0.1
1.0
2.1
3.1
3.7
0.0
1.0
2.2
3.0
1.1
2.2
3.0
3.3
3/14/2018
5/23/2018
7/26/2018
9/27/2018
Depth/Date


Secchi
Secchi (in)
60
50
40
30
20
10
0
16
38
15
12
18
12
15
12
57
24
41
40
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
3/14/2018
5/23/2018
7/26/2018
9/27/2018
WAP-2
WAP-5
WAP-6
Date/Site

APPENDIX D

Lakes of Missouri
Volunteer Monitoring Data

2016 Lakes of Missouri Volunteer Program (LMVP) Data

Site	Date	Temp F	Secchi INCHES	TP ug/L	TN ug/L	TCHLa ug/L	CHLa ug/L	PHEO ug/L	ISS mg/L	OSS mg/L	TSS mg/L	Comments	Depth
1	5/16/16	67	33	40	440	20.6	20	1.4	4.9	2.4	7.3		29
1	6/21/16	86	74	21	330	6.3	5.8	1.5	1.4	2.6	4		24
1	7/1/16	83	41			23.7	23.7	0.1	2.5	4.6	7.1		
1DEEP	5/16/16			46	490	0.5	0.5	0.1	17	3.8	20.8	Hand pump broke	
1DEEP	6/21/16			49	410	22.4	22.4	0.1	10.2	2.8	13		
1DEEP	7/1/16			29	400	21.2	20.4	2.3	4.8	4.4	9.2		
2	5/16/16	67	30	45	450	27.9	26.4	3.8	4.3	4	8.3		21
2	6/21/16	85	69	26	340	7.5	6.3	3.1	1.2	2.5	3.7		
2	7/1/16	83	28	88	530	21.8	19.6	5.6	6	4.2	10.2		15
2DEEP	5/16/16			62	570	1	0.6	0.8	44	10.4	54.4		
2DEEP	6/21/16	`		46	400	24.8	20.5	11.1	8.4	3.2	11.6		
2DEEP	7/1/16			42	420	21.4	18.7	7.1	13.6	4.4	18		
3	5/16/16		36	19	390	5.6	4.9	2.2	8.5	2	10.5		
3	6/21/16			17	250	8.6	7.5	3.2	5.6	1.5	7.1		
3	7/1/16			21	230	11.3	9.8	4.3	8.9	1.9	10.8		

Site 1 is in front of dam
Site 2 is in Lost Creek Arm
Site 3 is at Hwy 34 Bridge

Depth is simply the depth of the lake at the sampling location at the time of sample collection
DEEP sample sites represent water collected from near the bottom using a Van Dorn sampling bottle

Full report for all lakes in the LMVP can be found at http://www.lmvp.org/lakes.htm.

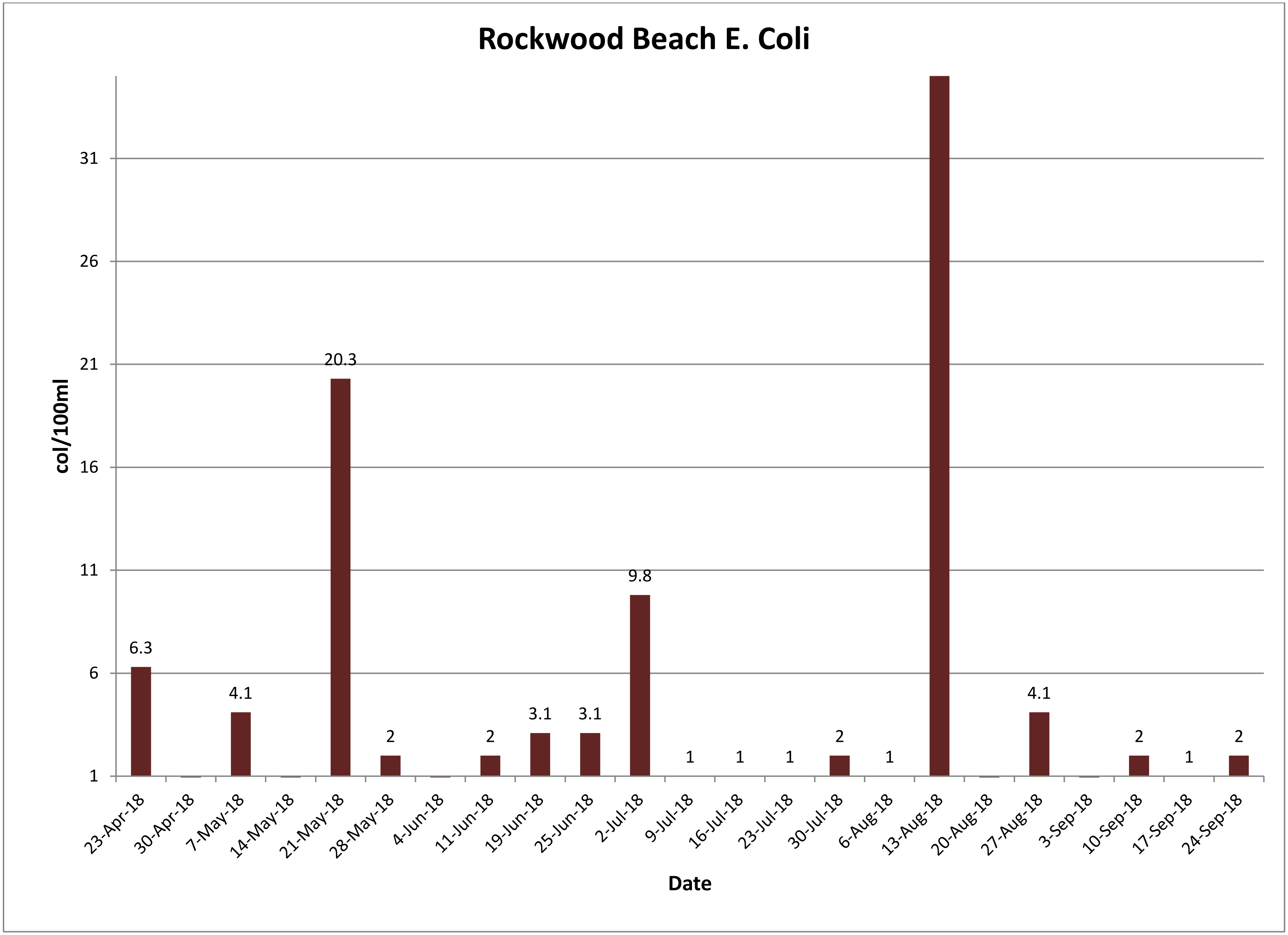
APPENDIX E

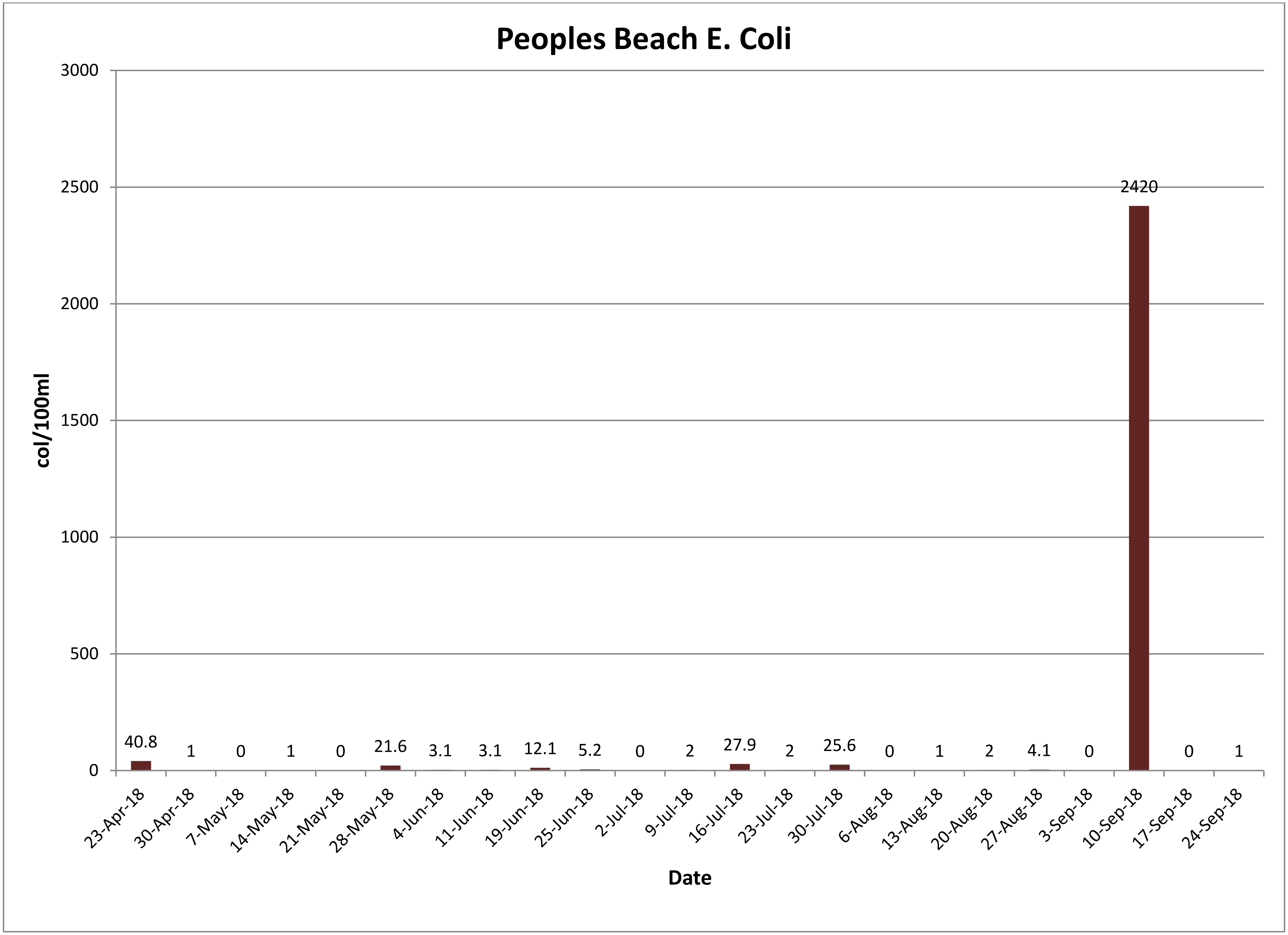
Beach Data & Graphs

E. Coli Beach Samples 2018

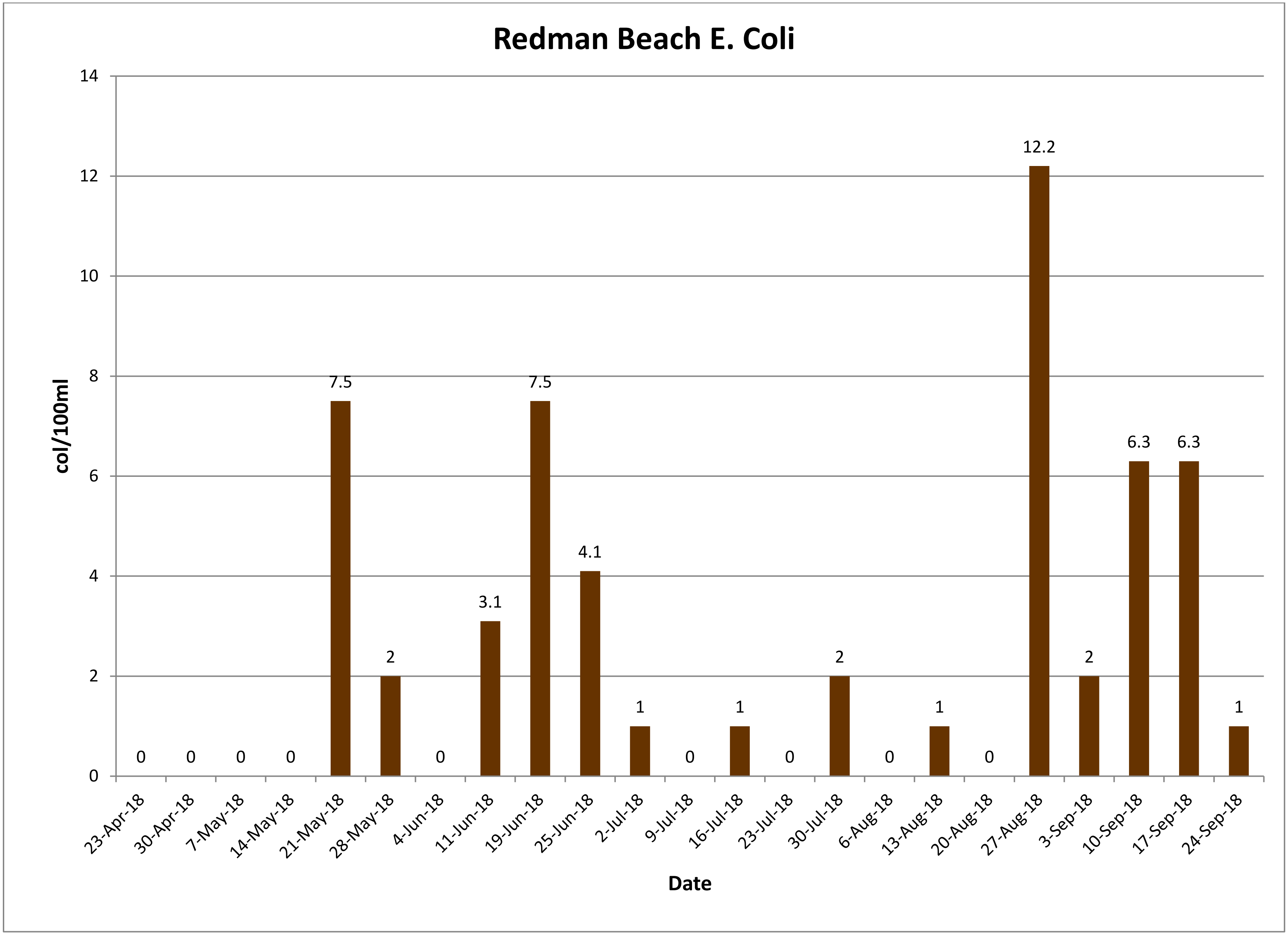
Week of	Water temp.	Rockwood	E. Coli Peoples	Redman	Rain Previous 2 days	Lake Level	Notes
23-Apr-18		6.3	40.8	Closed	1.42	363.13	
30-Apr-18		<1	1	Closed	0	362.93	
7-May-18		4.1	Closed	Closed	0.3	365.41	
14-May-18		<1	1	<1	0	362.04	
21-May-18		20.3	<1	7.5	0.55	360.59	
28-May-18		2	21.6	2	0	360.57	
4-Jun-18		<1	3.1	<1	0	360.15	
11-Jun-18		2	3.1	3.1	0	359.89	
19-Jun-18		3.1	12.1	7.5	0	359.85	
25-Jun-18		3.1	5.2	4.1	0.25	359.84	
2-Jul-18		9.8	<1	1	0	360.3	
9-Jul-18		1	2	<1	0.3	360.02	
16-Jul-18		1	27.9	1	0.01	360.03	
23-Jul-18		1	2	<1	0	360.07	
30-Jul-18		2	25.6	2	0	359.93	
6-Aug-18		1	<1	<1	0	359.87	
13-Aug-18		980	1	1	0	360.09	Re-tested Rockwood on 8/15/18 with result of <1
20-Aug-18		<1	2	<1	0.43	360.33	
27-Aug-18		4.1	4.1	12.2	0	360.35	
3-Sep-18		<1	<1	2	0	359.9	
10-Sep-18		2	2420	6.3	0	360.67	Re-tested peoples 9/13/18 with result of 2.0
17-Sep-18		1	<1	6.3	0	359.91	
24-Sep-18		2	1	1	0.24	360.09	

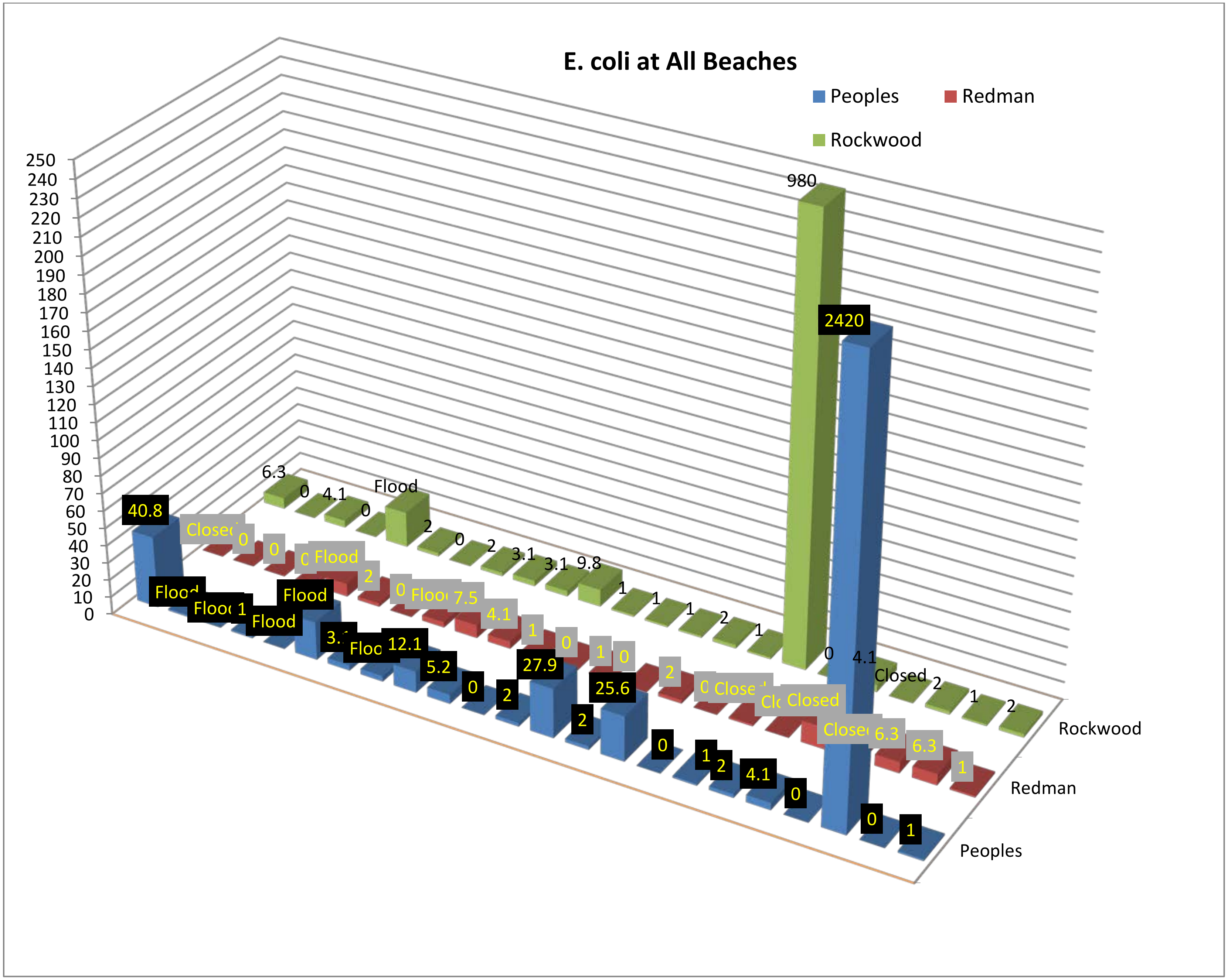
Old Standard, 235 for weekly and a Geometric mean under 126 for last 5 samples.
New Standard, Weekly Geometric means 190, DNR and EPA new standards. August 2013
Samples taken on the Monday of each week, except Memorial Day and Labor Day weekend, which will be taken on a Tuesday.
E. Coli is measured in Colony forming units per one hundred millileters, cfu/1000 mls
Peoples Creek closes at 363.0
Redman Creek closes at 365.5
Rockwood closes at 366.8


Rockwood Beach E. Coli
col/100ml
31
26
21
16
11
6
1
6.3
4.1
20.3
2
2
3.1
3.1
9.8
1
1
1
2
1
4.1
2
1
2
23-Apr-18
30-Apr-18
7-May-18
14-May-18
21-May-18
28-May-18
4-Jun-18
11-Jun-18
19-Jun-18
25-Jun-18
2-Jul-18
9-Jul-18
16-Jul-18
23-Jul-18
30-Jul-18
6-Aug-18
13-Aug-18
20-Aug-18
27-Aug-18
3-Sep-18
10-Sep-18
17-Sep-18
24-Sep-18
Date



Peoples Beach E. Coli
3000
2500
2000
1500
1000
500
0
col/100ml
40.8
1
0
1
0
21.6
3.1
3.1
12.1
5.2
0
2
27.9
2
25.6
0
1
2
4.1
0
2420
0
1
23-Apr-18
30-Apr-18
7-May-18
14-May-18
21-May-18
28-May-18
4-Jun-18
11-Jun-18
19-Jun-18
25-Jun-18
2-Jul-18
9-Jul-18
16-Jul-18
23-Jul-18
30-Jul-18
6-Aug-18
13-Aug-18
20-Aug-18
27-Aug-18
3-Sep-18
10-Sep-18
17-Sep-18
24-Sep-18
Date


Redman Beach E. Coli
14
12
10
8
6
4
2
0
col/100ml
7.5
2
3.1
7.5
4.1
1
1
2
1
12.2
2
6.3
6.3
1
0
23-Apr-18
30-Apr-18
7-May-18
14-May-18
21-May-18
28-May-18
4-Jun-18
11-Jun-18
19-Jun-18
25-Jun-18
2-Jul-18
9-Jul-18
16-Jul-18
23-Jul-18
30-Jul-18
6-Aug-18
13-Aug-18
20-Aug-18
27-Aug-18
3-Sep-18
10-Sep-18
17-Sep-18
24-Sep-18
Date


E. coli at All Beaches
Peoples
Redman
Rockwood
Rockwood
Redman
Peoples