



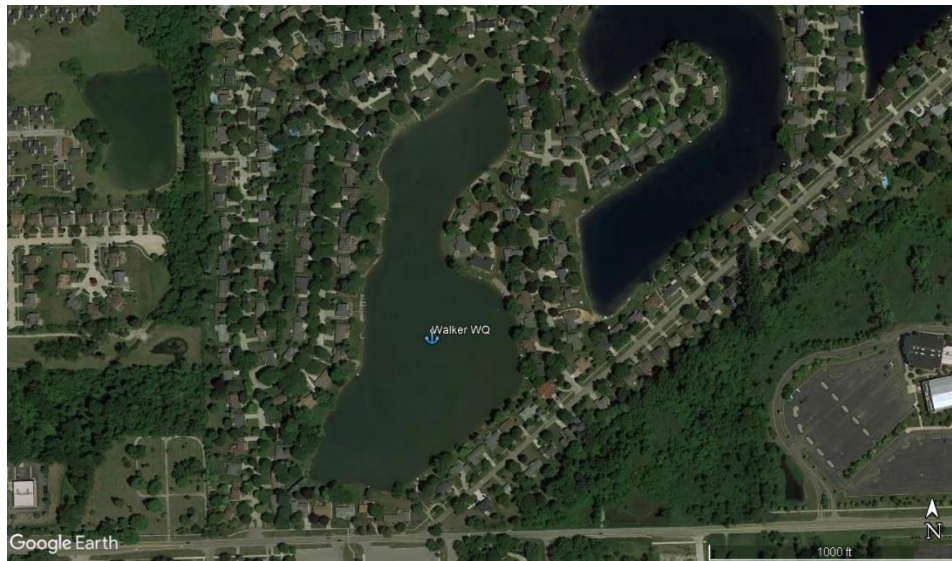
## Walker Lake 2021 Water Quality Review

### Introduction

This testing protocol's goals were to check various water quality parameters of Walker Lake, compare results to historical data, and identify any potential risks to Walker Lake's health. LakePro collected a water sample at one location on June 28<sup>th</sup>, 2021, and tested 14 parameters. LakePro utilized a YSI ProDSS Multiparameter Meter and a LaMotte SMART2 Colorimeter to conduct the tests.

### Sampling Location

The following aerial photograph shows the location of the sampling site.



### Results

Parameter	June 28 <sup>th</sup> , 2021	Target Range	Status
Temperature	82.0 °F	Less than 75 °F	● High
Dissolved Oxygen	7.2 mg/L	4.0 – 12.0 mg/L	● Healthy
Total Phosphorus	70 ppb	0 – 100 ppb	● Healthy
Phosphate	30 ppb	0 – 100 ppb	● Healthy
Nitrate Nitrogen	60 ppb	0 – 220 ppb	● Healthy
Chlorophyll-α	3.1 ppb	0 – 7.3 ppb	● Healthy
Transparency	4.2 feet	More than 6.5 feet	● Low
pH	7.6	7.0 – 9.0 S.U.	● Healthy
Total Dissolved Solids	291 ppm	0 – 1,000 ppm	● Healthy
Conductivity	607 μS	0 – 1,500 μS	● Healthy
Alkalinity	121 ppm	0 – 250 ppm	● Healthy
Hardness	156 ppm	100 – 300 ppm	● Healthy
Total Salinity	280 ppm	0 – 500 ppm	● Healthy
Chloride	122 ppm	0 – 230 ppm	● Healthy



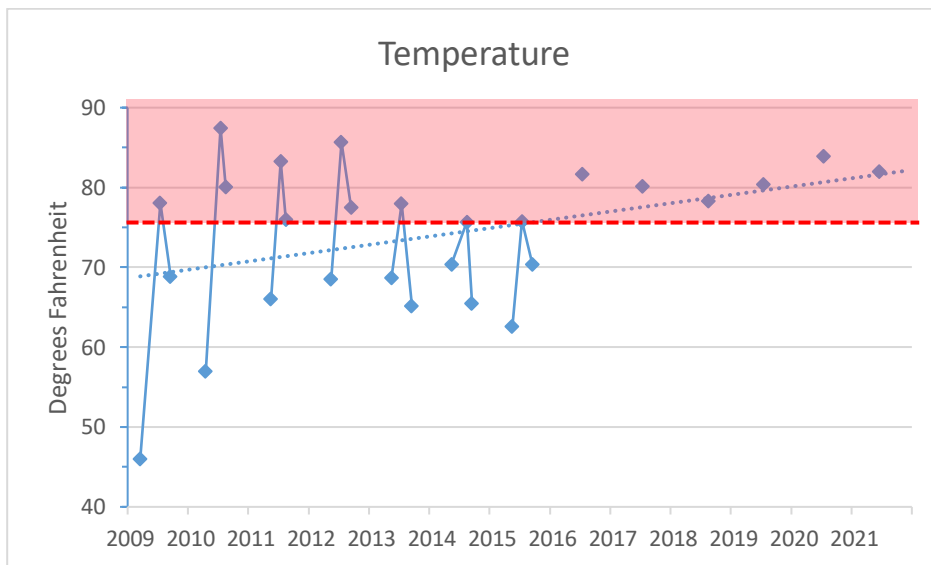
### Discussion

Walker Lake's water quality was excellent at the time of these tests. Results showed that most parameters were within target, except for temperature and transparency. Seasonal peaks in water temperature are typical because they are dependent on weather and air temperature. The low transparency is due to the natural turbidity of the water body.

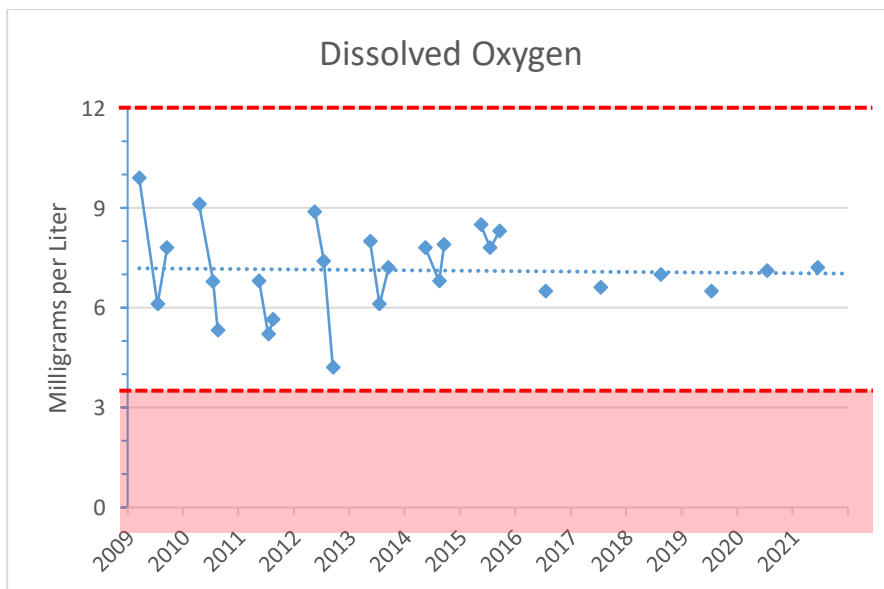
An in-depth look at the individual parameters and their results is below. The graphs include historical results and trendlines to indicate changes over time. The areas in red are outside the target range, and the dashed red line is the target limit.

#### Temperature and Dissolved Oxygen

Dissolved oxygen is vital for a healthy aquatic ecosystem. The amount of dissolved oxygen that can be in the water relies on water temperatures. Colder water can hold more dissolved oxygen, so cooler temperatures are generally better. The water **temperature** was above the target range at the time of this testing.



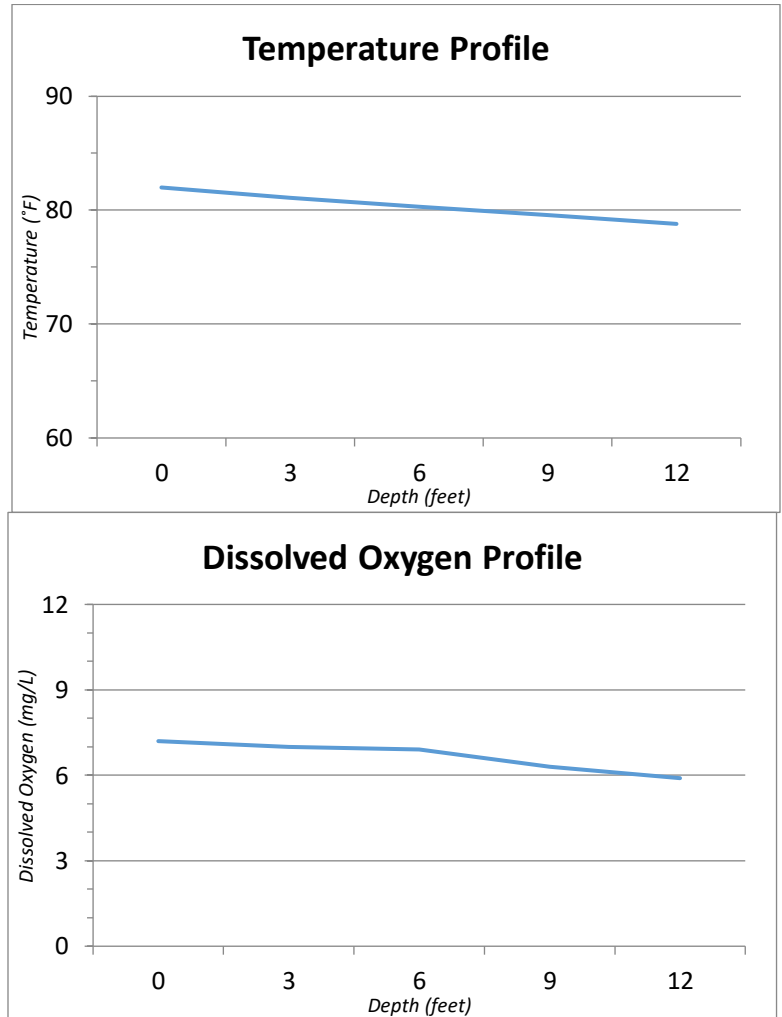
Because dissolved oxygen is reliant on water temperature, high temperatures can sometimes be a concern. However, despite the temperature, **dissolved oxygen** levels were within the target and indicative of a healthy aquatic ecosystem.





We also measured temperature and dissolved oxygen at three-foot intervals to create a depth profile. This data shows how the parameters changed with depth. Below are the results of this summer's depth profile.

Depth (Feet)	Temperature (°F)	D.O. (mg/L)
0	82.0	7.2
3	81.1	7.0
6	80.3	6.9
9	79.6	6.3
12	78.8	5.9

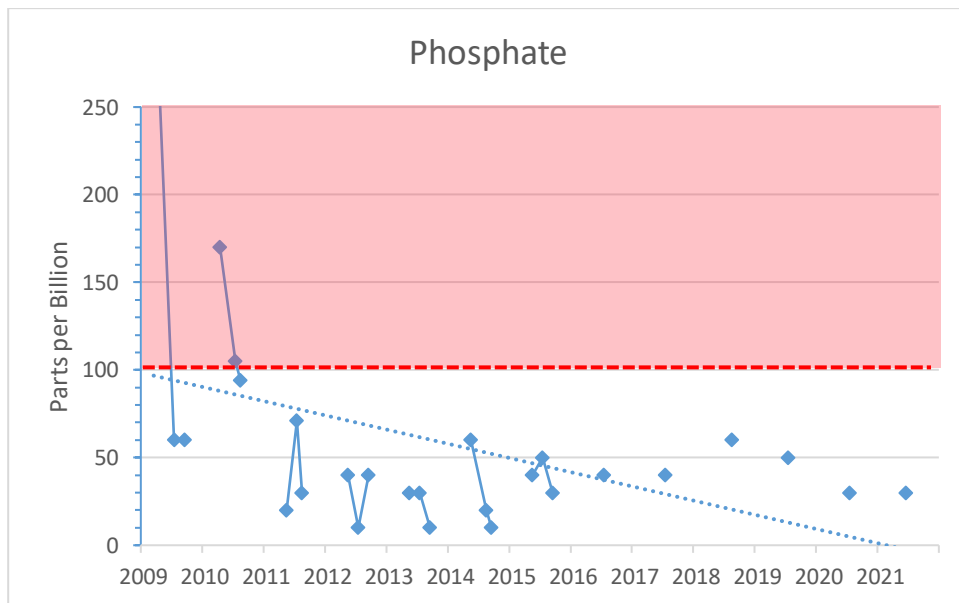
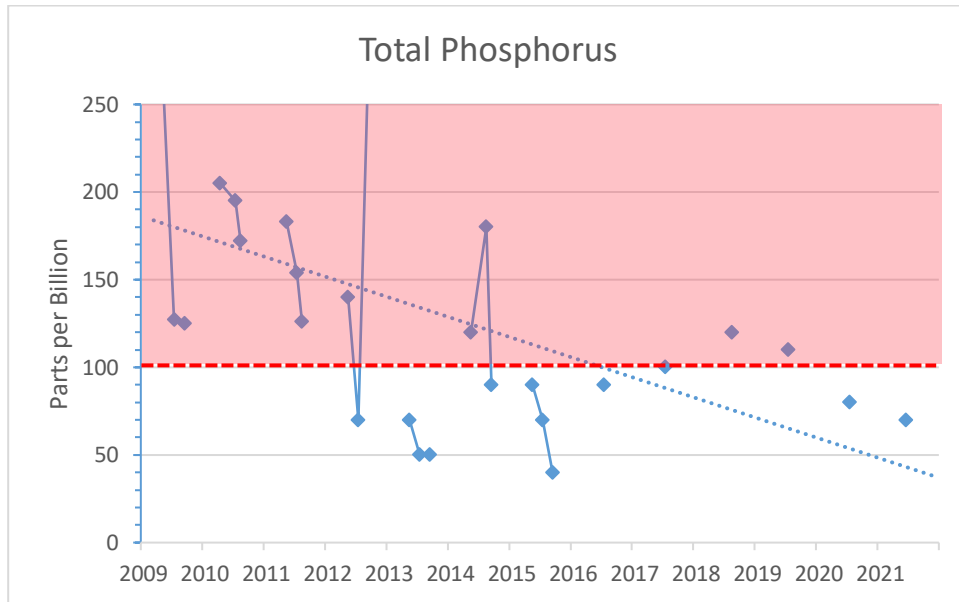


A thermocline was not present in Walker Lake, instead the temperature decreased slightly from the surface to the deep water. Dissolved oxygen levels remained steady throughout the water column. Oxygen at the bottom of the lake was abundant at the time of testing. Lack of cold water, however, limited the species available in the fishery.



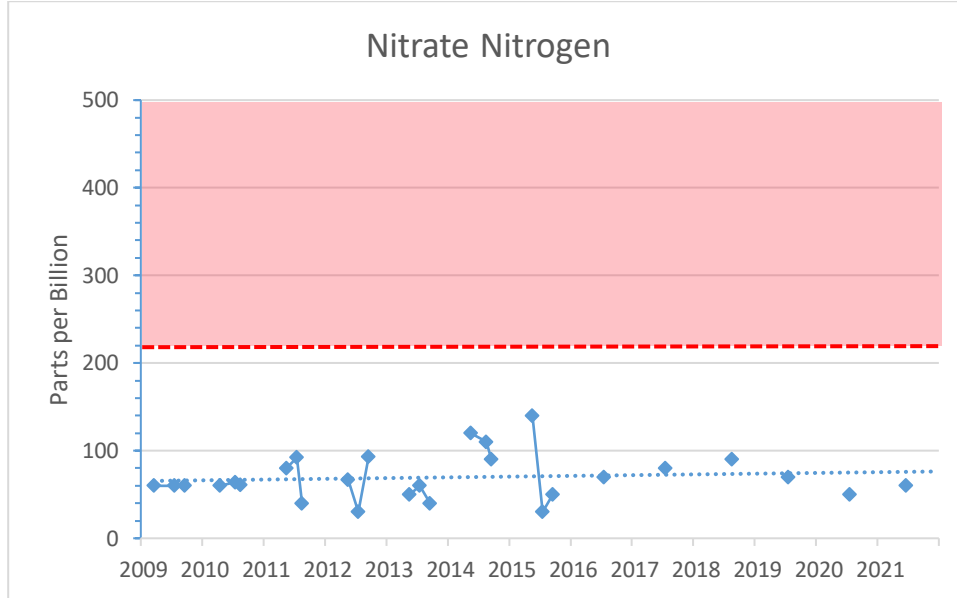
Nutrients, Plant Production, and Transparency

Nutrients in the water are the fuel for plant growth, and nutrient data reveals the potential for nuisance plant growth. Phosphorus is a major nutrient for aquatic plant growth. The **phosphorus** and the active form, **phosphate**, were within the target range. Both decreased or remained the same from last year and the overall trend is downward.

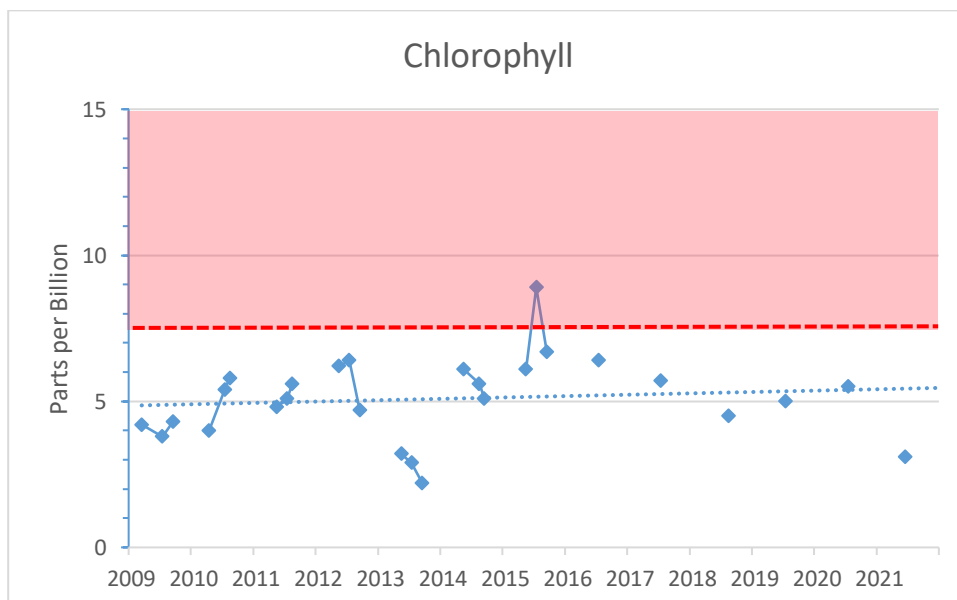




Nitrate is another major nutrient for aquatic plant growth. During this test, the **nitrate nitrogen** concentration was within the target range. Nitrate concentration has been on a slight upward trend historically but remained stable the past seven seasons. It is essential to fertilize and use the land responsibly to prevent more nutrients from entering the lake.

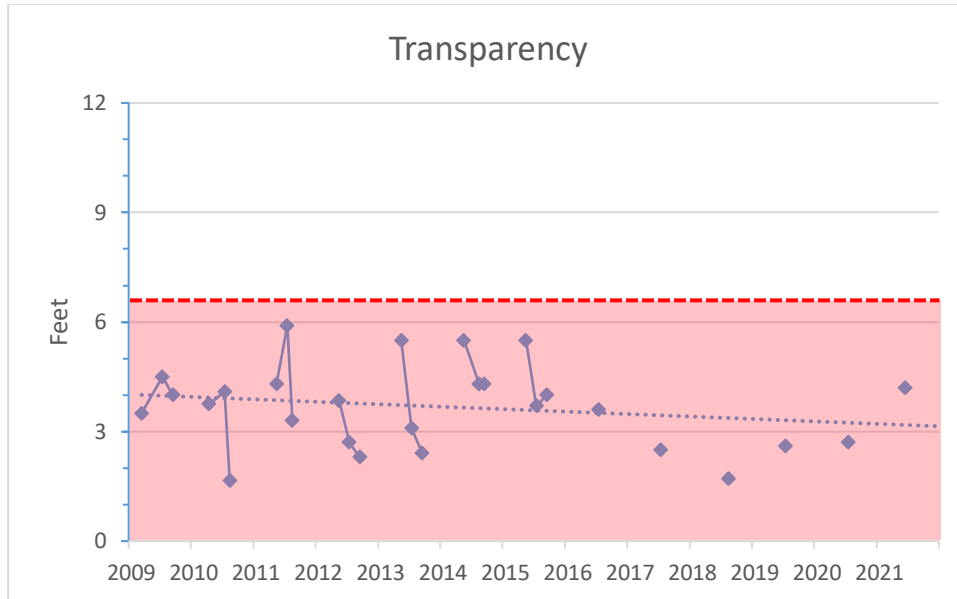


Chlorophyll concentration is an indicator of plant production. The **chlorophyll** concentration was within the target range and categorized the lake as moderately productive. This is not the natural concentration. Plant management with herbicides limits plant growth throughout the year, causing lower results for this test. Chlorophyll concentration is trending up, however the last five years show it flattening out. LakePro's management goal is to control nuisance algae while leaving some native aquatic plant growth for a healthy ecosystem.





One effect of plant growth on the lake is the reduction of water clarity. Algae stay suspended in the water column before forming green mats on the surface and can decrease clarity before it's visible. This summer, the **transparency** was outside the target range. The reason for the low clarity is the turbidity of the lake. Materials that cause turbidity include clay, silt, algae, and microscopic matter and organisms.



**Trophic State Indices**

To better understand the relationship between nutrients, plant production, and transparency, limnologists use Trophic State Indices (TSI) to score each category and examine the relationship between them. Lower scores tend to indicate a less productive lake. The TSIs for Walker Lake this summer were as follows:

Category	Water Quality Parameter	Trophic State Index (season average)	Classification
Nutrients	Total Phosphorus	65	Eutrophic
Plant Production	Chlorophyll	42	Mesotrophic
Clarity	Transparency	56	Mesotrophic

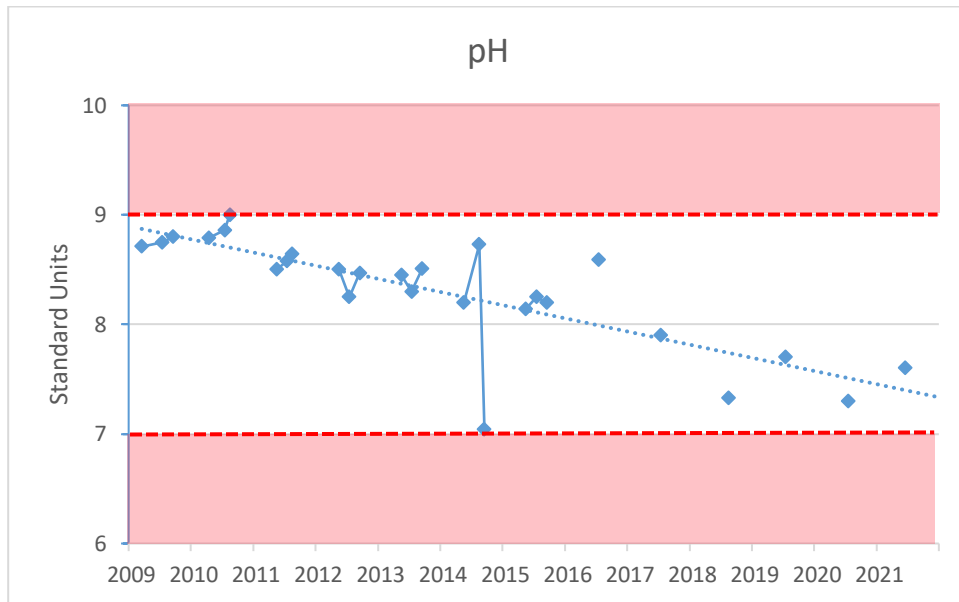
The TSI for total phosphorus classified the lake as eutrophic or very productive, based on the availability of nutrients to sustain plant growth. The TSI for chlorophyll was lower than the nutrient index, showing that the plants were not at the level predicted by the nutrient concentrations. One reason for this is the plant management program on the Lake. The TSI for transparency is classified as mesotrophic, or moderately productive. This difference was due to the turbidity that decreases clarity and sunlight penetration.



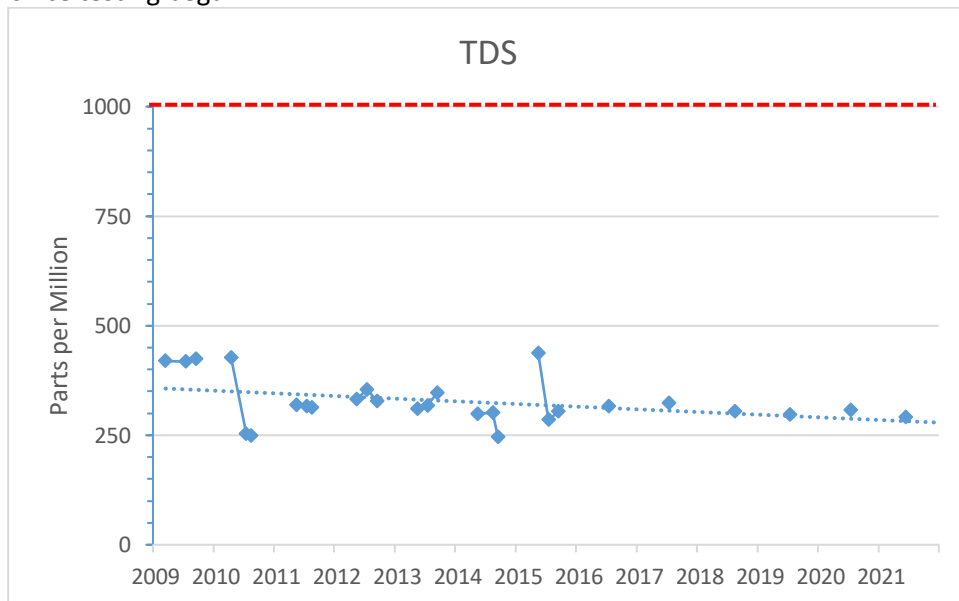
Water Chemistry Parameters

It is important to track the water chemistry of the lake. Significant changes or shifts in water chemistry can alert us to examine the water body further and make necessary changes and recommendations.

The **pH** of the lake remained within the target range this summer. The graph below shows a downward historical trend. Although it is in the target range, we will continue to watch pH levels and closely examine any further decline.



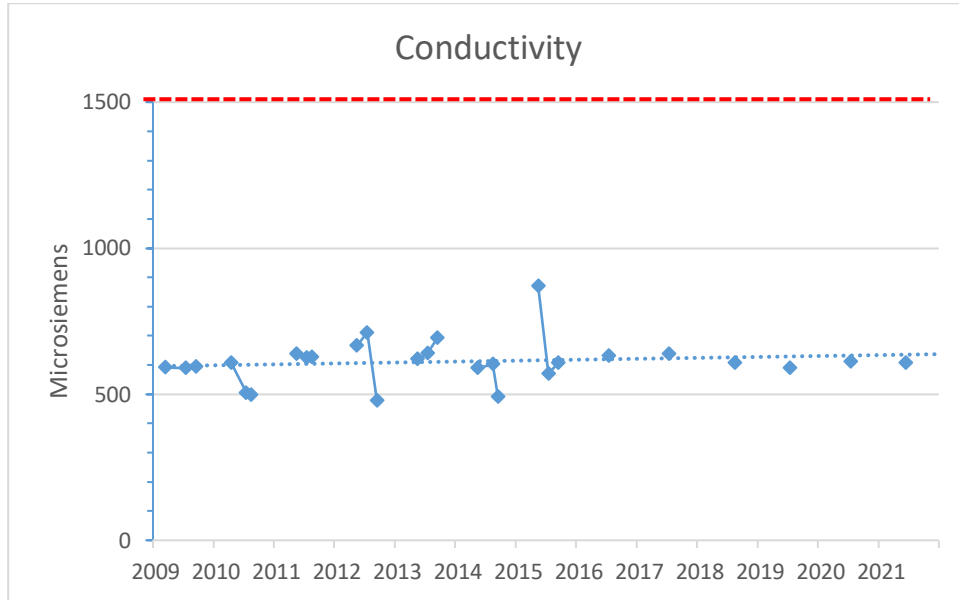
The **total dissolved solids (TDS)** results showed low amounts of dissolved substances in the water. This parameter includes nutrients, salts, and other substances, so it is positive when this parameter remains low. TDS has had a downward trend since testing began.



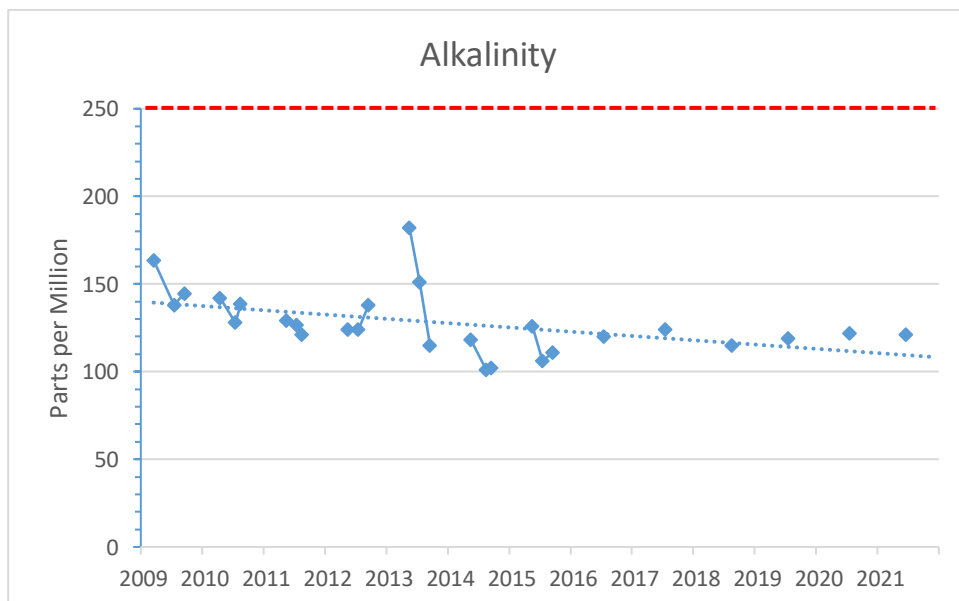




Conductivity measures the molecules in the water's ability to conduct electricity. The **conductivity** indicated a healthy amount of ionic molecules in the lake and no immediate concern about salts. No significant changes have been observed over the history of testing.



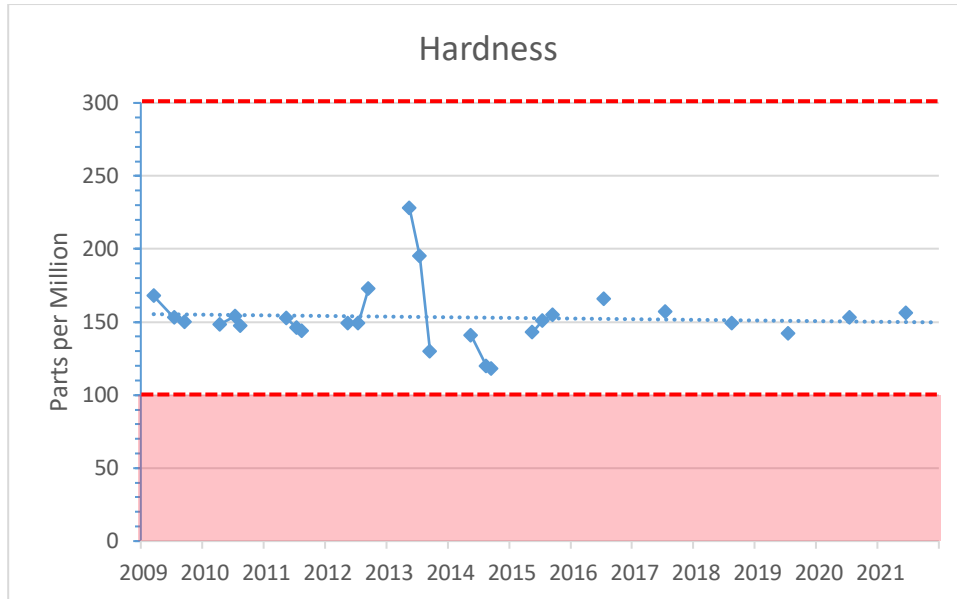
Alkalinity measures the concentration of Calcium Carbonate, a salt that is beneficial to the aquatic ecosystem. Carbonate ions are a natural buffer for acidity and prevent extreme changes in pH. The **alkalinity** was at a healthy level during this test, and historical trends are downward. Since 2013, alkalinity levels have remained relatively flat.



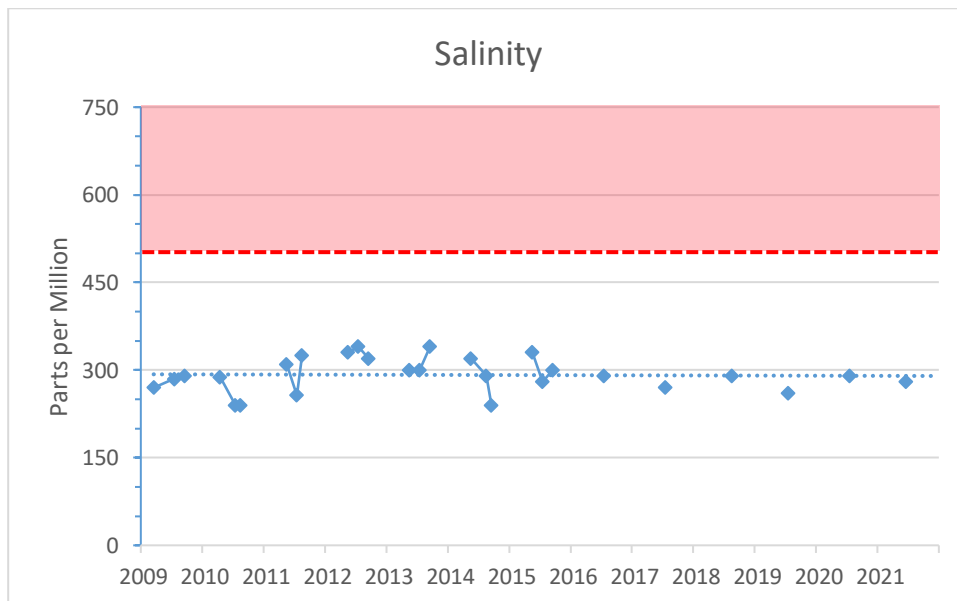




While alkalinity measures the carbonate concentration, hardness measures the calcium or magnesium concentration. Because one of the most common salts is calcium carbonate, hardness and alkalinity levels are typically very similar. **Hardness** was at a healthy level at the time of testing. Although a slight downward trend can be seen historically, hardness has remained relatively flat since testing began.

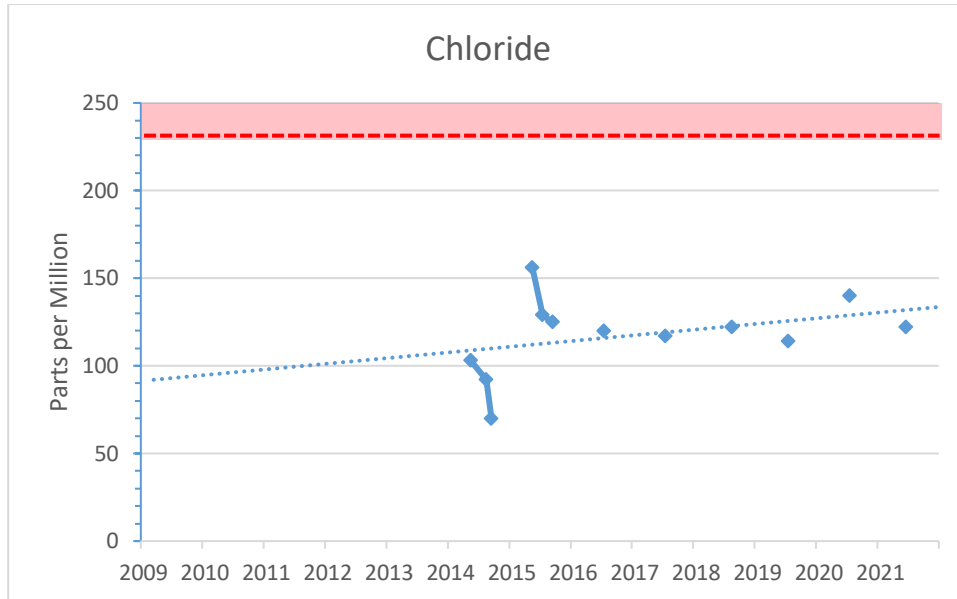


High salinity levels can be an indicator of pollution and may pose a risk to the ecosystem. **Salinity** was within the target range at the time of testing.





Chloride can also be an indicator of pollution. Some chloride is normal in a water body, but high levels can threaten the ecosystem. Road salts are a common source of chloride. As snow and ice melt in the spring, runoff carries salt and chloride to the lake. **Chloride** levels decreased slightly since last year but have remained steady since 2015.





### Summary & Conclusions

Overall, the water quality of Walker Lake was excellent this summer. The data gave us a view of how things changed from last year and strengthened the long-term trends.

The temperature and transparency were the only parameters outside of the target this year. Temperature is dependent on the weather and cannot be changed. And although temperatures were high, dissolved oxygen remained at a healthy level. The historical data does show an upward trend for temperature. One factor to remember in the upward trend is the number of testing events. Earlier years included spring tests with lower temperatures which would have flattened the trend line. Dissolved oxygen historical trends remain relatively steady despite the temperatures. We will continue to monitor temperatures and dissolved oxygen to ensure the concentrations do not decrease. Transparency was lower than the target due to the natural turbidity.

Nutrient levels remained relatively stable compared to last season, and the trends remain downward or relatively flat. All nutrient parameters remained within the target ranges.

The water chemistry parameters show varied trends, and all remained within the target ranges this year. Although they were within the target range, Salinity and pH levels are parameters we will continue to monitor for drastic changes.

In any lake or pond, there are always areas of quality that could be improved. That said, your continued efforts and care on Walker Lake leave it in excellent condition.

Thanks for choosing LakePro,

Tyson Wood  
*Lake Manager – LakePro, Inc.*



### **Analysis Information**

Temperature:	The water temperature directly affects the amount of oxygen that is able to dissolve into the water. The temperature of surface waters is not indicative of the entire water column.
Dissolved Oxygen:	D.O. is a measure of the amount of oxygen dissolved in the water. This oxygen is available to fish and other animals for respiration. Vegetation generally increases DO, particularly during the day and early evening. Animals and other respiring organisms consume the oxygen, mostly during the day. Oxygen is also added to the lake through wave action, rain, fountains and aerators.
Total Phosphorus:	Phosphorus is an essential nutrient for plant growth. However, concentrations exceeding 100 ppb can impair the water and results in nuisance vegetation growth.
Nitrate:	Nitrogen is also essential for plant growth. Nitrate is the predominant form of nitrogen in water. Excessive nitrate concentrations may also result in pollution and increased vegetation.
Chlorophyll-a:	Chlorophyll-a is a direct measurement of the amount of green pigment produced by plants and phytoplankton. This indicates the amount of plant growth and is used to calculate a Trophic State Index.
Transparency:	The ability of light to penetrate the water column is determined by the amount of dissolved and suspended particles in the water. Although aesthetically desirable, transparent water allows increased light to reach the lake bed and may result in vegetation growth.
pH:	pH is a measure of acidity or alkalinity. pH is a general measure of lake health and can roughly indicate the range of other measurements such as alkalinity and hardness.
TDS:	Total Dissolved Solids is the amount of all organic and inorganic substances in the water in a molecular or ionized state. Higher values generally indicate richer and more productive water. Lower values usually indicate cleaner and less productive water.
Conductivity:	Conductivity is a measure of the ability of water to conduct electricity. Dissolved ions in the water increase conductivity, thus TDS and Conductivity are closely related.
Alkalinity:	Alkalinity refers to the ability of the water to neutralize acids, mainly through the hydrogenation of carbonate ions. This is why the alkalinity is expressed as "ppm as CaCO <sub>3</sub> ". However, other basic molecules in the water can also contribute to alkalinity.

### **Trophic States**

Oligotrophic:	Water is very clear. Nutrient levels are generally low. Plant and algae productivity is also low. Sufficient dissolved oxygen in the bottom, cooler waters allows cold-water fish to survive, such as salmon and trout.
Mesotrophic:	Water is moderately clear. Nutrient levels are slightly elevated. Plant and algae productivity is present, but generally not a nuisance. Oxygen and temperature in the lower portion of the lake allow walleye and perch to survive.
Eutrophic:	Water is not clear due to high nutrients levels, increased turbidity, and excessive algal growth. There is no oxygen in the bottom, cooler waters, restricting the lake to warm water species, such as bass and bluegill.
Hypereutrophic:	Nutrient levels are extremely high, promoting very high algae productivity. Blue-green algae blooms are likely. High turbidity and algae growth make the water opaque. Little plant growth is restricted to invasive plants. The only fish that can survive this environment are rough fish, such as carp, catfish, and mudminnows.



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Date	Temperature °F	Dissolved Oxygen mg/L	Total Phosphorus ppb	Phosphate ppb	Nitrate ppb	Chlorophyll ppb	Secchi Disk Depth (feet)	pH	TDS ppm	Conductivity µS	Alkalinity mg/L	Hardness mg/L	Salinity ppm	Chloride ppm
3/26/2009	46.9	9.7	60	50	968	0.8	6.1	9.7	438	653	135	168	300	---
7/6/2009	78.4	6.1	75	60	396	0.8	6.3	8.8	417	589	156	191	286	---
9/1/2009	71.4	7.9	70	41	308	0.8	6.2	8.8	462	612	146	164	312	---
4/20/2010	59.4	10.3	110	100	308	0.6	9.8	8.8	454	638	121	162	306	---
7/7/2010	86.8	6.1	114	108	324	1.3	6.3	8.7	273	546	142	173	260	---
8/31/2010	81.2	5.2	112	86	292	0.9	6.1	8.5	356	641	141	165	270	---
5/12/2011	66.6	8.6	85	20	240	1.1	7.0	8.2	509	1006	143	167	265	---
7/6/2011	86.0	4.8	105	49	265	1.8	6.8	8.3	489	969	145	171	226	---
8/30/2011	78.4	5.2	88	10	396	0.9	4.6	8.3	509	719	141	167	347	---
5/11/2012	67.8	7.8	120	40	296	1.7	7.7	8.7	286	572	125	148	280	---
7/9/2012	86.0	6.5	70	10	308	1.1	4.7	8.3	326	653	132	168	310	---
9/6/2012	77.7	4.6	100	20	506	0.9	5.4	8.4	371	738	140	171	360	---
5/7/2013	69.2	7.9	50	20	308	6.1	6.5	8.2	423	857	169	210	470	---
7/10/2013	77.6	7.1	60	20	484	4.2	5.2	7.7	432	879	153	194	390	---
9/24/2013	66.9	7.6	40	20	176	3.1	4.0	8.1	531	1046	148	166	420	---
5/23/2014	71.3	8.1	40	20	308	1.4	5.6	8.0	296	590	150	183	370	112
8/5/2014	73.5	6.8	30	10	352	1.7	5.0	8.5	307	613	117	134	300	93
9/23/2014	66.2	9.0	30	10	308	1.1	6.1	8.0	305	610	132	162	300	88
5/6/2015	64.2	9.0	50	30	308	4.1	8.4	8.1	355	702	131	154	380	112
7/15/2015	75.6	6.8	40	10	220	3.0	6.7	8.1	305	611	121	160	300	81
9/16/2015	72.8	7.6	50	10	132	1.5	9.6	8.0	313	613	114	155	290	78
7/25/2016	81.8	7.2	60	30	308	2.1	10.0	8.6	306	598	121	165	290	79
7/19/2017	79.8	6.6	80	40	484	4.6	7.2	8.2	325	641	128	154	280	86
8/2/2018	79.0	7.0	70	40	440	3.9	5.7	7.4	356	713	122	160	350	81
7/22/2019	80.4	6.5	110	50	308	5.0	2.6	7.7	297	591	119	142	260	114
7/28/2020	84.0	7.1	80	30	50	5.5	2.7	7.3	307	613	122	153	290	170