



**FRESH WATER MONITORING PROGRAM  
ANNUAL REPORT**



**WATER YEAR 2016**

(October 1, 2015 through September 30, 2016)



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## EXECUTIVE SUMMARY

This annual report has been prepared by Hecla Greens Creek Mining Company (HGCMC) in accordance with the Fresh Water Monitoring Program (FWMP) contained in the mine's General Plan of Operations Appendix 1: Integrated Monitoring Plan (IMP). Monitoring data interpretative reports are presented for thirteen surface water and four groundwater monitoring sites.

Each site's interpretative report summarizes the annual dataset with respect to several goals and objectives outlined in the FWMP. Each report contains a list of any exceptions, omissions or errors that occurred during data collection. The report lists a comparison of each site's annual dataset to all appropriate applicable Alaska Water Quality Standards (AWQS). Finally, a series of summary tables and X-Y graphs have been generated to meet the specific statistical goals for each site.

All required sampling was accomplished as specified in the monitoring schedule and for each site the specified analytic suite (P or Q) was performed on the collected samples. Applicable holding times were achieved for all analytes, and no data points were qualified as outliers.

No exceedances of Alaska Water Quality Standards (AWQS) occurred along Greens Creek at the four monitoring points (Site 48, Site 6, Site 54, and Site 62) during Water Year 2016. Four exceedances (dissolved cadmium, dissolved mercury, dissolved selenium, and dissolved zinc) were recorded in May 2013 at the new surface water location Site 61, however the downgradient site (Site 62), which receives this drainage, during the same sample period was well within AWQS. To further investigate HGCMC switched the sampling frequency at Site 61 from quarterly to monthly during Water Year 2014 and through Water Year 2015 (reduced in August 2015). There had been no exceedances measured at Site 61 while the sampling frequency was increased, however in the current water year exceedances for dissolved cadmium were recorded in May 2016 and August 2016. It is speculated that the relining of Pond 23 (upgradient) may have contributed to these exceedances. HGCMC will continue to monitor Site 61 on a quarterly basis, however if the metal concentrations begin to trend upwards or if there continues to be spikes in the concentrations, a return to a monthly sampling will be considered.

Site 13 was in exceedance, four times, for dissolved cadmium and dissolved zinc. HGCMC removed 11,200 bank cubic yards of material from the 1350 during the 2014 summer season. It was after this disturbance that the exceedances started to occur. This has been seen before with other reclamation projects and with those the increased concentrations were short lived. In 2015 HGCMC removed additional material, at the 1350, from the access to the raised bore ventilation shafts. Late in August 2016 a collection system was installed at the base of the remaining material to be reclaimed. The effectiveness of this system will be evaluated during the Water Year 2017. HGCMC has no additional work planned for the 1350 reclamation, but will continue to monitor the area as it stabilizes and matures.

No exceedances of AWQS were recorded for Bruin Creek, during Water Year 2016; monitored at the up-gradient Site 49 and downgradient Site 46. There were no exceedances recorded at the

background Site 57, located upgradient from the mine operations near the waste rock facility Site 23.

Exceedances in the tailings area were noted for low pH, low alkalinity, and elevated levels of lead. The shallow wells (Site 27, Site 29, and Site 32) continued to express the natural condition of low pH and low alkalinity that characterize these sites located in organic rich peat sediments. Seven exceedances for dissolved lead occurred between two of the three down gradient shallow wells (Site 29 and Site 32). These exceedances continue the recent history of low to moderate levels of lead that may in part be due to minor amounts of tailings escaping the facility due to fugitive dust or tracking. HGCMC has been and will continue to improve best management practices to minimize fugitive dust and tracking.

Site 60 had exceedances for low alkalinity, low pH, and elevated mercury. This site's watershed was disturbed when the construction of Pond 7 began in 2004, resulting in a change from naturally acidic to alkaline conditions. HGCMC believes that the increase in pH and alkalinity increases the potential for adsorption of mercury on sediments and soil particles in the drainage. The pH of the Site 60 drainage now fluctuates seasonally and from year to year and may control the storage and release of mercury from the adsorbed fraction. Dissolution of tailings dust particles, which contain small amounts of mercury, and atmospheric deposition of mercury from natural (e.g. volcanoes) and anthropogenic sources (e.g. coal fired power plants in Asia) are potential sources of this metal in the drainage area. Two of the four samples collected during the current water year were within AWQS, the other two samples (0.016 µg/L, and 0.013 µg/L) were slightly above the AWQS of 0.012 µg/L. Sampling in adjacent drainages during water year 2009 and water year 2013 showed that this issue was isolated to only the Site 60 watershed.

The final two sites associated with the tailings facility, Site 9 and Site 609, had exceedances for low alkalinity and low pH respectively. The low alkalinity and pH values are expected given the naturally occurring acidic muskeg conditions in the headwaters near Site 27 and Site 29.

Graphical and non-parametric analyses for trends in the data were performed for all sites when sufficient data was available. It takes six years of monitoring a new site (Site 609, Site 711, Site 712, Site 61, and 62) before the statistical analyses can be performed. Statistically significant trends were identified for ten sites: Site 48, increasing trend in pH; Site 6, upward trend in pH; Site 54, upward trend in pH, downward trend in dissolved zinc; Site 60, upward trend in total sulfate and an increasing trend in total alkalinity; Site 27, upward trend in total alkalinity; Site 13, decreasing trend in total alkalinity; Site 9, decreasing trend in dissolved zinc and increasing trend in total alkalinity.

Site 48 is considered an up-gradient control site, the trends are a result of natural variation potentially being driven by large scale meteorological conditions. The Greens Creek sites (Site 48, Site 6, and Site 54) had similar low magnitude increasing trends in pH. Though this is an increasing trend the similar magnitude of increase across the three sites, including an upgradient background site, indicates natural variation.

A non-parametric comparison of medians was performed for all the appropriately paired surface sites (48-6, 6-54, 54-62). Significant differences were noted for the paired datasets from Greens Creek (48-6) for conductivity, total sulfate, and dissolved zinc. These differences have all been

noted in previous annual reports and do not appear to be increasing in magnitude. There were significant differences for the paired dataset (6-54) from Greens Creek for conductivity, dissolved zinc, and total alkalinity. Also, significant differences were noted between the paired Greens Creeks sites 54-62 for conductivity, pH, and total sulfate.

With the reduction in the sampling frequency for the Bruin Creek sites (49 and 46) a statistical analysis of median values cannot be calculated, instead the data from Site 46 is analyzed on an intra-site basis using the combined Shewhart-CUSUM control charts. An analysis using these charts reached the same conclusion as in previous reports that HGCMC is not having a measurable effect on Site 46.

With the removal of the Site 58 and Site 59 from the FWMP, it is not possible to perform inter-well comparison with the down gradient sites Site 27, Site 29, and Site 32. These sites are now also analyzed using the combined Shewhart-CUSUM control charts also. From this evaluation it is recognized that Site 27 has seen some recent changes. Primarily the specific conductance and total sulfate charts begin to go out of control early 2008. This is attributed to the building of the pad a of Pond 7. Both of these parameters are trending towards pre-pad disturbance levels, however with the construction of the tailings expansion (2015-2018) occurring immediately upgradient of the monitoring site some fluctuation in the water chemistry is occurring. It is expected that once the construction is completed and the area has stabilized that the fluctuations in water chemistry will stabilize. The other control chart for dissolved zinc first went out of control during water year 2007, a high fugitive dust year. Twice since zinc concentrations have been above the control limits, also associated with fugitive dust loading. However, after each of these events the values returned to the historical range.

## INTRODUCTION

This annual report for Water Year 2016 (October 1, 2015 through September 30, 2016) provides the information required by the Fresh Water Monitoring Program (FWMP). It is separated into several sections, the first of which provides general information applicable to the entire program, followed by a comprehensive analysis of the data for each specific site.

To avoid confusion data values reported by the laboratory as being below the Method Detection Limit (MDL) are assigned a value of zero for plotting purposes. This is done so that the values below MDL are visually distinct and thus can be properly interpreted. On several of the graphs presented, changes have occurred in MDL over the period shown. This leads to the visual impression that an upward trend exists when in fact the older analysis had MDL greater than ambient background levels. For the current Water Year's data the actual MDLs for non-detect values are listed in each site's table of results in the interpretative discussion of this report. For prior Water Year's historic MDLs please refer to GPO Appendix 1, Table 8-2.

The monitoring schedule varies from site to site and different sites are monitored for different analytes on different months of the year. Occasionally, sites scheduled for sampling may not be available due to weather or more rarely operational reasons. A copy of the Water Year 2016 sampling log is included in this section and any variations from scheduled sampling events are noted on each site's table of results presented in the interpretive section.

The following table outlines the Statistical Information Goals for each site sampled during the Water Year 2016.

Site	Trend			Median Comparison	Control Chart
	AWQS Comparison	Visual	Calc		
48	x	x	x		
6	x	x	x	6 vs 48	
54	x	x	x	54 vs 6	
62	x	x	x	62 vs 54	
46	x	x	x		x
49	x	x	x		
61	x	x	x		
13	x	x	x		
57	x	x	x		
27	x	x	x		x
29	x	x	x		x
32	x	x	x		x
9	x	x	x		
60	x	x	x		
609	x	x	x		
711	x	x	x		
712	x	x	x		

A comparison to Alaska Water Quality Standards (AWQS) is required for all sites. In Appendix A the specific water quality criteria used for each comparison are summarized. Trend analysis is carried out by two different methods. The first method is a visual trend analysis for each analyte. For each site sampled a series of time-concentration graphs are constructed for the previous five years of data collected. The second method is a non-parametric statistical method, Kendall seasonal trend analysis that is routinely done for conductivity, pH, alkalinity, and dissolved zinc. These are the key parameters along with sulfate that can be strongly affected by Acid Mine Drainage (AMD). Sulfate was added back into the required list of analytes in the 2002 Water Year. Median calculations are shown in the annual table of results for each site. Finally, for all down gradient sites that are paired with an upgradient reference site, which are monitored with a frequency greater than 4 times per year, a comparison of medians is presented for each specific site. These down gradient sites (upgradient site in parenthesis) include Site 6 (Site 48), Site 54 (Site 6), and Site 62 (Site 54). For each of these sites, a comparison of medians was performed for total alkalinity, pH, conductivity, total sulfate and dissolved zinc. The statistical test utilized is a non-parametric, Wilcoxon signed-rank test. A brief summary of the two main statistical procedures, the Wilcoxon-Mann-Whitney rank sum test and the Mann-Kendall seasonal trend are given below.

With the approved decrease in the sampling frequency at Site 46 and Site 49 the statistical procedures previously discussed are no longer useable. More recently the analysis of data for Site 46 has been conducted using intra-site methodologies instead of an inter-site comparison. In the interpretive section of Site 46 is a discussion of this new methodology. This technique was also applied to Site 27, Site 29, and Site 32. Much of the development and understanding of the new technique used has come from Resource Conservation and Recovery Act (RCRA) documents concerning ground water monitoring at waste sites.

### **Statistical Tests**

The Mann-Kendall seasonal trend test is a non-parametric test for zero slope of a linear regression of time-ordered data versus time. Briefly the test consists of tabulating the Mann-Kendall statistic  $S_k$  ( $k=1$  to 12, for each month) and its variance  $VAR(S)$  for data from each season (month). The  $S_k$  statistic is simply the sum of the number of positive differences minus the number of negative differences for time ordered data pairs. Any seasonal trend is removed by only considering data pairs taken within the same month. The individual monthly Mann-Kendall statistics ( $S_k$ ) are tested for homogeneity of trend which is used to determine if it is reasonable to combine the monthly  $S_k$  statistics into an overall annual statistic ( $\Sigma S_k$ ). If the test for monthly homogeneity is rejected the annualized statistic is not meaningful. However, the individual monthly Mann-Kendall statistics can still be tested for trend and a Sen's slope estimator can be calculated for each month (noted as  $Q_m$  in the interpretive section) with a significant trend.

The advantages of the Seasonal Kendall trend test is that it is a rank-based procedure especially suitable for non-normally distributed data, censored data, data containing outliers and non-linear trends. The null hypothesis ( $H_0$ ) states that the data ( $x_1, \dots, x_n$ ) are a sample of  $n$  independent and identically distributed random variables. The trend test statistic  $Z$  is used as a measure of trend magnitude, or of its significance. A positive  $Z$  value indicates an upward trend while a negative value indicates a downward trend. However, the  $Z$  statistic is not a direct quantification of trend magnitude. For trend of significant magnitude a separate statistic, Sen's slope estimator, is

calculated by computing the seasonally adjusted (monthly) median value for the slope. For datasets which fail the homogeneity test, individual monthly  $S_k$  statistics are compared to a theoretical probability distribution of  $S$  derived by Mann and Kendall (Table A18 in Gilbert, 1987). Further guidance and background on these statistical methods can be found in Gilbert (1987) or Helsel and Hirsch (1992).

The Wilcoxon signed-rank test is used to determine if the median difference between paired data points is equal to zero. In general terms the signed-rank is used to determine if a set of paired data observations,  $x$ 's and  $y$ 's, come from the same population (i.e. have the same median) or as the alternative hypothesis differ only in the location of the central value (median). If the data are from the same population then the differences of the paired data should be equally distributed around 0, or about half the differences should be greater than 0 and half should be less than 0. Computationally the test is straight forward. First the differences  $D_i = x_i - y_i$ ,  $i = 1 \dots N$  are computed for each pair. The absolute values of the differences  $|D_i|$ ,  $i = 1 \dots N$  are ranked from smallest to largest and data pairs that are tied, thus having differences of zero, are ignored. The ranks of the absolute differences are assigned the sign of the actual differences. For example, negative differences have negative-signed ranks and positive differences have positive-signed ranks thus the term "signed-rank" in the method name. The test statistic  $W^+$  is the sum of all positively signed ranks. The statistic  $W^+$  is then compared to tabled values that vary based on  $N$ . The one-tailed version of the signed-rank test has been applied to the key indicator analytes of conductivity, pH, total alkalinity, sulfate, and dissolved zinc as listed in the table below.

Analyte	Rationale	median  D	Tail	Reject $H_0$ if:
Specific Conductance	Conductivity, as a proxy for total dissolved solids, <b>increases</b> due to sulfide oxidation.	<0	X's < Y's	$W^+(calc) < W(table)_{\alpha,n}$
Field-pH	pH <b>decreases</b> though the addition of $H^+$ generated by pyrite oxidation.	>0	X's > Y's	$W^+(calc) > W(table)_{\alpha,n}$
Total Alkalinity	Total alkalinity <b>decreases</b> by consumption of buffering capacity due to $H^+$ produced by pyrite oxidation, associated with waste rock.	>0	X's > Y's	$W^+(calc) > W(table)_{\alpha,n}$
Total Alkalinity	Total alkalinity <b>increase</b> by the weathering of carbonate mineralogy, associated with tailings	<0	X's < Y's	$W^+(calc) < W(table)_{\alpha,n}$
Total Sulfate	Total sulfate <b>increases</b> due to oxidation of sulfides	<0	X's < Y's	$W^+(calc) < W(table)_{\alpha,n}$
Dissolved Zinc	Dissolved zinc <b>increases</b> due to sulfide oxidation and is more readily soluble at neutral pH than other metals.	<0	X's < Y's	$W^+(calc) < W(table)_{\alpha,n}$

X: Upgradient Site

Y: Downgradient Site

Further guidance and background on the statistical methods utilized in this report can be found in one of the following references: Helsel and Hirsch (1992), Gilbert (1987), or Section 3.3.3.1 of the EPA document "Guidance for Data Quality Assessment" EPA/600/R-96/084.

**Qualified Data by QA Reviewer** - QA reports provide a summary for each site section of data limitations found in the monthly QA reviews. They list all data for that site that was qualified by the QA Reviewer for Water Year 2016 along with the reason for qualification. These data are all included in the data analyses, unless also identified as an outlier in the Qualified Data Summary.

## **INTERVENTIONS**

This section identifies any procedural changes, natural phenomena, mine operational changes, or other interventions that could have affected data during Water Year 2016. Results of any visual data analyses to detect effects of these interventions are also indicated.

Prior interventions (and negotiated mid-year program modifications such as changes to laboratories, methods, detection limits, and reporting limits), and anything else which may affect data comparability and quality which occurred during previous Water Years, are documented in the “General History” section of the FWMP and in previous annual reports.

## **MID-YEAR MODIFICATIONS**

There were no mid-year modifications.



## 2016 Water Year October 2015 Through September 2016 Annual Water Quality Monitoring Schedule-Laboratory Samples

Site Number	Sample Identifier	Site Name	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
6	006FMS	Middle Greens Creek	P	P	Q	P	Q	P	P	P	P	P	P	P
9	009FMS	Tributary Creek-Lower		Q						Q		Q		Q
13	013FMS	Mine Adit Discharge East		Q						Q			Q	
27	027FMG	Monitoring Well 2S		Q						Q		Q	Q	Q
29	029FMG	Monitoring Well 3S		Q						Q		Q		Q
32	032FMG	Monitoring Well 5S		Q						Q		Q		Q
46	046FMS	Lower Bruin Creek		Q			Q			P			P	
48	048FMS	Upper Greens Creek	P	P	Q	P	Q	P	P	P	P	P	P	P
49	049FMS	Control Site Upper Bruin Creek		Q			Q			P			P	
54	054FMS	Greens Creek below D-Pond	P	P	Q	P	Q	P	P	P	P	P	P	P
57	057FMG	Monitoring Well -23-00-03		Q			Q			Q			Q	
60	060FMS	Althea Creek - Lower		Q						Q		Q		Q
61	061FMS	Greens Creek Floodplain		Q			Q			P			P	
62	062FMS	Greens Creek Lower Than 54	P	P	Q	P	Q	P	P	P	P	P	P	P
609	609FMS	Further Creek Lower		Q						Q		Q		Q
711	711FMS	Greens Creek Above Site E									Q			P
712	712FMS	Greens Creek Below Site E									Q			P
1067	1067	TRIP BLANK		Q						Q				Q
1068	1068	FIELD BLANK @ SITE	54	46	6	48	49	54	6	60	712	32	57	9

	Sample not taken
	Off schedule sample
	Regular sample

## **SAMPLE SUITES**

### **Suite P**

(Surface water only)

Conductivity  
pH  
Temperature  
Hardness  
Sulfate  
Total Alkalinity  
Dissolved Arsenic  
Dissolved Cadmium  
Dissolved Copper  
Dissolved Lead  
Dissolved Mercury  
Dissolved Zinc

### **Suite Q**

(Groundwater and surface water)

Conductivity  
pH  
Temperature  
Hardness  
Sulfate  
Total Alkalinity  
Dissolved Arsenic  
Dissolved Barium  
Dissolved Cadmium  
Dissolved Chromium  
Dissolved Copper  
Dissolved Lead  
Dissolved Mercury  
Dissolved Nickel  
Dissolved Selenium  
Dissolved Silver  
Dissolved Zinc

## PERSONNEL INVOLVED

### USFS

Chad Van Ormer, Monument Ranger

Matt Reece  
Curtis Caton  
Edward Gazzetti  
Richard Dudek

### Biomonitoring (Fish and Game)

Kate Kanouse  
Jackie Timothy  
Ben Brewster

### Consultants

Pete Condon, Petros GeoConsulting,  
Geochemist

### Laboratory Analysis

Brenda Lasorsa, Project Coordinator  
**Battelle Marine Sciences Laboratory**

Sue Weber, Project Manager  
ACZ

David Wetzel, Project Manager  
Admiralty Environmental

### HGCMC

Scott Hartman, General Manager

Christopher Wallace, Environmental Manager  
Mitch Brooks, Environmental Engineer  
David Landes, Environmental Engineer  
Ted Morales, Environmental Technician  
Cameron Sell, Environmental Technician  
Gunnar Fredheim, Environmental Technician

### Data Review

Suzan Huges, Project Coordinator  
Environmental Synectics, Inc.  
Evin McKinney, Senior Scientist  
Environmental Synectics, Inc.  
Leticia Sangalang, Senior Scientist  
Environmental Synectics, Inc.

## SITE COORDINATES

<b>Site</b>	<b>Site Name</b>	<b>Latitude</b>	<b>Longitude</b>
6	Greens Creek – Middle	58°04'47.424" N	134°38'25.849" W
9	Tributary Creek - Lower	58°06'22.040" N	134°44'44.100" W
13	East Mine Drainage Upper	58°04'47.685" N	134°37'39.951" W
27	Monitoring Well-2S	58°06'48.546" N	134°44'38.365" W
29	Monitoring Well-3S	58°06'59.860" N	134°44'51.821" W
32	Monitoring Well-5S	58°06'57.732" N	134°44'51.225" W
46	Bruin Creek – Lower	58°04'46.450" N	134°38'32.580" W
48	Greens Creek – Upper	58°05'01.350" N	134°37'33.590" W
49	Bruin Creek – Upper	58°05'04.070" N	134°38'30.410" W
54	Greens Creek - Lower	58°04'41.681" N	134°38'46.529" W
57	Monitoring Well-23-00-03	58°04'59.933" N	134°38'39.881" W
60	Althea Creek - Lower	58°04'41.770" N	134°45'08.432" W
609	Further Creek – Lower	58°07'05.707" N	134°45'06.332" W
61	Greens Creek Floodplain	58°04'43.480" N	134°38'52.910" W
62	Greens Creek Lower Than 54	58°04'38.650" N	134°39'06.000" W
711	Greens Creek Above Site E	58°04'08.425" N	134°43'27.181" W
712	Greens Creek Below Site E	58°04'13.858" N	134°43'42.438" W

## **PROPOSED PROGRAM MODIFICATIONS**

HGCMC is not proposing changes to the FWMP during the 2017 Water Year.

## **BIBLIOGRAPHY**

Environmental Protection Agency (1998). *EPA Guidance for Data Quality Assessment*. EPA QA/G-9, EPA/600-R-96/084. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. 219 pp.

Gilbert, Richard O. (1987). *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold, New York. 320 pp.

Helsel, D.R., and Hirsch, R.M. (1992). *Statistical methods in water resource*. Elsevier Publishers, Amsterdam. 510 pp.

# INTERPRETIVE REPORT

## SITE 48

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses with the exception of the outliers shown in the table below. During the current year no new data points were flagged as outliers, after review by HGCMC.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeded these criteria.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of trends in concentration. There were no visually obvious trends.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

<b>Parameter</b>	<u>Mann-Kendall test statistics</u>			<u>Sen's slope estimate</u>	
	<b>n*</b>	<b>p**</b>	<b>Trend</b>	<b>Q</b>	<b>Q(%)</b>
Conductivity Field	6	0.88			
pH Field	6	0.99	+	0.04	0.5
Alkalinity, Total	6	0.87			
Sulfate, Total	6	0.33			
Zinc, Dissolved	6	0.08			

\* Number of Years \*\* Significance level

For datasets with a statistically significant trend ( $\alpha/2=2.5\%$ ) a Seasonal-Sen's Slope estimate statistic has also been calculated. For the current water year field pH has a slope estimate of 0.04 su/year, slightly less than the Sen's Slope estimates reported over the past couple of years.

## Table of Results for Water Year 2016

### Site 048FMS - 'Upper Greens Creek'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)	6.1	1.7	2.80	1.8	2.60	2.1	7.9	4.5	5.6	11	11.5	8.7	5.05
Conductivity-Field(µmho)	89.7	134.1	129.6	114	111.3	141.3	77.4	95.5	81.3	118.8	130.1	117.8	115.9
Conductivity-Lab (µmho)	74	109	80	93	113	137	66	91	81	121	127	117	101
pH Lab (standard units)	7.76	7.76	7.69	7.62	7.67	7.82	7.51	7.79	7.61	7.69	7.71	7.77	7.70
pH Field (standard units)	7.86	7.46	7.82	7.84	7.67	7.82	7.84	7.91	7.87	8.01	8	7.98	7.85
Total Alkalinity (mg/L)	35.2	47.8	49.1	42.9	42.6	51.5	30.8	41.2	35.9	49.2	49.8	48.2	45.4
Total Sulfate (mg/L)	7.7	14.4	15.7	15.2	13	17	7.5	9.4	7.1	13.7	14.3	11.2	13.4
Hardness (mg/L)	42.5	60.8	64.4	55.8	55.3	66.5	37.6	45.3	38.2	56.3	60.6	56.3	56.1
Dissolved As (ug/L)	0.206	0.206	0.192	0.223	0.197	0.184	0.185	0.201	0.233	0.245	0.234	0.238	0.206
Dissolved Ba (ug/L)			28.9		24.6								26.8
Dissolved Cd (ug/L)	0.0351	0.0424	0.0445	0.0403	0.0396	0.0333	0.0268	0.0301	0.025	0.0318	0.0238	0.0301	0.0326
Dissolved Cr (ug/L)			0.149		0.097								0.123
Dissolved Cu (ug/L)	0.666	0.444	0.43	0.56	0.636	0.354	0.577	0.316	0.241	0.257	0.263	0.427	0.429
Dissolved Pb (ug/L)	0.0211	0.0062	0.0081	0.0137	0.009	0.0015	0.0089	0.0015	0.0036	0.0015	0.0015	0.0051	0.0057
Dissolved Ni (ug/L)			0.543		0.37								0.457
Dissolved Ag (ug/L)			0.002		0.002								0.002
Dissolved Zn (ug/L)	7.93	4.71	5.41	4.22	4.43	3.21	2.46	2.48	1.92	1.72	1.63	1.75	2.85
Dissolved Se (ug/L)			0.829		0.661								0.745
Dissolved Hg (ug/L)	0.00168	0.000796	0.000779	0.00137	0.00153	0.000638	0.00155	0.000679	0.000435	0.000403	0.000564	0.000702	0.000741

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

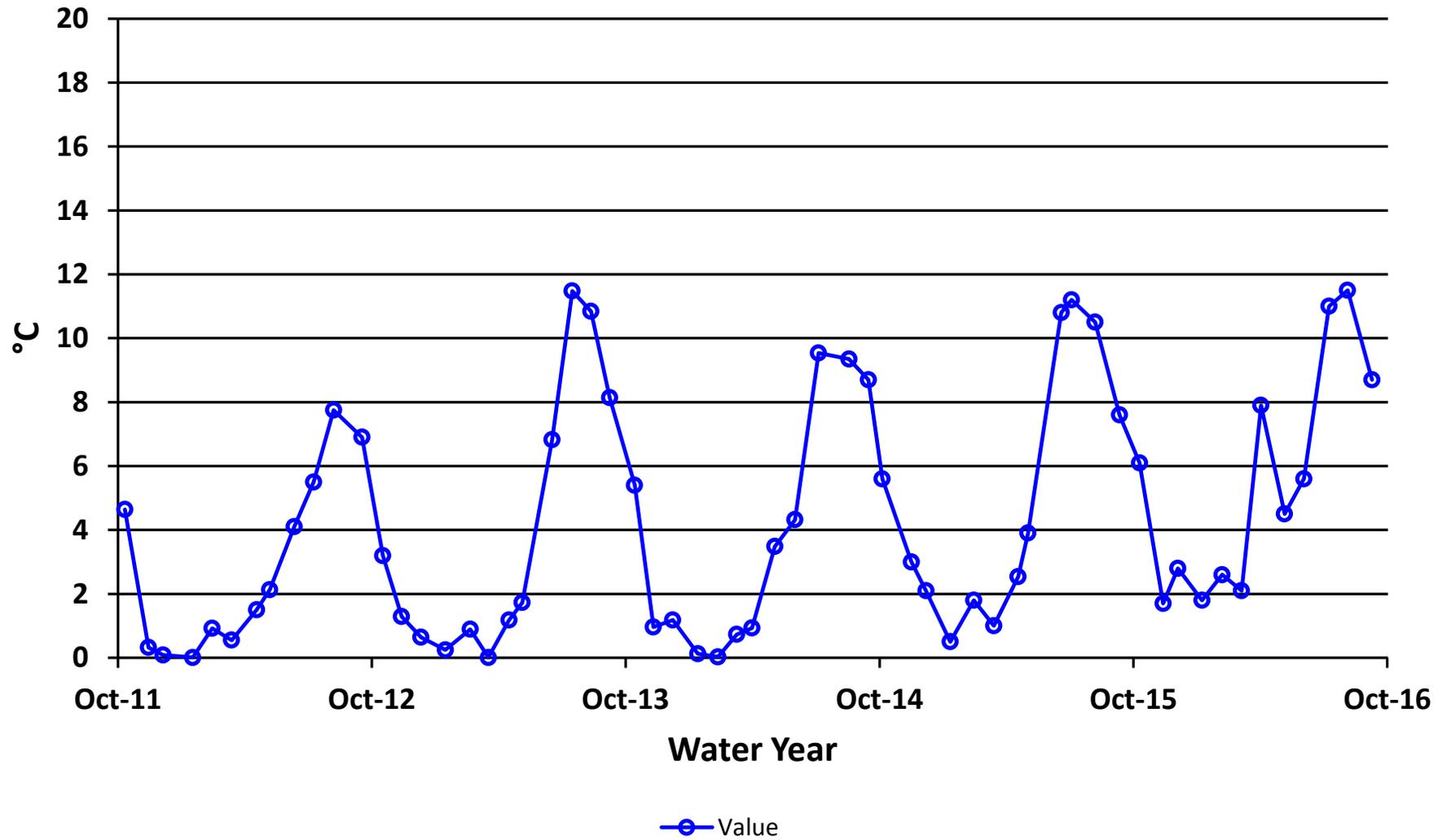
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

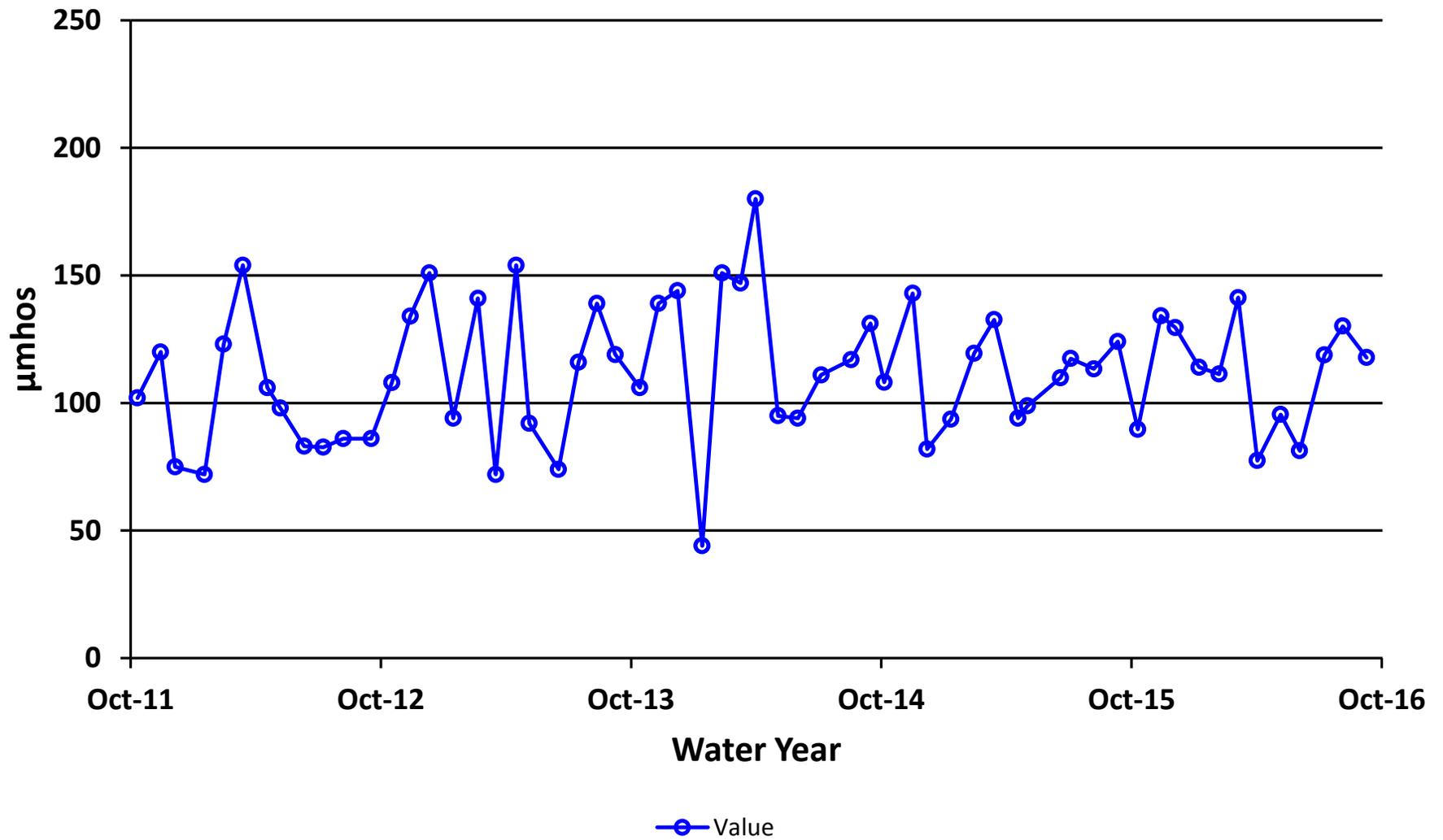
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
048FMS	11/16/2015	12:00 PM	Diss. Pb-ICP/MS	0.00617	µg/L	J	Below Quantitative Range
	12/7/2015	12:00 PM	Diss. Cr-ICP/MS	0.14	µg/L	J	Below Quantitative Range
			Diss. Pb-ICP/MS	0.00813	µg/L	J	Below Quantitative Range
	2/9/2016	12:00 PM	Diss. Cr-ICP/MS	0.09	µg/L	J	Below Quantitative Range
			Diss. Pb-ICP/MS	0.00895	µg/L	J	Below Quantitative Range
	3/8/2016	12:00 PM	Diss. Hg-CVAF	0.000638	µg/L	U	Field Blank Contamination
	4/5/2016	12:00 PM	Diss. Pb-ICP/MS	0.0089	µg/L	J	Below Quantitative Range
	6/6/2016	12:00 PM	Diss. Pb-ICP/MS	0.00362	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Sulfate	14.3	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Pb-ICP/MS	0.00511	µg/L	J	Below Quantitative Range
			Sulfate	11.2	mg/L	J	Sample Receipt Temperature
	11/16/2015	12:00 PM	Diss. Pb-ICP/MS	0.00653	µg/L	J	Below Quantitative Range

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

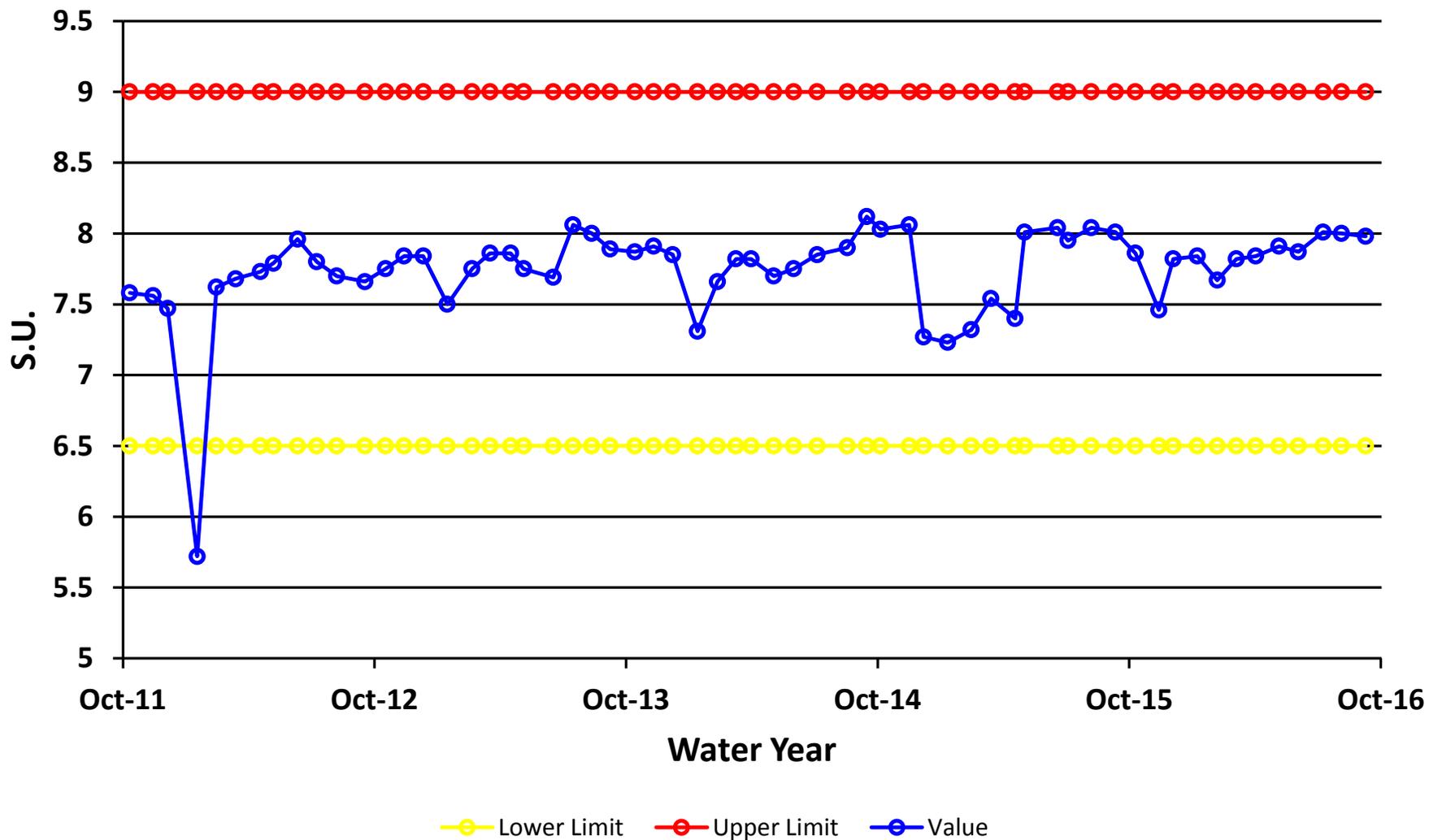
# Site 48 - Water Temperature



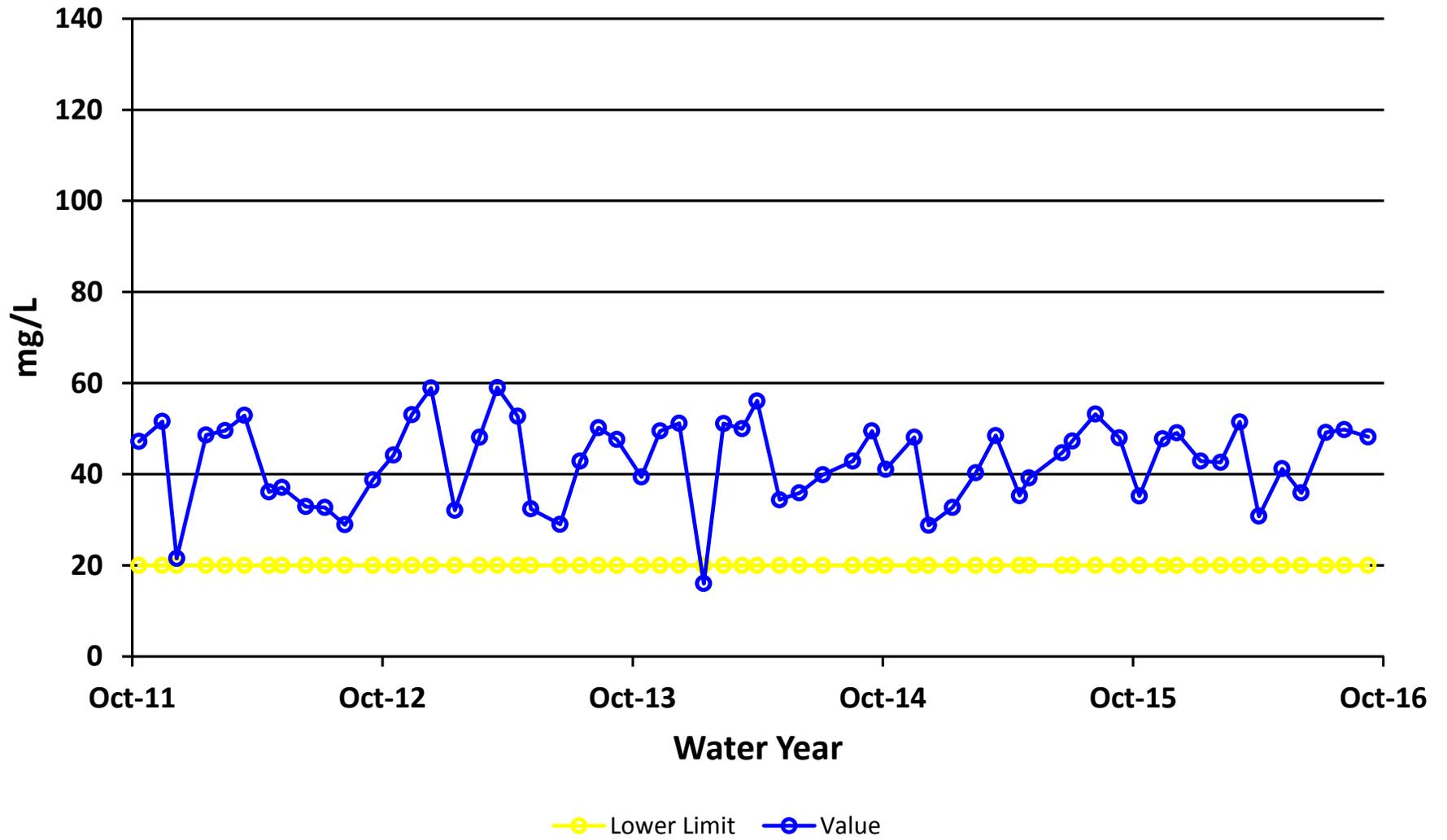
# Site 48 - Conductivity Field



# Site 48 - pH Field

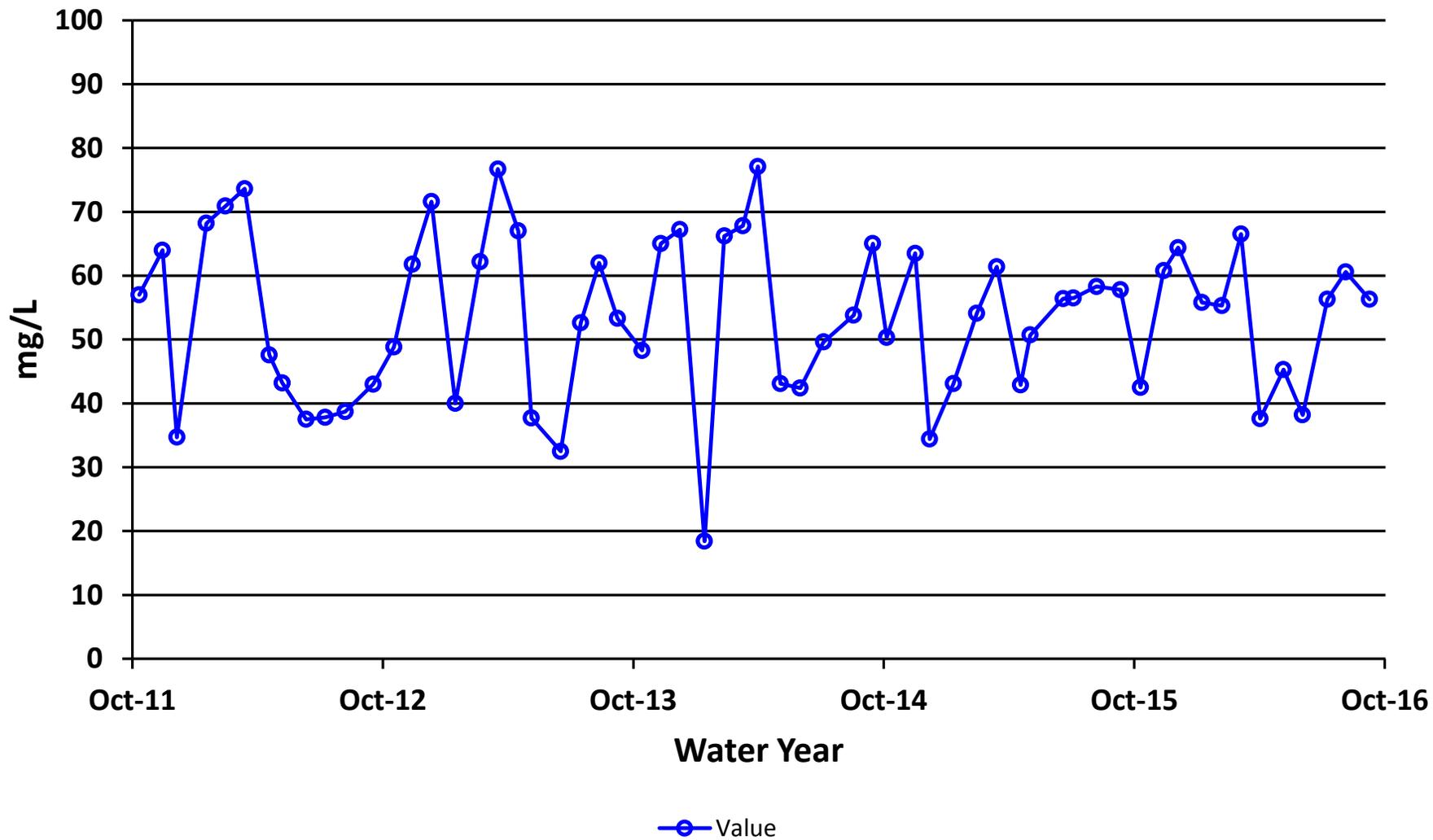


# Site 48 - Alkalinity

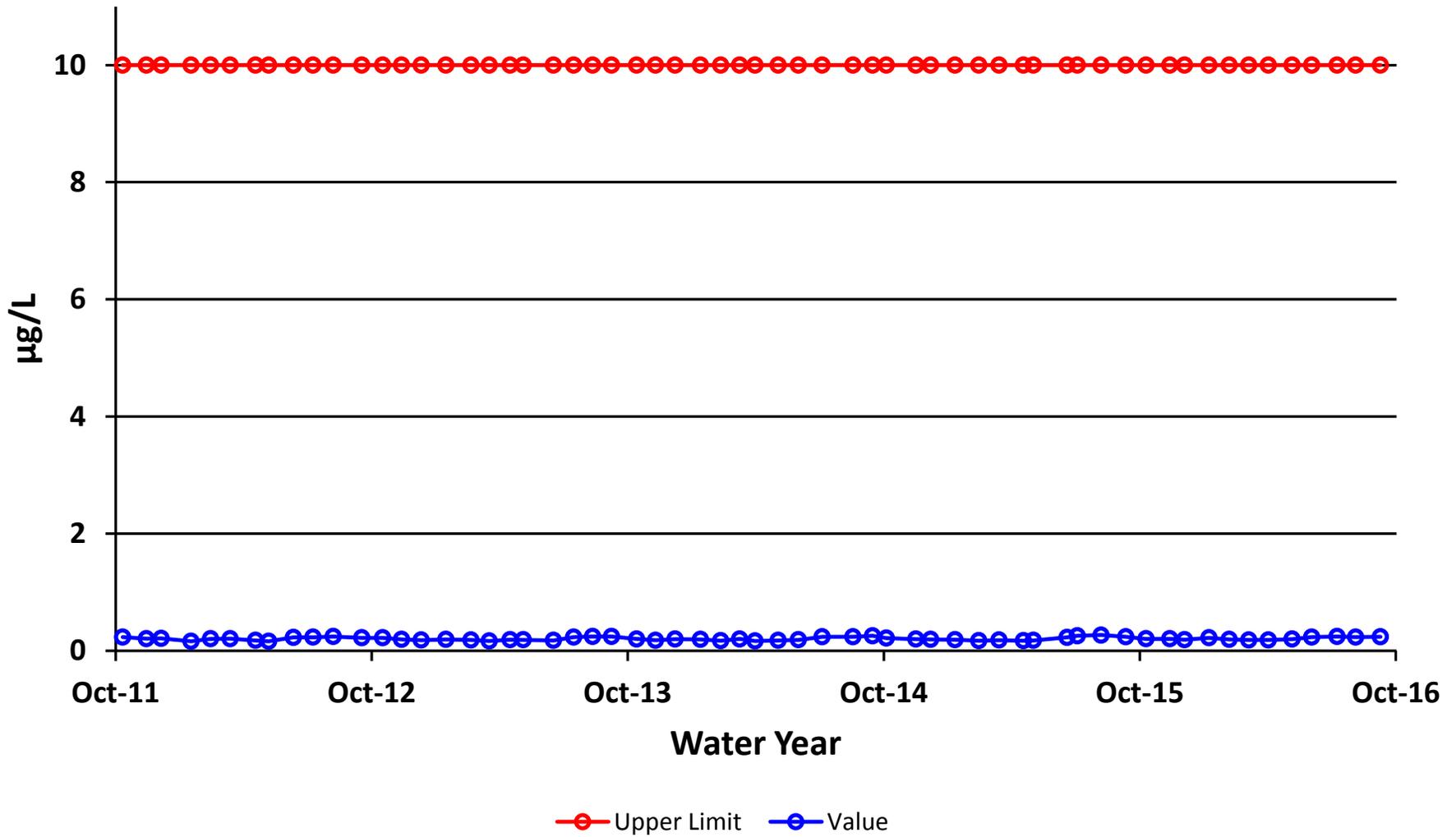




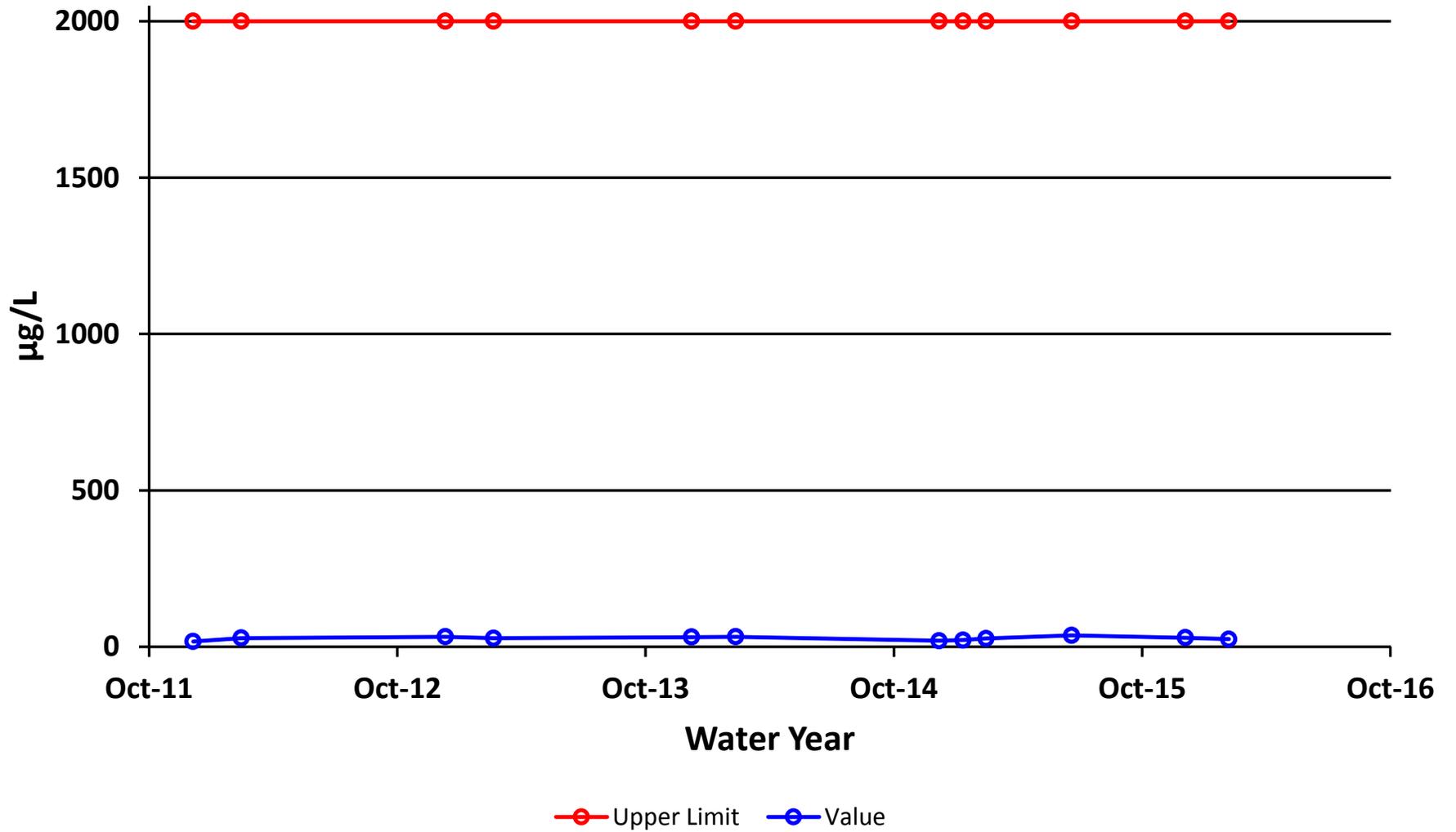
# Site 48 - Hardness



# Site 48 - Arsenic Dissolved

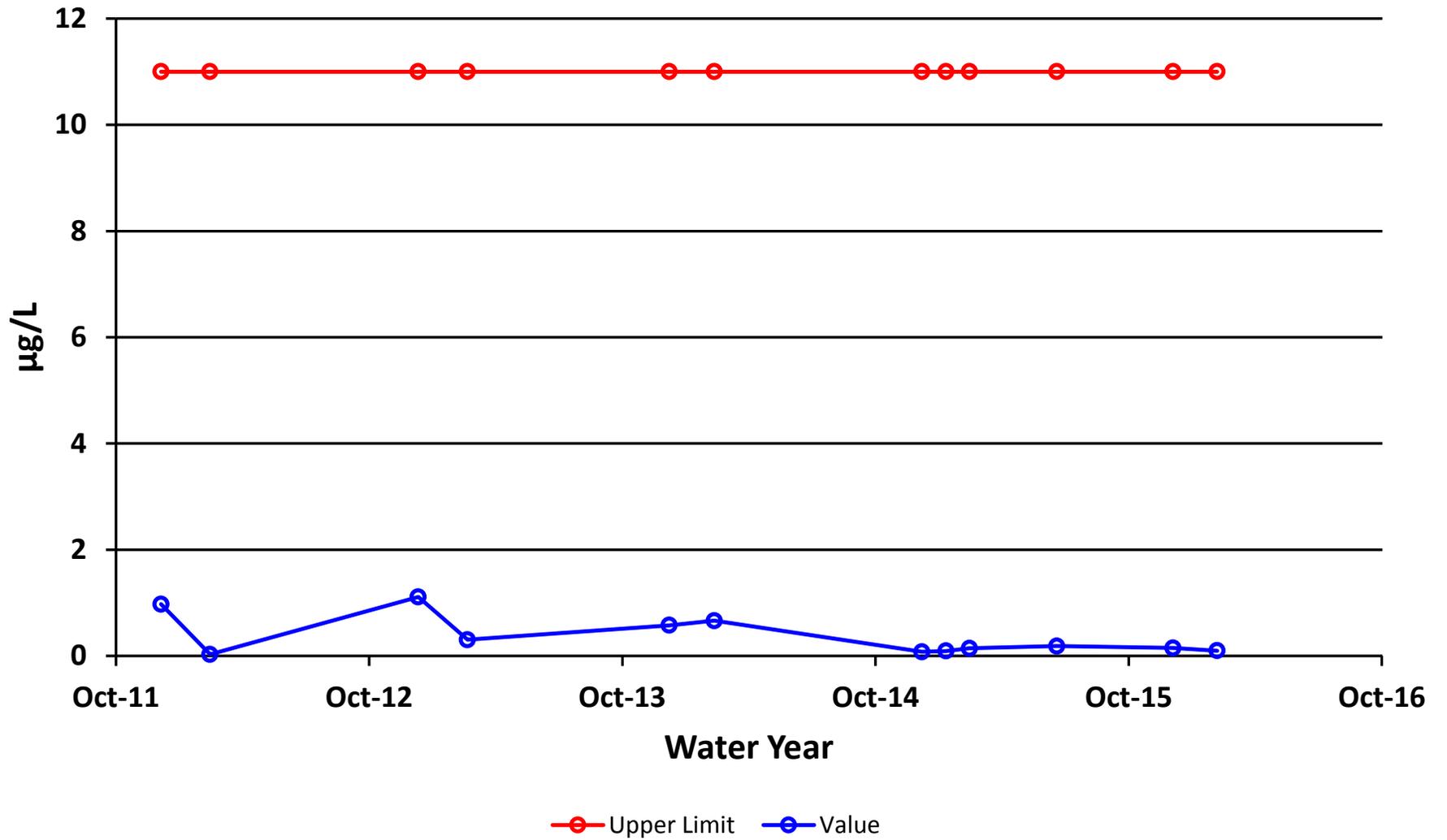


# Site 48 - Barium Dissolved

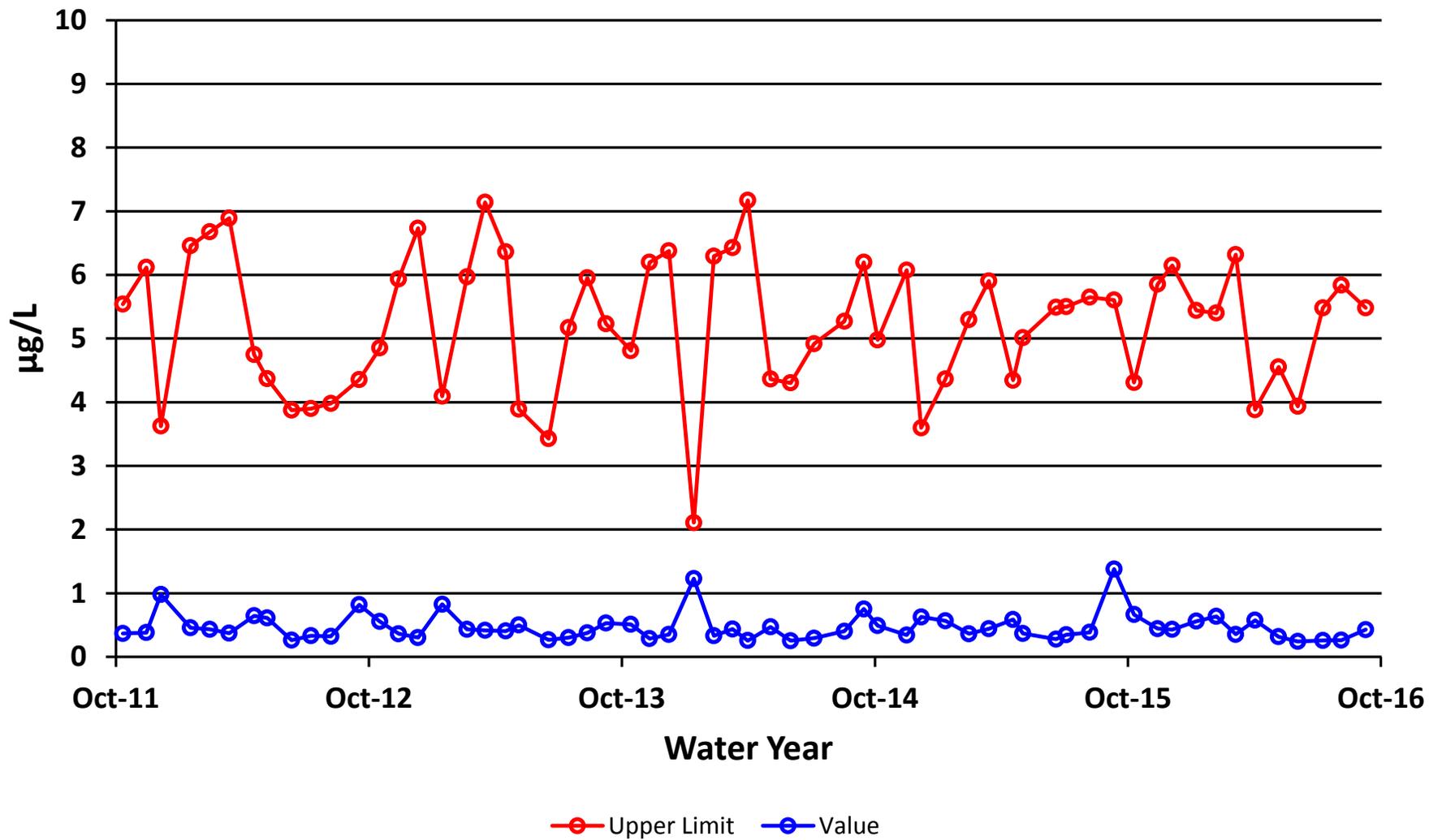




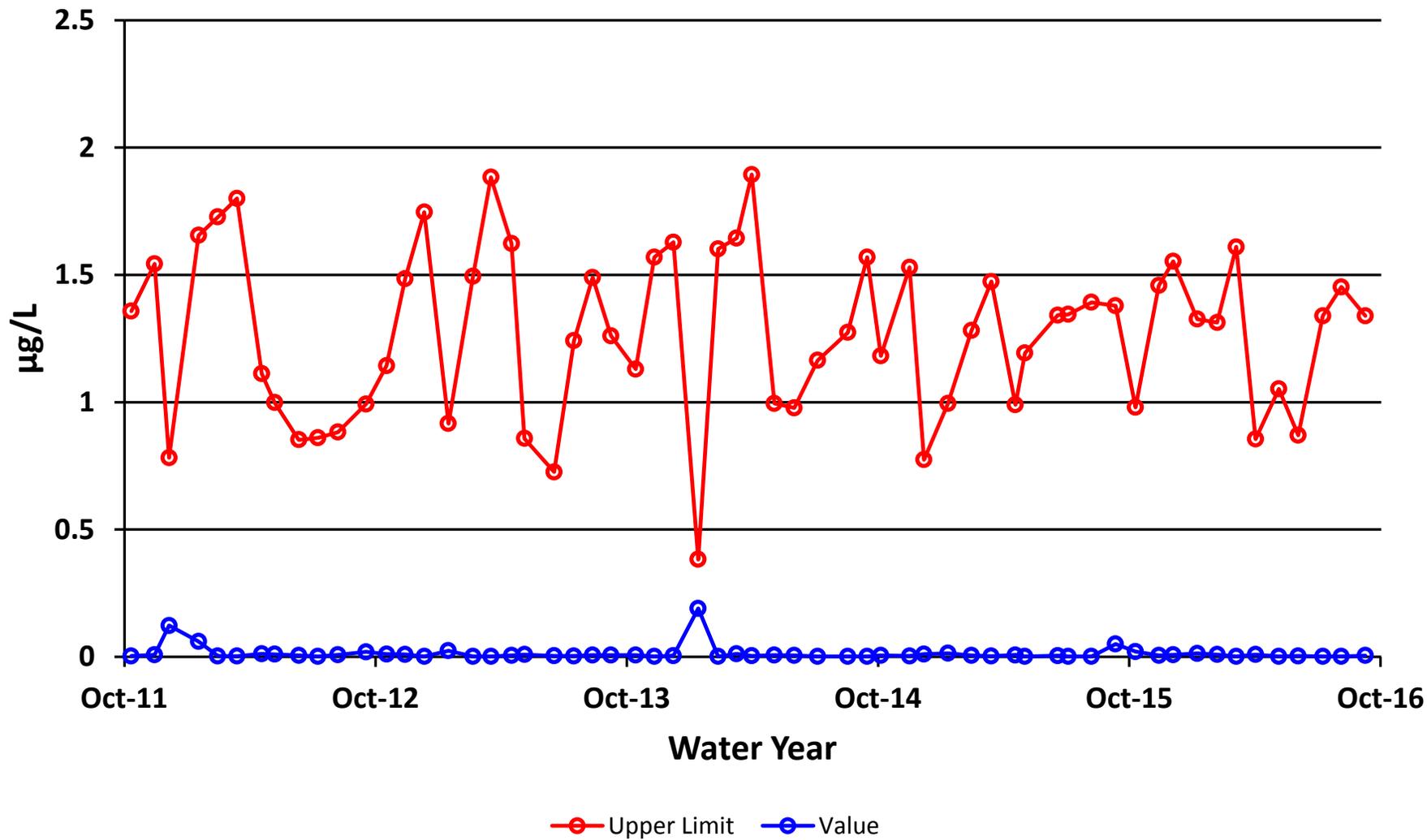
# Site 48 - Chromium Dissolved



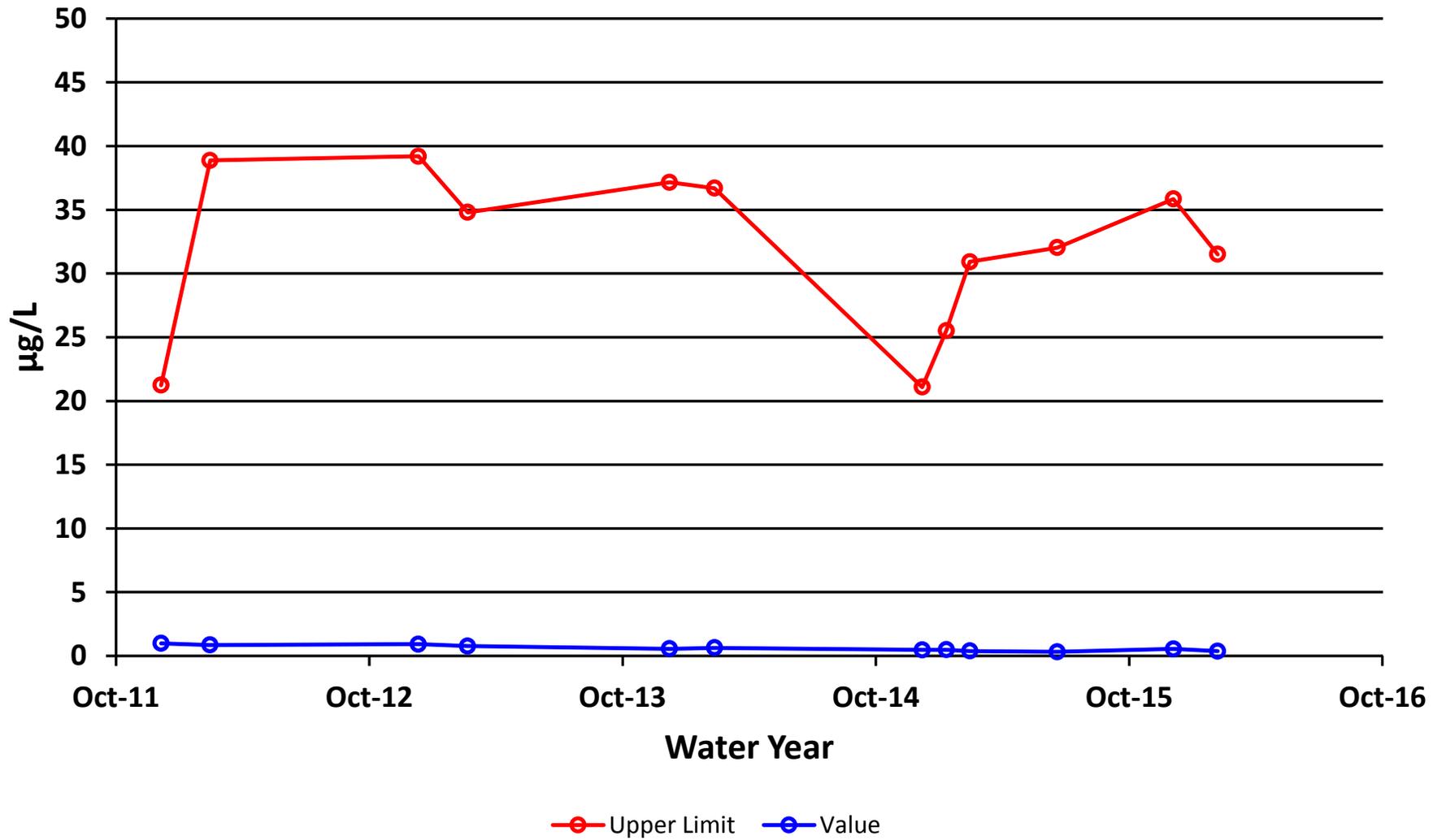
# Site 48 - Copper Dissolved



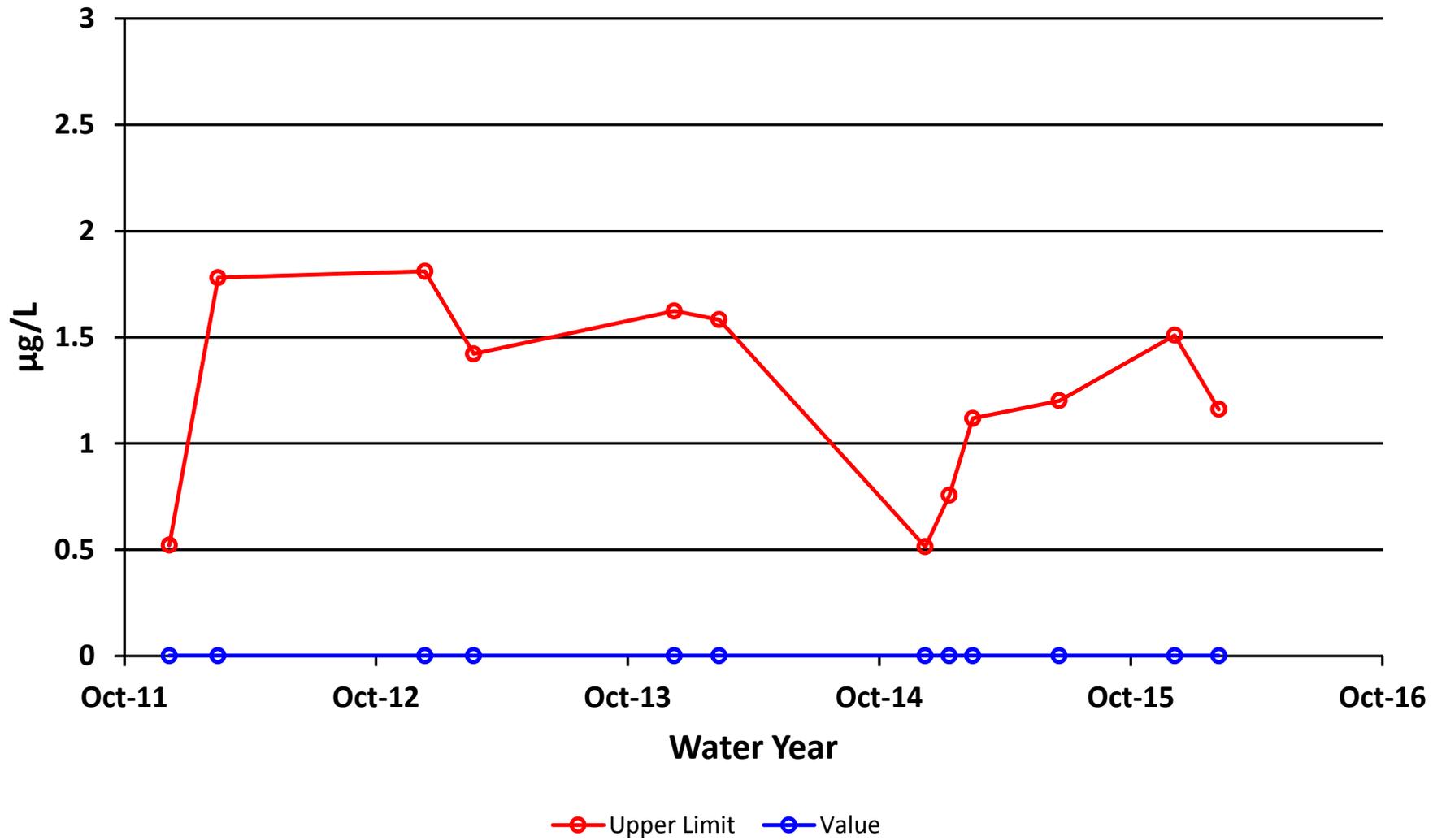
# Site 48 - Lead Dissolved



# Site 48 - Nickel Dissolved

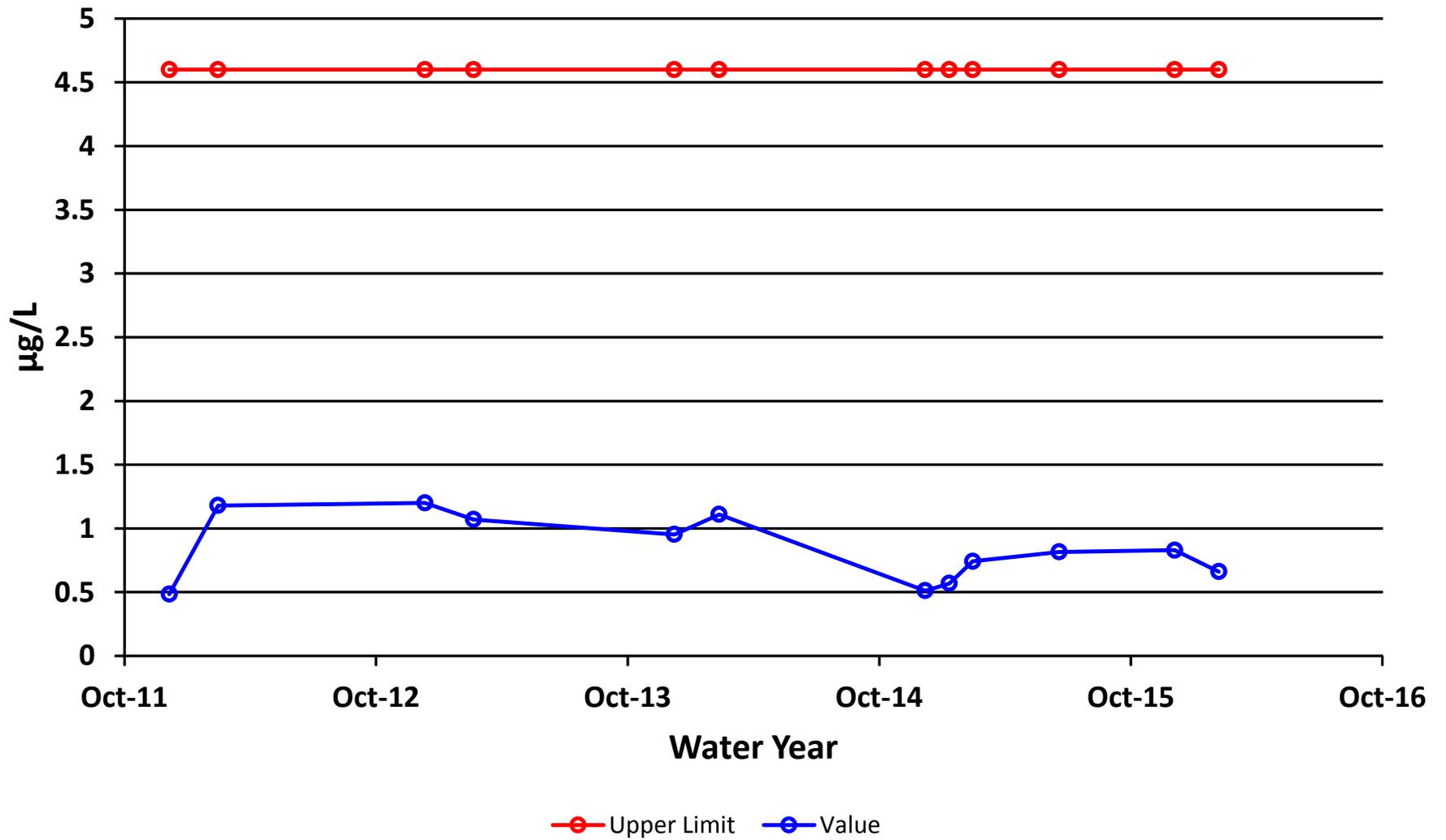


# Site 48 - Silver Dissolved





# Site 48 - Selenium Dissolved





# INTERPRETIVE REPORT

## SITE 6

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses with the exception of the outliers shown in the table below. During the current year no new data points were flagged as outliers after review by HGCMC.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeded these criteria.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. There were no visually obvious trends.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results of the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.50			
pH Field	6	1.00	+	0.05	0.6
Alkalinity, Total	6	0.91			
Sulfate, Total	6	0.16			
Zinc, Dissolved	6	0.04			

\* Number of Years \*\* Significance level

Out of the five parameters evaluated field pH had a statistically significant positive slope (0.05 su/year), slightly less than the past couple of years. The direction and magnitude of trend is similar to the pH trend measured at the background site (Site 48). Currently, HGCMC does not believe that this increasing trend is a significant indication of changes in water chemistry.

A comparison of median values for alkalinity, laboratory pH, lab conductivity, total sulfate, and dissolved zinc between Site 6 and Site 48 has been conducted as specified in the Statistical Information Goals for Site 6. Additionally, X-Y plots have been generated for total alkalinity, field pH, specific conductance, total sulfate, and dissolved zinc that co-plot data from Site 6 and Site 48, the upstream control site, to aid in the comparison between those sites. Calculation details of the non-parametric signed-rank tests are presented in detail on the pages following this interpretive section. The table below summarizes the results of the signed-rank test as performed on the Water Year 2016 dataset.

**Table of Summary Statistics for Median Analysis**

Site 6 vs Site 48				
Parameter	Signed Ranks	Site 48	Site 6	Median
	p-value	median	median	Differences
Conductivity Field	<0.01	115.9	122.6	-4.9
pH Field	0.212	7.85	7.83	0.02
Alkalinity, Total	<0.01	45.35	46.9	-0.9
Sulfate, Total	<0.01	13.4	14.9	-1.30
Zinc, Dissolved	<0.01	2.85	6.08	-2.31

Field pH does not have a statistically significant difference between measured median values at a significance level of  $\alpha=0.05$  for a one-tailed test. The median values for field pH for Site 48 and Site 6 are 7.85 su and 7.83 su respectively and the median of differences, Site 48 minus Site 6, is 0.02 su.

The median values for field conductivity for Site 48 and Site 6 are 115.9  $\mu\text{S}/\text{cm}$  and 122.6  $\mu\text{S}/\text{cm}$  respectively. Median values for total alkalinity for Site 48 and Site 6 are 45.4 mg/L and 46.9

mg/L respectively. The median values for total sulfate for Site 48 and Site 6 are 13.4 mg/L and 14.9 mg/L respectively.

Dissolved zinc results are similar to those observed in previous years. The current median values for Site 48 and Site 6 are 2.85 µg/L and 6.08 µg/L respectively, with a median difference of -2.31 µg/L. Signed-rank test results for prior datasets for Water Years 2000 – 2015 show similar statistically significant differences with a median difference ranging from -1.7 µg/L to -4.77 µg/L dissolved zinc.

These differences have been relatively consistent over the past several years and do not appear to be increasing. Also, the magnitude of the relative differences is small with respect to field conductivity and well below the applicable AWQS in the case of total sulfate and dissolved zinc. Taking into consideration the small magnitude of the differences that are measurable between the two sites, the current FWMP program is sufficient to monitor for water quality changes in this section of Greens Creek. Thus, if an upward trend in total sulfate, or dissolved zinc at Site 6 is occurring, the current program is sufficient for identifying the change before any water quality values are impaired.

## Table of Results for Water Year 2016

### Site 006FMS - 'Greens Creek Middle'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)	6.1	1.8	2.9	1.8	2.6	2.1	7.7	4.4	5.7	10.9	11.3	8.6	5.1
Conductivity-Field(µmho)	92.3	142.5	133.8	126.5	118.2	148.7	78.8	100	85.6	124.1	136.7	121	122.6
Conductivity-Lab (µmho)	76	117	82	104	118	143	67	95	86	125	133	121	111
pH Lab (standard units)	7.67	7.55	7.71	7.65	7.58	7.79	7.37	7.84	7.65	7.69	7.69	7.7	7.68
pH Field (standard units)	7.83	7.51	7.83	7.81	7.7	7.79	7.86	7.89	7.79	8.03	7.94	7.96	7.83
Total Alkalinity (mg/L)	35.6	48.9	49.4	45.4	44.1	51.8	31.5	43.1	37.2	49.9	51.4	48.4	46.9
Total Sulfate (mg/L)	8.6	17	19.2	18.6	15.1	19.7	8	10.1	8.7	14.6	15.2	11.9	14.9
Hardness (mg/L)	43.3	63.7	67.9	58.1	58.6	69.3	38.2	46.5	40.4	59.1	60.9	57.9	58.4
Dissolved As (ug/L)	0.198	0.205	0.215	0.201	0.182	0.169	0.188	0.182	0.207	0.227	0.224	0.232	0.203
Dissolved Ba (ug/L)			28		23.9								26.0
Dissolved Cd (ug/L)	0.0552	0.0616	0.0605	0.055	0.0563	0.0444	0.0343	0.0384	0.0333	0.0361	0.0403	0.0405	0.0425
Dissolved Cr (ug/L)			0.066		0.103								0.085
Dissolved Cu (ug/L)	0.743	0.523	0.47	0.578	0.713	0.39	0.598	0.369	0.243	0.278	0.348	0.475	0.473
Dissolved Pb (ug/L)	0.0341	0.0111	0.0116	0.0337	0.0184	0.0069	0.0192	0.0054	0.0046	0.0049	0.0108	0.0094	0.0110
Dissolved Ni (ug/L)			0.602		0.444								0.523
Dissolved Ag (ug/L)			0.002		0.002								0.002
Dissolved Zn (ug/L)	8.26	10.8	11	9.32	10.4	7.48	4.68	4.38	3.77	3.03	3.19	4.14	6.08
Dissolved Se (ug/L)			1		0.745								0.873
Dissolved Hg (ug/L)	0.00175	0.000897	0.000853	0.00127	0.00162	0.000647	0.00157	0.000769	0.000454	0.000424	0.000578	0.000772	0.000813

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

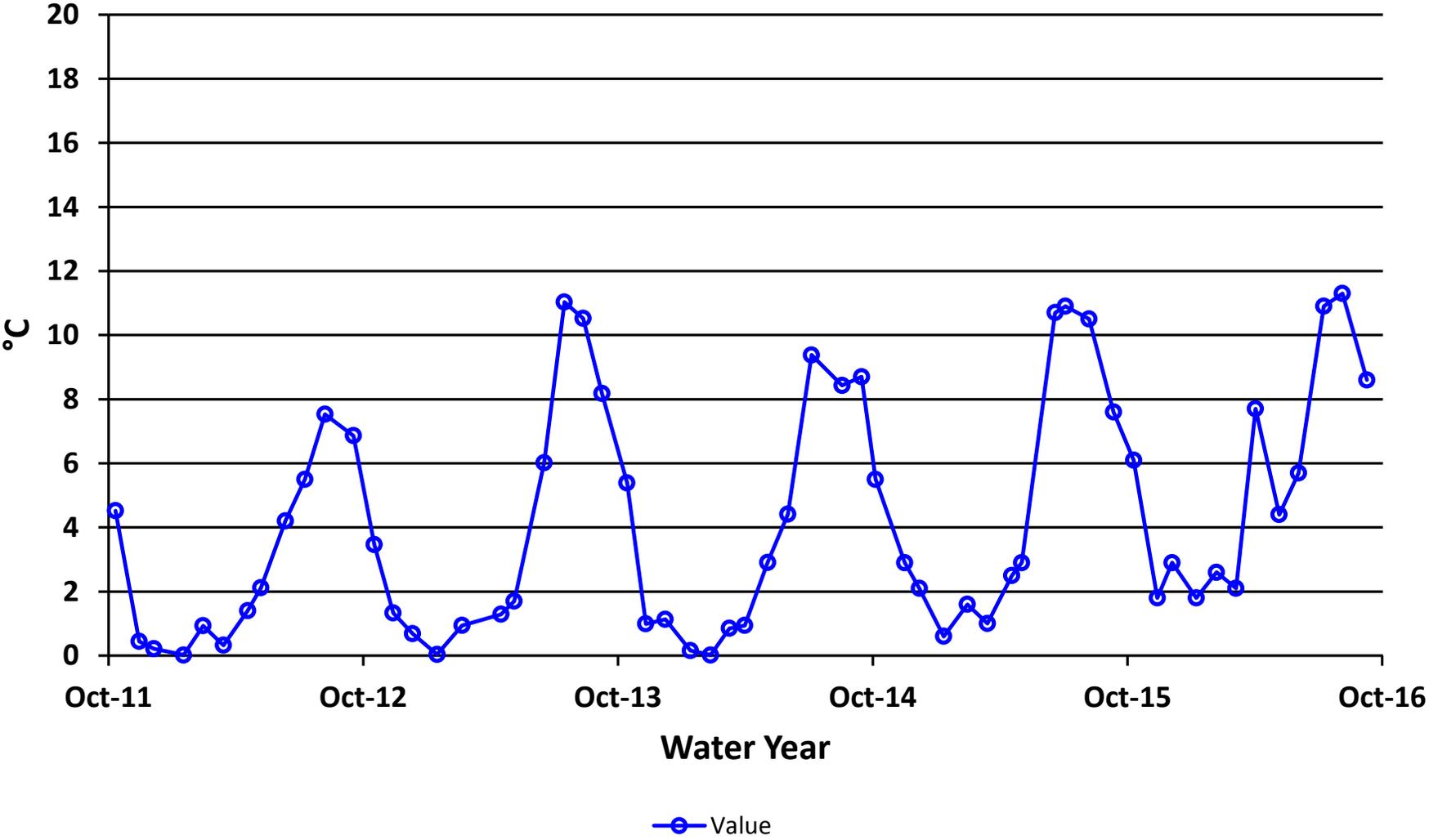
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

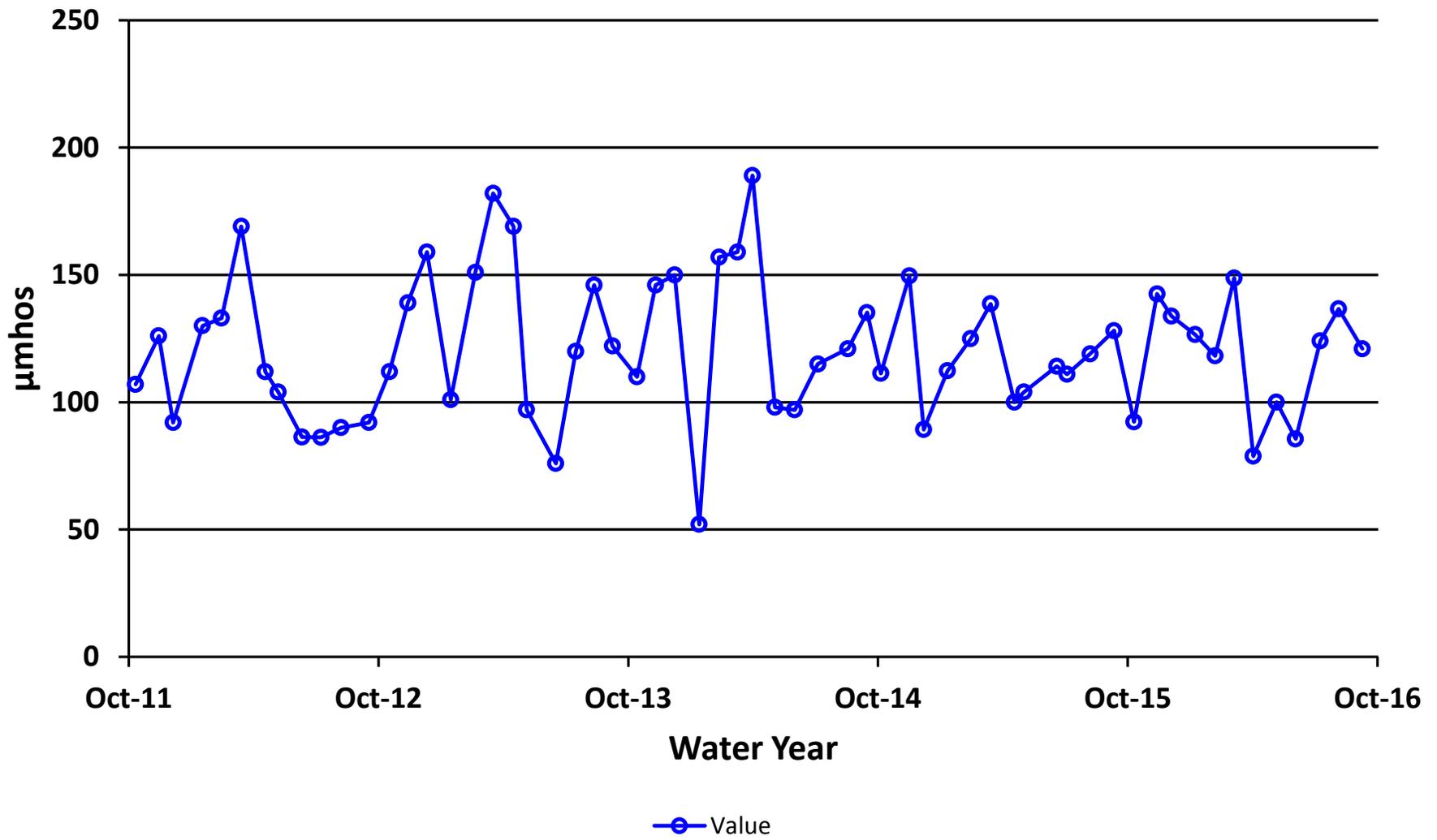
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
006FMS	12/7/2015	12:00 PM	Diss. Cr-ICP/MS	0.06	µg/L	J	Below Quantitative Range
	2/9/2016	12:00 PM	Diss. Cr-ICP/MS	0.1	µg/L	J	Below Quantitative Range
	3/8/2016	12:00 PM	Diss. Hg-CVAF	0.000647	µg/L	U	Field Blank Contamination
			Diss. Pb-ICP/MS	0.00687	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Pb-ICP/MS	0.00538	µg/L	J	Below Quantitative Range
	6/6/2016	12:00 PM	Diss. Pb-ICP/MS	0.00462	µg/L	J	Below Quantitative Range
	7/12/2016	12:00 PM	Diss. Pb-ICP/MS	0.00491	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Sulfate	15.2	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Sulfate	11.9	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

# Site 6 - Water Temperature

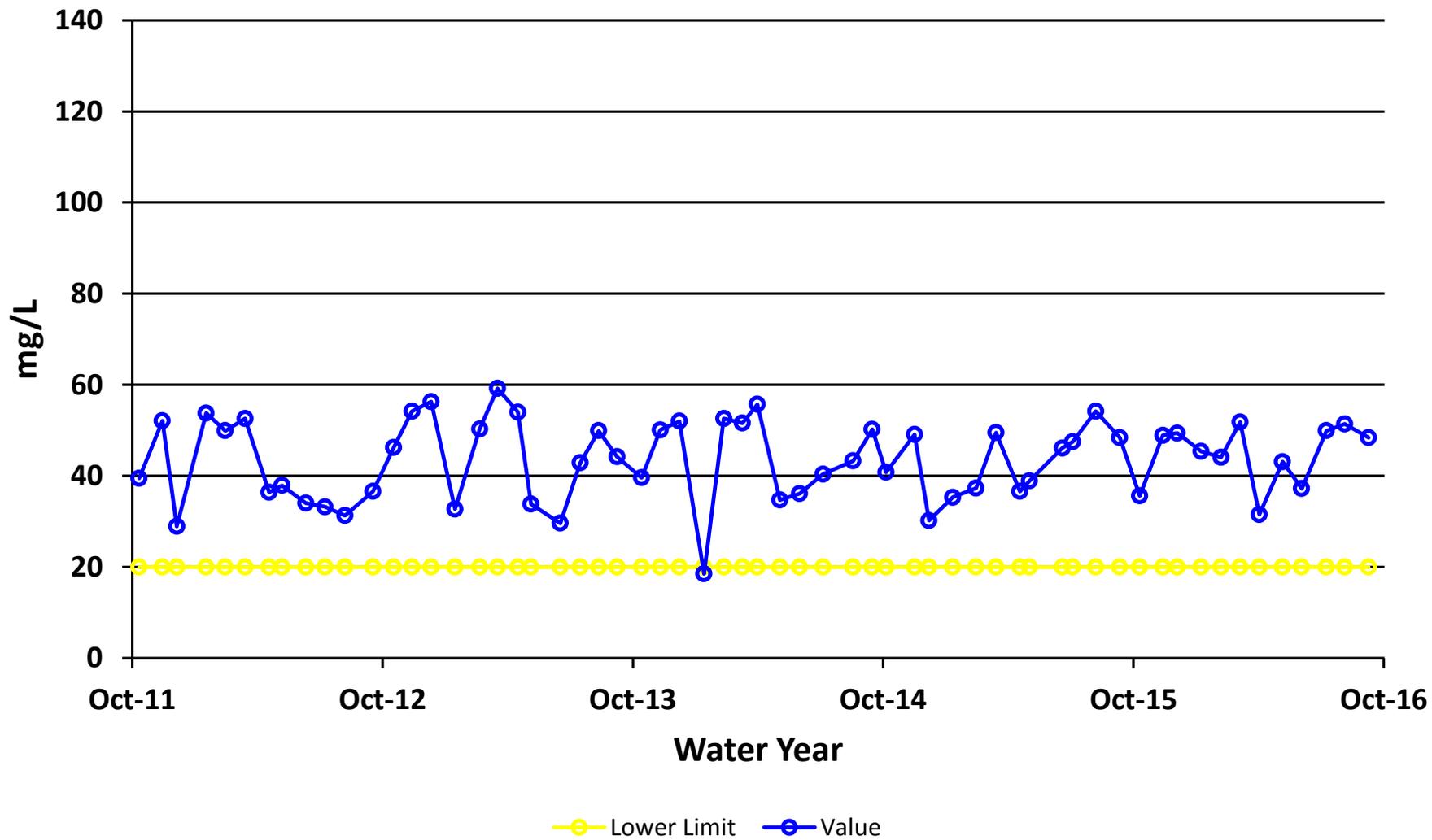


# Site 6 - Conductivity Field



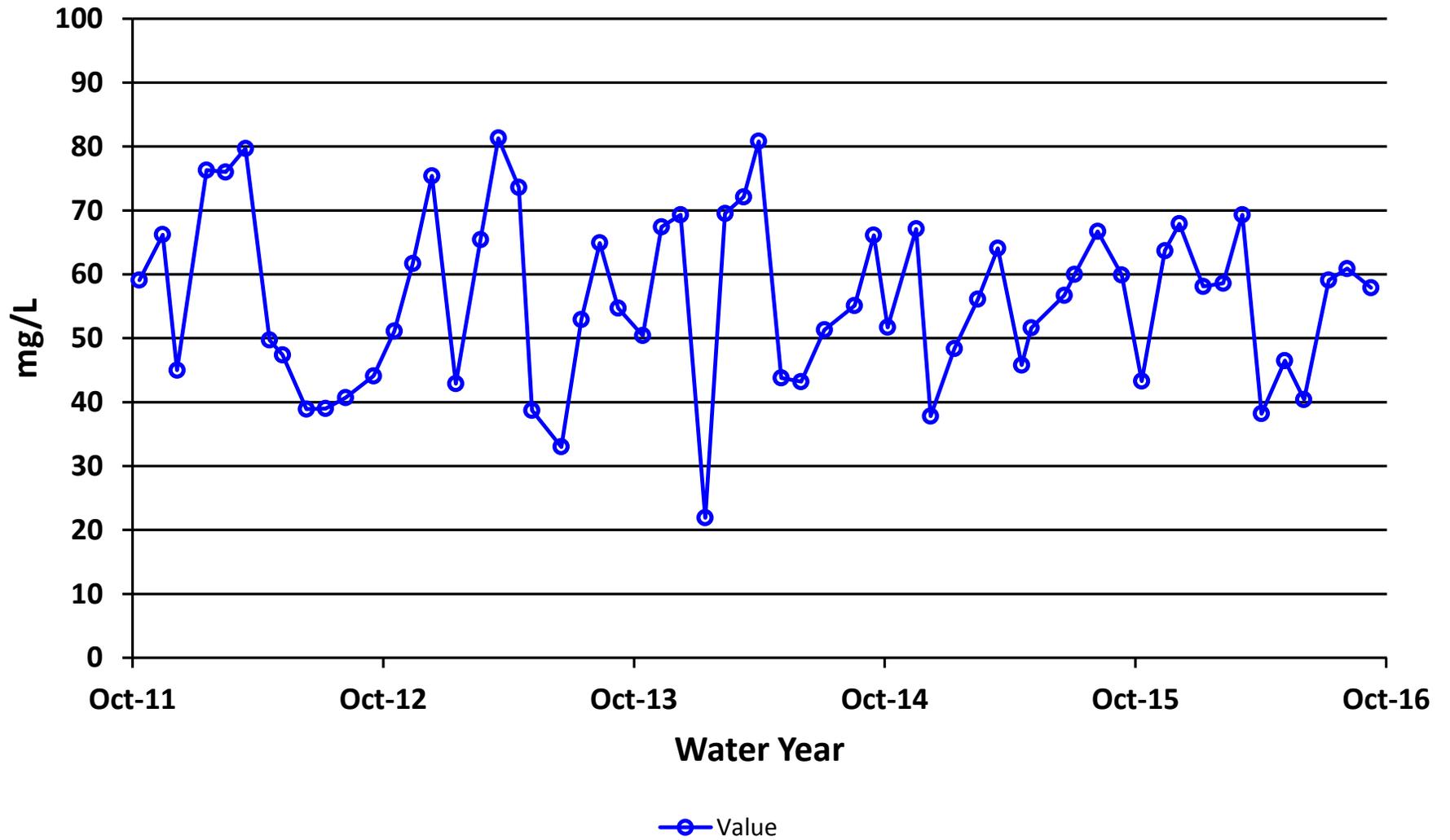


# Site 6 - Alkalinity

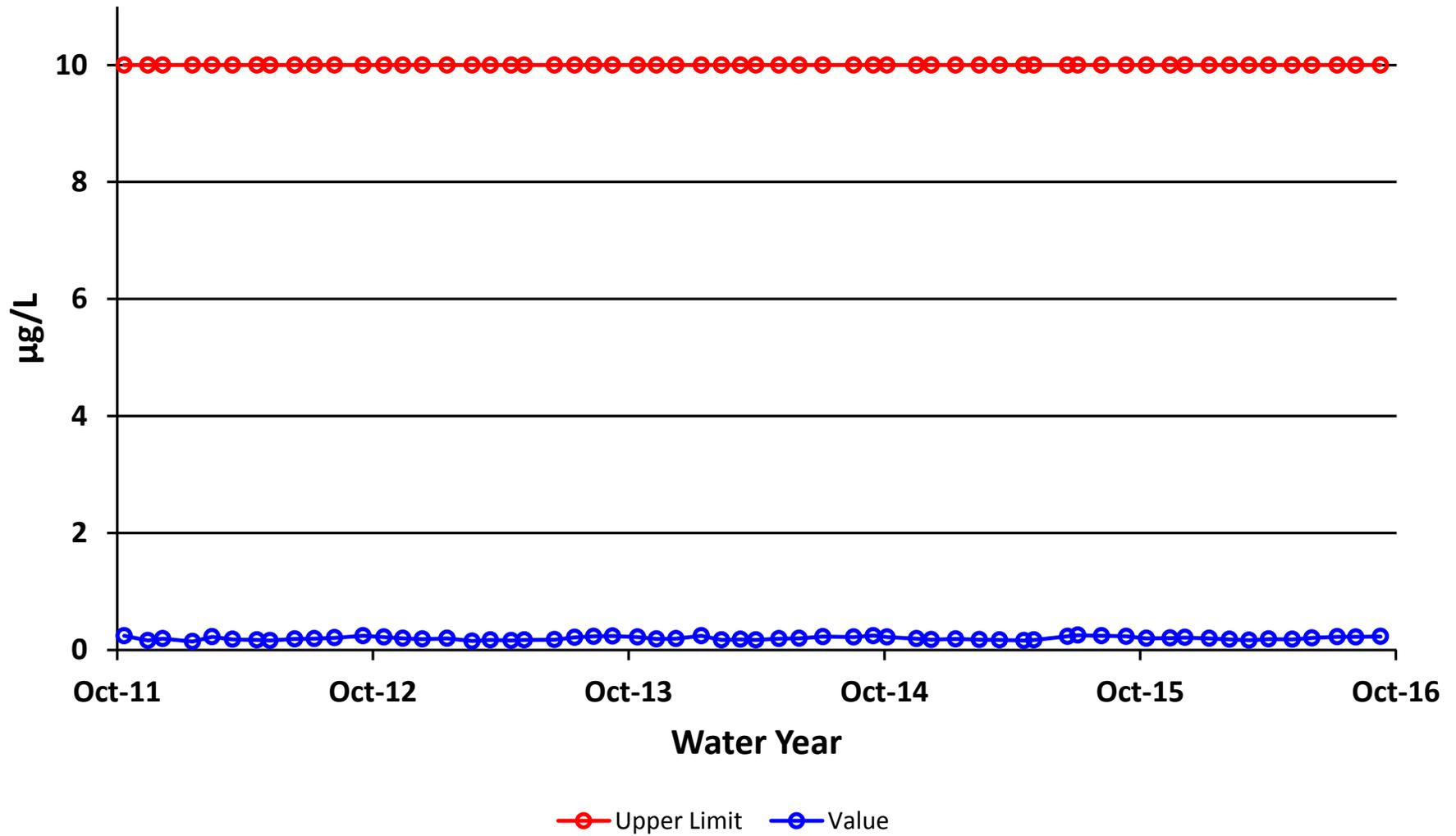




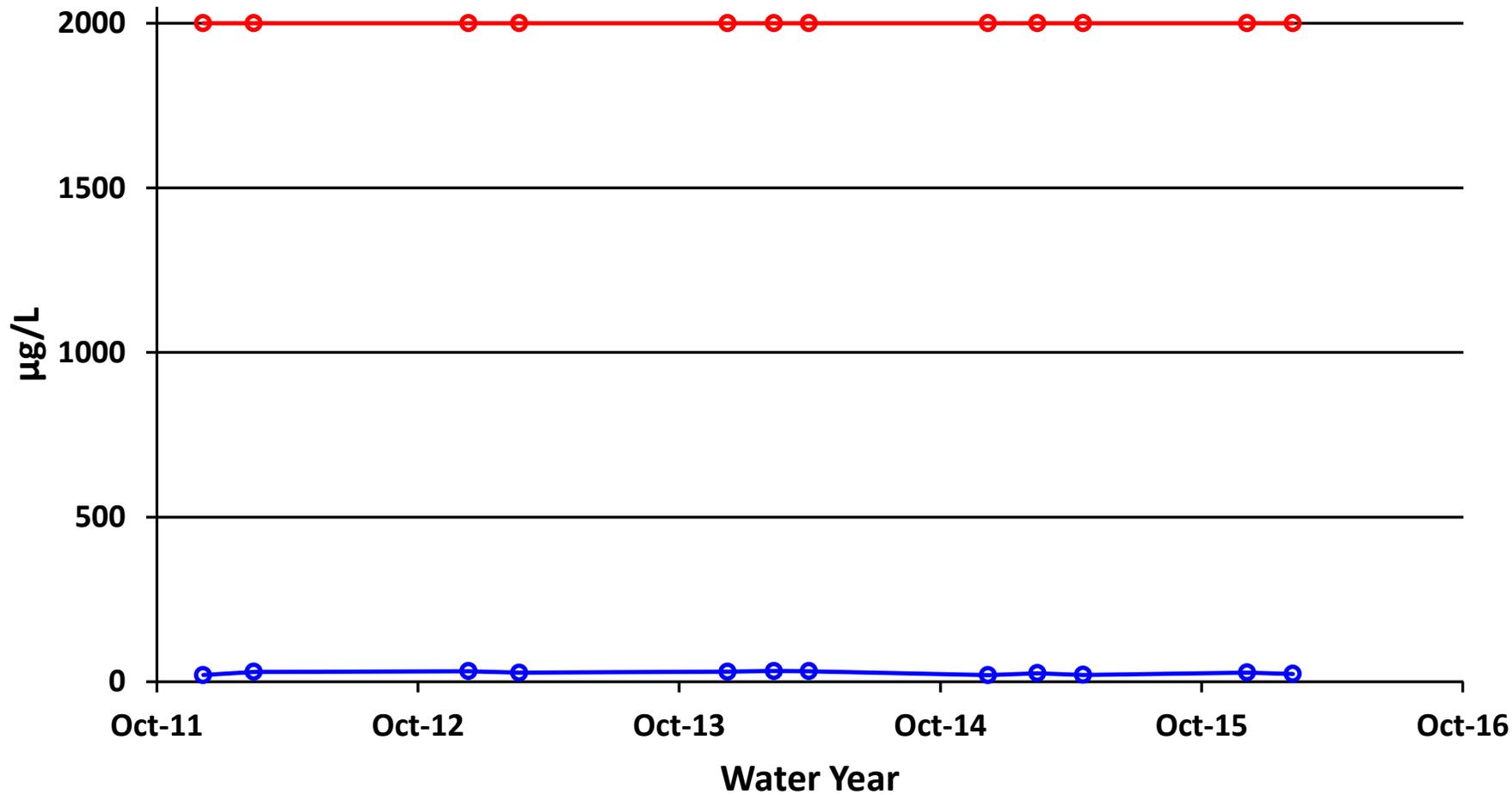
# Site 6 - Hardness



# Site 6 - Arsenic Dissolved



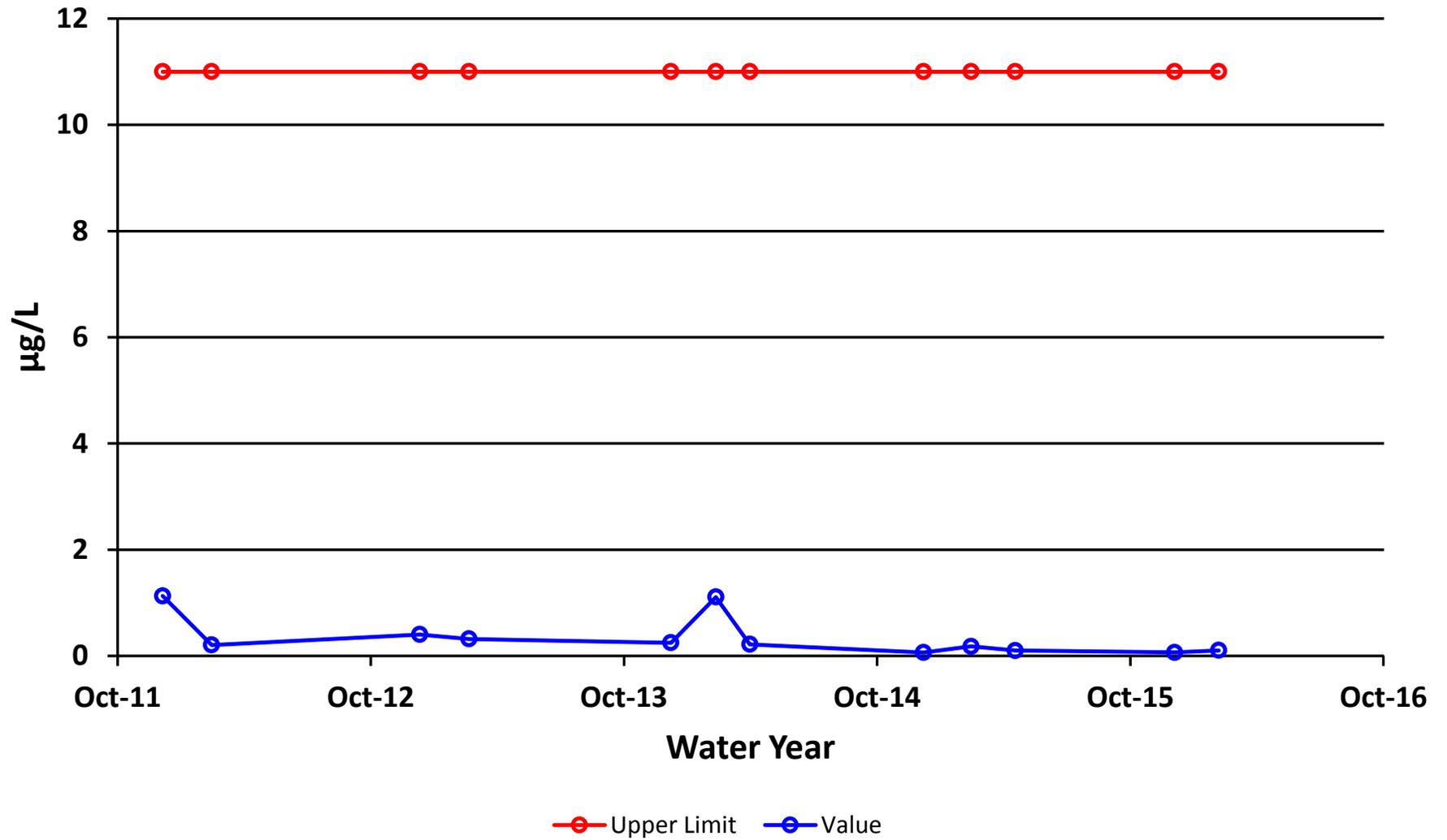
# Site 6 - Barium Dissolved



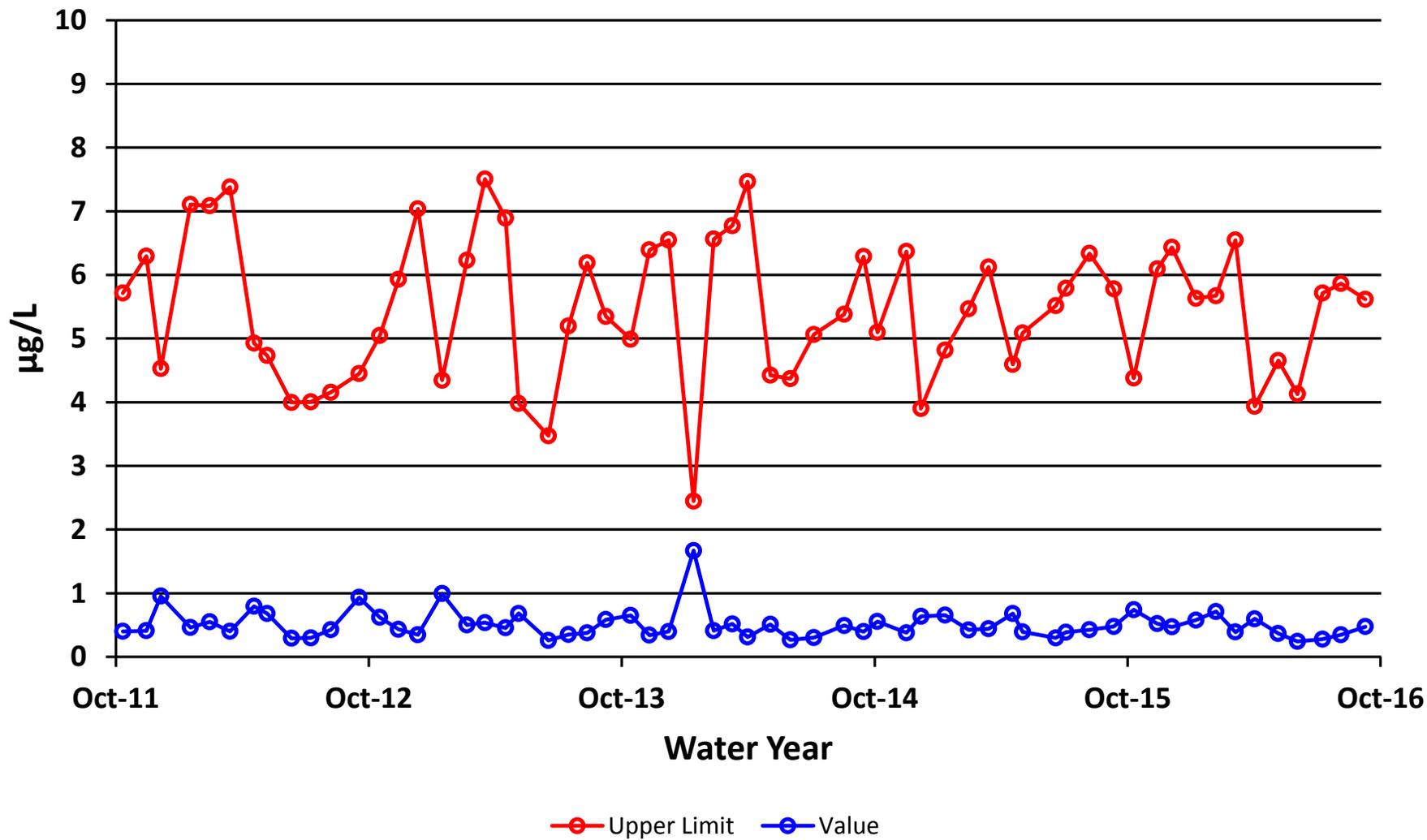
○ Upper Limit    ○ Value



## Site 6 - Chromium Dissolved

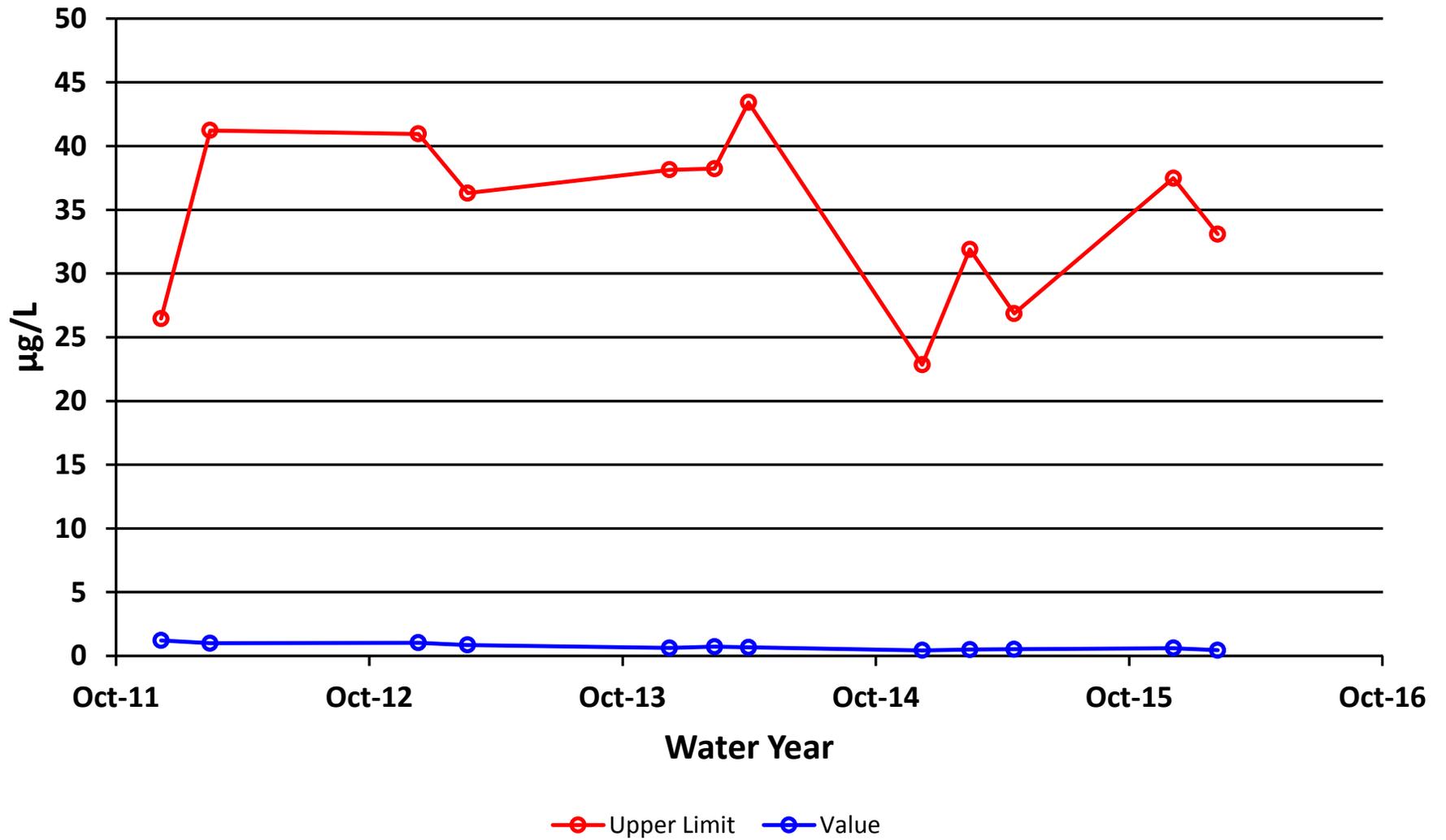


# Site 6 - Copper Dissolved

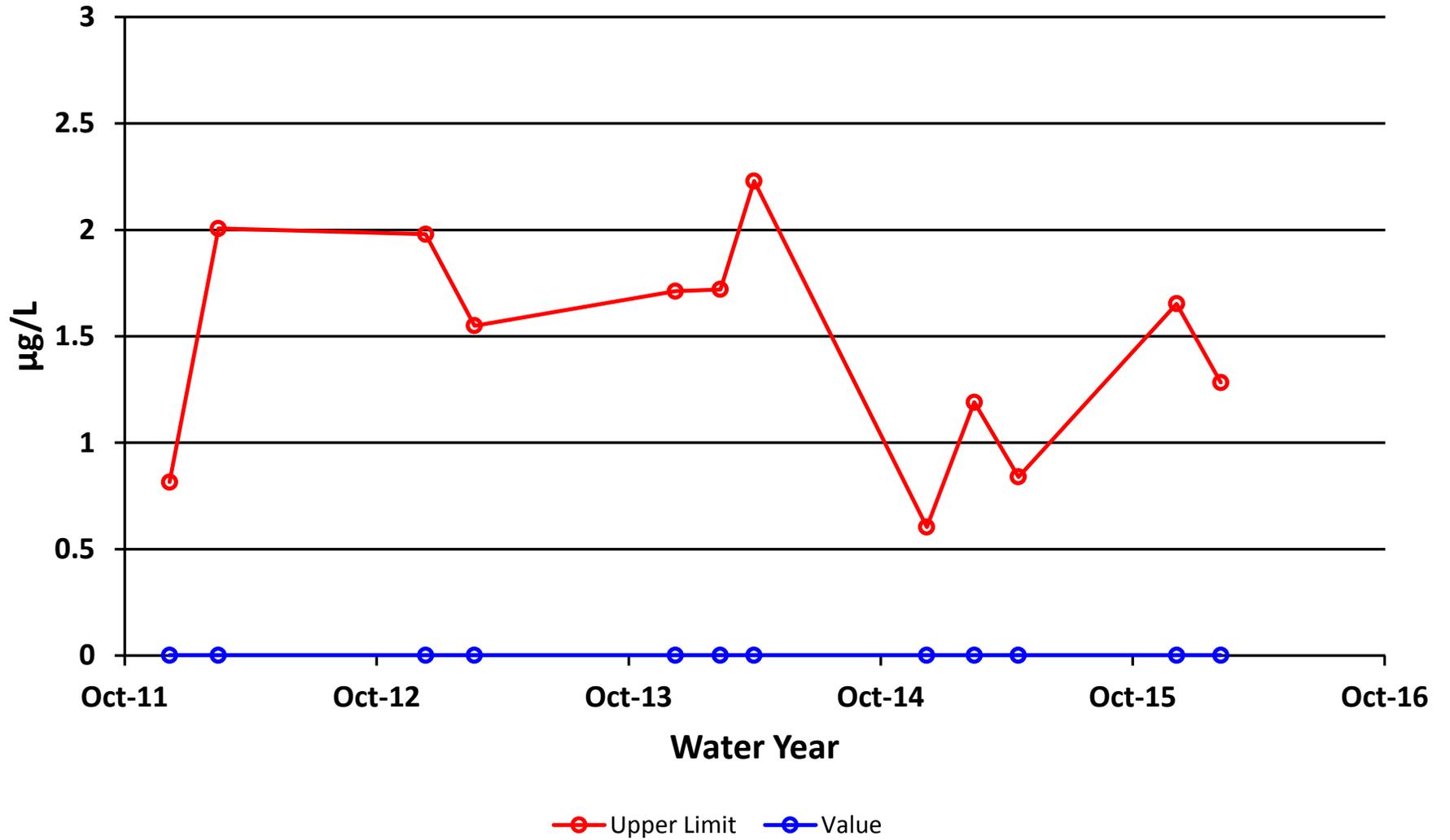




## Site 6 - Nickel Dissolved

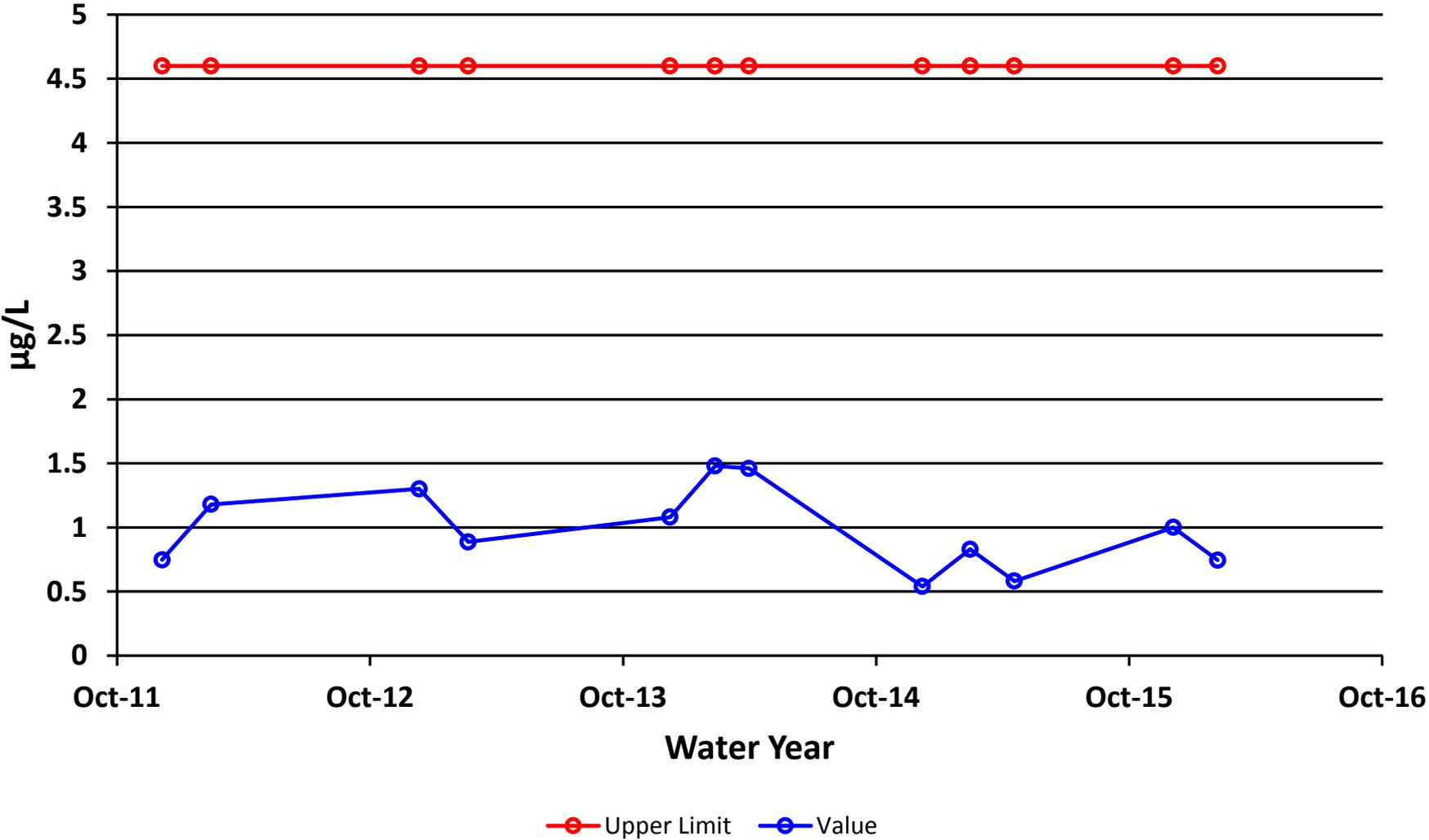


### Site 6 - Silver Dissolved





# Site 6 - Selenium Dissolved





**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Specific Conductance, Field ( $\mu\text{S}/\text{cm}$ )**

Site	<b>X</b>	<b>Y</b>	Differences		
	#48	#6	<b>D</b>	<b> D </b>	<b>Rank</b>
Year	WY2016	WY2016			
Oct	89.70	92.30	-2.60	2.60	-2
Nov	134.10	142.50	-8.40	8.40	-11
Dec	129.60	133.80	-4.20	4.20	-4
Jan	114.00	126.50	-12.50	12.50	-12
Feb	111.30	118.20	-6.90	6.90	-9
Mar	141.30	148.70	-7.40	7.40	-10
Apr	77.40	78.80	-1.40	1.40	-1
May	95.50	100.00	-4.50	4.50	-6
Jun	81.30	85.60	-4.30	4.30	-5
Jul	118.80	124.10	-5.30	5.30	-7
Aug	130.10	136.70	-6.60	6.60	-8
Sep	117.80	121.00	-3.20	3.20	-3
Median	115.90	122.55	-4.90	4.90	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
 **$\Sigma R= -78$**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **pH, Field, Standard Units**

Site	<b>X</b>	<b>Y</b>	Differences		
	#48	#6	<b>D</b>	<b> D </b>	<b>Rank</b>
Year	WY2016	WY2016			
Oct	7.86	7.83	0.03	0.03	7
Nov	7.46	7.51	-0.05	0.05	-10
Dec	7.82	7.83	-0.01	0.01	-1
Jan	7.84	7.81	0.03	0.03	7
Feb	7.67	7.70	-0.03	0.03	-9
Mar	7.82	7.79	0.03	0.03	7
Apr	7.84	7.86	-0.02	0.02	-5
May	7.91	7.89	0.02	0.02	3
Jun	7.87	7.79	0.08	0.08	12
Jul	8.01	8.03	-0.02	0.02	-3
Aug	8.00	7.94	0.06	0.06	11
Sep	7.98	7.96	0.02	0.02	3
Median	7.85	7.83	0.02	0.03	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= 22**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>28</b>
p-test
0.212

$H_0$	median [D]=0	ACCEPT
$H_1$	median [D]<0	

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Total Alk, (mg/l)**

**X                  Y**

Site	#48	#6	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	35.20	35.60	-0.40	0.40	-4
Nov	47.80	48.90	-1.10	1.10	-7
Dec	49.10	49.40	-0.30	0.30	-2.5
Jan	42.90	45.40	-2.50	2.50	-12
Feb	42.60	44.10	-1.50	1.50	-9
Mar	51.50	51.80	-0.30	0.30	-2.5
Apr	30.80	31.50	-0.70	0.70	-5.5
May	41.20	43.10	-1.90	1.90	-11
Jun	35.90	37.20	-1.30	1.30	-8
Jul	49.20	49.90	-0.70	0.70	-5.5
Aug	49.80	51.40	-1.60	1.60	-10
Sep	48.20	48.40	-0.20	0.20	-1
Median	45.35	46.90	-0.90	0.90	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= -78**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Sulfate, Total (mg/l)**

**X Y**

Site	#48	#6	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	7.7	8.6	-1.0	1.0	-6
Nov	14.4	17.0	-2.6	2.6	-9
Dec	15.7	19.2	-3.5	3.5	-12
Jan	15.2	18.6	-3.4	3.4	-11
Feb	13.0	15.1	-2.1	2.1	-8
Mar	17.0	19.7	-2.7	2.7	-10
Apr	7.5	8.0	-0.6	0.6	-1
May	9.4	10.1	-0.7	0.7	-2
Jun	7.1	8.7	-1.6	1.6	-7
Jul	13.7	14.6	-0.9	0.9	-4.5
Aug	14.3	15.2	-0.9	0.9	-4.5
Sep	11.2	11.9	-0.7	0.7	-3
Median	13.4	14.9	-1.3	1.3	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= -78**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Zinc, Dissolved (ug/l)**

**X                    Y**

Site	#48	#6	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	7.93	8.26	-0.33	0.33	-1
Nov	4.71	10.80	-6.09	6.09	-12
Dec	5.41	11.00	-5.59	5.59	-10
Jan	4.22	9.32	-5.10	5.10	-9
Feb	4.43	10.40	-5.97	5.97	-11
Mar	3.21	7.48	-4.27	4.27	-8
Apr	2.46	4.68	-2.22	2.22	-6
May	2.48	4.38	-1.90	1.90	-5
Jun	1.92	3.77	-1.85	1.85	-4
Jul	1.72	3.03	-1.31	1.31	-2
Aug	1.63	3.19	-1.56	1.56	-3
Sep	1.75	4.14	-2.39	2.39	-7
Median	2.85	6.08	-2.31	2.31	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= -78**

<b>α</b>
0.05
<b>W'<sub>α,n</sub></b>
17

<b>W<sup>+</sup><sub>=</sub></b>
<b>0</b>
<b>p-test</b>
0.000

H <sub>0</sub>	median [D]=0	<b>REJECT</b>
H <sub>1</sub>	median [D]<0	<b>ACCEPT</b>

# INTERPRETIVE REPORT

## SITE 54

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses with the exception of the outliers shown in the table below. During the current year no new data points were flagged as outliers after review by HGCMC.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeded these criteria.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. There were no visually obvious trends.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.57			
pH Field	6	1.00	+	0.05	0.6
Alkalinity, Total	6	0.81			
Sulfate, Total	6	0.05			
Zinc, Dissolved	6	0.02	-	-0.18	-2.7

\* Number of Years \*\* Significance level

Field pH had a statistically significant ( $p = 1$ ) trend with a slope estimate of 0.05 su/yr or 0.6% increase. However given the low magnitude and similar trend noted at Site 6 and Site 48, HGCMC does not believe that this is a significant indication of changes in water chemistry at Site 54.

A comparison of median values for total alkalinity, field pH, field conductivity, total sulfate, and dissolved zinc between Site 54 and Site 6 has been conducted as specified in the Statistical Information Goals for Site 54. Additionally, X-Y plots have been generated for total alkalinity, field pH, specific conductance, total sulfate, and dissolved zinc that co-plot data from Site 54 and Site 6, the upstream control site, to aid in the comparison between those sites. Calculation details of the non-parametric signed-rank tests are presented in detail on the pages following this interpretive section. The table below summarizes the results of the signed-rank test as performed on the Water Year 2016 dataset.

**Table of Summary Statistics for Median Analysis**

Site 54 vs Site 6				
Parameter	Signed Ranks	Site 6	Site 54	Median
	p-value	median	median	Differences
Conductivity Field	<0.01	122.6	124.2	-1.3
pH Field	0.055	7.83	7.82	0
Alkalinity, Total	<0.01	46.9	48.7	-1.1
Sulfate, Total	0.483	14.9	14.8	-0.10
Zinc, Dissolved	<0.01	6.08	5.77	0.32

The significant difference in specific conductivity is similar in magnitude and direction as observed for WY2002 – WY2015. In general, the trend in conductivity is similar to differences measured between Site 48 and Site 6, although of a smaller magnitude. HGCMC feels the current FWMP program is adequate to measure and quantify future changes that may occur between Site 6 and Site 54, given the small magnitude of the differences and the consistency of the variations over the past several years.

## Table of Results for Water Year 2016

### Site 054FMS - 'Greens Creek Below D-Pond'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)	6.1	1.9	2.9	1.9	2.6	2.1	7.7	4.5	5.7	10.5	11.3	8.5	5.1
Conductivity-Field(µmho)	93.6	143.7	138.1	130	119.5	150	78.4	101.6	85.8	125.4	138.2	122.9	124.2
Conductivity-Lab (µmho)	78	117	85	106	122	147	67	96	87	128	135	124	112
pH Lab (standard units)	7.65	7.39	7.63	7.64	7.8	7.81	7.52	7.83	7.64	7.59	7.67	7.66	7.65
pH Field (standard units)	7.82	7.51	7.8	7.81	7.7	7.8	7.86	7.9	7.48	7.98	7.93	7.91	7.82
Total Alkalinity (mg/L)	35.8	50.4	51.4	47.8	44.2	53.2	31.8	43.2	36.6	50.9	53	49.6	48.7
Total Sulfate (mg/L)	8.5	16.1	17.6	19	15.6	19.7	8.1	10.2	8.9	14	15.5	12	14.8
Hardness (mg/L)	44.2	65.6	70	64.2	60	70	39.3	47.6	40.6	60.3	61.8	59.1	60.2
Dissolved As (ug/L)	0.189	0.17	0.21	0.21	0.182	0.172	0.189	0.185	0.204	0.204	0.231	0.237	0.197
Dissolved Ba (ug/L)	23.5		28.6		23.4								23.5
Dissolved Cd (ug/L)	0.0537	0.0568	0.0595	0.0485	0.0546	0.0438	0.0336	0.0387	0.0309	0.0381	0.0377	0.0371	0.0413
Dissolved Cr (ug/L)	0.076		0.103		0.105								0.103
Dissolved Cu (ug/L)	0.754	0.544	0.491	0.531	0.702	0.383	0.588	0.376	0.278	0.267	0.363	0.477	0.484
Dissolved Pb (ug/L)	0.0285	0.0128	0.013	0.0302	0.0188	0.0065	0.0213	0.0065	0.0049	0.0059	0.0113	0.0098	0.0121
Dissolved Ni (ug/L)	0.572		0.642		0.428								0.572
Dissolved Ag (ug/L)	0.002		0.002		0.002								0.002
Dissolved Zn (ug/L)	7.84	9.8	10.5	8.62	9.62	7.08	4.46	4.21	3.75	3.19	3.32	3.9	5.77
Dissolved Se (ug/L)	0.573		0.96		0.759								0.759
Dissolved Hg (ug/L)	0.00188	0.000953	0.000885	0.00119	0.00165	0.000674	0.00154	0.000746	0.000476	0.00039	0.000579	0.000794	0.000840

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

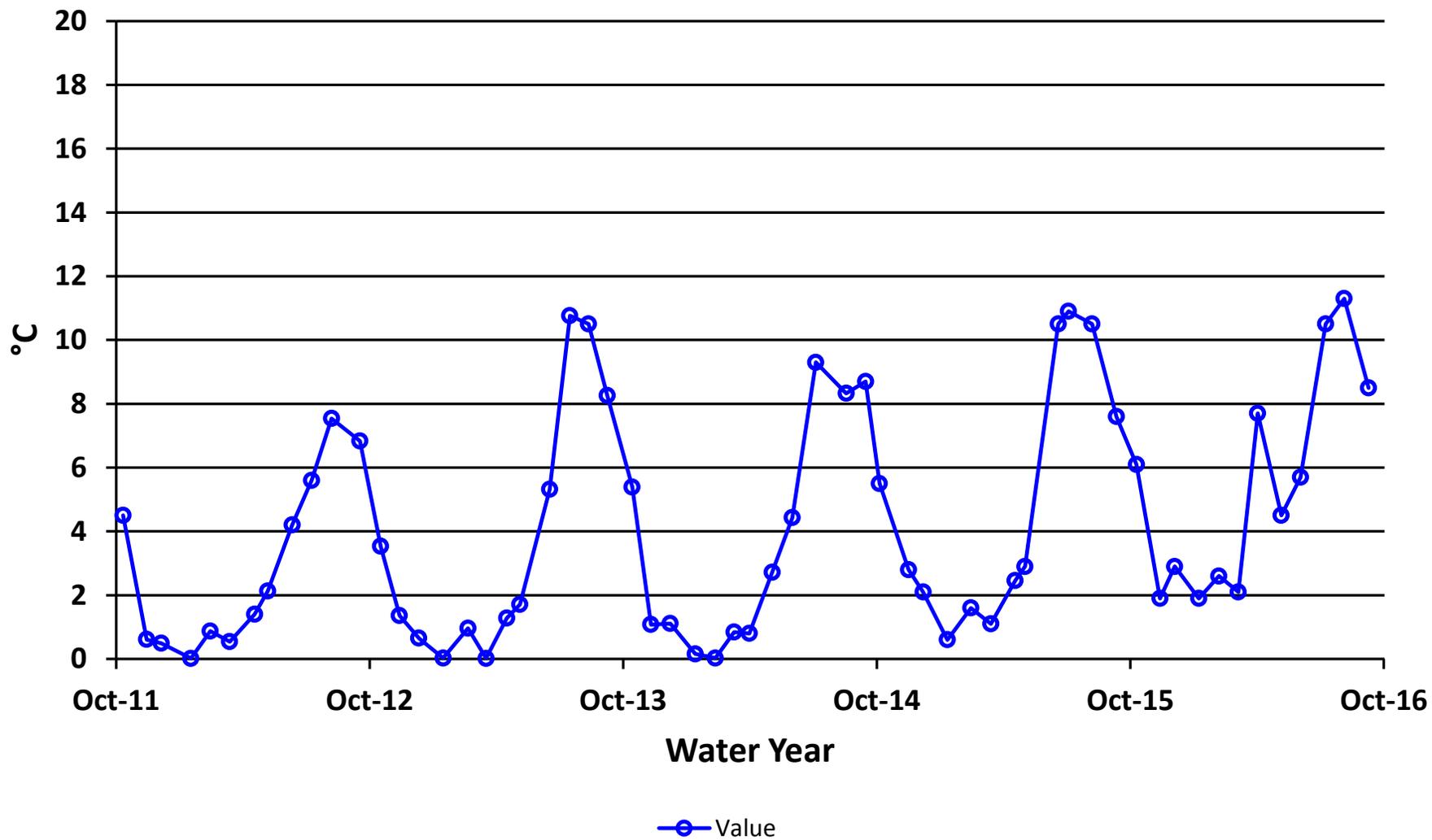
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

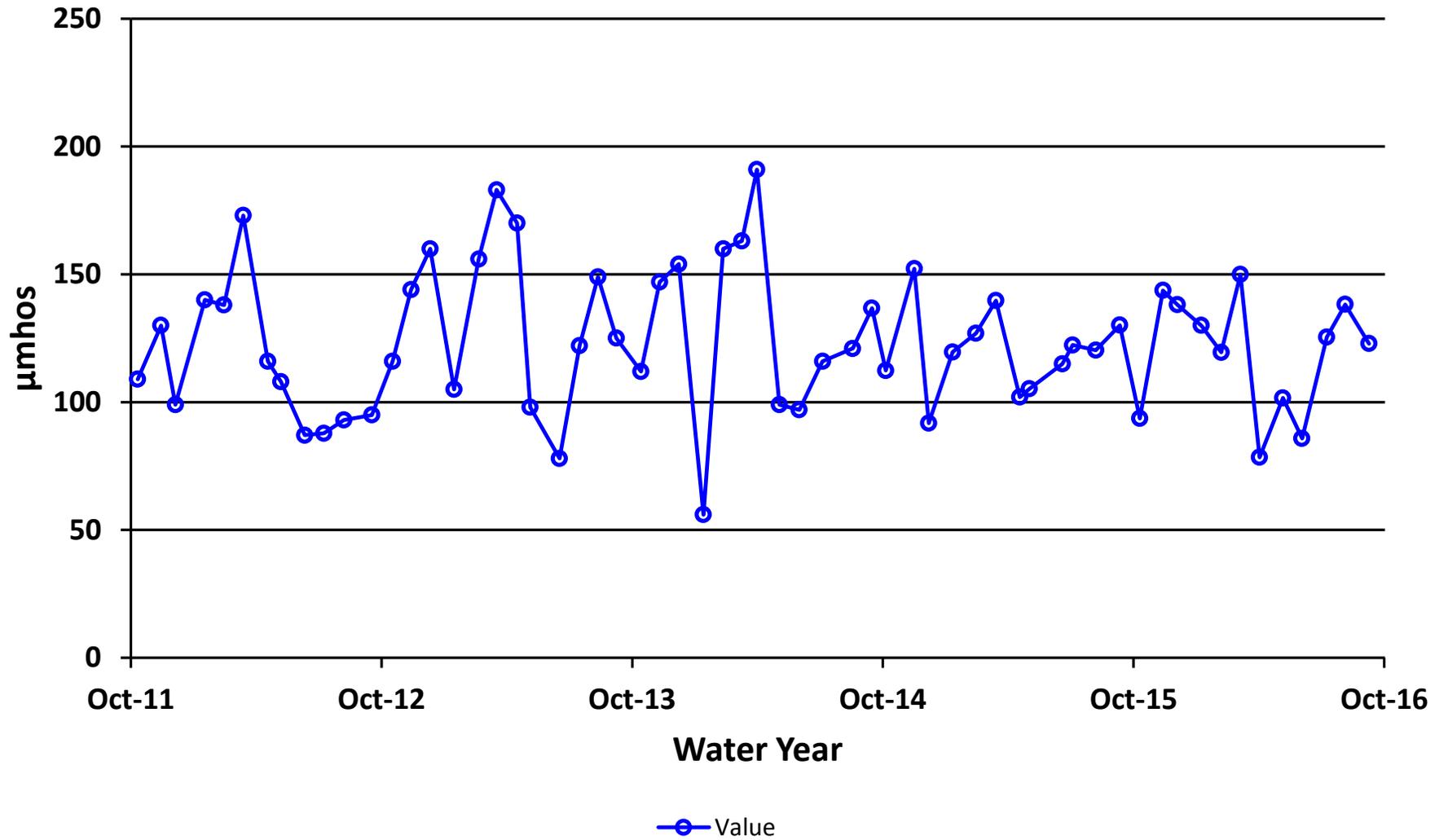
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
054FMS	10/13/2015	12:00 PM	Diss. Cr-ICP/MS	0.07	µg/L	J	Below Quantitative Range
	12/7/2015	12:00 PM	Diss. Cr-ICP/MS	0.1	µg/L	J	Below Quantitative Range
	1/11/2016	12:00 PM	Diss. Hg-CVAF	0.00119	µg/L	U	Field Blank Contamination
	2/9/2016	12:00 PM	Diss. Cr-ICP/MS	0.1	µg/L	J	Below Quantitative Range
	3/8/2016	12:00 PM	Diss. Hg-CVAF	0.000674	µg/L	U	Field Blank Contamination
			Diss. Pb-ICP/MS	0.00653	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Pb-ICP/MS	0.0065	µg/L	J	Below Quantitative Range
	6/6/2016	12:00 PM	Diss. Pb-ICP/MS	0.00491	µg/L	J	Below Quantitative Range
	7/12/2016	12:00 PM	Diss. Pb-ICP/MS	0.00589	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Sulfate	15.5	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Sulfate	12	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

# Site 54 - Water Temperature

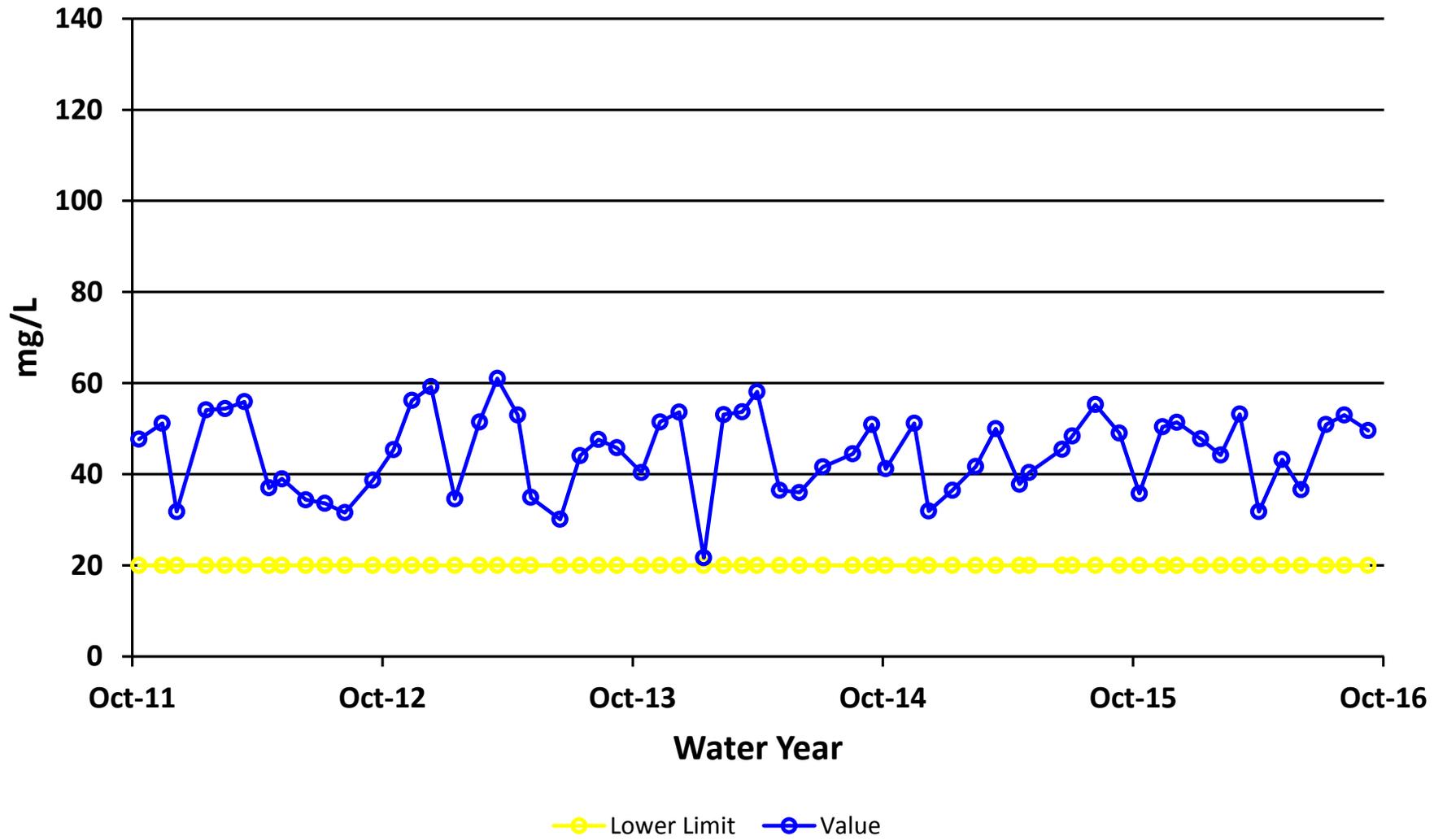


# Site 54 - Conductivity Field



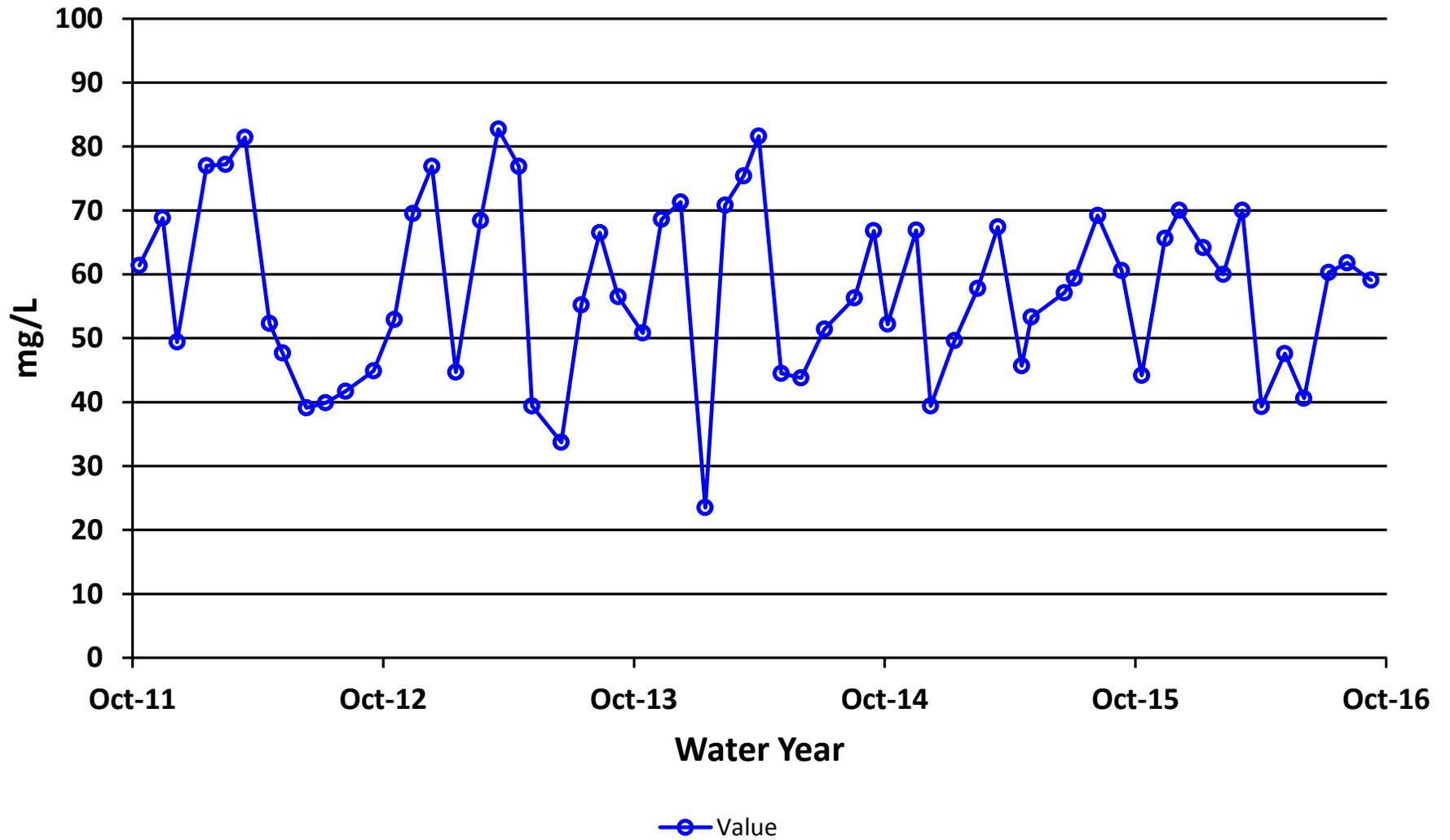


# Site 54 - Alkalinity

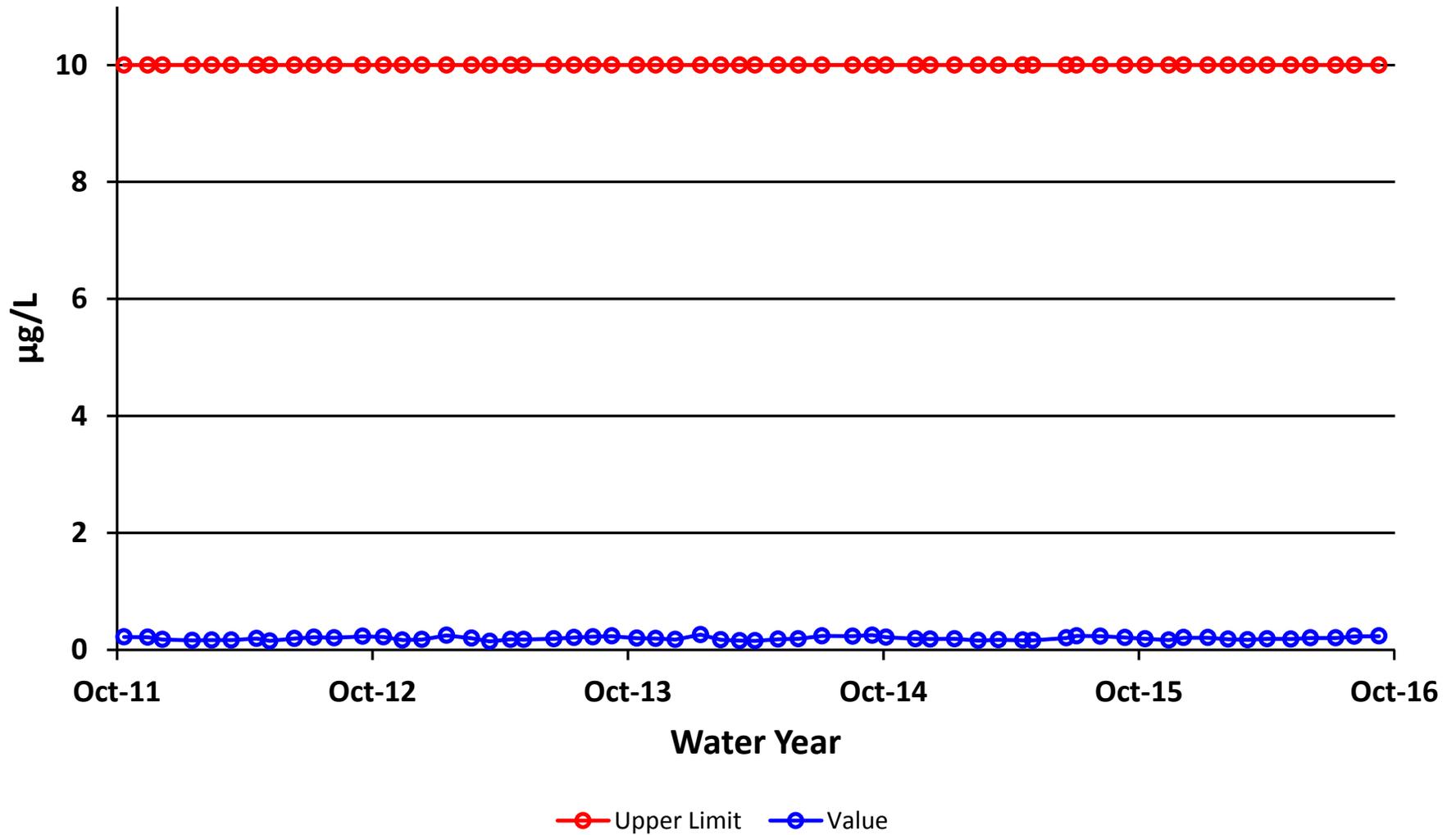




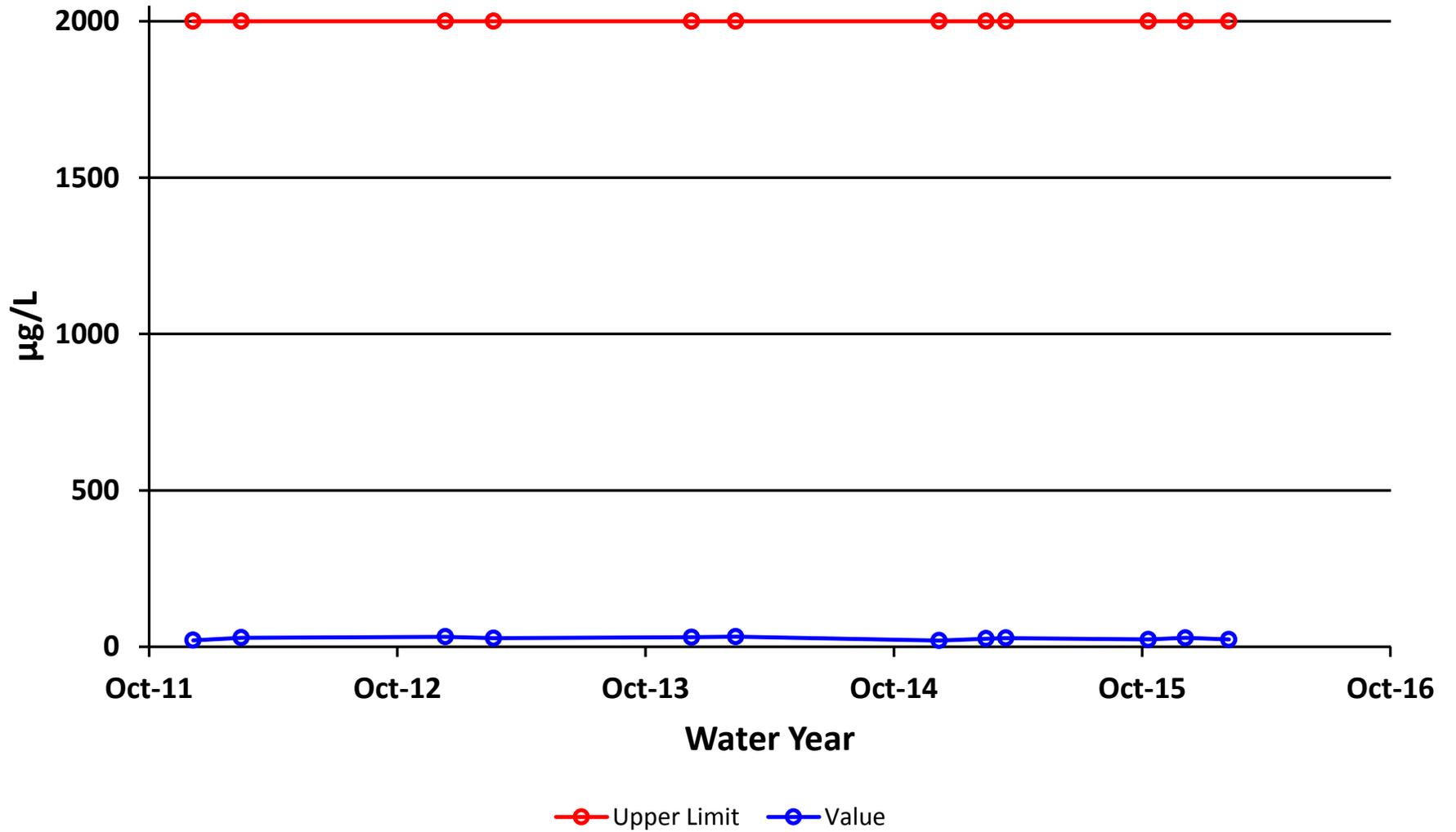
# Site 54 - Hardness



# Site 54 - Arsenic Dissolved

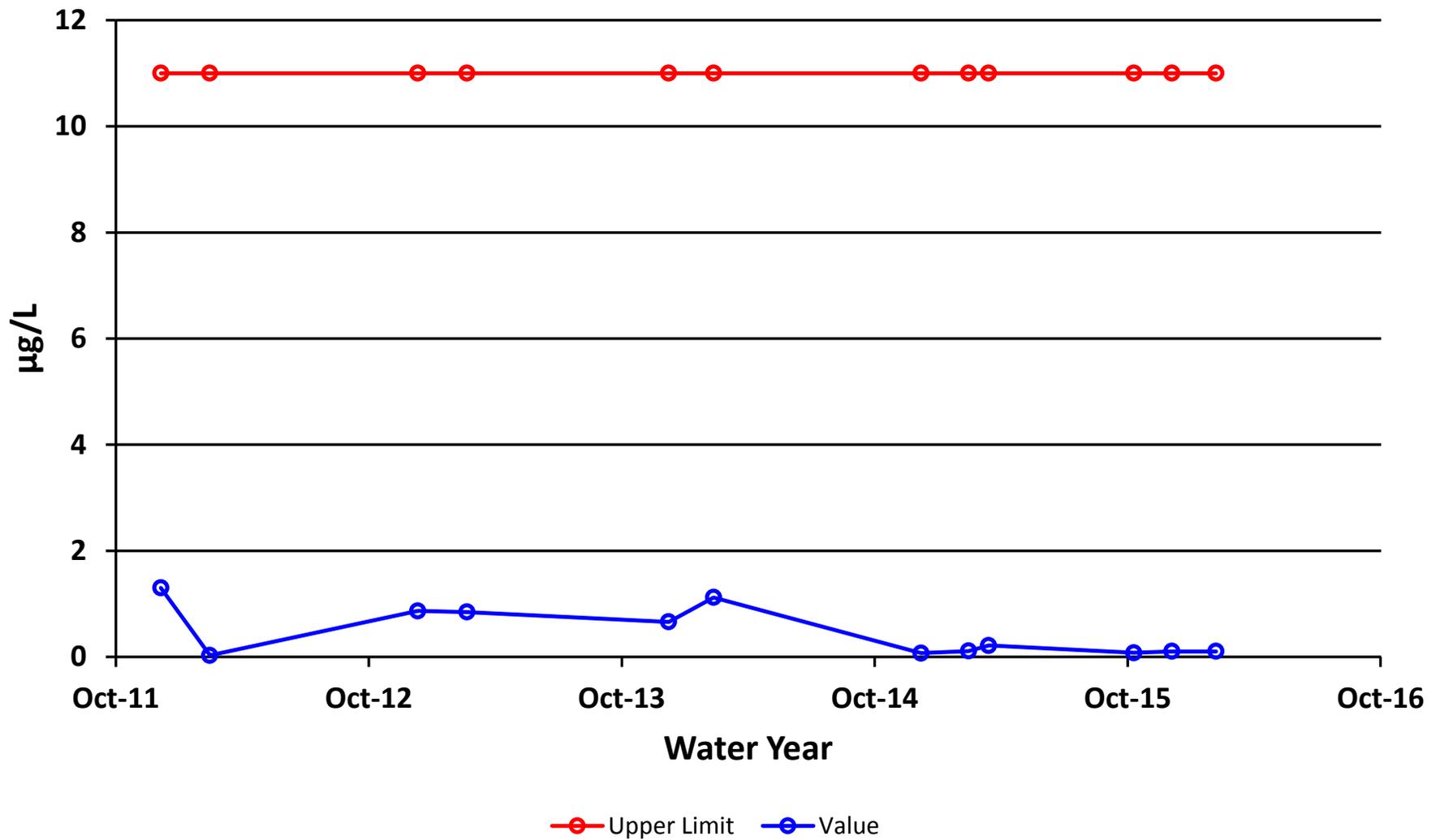


# Site 54 - Barium Dissolved

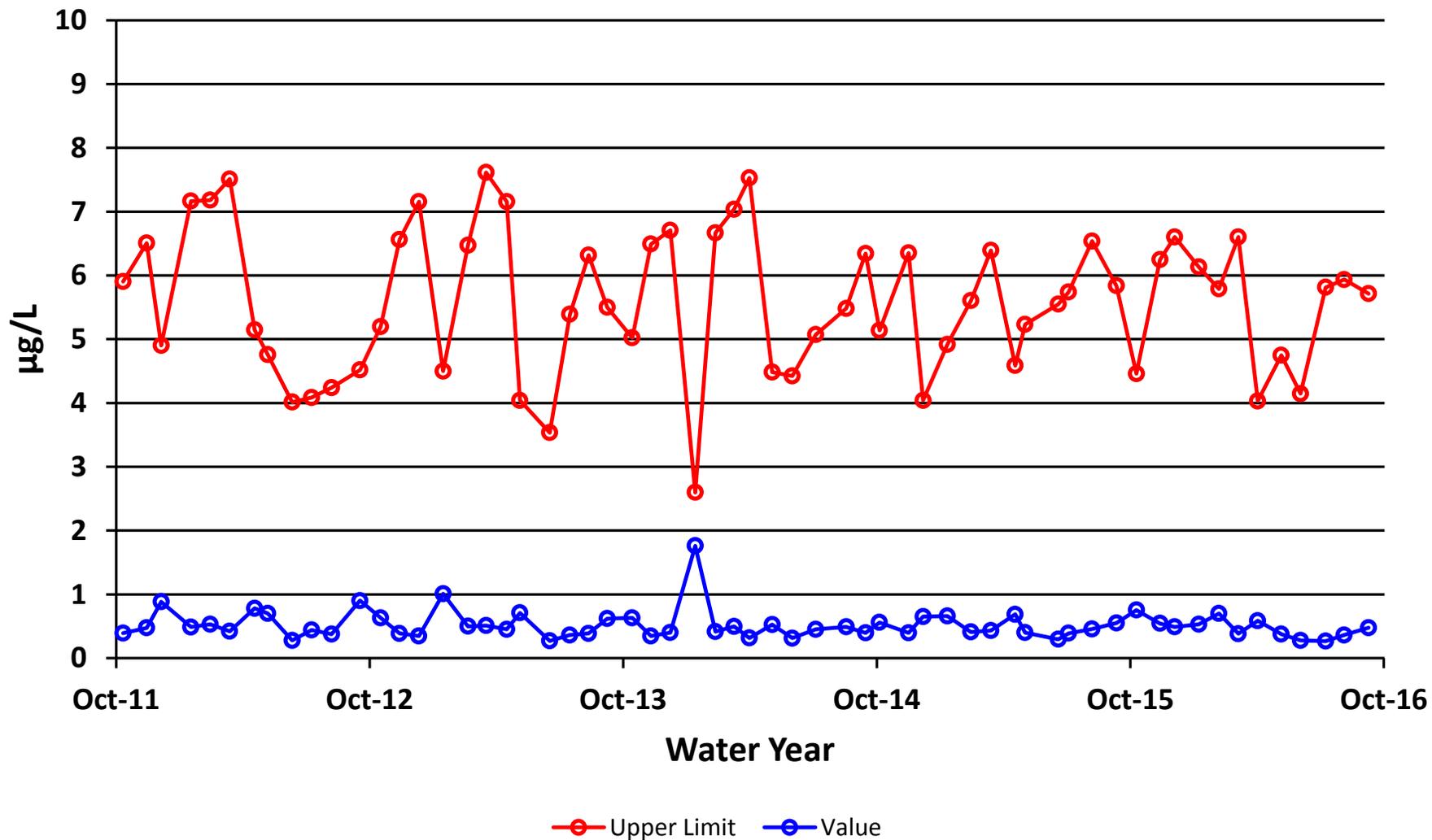




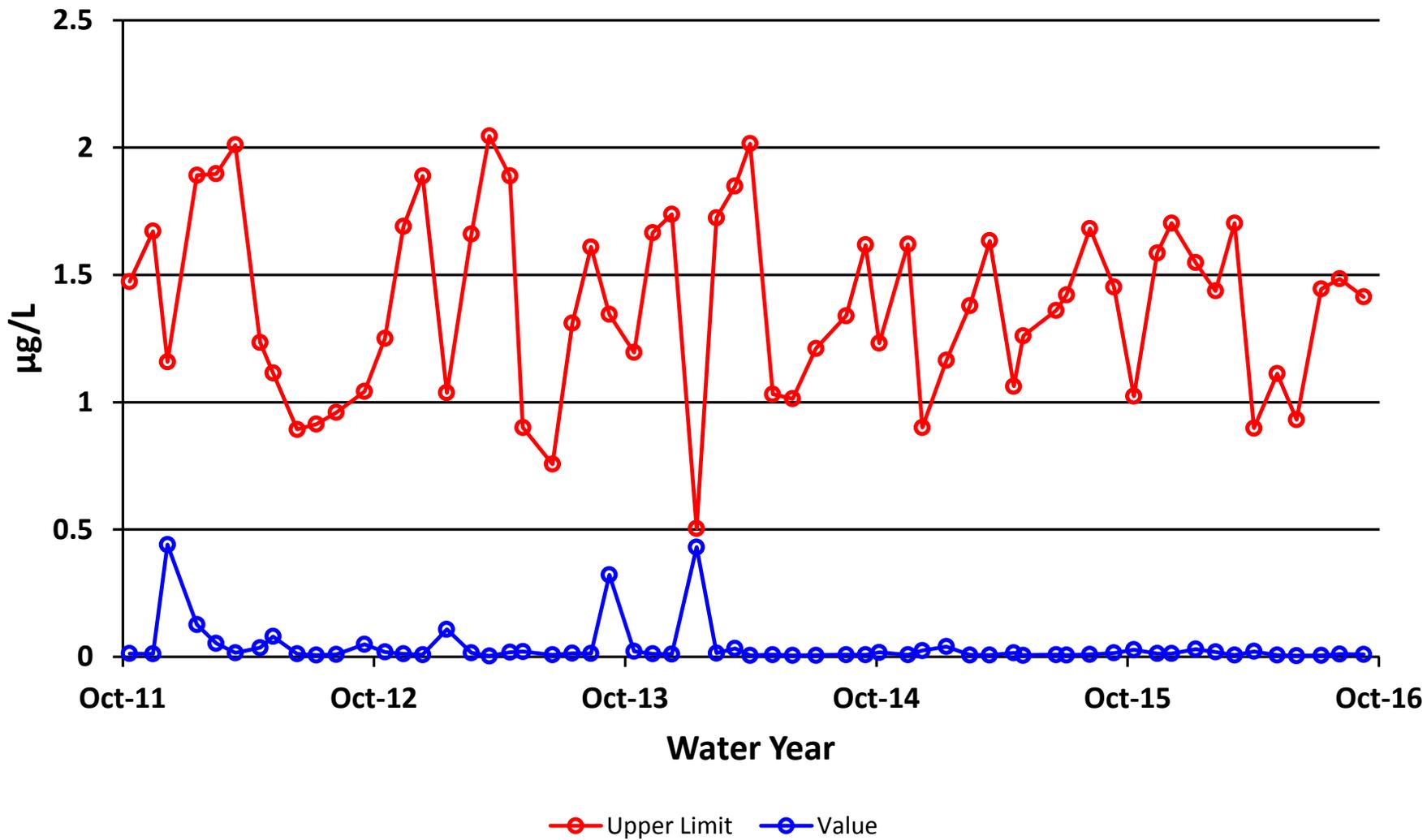
# Site 54 - Chromium Dissolved



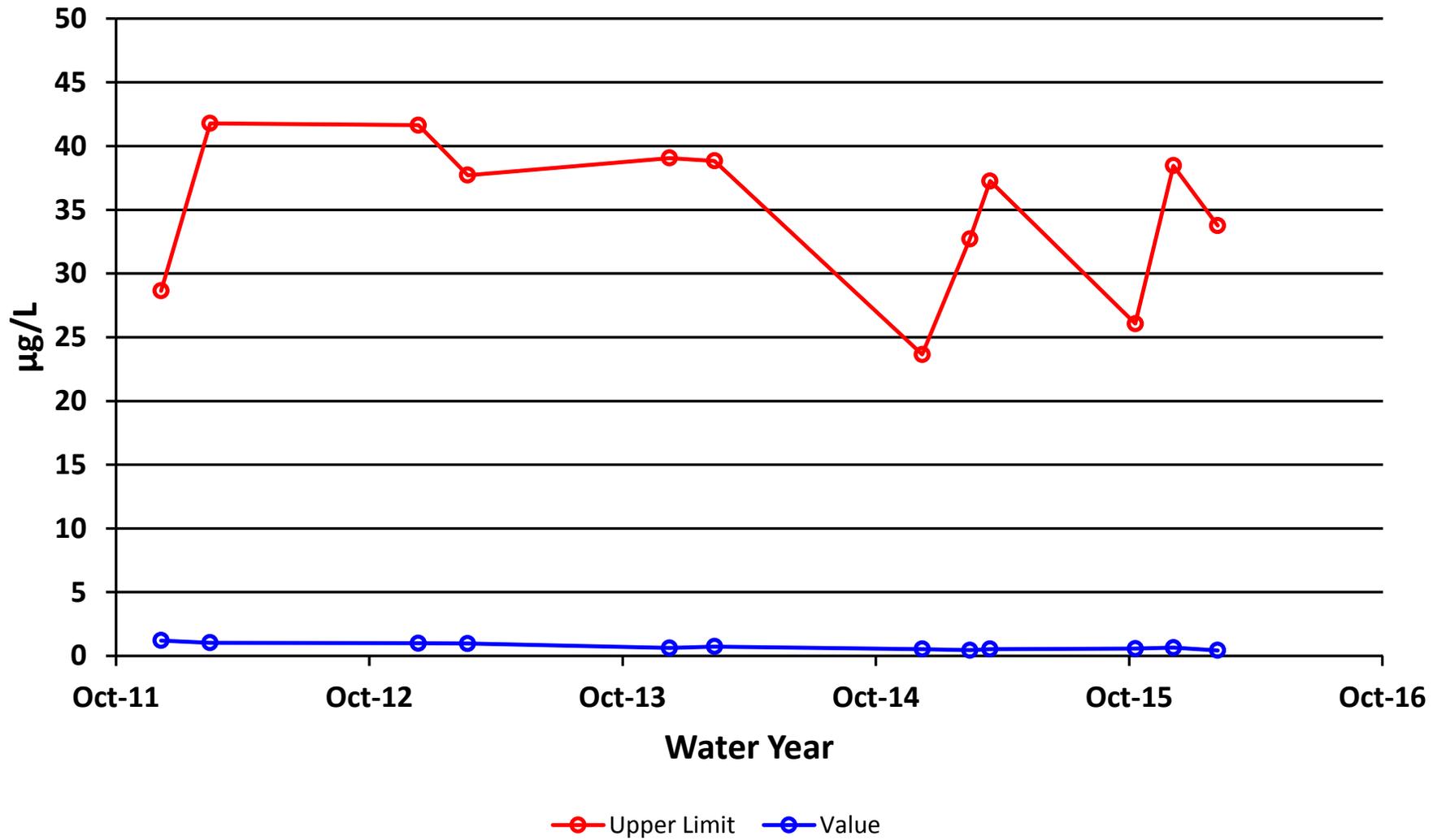
# Site 54 - Copper Dissolved



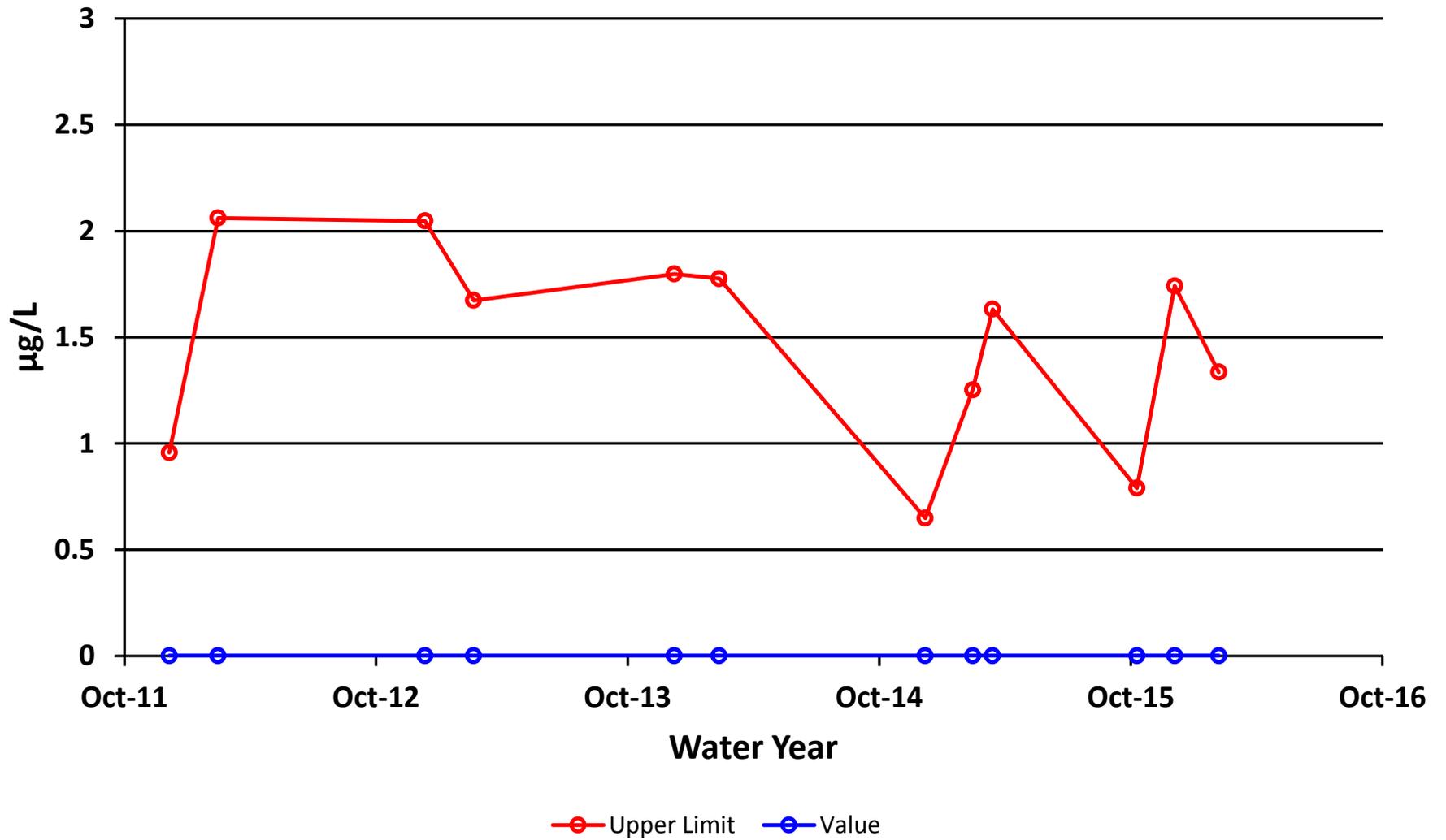
# Site 54 - Lead Dissolved



# Site 54 - Nickel Dissolved

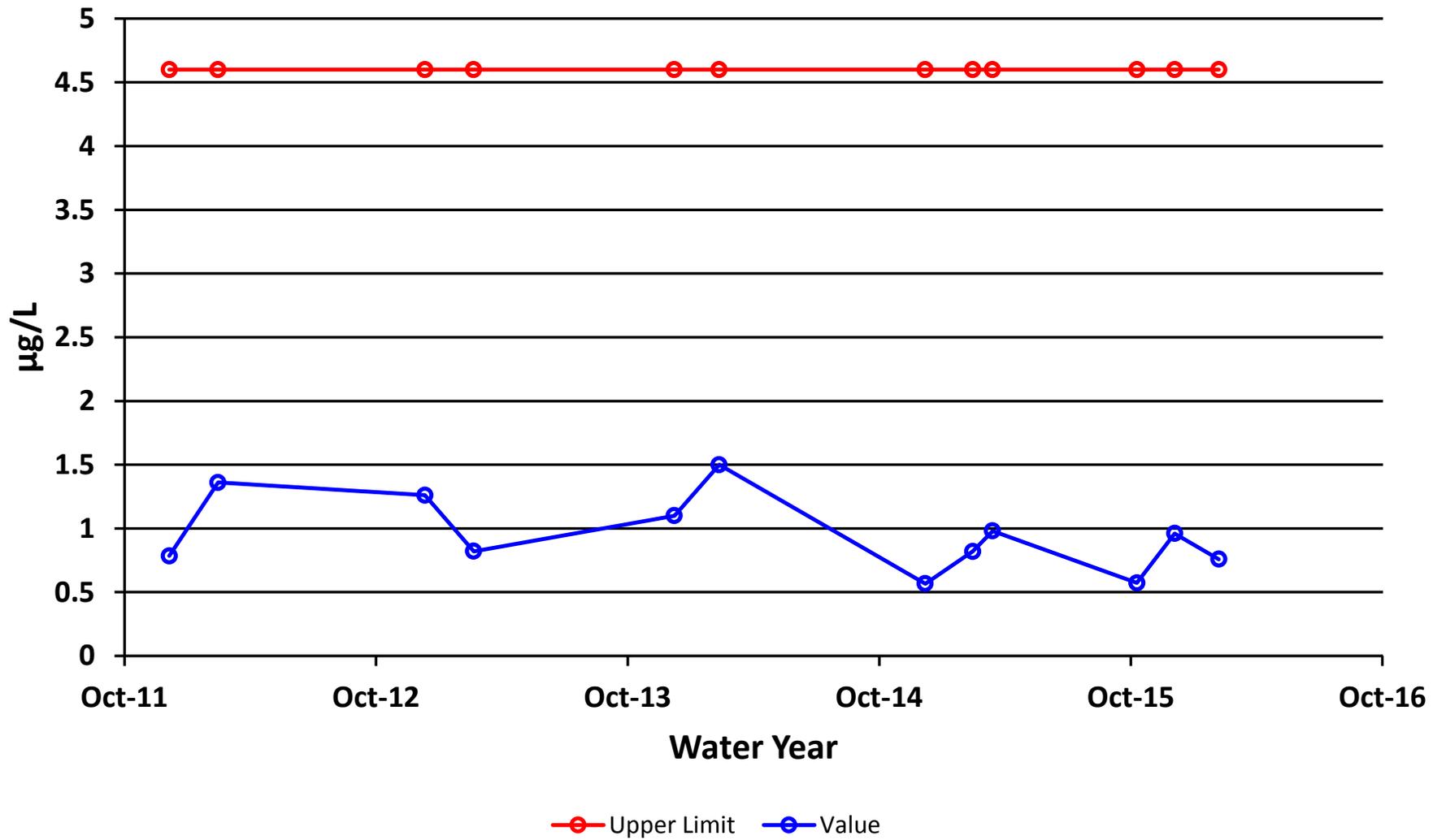


# Site 54 - Silver Dissolved





# Site 54 - Selenium Dissolved





**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Specific Conductance, Field ( $\mu\text{S}/\text{cm}$ )**

Site	<b>X</b>	<b>Y</b>	Differences		
	#6	#54	<b>D</b>	<b> D </b>	<b>Rank</b>
Year	WY2016	WY2016			
Oct	92.30	93.60	-1.30	1.30	-4.5
Nov	142.50	143.70	-1.20	1.20	-3
Dec	133.80	138.10	-4.30	4.30	-12
Jan	126.50	130.00	-3.50	3.50	-11
Feb	118.20	119.50	-1.30	1.30	-4.5
Mar	148.70	150.00	-1.30	1.30	-6.5
Apr	78.80	78.40	0.40	0.40	2
May	100.00	101.60	-1.60	1.60	-9
Jun	85.60	85.80	-0.20	0.20	-1
Jul	124.10	125.40	-1.30	1.30	-6.5
Aug	136.70	138.20	-1.50	1.50	-8
Sep	121.00	122.90	-1.90	1.90	-10
Median	122.55	124.15	-1.30	1.30	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
 **$\Sigma R = -74$**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>2</b>
p-test
0.001

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **pH, Field, Standard Units**

**X                  Y**

Site	#6	#54	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	7.83	7.82	0.01	0.01	1
Nov	7.51	7.51	0.00		
Dec	7.83	7.80	0.03	0.03	5
Jan	7.81	7.81	0.00		
Feb	7.70	7.70	0.00		
Mar	7.79	7.80	-0.01	0.01	-2.5
Apr	7.86	7.86	0.00		
May	7.89	7.90	-0.01	0.01	-4
Jun	7.79	7.48	0.31	0.31	8
Jul	8.03	7.98	0.05	0.05	6.5
Aug	7.94	7.93	0.01	0.01	2.5
Sep	7.96	7.91	0.05	0.05	6.5
Median	7.83	7.82	0.00	0.02	

<b>n</b>	<b>m</b>
12	8

**N= 8**  
**ΣR= 23**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
5

$W^+_{=}$
<b>6.5</b>
p-test
0.055

$H_0$	median [D]=0	ACCEPT
$H_1$	median [D]<0	

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Total Alk, (mg/l)**

Site	<b>X</b>	<b>Y</b>	Differences		
	#6	#54	<b>D</b>	<b> D </b>	<b>Rank</b>
Year	WY2016	WY2016			
Oct	35.60	35.80	-0.20	0.20	-3
Nov	48.90	50.40	-1.50	1.50	-9
Dec	49.40	51.40	-2.00	2.00	-11
Jan	45.40	47.80	-2.40	2.40	-12
Feb	44.10	44.20	-0.10	0.10	-1.5
Mar	51.80	53.20	-1.40	1.40	-8
Apr	31.50	31.80	-0.30	0.30	-4
May	43.10	43.20	-0.10	0.10	-1.5
Jun	37.20	36.60	0.60	0.60	5
Jul	49.90	50.90	-1.00	1.00	-6
Aug	51.40	53.00	-1.60	1.60	-10
Sep	48.40	49.60	-1.20	1.20	-7
Median	46.90	48.70	-1.10	1.10	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= -68**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>5</b>
p-test
0.002

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Sulfate, Total (mg/l)**

Site	<b>X</b>	<b>Y</b>	Differences		
	#6	#54	<b>D</b>	<b> D </b>	<b>Rank</b>
Year	WY2016	WY2016			
Oct	8.6	8.5	0.1	0.1	4
Nov	17.0	16.1	0.9	0.9	10
Dec	19.2	17.6	1.6	1.6	11
Jan	18.6	19.0	-0.4	0.4	-7
Feb	15.1	15.6	-0.5	0.5	-8
Mar	19.7	19.7	0.0		
Apr	8.0	8.1	0.0	0.0	-1
May	10.1	10.2	-0.1	0.1	-2.5
Jun	8.7	8.9	-0.3	0.3	-5
Jul	14.6	14.0	0.6	0.6	9
Aug	15.2	15.5	-0.3	0.3	-6
Sep	11.9	12.0	-0.1	0.1	-2.5
Median	14.9	14.8	-0.1	0.3	

<b>n</b>	<b>m</b>
12	11

**N= 11**  
**ΣR= 2**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
13

$W^+_{=}$
<b>32</b>
p-test
0.483

$H_0$	median [D]=0	ACCEPT
$H_1$	median [D]<0	

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Zinc, Dissolved (ug/l)**

**X                      Y**

Site	#6	#54	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	8.26	7.84	0.42	0.42	8
Nov	10.80	9.80	1.00	1.00	12
Dec	11.00	10.50	0.50	0.50	9
Jan	9.32	8.62	0.70	0.70	10
Feb	10.40	9.62	0.78	0.78	11
Mar	7.48	7.08	0.40	0.40	7
Apr	4.68	4.46	0.22	0.22	5
May	4.38	4.21	0.17	0.17	4
Jun	3.77	3.75	0.02	0.02	1
Jul	3.03	3.19	-0.16	0.16	-3
Aug	3.19	3.32	-0.13	0.13	-2
Sep	4.14	3.90	0.24	0.24	6
Median	6.08	5.77	0.32	0.32	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= 68**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>5</b>
p-test
0.002

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

## INTERPRETIVE REPORT

### SITE 62

Sampling at this site was initiated during the spring of the Water Year 2013. Site 62 is located approximately 1,000 feet downstream from Site 54, and therefore is downstream of Site 23 and Inactive Site D. Sampling is on a monthly basis in conjunction with the other routine monthly sampling along Greens Creek.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past year is included in the report. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeded these criteria.

#### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Because of the limited amount of data, visual trend analysis and statistical analysis of the data was not performed.

A comparison of median values for total alkalinity, field pH, field conductivity, total sulfate, and dissolved zinc between Site 62 and Site 54 has been conducted. Additionally, X-Y plots have been generated for total alkalinity, field pH, specific conductance, total sulfate, and dissolved zinc that co-plot data from Site 62 and Site 54, the upstream control site, to aid in the comparison between those sites. Calculation details of the non-parametric signed-rank tests are presented in detail on the pages following this interpretive section. The table below summarizes the results of the signed-rank test as performed on the Water Year 2016 dataset.

**Table of Summary Statistics for Median Analysis**

<b>Site 62 vs Site 54</b>				
<b>Parameter</b>	<b>Signed Ranks p-value</b>	<b>Site 54 median</b>	<b>Site 62 median</b>	<b>Median Differences</b>
Conductivity Field	<0.01	124.2	131.0	-7.5
pH Field	<0.01	7.82	7.75	0.05
Alkalinity, Total	<0.01	48.7	51.8	-3.0
Sulfate, Total	<0.01	14.8	16.3	-1.0
Zinc, Dissolved	0.515	5.77	5.71	0.1

Three of the five parameters compared between Site 54 and Site 62 had statistically significant median differences. Similar results to these were obtained when comparing other paired (48-6 and 6-54) sites along Greens Creek. HGCMC feels the current FWMP program is adequate to measure and quantify future changes that may occur between Site 54 and Site 62.

## Table of Results for Water Year 2016

### Site 062FMS - 'Greens Creek Below Site 54'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)	6	1.9	3.0	2.1	2.6	2	7.7	4.2	5.7	10.7	11	8.5	5.0
Conductivity-Field(µmho)	101.3	156	148.3	136.8	127.5	161.8	85.2	106.8	88.1	132.6	146.5	129.3	131.0
Conductivity-Lab (µmho)	84	124	96	116	131	157	72	100	89	134	142	130	120
pH Lab (standard units)	7.67	7.79	7.73	7.74	7.69	7.81	7.48	7.64	7.54	7.56	7.49	7.64	7.66
pH Field (standard units)	7.63	7.04	7.76	7.76	7.47	7.74	7.88	7.49	7.45	8.01	7.77	7.91	7.75
Total Alkalinity (mg/L)	38.8	53.3	56	51.6	47.5	56.5	34.2	44	40.2	53.5	55.3	52	51.8
Total Sulfate (mg/L)	9.8	17.6	18.5	19.9	16.5	21.1	9	10.2	9.2	16.1	16.7	13	16.3
Hardness (mg/L)	47.5	70.9	75.2	70.2	63.5	75.2	42.3	49.7	42.5	63.5	66.7	62.6	63.5
Dissolved As (ug/L)	0.192	0.187	0.194	0.205	0.184	0.162	0.19	0.186	0.216	0.21	0.206	0.225	0.193
Dissolved Ba (ug/L)			29.2		24.8								27.0
Dissolved Cd (ug/L)	0.0548	0.0588	0.0612	0.0487	0.0554	0.0465	0.0341	0.039	0.033	0.0409	0.0406	0.041	0.0438
Dissolved Cr (ug/L)			0.158		0.112								0.135
Dissolved Cu (ug/L)	1.08	0.52	0.468	0.473	0.649	0.371	0.567	0.363	0.255	0.264	0.336	0.475	0.471
Dissolved Pb (ug/L)	0.0313	0.0133	0.0133	0.0297	0.0191	0.0086	0.0202	0.0076	0.0058	0.0082	0.0082	0.0098	0.0116
Dissolved Ni (ug/L)			0.644		0.423								0.534
Dissolved Ag (ug/L)			0.002		0.002								0.002
Dissolved Zn (ug/L)	7.65	9.75	10.4	8.08	9.41	7.09	4.33	4.33	3.61	3.68	3.53	3.79	5.71
Dissolved Se (ug/L)			1.03		0.839								0.935
Dissolved Hg (ug/L)	0.00188	0.000898	0.000809	0.000967	0.00156	0.000653	0.00145	0.000787	0.000562	0.000488	0.000563	0.000781	0.000798

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

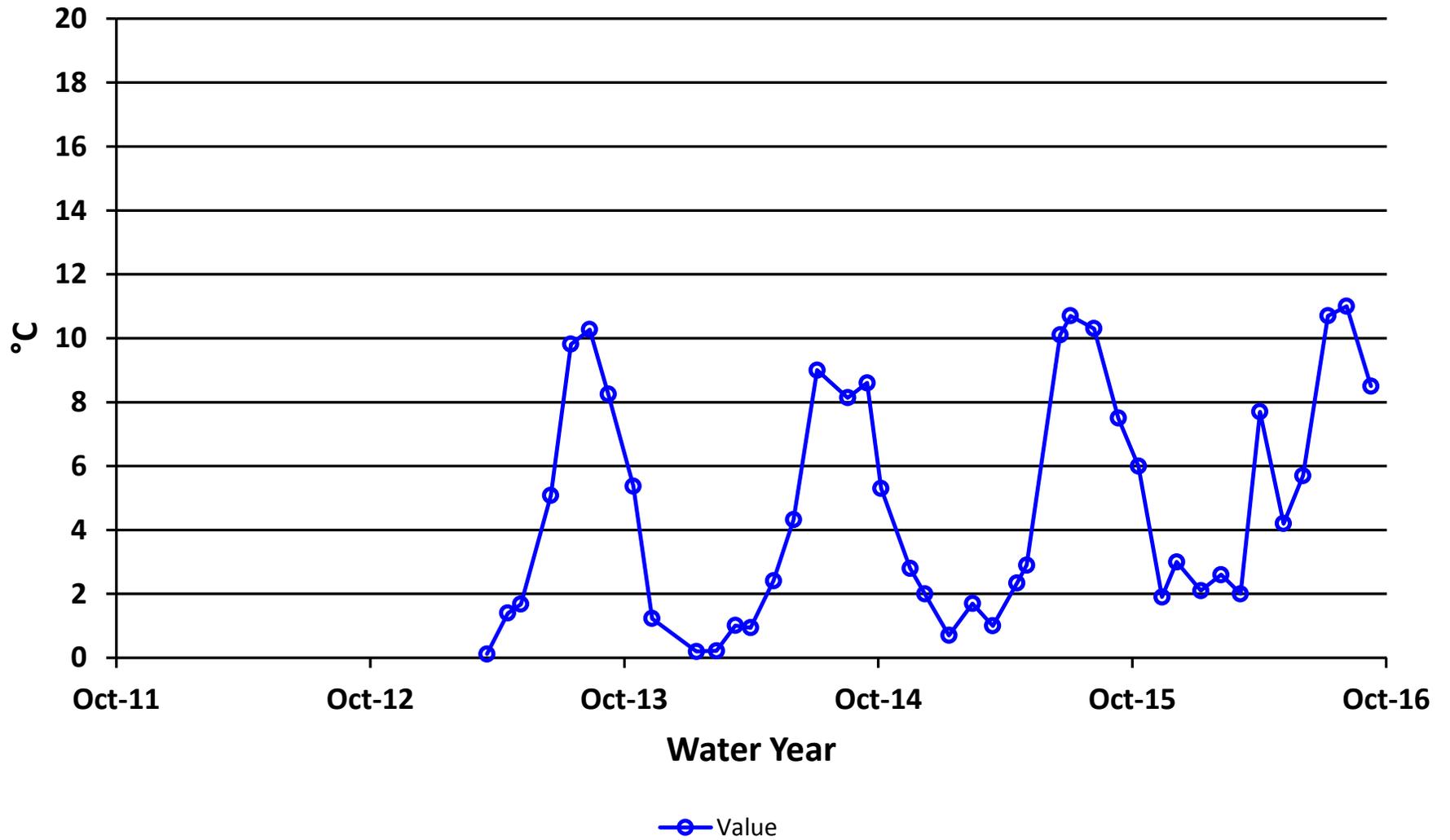
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

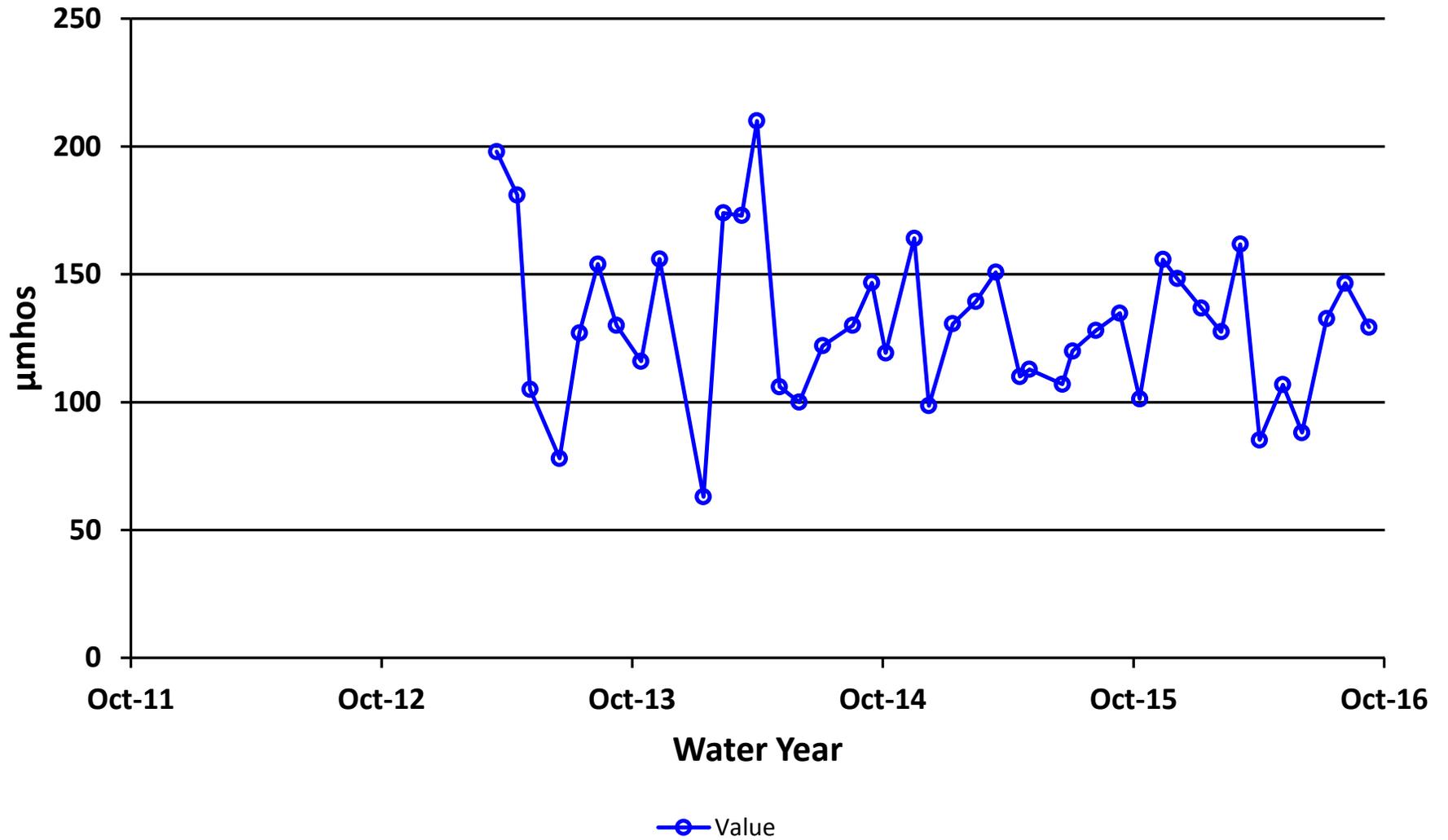
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
062FMS	12/7/2015	12:00 PM	Diss. Cr-ICP/MS	0.15	µg/L	J	Below Quantitative Range
	1/11/2016	12:00 PM	Diss. Hg-CVAF	0.000967	µg/L	U	Field Blank Contamination
	2/9/2016	12:00 PM	Diss. Cr-ICP/MS	0.11	µg/L	J	Below Quantitative Range
	3/8/2016	12:00 PM	Diss. Hg-CVAF	0.000653	µg/L	U	Field Blank Contamination
			Diss. Pb-ICP/MS	0.00857	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Pb-ICP/MS	0.00763	µg/L	J	Below Quantitative Range
	6/6/2016	12:00 PM	Diss. Pb-ICP/MS	0.00583	µg/L	J	Below Quantitative Range
	7/12/2016	12:00 PM	Diss. Pb-ICP/MS	0.00818	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Diss. Pb-ICP/MS	0.00819	µg/L	J	Below Quantitative Range
			Sulfate	16.7	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Sulfate	13	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

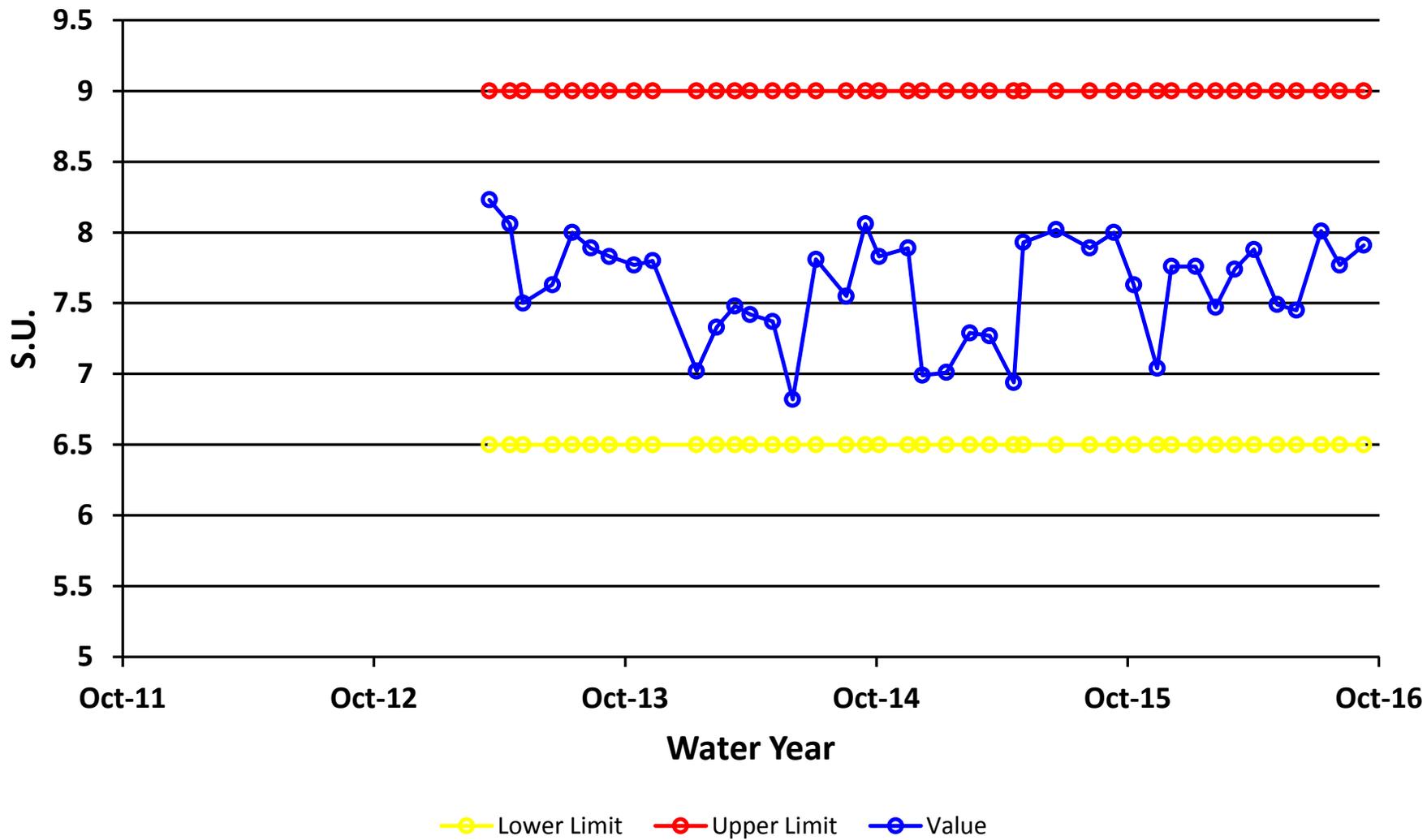
# Site 62 - Water Temperature



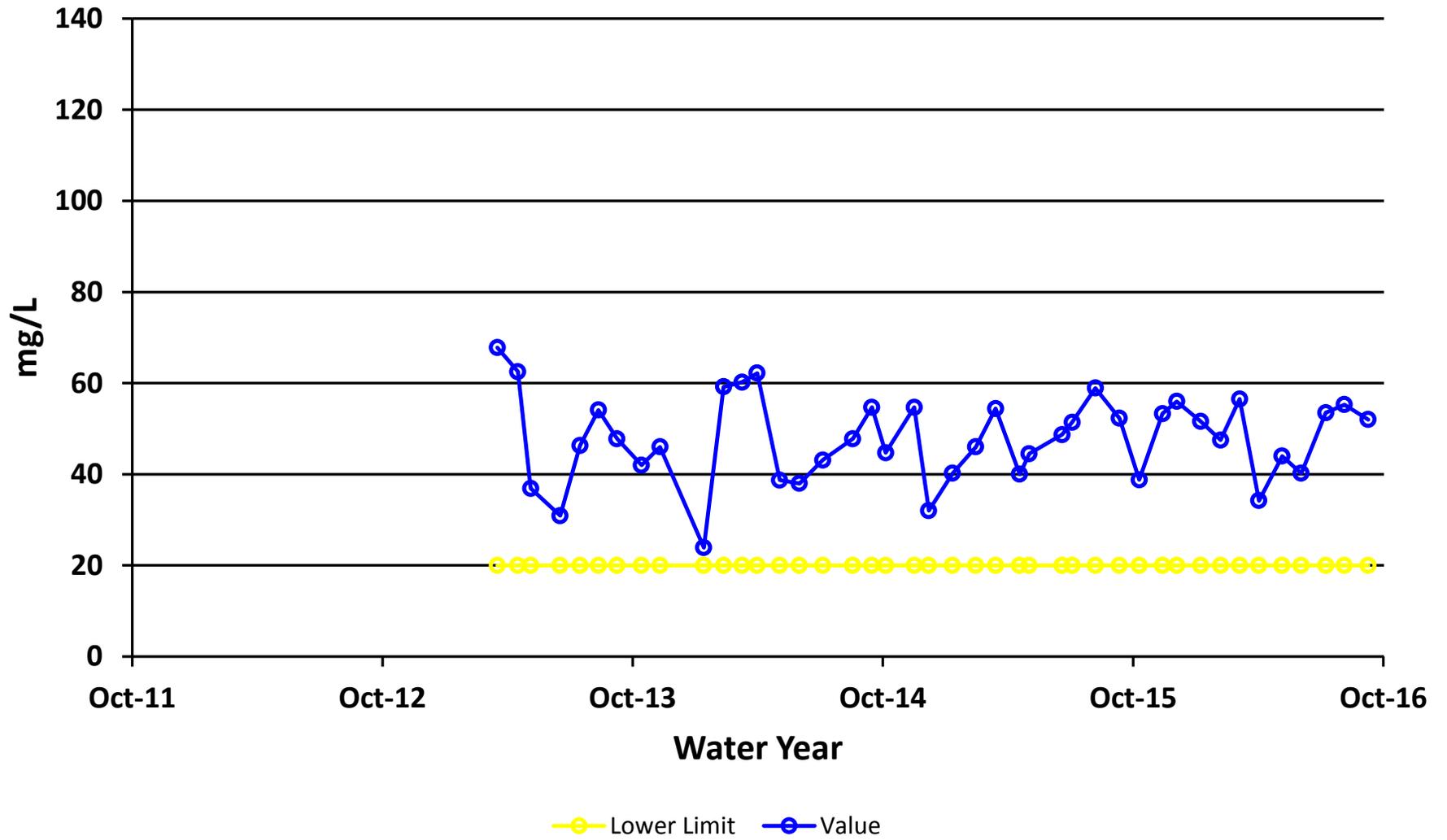
## Site 62 - Conductivity Field



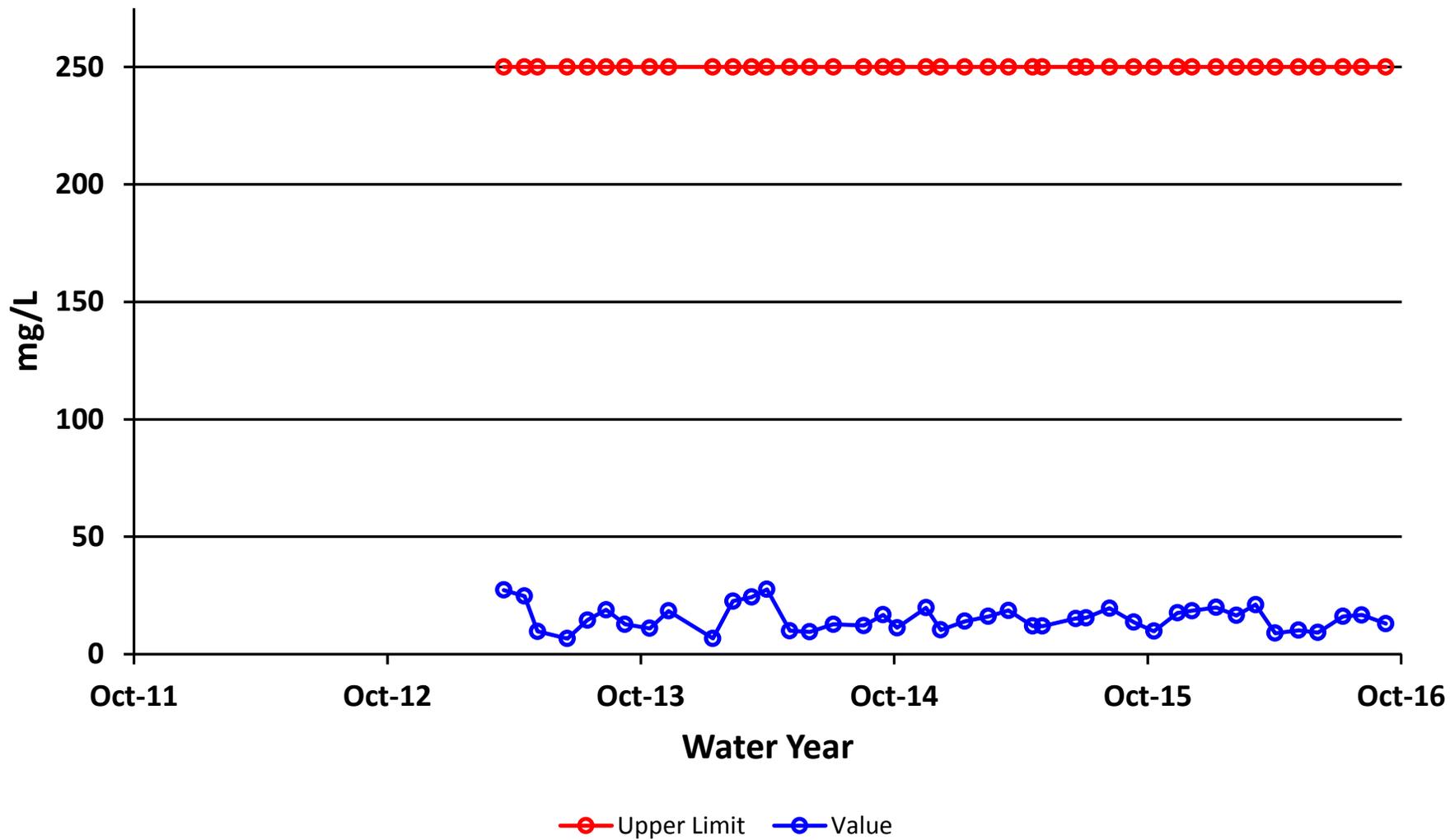
# Site 62 - pH Field



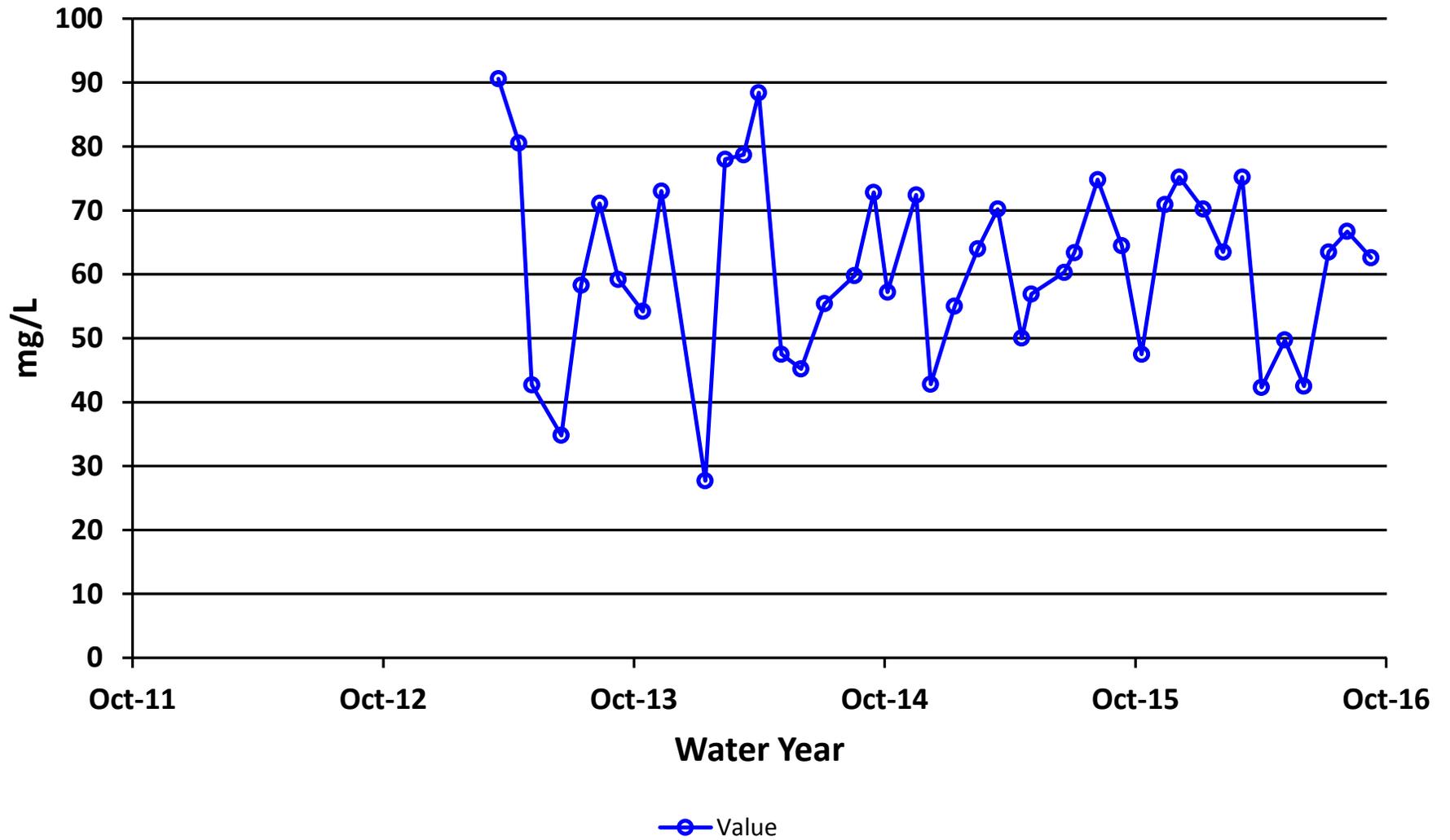
# Site 62 - Alkalinity



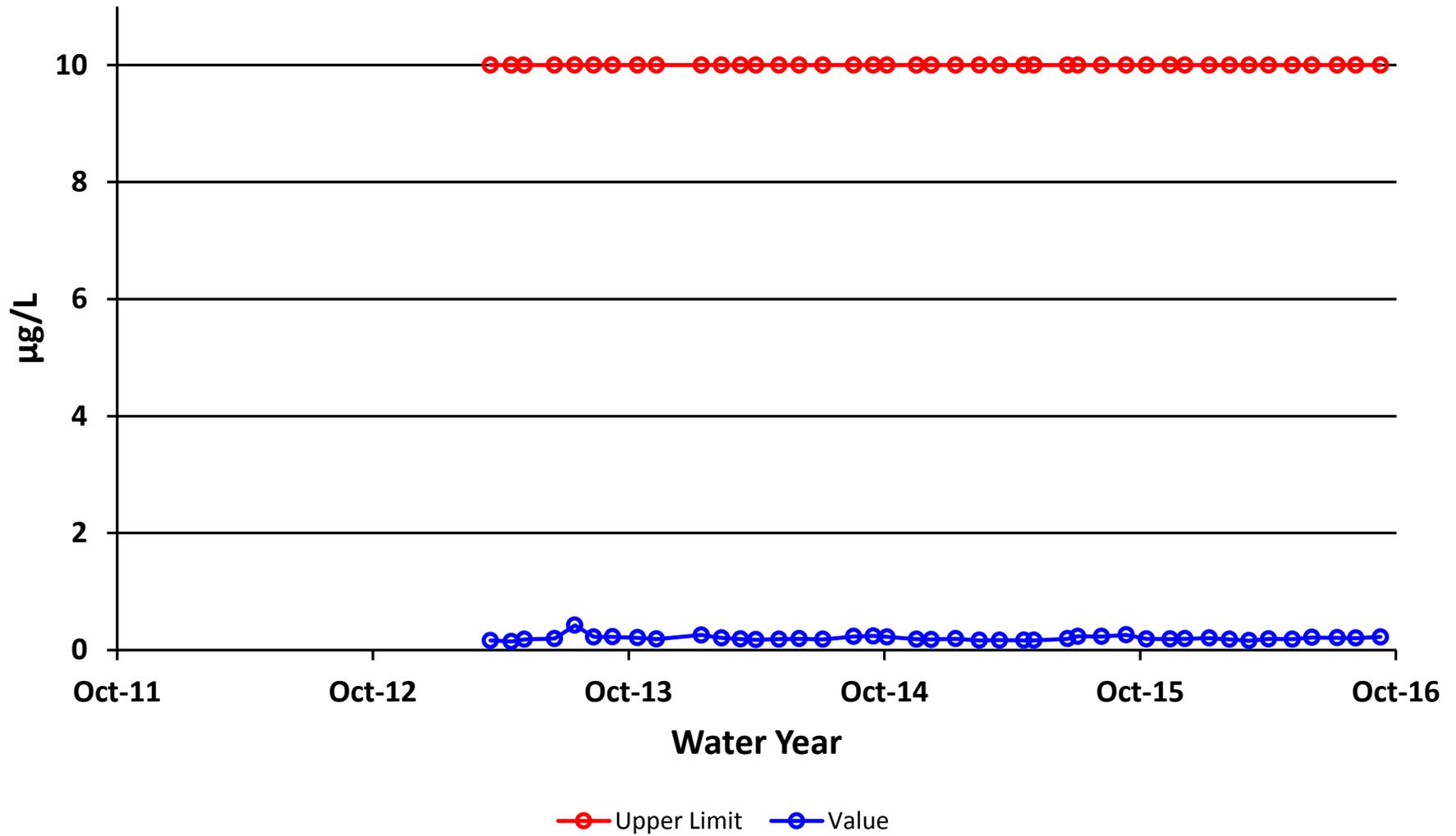
# Site 62 - Sulfate



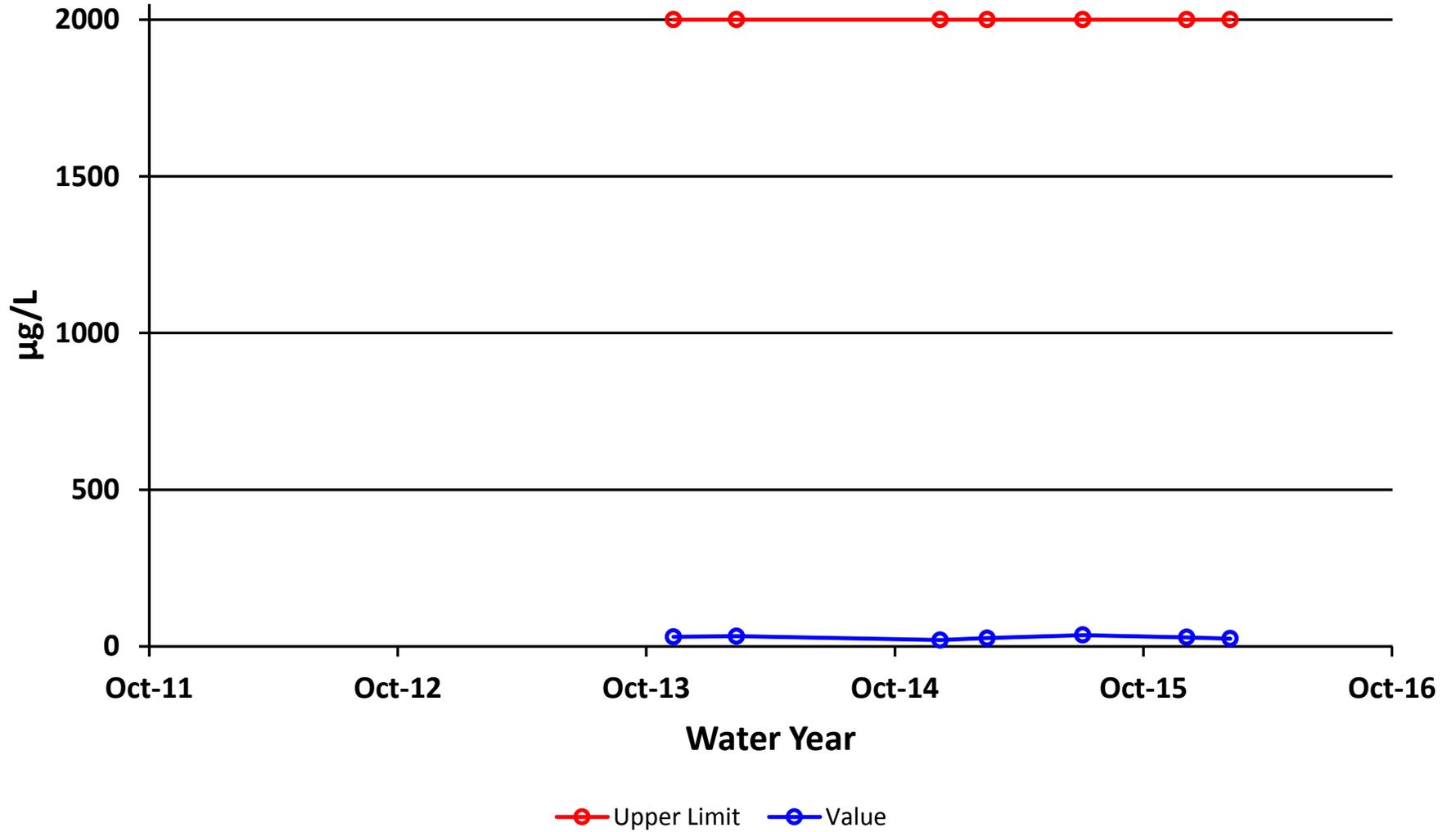
# Site 62 - Hardness



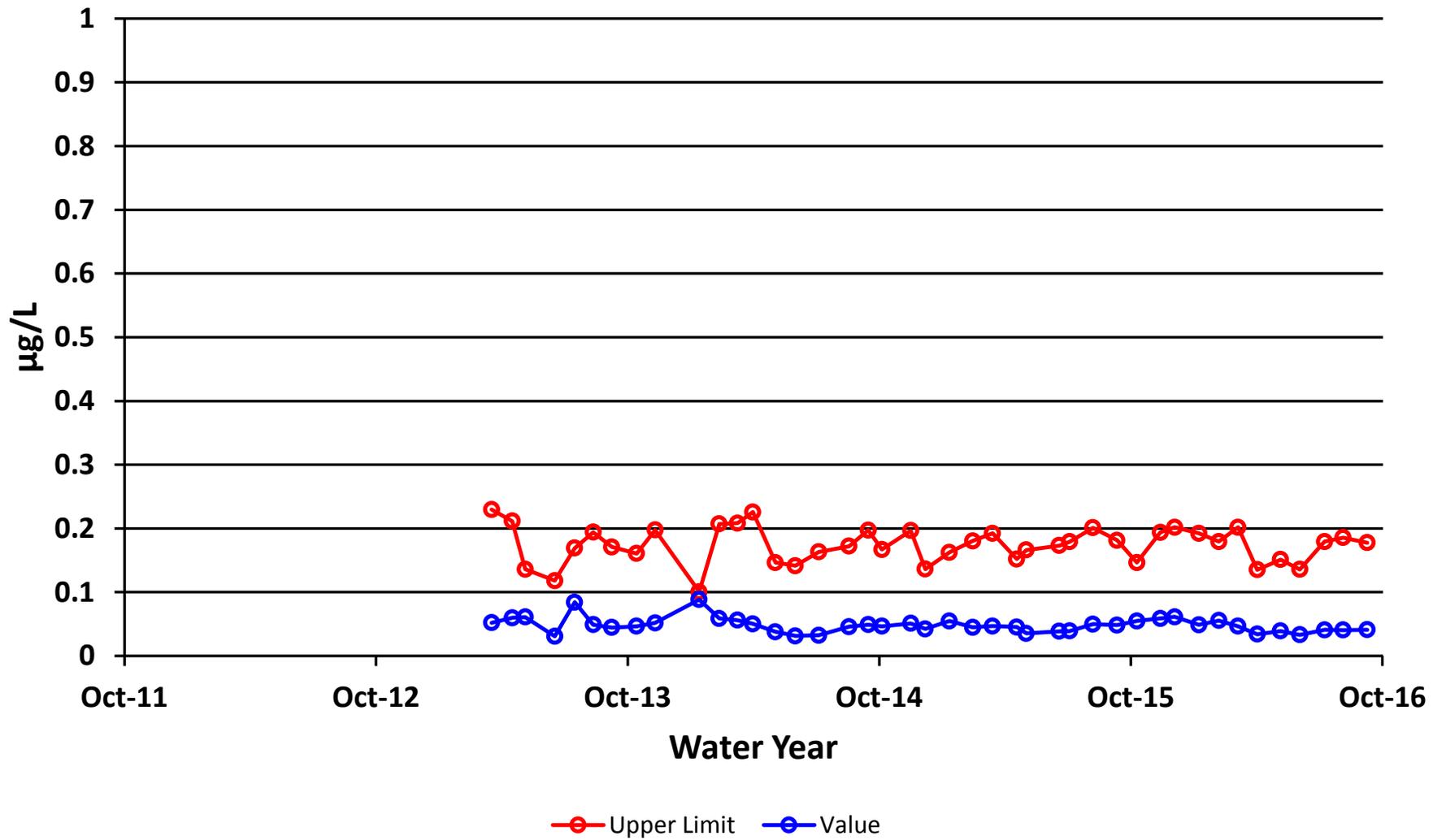
# Site 62 - Arsenic Dissolved



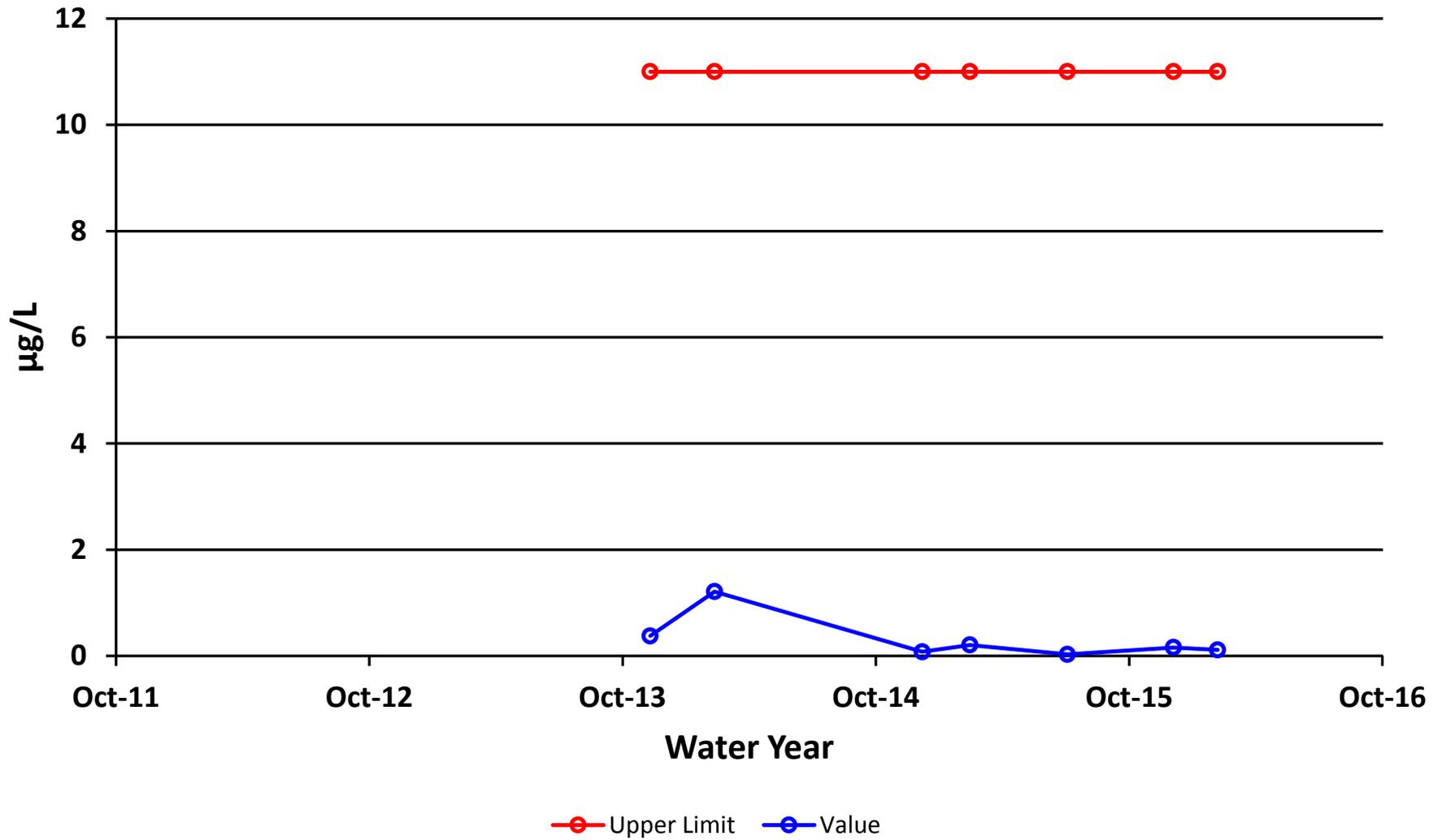
# Site 62 - Barium Dissolved



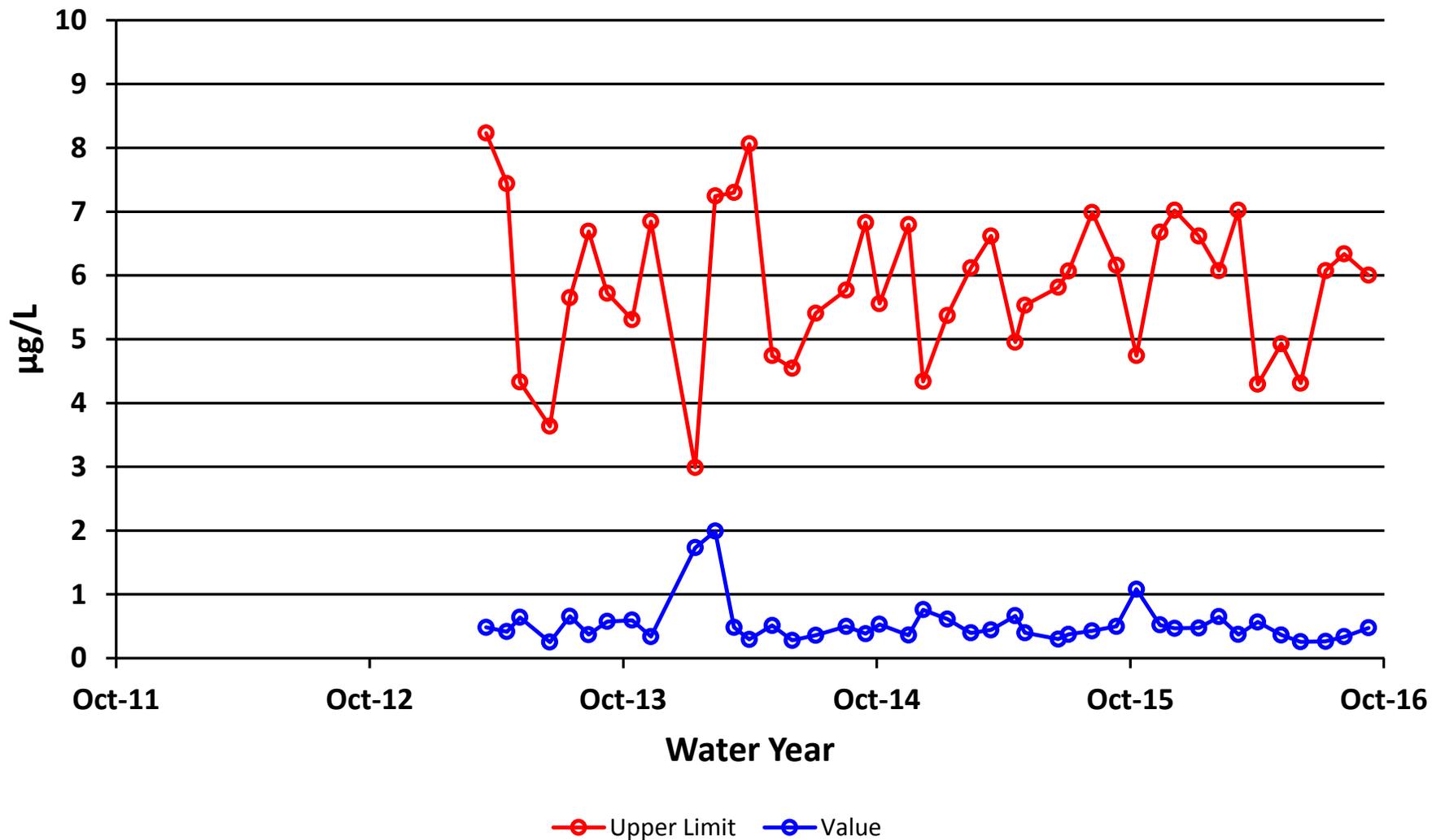
# Site 62 - Cadmium Dissolved



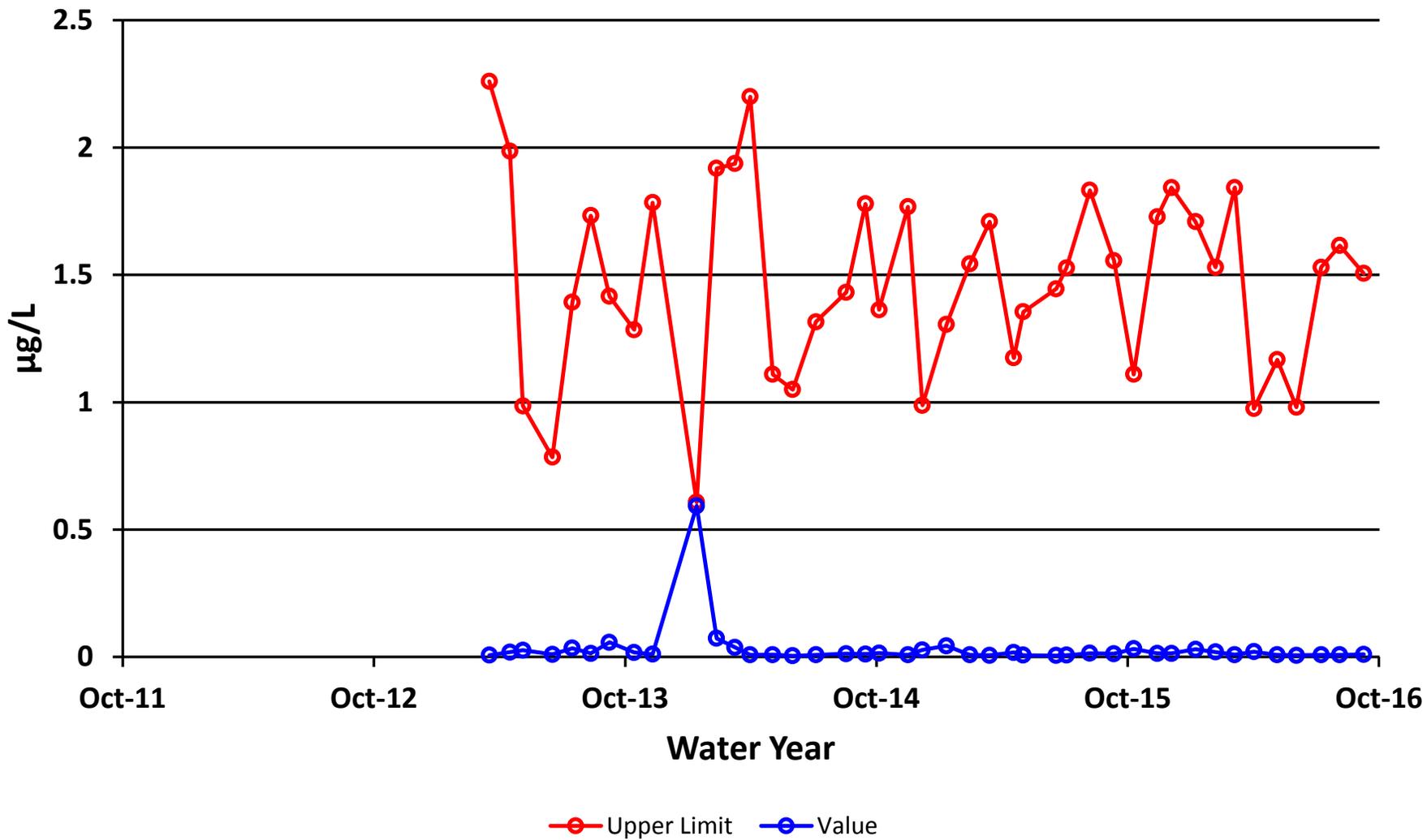
# Site 62 - Chromium Dissolved



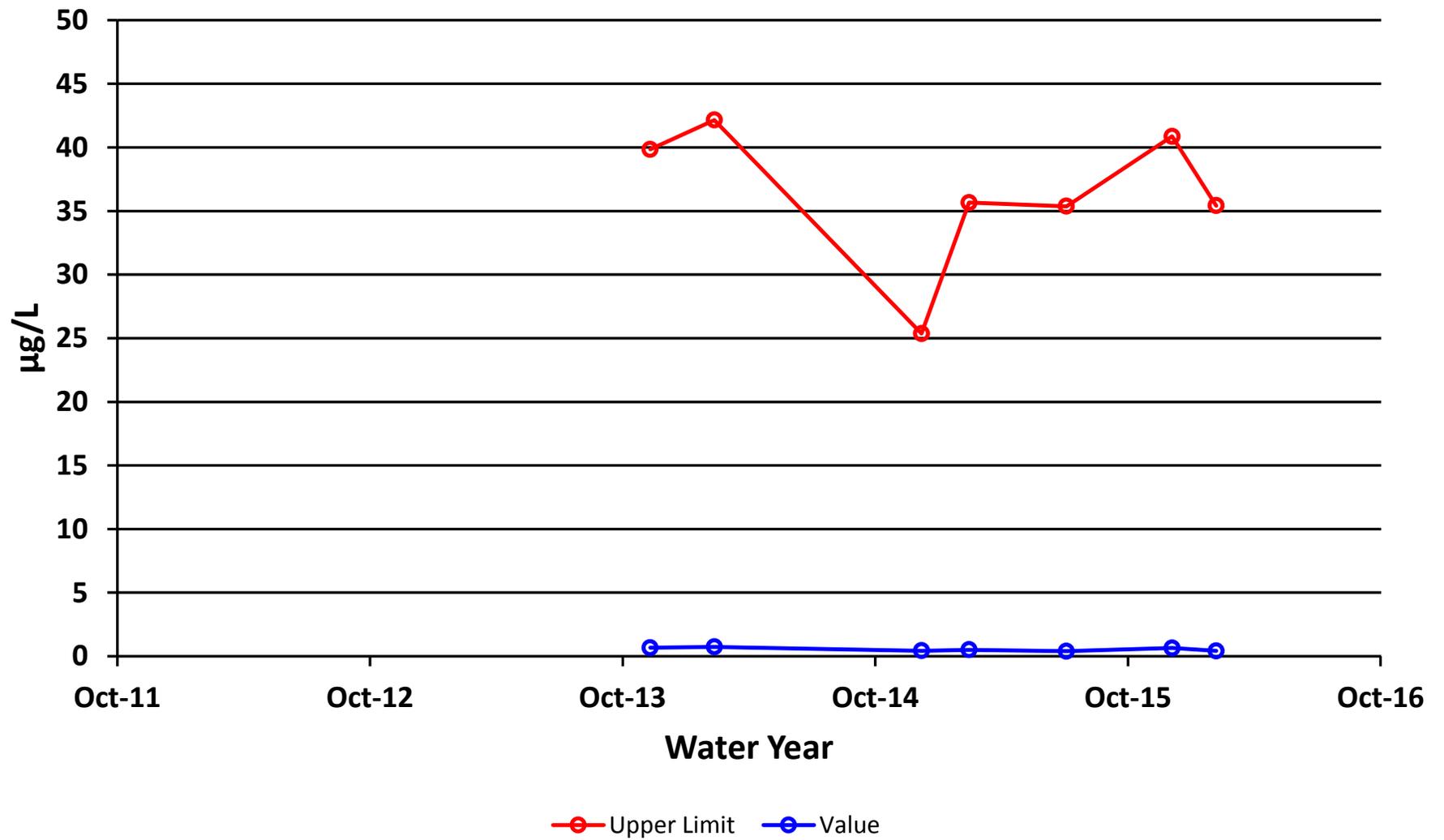
# Site 62 - Copper Dissolved



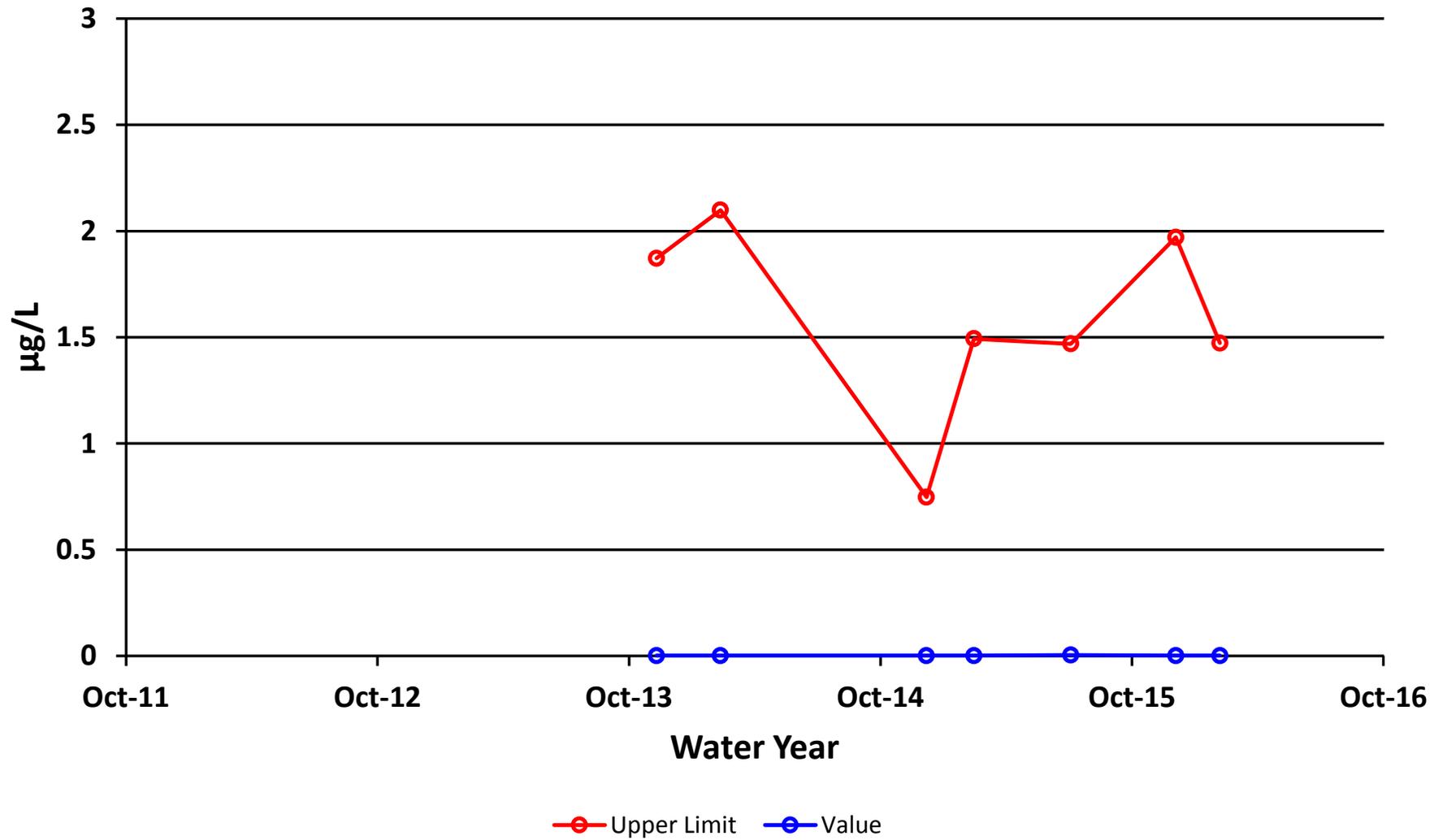
### Site 62 - Lead Dissolved



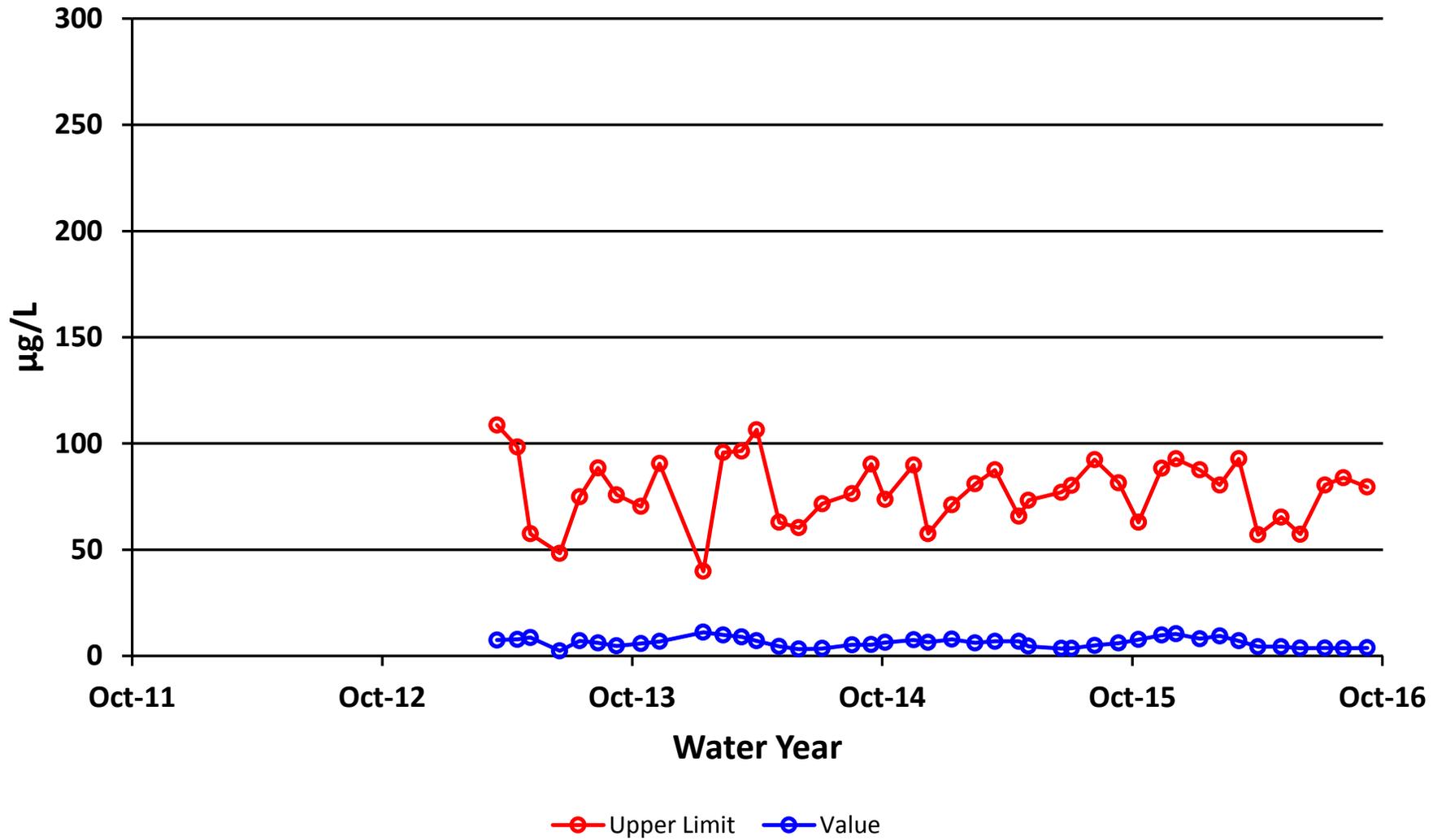
## Site 62 - Nickel Dissolved



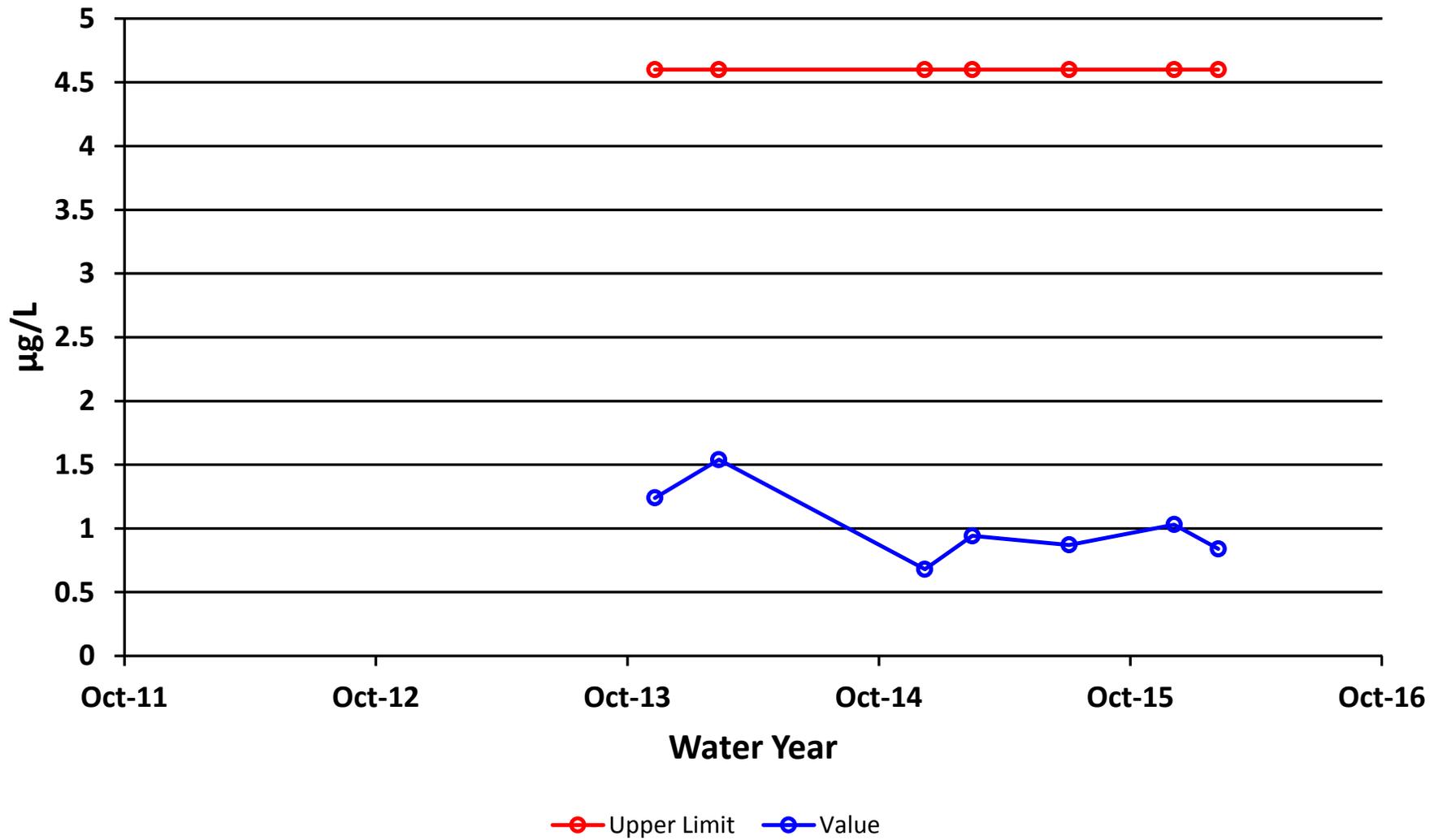
## Site 62 - Silver Dissolved



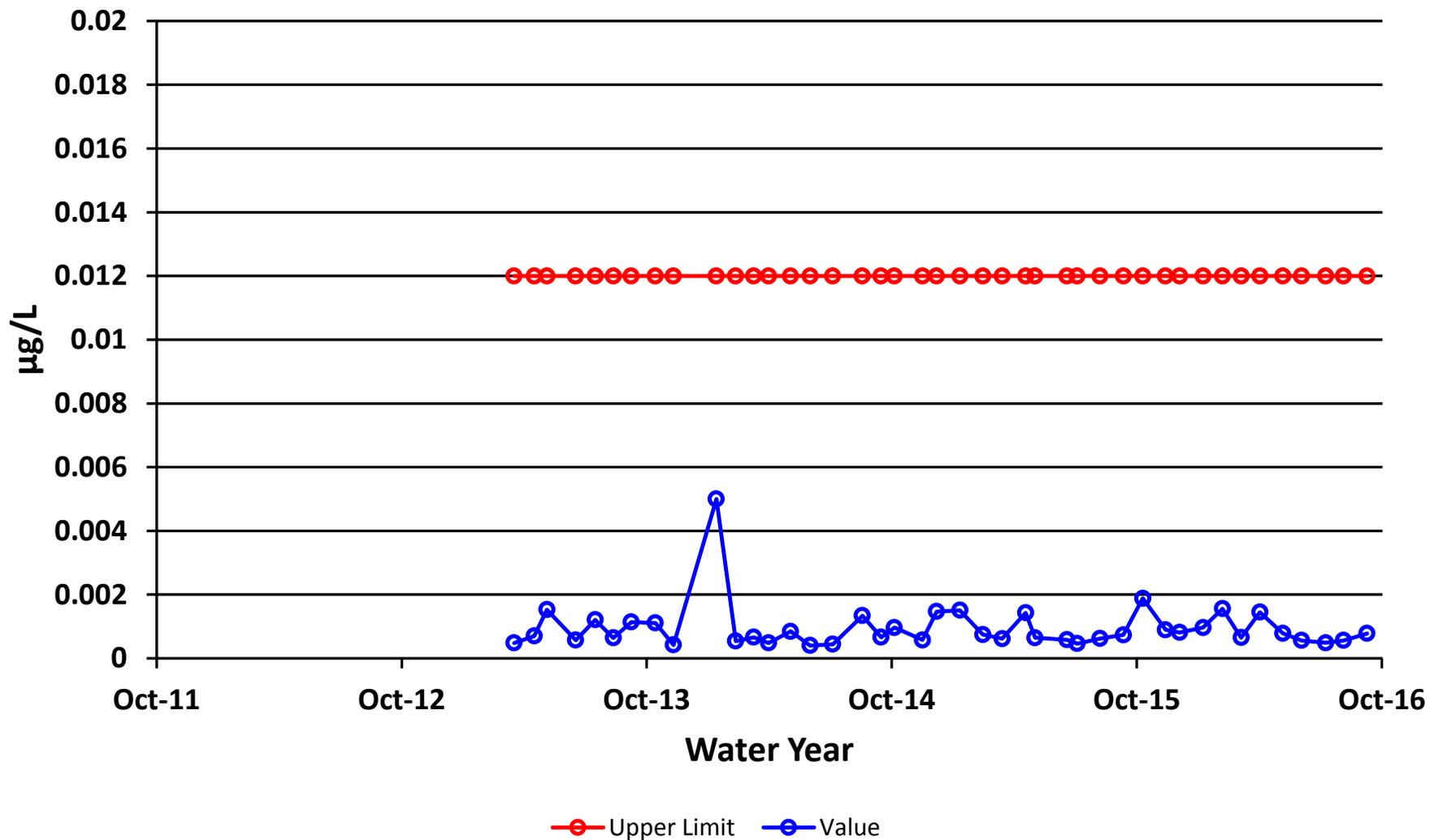
# Site 62 - Zinc Dissolved



# Site 62 - Selenium Dissolved



# Site 62 - Mercury Dissolved



**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Specific Conductance, Field ( $\mu\text{S}/\text{cm}$ )**

**X                      Y**

Site	#54	#62	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	93.60	101.30	-7.70	7.70	-7
Nov	143.70	155.80	-12.10	12.10	-12
Dec	138.10	148.30	-10.20	10.20	-10
Jan	130.00	136.80	-6.80	6.80	-5
Feb	119.50	127.50	-8.00	8.00	-8
Mar	150.00	161.80	-11.80	11.80	-11
Apr	78.40	85.20	-6.80	6.80	-4
May	101.60	106.80	-5.20	5.20	-2
Jun	85.80	88.10	-2.30	2.30	-1
Jul	125.40	132.60	-7.20	7.20	-6
Aug	138.20	146.50	-8.30	8.30	-9
Sep	122.90	129.30	-6.40	6.40	-3
Median	124.15	130.95	-7.45	7.45	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
 **$\Sigma R= -78$**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **pH, Field, Standard Units**

**X                  Y**

Site	#54	#62	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	7.82	7.63	0.19	0.19	8
Nov	7.51	7.04	0.47	0.47	11
Dec	7.80	7.76	0.04	0.04	4
Jan	7.81	7.76	0.05	0.05	5
Feb	7.70	7.47	0.23	0.23	9
Mar	7.80	7.74	0.06	0.06	6
Apr	7.86	7.88	-0.02	0.02	-1
May	7.90	7.49	0.41	0.41	10
Jun	7.48	7.45	0.03	0.03	2.5
Jul	7.98	8.01	-0.03	0.03	-2.5
Aug	7.93	7.77	0.16	0.16	7
Sep	7.91	7.91	0.00		
Median	7.82	7.75	0.05	0.06	

<b>n</b>	<b>m</b>
12	11

**N= 11**  
**ΣR= 59**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
13

$W^+_{=}$
<b>3.5</b>
p-test
0.002

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Total Alk, (mg/l)**

**X                  Y**

Site	#54	#62	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	35.80	38.80	-3.00	3.00	-7
Nov	50.40	53.30	-2.90	2.90	-6
Dec	51.40	56.00	-4.60	4.60	-12
Jan	47.80	51.60	-3.80	3.80	-11
Feb	44.20	47.50	-3.30	3.30	-8.5
Mar	53.20	56.50	-3.30	3.30	-8.5
Apr	31.80	34.20	-2.40	2.40	-3.5
May	43.20	44.00	-0.80	0.80	-1
Jun	36.60	40.20	-3.60	3.60	-10
Jul	50.90	53.50	-2.60	2.60	-5
Aug	53.00	55.30	-2.30	2.30	-2
Sep	49.60	52.00	-2.40	2.40	-3.5
Median	48.70	51.80	-2.95	2.95	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= -78**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Sulfate, Total (mg/l)**

**X                    Y**

Site	#54	#62	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	8.5	9.8	-1.3	1.3	-8
Nov	16.1	17.6	-1.5	1.5	-10
Dec	17.6	18.5	-0.9	0.9	-3
Jan	19.0	19.9	-0.9	0.9	-3
Feb	15.6	16.5	-0.9	0.9	-3
Mar	19.7	21.1	-1.4	1.4	-9
Apr	8.1	9.0	-0.9	0.9	-5
May	10.2	10.2	0.0		
Jun	8.9	9.2	-0.3	0.3	-1
Jul	14.0	16.1	-2.1	2.1	-11
Aug	15.5	16.7	-1.2	1.2	-7
Sep	12.0	13.0	-1.0	1.0	-6
Median	14.8	16.3	-1.0	1.0	

<b>n</b>	<b>m</b>
12	11

**N= 11**  
**ΣR= -66**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
13

$W^+_{=}$
<b>0</b>
p-test
0.000

$H_0$	median [D]=0	<b>REJECT</b>
$H_1$	median [D]<0	<b>ACCEPT</b>

**Wilcoxon-signed-ranks test**

**Exact Form**

Variable: **Zinc, Dissolved (ug/l)**

**X                    Y**

Site	#54	#62	Differences		
Year	WY2016	WY2016	<b>D</b>	<b> D </b>	<b>Rank</b>
Oct	7.84	7.65	0.19	0.19	8
Nov	9.80	9.75	0.05	0.05	2
Dec	10.50	10.40	0.10	0.10	3
Jan	8.62	8.08	0.54	0.54	12
Feb	9.62	9.41	0.21	0.21	9
Mar	7.08	7.09	-0.01	0.01	-1
Apr	4.46	4.33	0.13	0.13	6
May	4.21	4.33	-0.12	0.12	-5
Jun	3.75	3.61	0.14	0.14	7
Jul	3.19	3.68	-0.49	0.49	-11
Aug	3.32	3.53	-0.21	0.21	-10
Sep	3.90	3.79	0.11	0.11	4
Median	5.77	5.71	0.10	0.14	

<b>n</b>	<b>m</b>
12	12

**N= 12**  
**ΣR= 24**

$\alpha$
0.05
<b><math>W'_{\alpha,n}</math></b>
17

$W^+_{=}$
<b>27</b>
p-test
0.190

$H_0$	median [D]=0	ACCEPT
$H_1$	median [D]<0	

# INTERPRETIVE REPORT

## SITE 61

Sampling at this site was initiated during the spring of Water Year 2013. This site was added to the FWMP at the request of the state and federal regulators. Site 61 is located in a floodplain of Greens Creek, approximately 250 feet down gradient of D Pond. The sampling location is at just past the confluence of two drainages, one of which originates from the north and the other from the east. Sampling began in May 2013 and will occur on quarterly basis

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past year is included in the report. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers have been identified by HGCMC for the period of October 2013 through September 2016.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. Two exceedances were identified as listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
9-May-16	Cadmium Dissolved	0.559 µg/L		0.50	274 mg/L
8-Aug-16	Cadmium Dissolved	0.415 µg/L		0.409	208 mg/L

As a result of the monitoring and reporting for Water Year 2013, HGCMC increased the sample frequency to monthly for Site 61. The first sample collected at Site 61 (6 May 2013) was in exceedance for cadmium, mercury, selenium, and zinc. Since that sampling there have been no other water quality exceedances. HGCMC returned to sampling Site 61 on a quarterly basis after the August 2015 sampling event. The two exceedances for dissolved cadmium were slightly above the hardness based AWQS. Though these samples were above the AWQS, the FWMP was designed to monitor for long term changes in water quality. The down gradient monitoring site (Site 62) that receives the water monitored at Site 61 was well below the AWQS for dissolved cadmium. HGCMC will continue to monitor Site 61 on a quarterly basis, and will evaluate the need to increase the sampling frequency if additional exceedances are recorded.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Because of the limited (less than 5 years) amount of data, visual trend analysis and statistical analysis of the data was not performed.

## Table of Results for Water Year 2016

### Site 061FMS - 'Greens Creek Floodplain'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		4			4.5			6.5			7.9		5.5
Conductivity-Field(µmho)		347			446			579			411		428.5
Conductivity-Lab (µmho)		465			432			530			424		449
pH Lab (standard units)		7.6			7.62			7.6			7.28		7.60
pH Field (standard units)		7.38			7.59			7.58			7.4		7.49
Total Alkalinity (mg/L)		112			109			107			125		110.5
Total Sulfate (mg/L)		120			96.6			156			94.7		108.3
Hardness (mg/L)		248			222			274			208		235.0
Dissolved As (ug/L)		0.201			0.188			0.202			0.208		0.202
Dissolved Ba (ug/L)		47.3			48.2			58.1					48.2
Dissolved Cd (ug/L)		0.395			0.392			0.559			0.415		0.4050
Dissolved Cr (ug/L)		0.407			0.305			0.265					0.305
Dissolved Cu (ug/L)		0.411			0.26			0.394			0.291		0.343
Dissolved Pb (ug/L)		0.0592			0.0314			0.147			0.0415		0.0504
Dissolved Ni (ug/L)		2.6			1.71			2.77					2.600
Dissolved Ag (ug/L)		0.002			0.002			0.002					0.002
Dissolved Zn (ug/L)		140			114			164			89.5		127.00
Dissolved Se (ug/L)		1.27			1.15			1.7					1.270
Dissolved Hg (ug/L)		0.000176			0.000133			0.000225			0.000272		0.000201

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

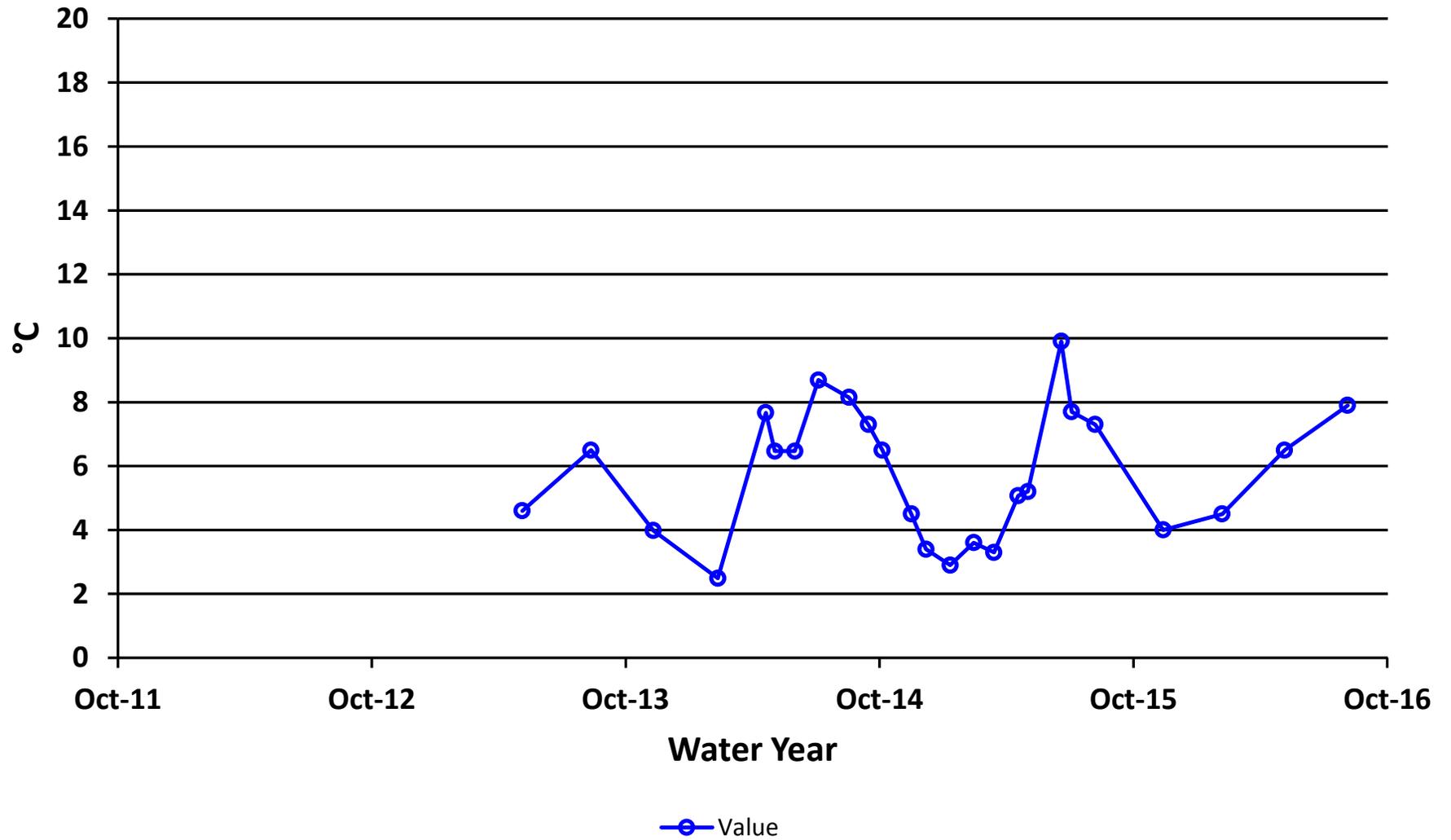
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

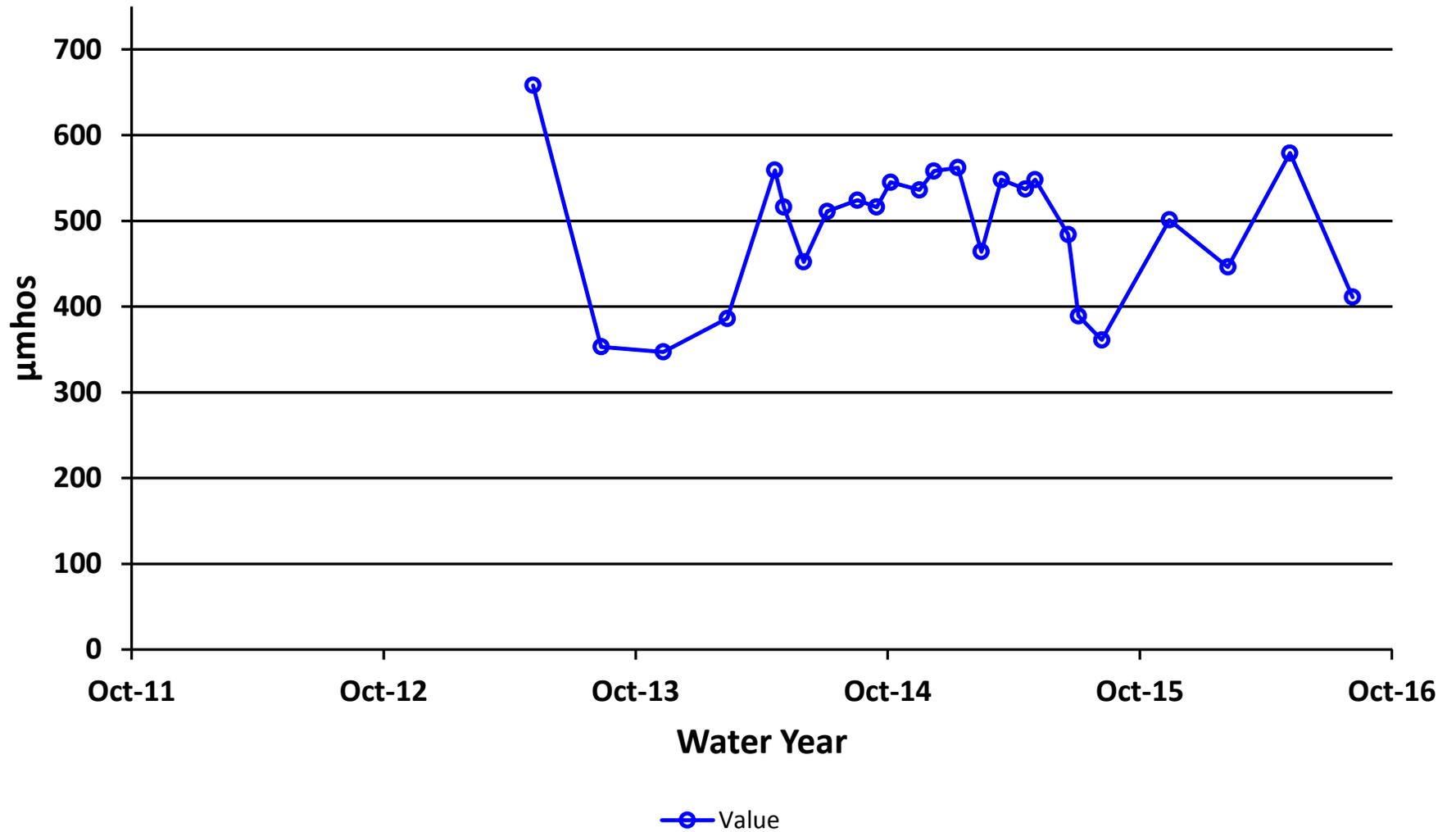
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
061FMS	11/16/2015	12:00 PM	Diss. Hg-CVAF	0.000176	µg/L	J	Below Quantitative Range
	2/9/2016	12:00 PM	Diss. Hg-CVAF	0.000133	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Hg-CVAF	0.000225	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Diss. Hg-CVAF	0.000272	µg/L	J	Below Quantitative Range
			Sulfate	94.7	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

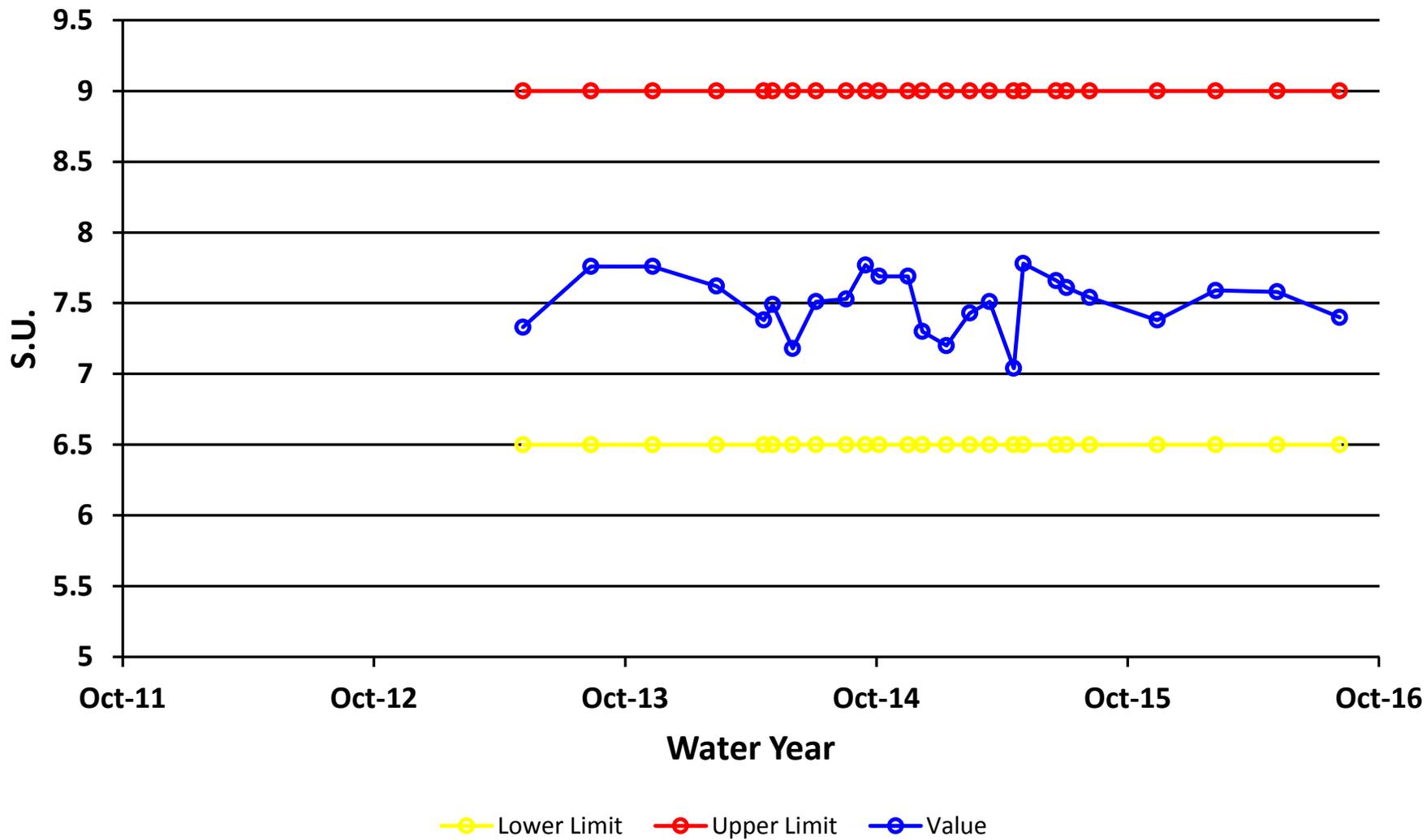
# Site 61 - Water Temperature



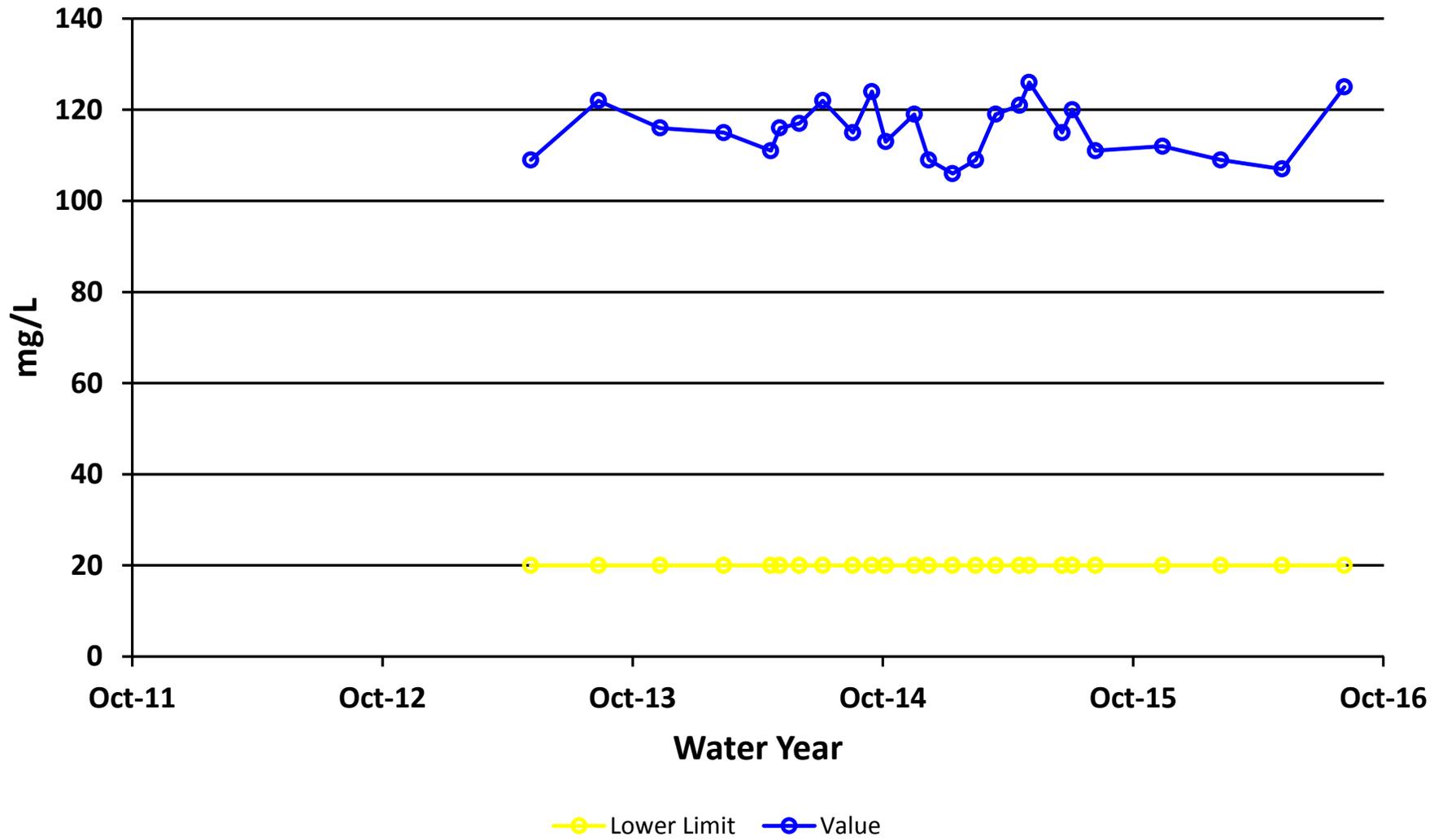
## Site 61 - Conductivity Field



# Site 61 - pH Field

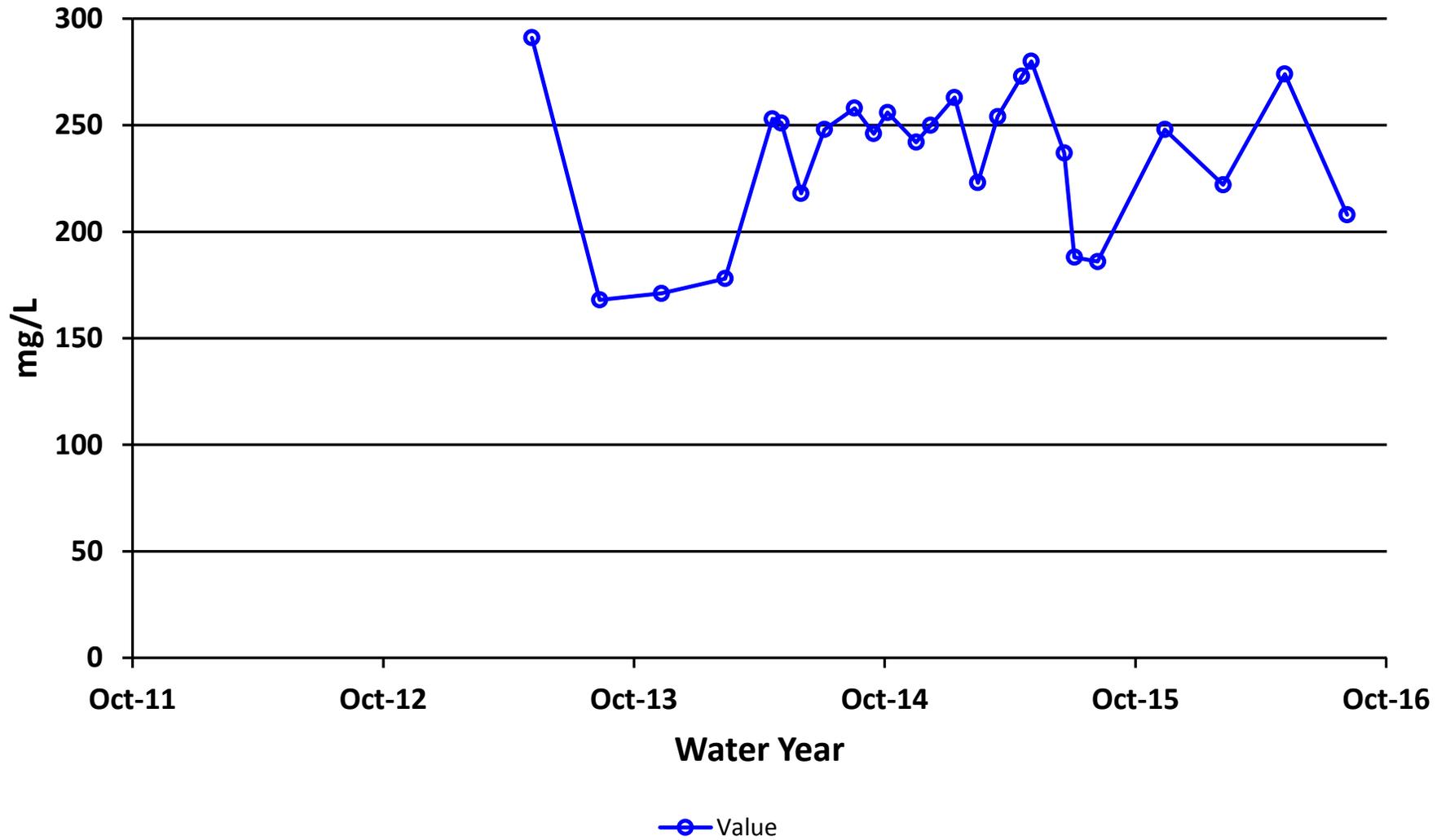


# Site 61 - Alkalinity

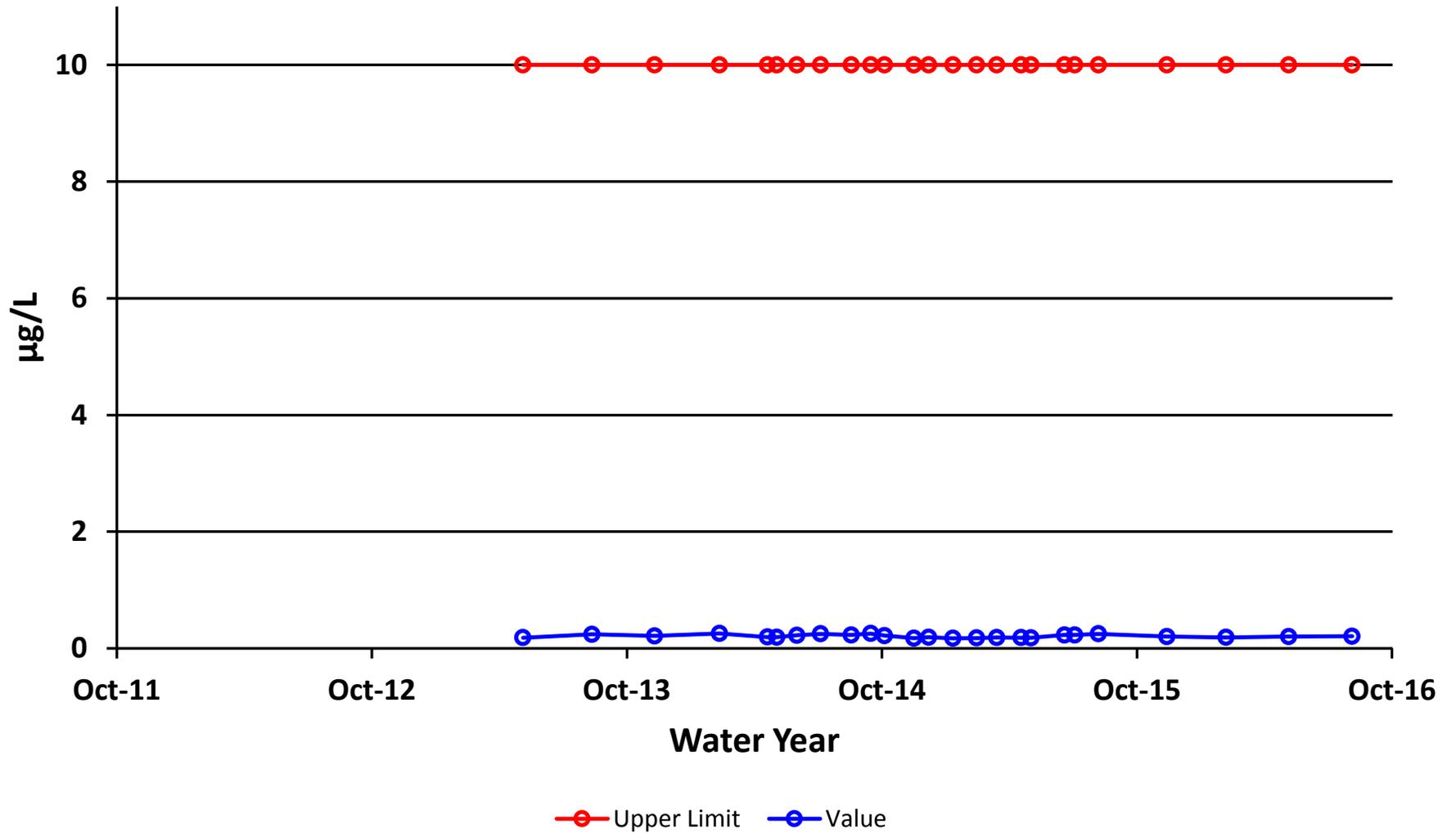




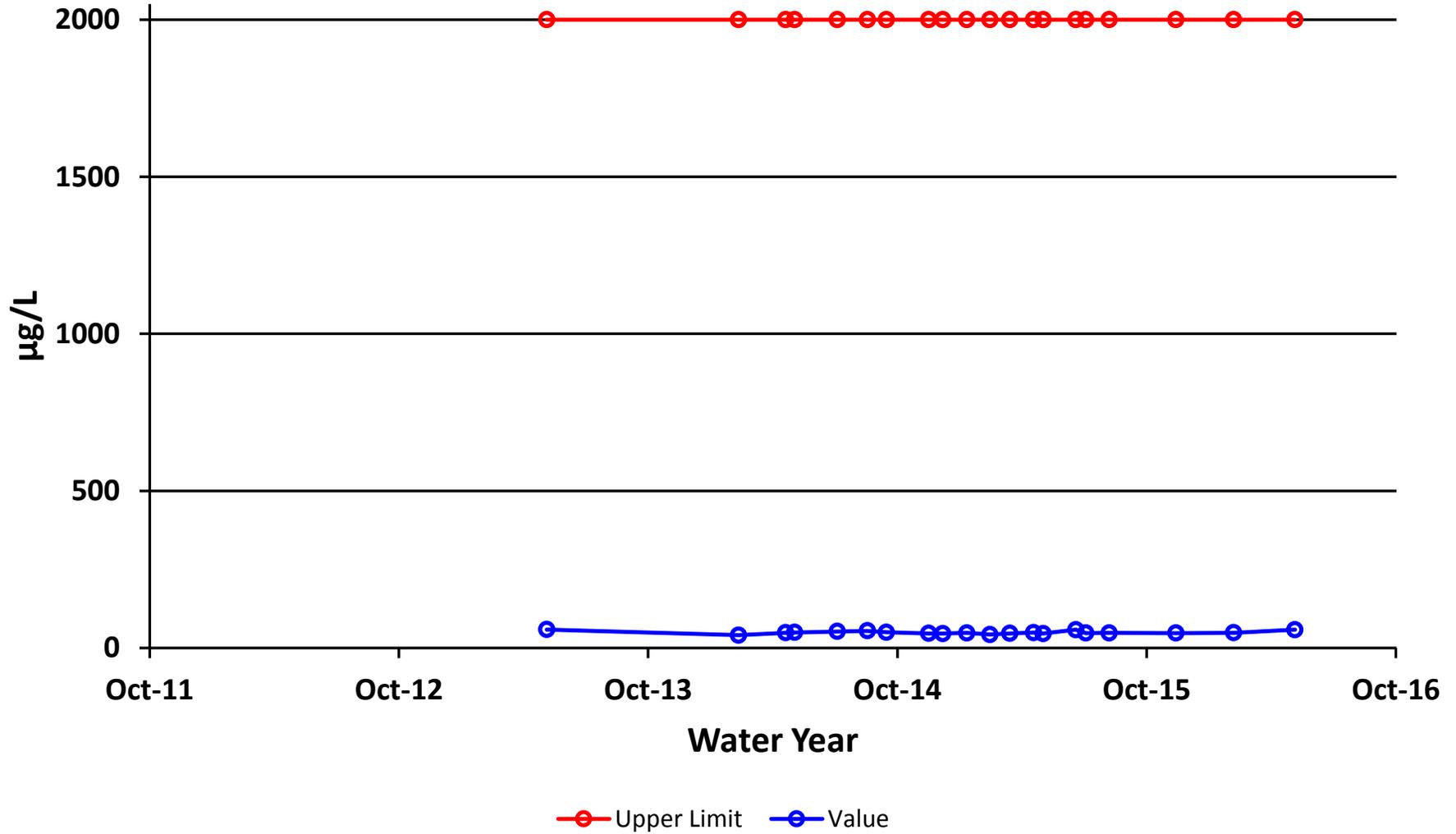
### Site 61 - Hardness



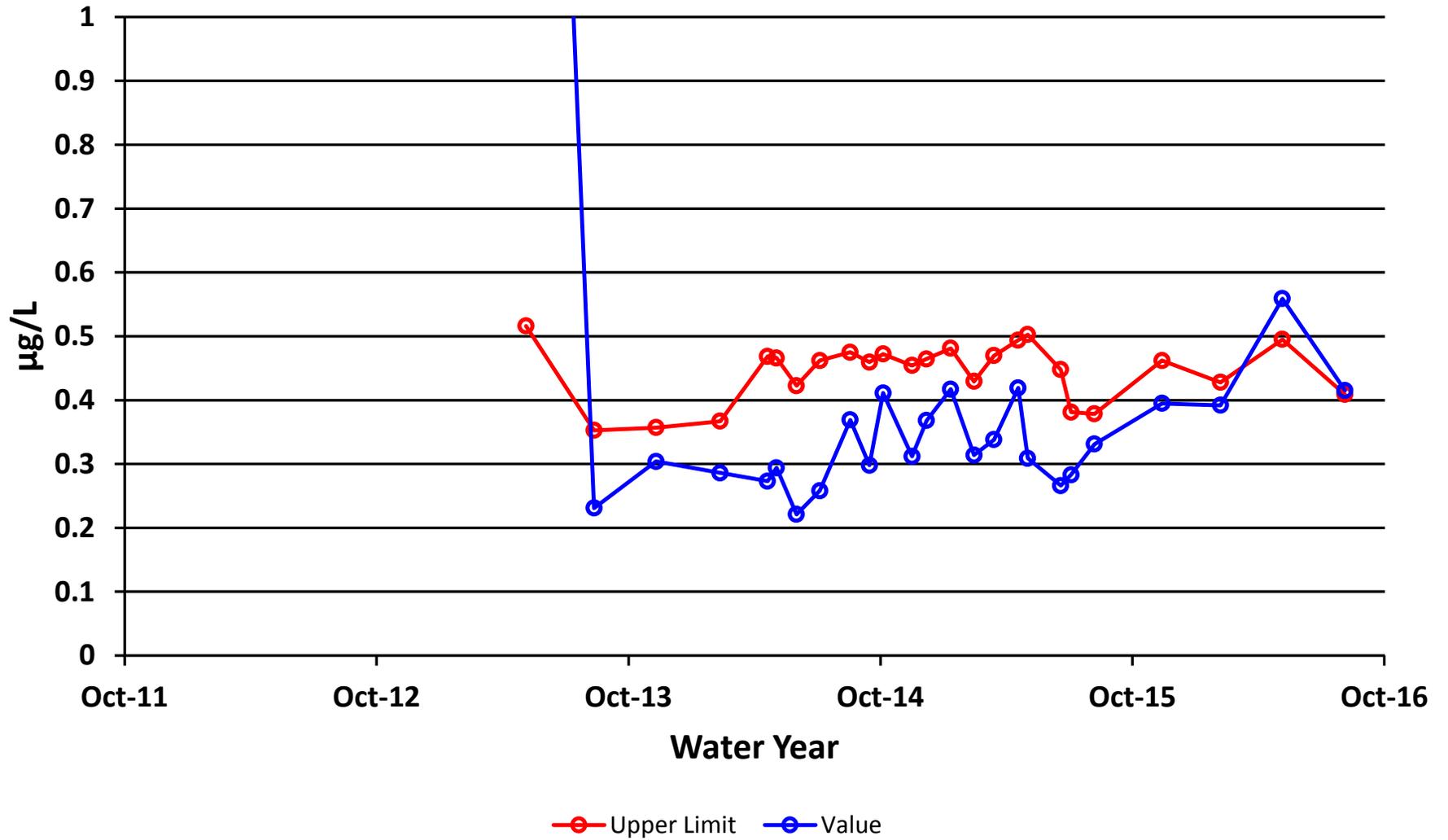
# Site 61 - Arsenic Dissolved



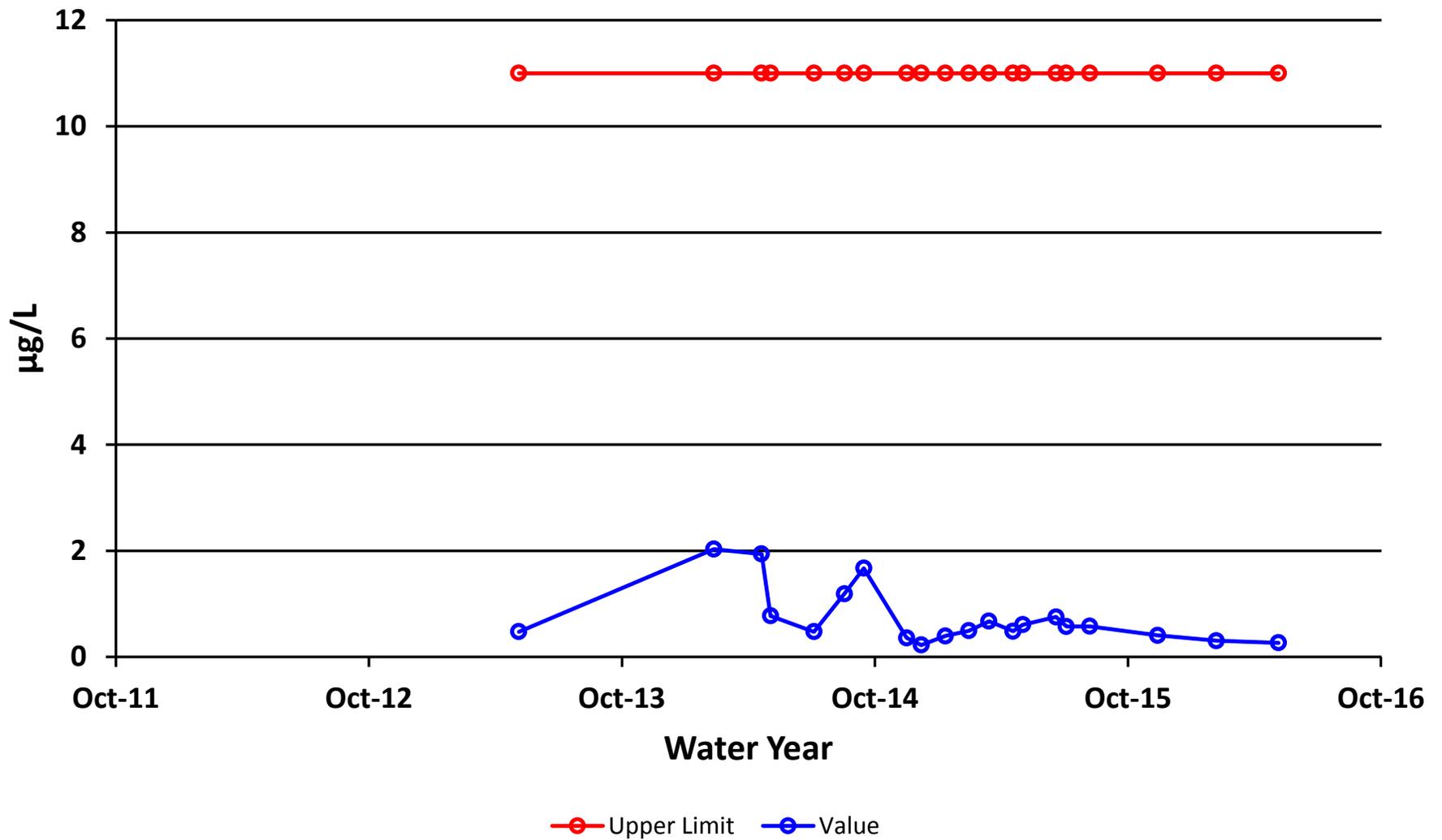
# Site 61 - Barium Dissolved



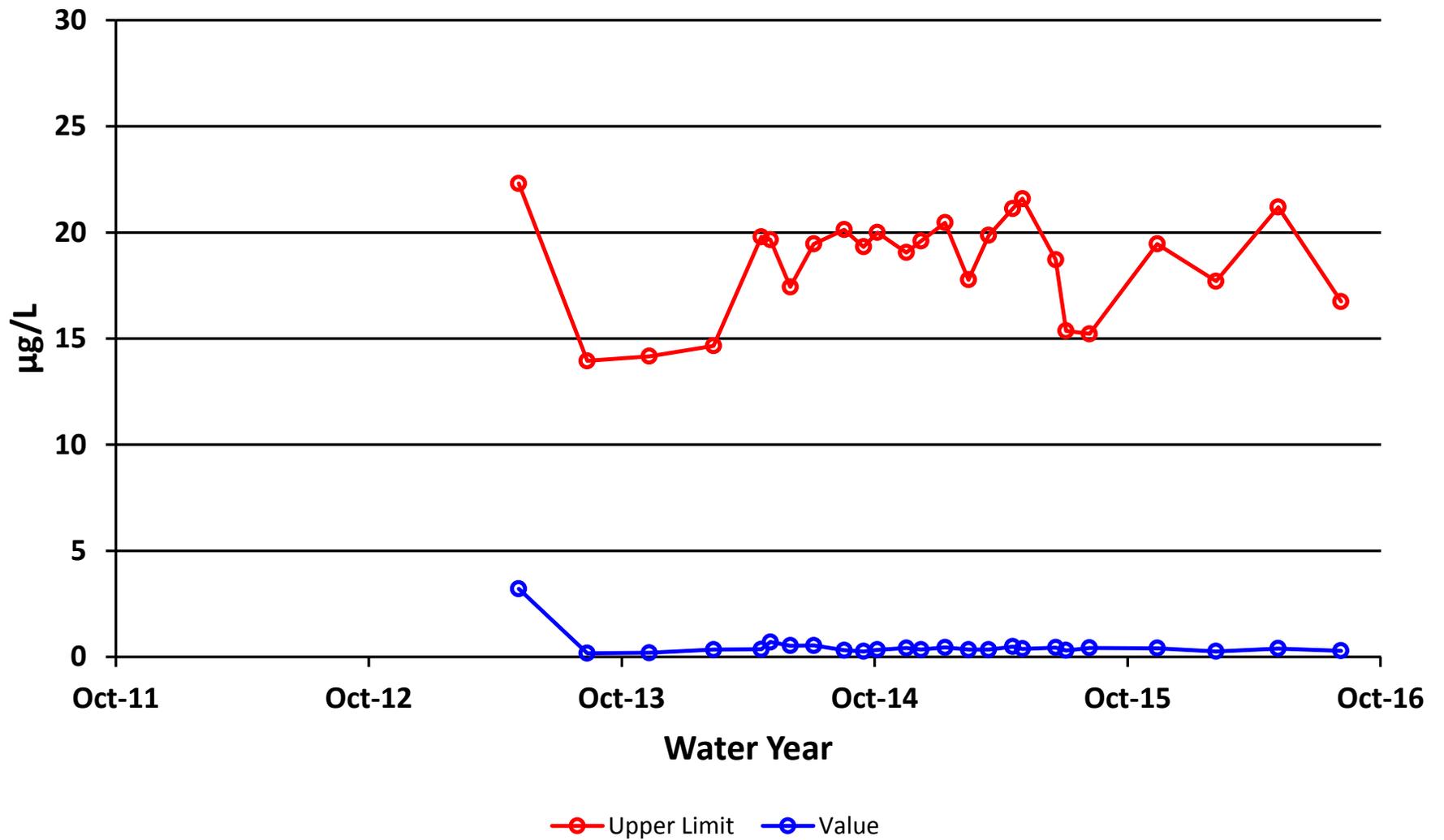
# Site 61 - Cadmium Dissolved



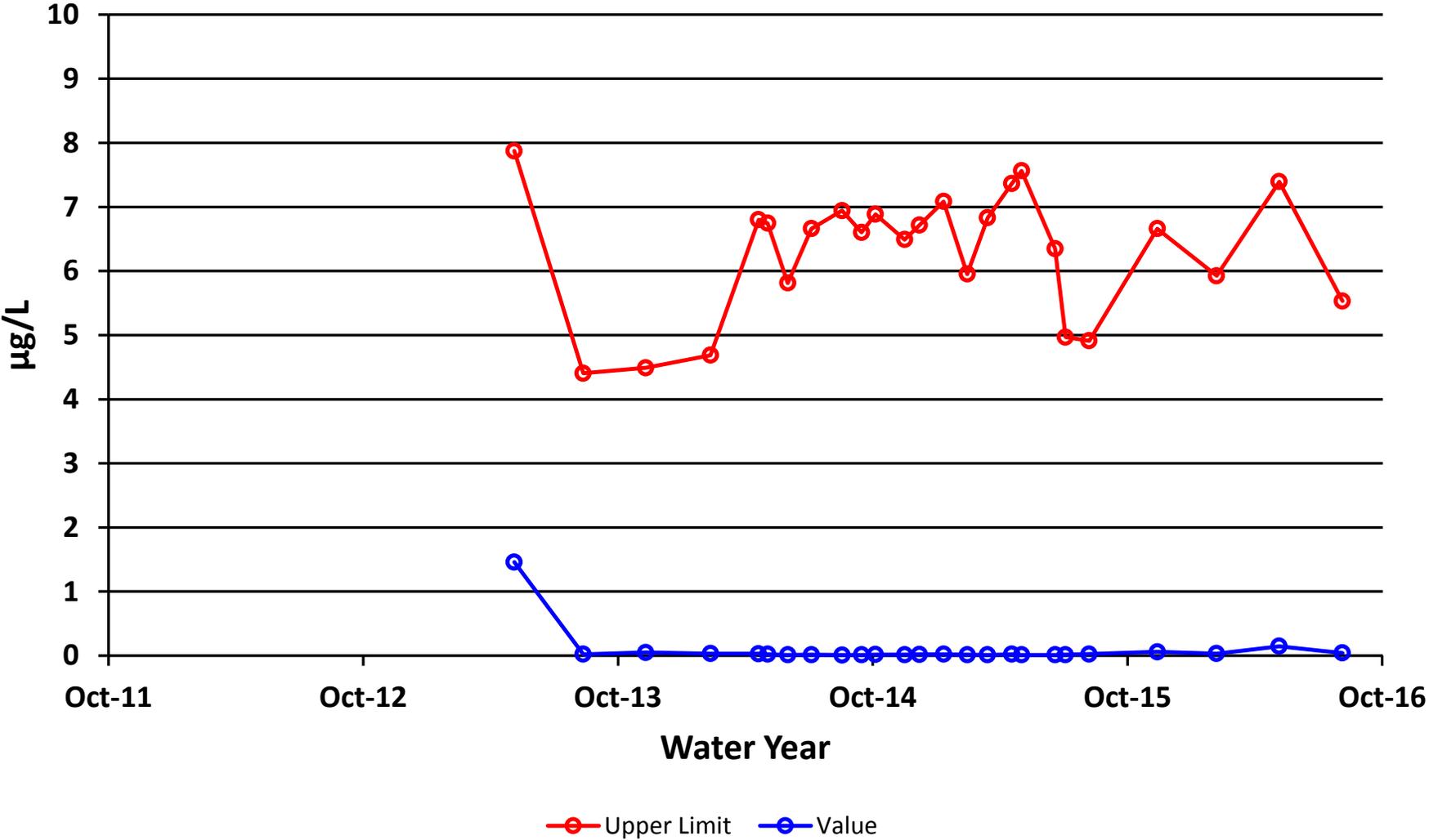
# Site 61 - Chromium Dissolved



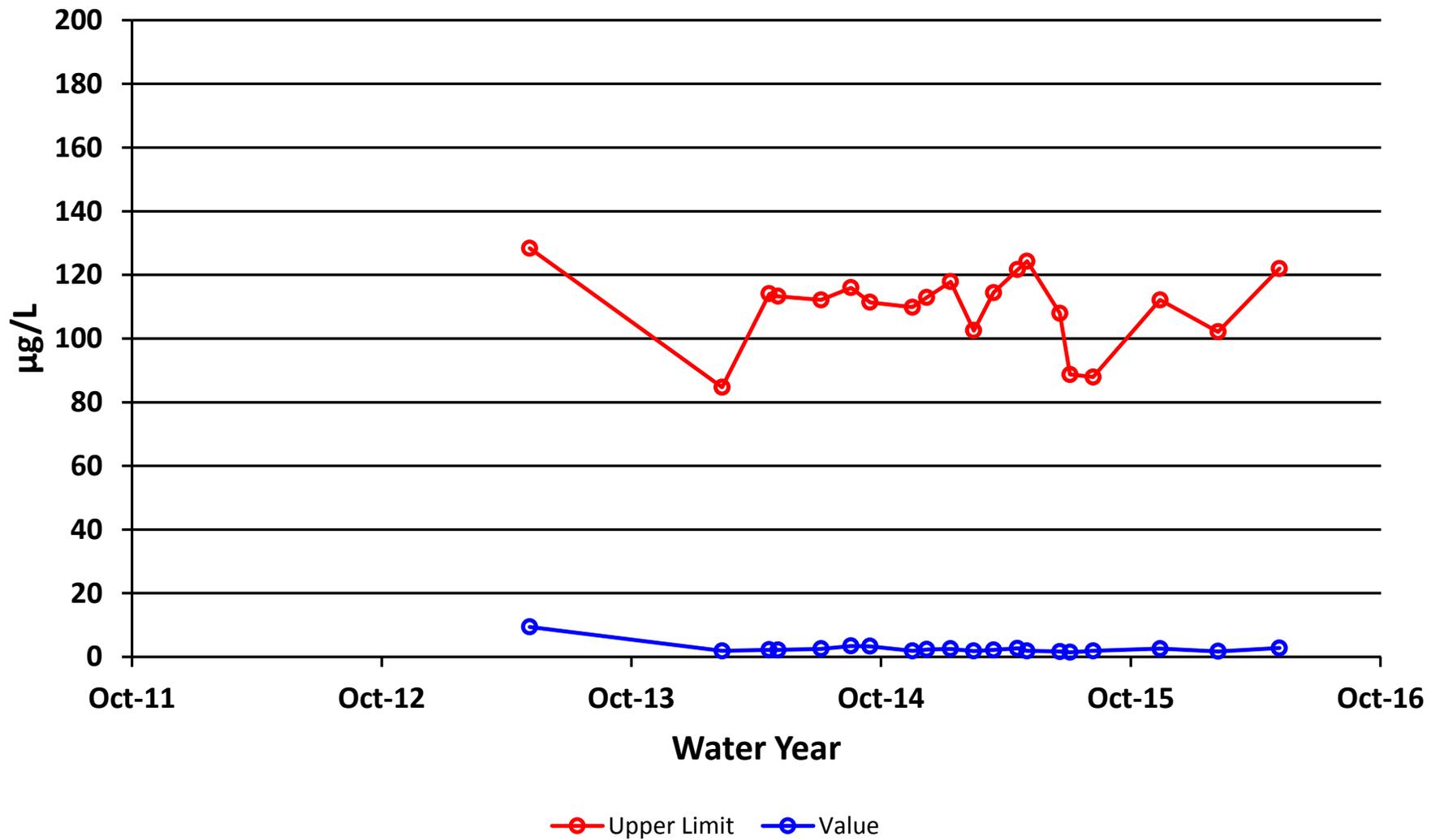
# Site 61 - Copper Dissolved



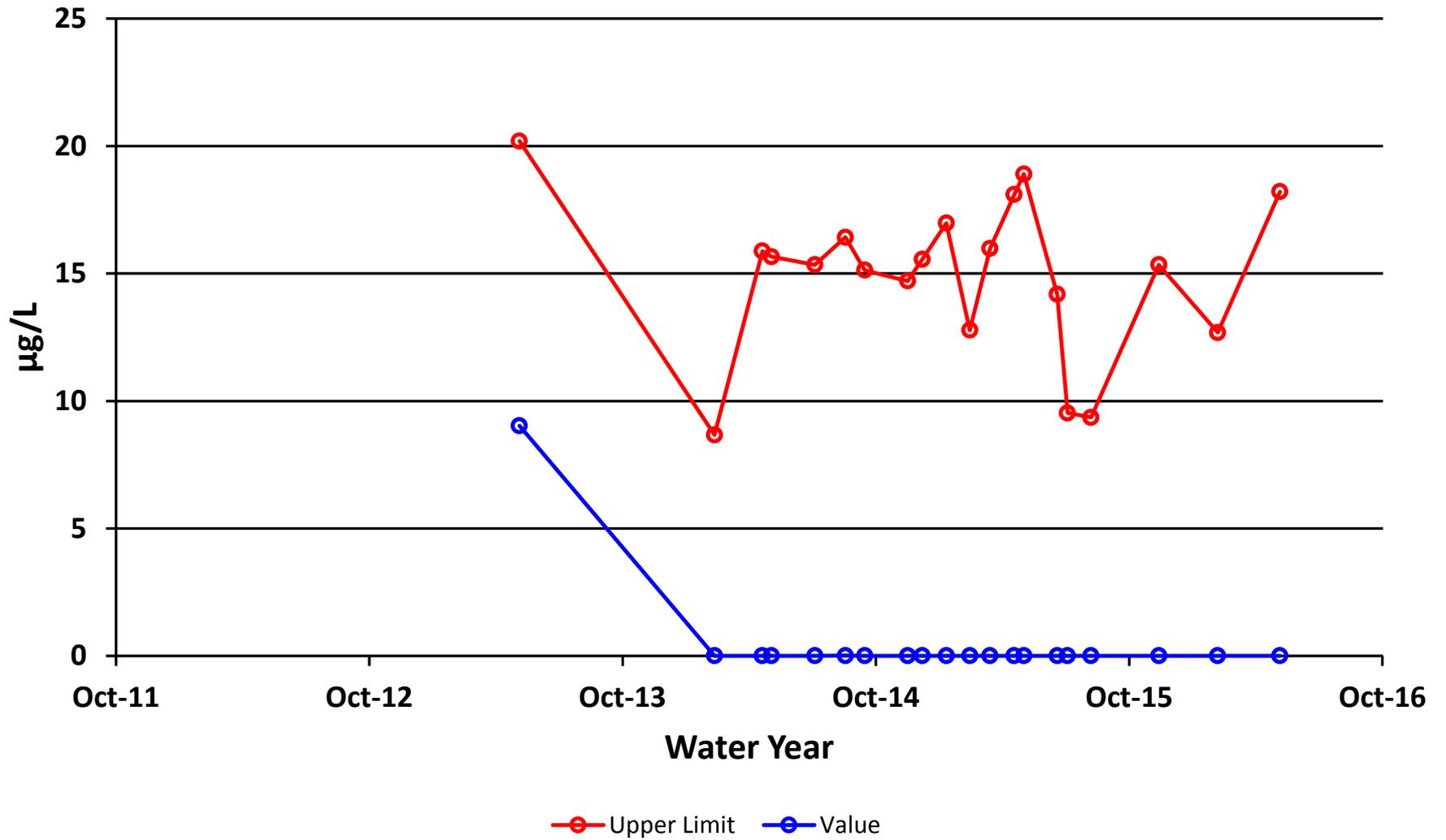
# Site 61 - Lead Dissolved



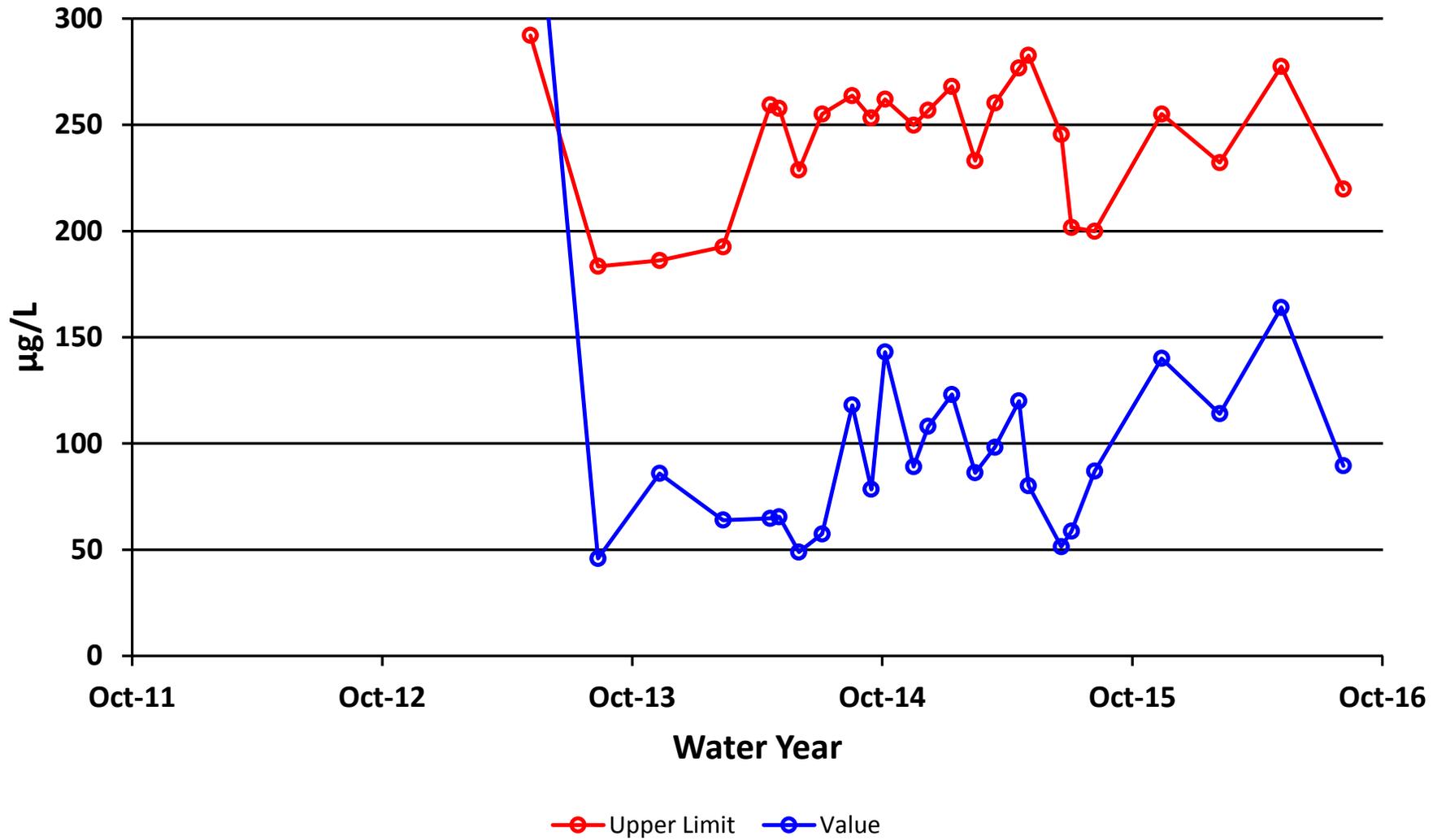
# Site 61 - Nickel Dissolved



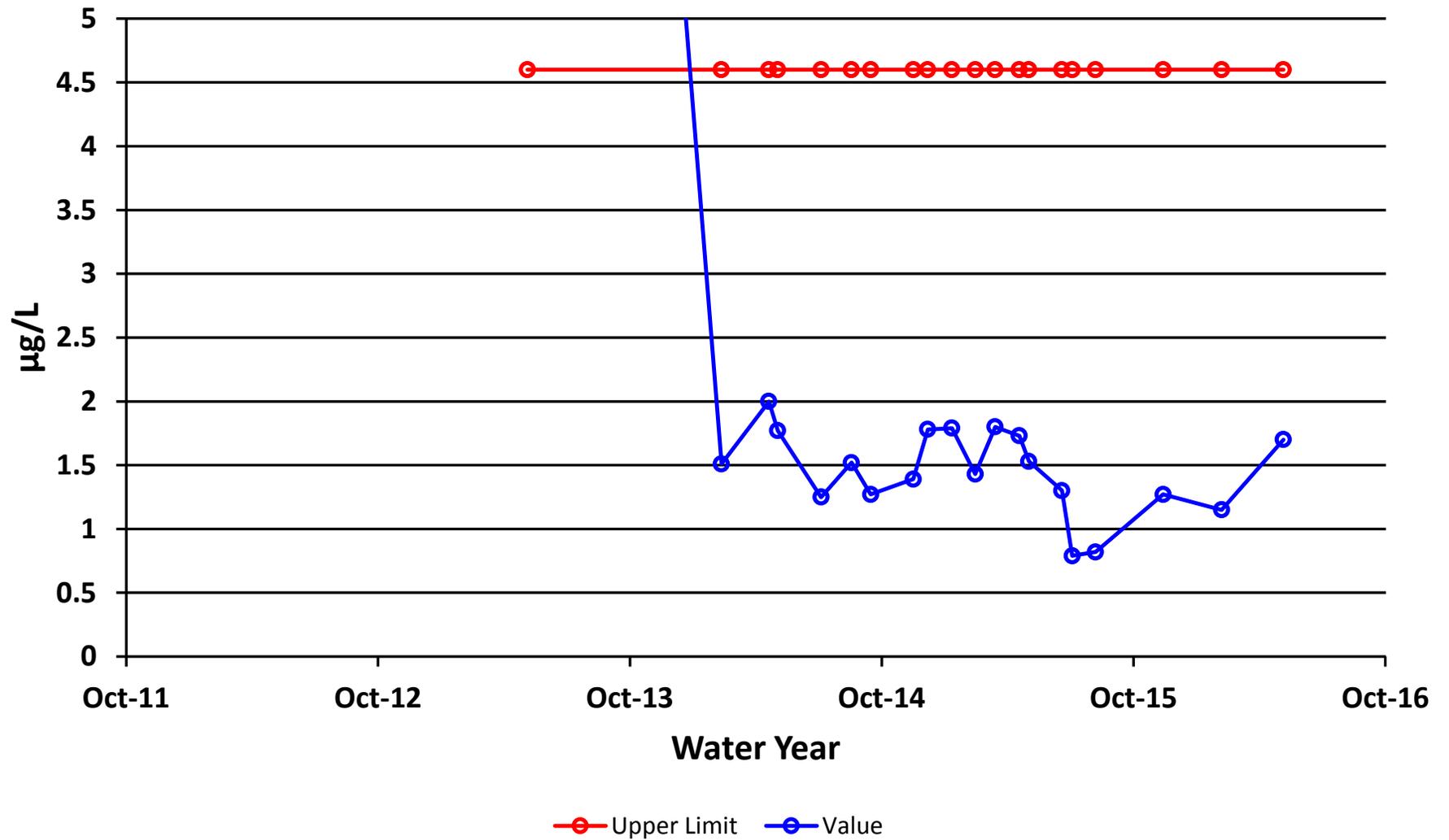
# Site 61 - Silver Dissolved



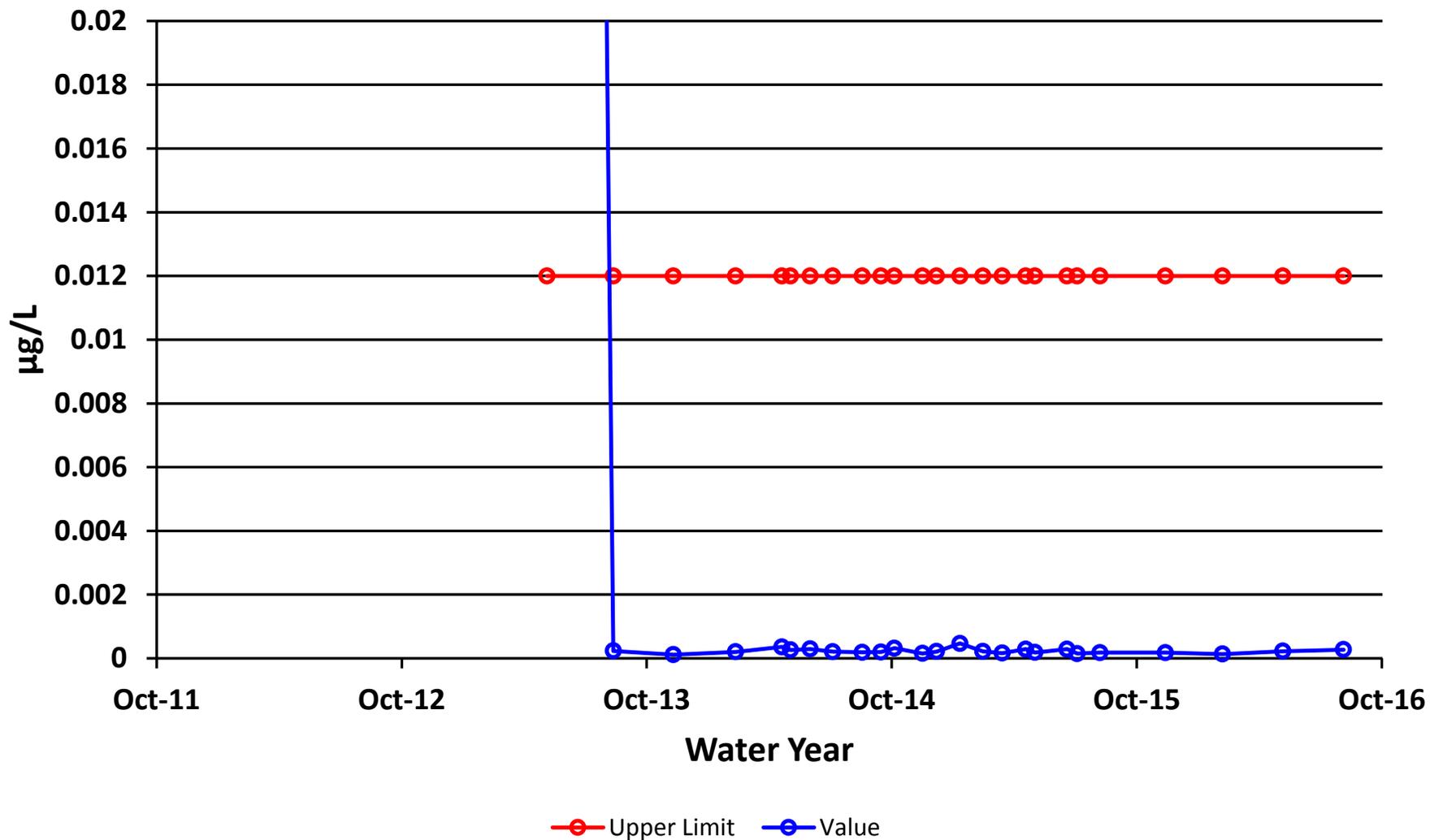
# Site 61 - Zinc Dissolved



# Site 61 - Selenium Dissolved



# Site 61 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 49

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeding these criteria have been identified as listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. There were no visually obvious trends identified.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The below table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). For datasets with a statistically significant trend ( $\alpha/2=2.5\%$ ) a Seasonal-Sen’s Slope estimate statistic has also been calculated. There were no statistically significant trends identified at Site 49 during WY2016.

**Table of Summary Statistics for Trend Analysis**

<b>Parameter</b>	<u>Mann-Kendall test statistics</u>			<u>Sen's slope estimate</u>	
	<b>n*</b>	<b>p**</b>	<b>Trend</b>	<b>Q</b>	<b>Q(%)</b>
Conductivity Field	6	0.55			
pH Field	6	0.84			
Alkalinity, Total	6	0.61			
Sulfate, Total	6	0.50			
Zinc, Dissolved	6	0.07			

\* Number of Years \*\* Significance level

## Table of Results for Water Year 2016

### Site 049FMS - 'Upper Bruin Creek'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		1.8			3.1			5			11.6		4.1
Conductivity-Field(µmho)		153.7			146.7			116.7			168.2		150.2
Conductivity-Lab (µmho)		125			151			111			167		138
pH Lab (standard units)		7.79			7.79			7.8			7.64		7.79
pH Field (standard units)		7.6			7.96			8.06			8.07		8.01
Total Alkalinity (mg/L)		62.6			63			53.7			71.7		62.8
Total Sulfate (mg/L)		10.5			13.3			7.9			13.1		11.8
Hardness (mg/L)		72.1			76.3			56.1			78.4		74.2
Dissolved As (ug/L)		0.165			0.156			0.166			0.18		0.166
Dissolved Ba (ug/L)		10.3			9.9								10.1
Dissolved Cd (ug/L)		0.0293			0.0274			0.0287			0.0282		0.0285
Dissolved Cr (ug/L)		0.187			0.169								0.178
Dissolved Cu (ug/L)		0.551			0.489			0.45			0.476		0.483
Dissolved Pb (ug/L)		0.0065			0.0055			0.0046			0.005		0.0053
Dissolved Ni (ug/L)		0.859			0.69								0.775
Dissolved Ag (ug/L)		0.002			0.002								0.002
Dissolved Zn (ug/L)		2.44			2.05			2.09			1.21		2.07
Dissolved Se (ug/L)		0.543			0.607								0.575
Dissolved Hg (ug/L)		0.00154			0.00176			0.00154			0.00147		0.001540

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

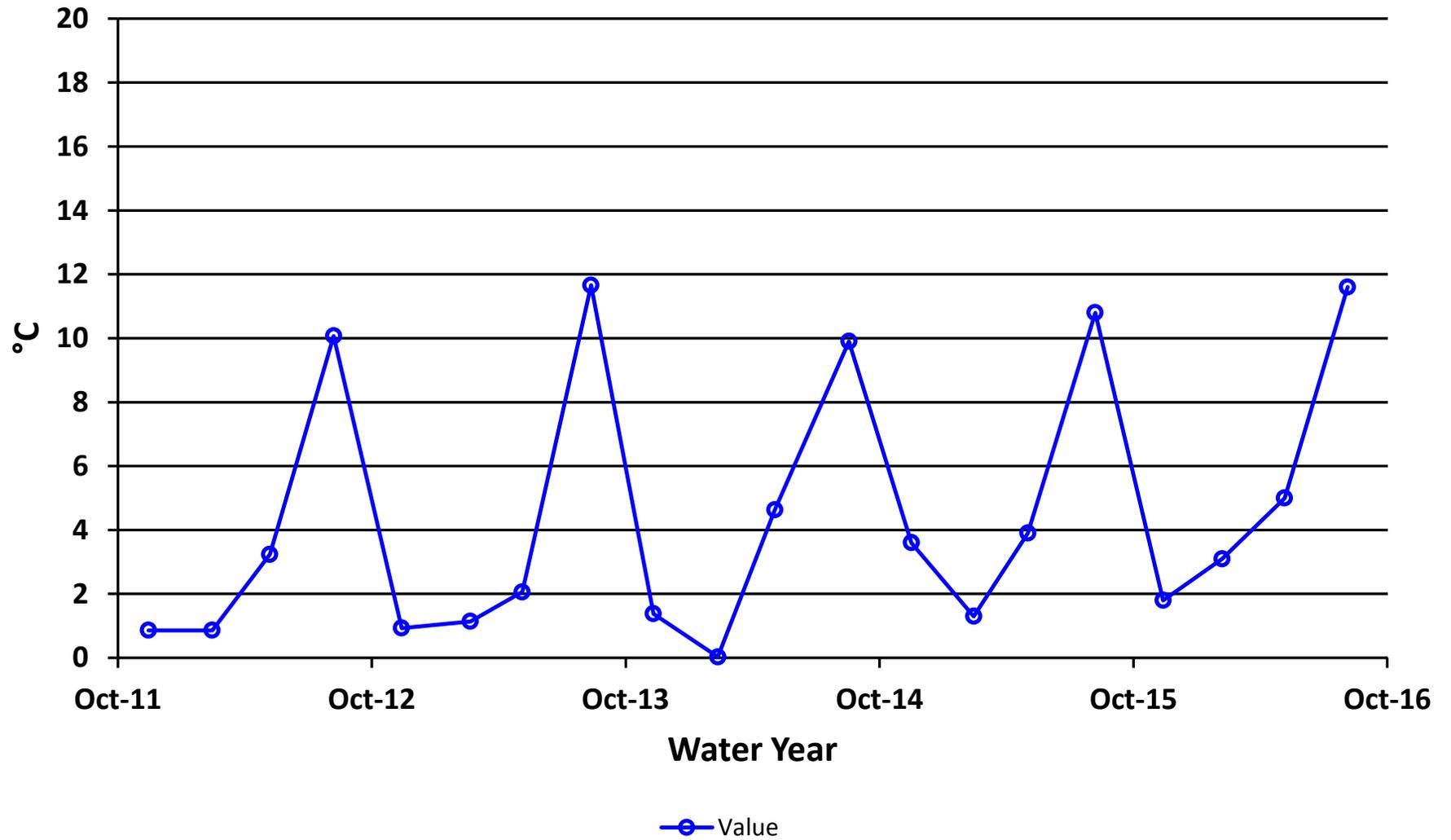
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

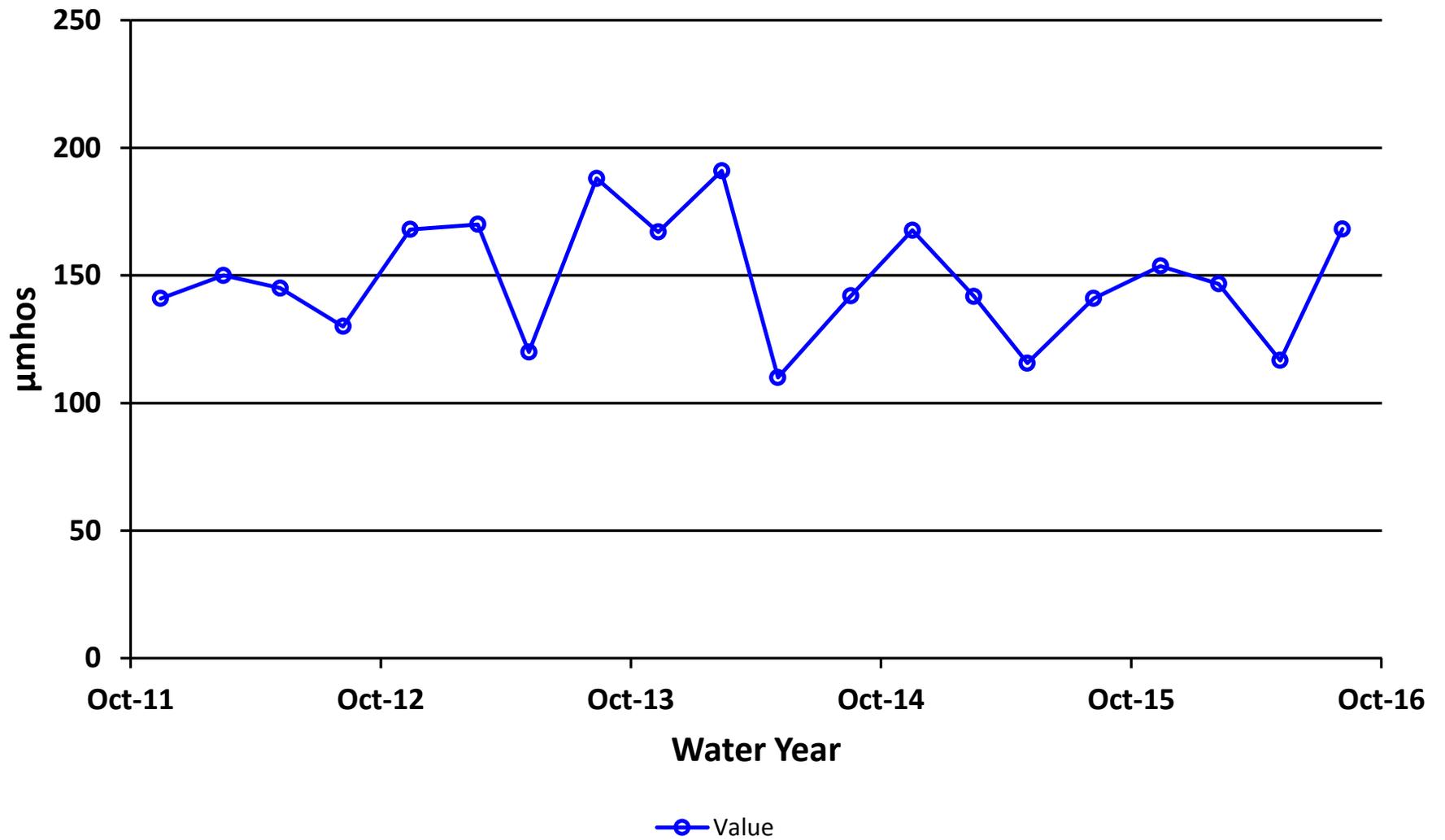
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
049FMS	2/9/2016	12:00 PM	Diss. Cr-ICP/MS	0.16	µg/L	J	Below Quantitative Range
			Diss. Pb-ICP/MS	0.00549	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Pb-ICP/MS	0.00463	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Diss. Pb-ICP/MS	0.00501	µg/L	J	Below Quantitative Range
			Sulfate	13.1	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

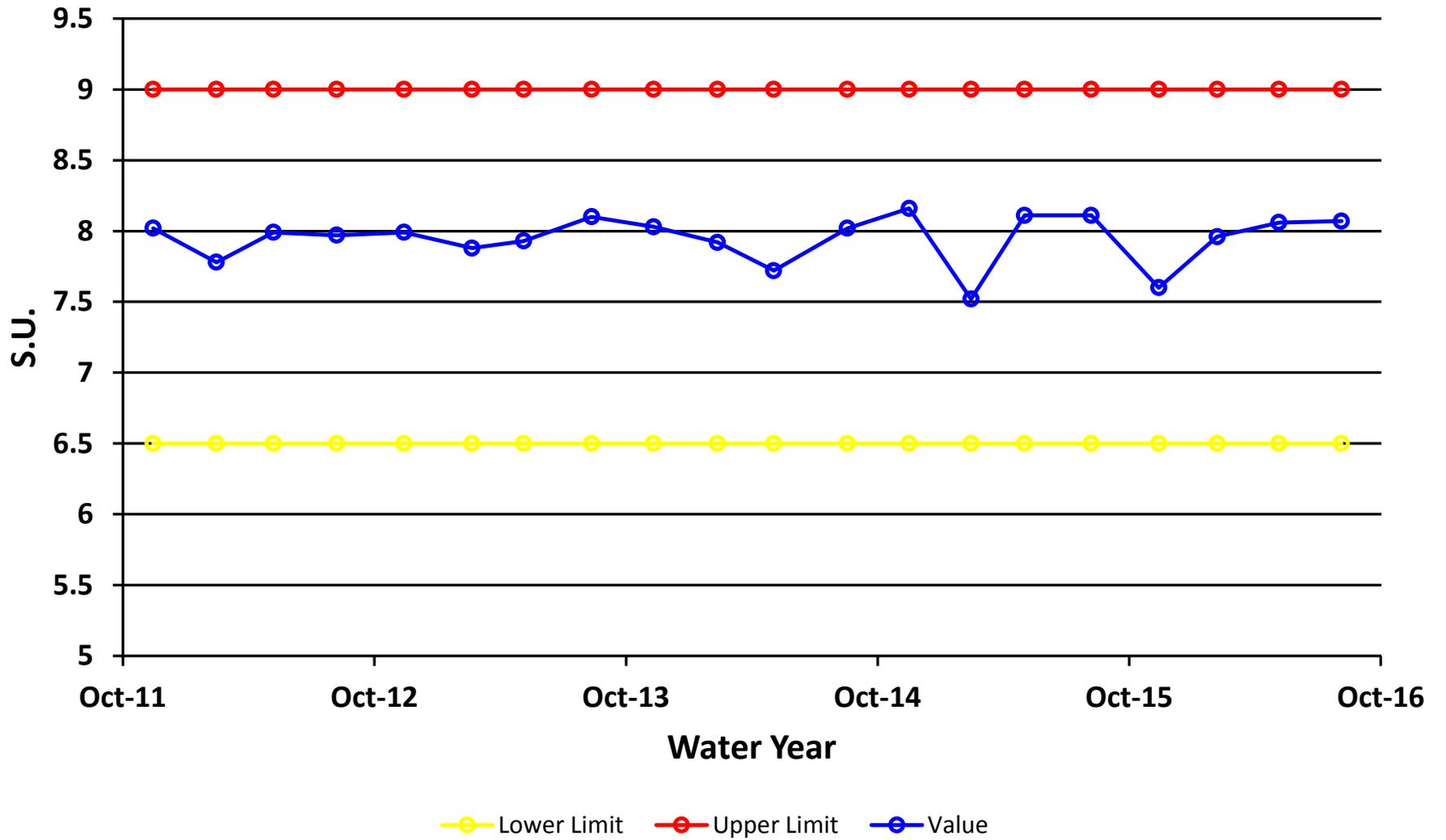
## Site 49 - Water Temperature



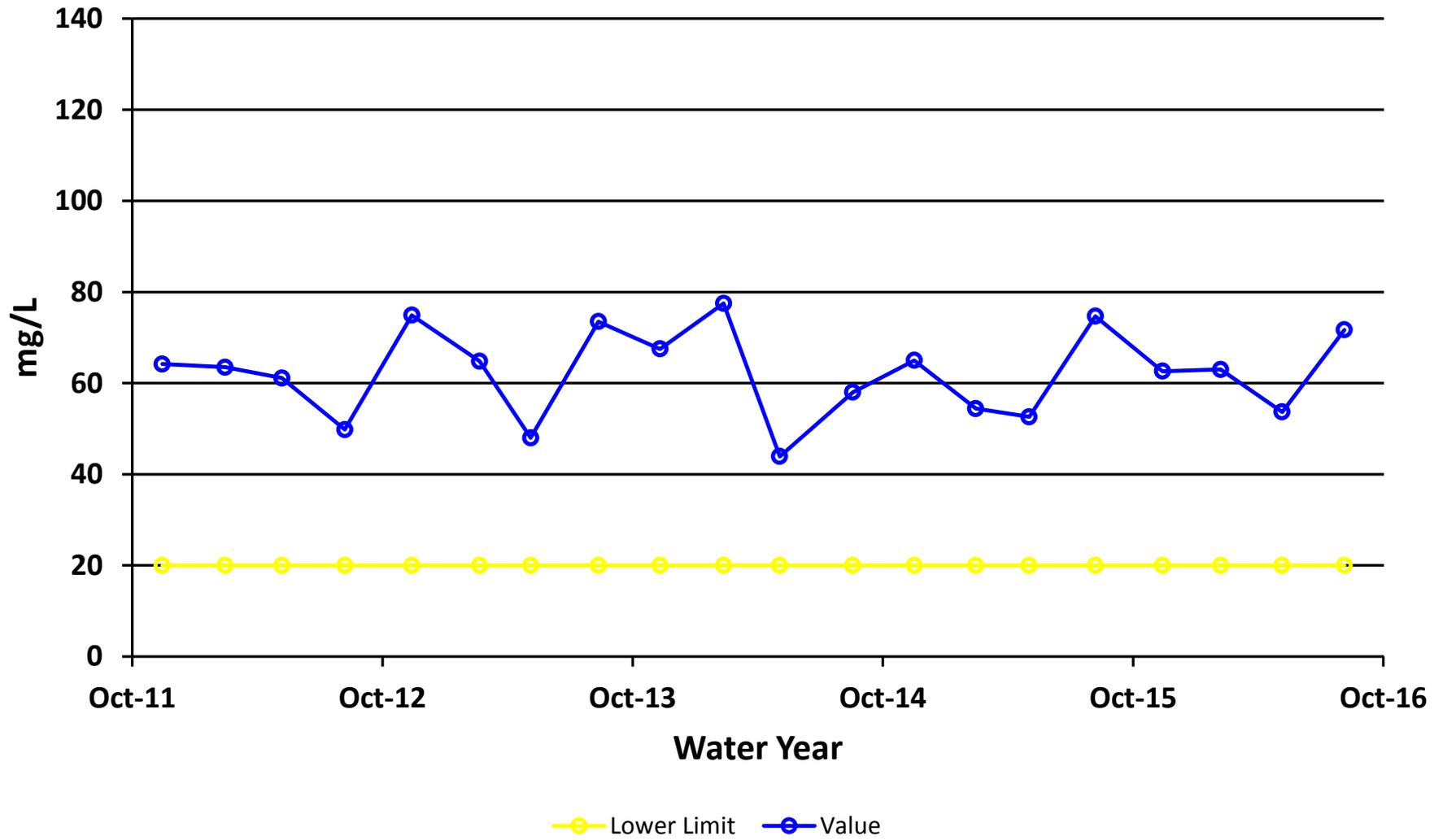
## Site 49 - Conductivity Field



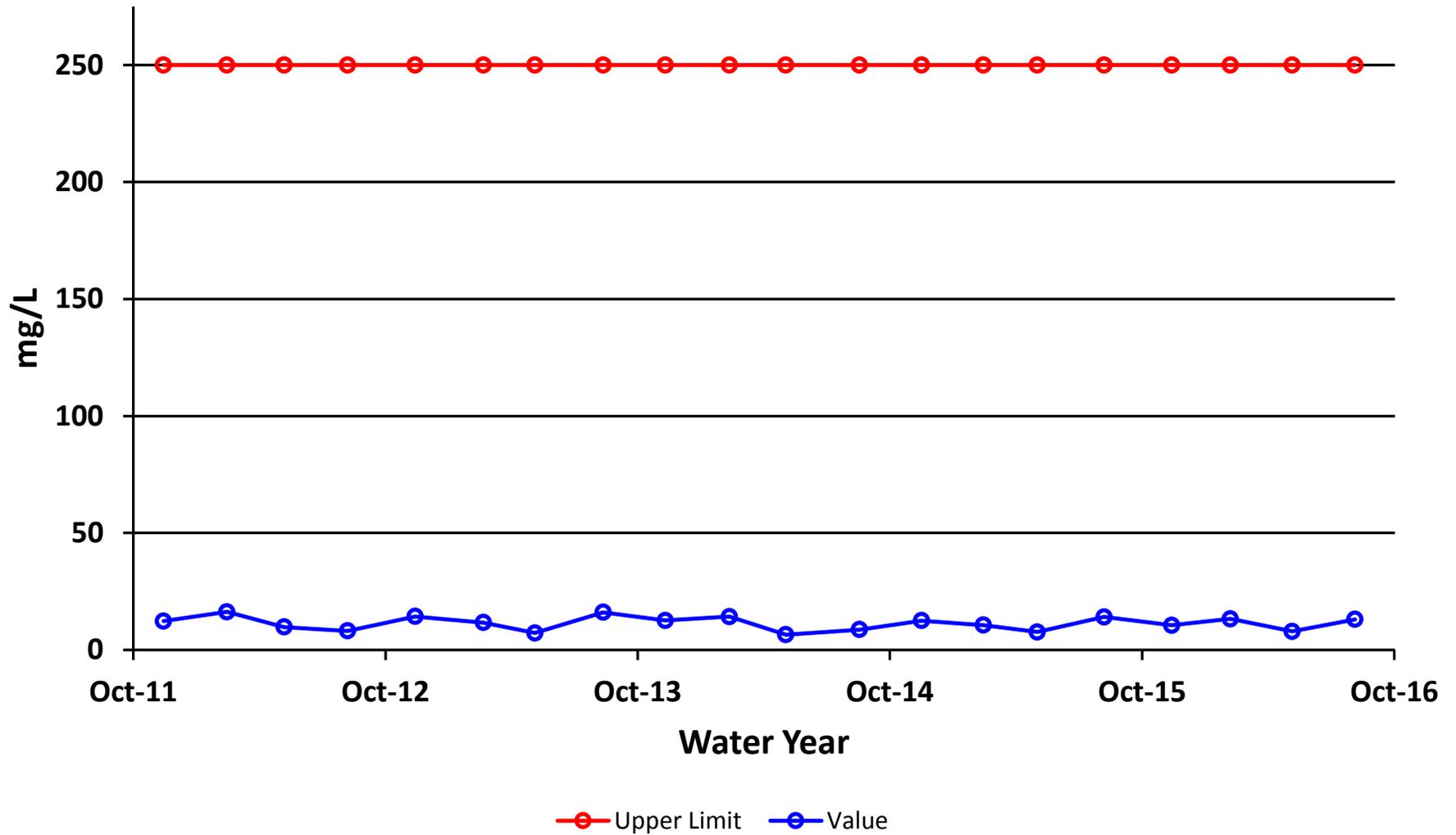
# Site 49 - pH Field



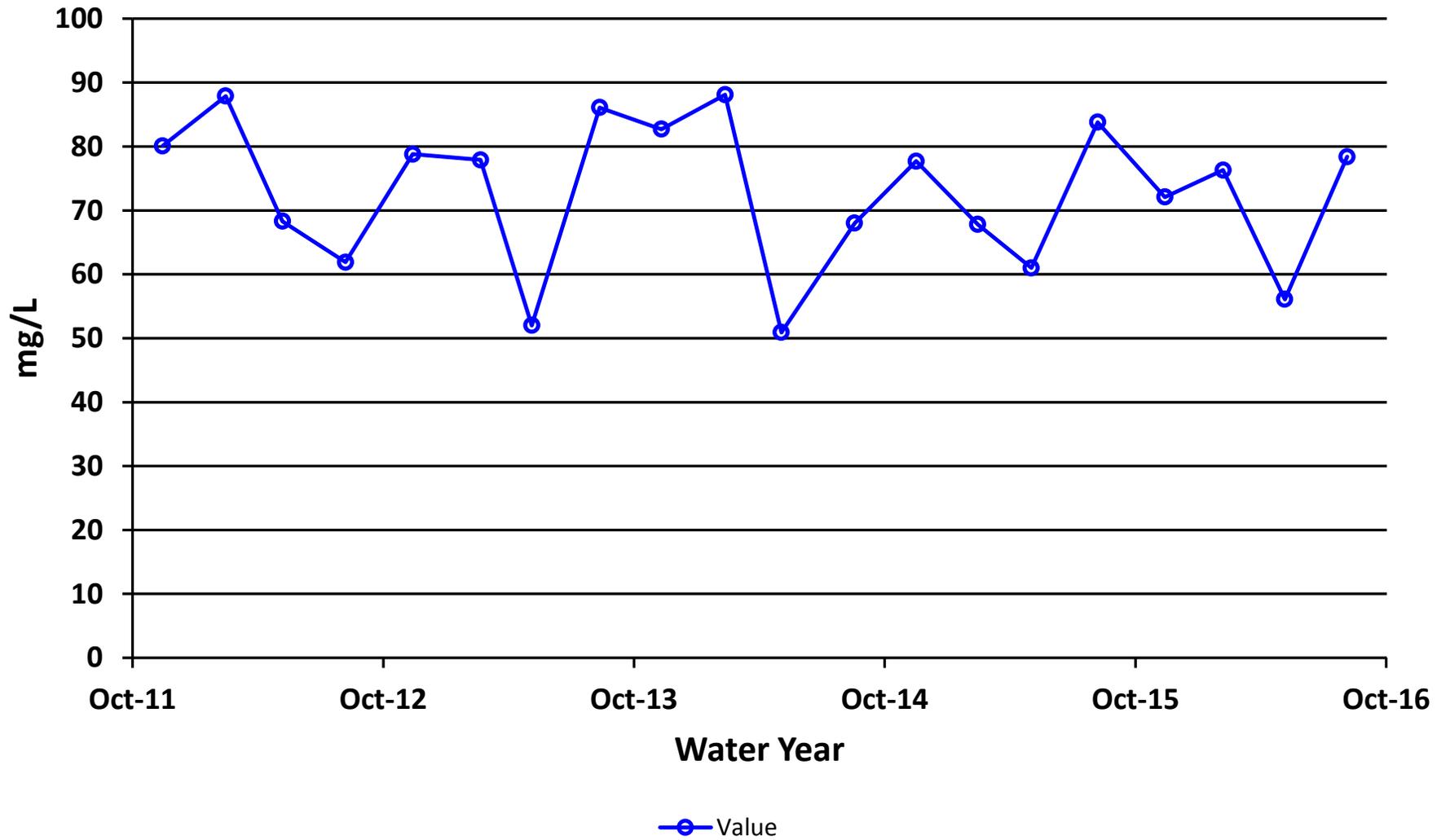
# Site 49 - Alkalinity



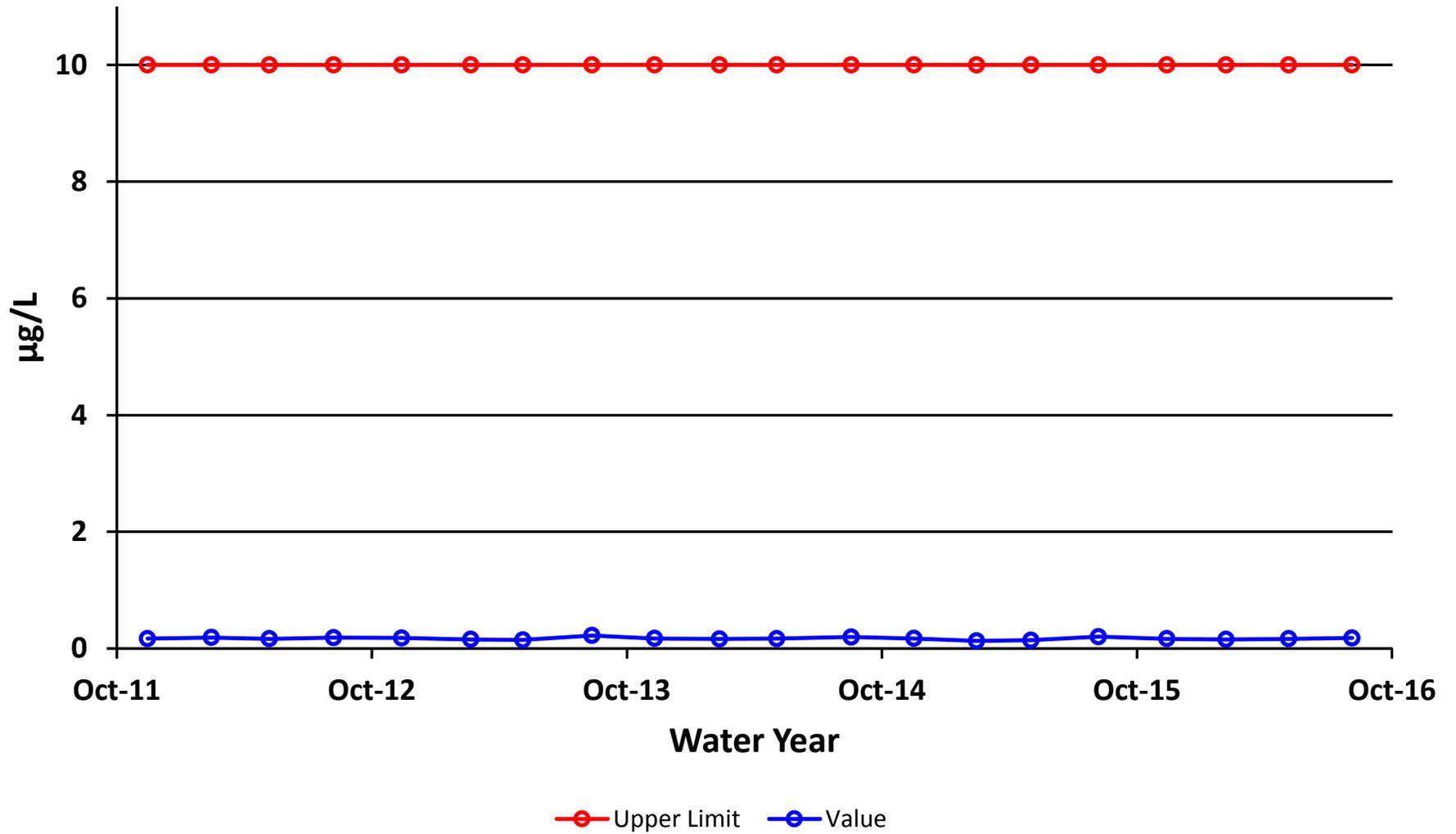
# Site 49 - Sulfate



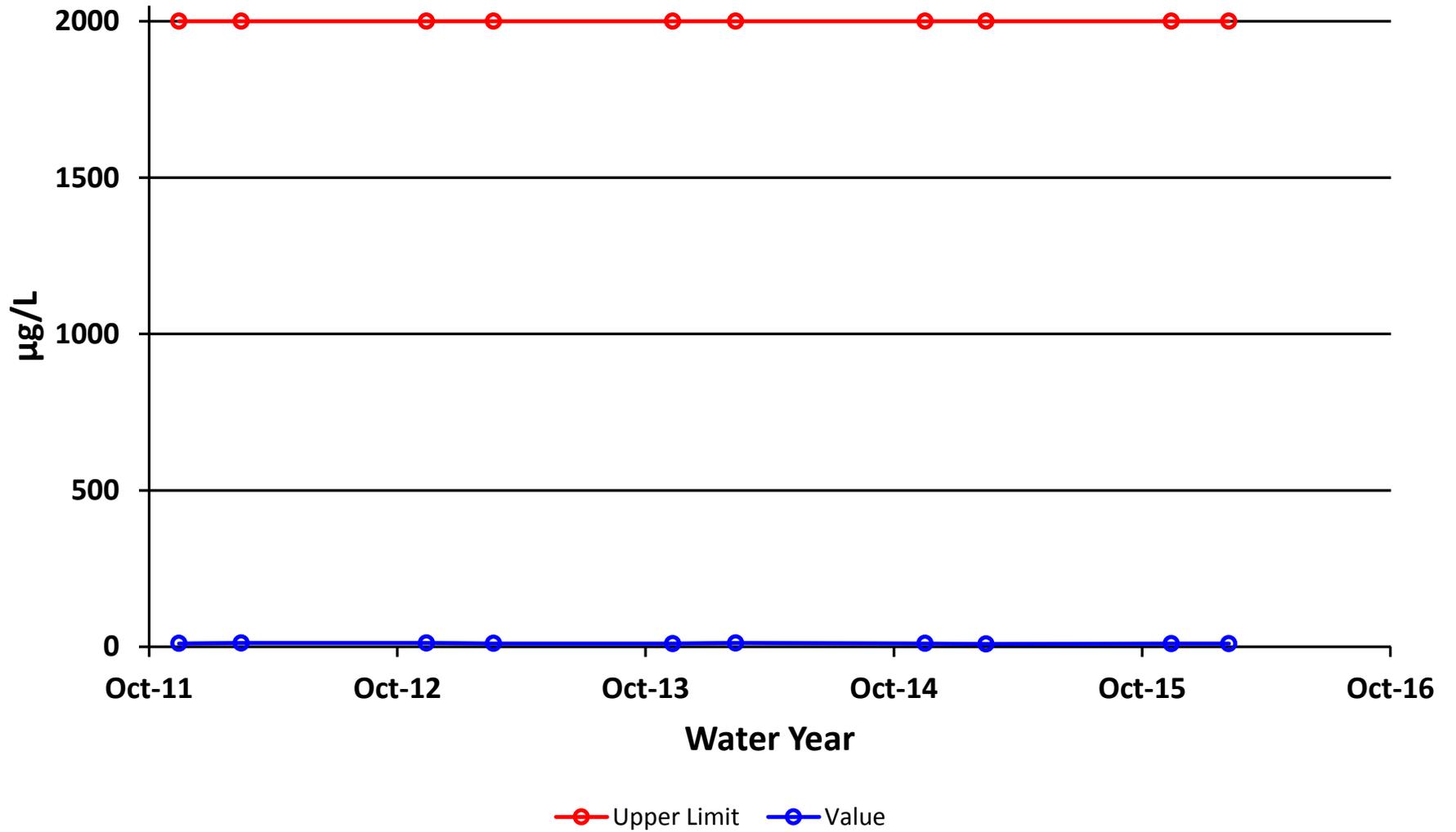
## Site 49 - Hardness



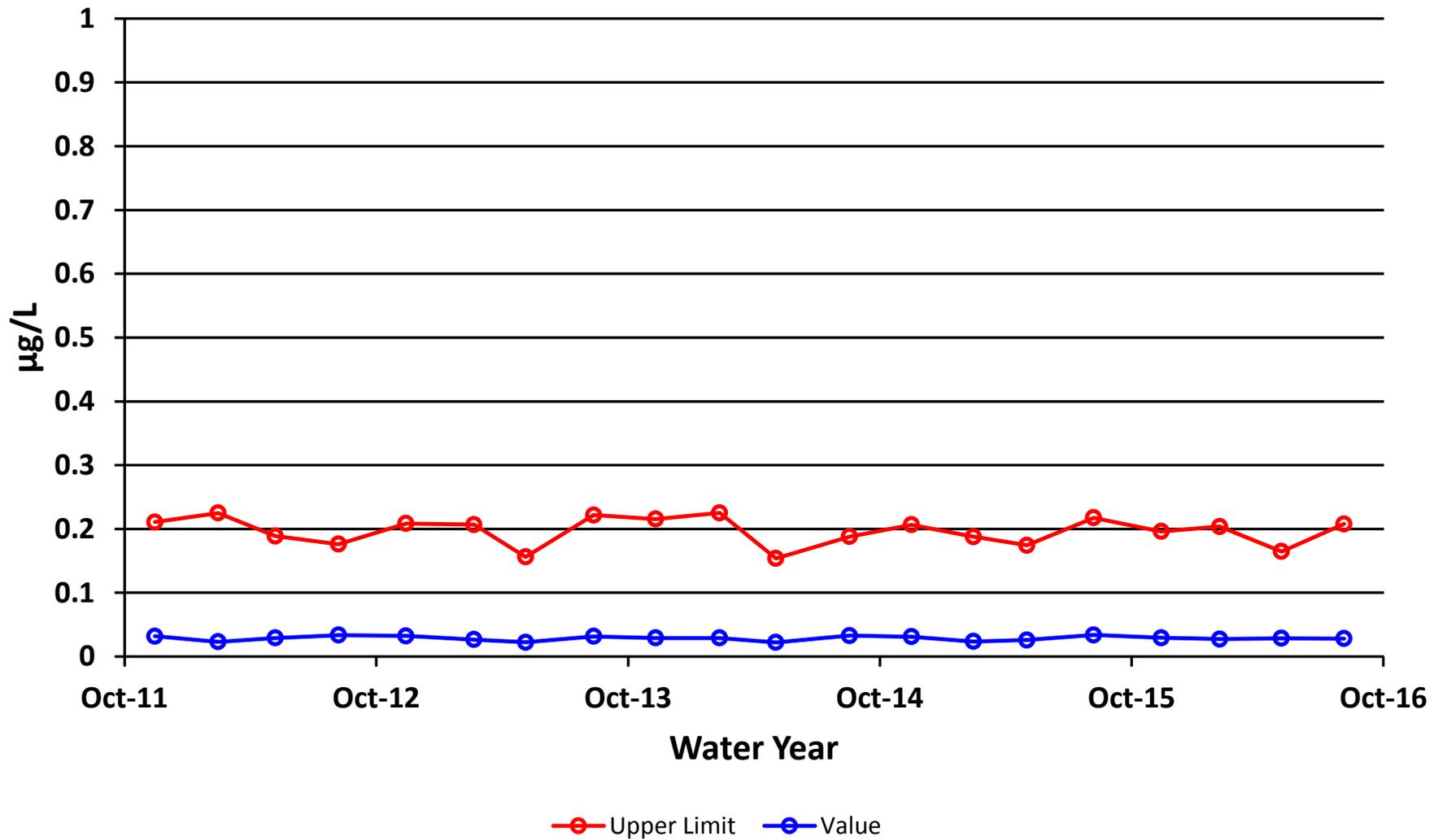
# Site 49 - Arsenic Dissolved



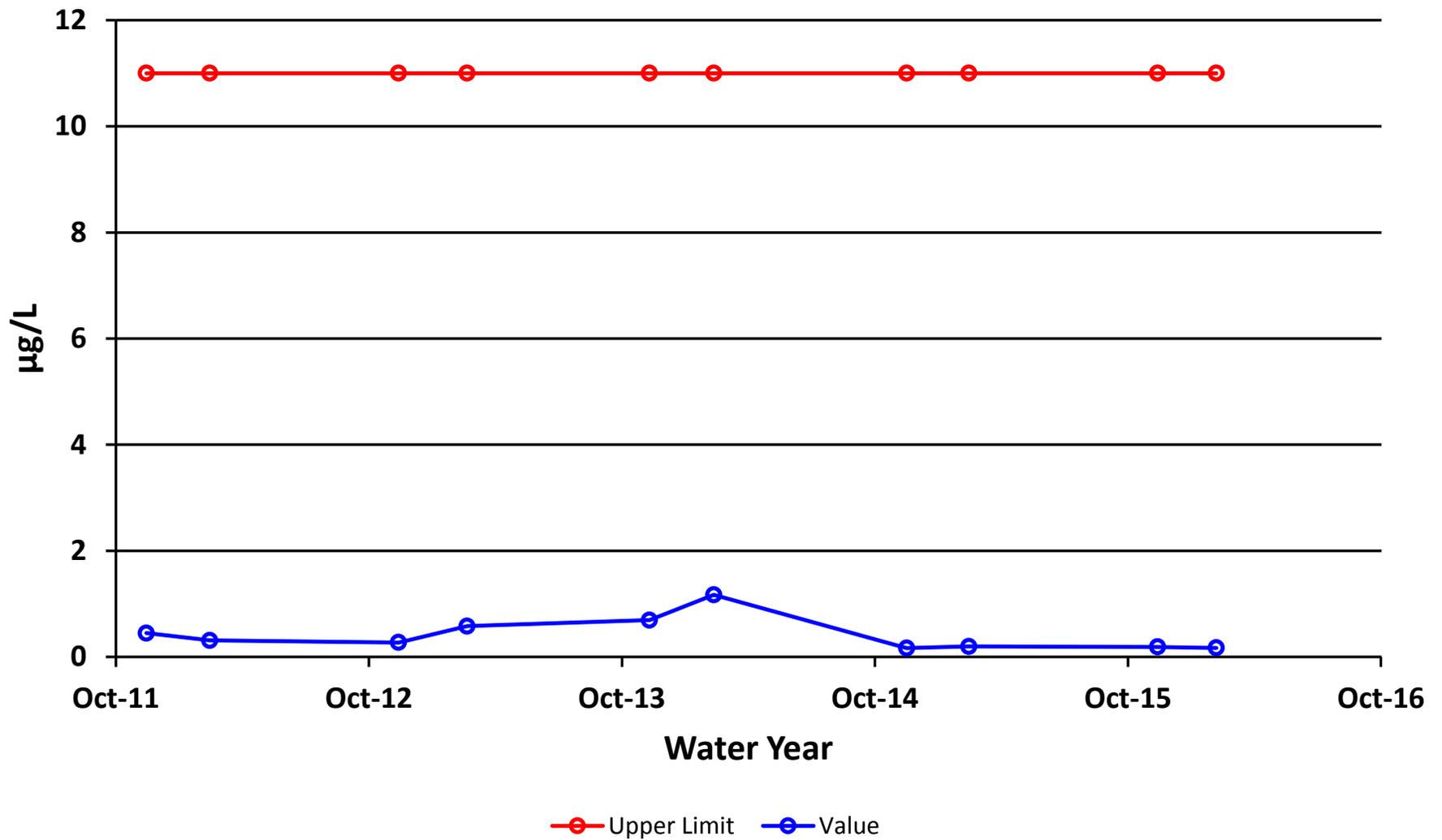
# Site 49 - Barium Dissolved



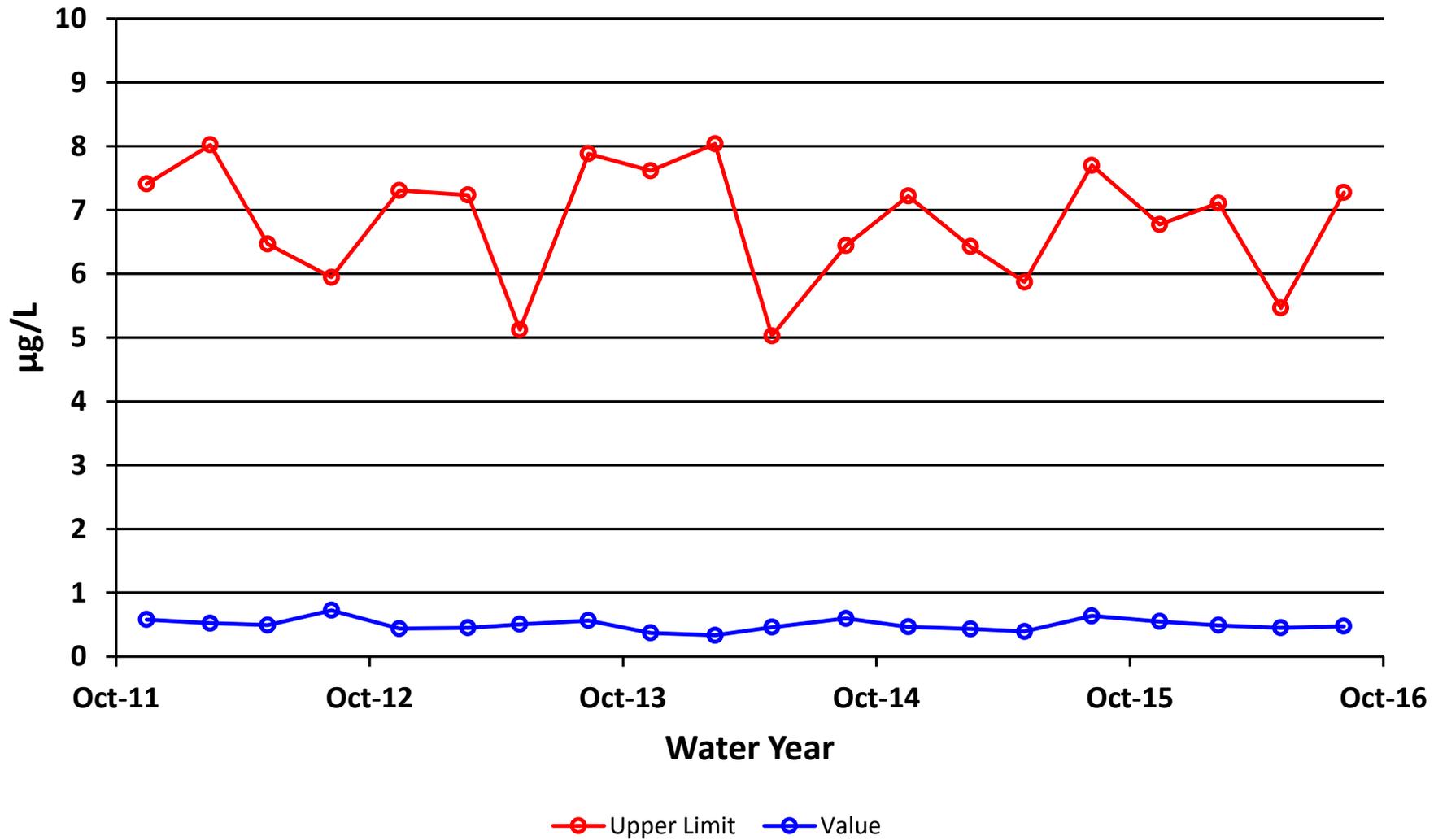
## Site 49 - Cadmium Dissolved



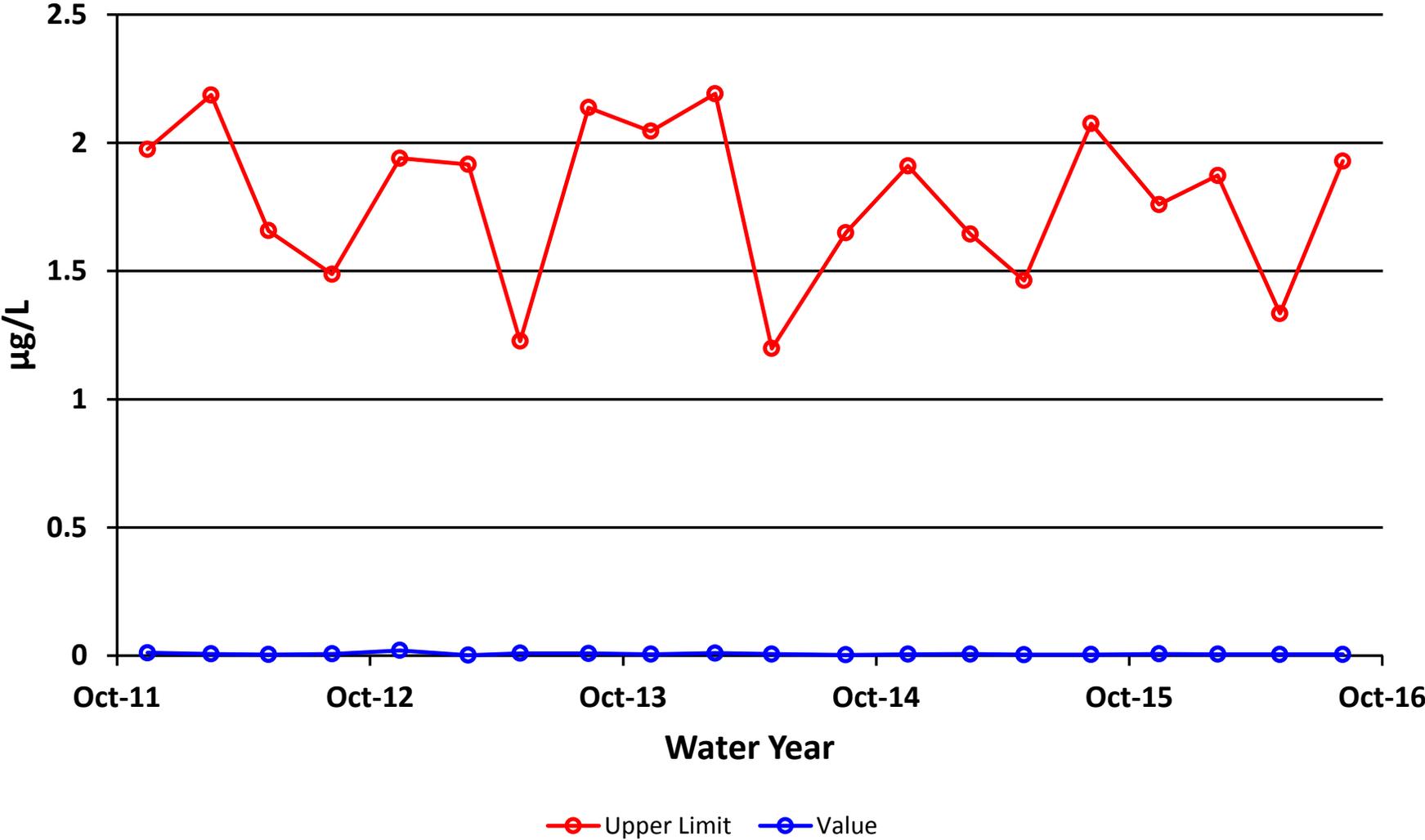
## Site 49 - Chromium Dissolved



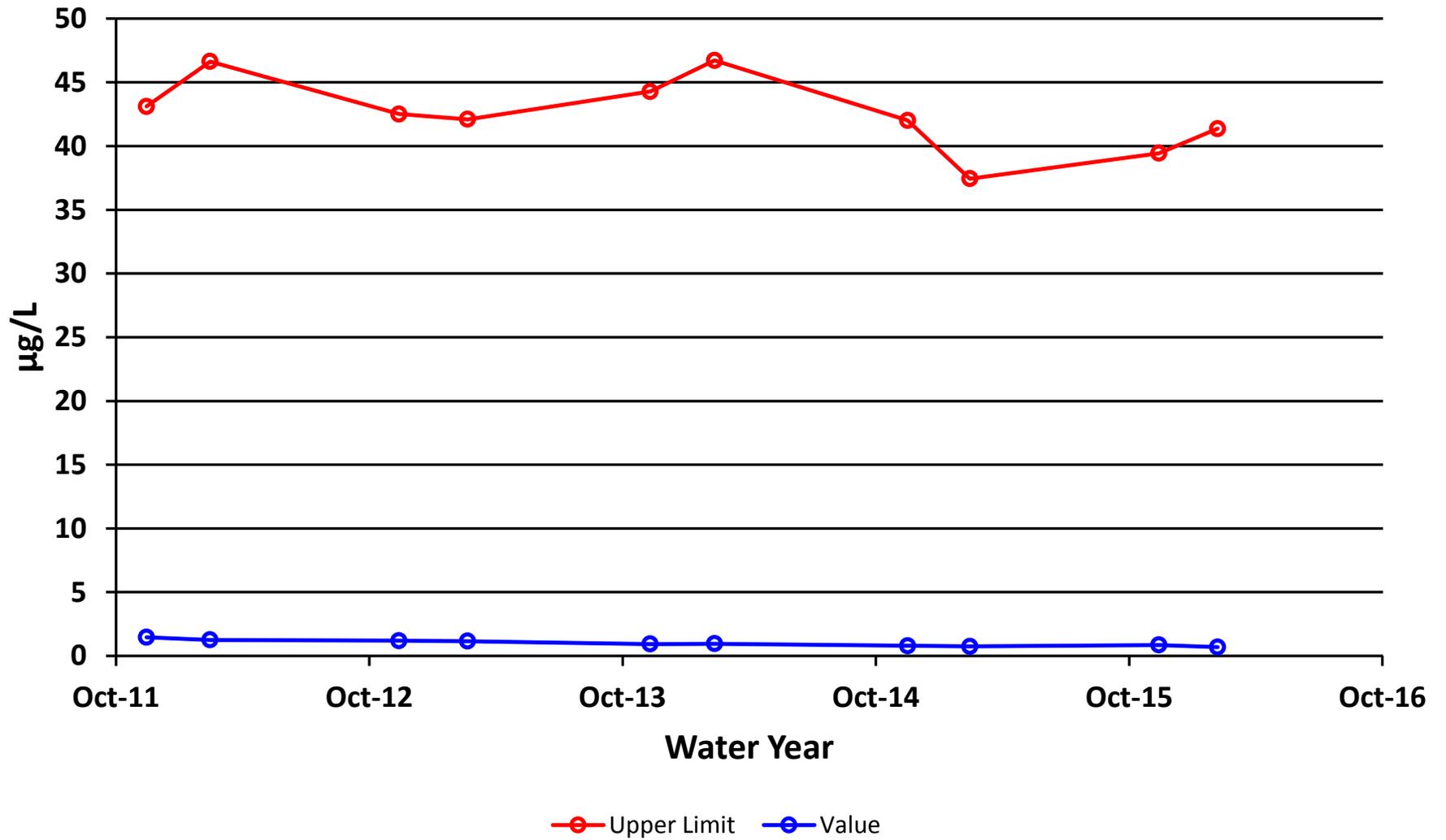
# Site 49 - Copper Dissolved



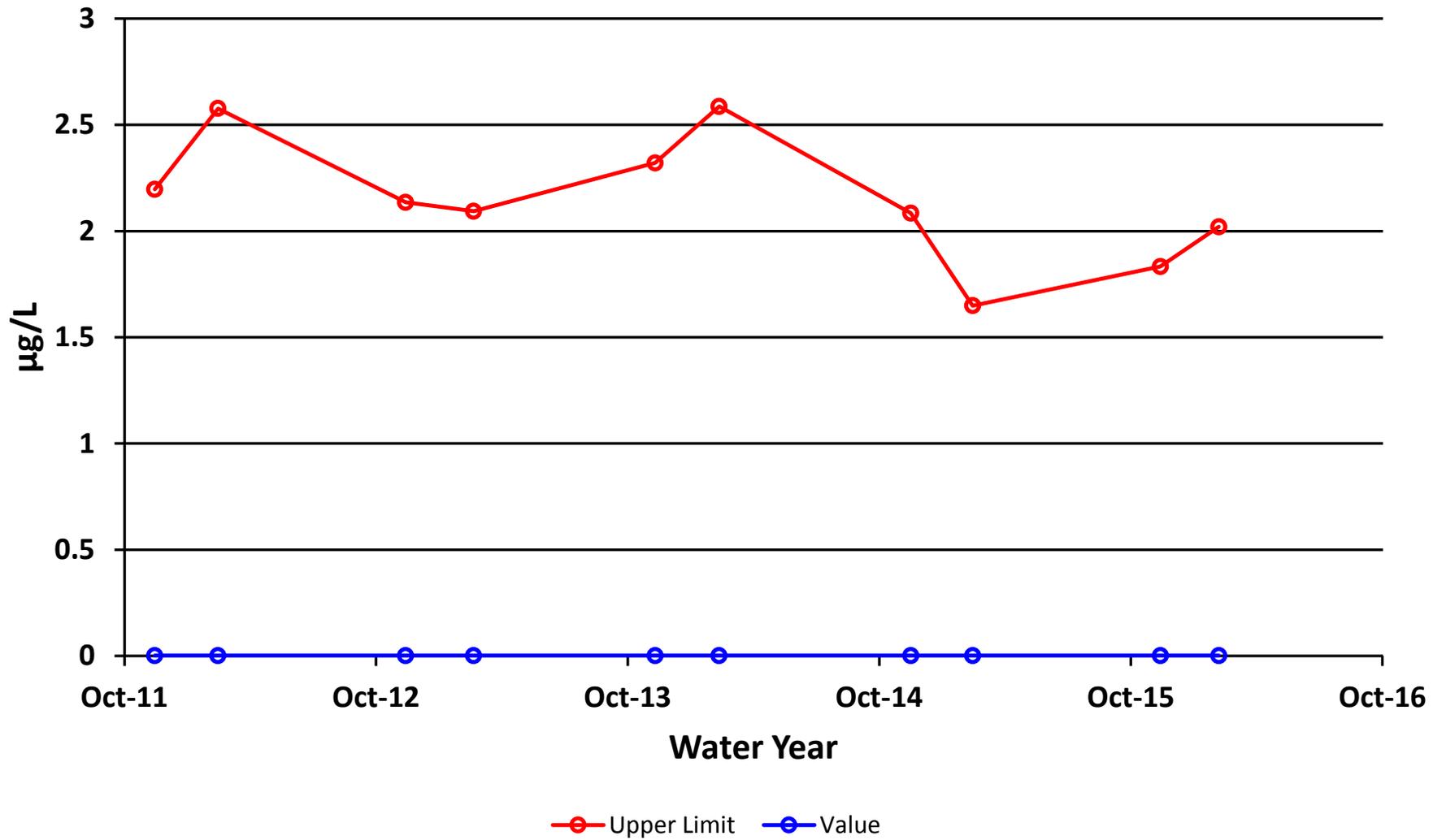
# Site 49 - Lead Dissolved



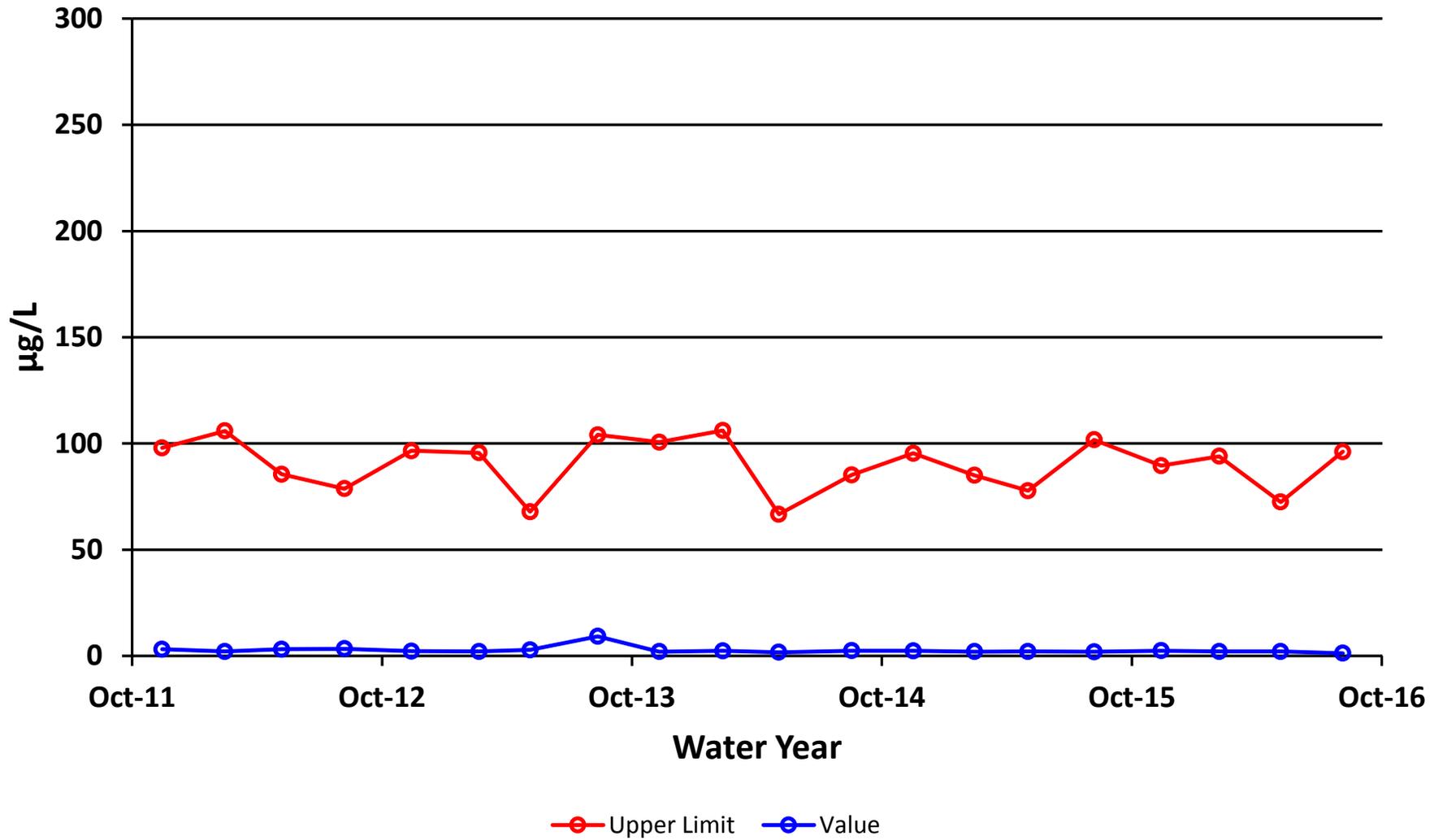
## Site 49 - Nickel Dissolved



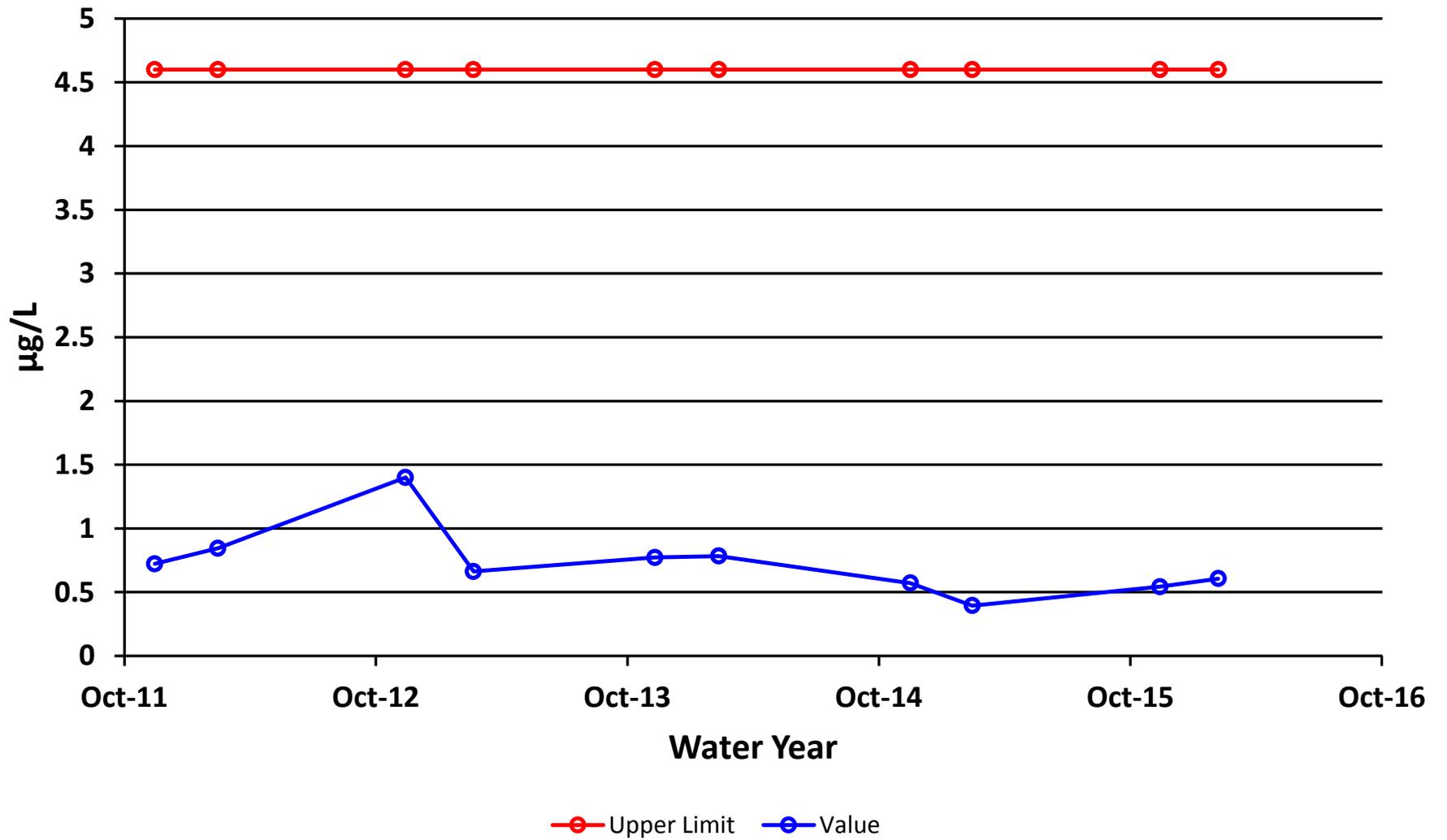
# Site 49 - Silver Dissolved



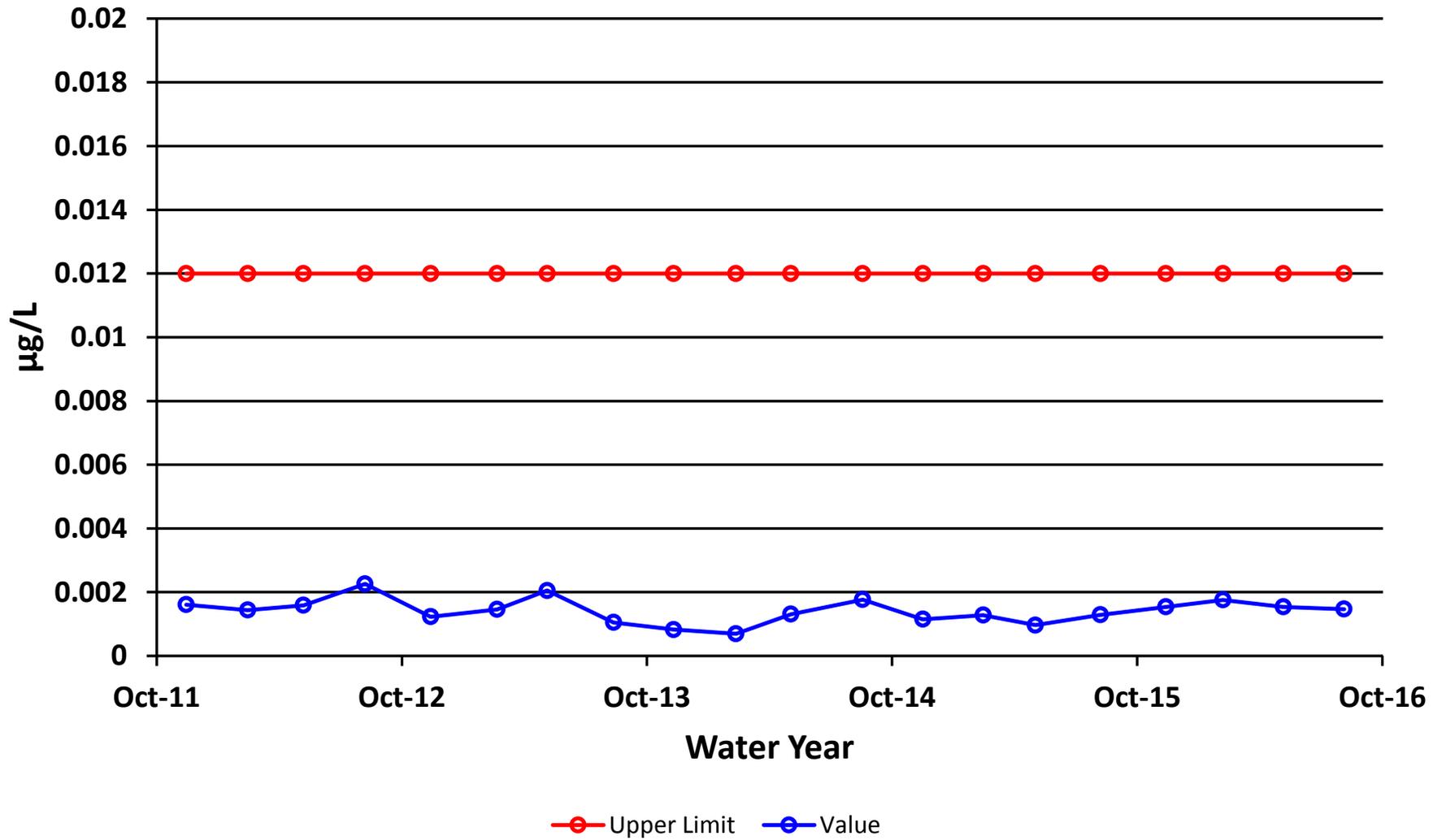
# Site 49 - Zinc Dissolved



# Site 49 - Selenium Dissolved



# Site 49 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 46

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeding these criteria have been identified as listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. No visually obvious trends were identified.

A non-parametric statistical analysis for trend was performed for field conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). Datasets with a statistically significant trend ( $\alpha/2=2.5\%$ ) a Seasonal-Sen’s Slope estimate statistic has also been calculated. There were no statistically significant trends detected for the reporting period.

**Table of Summary Statistics for Trend Analysis**

<b>Parameter</b>	<u>Mann-Kendall test statistics</u>			<u>Sen's slope estimate</u>	
	<b>n*</b>	<b>p**</b>	<b>Trend</b>	<b>Q</b>	<b>Q(%)</b>
Conductivity Field	6	0.82			
pH Field	6	0.93			
Alkalinity, Total	6	0.84			
Sulfate, Total	6	0.55			
Zinc, Dissolved	6	0.08			

\* Number of Years \*\* Significance level

Analytical results from Site 46 were analyzed using combined Shewhart-CUSUM charts. The Shewhart-CUSUM is a sequential analysis technique to determine changes in a variable. For a detailed explanation of the Shewhart-CUSUM calculations, see the corresponding section in the 2015 FWMP report.

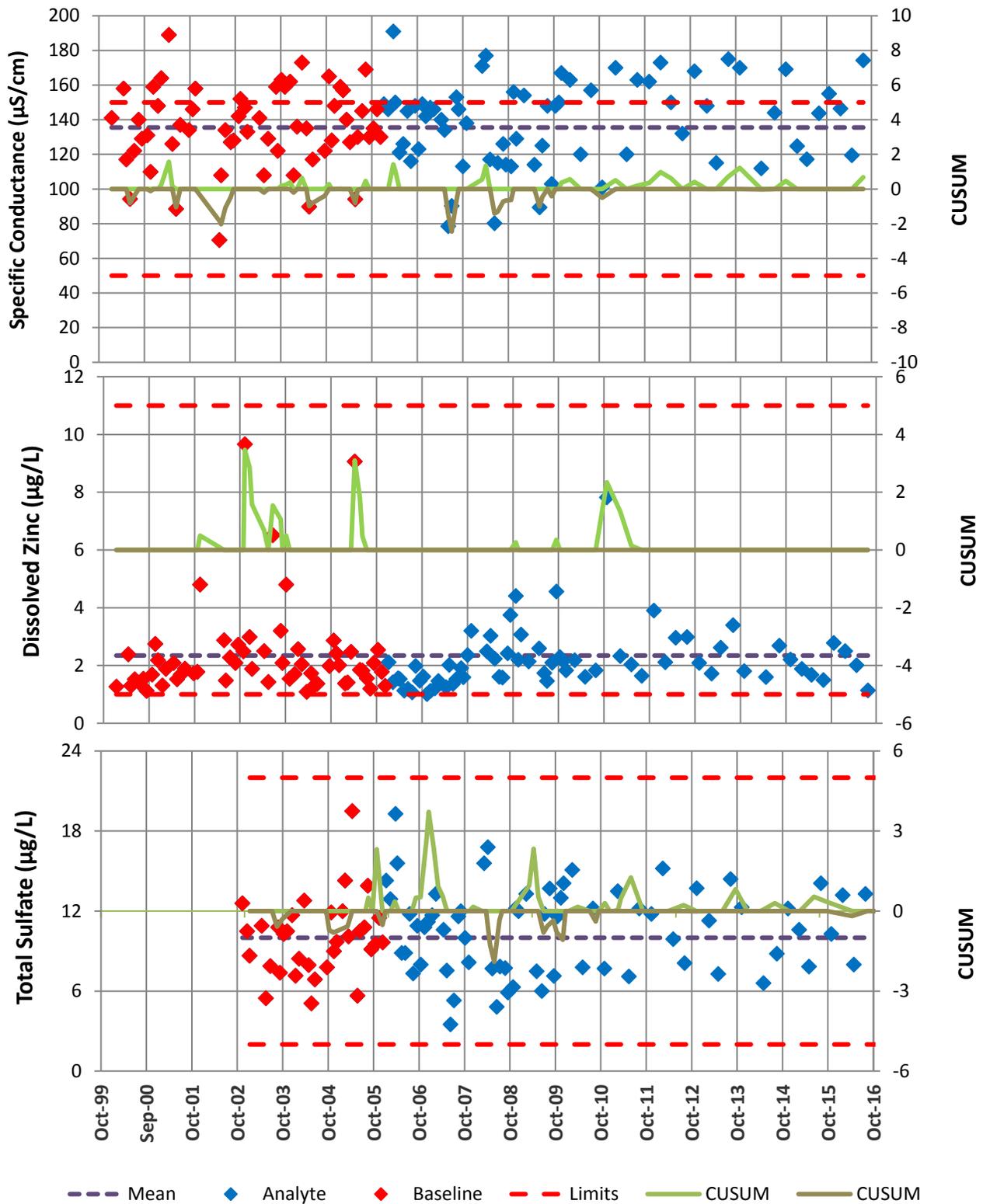
For this year's FWMP report the combined Shewhart-CUSUM control chart statistical analysis was carried out on the specific conductance, dissolved zinc, and total sulfate data from Site 46. In order to use the analysis, background values were calculated for each of the analytes. The first several years of sampling were chosen for these calculations, summarized in the Table 1.

The visual representations of these calculations are graphed in Figure 1. All three of the analytes have previously reached the lowest control limit (SCL=2). Each of the sites were below the EPA recommend control limit of SCL=4.5. Values for the CUSUM statistic ranged from a low of 0, observed in each analysis to a high of 3.7 recorded for total sulfate. None of the analyses exceed the established limit of h=5 (dotted redlines). In order for a process to be considered 'out of control' both metrics (Shewhart & CUSUM) need to be 'out of control'. Note (Figure 1) that none of the analytes went out of control during the monitoring period. This supports the conclusion drawn in the previous FWMP reports that HGCMC activities in the Site23 / D Pile area are not having a measurable effect on Bruin Creek.

**Table 1. Specific Conductance, Dissolved Zinc, and Total Sulfate Baseline Periods, Summary Statistics and Various Control Limits**

	Site 46 Conductivity ( $\mu\text{S}/\text{cm}$ )	Site 46 Diss. Zinc ( $\mu\text{g}/\text{L}$ )	Site 46 Total Sulfate (mg/L)
<b>Baseline Statistics</b>			
Baseline Period	12/1/99–12/14/05	12/1/99–12/14/05	11/12/02–12/14/05
Number of Samples	58	58	33
Mean ( $\bar{x}$ )	135.5	2.3	10.0
Standard Deviation	22.9	1.6	2.86
<b>Shewhart-CUSUM Control Limits (SCL)</b>			
Control Limit (mean $\bar{x} + 2s$ )	181.4	5.6	15.7
Control Limit (mean $\bar{x} + 3s$ )	204.4	7.3	18.6
Control Limit (mean $\bar{x} + 4s$ )	227.3	8.9	21.5
Control Limit (mean $\bar{x} + 4.5s$ )	238.8	9.7	22.9
<b>CUSUM Control Limits</b>			
Cumulative increase (h)	5	5	5

**Figure 1. Observed Measurements for Specific Conductance, Dissolved Zinc, and Total Sulfate from Site 46 Compared to the Shewhart-CUSUM Control Limits From Table 2**



## Table of Results for Water Year 2016

### Site 046FMS - 'Lower Bruin Creek'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		2.1			3.0			5			11.8		4.0
Conductivity-Field(µmho)		155			146.4			119.5			174.2		150.7
Conductivity-Lab (µmho)		126			151			113			171		139
pH Lab (standard units)		7.79			7.71			7.86			7.72		7.76
pH Field (standard units)		7.71			7.98			8.04			7.94		7.96
Total Alkalinity (mg/L)		62.7			63.2			55.1			75		63.0
Total Sulfate (mg/L)		10.3			13.2			8			13.3		11.8
Hardness (mg/L)		71.2			75.8			57.5			81.1		73.5
Dissolved As (ug/L)		0.353			0.272			0.257			0.238		0.265
Dissolved Ba (ug/L)		11.7			11.8								11.8
Dissolved Cd (ug/L)		0.0278			0.0277			0.0296			0.0258		0.0278
Dissolved Cr (ug/L)		0.135			0.18								0.158
Dissolved Cu (ug/L)		0.636			0.624			0.505			0.528		0.576
Dissolved Pb (ug/L)		0.0322			0.0288			0.0158			0.0132		0.0223
Dissolved Ni (ug/L)		0.83			0.668								0.749
Dissolved Ag (ug/L)		0.002			0.002								0.002
Dissolved Zn (ug/L)		2.78			2.5			2.01			1.14		2.26
Dissolved Se (ug/L)		0.523			0.558								0.541
Dissolved Hg (ug/L)		0.00158			0.00175			0.00166			0.00138		0.001620

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

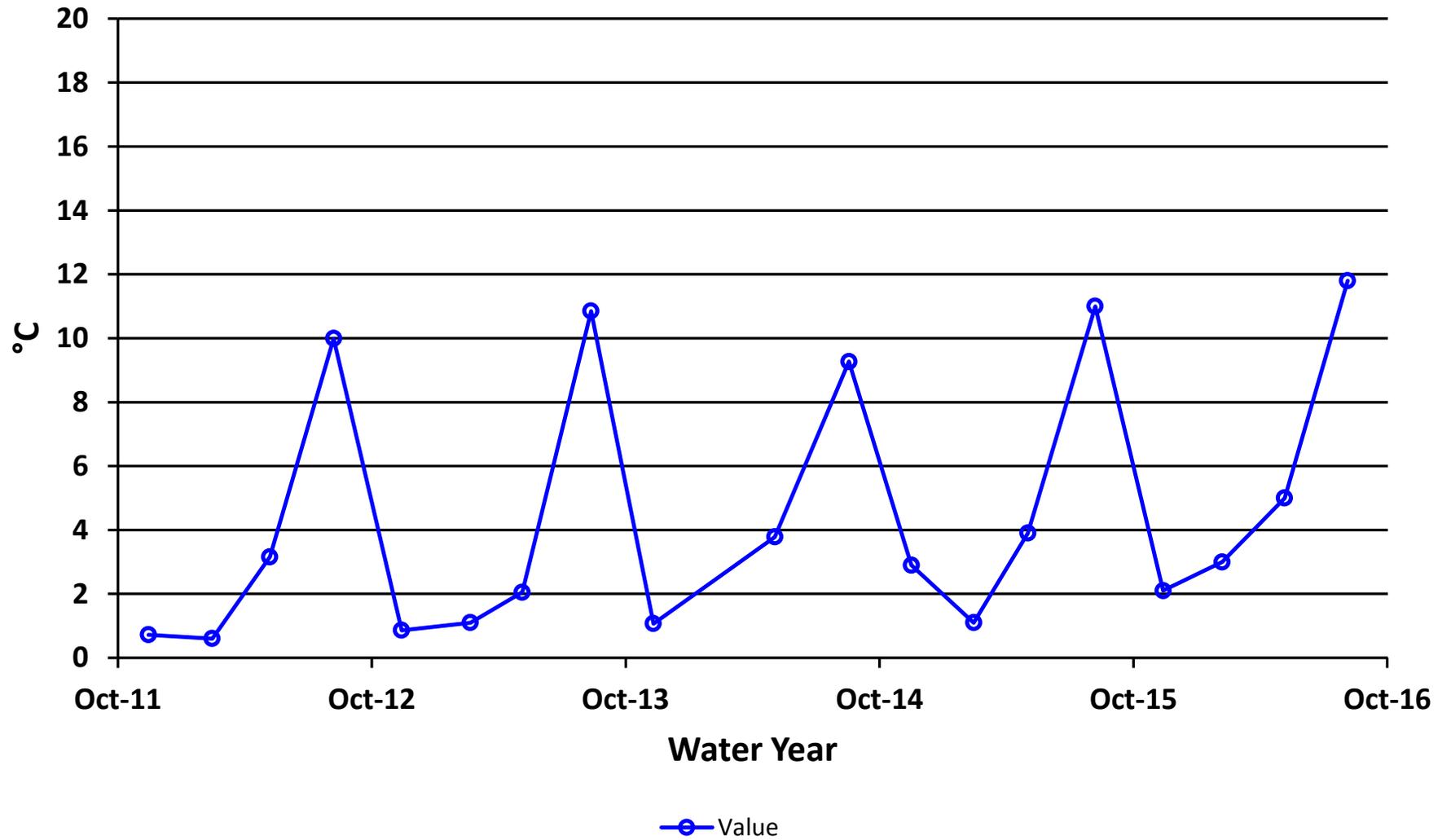
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

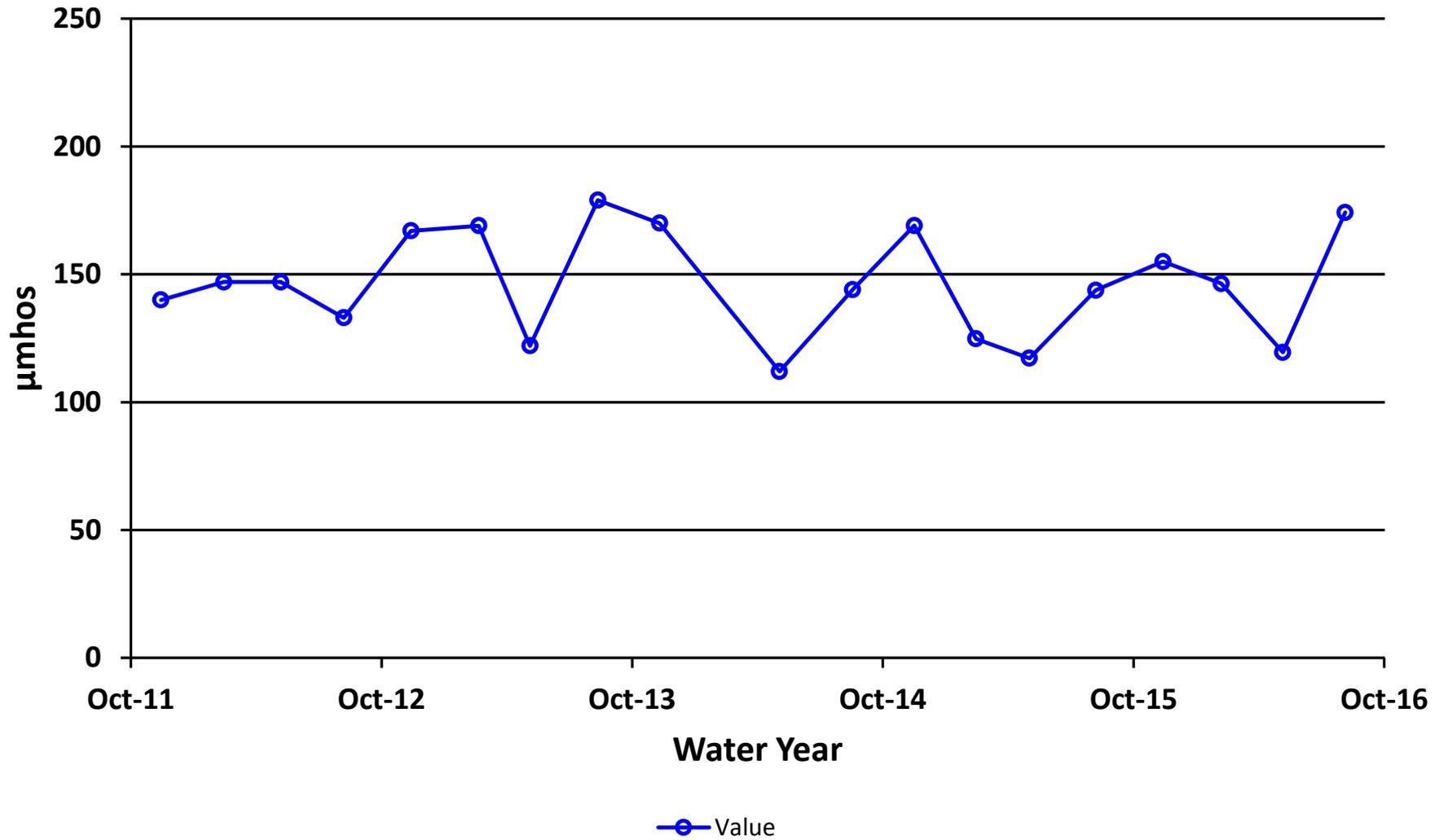
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
046FMS	11/16/2015	12:00 PM	Diss. Cr-ICP/MS	0.13	µg/L	J	Below Quantitative Range
046FMS	8/8/2016	12:00 PM	Sulfate	13.3	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

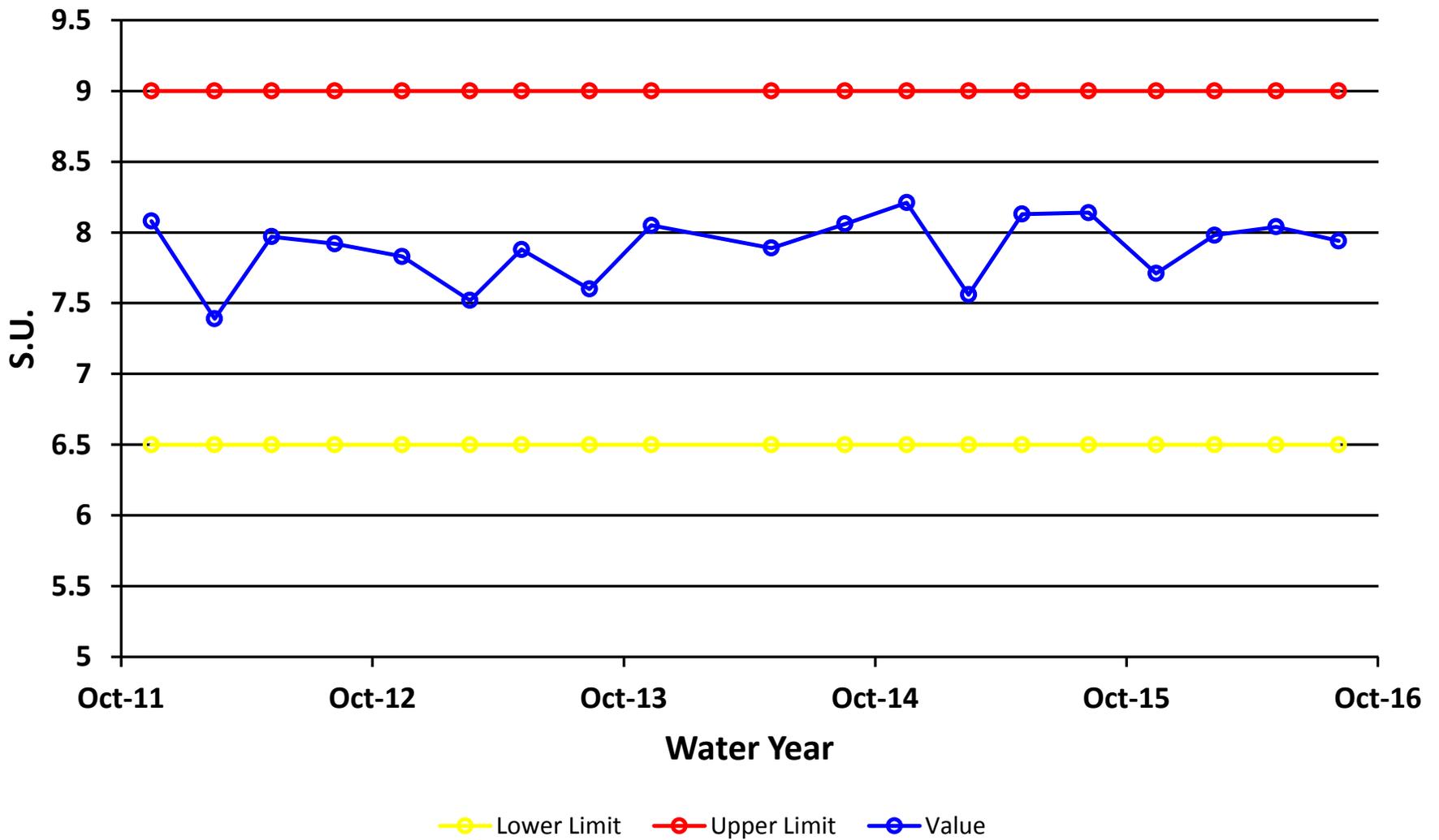
## Site 46 - Water Temperature



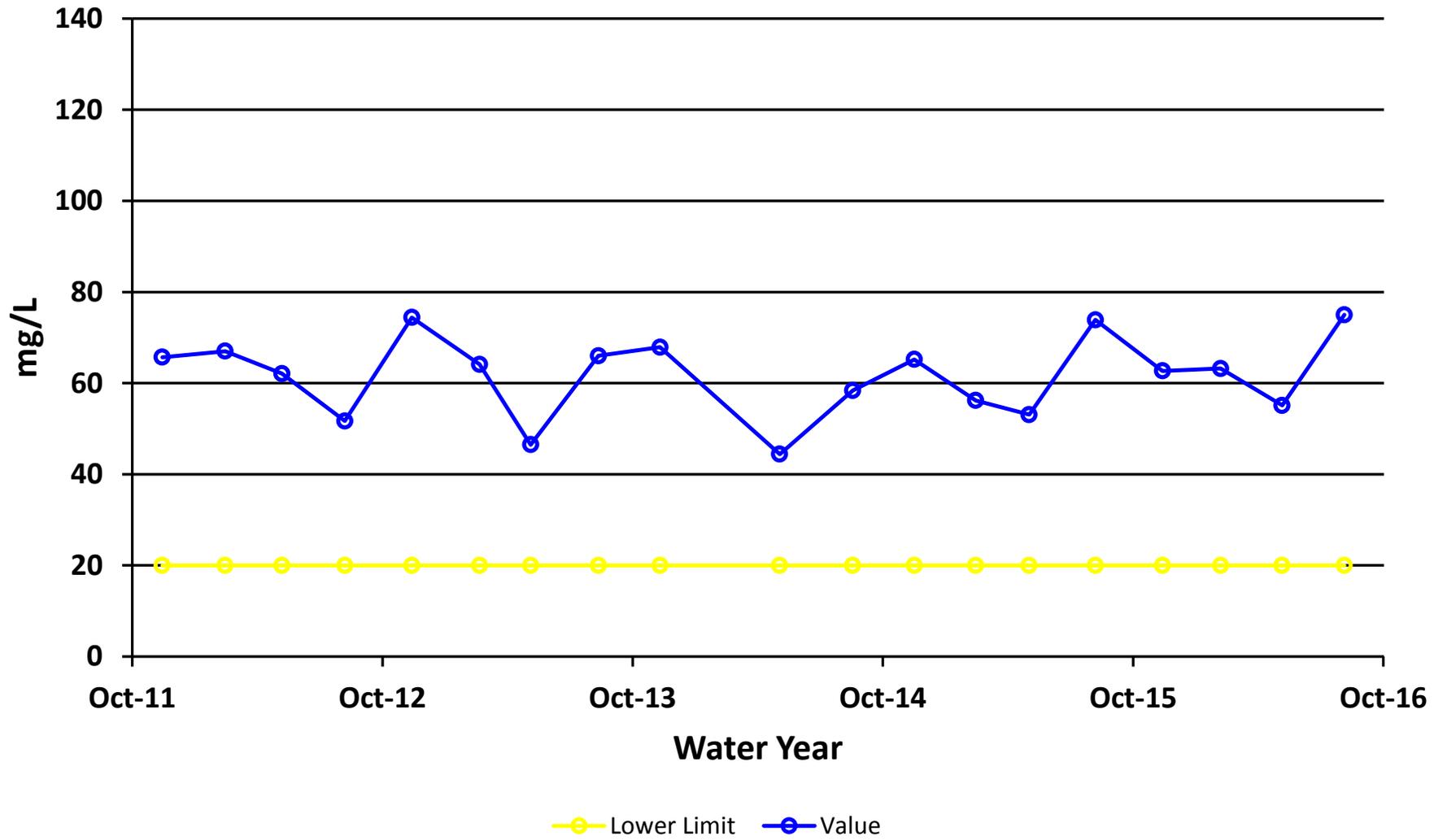
## Site 46 - Conductivity Field



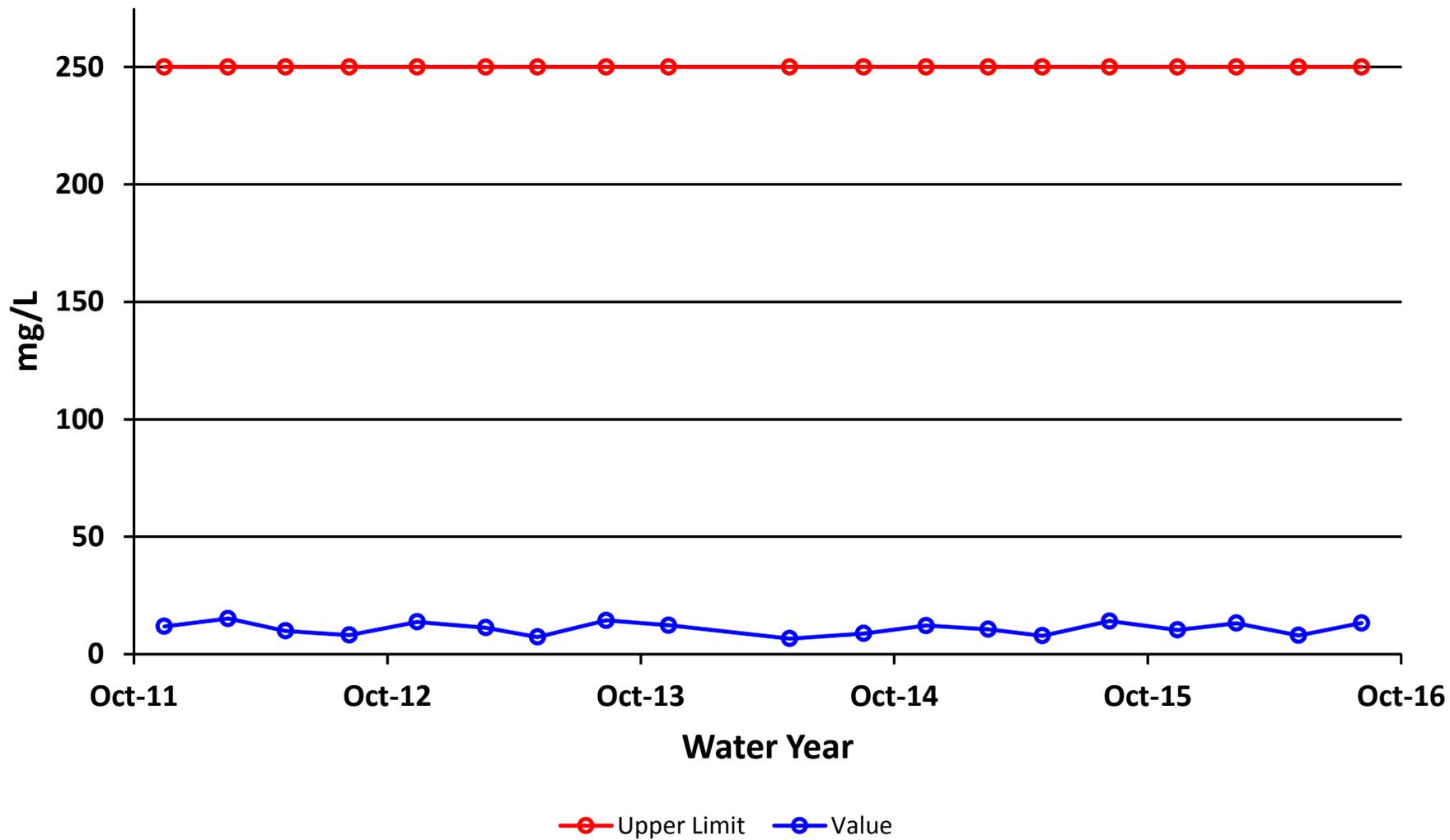
# Site 46 - pH Field



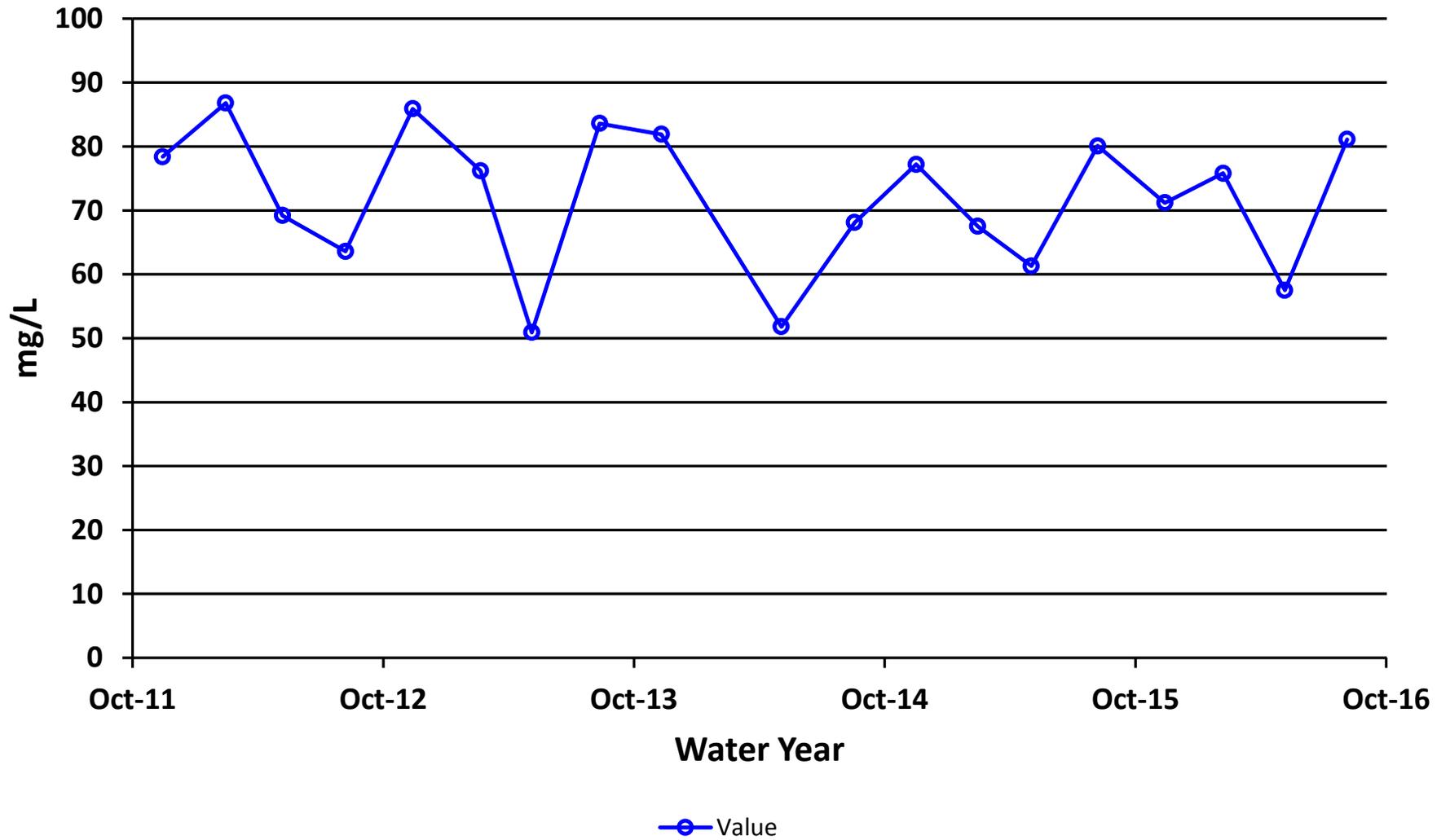
# Site 46 - Alkalinity



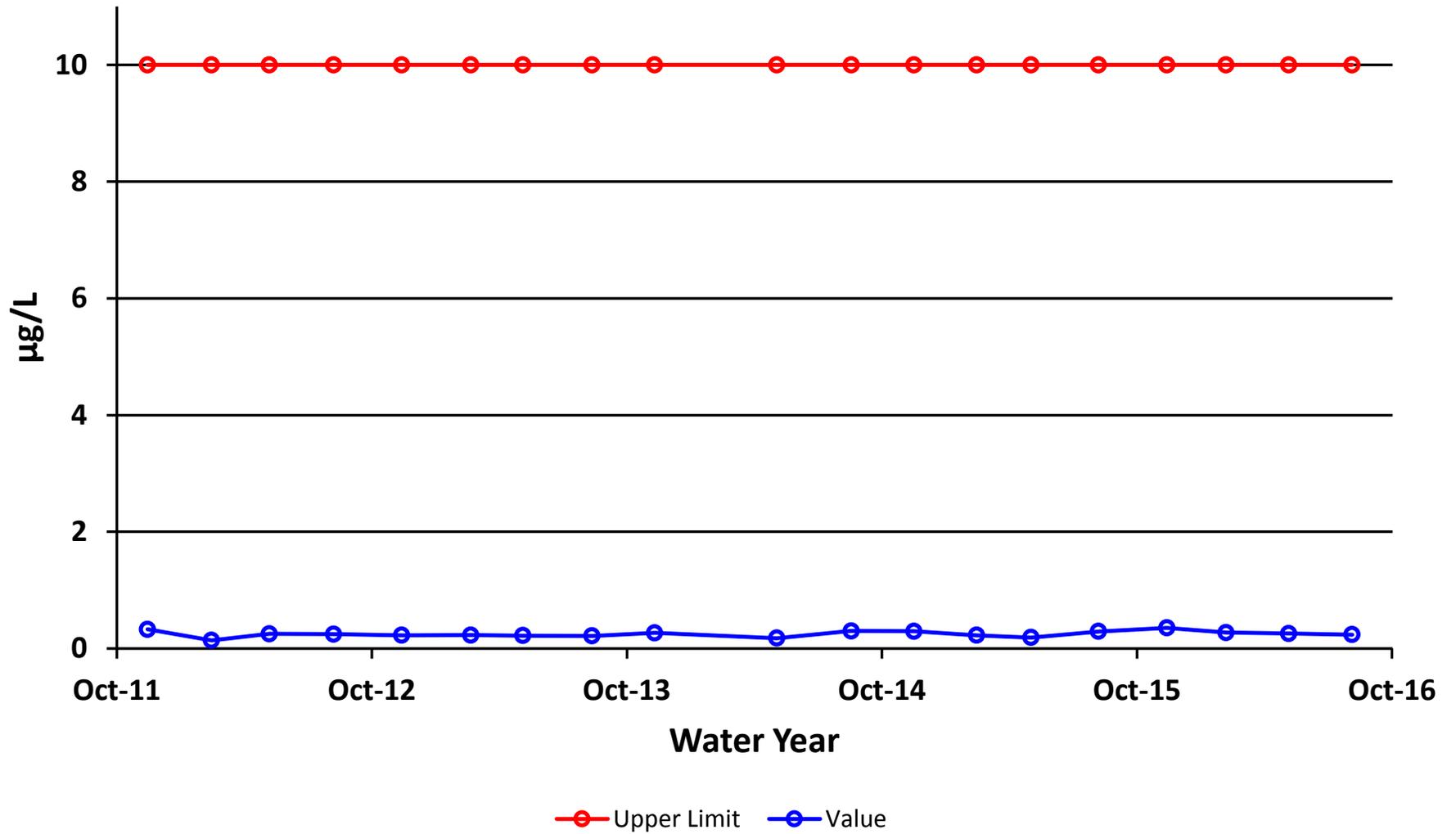
# Site 46 - Sulfate



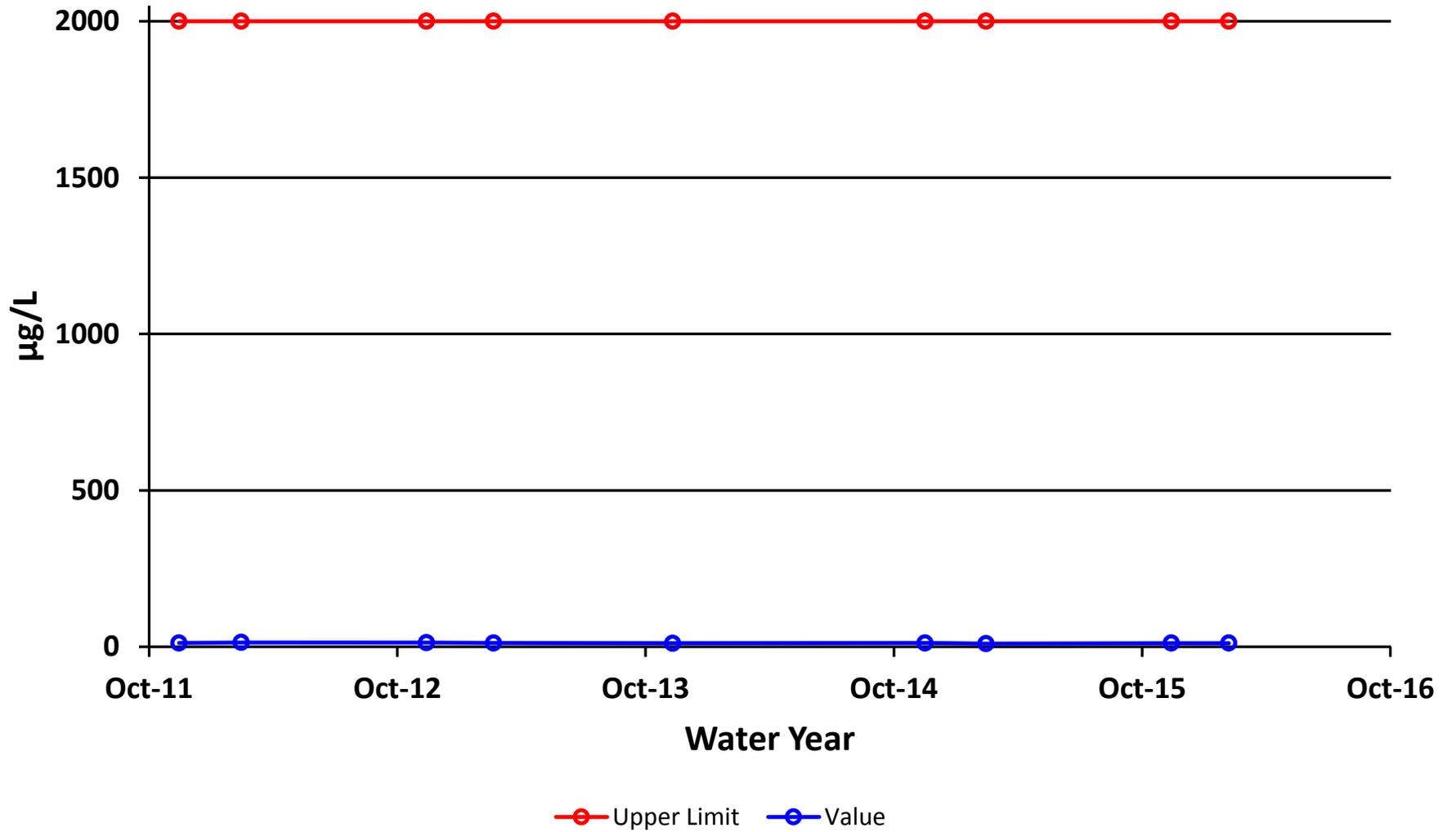
## Site 46 - Hardness



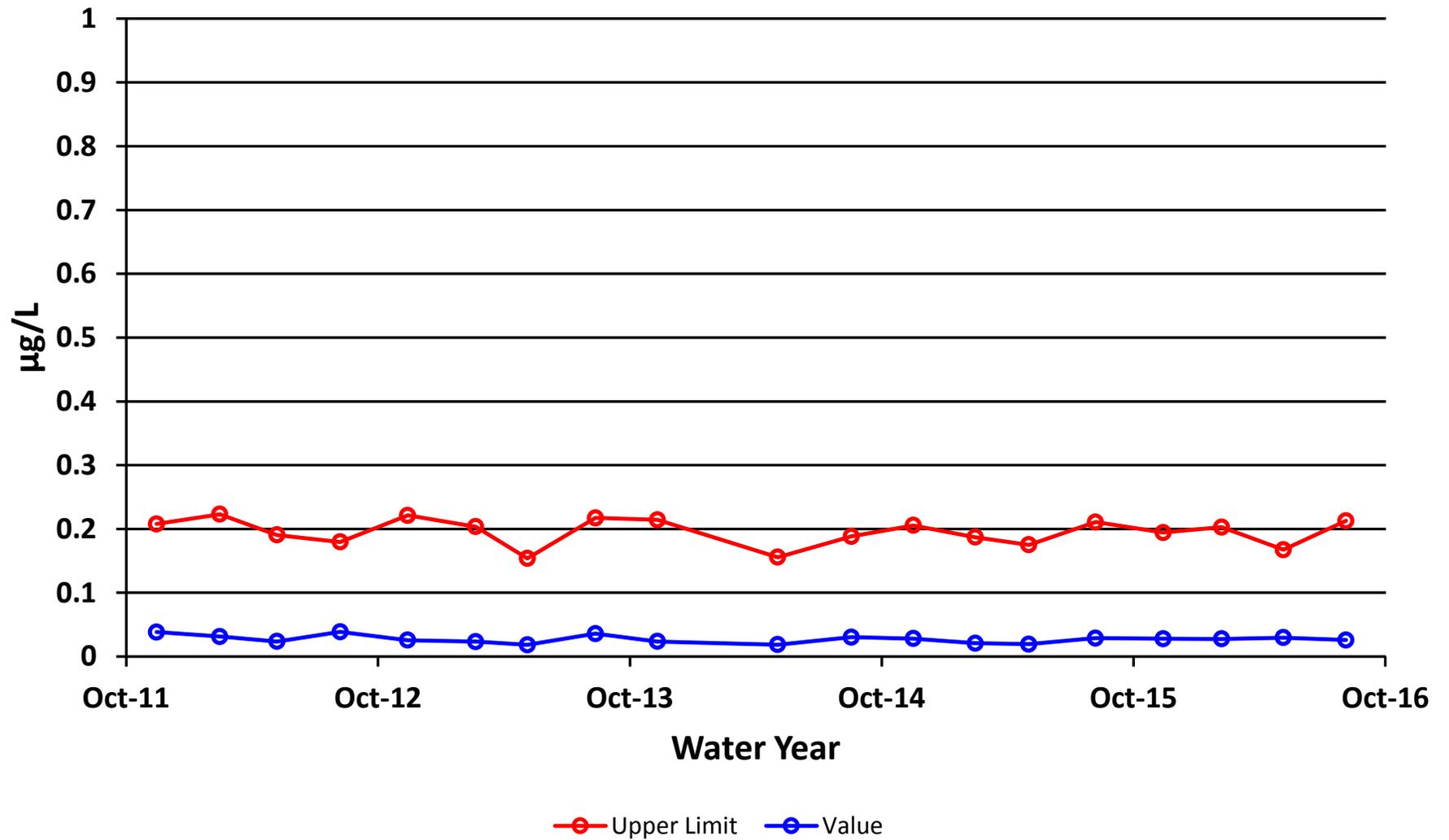
# Site 46 - Arsenic Dissolved



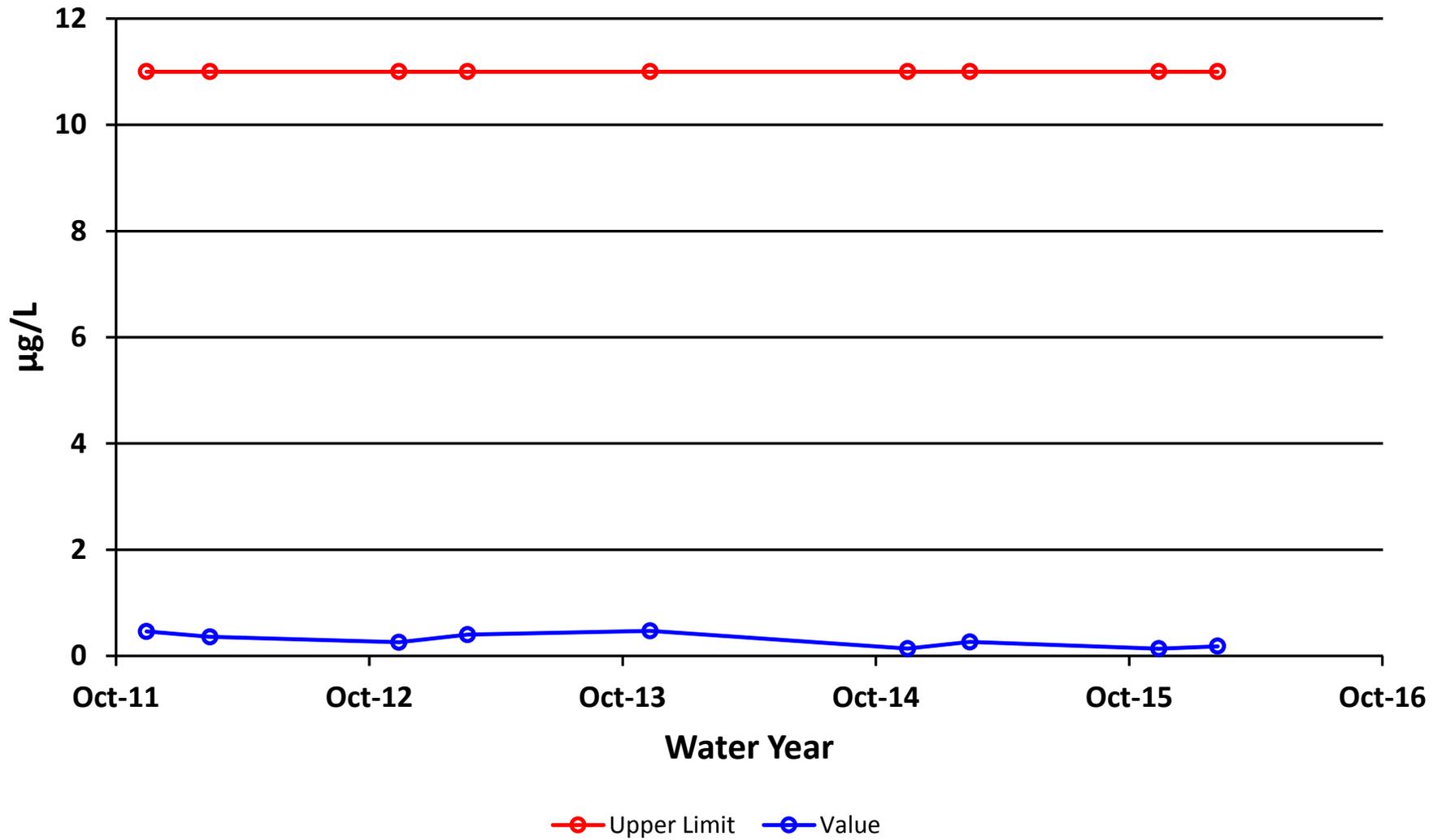
# Site 46 - Barium Dissolved



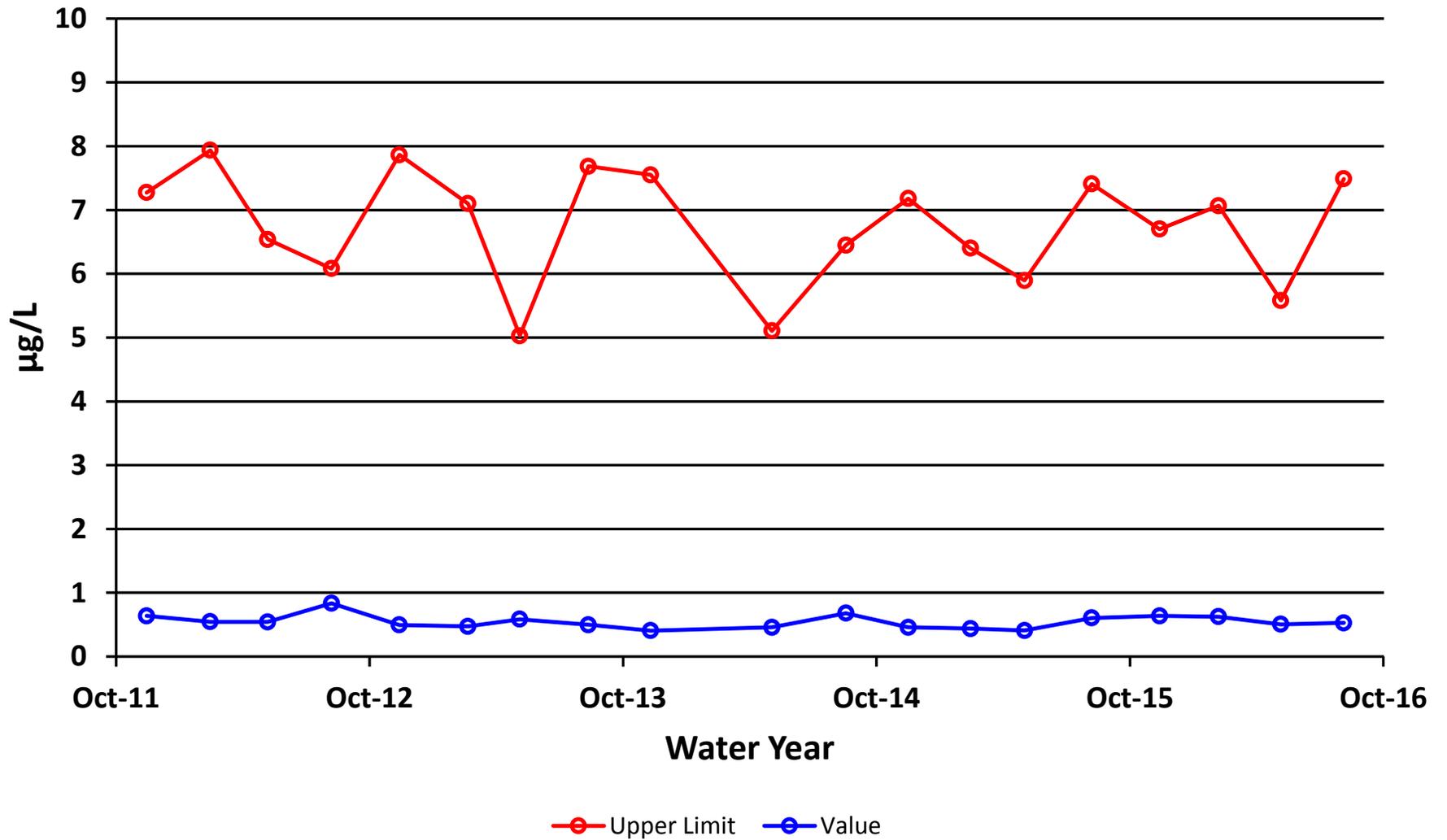
## Site 46 - Cadmium Dissolved



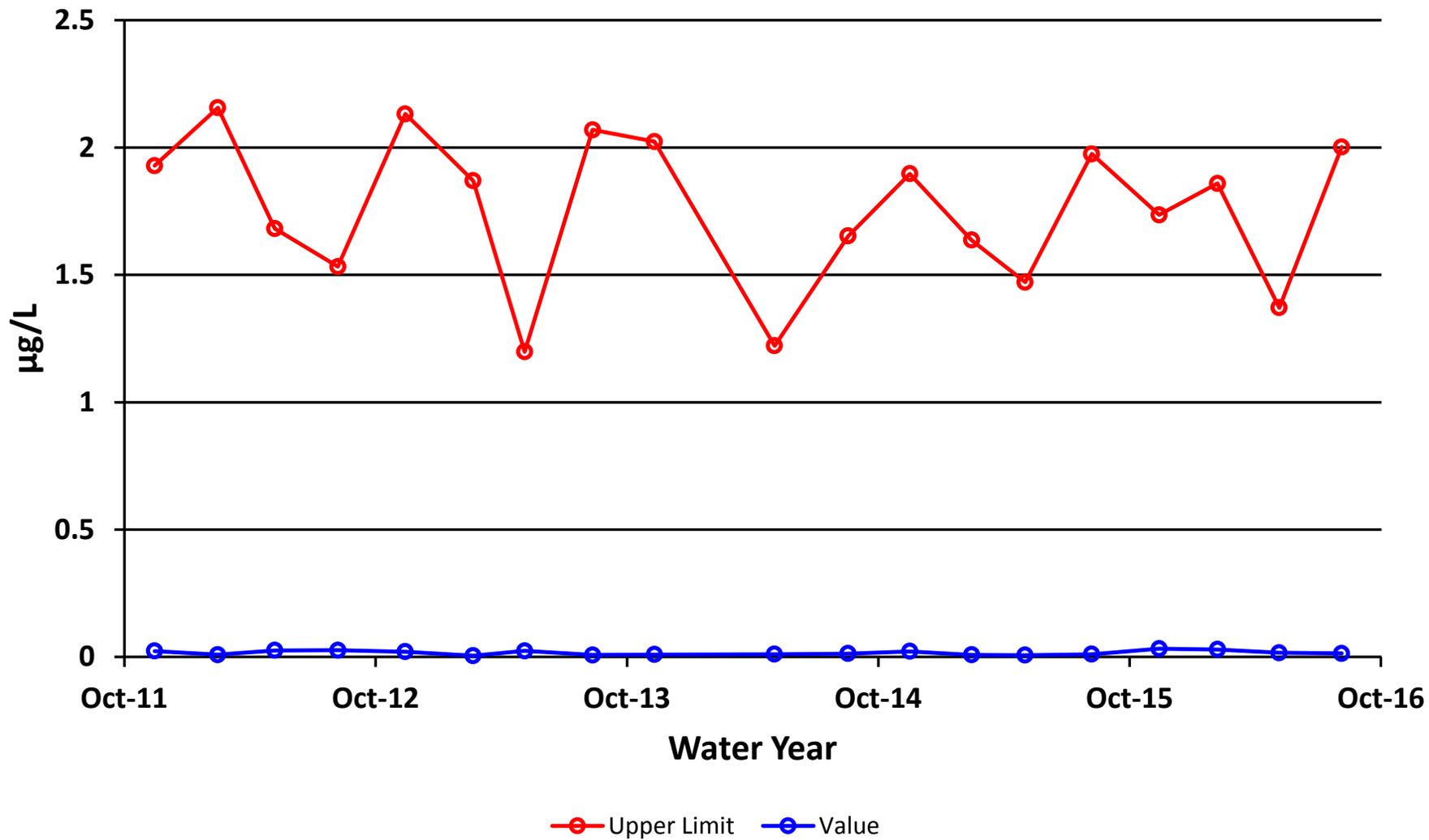
## Site 46 - Chromium Dissolved



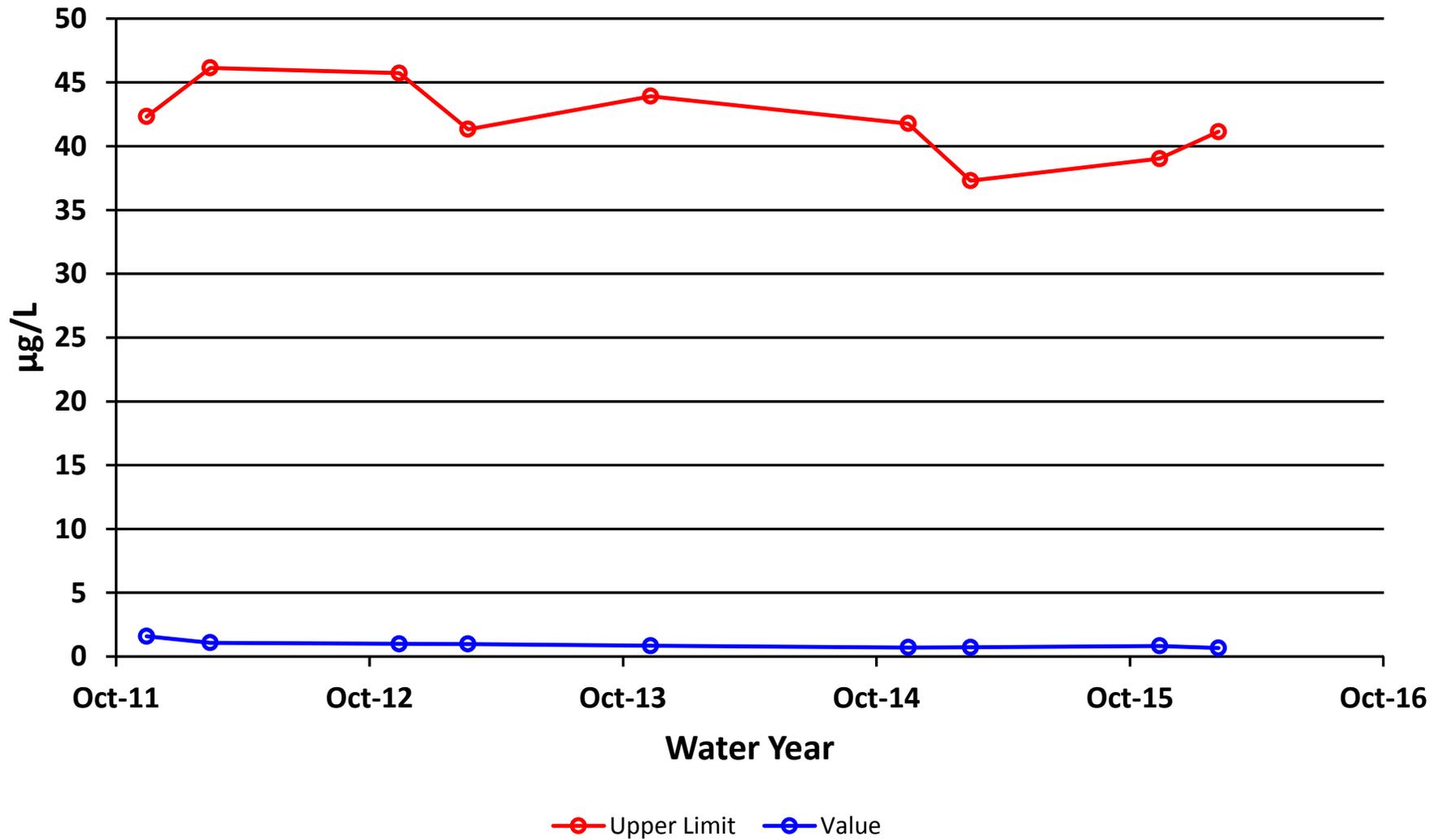
# Site 46 - Copper Dissolved



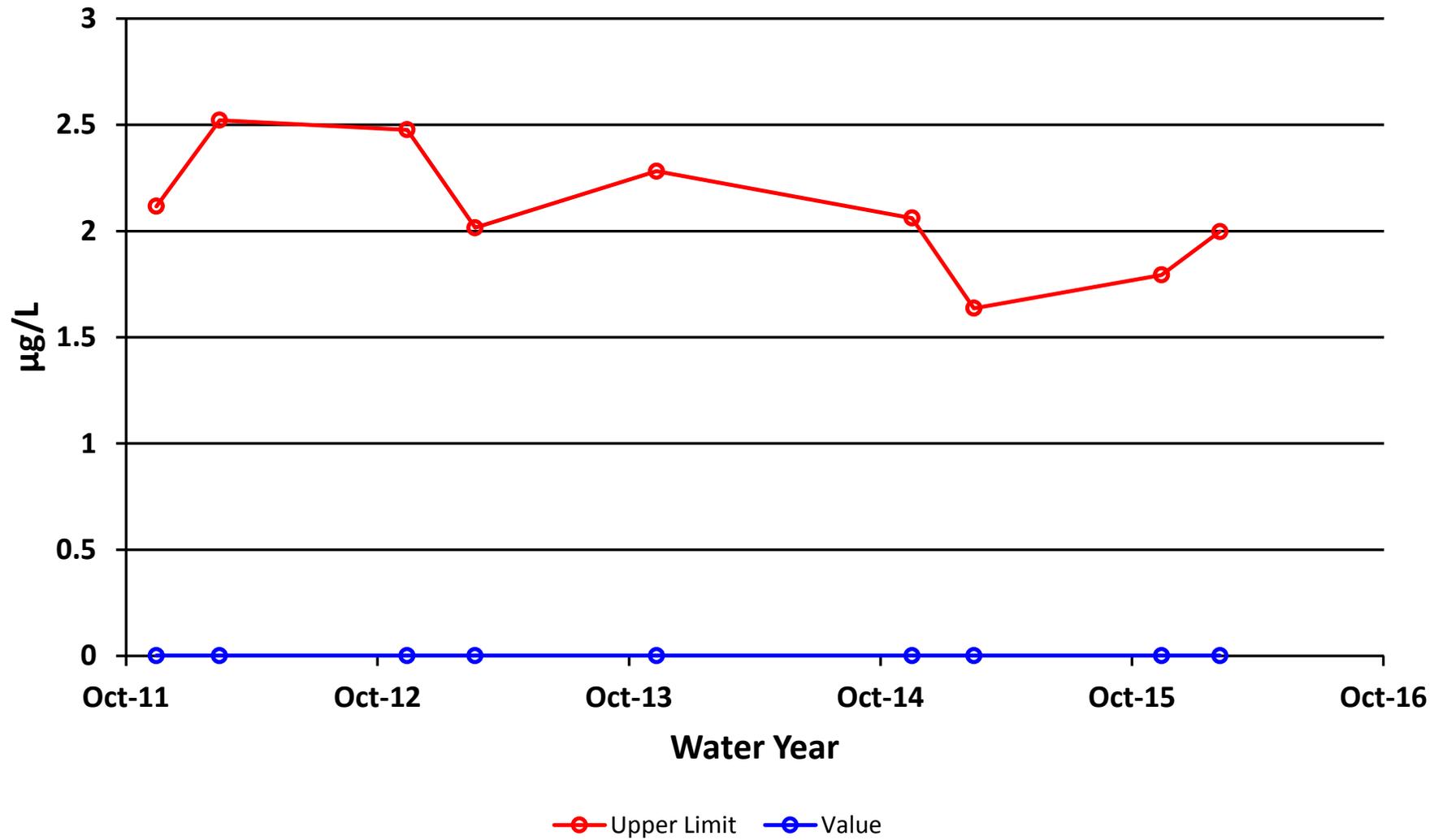
### Site 46 - Lead Dissolved



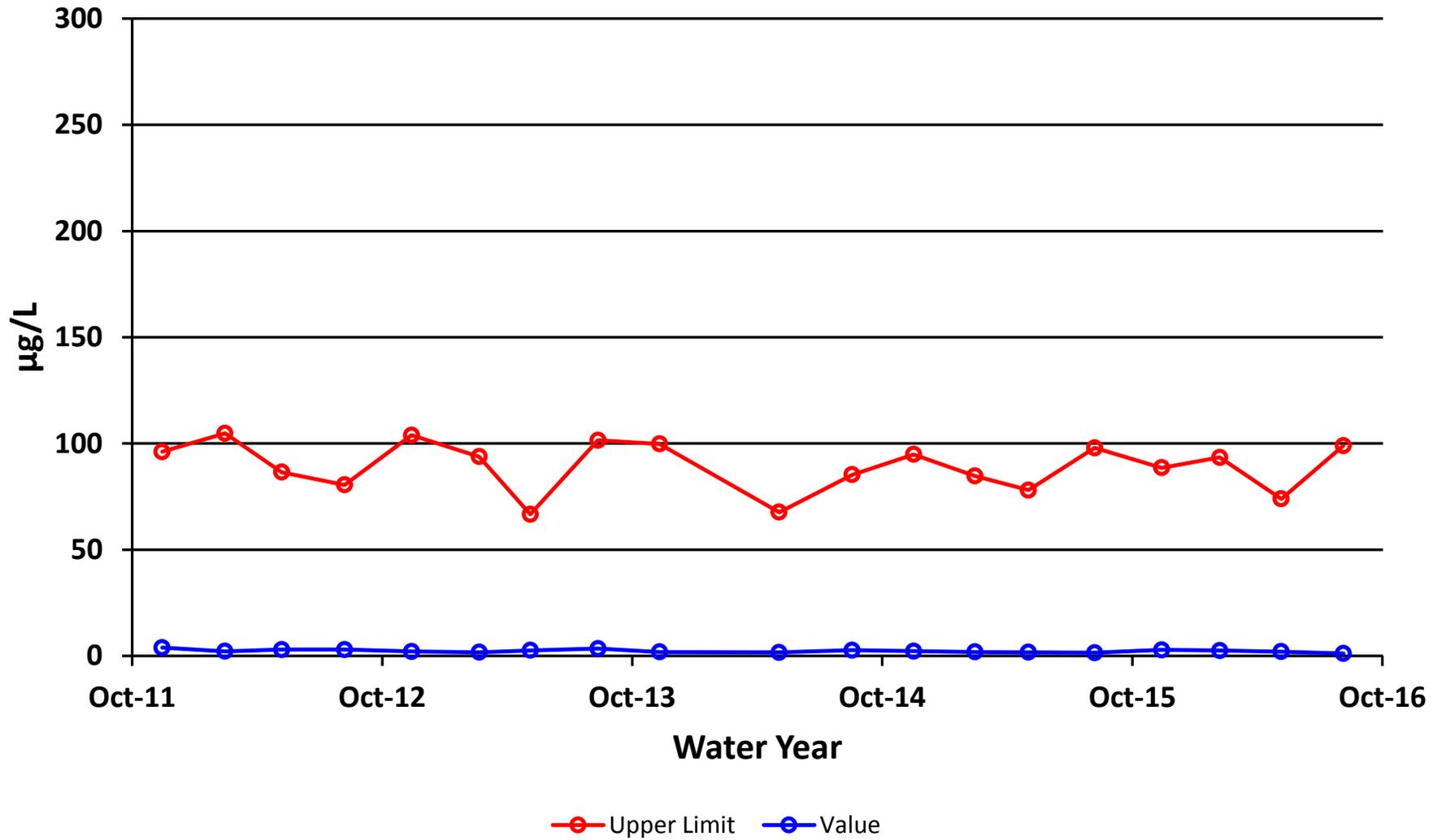
## Site 46 - Nickel Dissolved



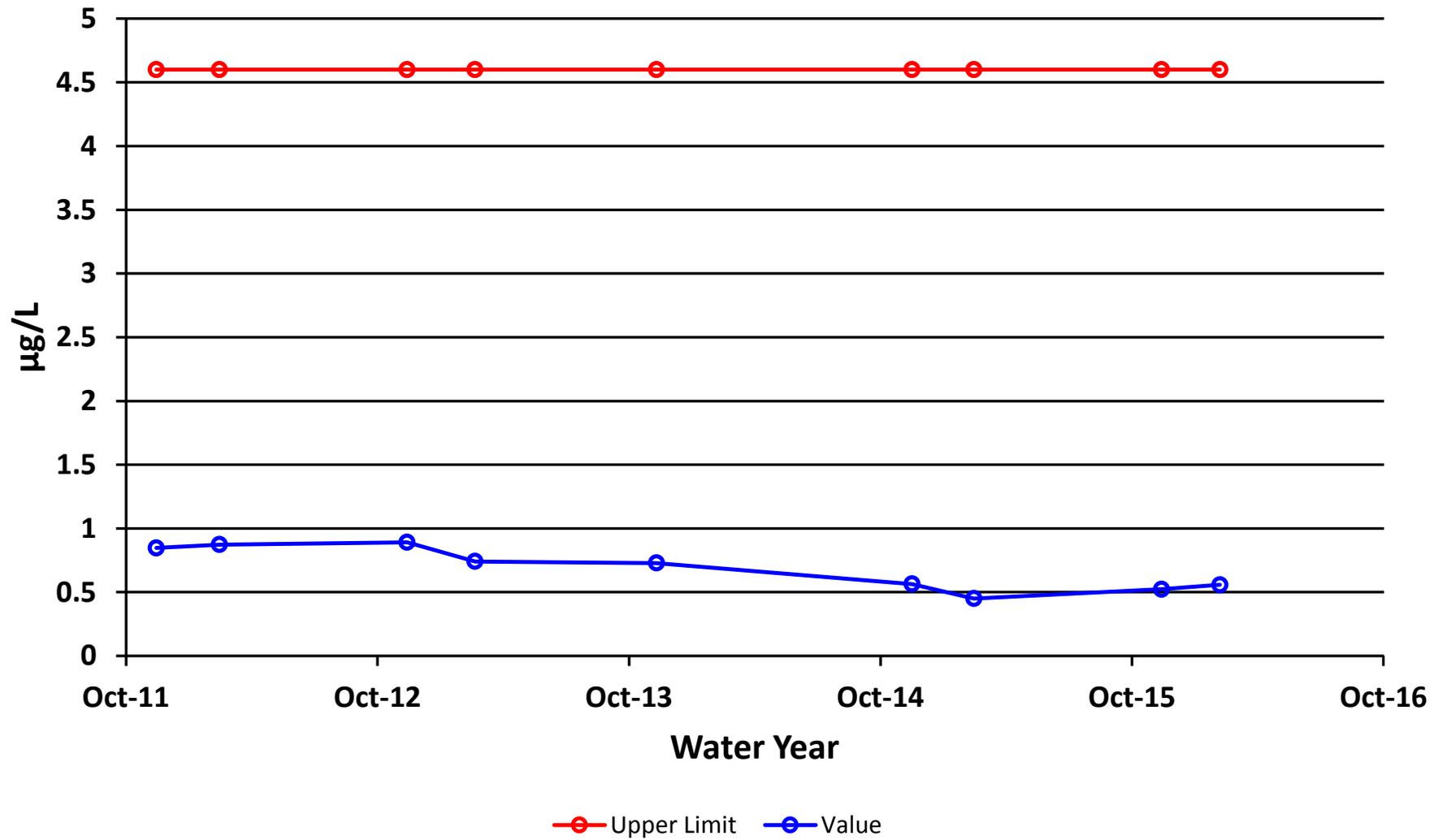
## Site 46 - Silver Dissolved



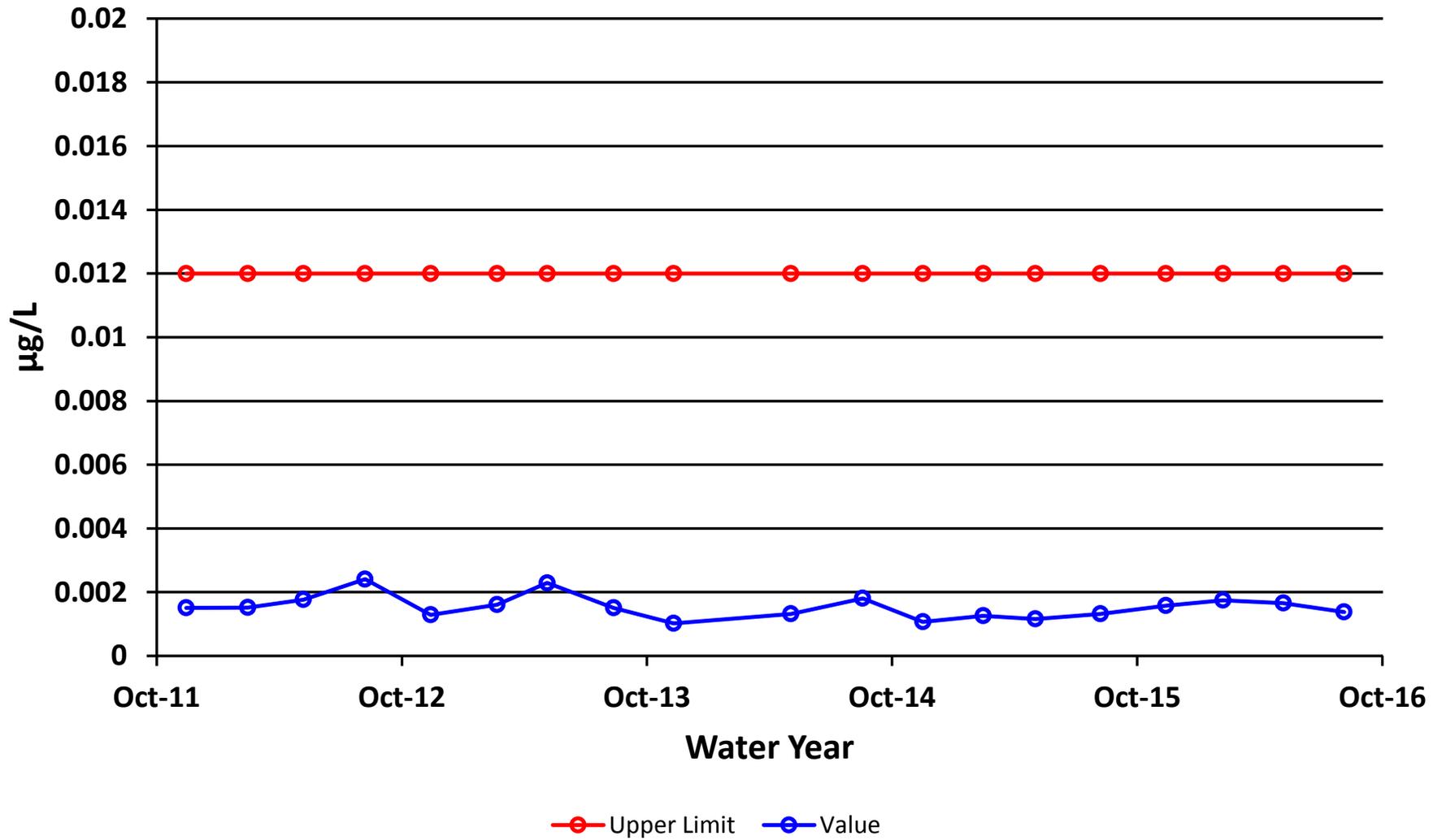
# Site 46 - Zinc Dissolved



## Site 46 - Selenium Dissolved



# Site 46 - Mercury Dissolved



## INTERPRETIVE REPORT

### SITE 57

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeding these criteria were identified in the current water year.

#### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. Though hardness and conductivity have been trending down gradually during the 2013 and 2014 Water Years, in the 2015 Water Year both parameters dropped sharply but rebounded to historical levels and have remained there during the 2016 Water Year. Dissolved cadmium and dissolved zinc, which have shown large variation in the past, were both in exceedance during and one sampling after the sharp drop in hardness. Both analytes have returned to historical levels during the 2016 Water Year. Site 57 is upgradient to the mining operations (background monitoring) and demonstrates that there can be large natural variation in water quality.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). Datasets with a statistically significant trend ( $\alpha/2=2.5\%$ ) a Seasonal-Sen’s Slope estimate

statistic has also been calculated. There were no statistically significant trends calculated for these parameters this water year.

**Table of Summary Statistics for Trend Analysis**

<b>Parameter</b>	<u>Mann-Kendall test statistics</u>			<u>Sen's slope estimate</u>	
	<b>n*</b>	<b>p**</b>	<b>Trend</b>	<b>Q</b>	<b>Q(%)</b>
Conductivity Field	6	0.20			
pH Field	6	0.56			
Alkalinity, Total	6	0.14			
Sulfate, Total	6	0.08			
Zinc, Dissolved	6	0.71			

\* Number of Years \*\* Significance level

## Table of Results for Water Year 2016

### Site 057FMG - 'Monitoring Well -23-00-03'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		3.7			5.6			6.7			7.9		6.2
Conductivity-Field(µmho)		362			445			448			395		420.0
Conductivity-Lab (µmho)		338			413			416			370		392
pH Lab (standard units)		7.61			7.58			7.68			7.47		7.60
pH Field (standard units)		7.47			7.75			7.76			7.72		7.74
Total Alkalinity (mg/L)		135			150			143			143		143.0
Total Sulfate (mg/L)		40.4			62.1			63.4			44.3		53.2
Hardness (mg/L)		197			219			214			184		205.5
Dissolved As (ug/L)		0.568			0.574			0.389			0.54		0.554
Dissolved Ba (ug/L)		29.7			30.9			32.9			25.5		30.3
Dissolved Cd (ug/L)		0.164			0.186			0.187			0.159		0.1750
Dissolved Cr (ug/L)		0.436			0.357			0.218			0.392		0.375
Dissolved Cu (ug/L)		0.323			0.133			0.887			0.958		0.605
Dissolved Pb (ug/L)		0.202			0.0015			0.145			0.0356		0.0903
Dissolved Ni (ug/L)		0.689			0.222			0.552			0.296		0.424
Dissolved Ag (ug/L)		0.002			0.002			0.002			0.002		0.002
Dissolved Zn (ug/L)		16			2.1			39.6			12.5		14.25
Dissolved Se (ug/L)		0.74			0.759			0.736			0.737		0.739
Dissolved Hg (ug/L)		0.000138			0.00005			0.00018			0.000137		0.000138

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

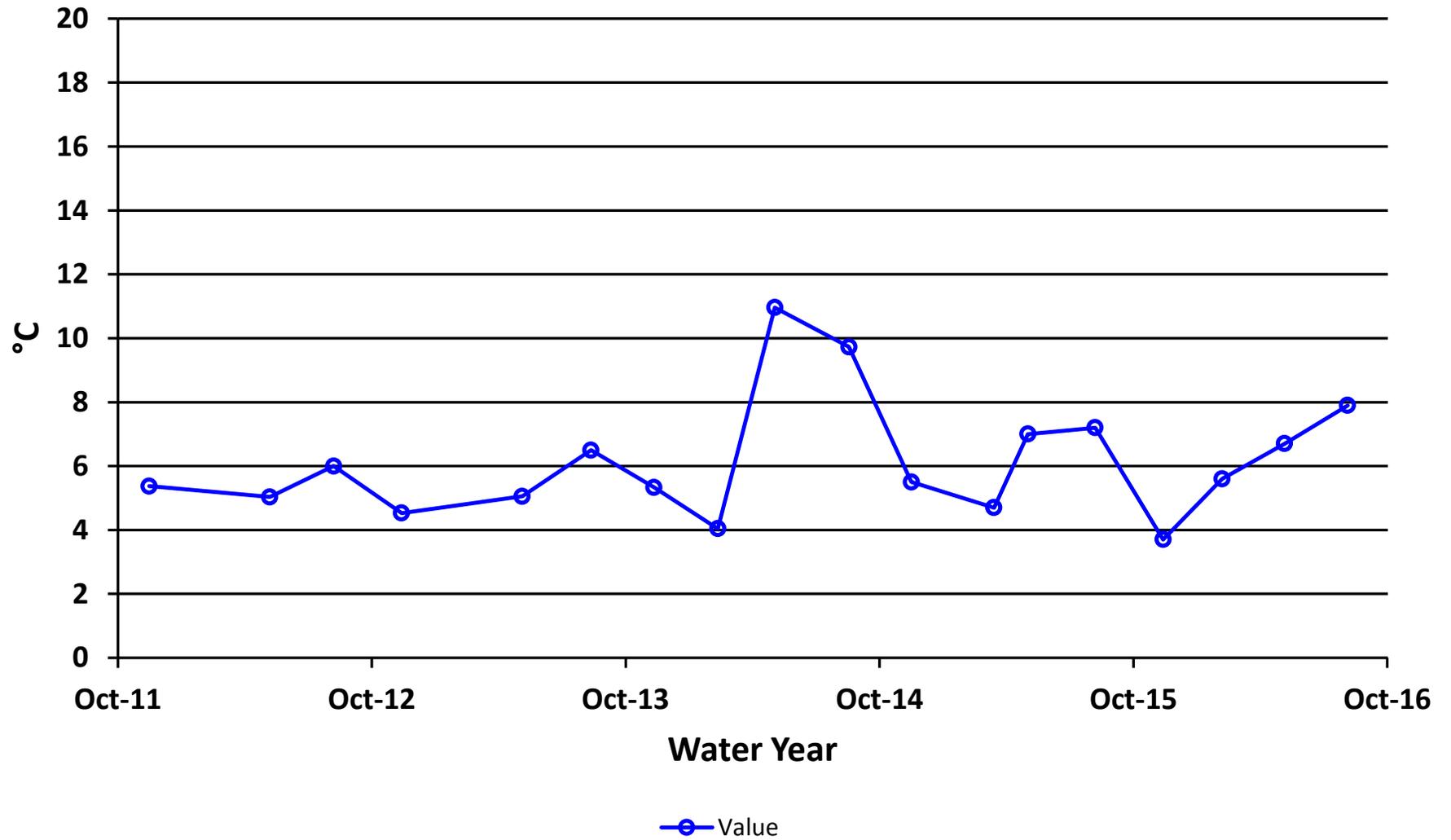
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

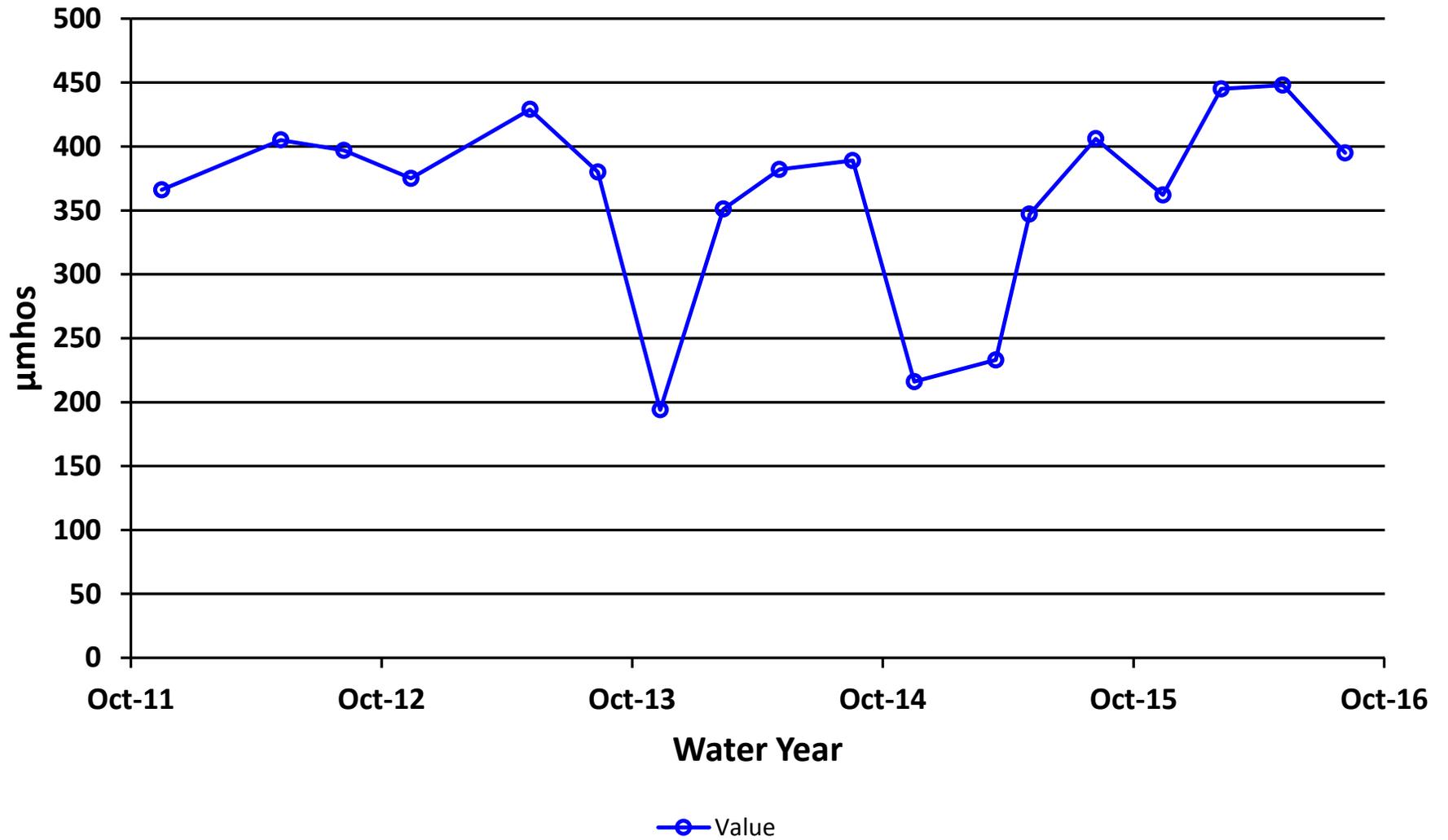
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
057FMG	11/16/2015	12:00 PM	Diss. Hg-CVAF	0.000138	µg/L	J	Below Quantitative Range
	5/9/2016	12:00 PM	Diss. Hg-CVAF	0.00018	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Diss. Hg-CVAF	0.000137	µg/L	J	Below Quantitative Range
			Sulfate	44.3	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

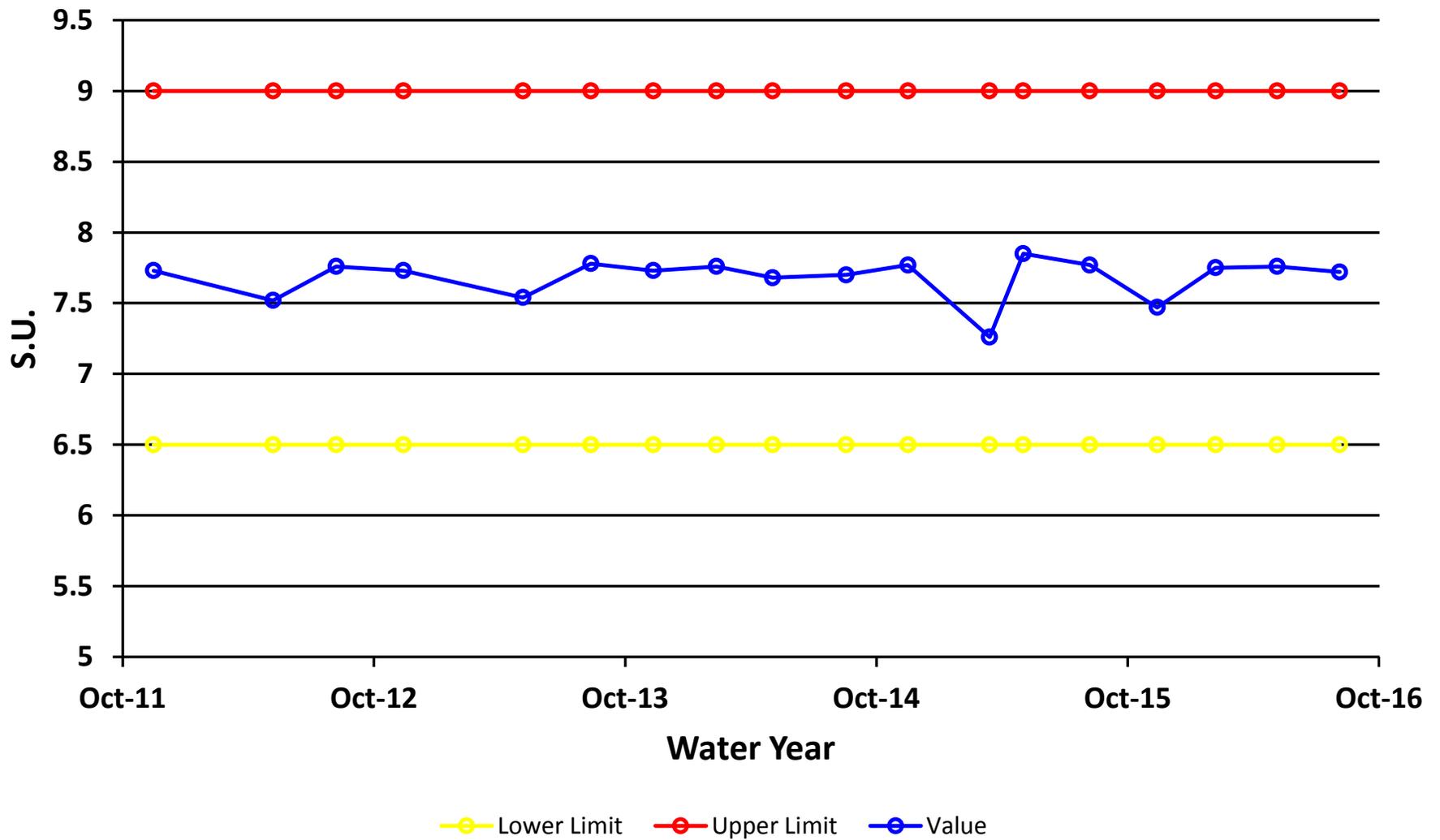
## Site 57 - Water Temperature



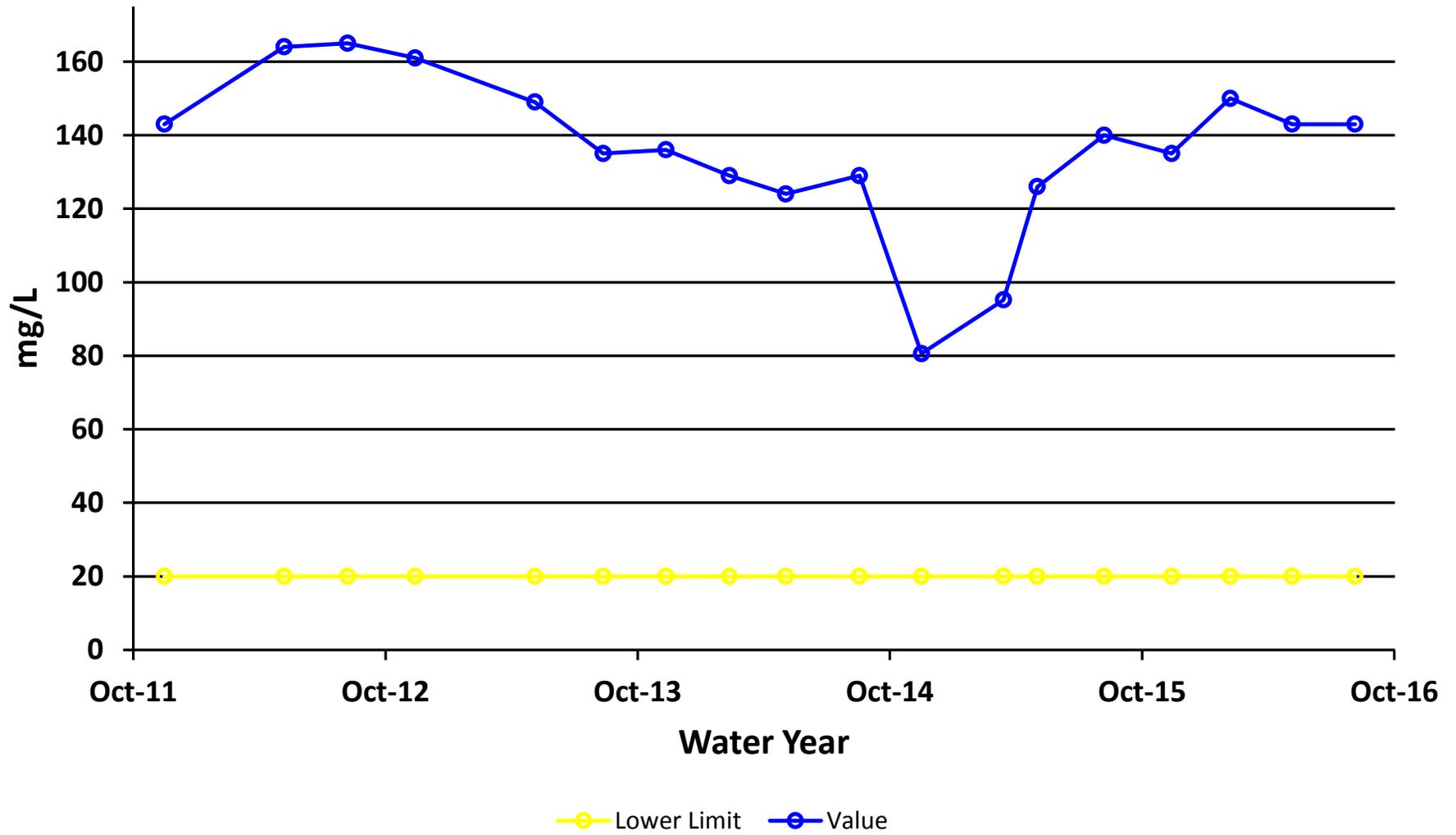
## Site 57 - Conductivity Field



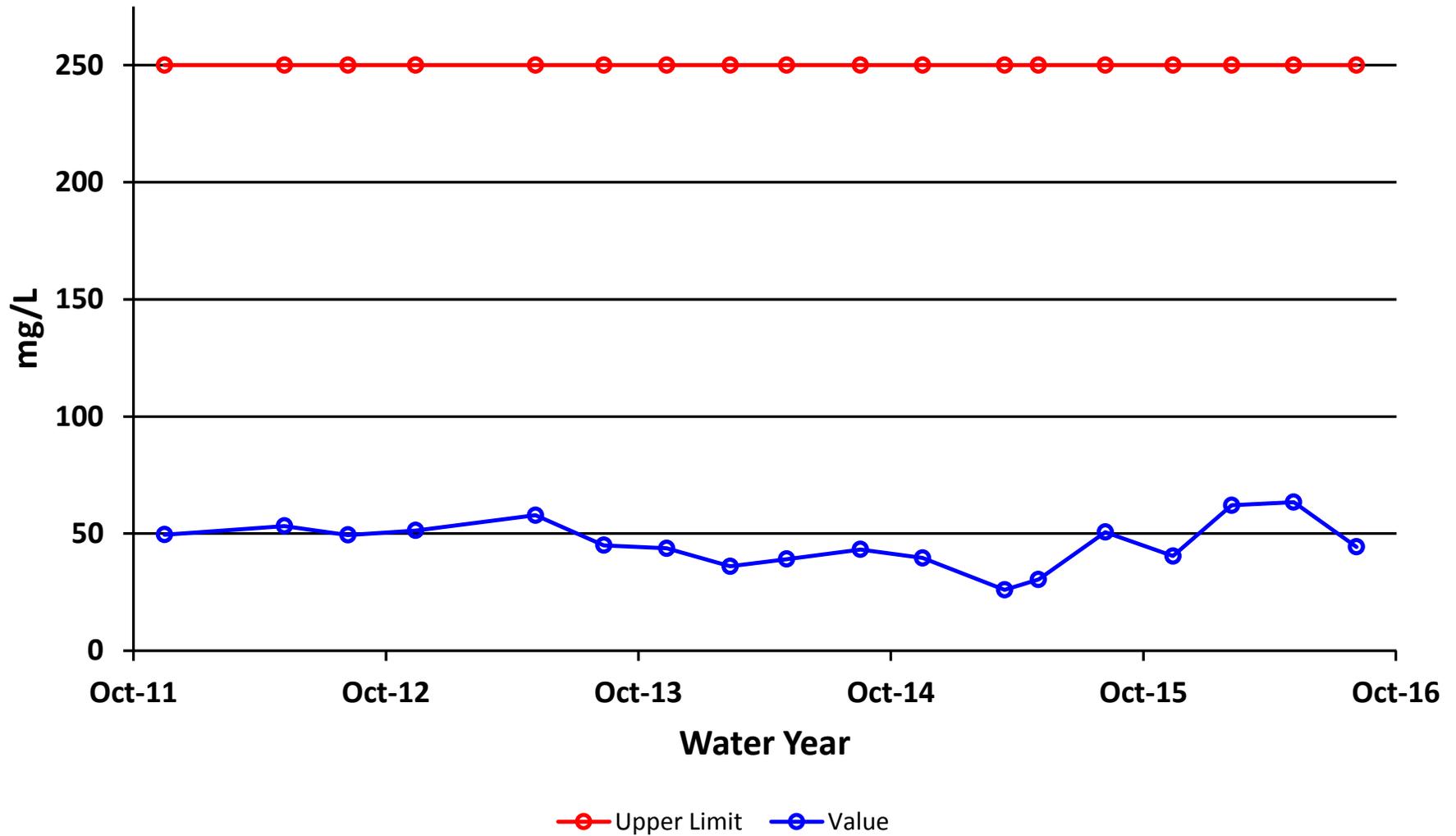
# Site 57 - pH Field



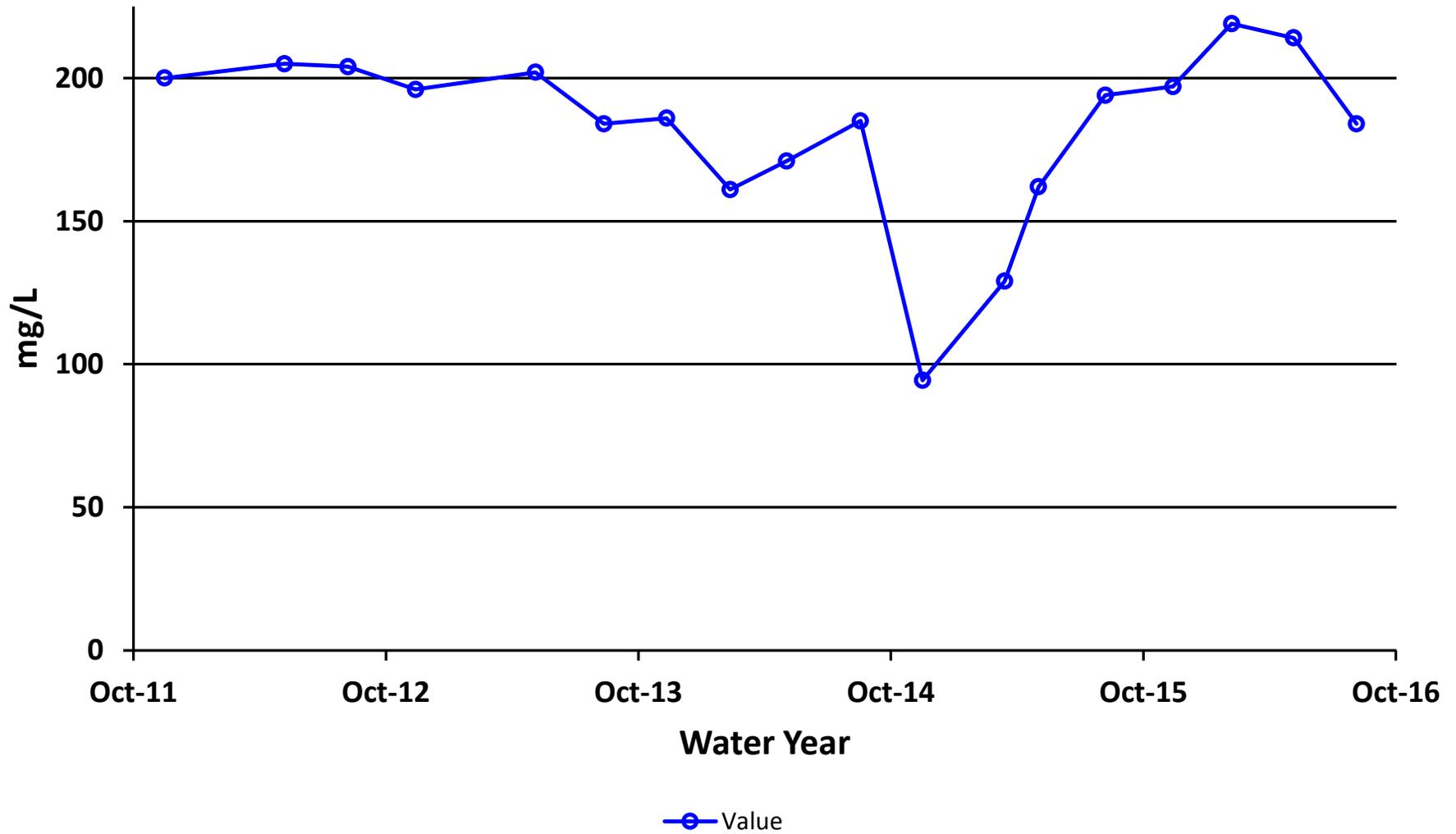
# Site 57 - Alkalinity



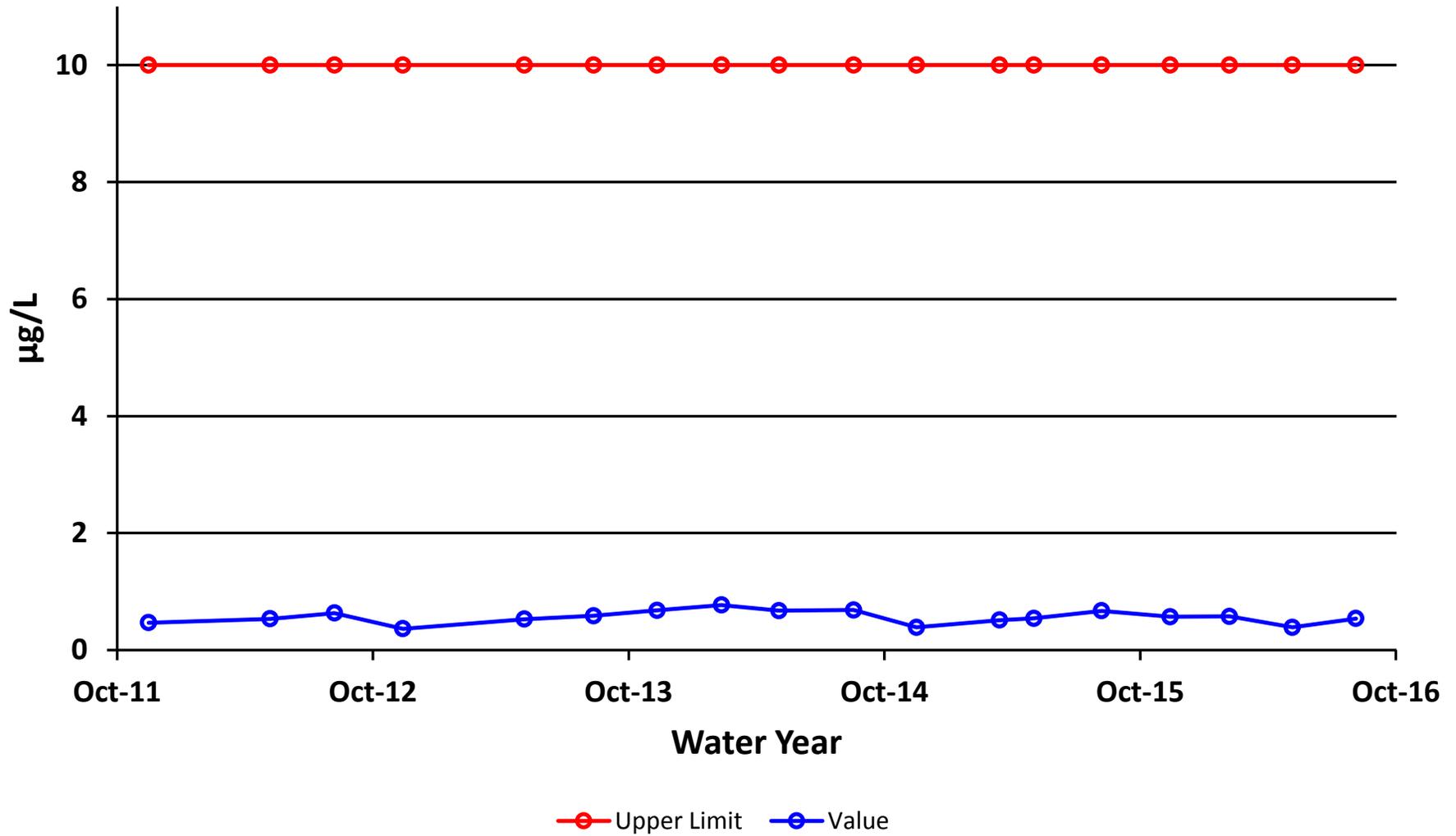
# Site 57 - Sulfate



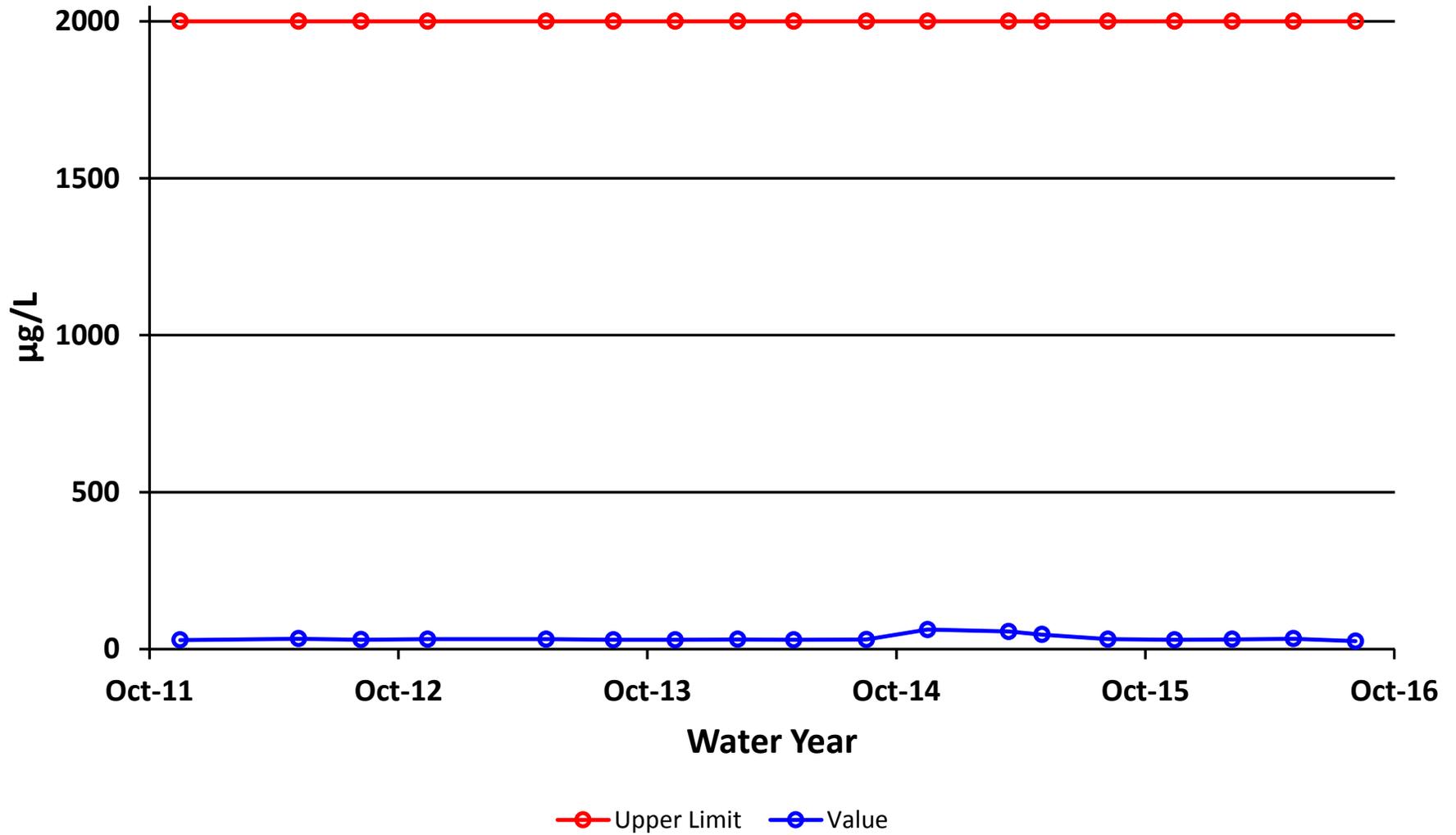
### Site 57 - Hardness



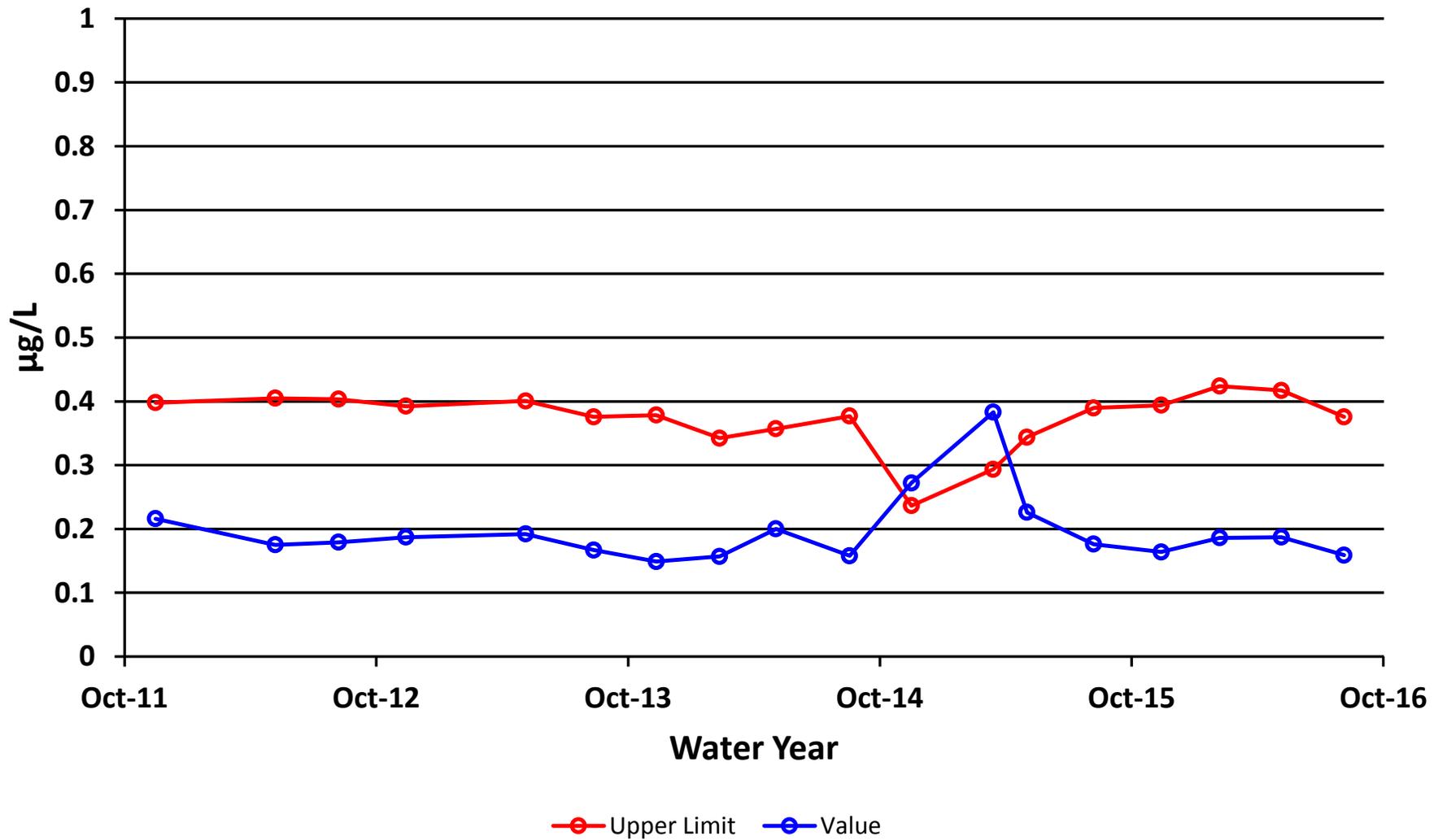
# Site 57 - Arsenic Dissolved



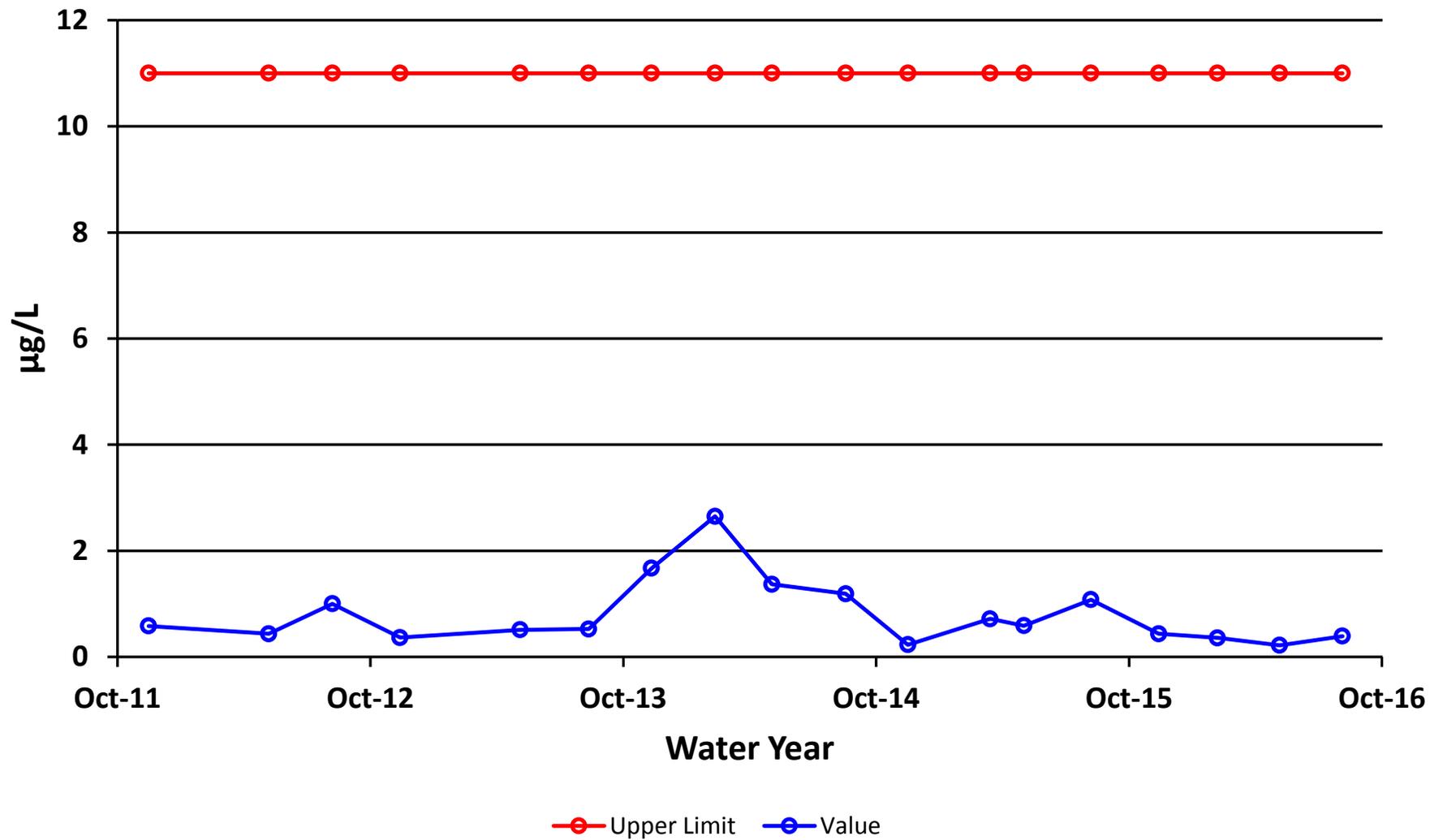
# Site 57 - Barium Dissolved



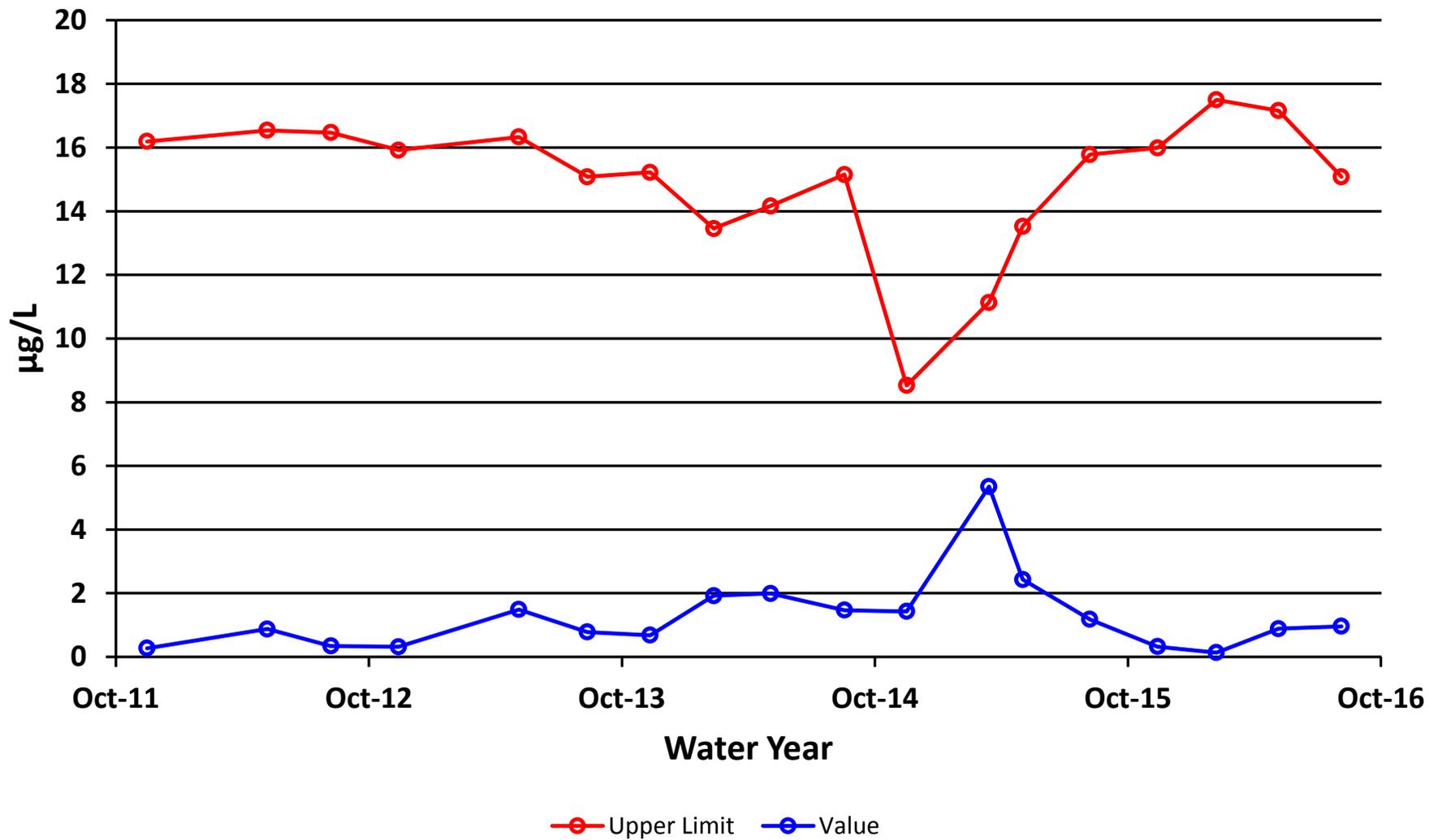
## Site 57 - Cadmium Dissolved



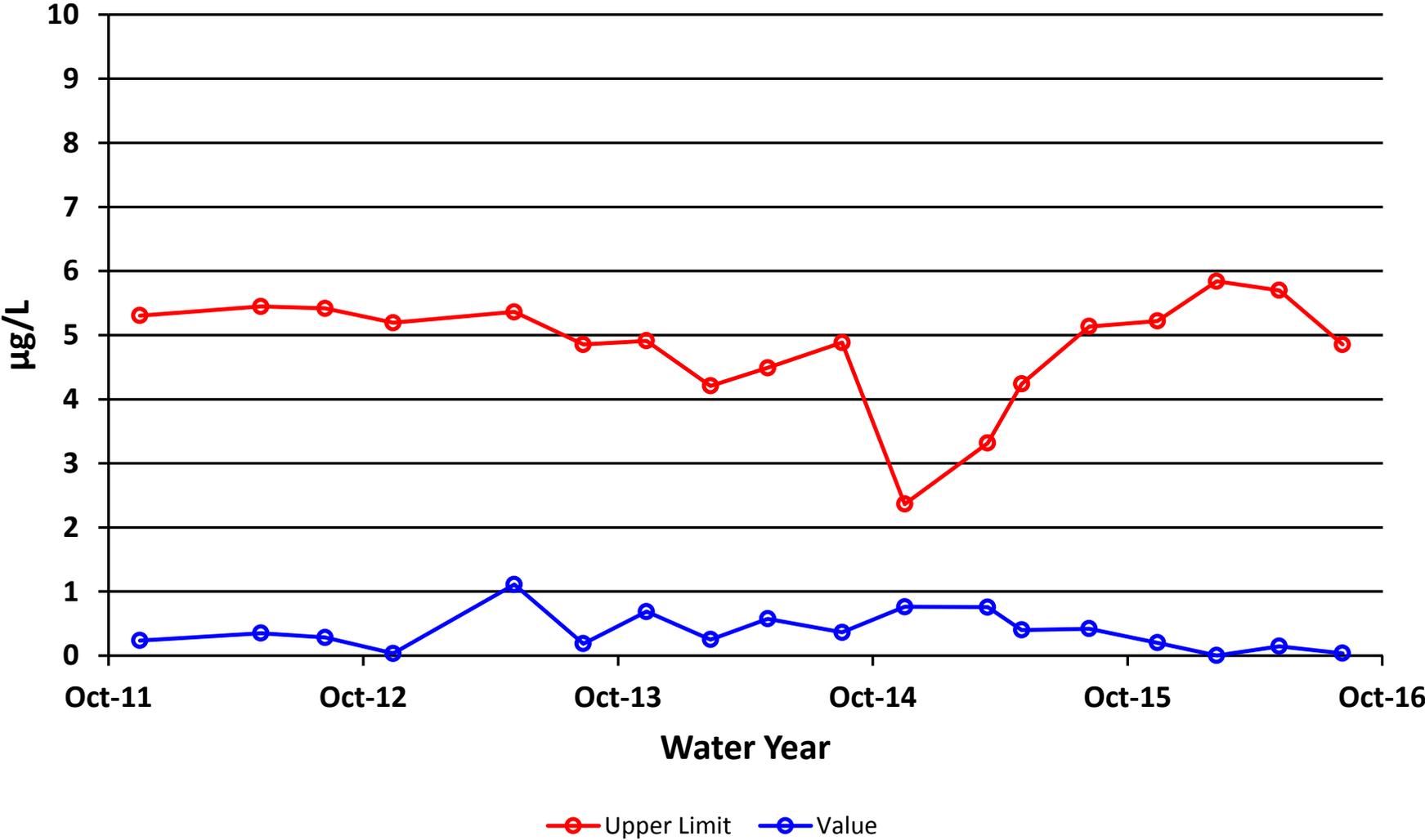
## Site 57 - Chromium Dissolved



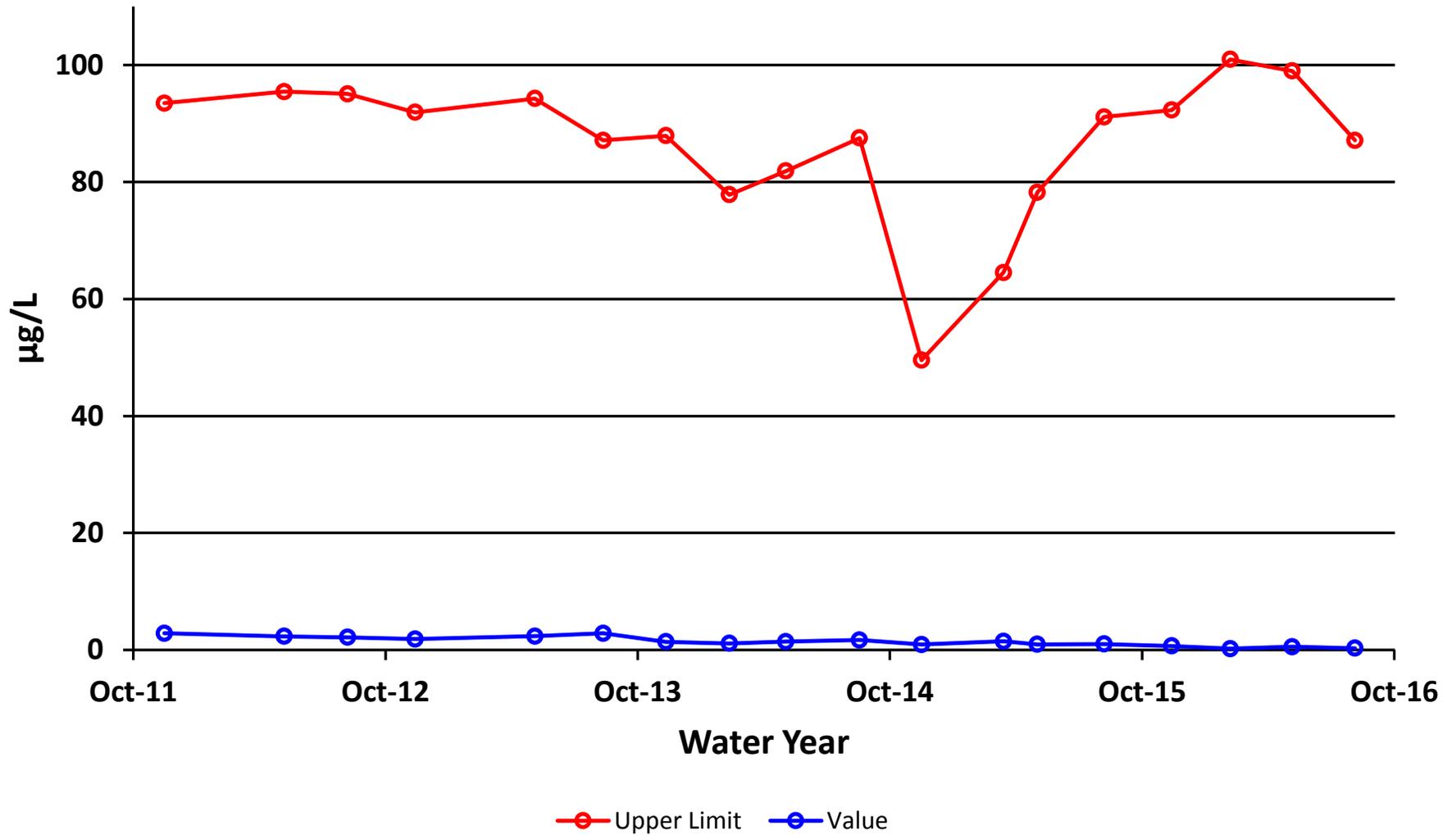
# Site 57 - Copper Dissolved



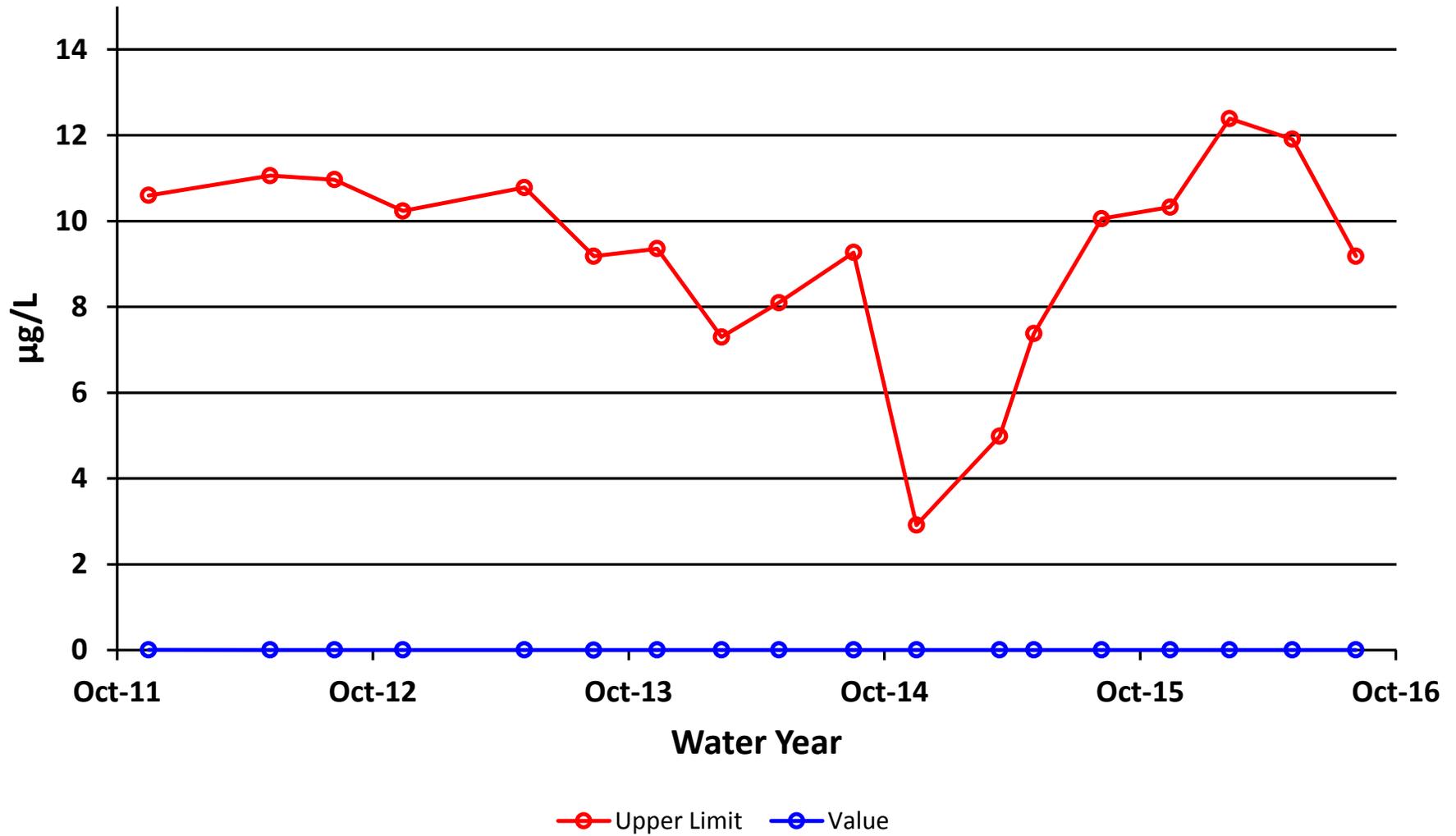
# Site 57 - Lead Dissolved



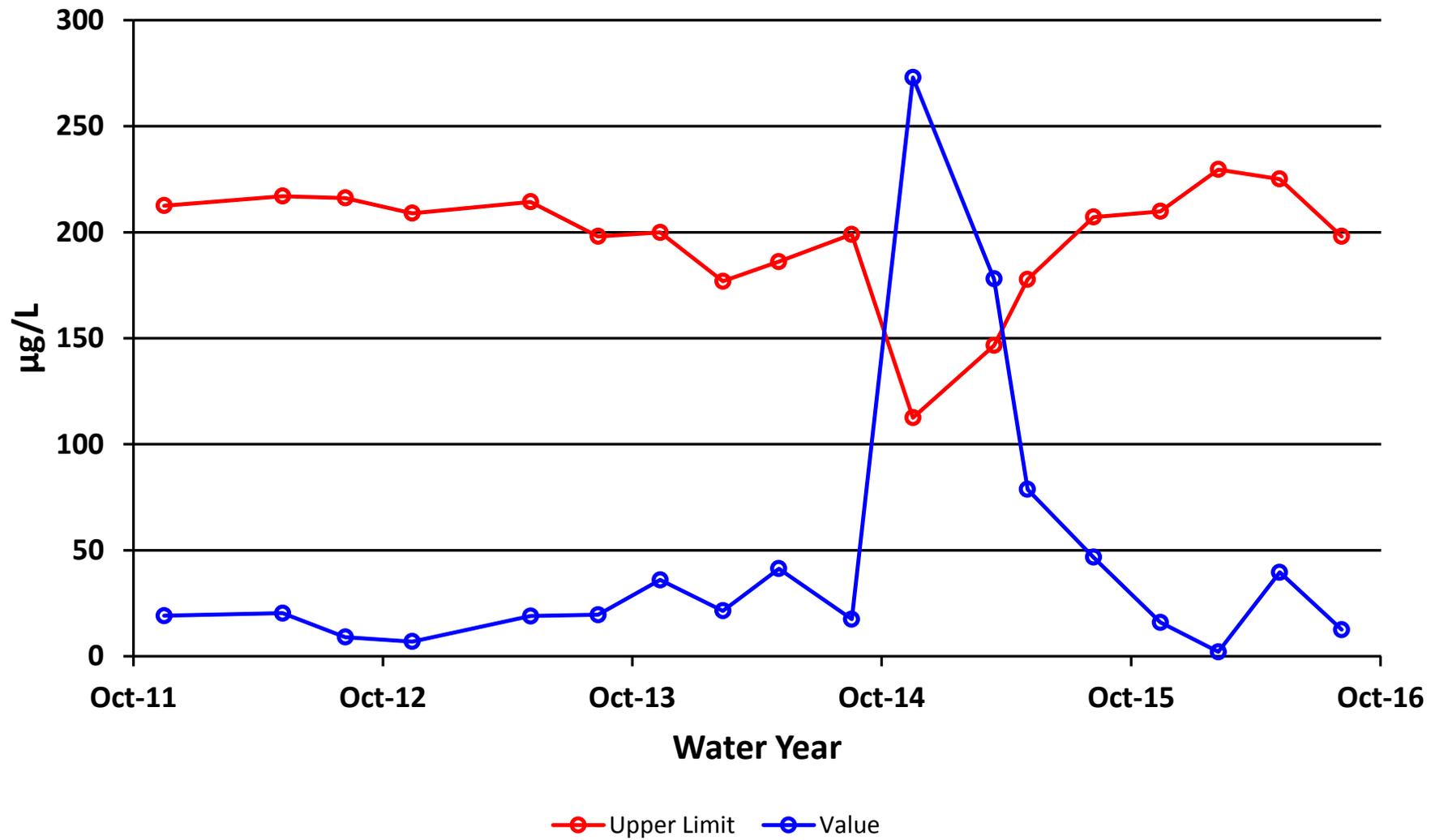
# Site 57 - Nickel Dissolved



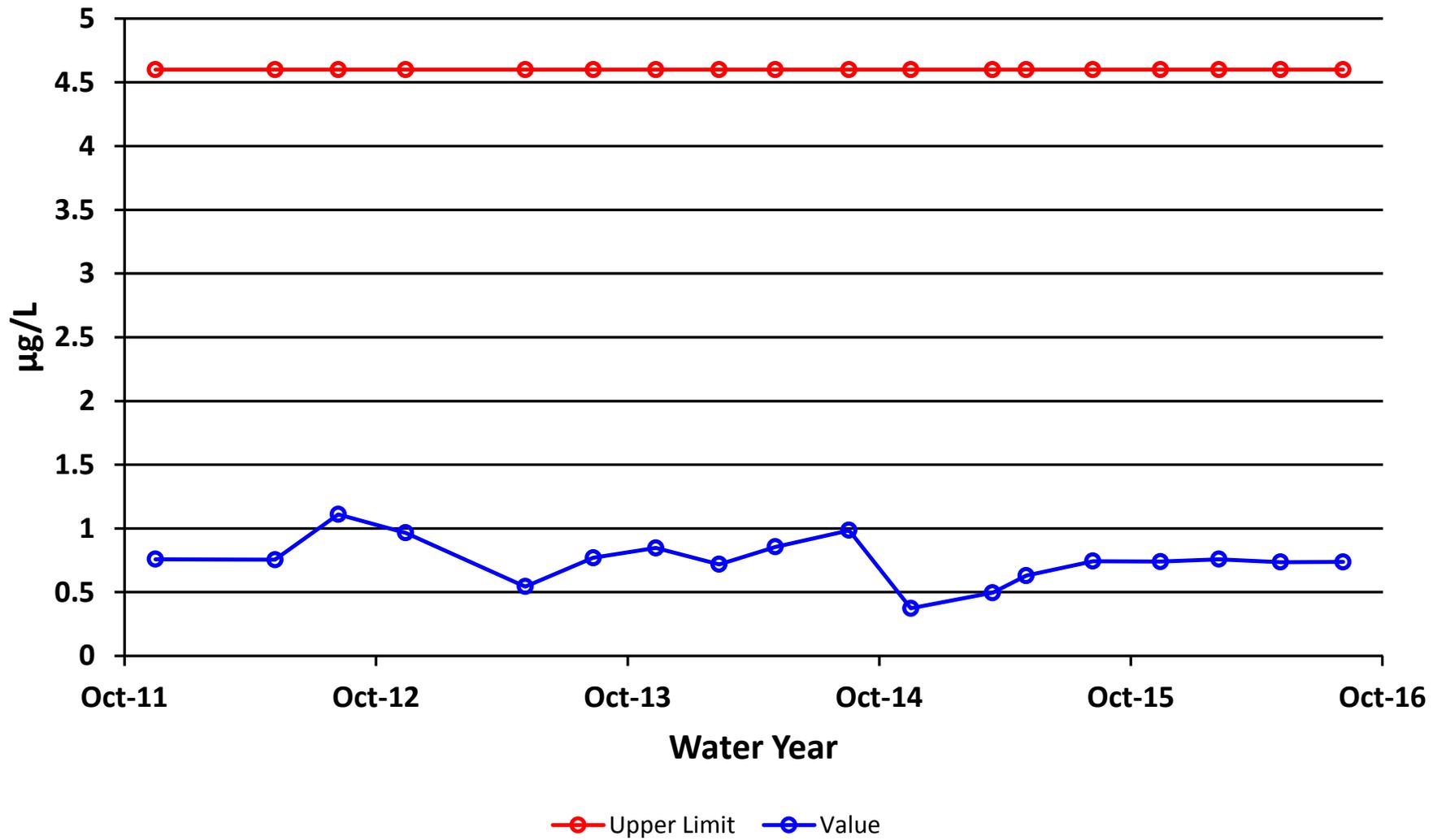
# Site 57 - Silver Dissolved



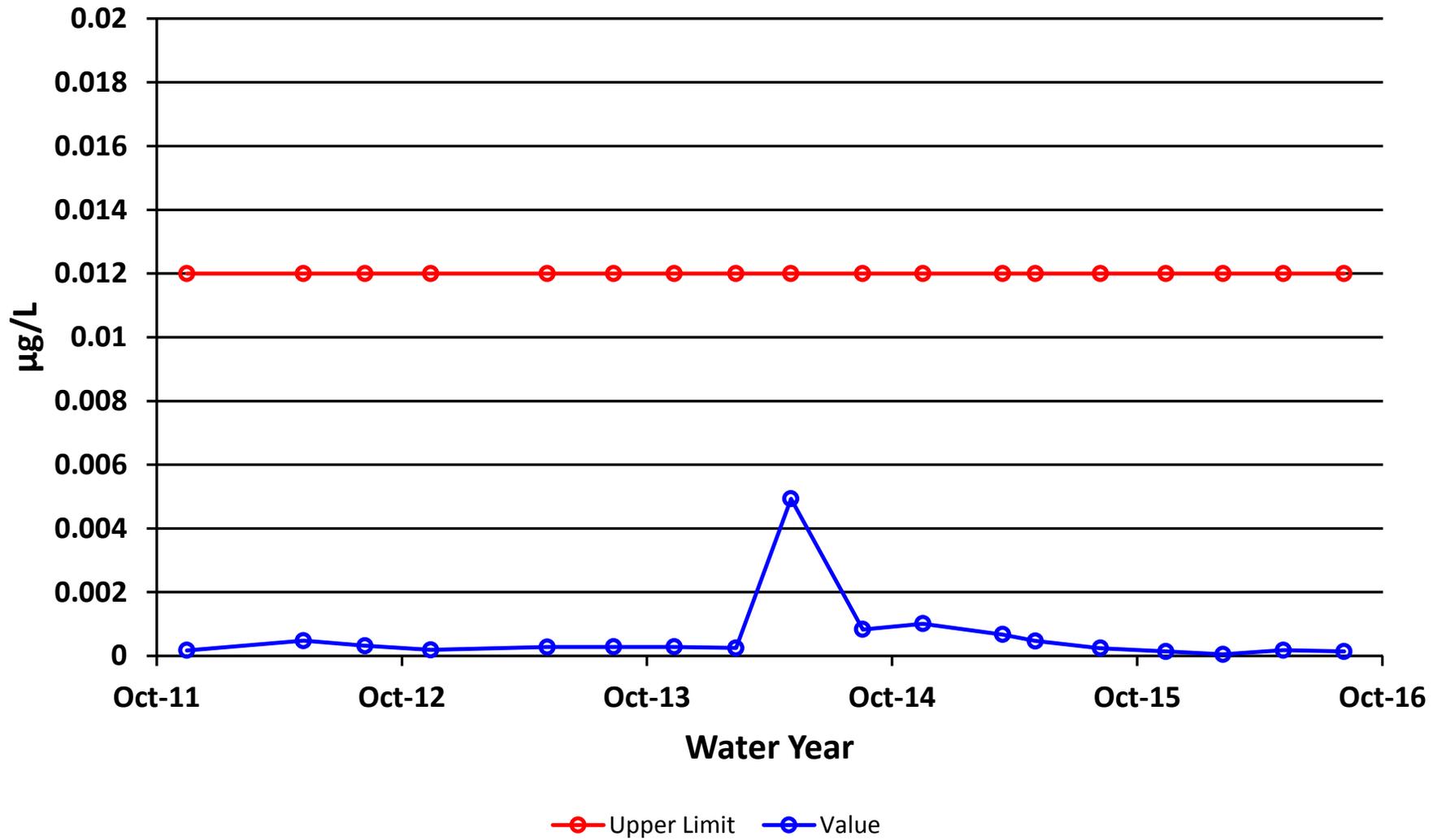
## Site 57 - Zinc Dissolved



# Site 57 - Selenium Dissolved



## Site 57 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 13

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. Eight results exceeding these criteria have been identified as listed in the table below.

**Table of Exceedance for Water Year 2016**

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
13-Oct-15	Cadmium Dissolved	8.34 µg/L		0.28	120 mg/L
7-Dec-15	Cadmium Dissolved	3.99 µg/L		0.27	115 mg/L
9-May-16	Cadmium Dissolved	9.20 µg/L		0.33	151 mg/L
8-Aug-16	Cadmium Dissolved	0.62 µg/L		0.32	147 mg/L
13-Oct-15	Zinc Dissolved	2,305 µg/L		138	120 mg/L
7-Dec-15	Zinc Dissolved	1,617 µg/L		133	115 mg/L
9-May-16	Zinc Dissolved	3,280 µg/L		168	151 mg/L
8-Aug-16	Zinc Dissolved	255 µg/L		164	147 mg/L

Over several years waste rock material has been removed from the 1350 Area. It was not until 2011 that any material was removed from the Eastern Lobe, the area that contributes to the Site 13 drainage; however the material removed was not in the direct drain path for Site 13. During 2012 no material was removed, a limited amount was removed in 2013, HGCMC removed most of the remaining material in 2014, a small amount of material was removed in 2015, and no material was removed in 2016. Only the material in the road access was left and it will be removed during final reclamation.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Cadmium, nickel, lead, and zinc all sharply

increased at Site 13 after waste rock material was removed in 2014. Lead levels were well below the AWQS in Water Year 2016, however dissolved zinc and dissolved cadmium continued to have measurements above the respective AWQS in the 2106 Water Year. As seen with other reclamation projects (e.g. the 960) there is usually an initial increase in metals concentration. HGCMC had expected to see these elevated levels attenuate throughout, as they had appeared to be doing in the 2015 Water Year. Though HGCMC expects these elevated concentrations will attenuate with time, a collection system was installed in late August 2016 at the toe of the material left in place. Monitoring conducted in Water Year 2017 will be used to evaluate the effectiveness of the system.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). For datasets with a statistically significant trend a Seasonal-Sen's Slope estimate statistic has also been calculated. There is a statistically significant ( $\alpha/2=2.5\%$ ) decreasing (-21.3 mg/L/yr) trend for total alkalinity analyzed from Site 13. This change is potentially a result of the material removal. HGCMC feels the current FWMP program is sufficient to monitor current and future changes at Site 13 before water quality values are impaired long term.

**Table of Summary Statistics for Trend Analysis**

<b>Parameter</b>	<u>Mann-Kendall test statistics</u>			<u>Sen's slope estimate</u>	
	<b>n*</b>	<b>p**</b>	<b>Trend</b>	<b>Q</b>	<b>Q(%)</b>
Conductivity Field	6	0.03			
pH Field	6	0.50			
Alkalinity, Total	6	0.02	-	-21.3	-36.8
Sulfate, Total	6	0.06			
Zinc, Dissolved	6	0.94			

\* Number of Years \*\* Significance level

## Table of Results for Water Year 2016

### Site 013FMS - '1350 East Drainage'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)	7.6		1.8					7.7			14.3		7.7
Conductivity-Field(µmho)	268		248					334			313		290.5
Conductivity-Lab (µmho)	238		165					314			304		271
pH Lab (standard units)	7.1		7.31					7.49			7.47		7.39
pH Field (standard units)	7.48		7.44					7.46			7.75		7.47
Total Alkalinity (mg/L)	28.1		34					38			69		36.0
Total Sulfate (mg/L)	98.5		73.9					117			83.5		91.0
Hardness (mg/L)	120		115					151			147		133.5
Dissolved As (ug/L)	0.111		0.089					0.112			0.185		0.112
Dissolved Ba (ug/L)	14.3		8.7					14.6			6.9		11.5
Dissolved Cd (ug/L)	8.3		4					9.2			0.6		6.2
Dissolved Cr (ug/L)	0.216		0.098					0.082			0.083		0.091
Dissolved Cu (ug/L)	1.39		0.78					0.94			1.07		1.01
Dissolved Pb (ug/L)	0.637		0.065					0.125			0.01		0.095
Dissolved Ni (ug/L)	7.9		5.2					7.5			1.5		6.4
Dissolved Ag (ug/L)	0.009		0.002					0.002			0.002		0.002
Dissolved Zn (ug/L)	2305		1617					3280			255		1,961
Dissolved Se (ug/L)	0.178		0.142					0.159			0.208		0.169
Dissolved Hg (ug/L)	0.00235		0.000832					0.00111			0.000733		0.000971

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

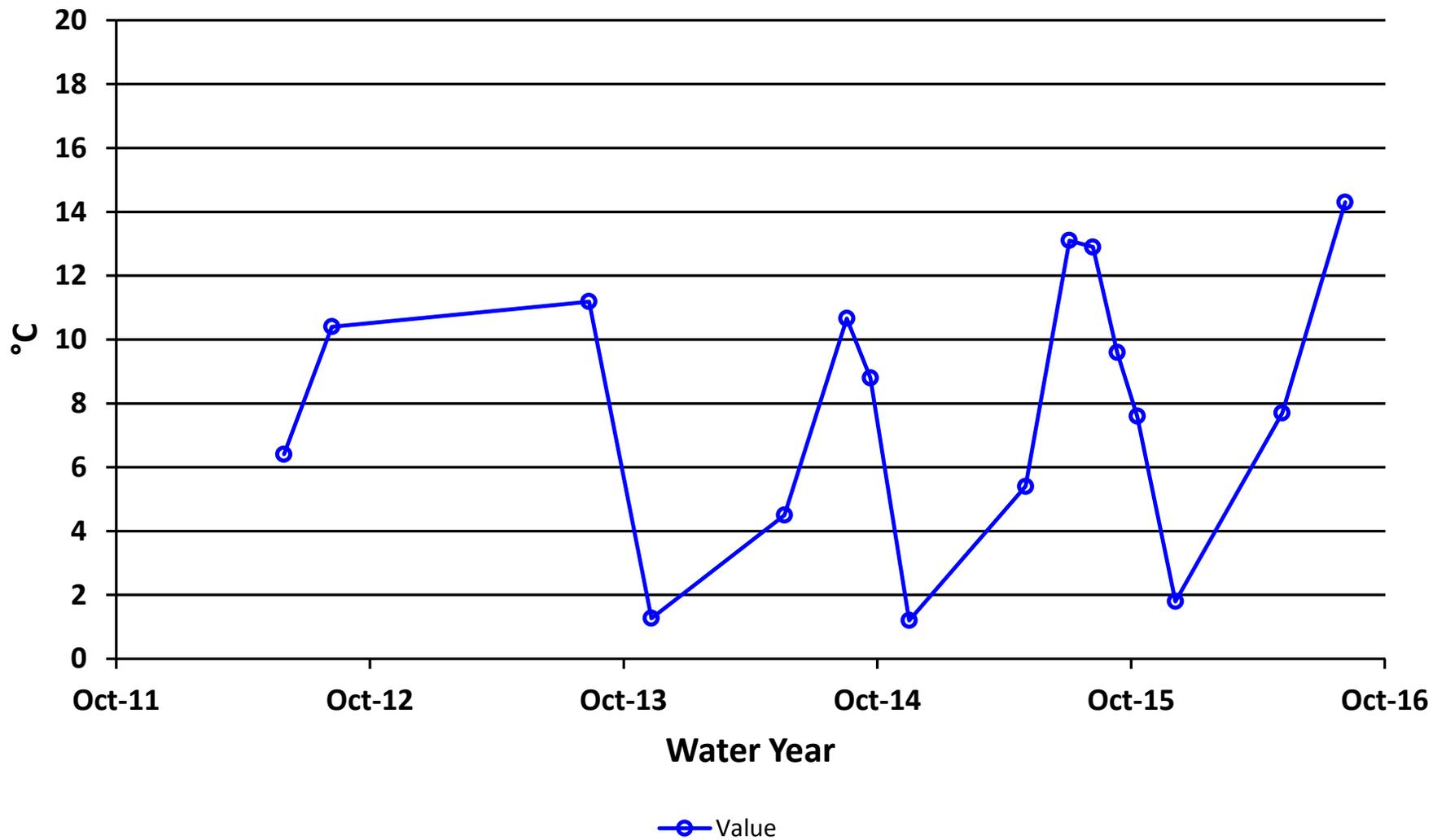
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

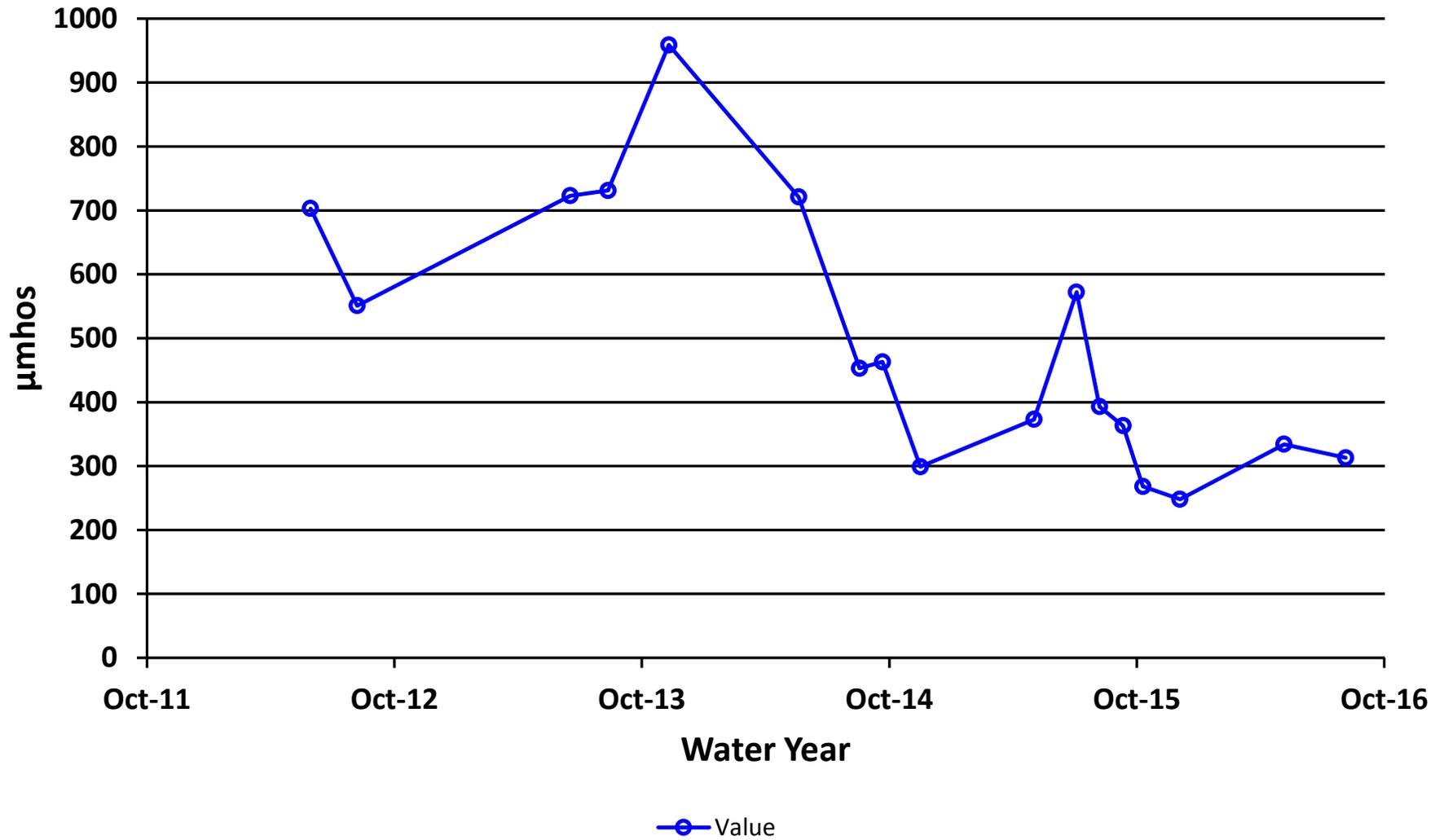
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
013FMS	10/13/2015	12:00 PM	Diss. Ag-ICP/MS	0.00911	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.17	µg/L	J	Below Quantitative Range
	12/7/2015	12:00 PM	Diss. Cr-ICP/MS	0.09	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.14	µg/L	J	Below Quantitative Range
5/9/2016	12:00 PM		Diss. Cr-ICP/MS	0.08	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.15	µg/L	J	Below Quantitative Range
8/8/2016	12:00 PM		Diss. Cr-ICP/MS	0.08	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.2	µg/L	J	Below Quantitative Range
			Sulfate	83.5	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

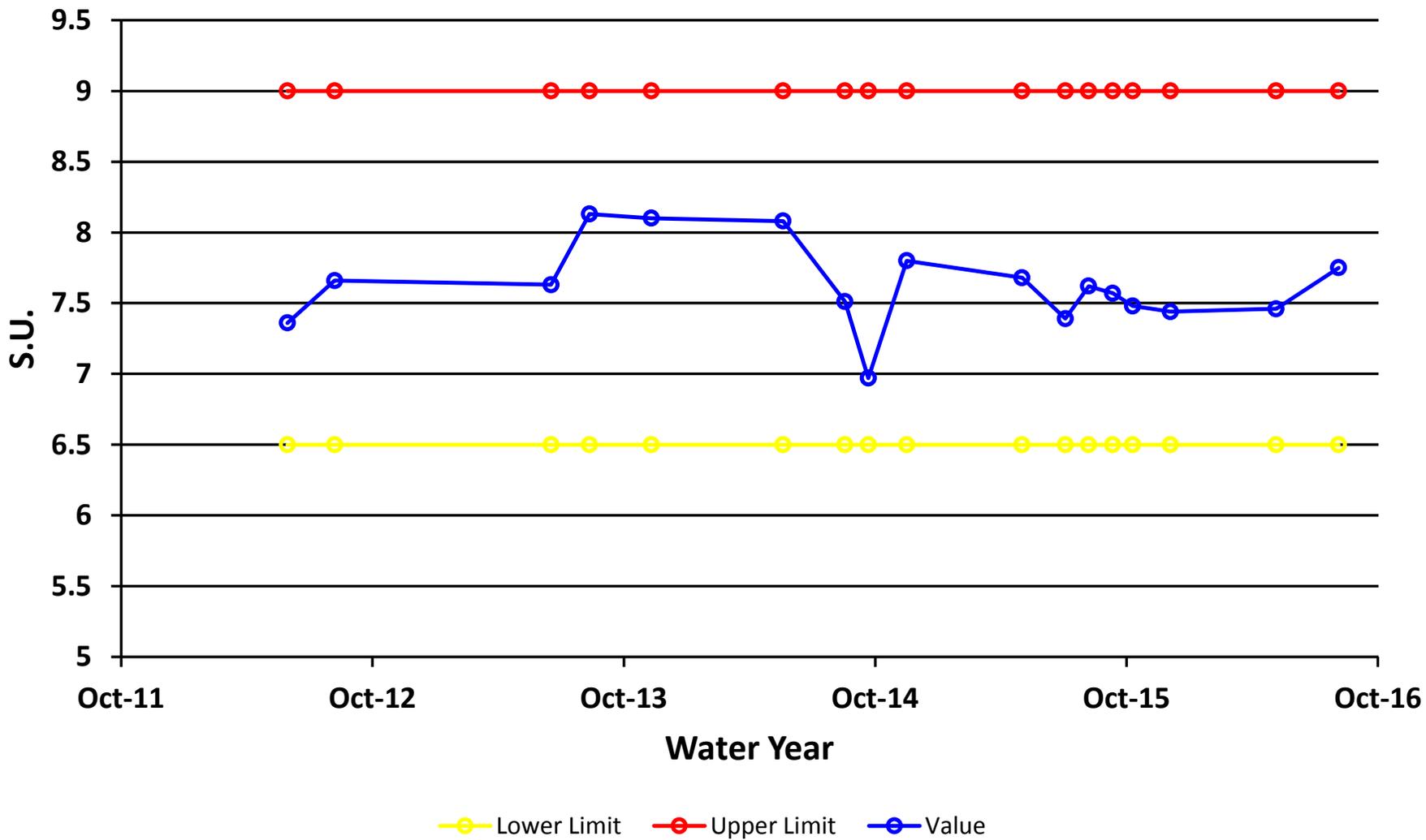
## Site 13 - Water Temperature



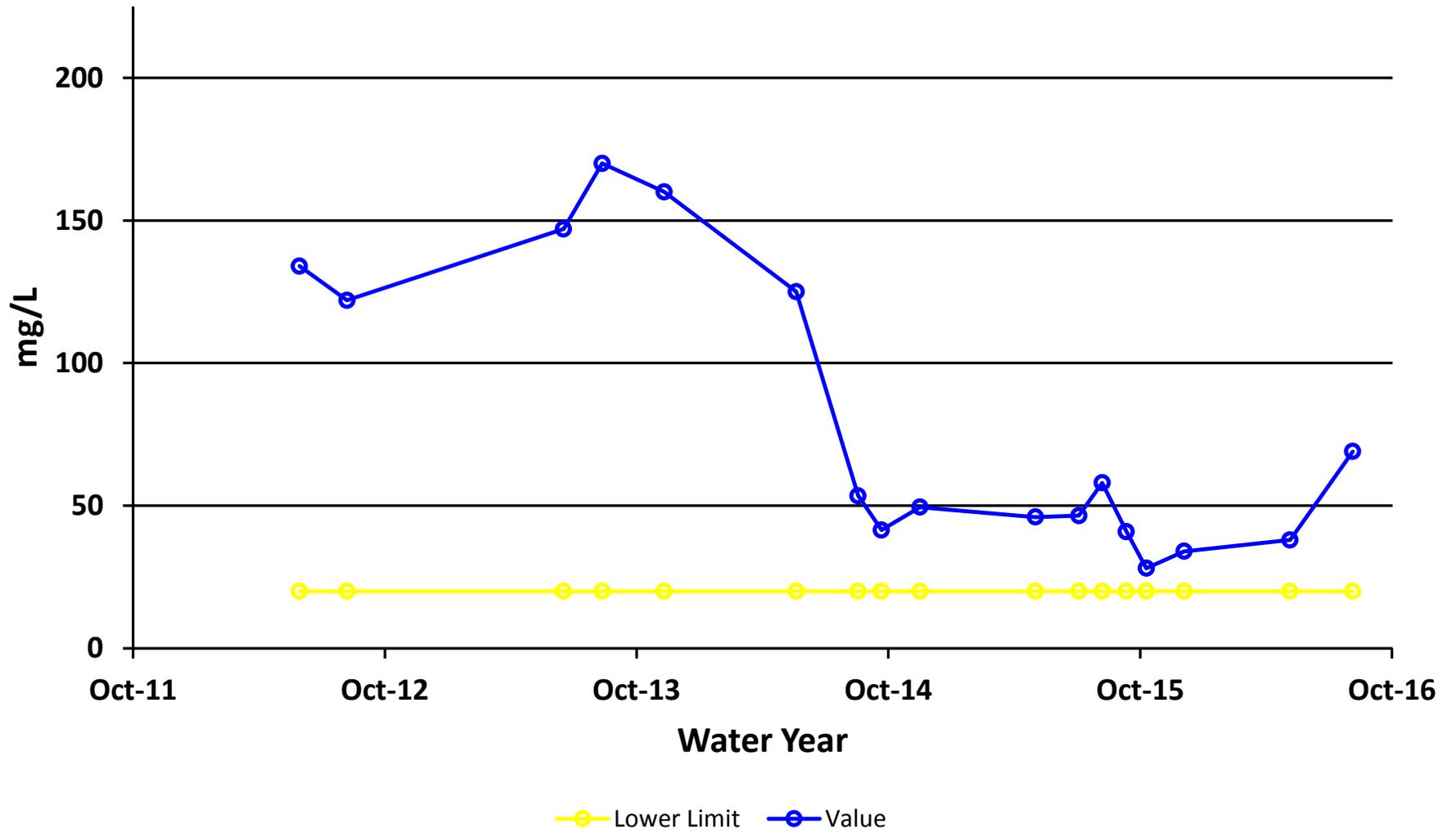
## Site 13 - Conductivity Field



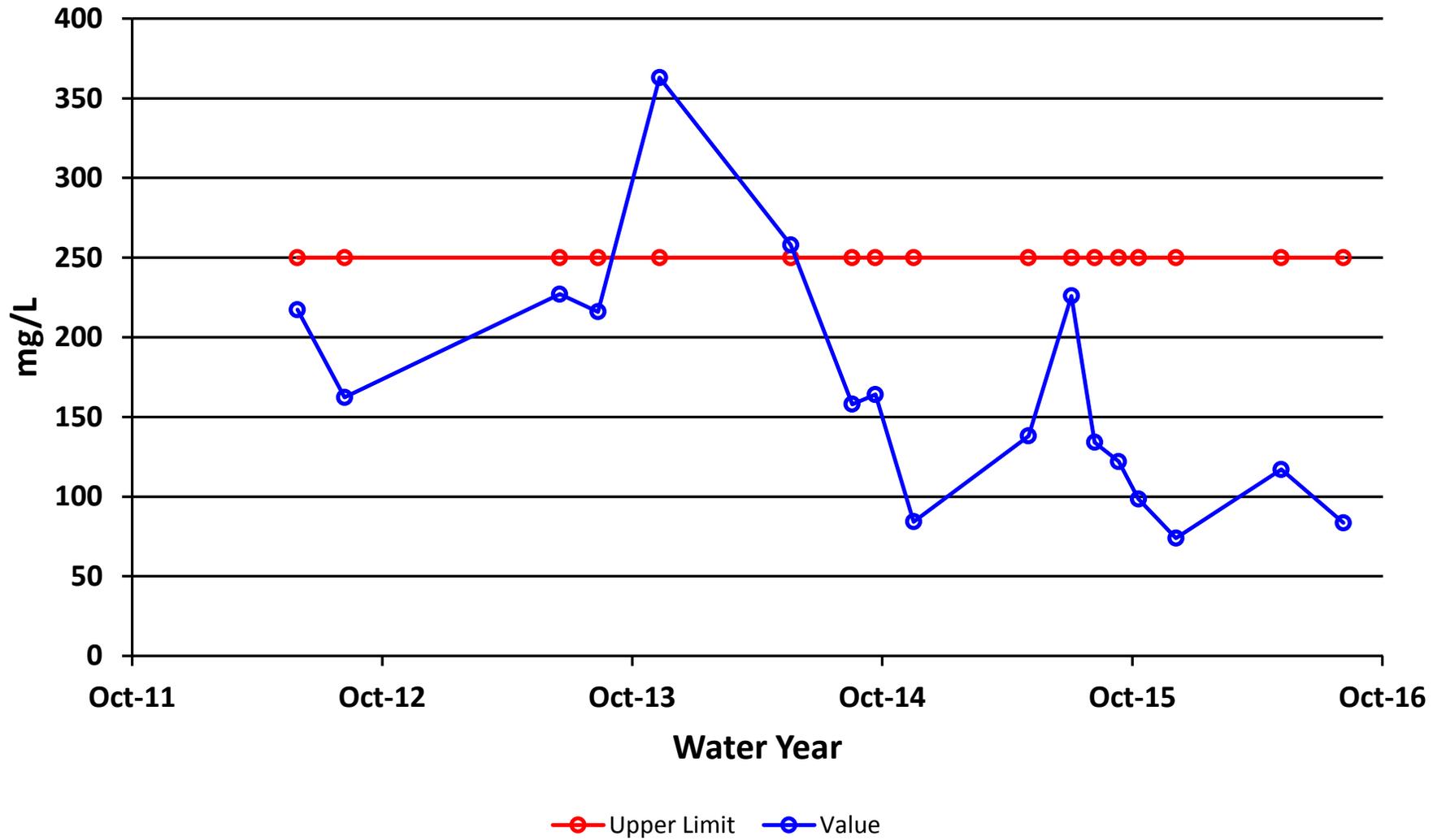
# Site 13 - pH Field



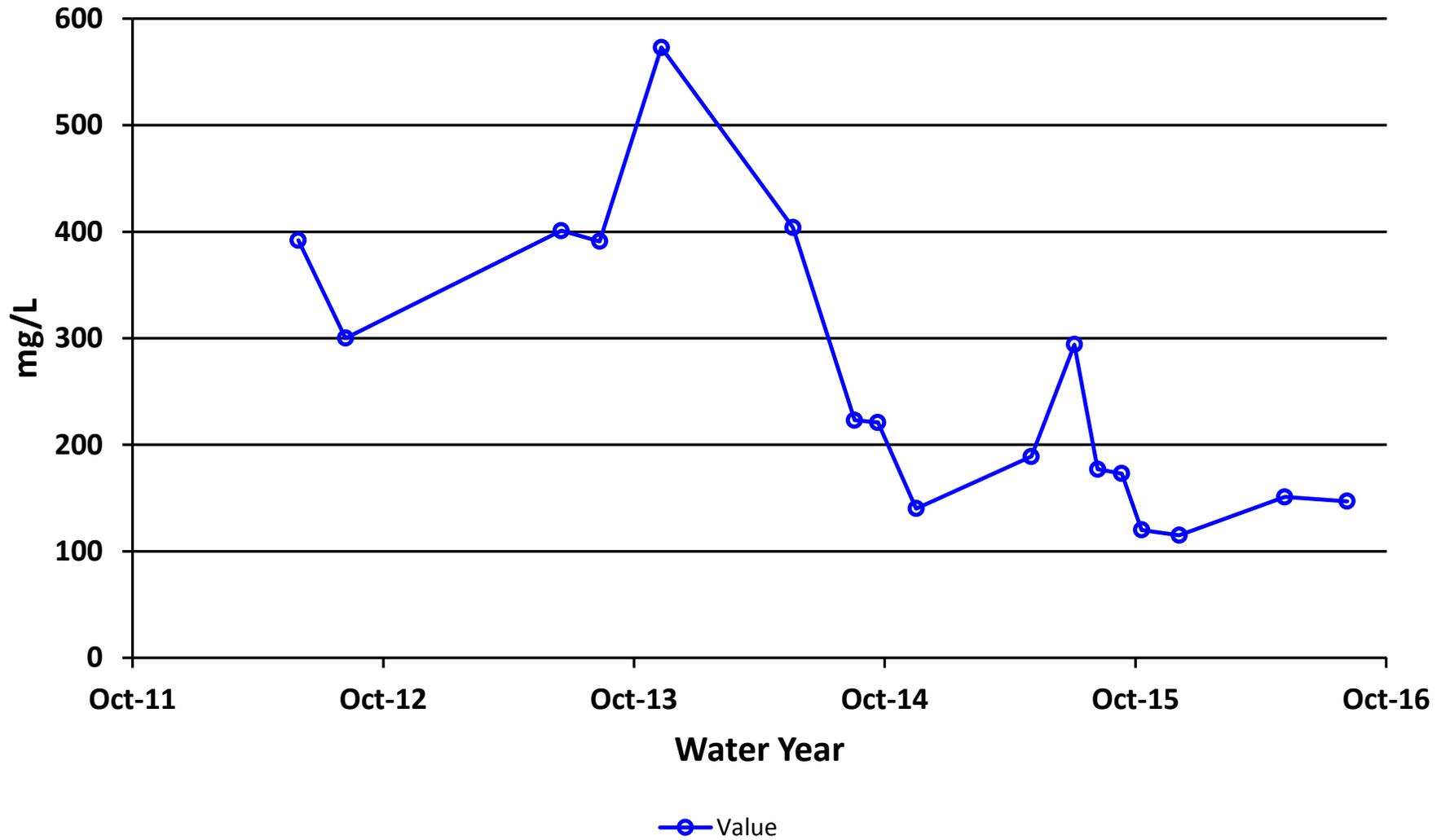
# Site 13 - Alkalinity



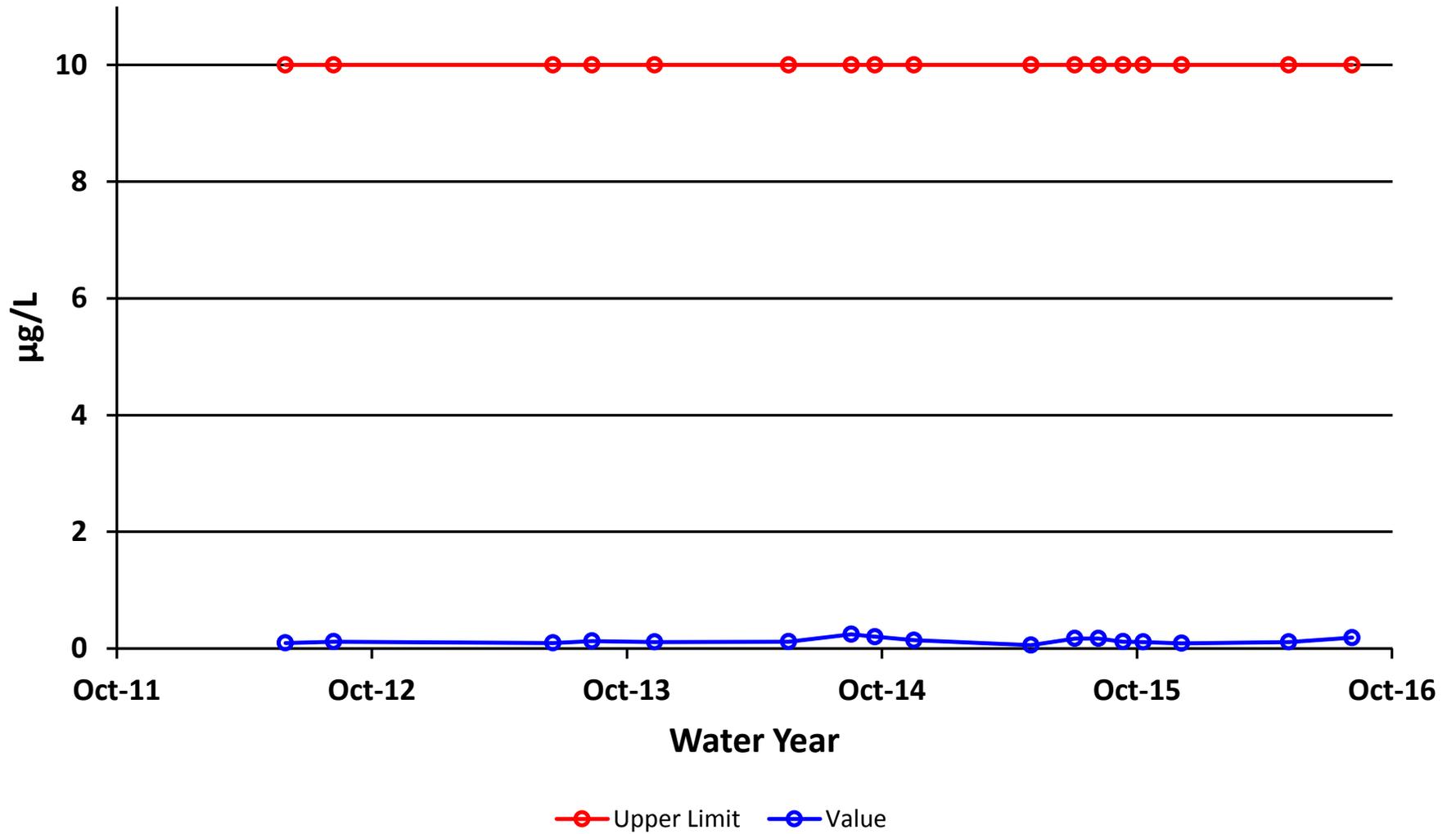
# Site 13 - Sulfate



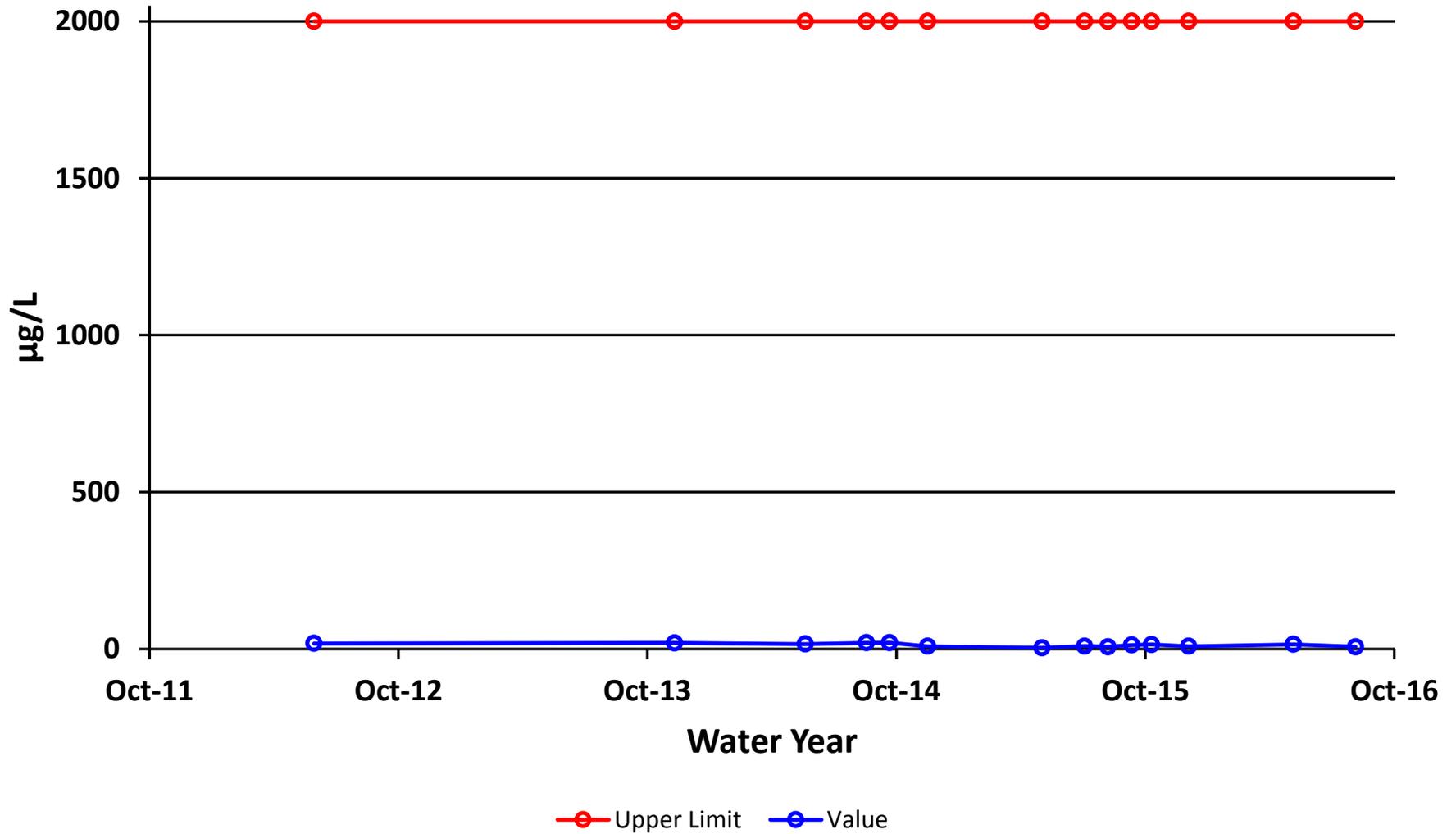
### Site 13 - Hardness



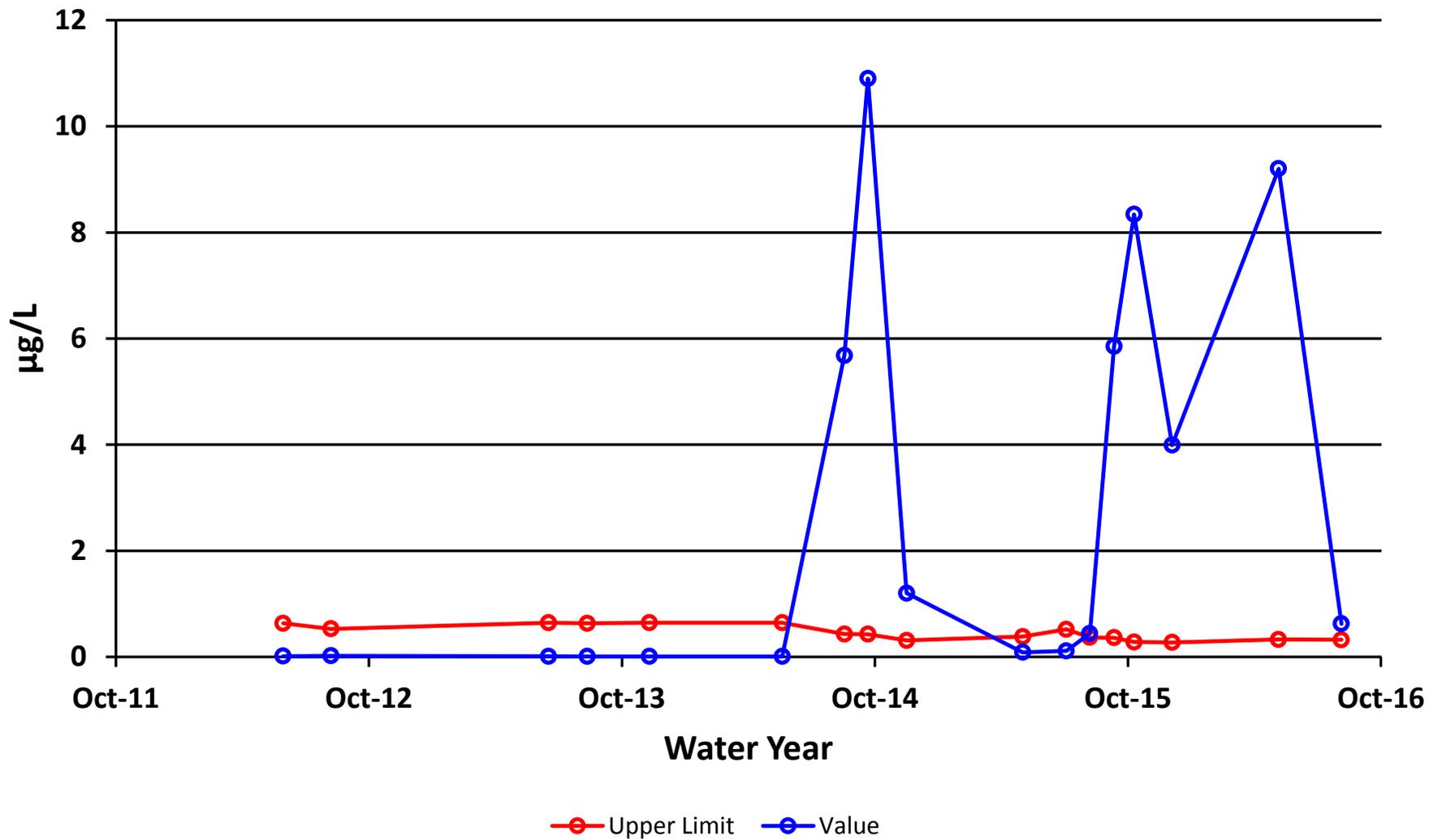
# Site 13 - Arsenic Dissolved



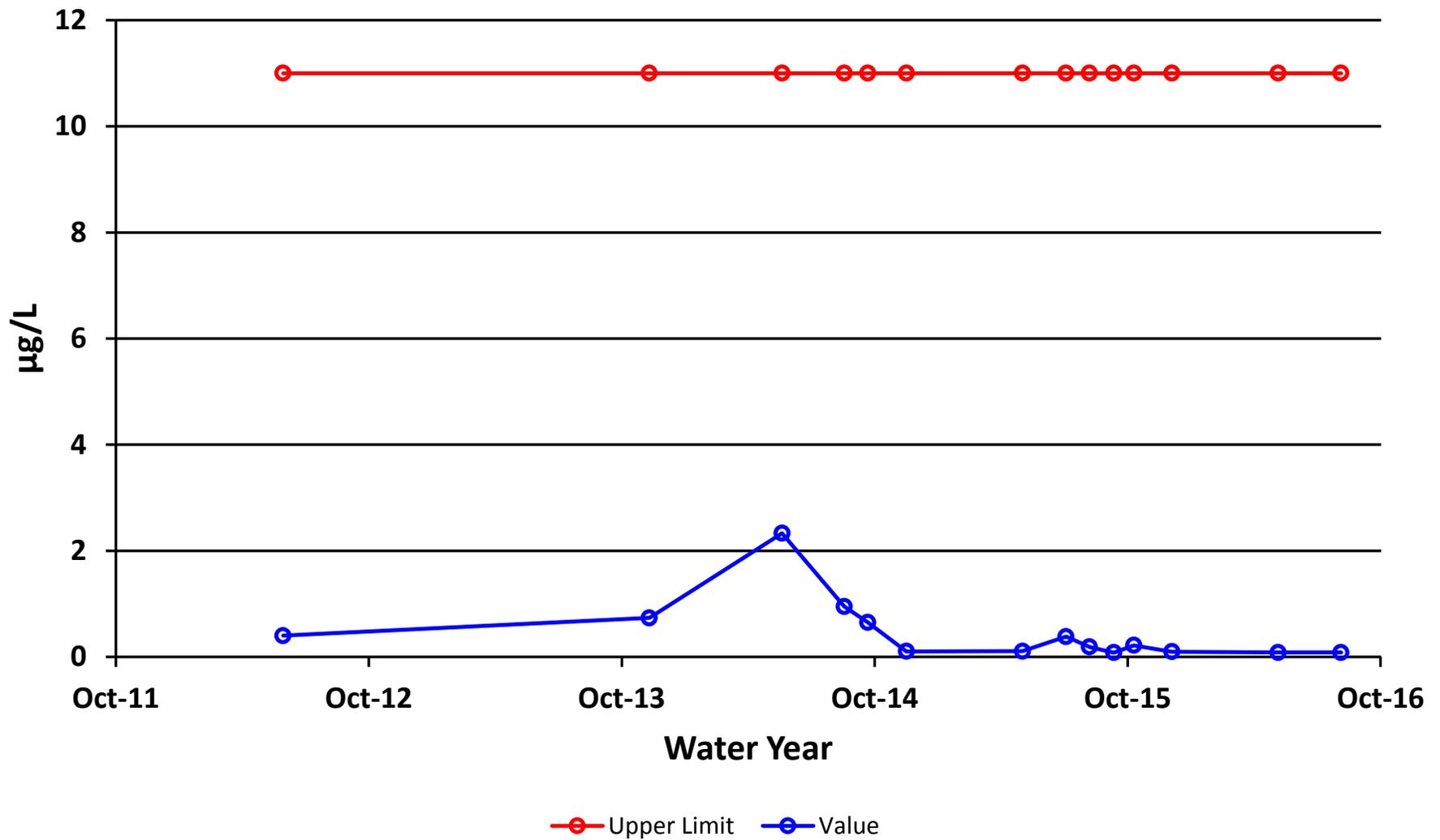
# Site 13 - Barium Dissolved



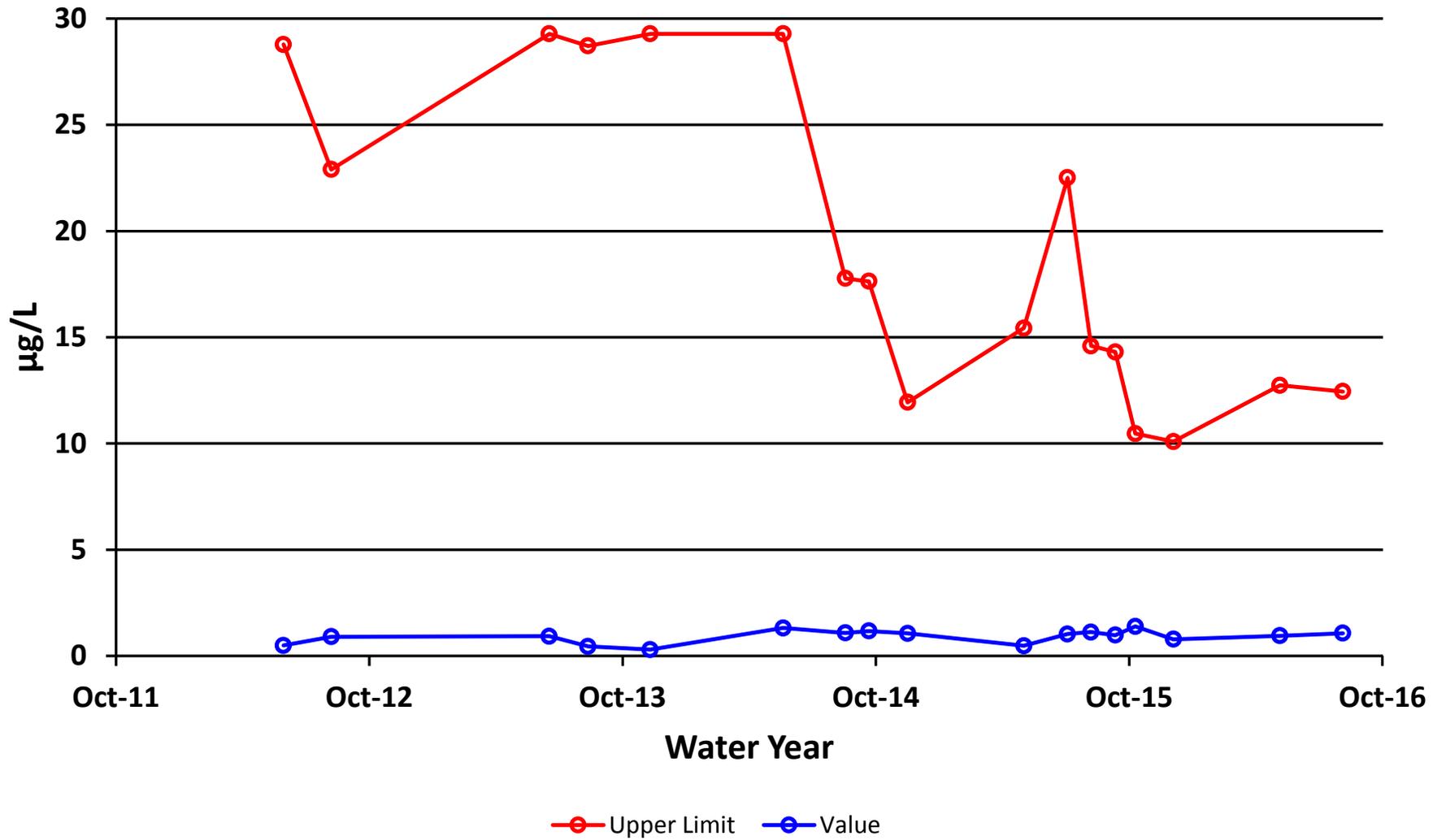
# Site 13 - Cadmium Dissolved



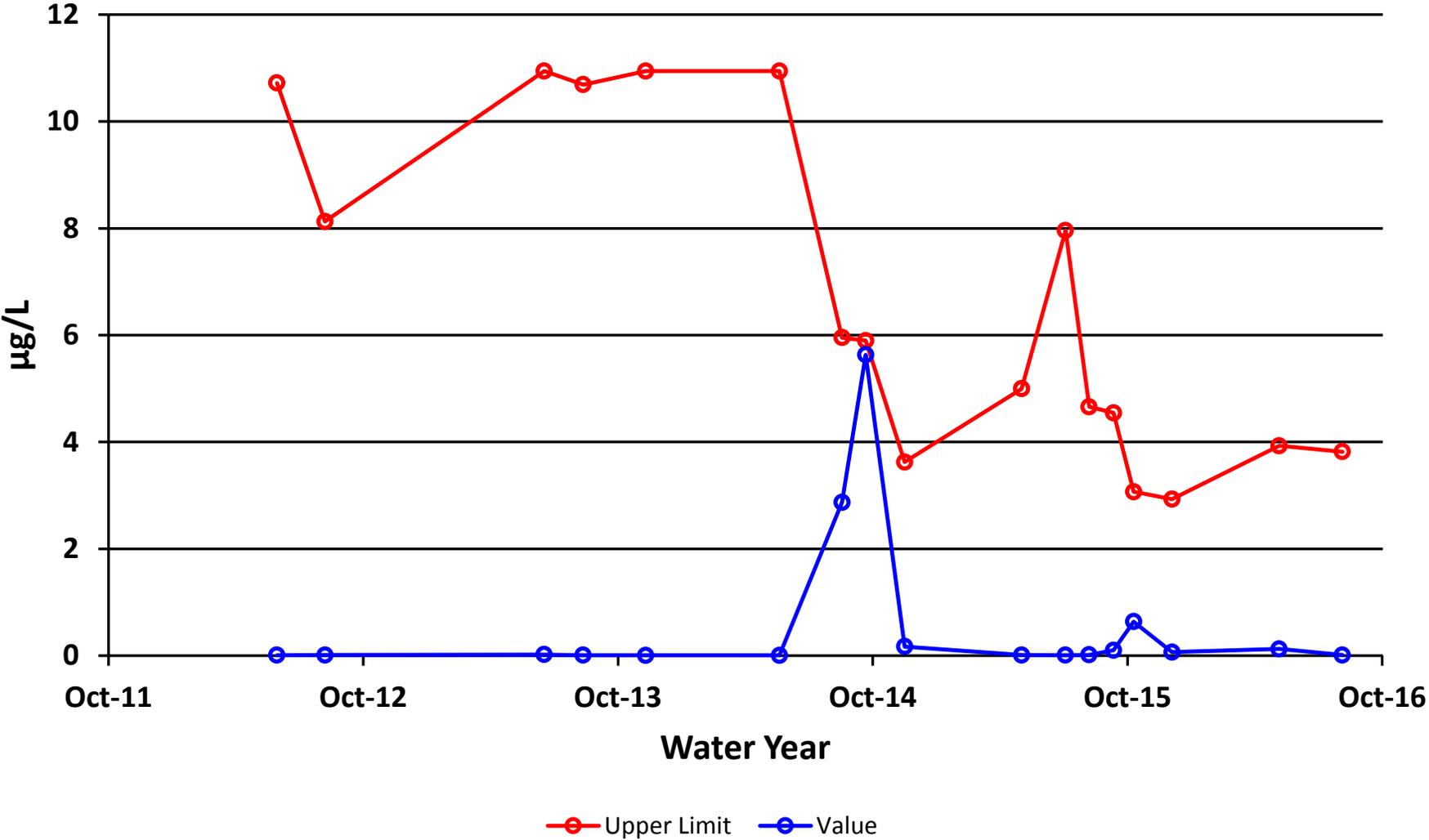
# Site 13 - Chromium Dissolved



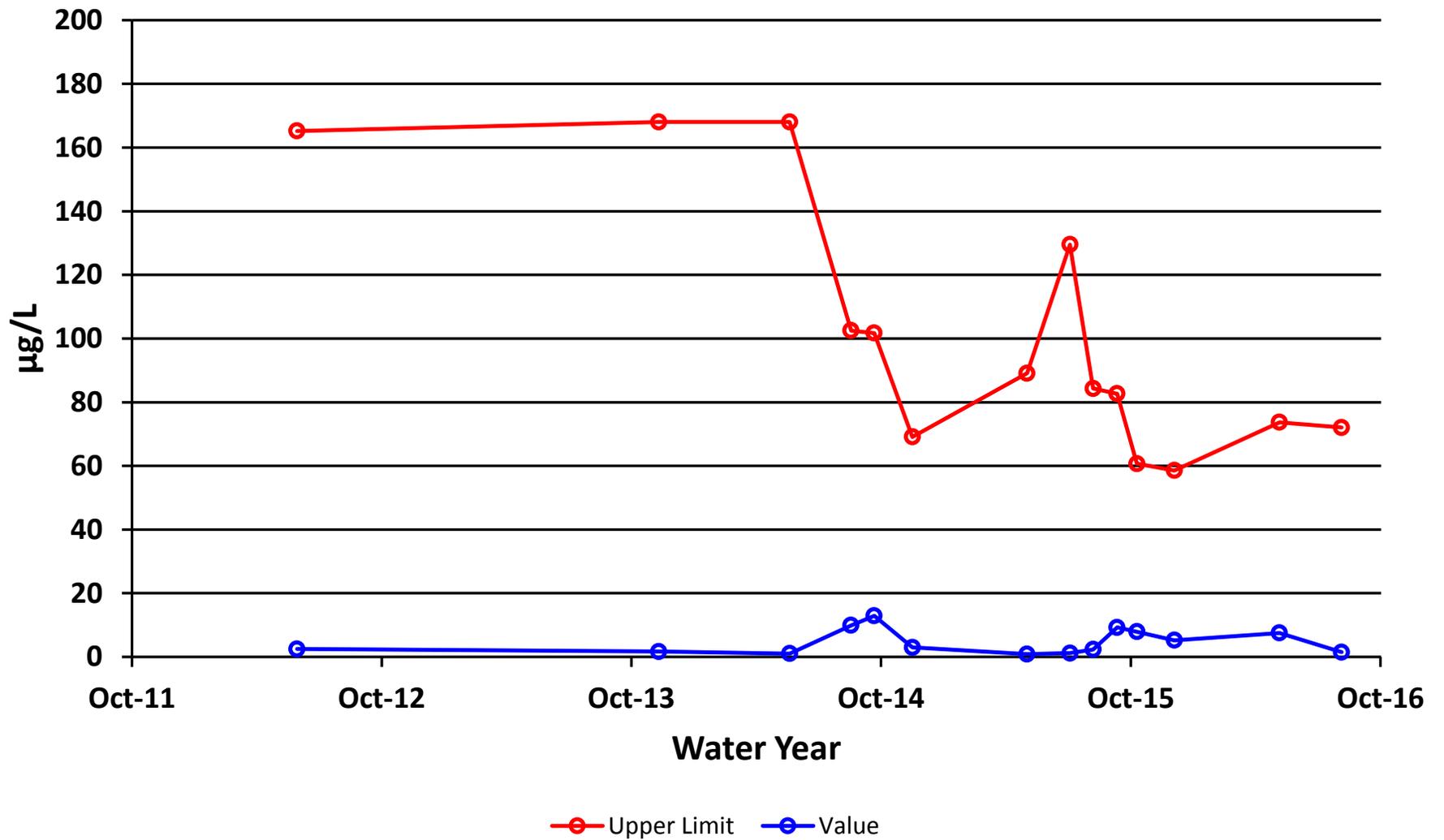
### Site 13 - Copper Dissolved



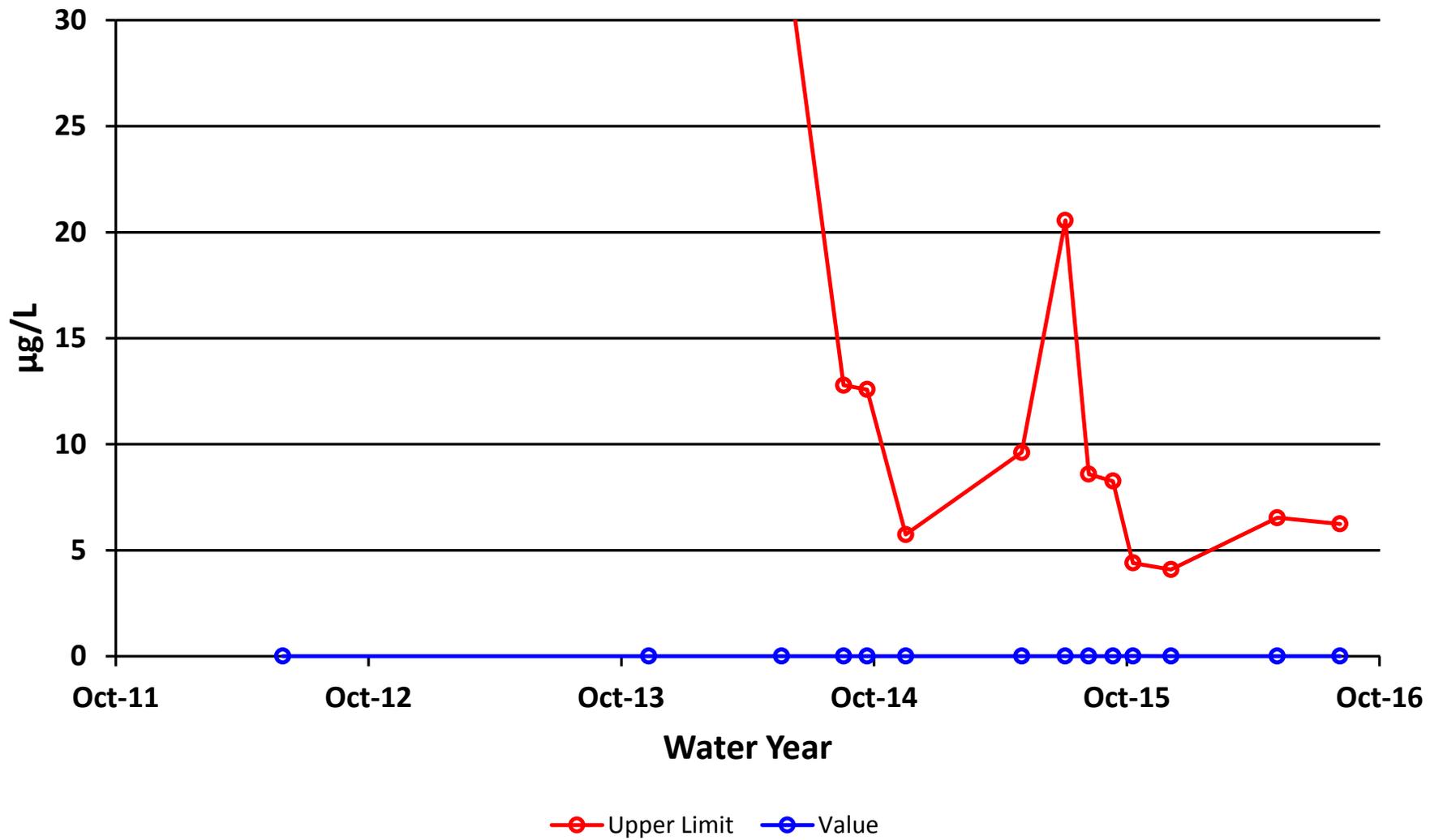
# Site 13 - Lead Dissolved



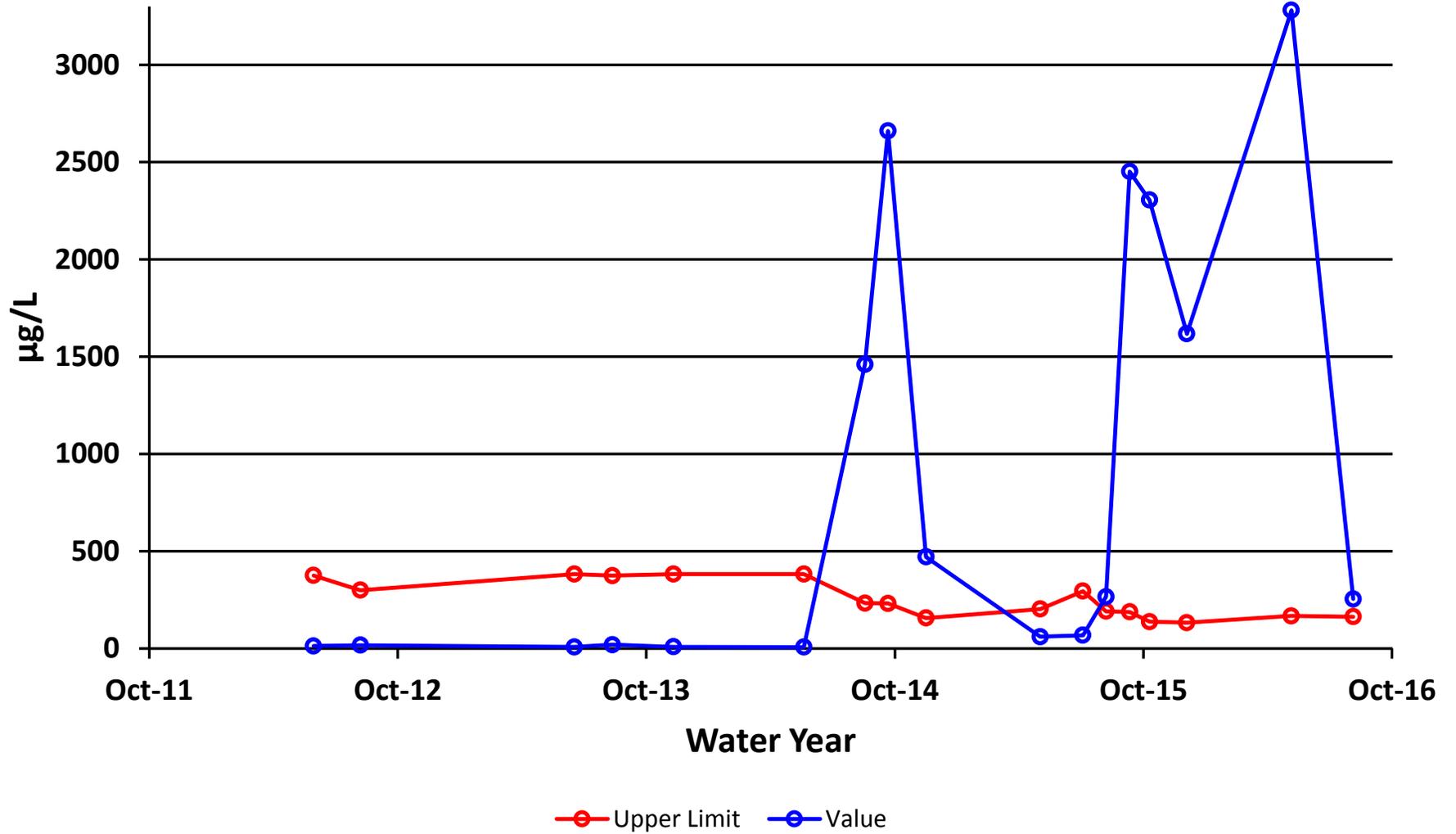
# Site 13 - Nickel Dissolved



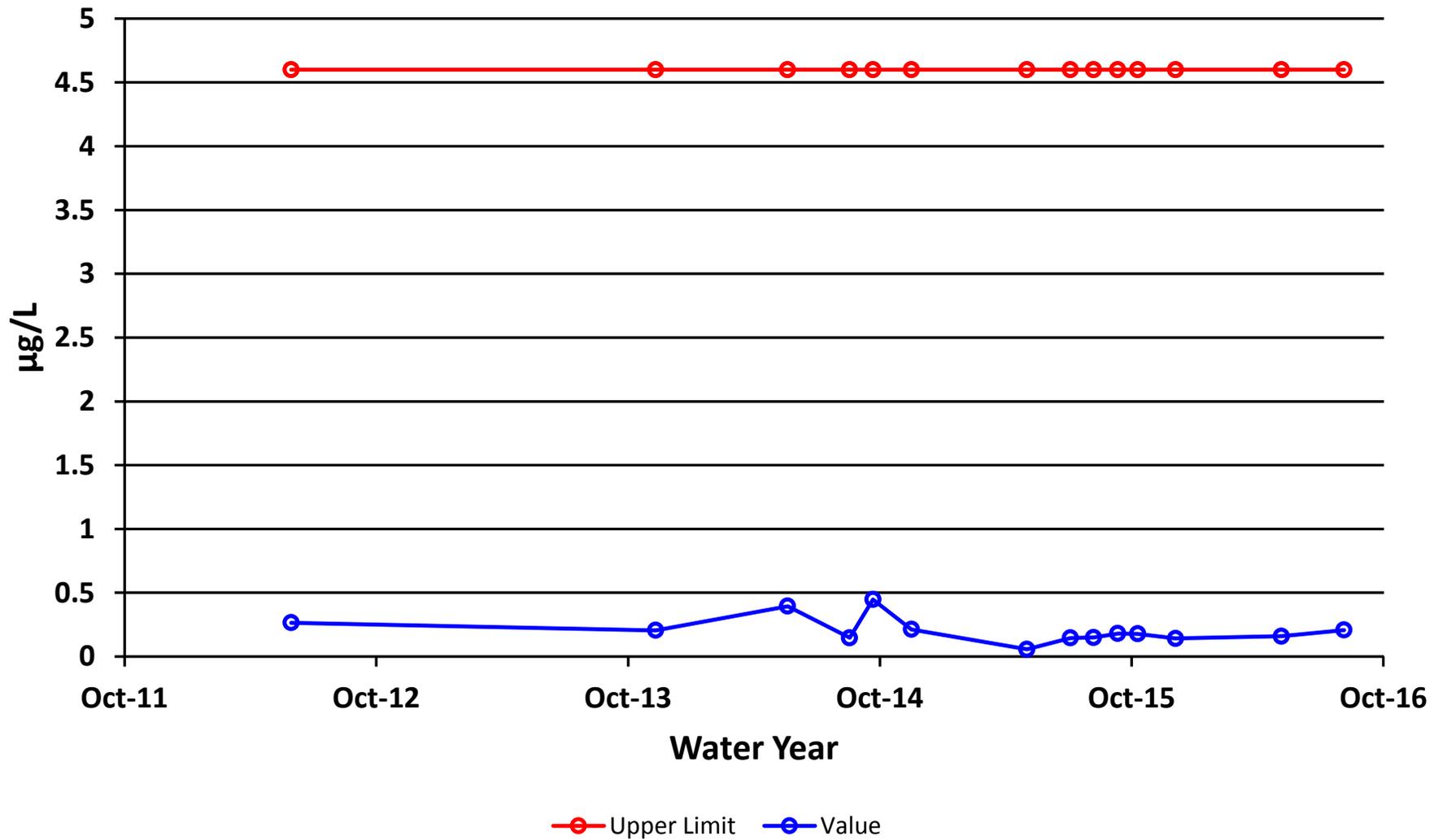
# Site 13 - Silver Dissolved



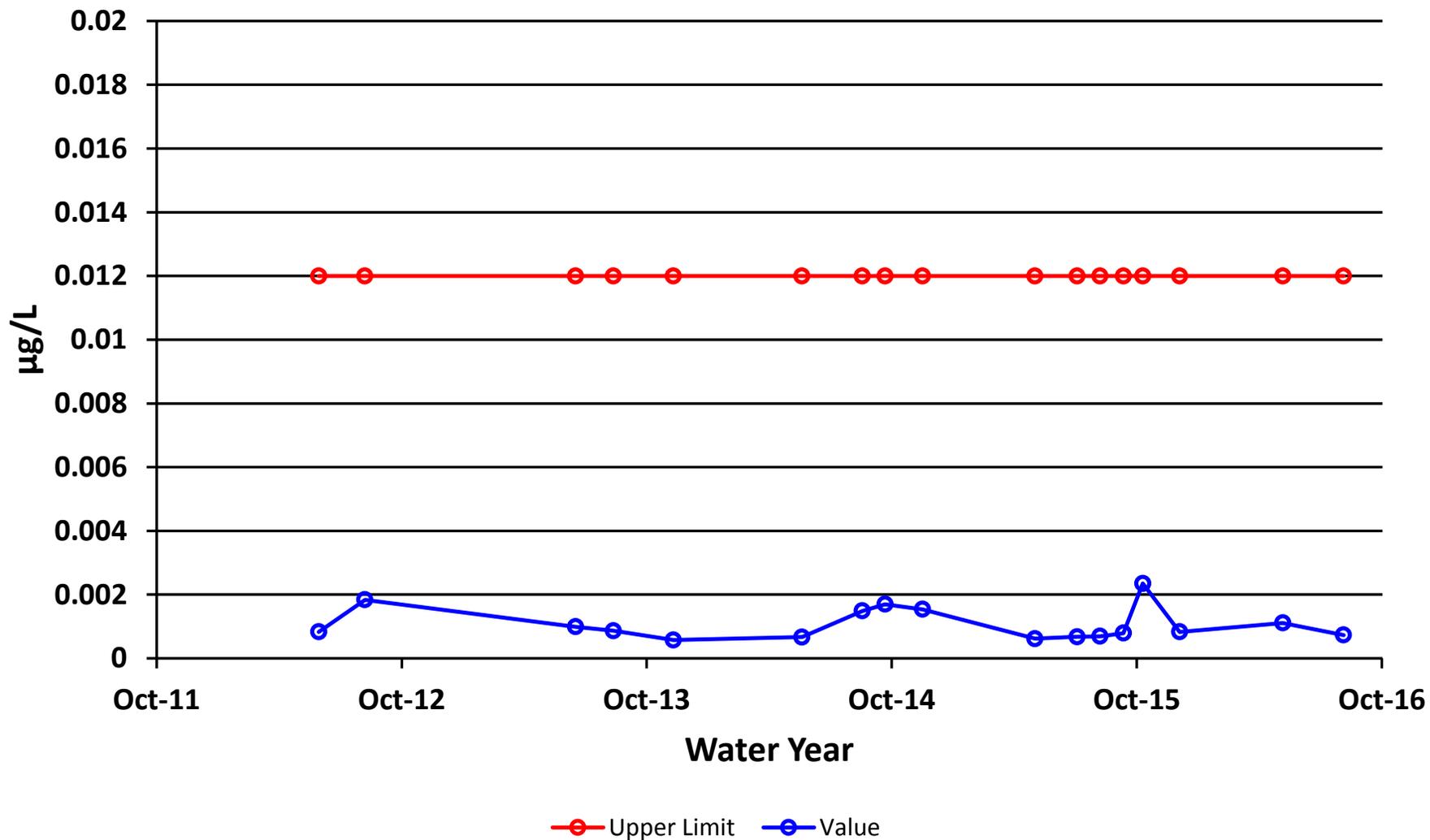
# Site 13 - Zinc Dissolved



# Site 13 - Selenium Dissolved



# Site 13 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 27

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The summer sample was taken in August instead of July, because of a bear in the vicinity of the well when the technicians went to collect the sample in July. HGCMC environmental department has a policy of postponing sampling when *Ursus arctos sitkensis* is in the vicinity.

The data have been compared to the strictest fresh water quality criterion for each applicable analyte. Three samples exceeding these criteria have been identified, as listed in the table below. The exceedances were for field pH values which are below the lower limit of 6.5 su listed in the AWQS. Values for field pH from other wells completed into organic rich peat sediments similar to Site 27 have historically resulted in pH values ranging from 5 to 6 su (e.g. Sites 29 and 32). All of the other analytes were within AWQS for the current water year.

**Table of Exceedance for Water Year 2016**

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
17-Nov-15	pH Field	6.30 su	6.5	9	58.5 mg/L
10-May-16	pH Field	6.44 su	6.5	9	56.3 mg/L
12-Sep-16	pH Field	6.46 su	6.5	9	48.3 mg/L

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. Visually the increasing trend in total sulfate values, which started in 2008, has since ‘leveled’ off. The maximum value recorded was 34.8 mg/L in October 2009. During the current water year the median total sulfate value was 16.6 mg/L. Over the past two water years there has been a slight increase in alkalinity.

Non-parametric statistical analyses were performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The below table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.52			
pH Field	6	0.88			
Alkalinity, Total	6	1.00	+	5.0	13.6
Sulfate, Total	6	0.88			
Zinc, Dissolved	6	0.45			

\* Number of Years \*\* Significance level

For datasets with a statistically significant trend ( $\alpha/2=2.5\%$ ) a Seasonal-Sen's Slope estimate statistic has also been calculated. The dataset for total alkalinity has a statistically significant ( $p < 0.01$ ) trend with a slope estimate of 5.0 mg/L/yr over the last 6 years (similar to the slope estimation, 3.0 mg/L/yr, for Water Year 2015).

An intra-well analysis was performed using combined Shewhart-CUSUM charts for conductivity, dissolved zinc, and total sulfate. Table 1 contains a summary of the baseline statistics along with the control limits used.

**Table 1. Specific Conductance, Dissolved Zinc, and Total Sulfate Baseline Periods, Summary Statistics and Various Control Limits**

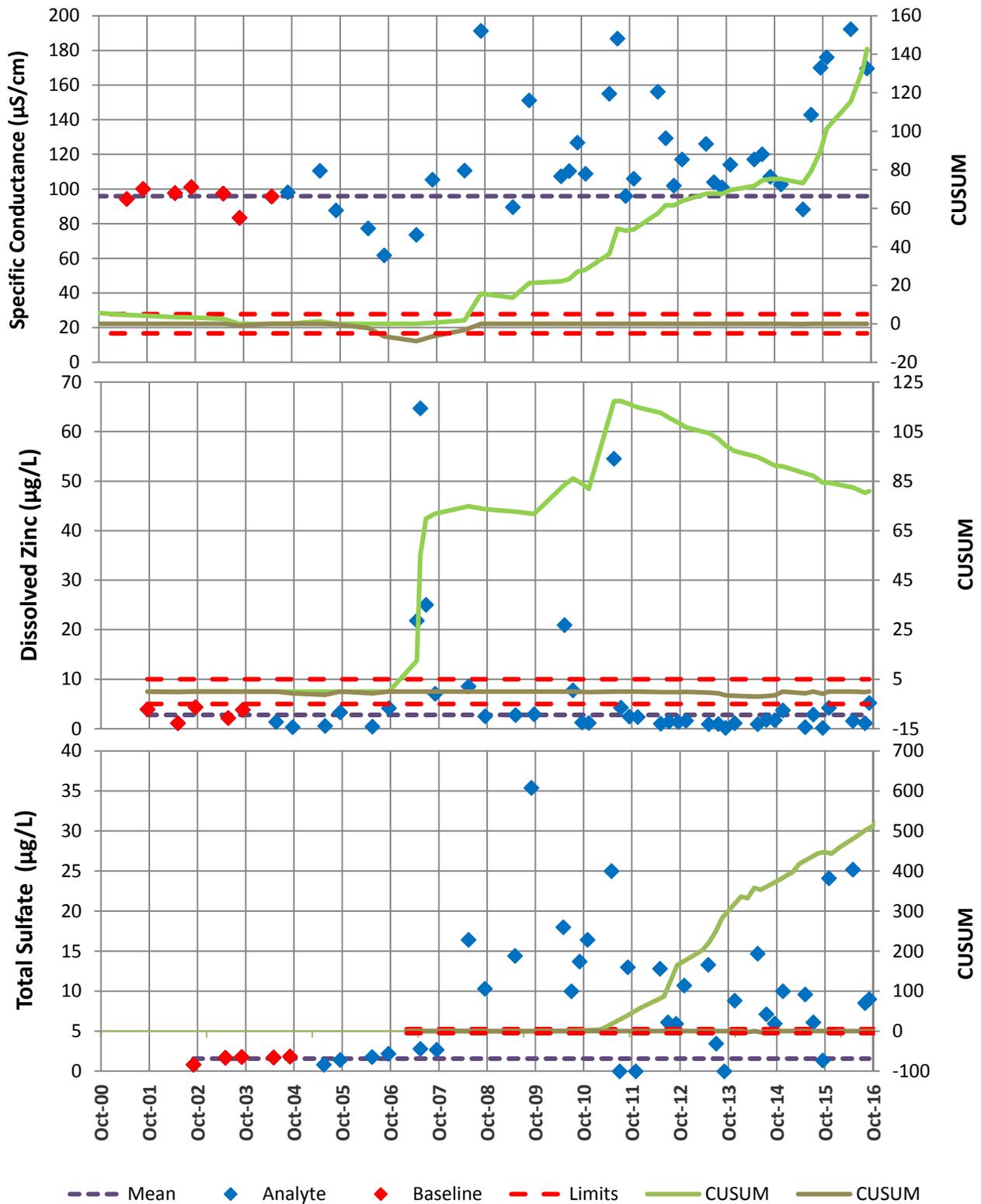
	Site 27 Conductivity ( $\mu\text{S}/\text{cm}$ )	Site 27 Diss. Zinc ( $\mu\text{g}/\text{L}$ )	Site 27 Total Sulfate ( $\text{mg}/\text{L}$ )
<b>Baseline Statistics</b>			
Baseline Period	09/18/01-05/18/04	09/18/01-05/18/04	09/17/02-09/21/04
Number of Samples	6	6	5
Mean (x)	95.88	2.78	1.56
Standard Deviation	6.43	1.42	0.43
<b>Shewhart-CUSUM Control Limits (SCL)</b>			
Control Limit (mean x + 2s)	108.6	5.6	2.4
Control Limit (mean x + 3s)	115.5	7.0	2.8
Control Limit (mean x + 4s)	122.3	8.4	3.3
Control Limit (mean x + 4.5s)	125.7	9.2	3.5
<b>CUSUM Control Limits</b>			
Cumulative increase (h)	5	5	5

Figure 1 shows the three analytes examined eventually went out of control. Total sulfate went out of control during the Water Year 2008. This has been discussed in previous reports and is related to the material that was placed to the east of Pond 7 to form a pad. The fill material originated from the northern expansion of the tailings facility and from the figure it appears that there was some easily weathered sulfide mineralogy in the freshly blasted material. Total sulfate concentration initially were decreasing through Water Year 2015, however there was an increase in late 2016 and early 2017 likely caused by the recent disturbance (tailings expansion) in the vicinity of the monitoring well. Though recent concentrations are above the baseline values the median concentration was 16.6 µg/L well below the AWQS of 250 µg/L.

Specific conductance also went out of control in water year 2008 as would be expected with the increase in total sulfate driving the increase in conductivity. Specific conductivity increased during late 2015 and remained elevated during the 2016 Water Year, this correlates with the excavation and construction of the Stage 3 Phase 1 tailings expansion that began in May 2015. Once the construction (disturbance) is completed the conductivity values are expected to drop as the area stabilizes.

Dissolved zinc went out of control beginning in water year 2007. After the first increase in water year 2007 concentrations returned to near baseline levels resulting in the flattening of the CUSUM values. Then water years 2010 and 2011 each had dissolved zinc concentrations that further increased the CUSUM value. Since the fall of 2011 the CUSUM measurement has been trending downward indicating that the concentrations are around the baseline mean. HGCMC will investigate resetting the CUSUM value to zero in the next report.

Figure 1. Observed Measurements for Specific Conductance, Dissolved Zinc, and Total Sulfate from Site 27 Compared to the Shewhart-CUSUM Control Limits From Table 1



## Table of Results for Water Year 2016

### Site 027FMG - 'Monitoring Well - 2S'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		5.7						8			12.8	10.9	9.5
Conductivity-Field(µmho)		176						192.3			211	169.5	184.2
Conductivity-Lab (µmho)		182						187			173	148	178
pH Lab (standard units)		6.39						6.44			6.26	6.35	6.37
pH Field (standard units)		6.3						6.44			6.56	6.46	6.45
Total Alkalinity (mg/L)		61.4						53.5			73.9	55.3	58.4
Total Sulfate (mg/L)		24.1						25.2			8.5	9	16.6
Hardness (mg/L)		58.5						56.3			53.4	48.3	54.9
Dissolved As (ug/L)		4.42						1.86			1.89	3.42	2.655
Dissolved Ba (ug/L)		76.7						69.1			68.3	69.3	69.2
Dissolved Cd (ug/L)		0.0018						0.0018			0.0018	0.0064	0.0018
Dissolved Cr (ug/L)		0.258						0.133			0.235	0.203	0.219
Dissolved Cu (ug/L)		0.06						0.026			0.043	0.117	0.052
Dissolved Pb (ug/L)		0.112						0.0348			0.0146	0.167	0.0734
Dissolved Ni (ug/L)		0.768						0.6			0.15	0.734	0.667
Dissolved Ag (ug/L)		0.002						0.002			0.002	0.002	0.002
Dissolved Zn (ug/L)		4.22						1.54			1.12	5.18	2.88
Dissolved Se (ug/L)		0.097						0.057			0.075	0.057	0.066
Dissolved Hg (ug/L)		0.000312						0.000307			0.000293	0.000602	0.000310

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

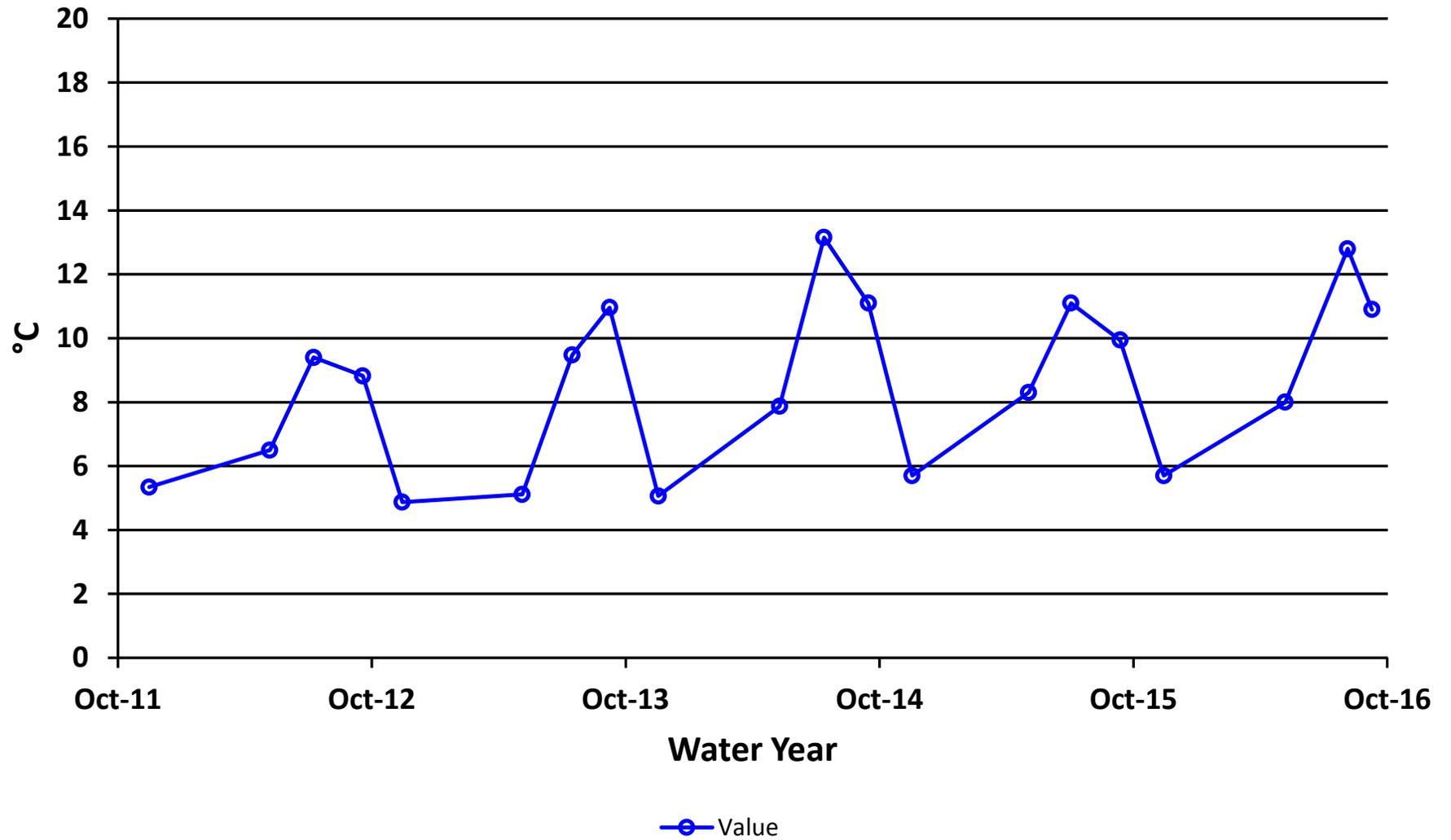
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

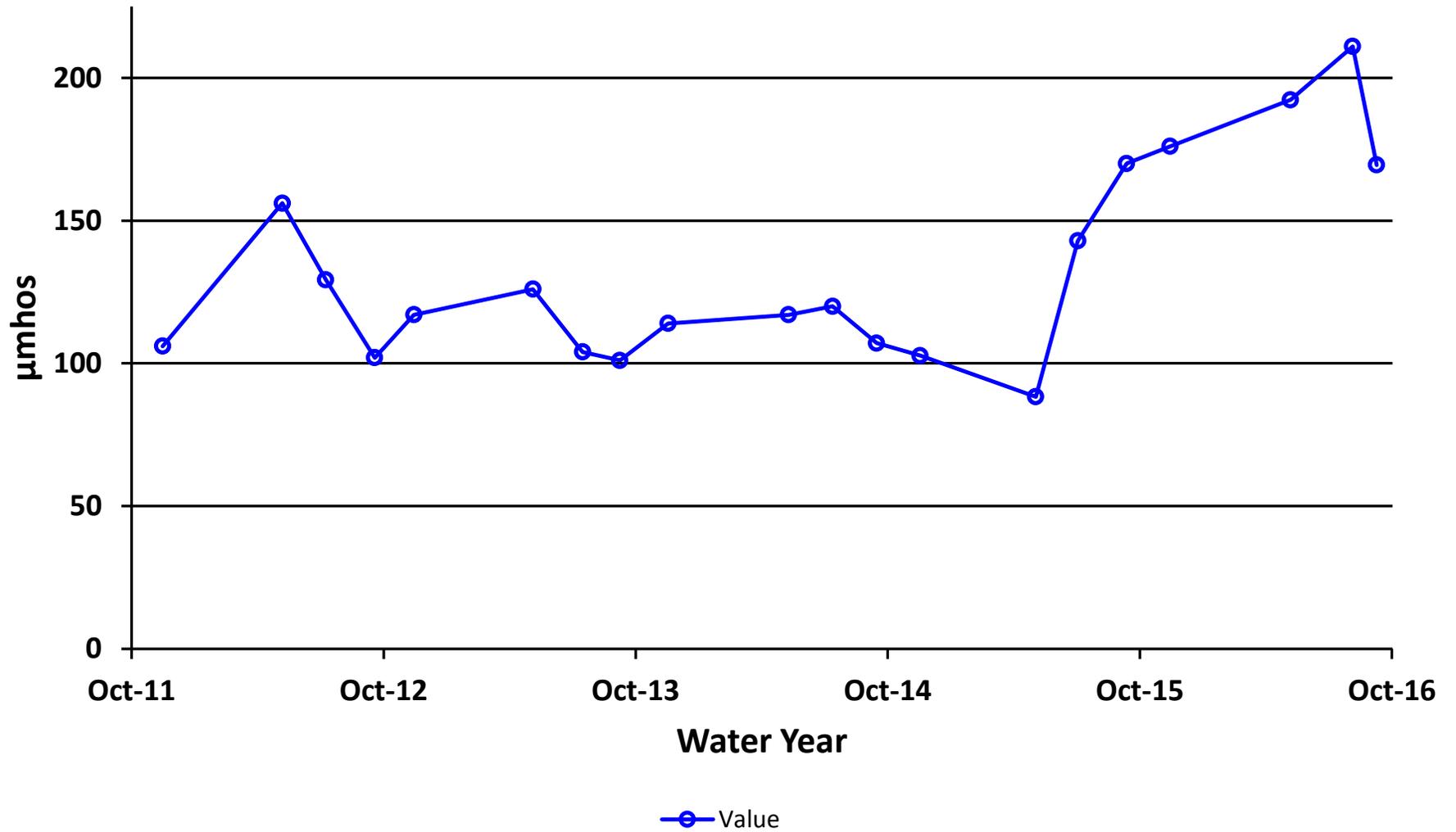
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
027FMG	11/17/2015	12:00 PM	Diss. Se-ICP/MS	0.09	µg/L	J	Below Quantitative Range
	8/8/2016	12:00 PM	Diss. Hg-CVAF	0.000293	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.07	µg/L	J	Below Quantitative Range
			Sulfate	8.54	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Cd-ICP/MS	0.00636	µg/L	J	Below Quantitative Range
			Sulfate	8.98	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

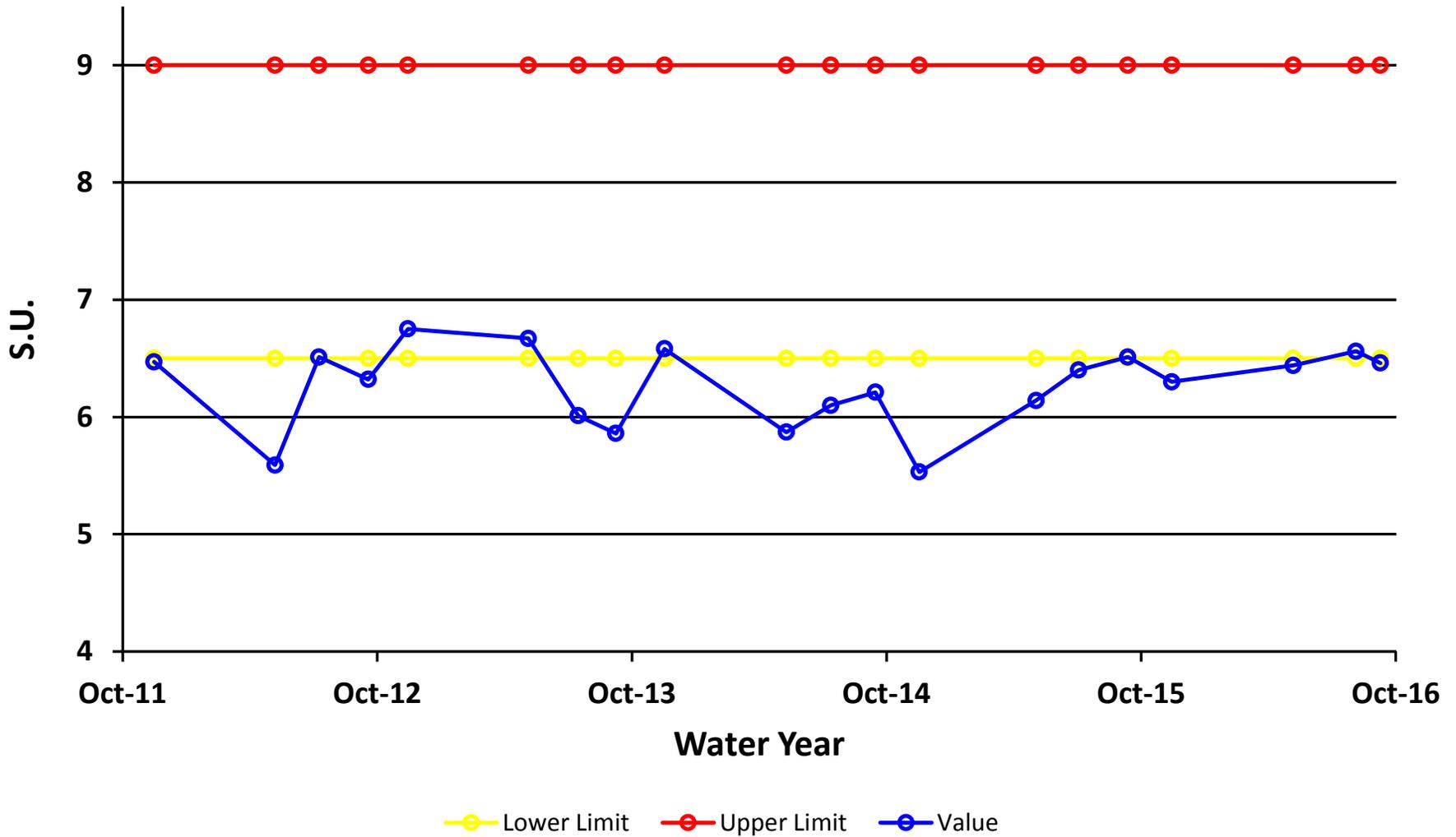
## Site 27 - Water Temperature



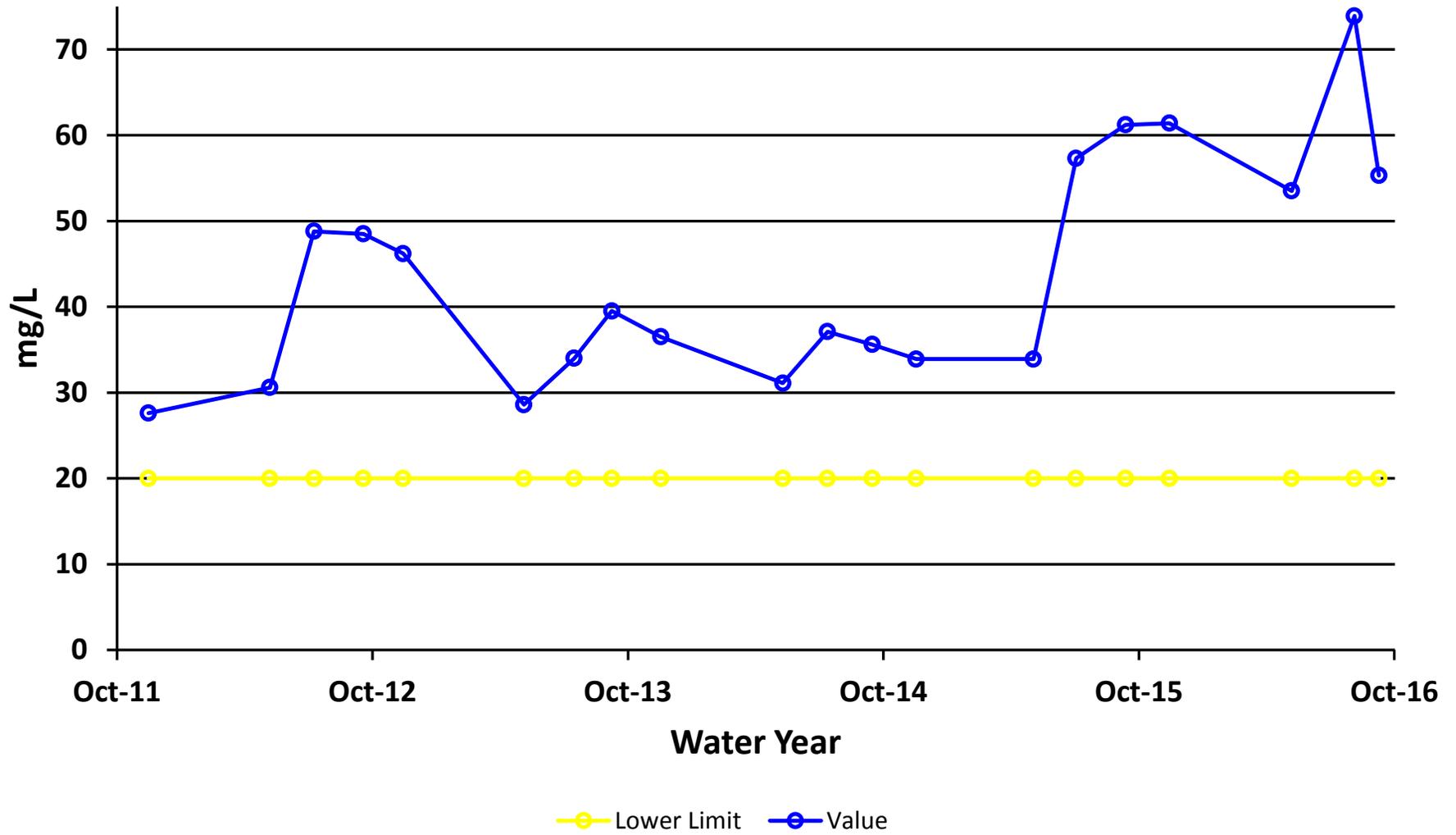
## Site 27 - Conductivity Field



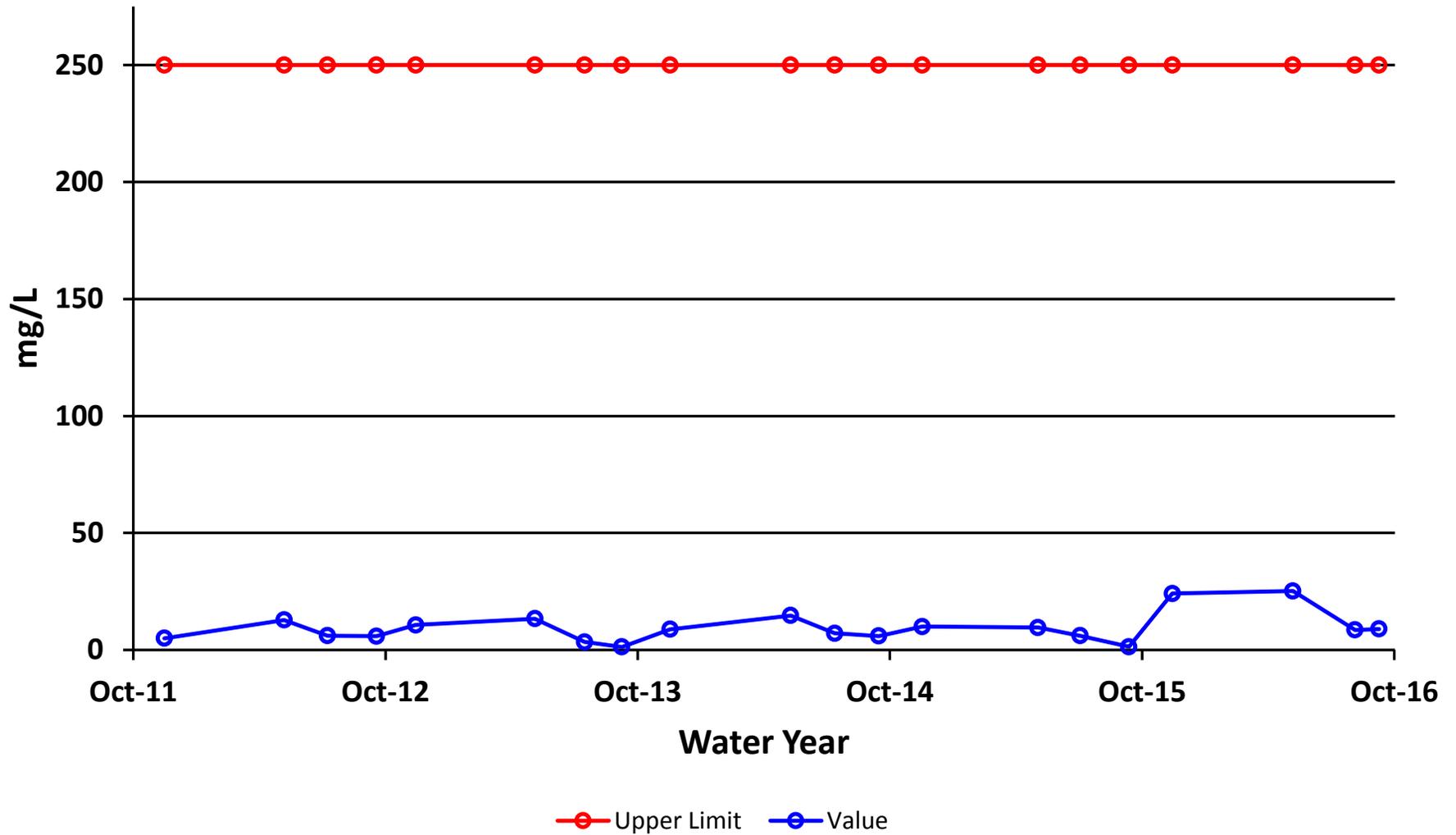
# Site 27 - pH Field



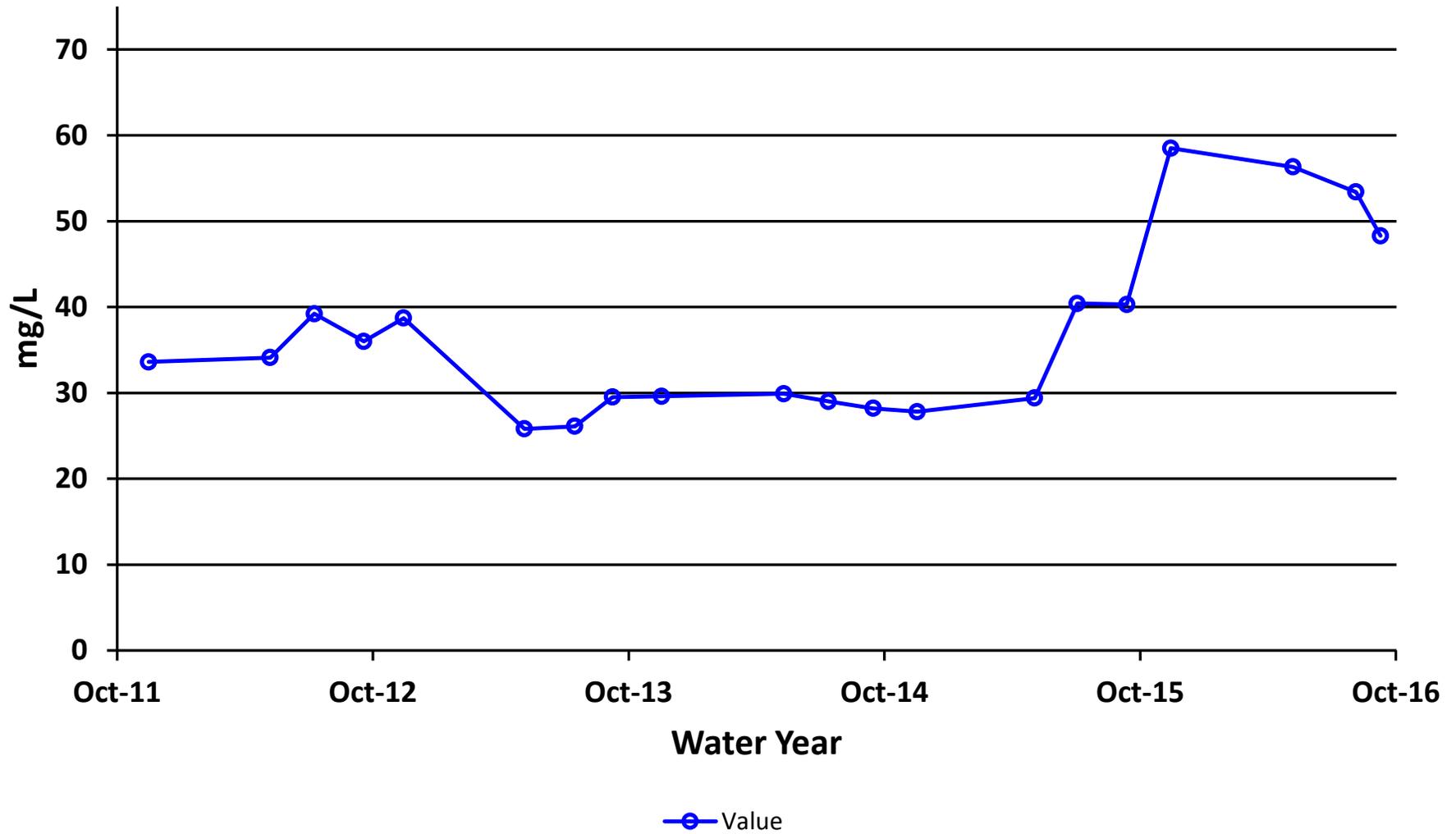
# Site 27 - Alkalinity



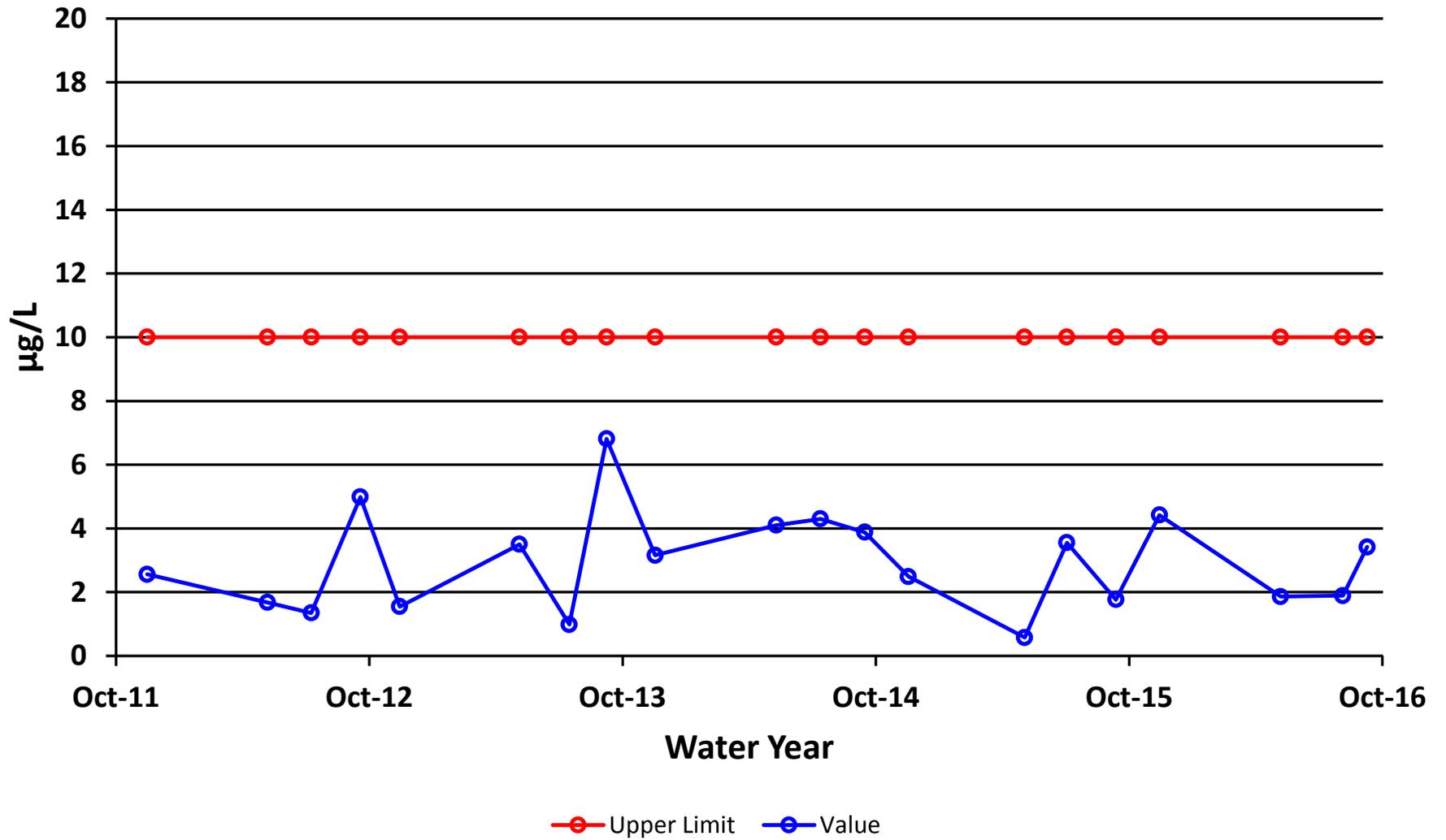
# Site 27 - Sulfate



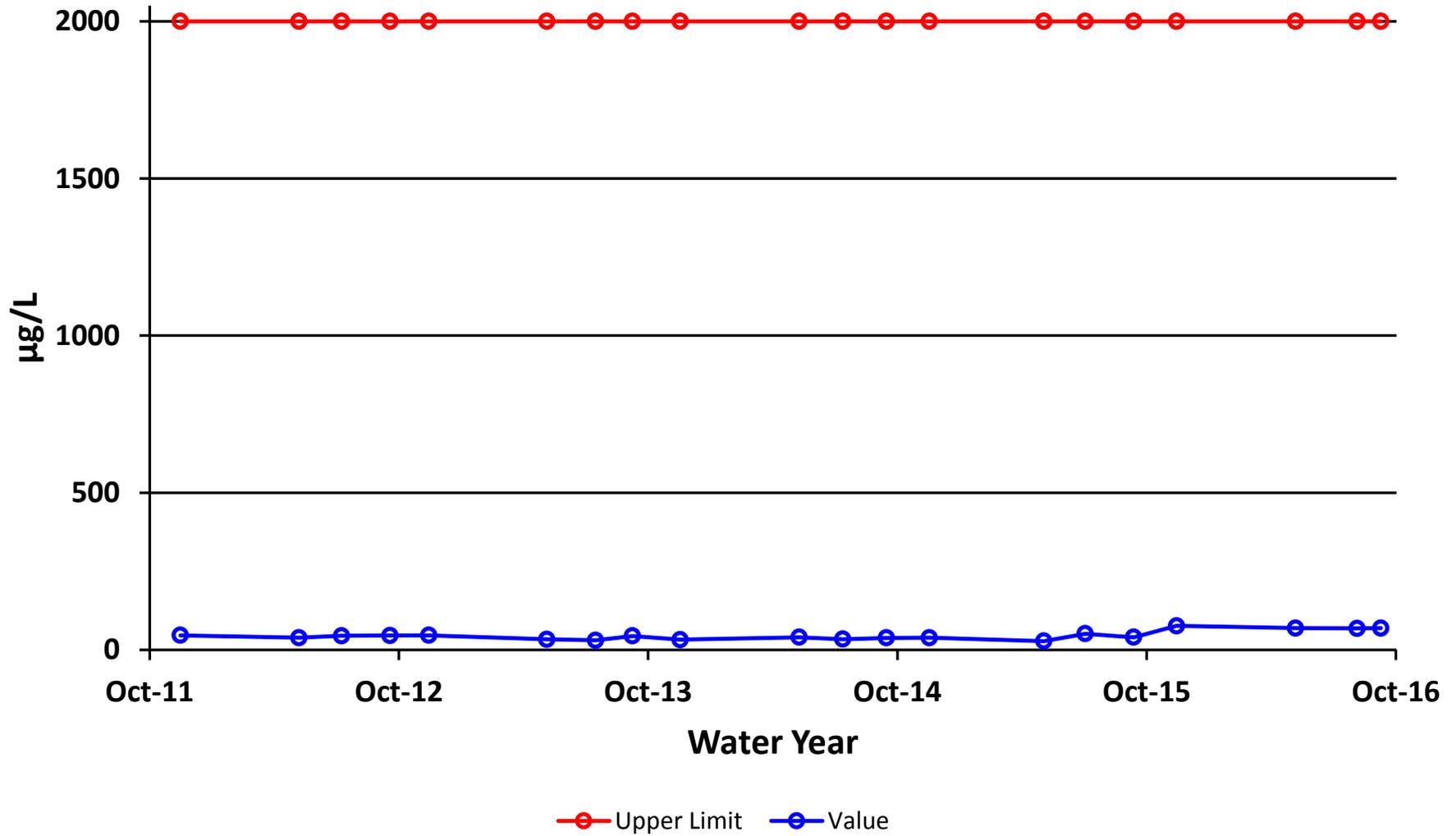
# Site 27 - Hardness



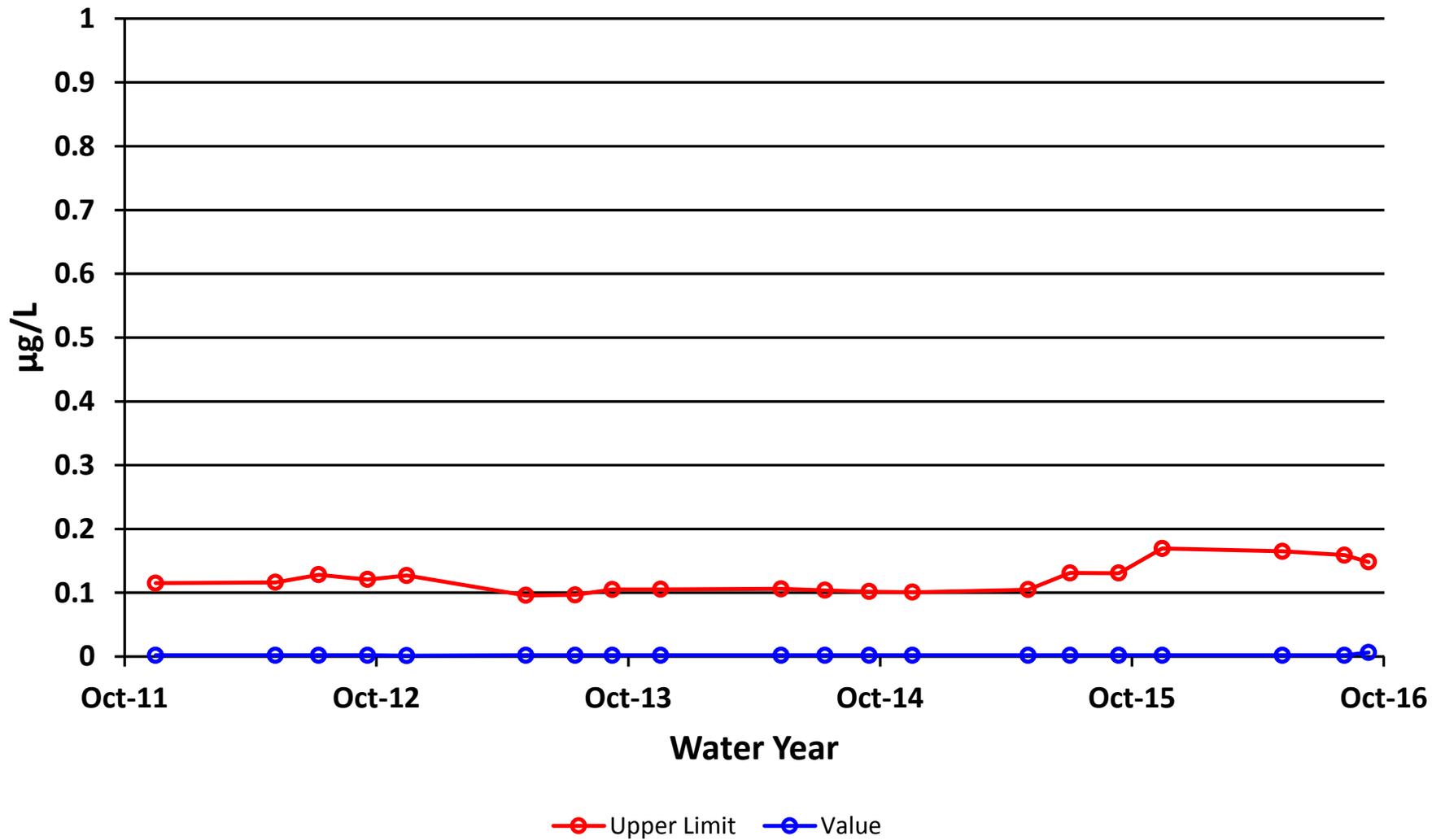
## Site 27 - Arsenic Dissolved



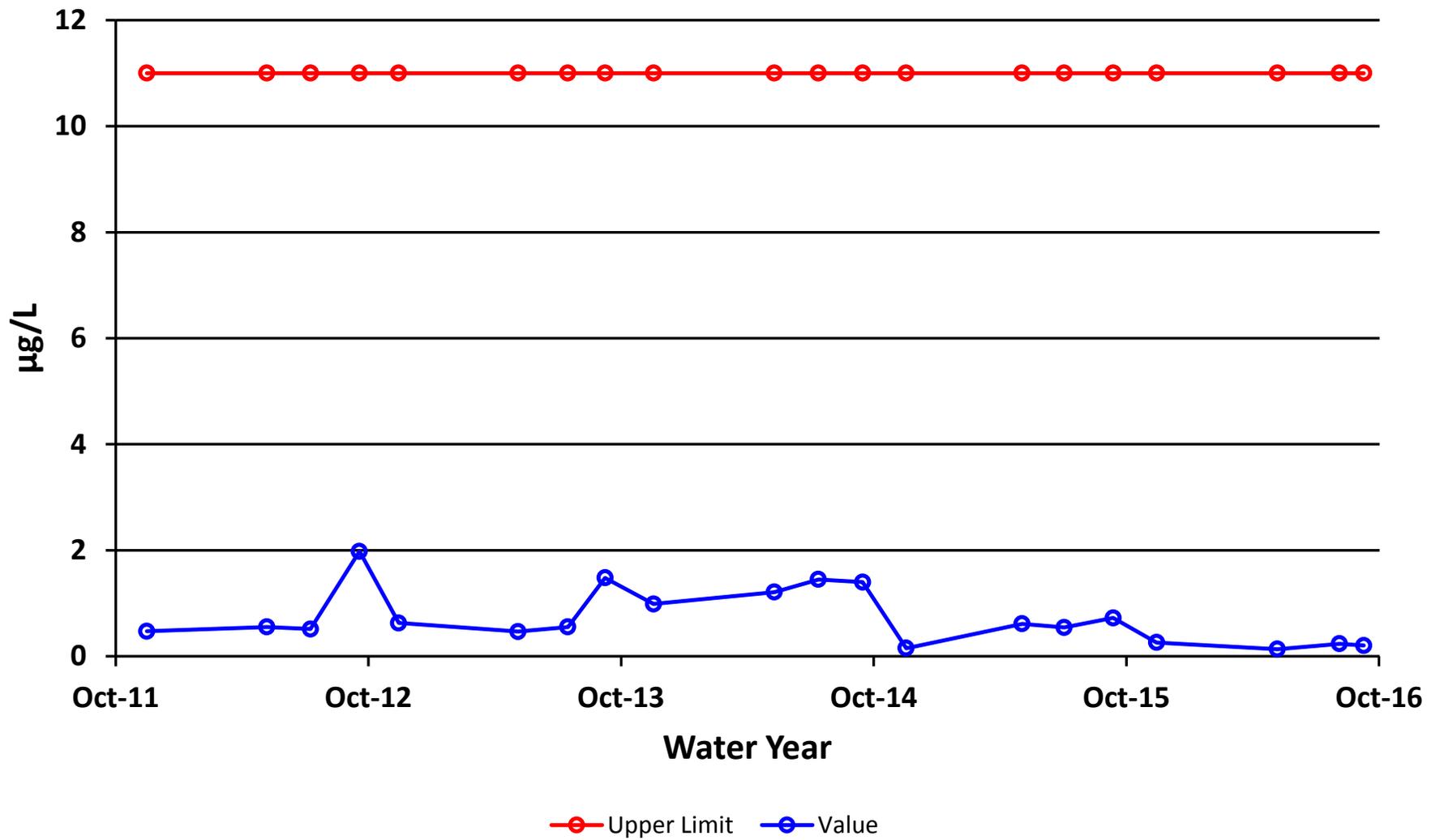
# Site 27 - Barium Dissolved



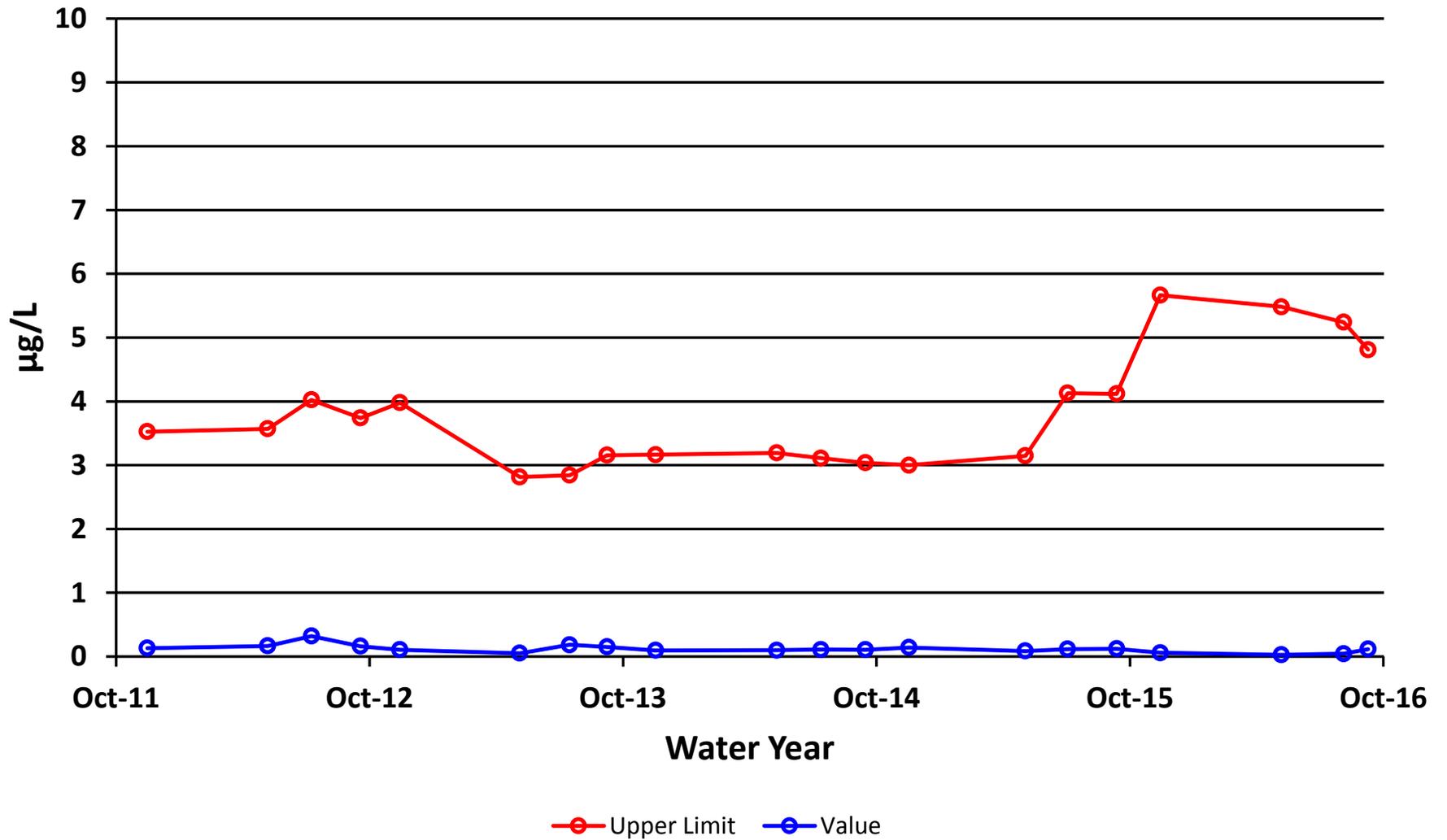
## Site 27 - Cadmium Dissolved



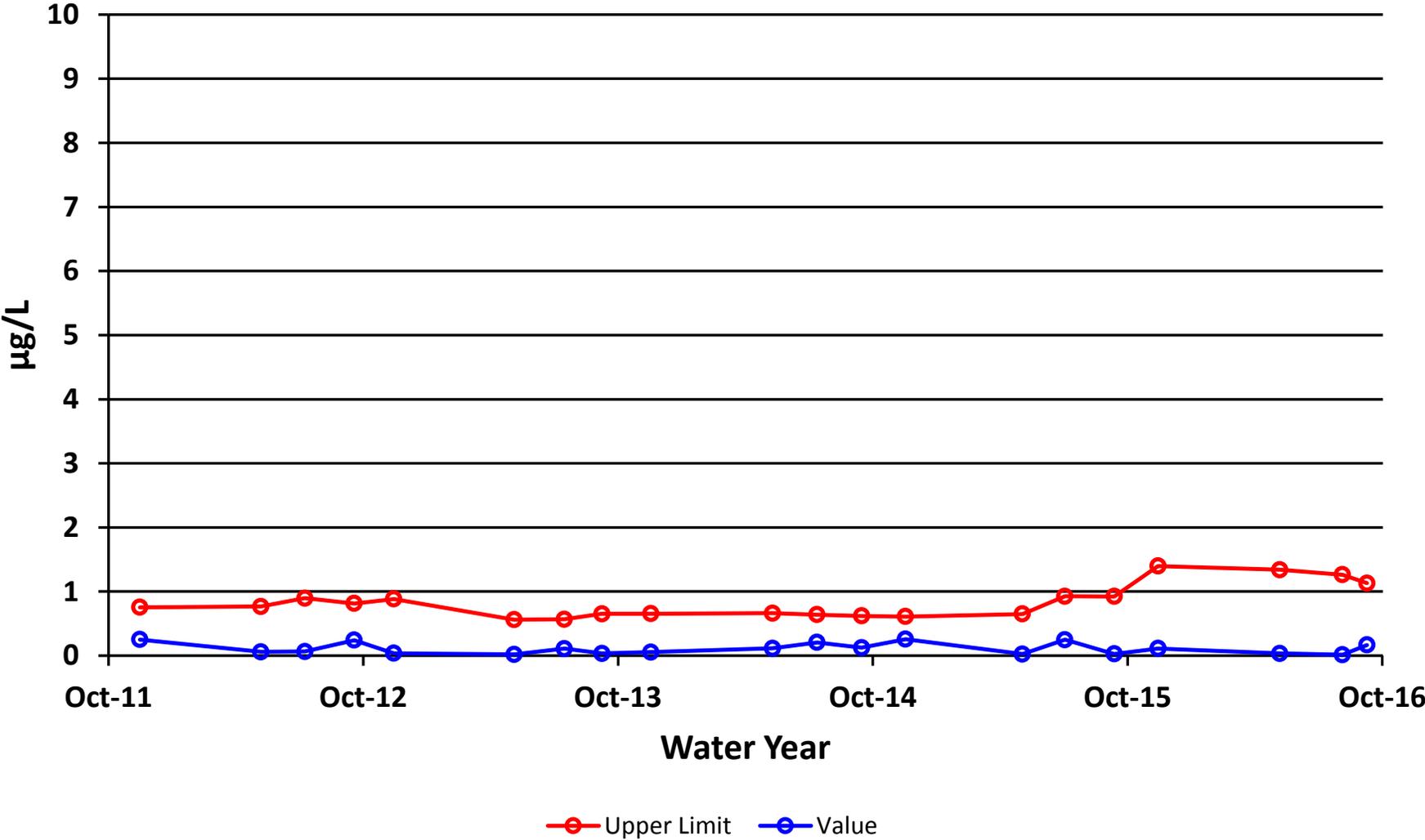
# Site 27 - Chromium Dissolved



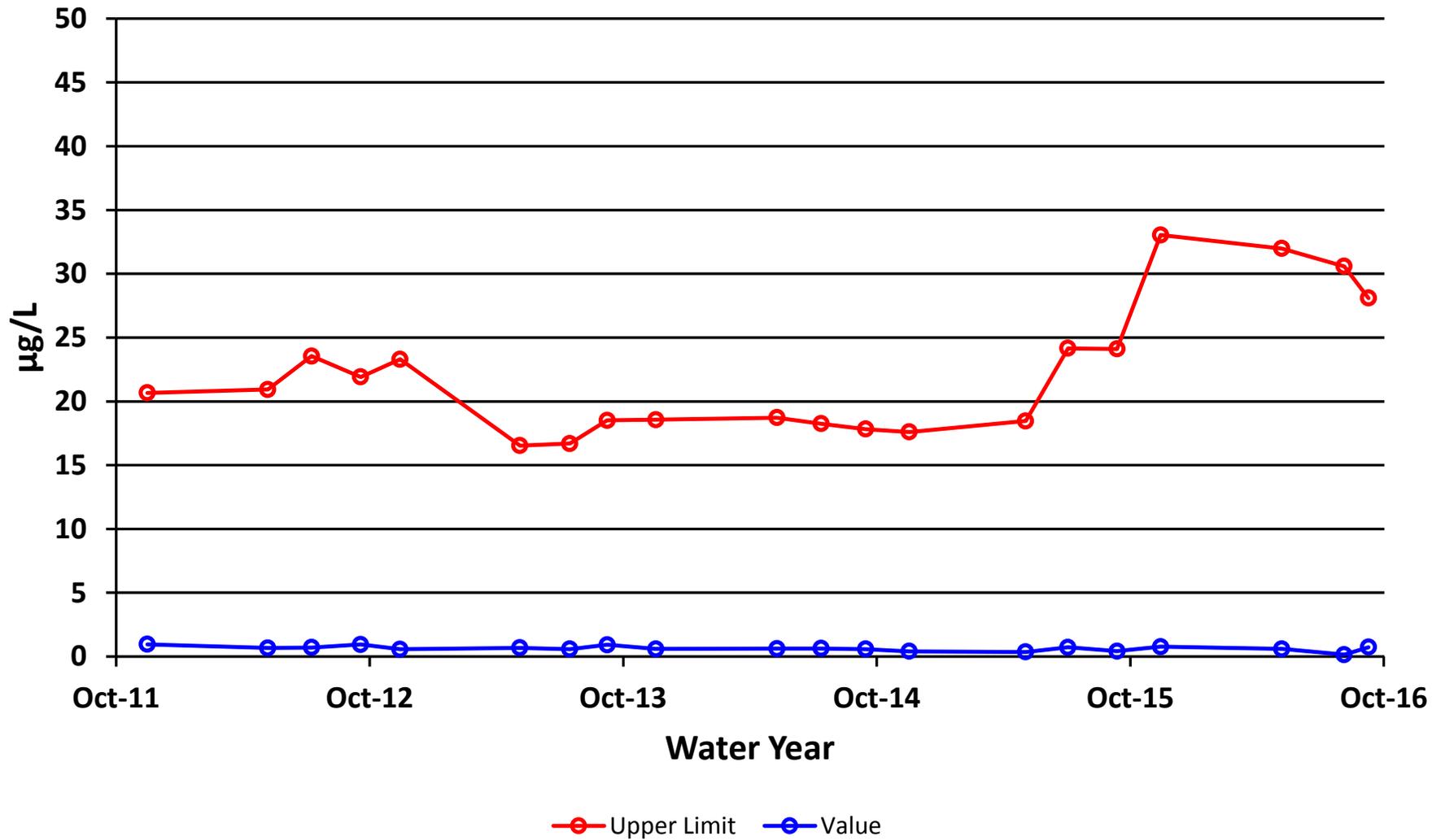
## Site 27 - Copper Dissolved



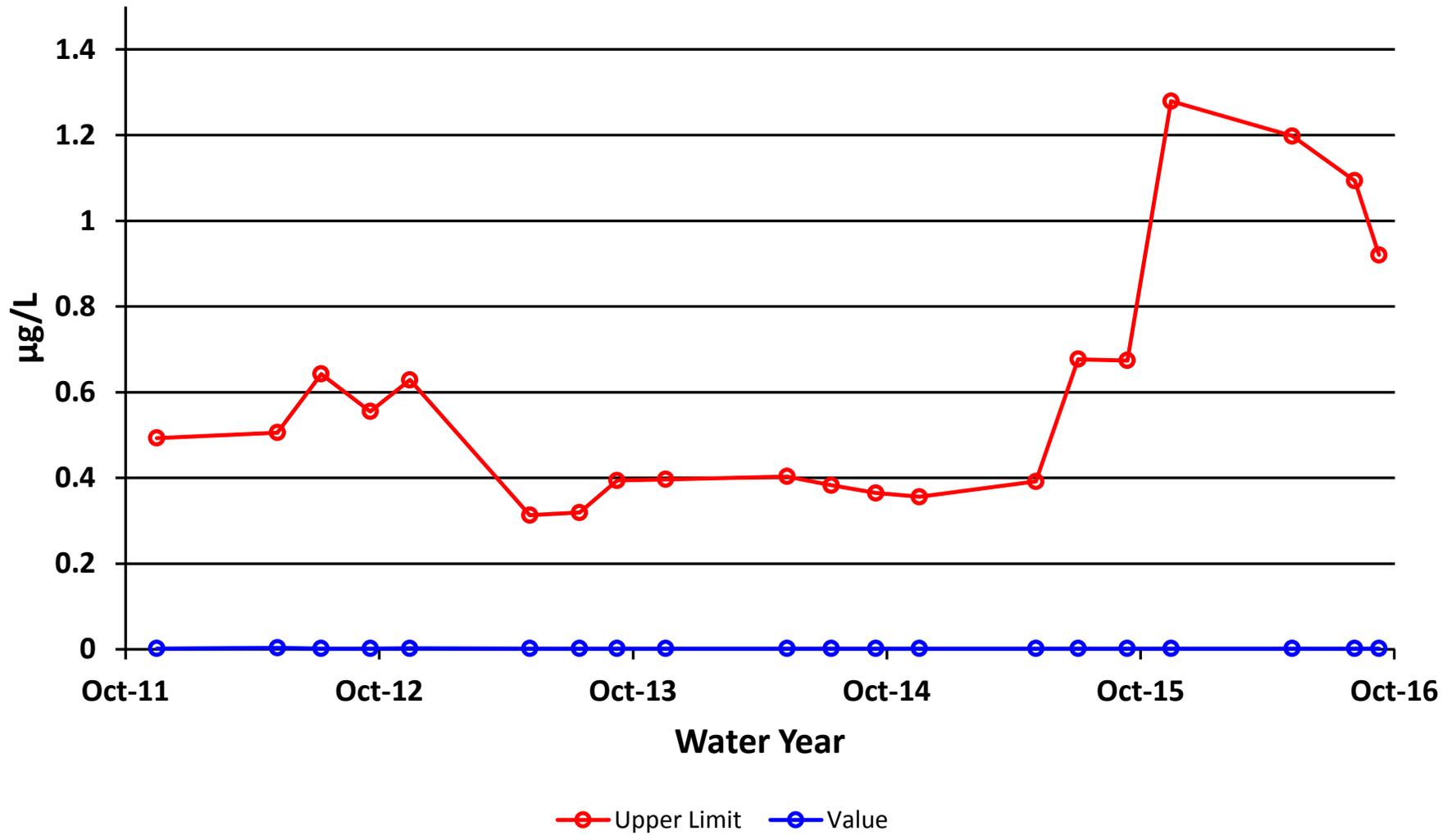
# Site 27 - Lead Dissolved



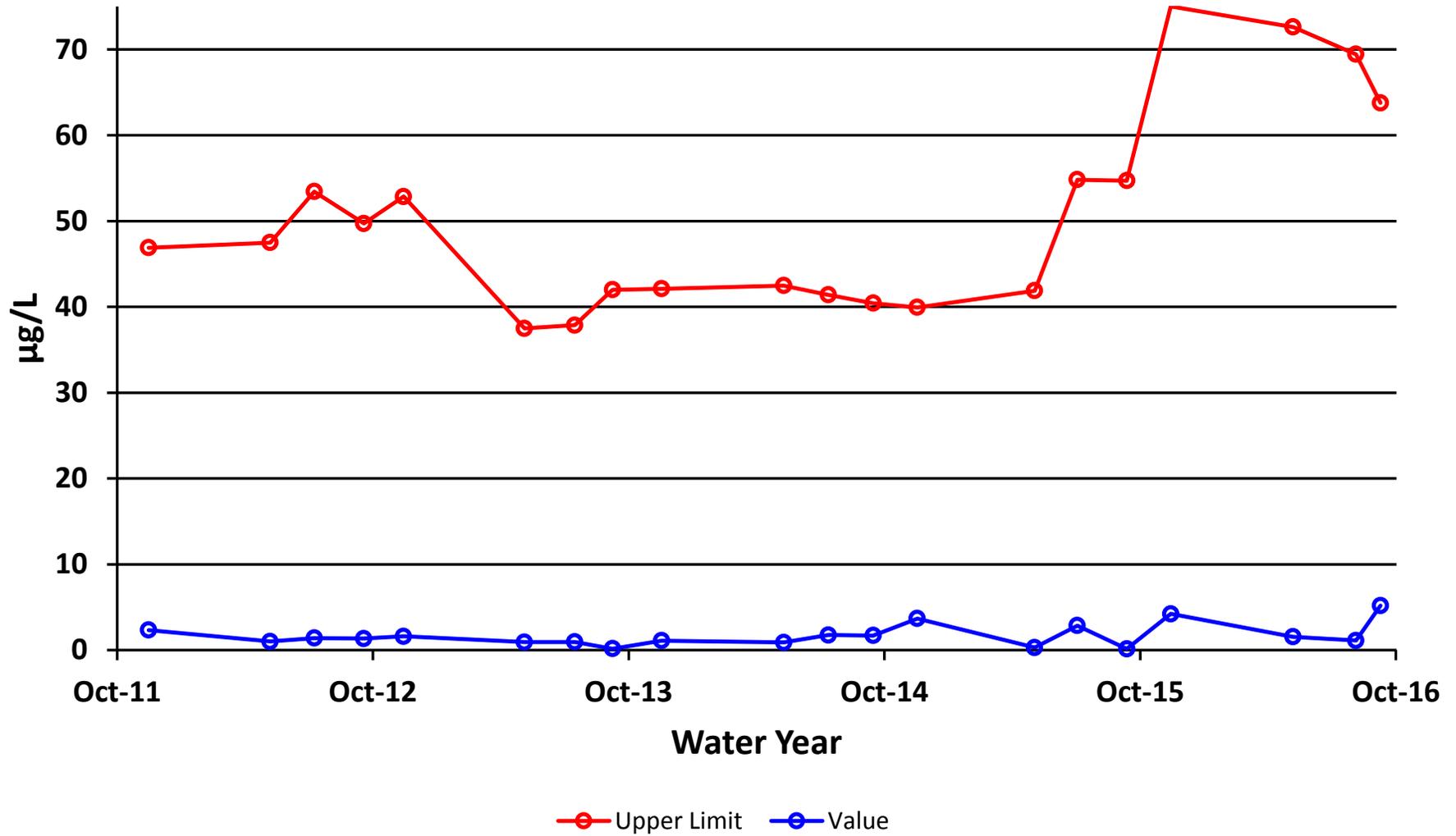
## Site 27 - Nickel Dissolved



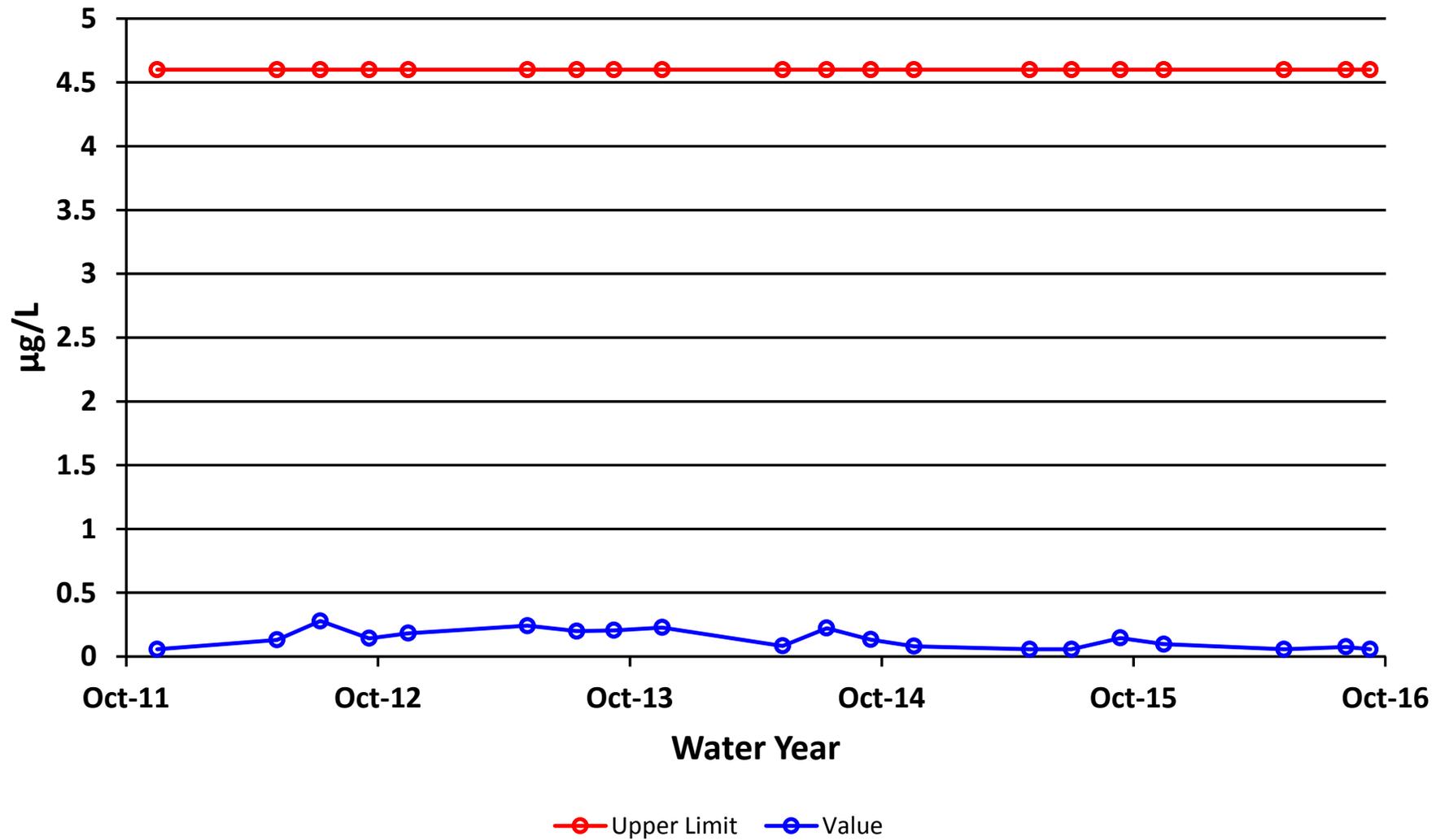
# Site 27 - Silver Dissolved



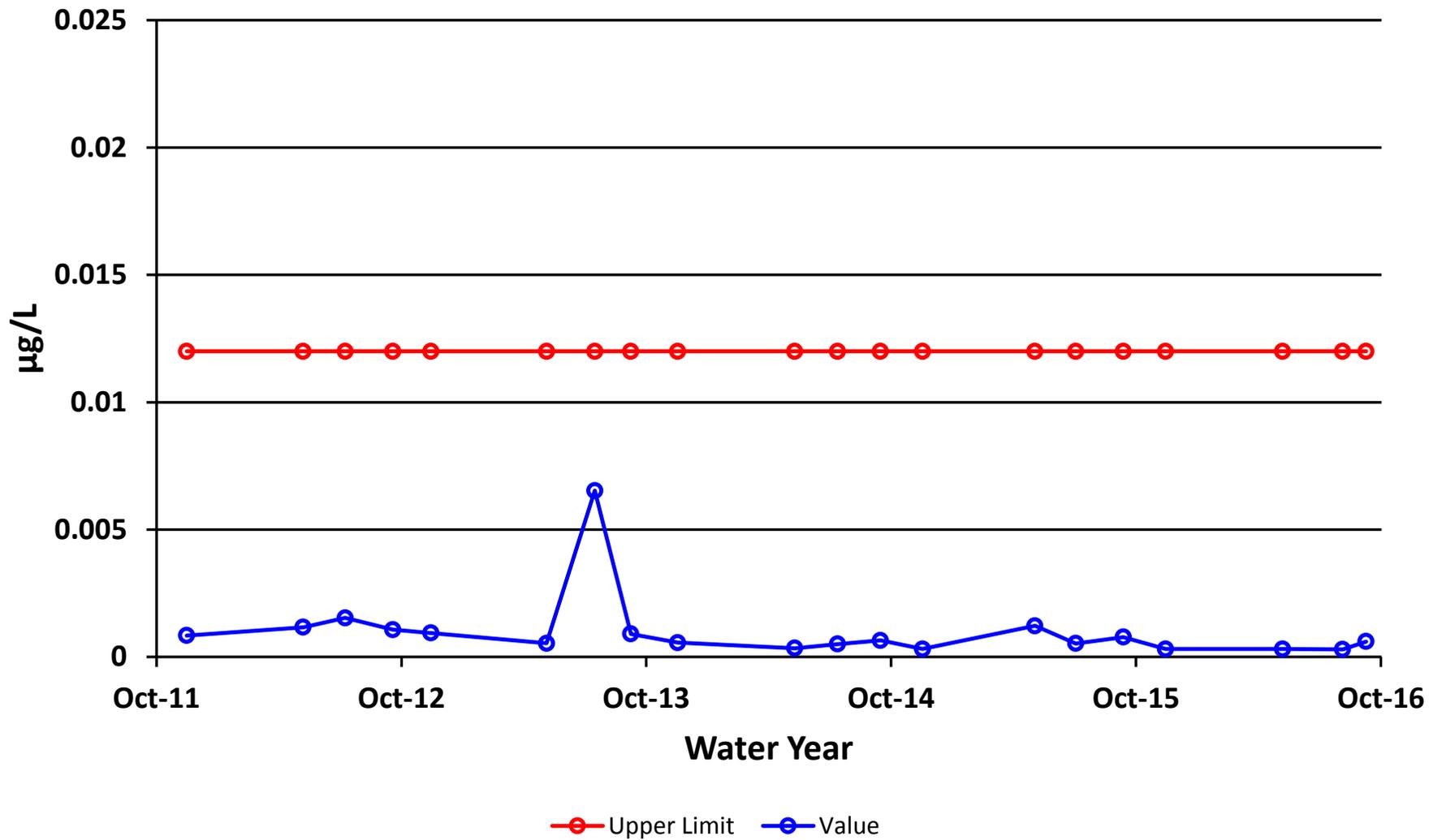
# Site 27 - Zinc Dissolved



## Site 27 - Selenium Dissolved



## Site 27 - Mercury Dissolved



## INTERPRETIVE REPORT

### SITE 29

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. Several results exceeding these criteria have been identified, as listed in the table below.

**Table of Exceedance for Water Year 2016**

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
17-Nov-15	Alkalinity	13.6 mg/L	20		19.3 mg/L
10-May-16	Alkalinity	7.7 mg/L	20		15.3 mg/L
13-Jul-16	Alkalinity	6.0 mg/L	20		9.56 mg/L
12-Sep-16	Alkalinity	17.0 mg/L	20		19.4 mg/L
10-May-16	Lead Dissolved	0.36 µg/L		0.31	15.3 mg/L
13-Jul-16	Lead Dissolved	0.25 µg/L		0.18	9.56 mg/L
12-Sep-16	Lead Dissolved	0.57 µg/L		0.41	19.4 mg/L
17-Nov-15	pH Field	5.0 su	6.5	9.0	19.3 mg/L
10-May-16	pH Field	5.1 su	6.5	9	15.3 mg/L
13-Jul-16	pH Field	4.9 su	6.5	9	9.56 mg/L
12-Sep-16	pH Field	5.4 su	6.5	9	19.4 mg/L

Four of these records are for field pH with values below the lower limit of 6.5 su listed in AWQS. Field pH from other wells completed in organic rich peat sediments similar to Site 29 have historically resulted in pH values ranging from 5 to 6 su (*e.g.* Site 27 and 32). Another four exceedances were for total alkalinity below the lower limit of 20 mg/L, also in the historical range recorded for organic rich peat waters.

Three of the four samples for dissolved lead was in exceedance. The most probable mechanism for dispersal of the lead, and potentially other metals away from the tailings pile, would be as fugitive tailings dust transported during cold, desiccating winds during winter or due to dust induced by truck traffic during dry summer conditions.

The temporal changes in some analytes (e.g. dissolved lead and zinc) may reflect the changing topography of the tails dry stack facility. After the northwest expansion was completed in 2008 HGCMC commenced to place the majority of the tailings in the northwest region. For a couple of years the northwest area was mostly bowl shaped and below the tree line. During the last couple of years this area has been brought up in elevation. With the increase in elevation this area is not as protected from the winds that predominantly prevail from the northeast. Dispersal of fugitive dust from this region would be to the southwest towards Site 29 and Site 32, which likely explains the increase in lead observed during water year 2014. In Water Year 2015 tailings were not placed in the northwest, but primarily in the central and eastern portion of the facility. This would result in less fugitive dust in the area of Site 29 and may explain the lower lead values in the 2015 samples. There was heavy construction activity occurring in the tailings facility in Water Year 2016 which may have increased fugitive dust emissions away from the tailings pile.

In 2011 HGCMC implemented a biweekly dust monitoring program to support the snow monitoring program. This program has continued into 2016 and the results from this monitoring are summarized in the 2016 Tailings and Waste Rock Annual Report.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. There appears to be no obvious visual trends.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). No statistically significant trends were found with the trend analysis.

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.27			
pH Field	6	0.73			
Alkalinity, Total	6	0.50			
Sulfate, Total	6		Inconsistent detection limits		
Zinc, Dissolved	6	0.36			

\* Number of Years \*\* Significance level

Trend analysis was not performed on the total sulfate dataset because of a change in the method detection limit used by the analytical laboratories. A primary assumption of the Mann-Kendall test is "... only one censoring threshold exists. When more than one detection limit exists, the Mann-Kendall test cannot be performed without further censoring the data." In order to prevent this from occurring HGCMC has worked to establish a consistent MDL for sulfate from the laboratory.

With the discontinuation of sampling at Site 58 during Water Year 2013, an inter-well comparison is no longer feasible. Instead an intra-well analysis was performed using combined Shewhart-CUSUM charts for conductivity, dissolved zinc, and alkalinity. Table 1 contains a summary of the baseline statistics along with the control limits used.

**Table 1. Specific Conductance, Dissolved Zinc, and Total Sulfate Baseline Periods, Summary Statistics and Various Control Limits**

	Site 29 Conductivity ( $\mu\text{S}/\text{cm}$ )	Site 29 Diss. Zinc ( $\mu\text{g}/\text{L}$ )	Site 29 Alkalinity ( $\text{mg}/\text{L}$ )
<b>Baseline Statistics</b>			
Baseline Period	05/11/00-09/15/05	05/11/00-09/15/05	04/27/95-09/13/00
Number of Samples	12	12	5
Mean (x)	122.27	3.60	1.56
Standard Deviation	24.8	1.35	0.43
<b>Shewhart-CUSUM Control Limits (SCL)</b>			
Control Limit (mean $x + 2s$ )	171.9	6.3	2.4
Control Limit (mean $x + 3s$ )	196.7	7.6	2.8
Control Limit (mean $x + 4s$ )	221.4	9.0	3.3
Control Limit (mean $x + 4.5s$ )	233.8	9.7	3.5
<b>CUSUM Control Limits</b>			
Cumulative increase (h)	5	5	5

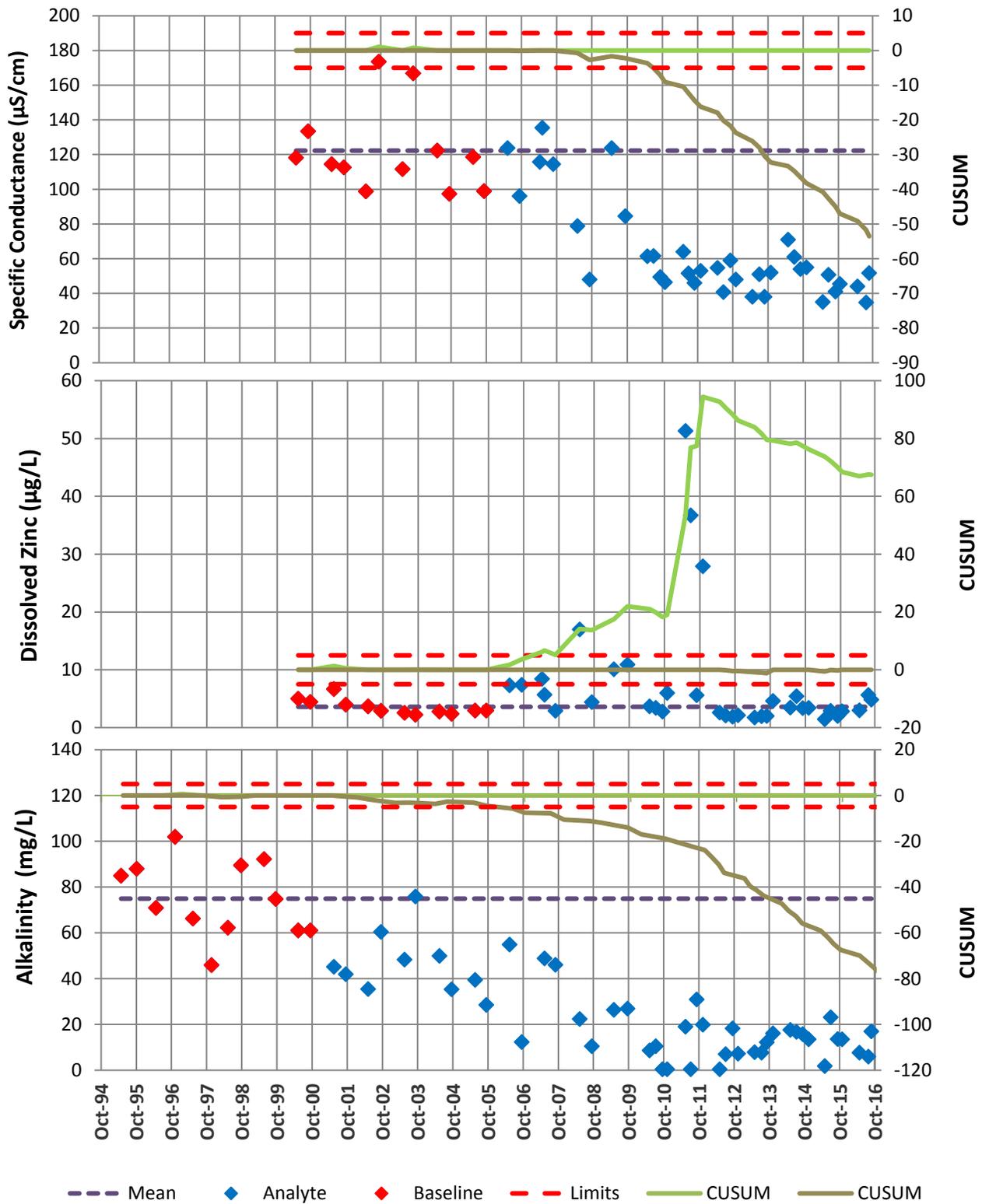
Site 29 was installed in 1988 and has an extensive sampling history, however establishing a baseline has been difficult. Since the installation of the well a number of the monitored parameters (*i.e.* alkalinity, specific conductance, total sulfate, and etc...) have been in constant flux. Because the CUSUM process compares the mean and standard deviation of the chosen baseline to the collected data it is possible to detect continual changes in the analytes without having a background data set. After reviewing the data for the three parameters, data periods were chosen based upon the data having a period of minimal flux. This period was then used for the calculation of the baseline statistics.

All three of the parameters examined (Figure 1) eventually went out of control with respects to the chosen baseline data statistics. If the pore/contact water from inside the tailings facility was not contained, the well water would have high conductivity, high dissolved zinc, and high

alkalinity. Two of the three charts in Figure 1 have long term decreasing trends; it is dissolved zinc that has periodically had higher values. As previously discussed it is hypothesized that the increase in dissolved zinc results from the accumulation of fugitive dust in the snow pack during the winter. In the spring when the snow pack melts this material is released as a pulse. Most years the deposited material is not present by the fall sampling. With the implementation of additional best management practices, HGCMC expects to decrease the amount of fugitive dust leaving the tailings disposal facility.

The long term decreasing trends in specific conductance and alkalinity are potentially the result of the weathering of the rock originally used to build the access roads and embankments for the tailings facility. In recent years HGCMC has reported on water chemistry changes in the FWMP directly related to construction activities in the tailings facility. As previously discussed in the report, with regards to Site 27, there was an increase in total sulfate and conductivity after the pad was built east of Pond 7. In the 5-6 years after this pad was built the values for these parameters are still elevated, though trending towards pre-disturbance conditions. A similar sort of change was also recorded at Site 60 after the construction of Pond 7. Until the groundwater collection system was brought online there were substantial increases for specific conductivity and alkalinity at Site 60. These are two examples of where the placement of construction rock has resulted in changes to the water chemistry. Therefore, the decreasing trends in alkalinity and specific conductance seen at Site 29 are potentially the result of weathering of the initial rock placed for construction of the tailings facility.

**Figure 1. Observed Measurements for Specific Conductance, Dissolved Zinc, and Alkalinity from Site 29 Compared to the Shewhart-CUSUM Control Limits From Table 1**



## Table of Results for Water Year 2016

### Site 029FMG - 'Monitoring Well - 3S'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		6.1						7.8		8.8		10.2	8.3
Conductivity-Field(µmho)		45.5						44.1		34.7		51.8	44.8
Conductivity-Lab (µmho)		37						36		30		44	37
pH Lab (standard units)		5.09						4.84		4.8		5.21	4.97
pH Field (standard units)		4.98						5.1		4.88		5.36	5.04
Total Alkalinity (mg/L)		13.6						7.7		6		17	10.7
Total Sulfate (mg/L)		0.3						0.3		0.3		0.3	0.3
Hardness (mg/L)		19.3						15.3		9.6		19.4	17.3
Dissolved As (ug/L)		7.45						6.2		4.54		7.34	6.770
Dissolved Ba (ug/L)		6.9						5.8		4.2		7.2	6.4
Dissolved Cd (ug/L)		0.0018						0.0018		0.0018		0.0058	0.0018
Dissolved Cr (ug/L)		1.13						0.589		0.461		0.512	0.551
Dissolved Cu (ug/L)		0.215						0.279		0.23		0.329	0.255
Dissolved Pb (ug/L)		0.394						0.361		0.251		0.569	0.3775
Dissolved Ni (ug/L)		1.17						1.02		0.835		1.08	1.050
Dissolved Ag (ug/L)		0.002						0.002		0.002		0.002	0.002
Dissolved Zn (ug/L)		2.83						2.98		5.66		4.84	3.91
Dissolved Se (ug/L)		0.057						0.057		0.057		0.057	0.057
Dissolved Hg (ug/L)		0.000726						0.000738		0.000699		0.000806	0.000732

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

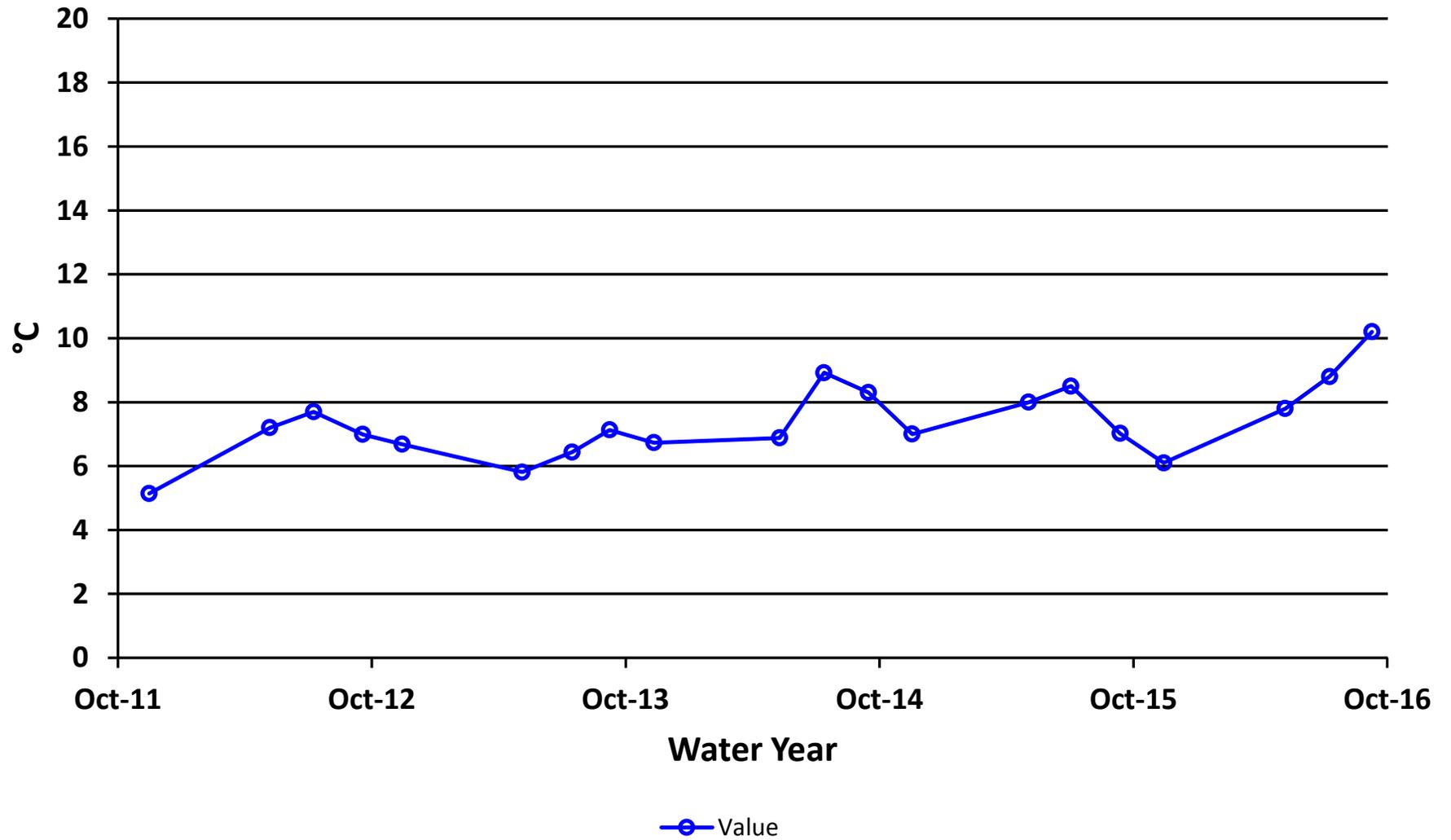
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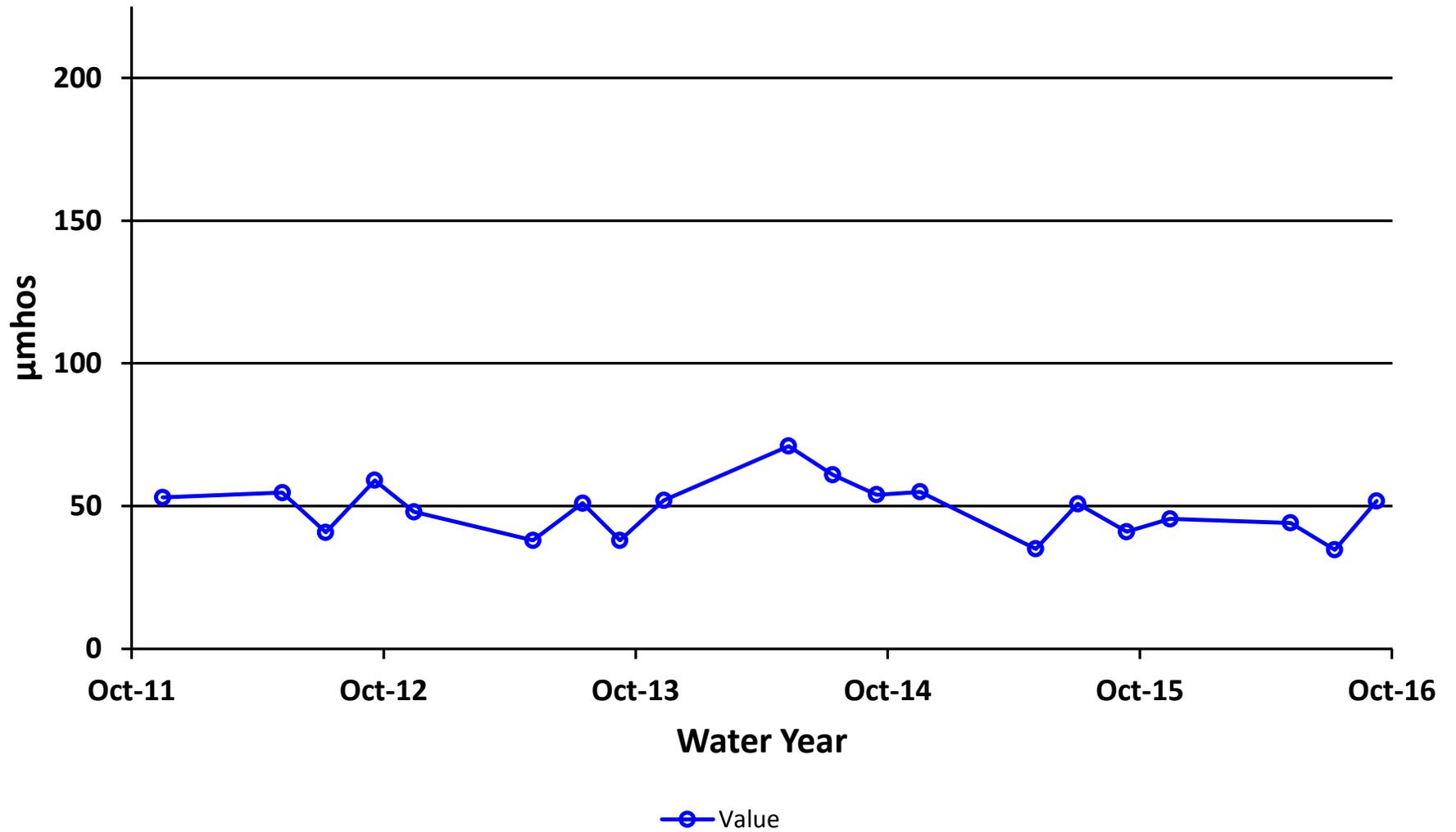
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
029FMG	7/13/2016	12:00 PM	Conductivity	29.5	µmhos	J	Below Quantitative Range
			Sulfate	-0.5	mg/L	UJ	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Cd-ICP/MS	0.00577	µg/L	J	Below Quantitative Range
			Sulfate	-0.5	mg/L	UJ	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

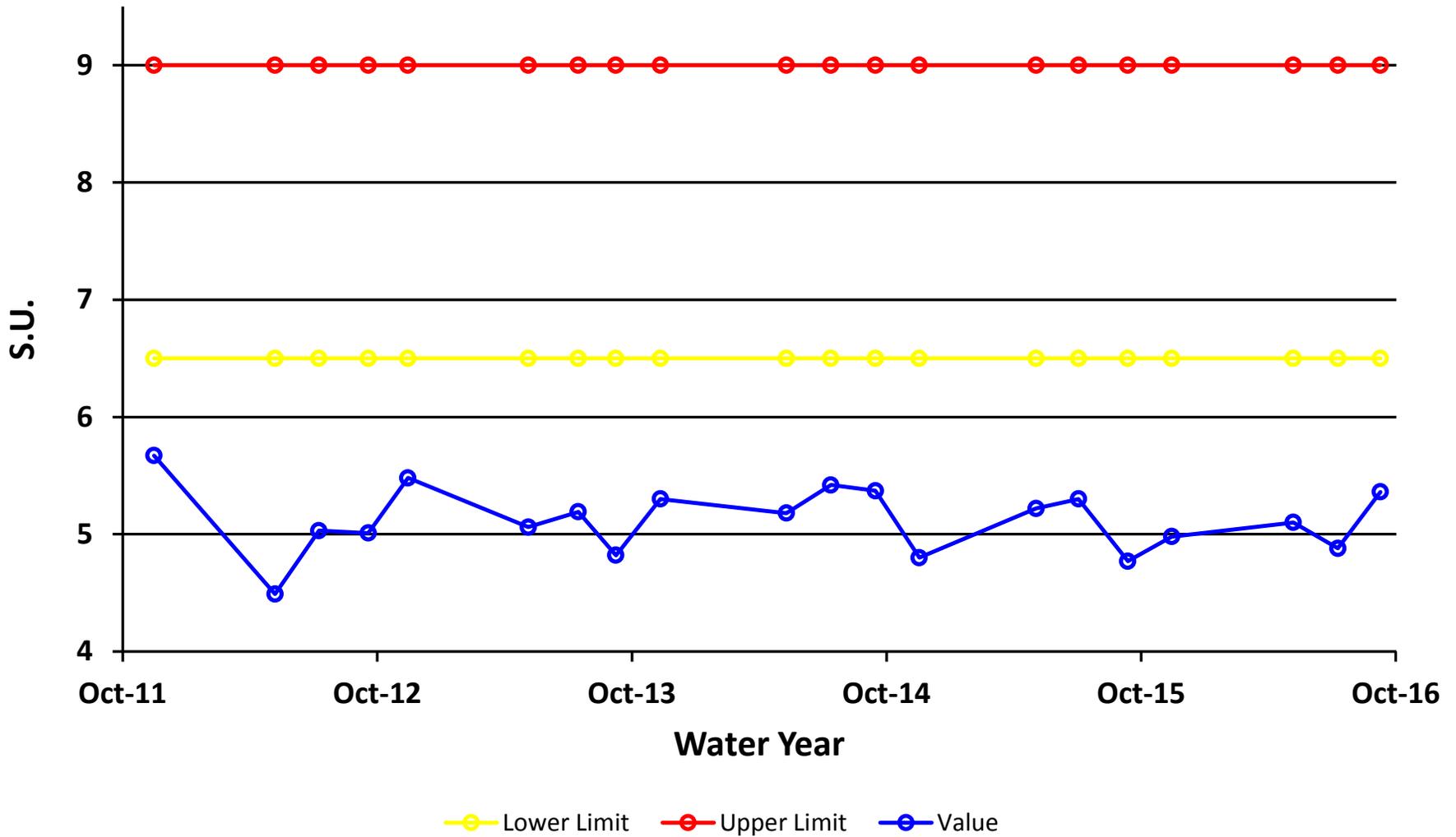
## Site 29 - Water Temperature



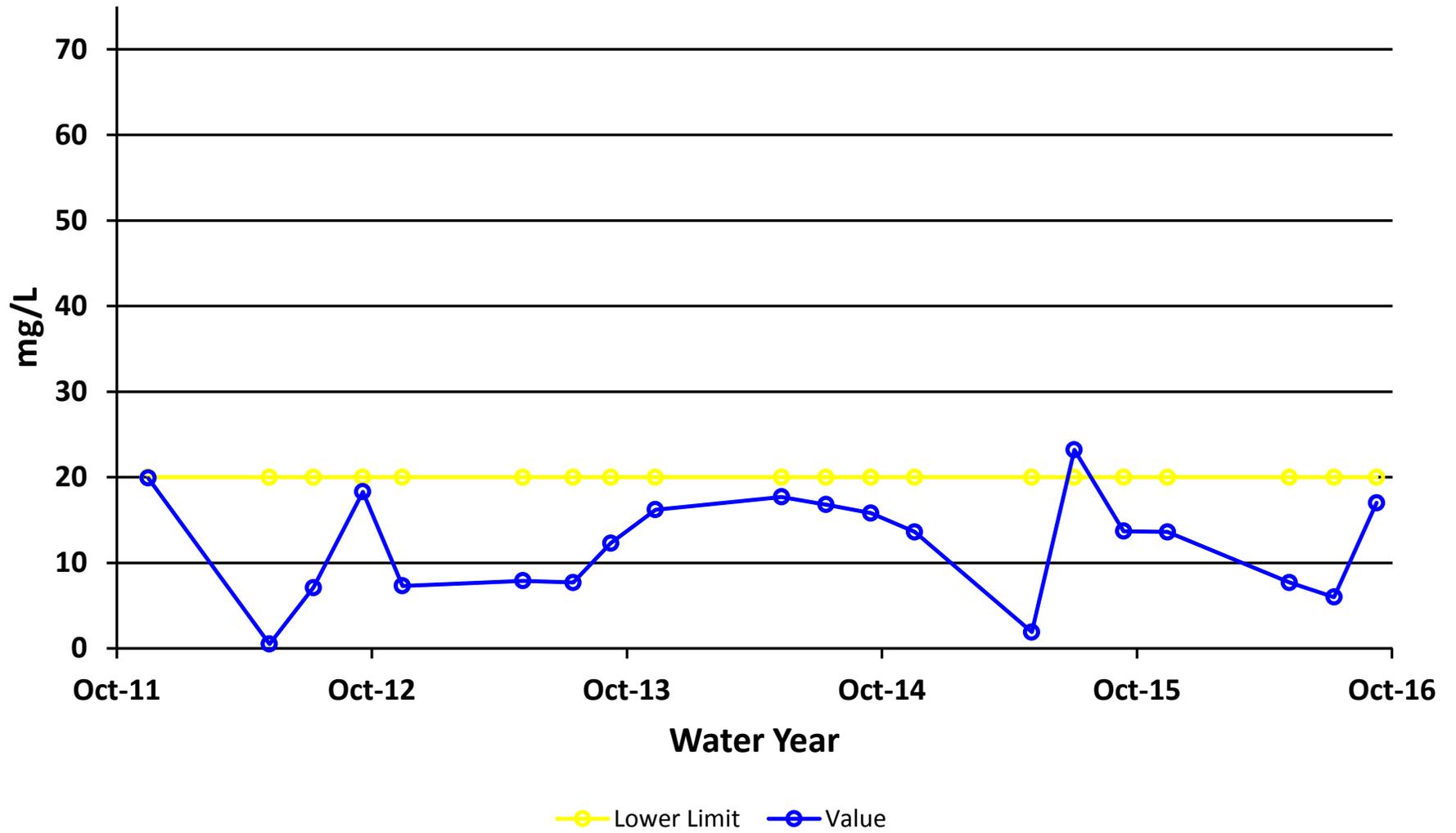
## Site 29 - Conductivity Field



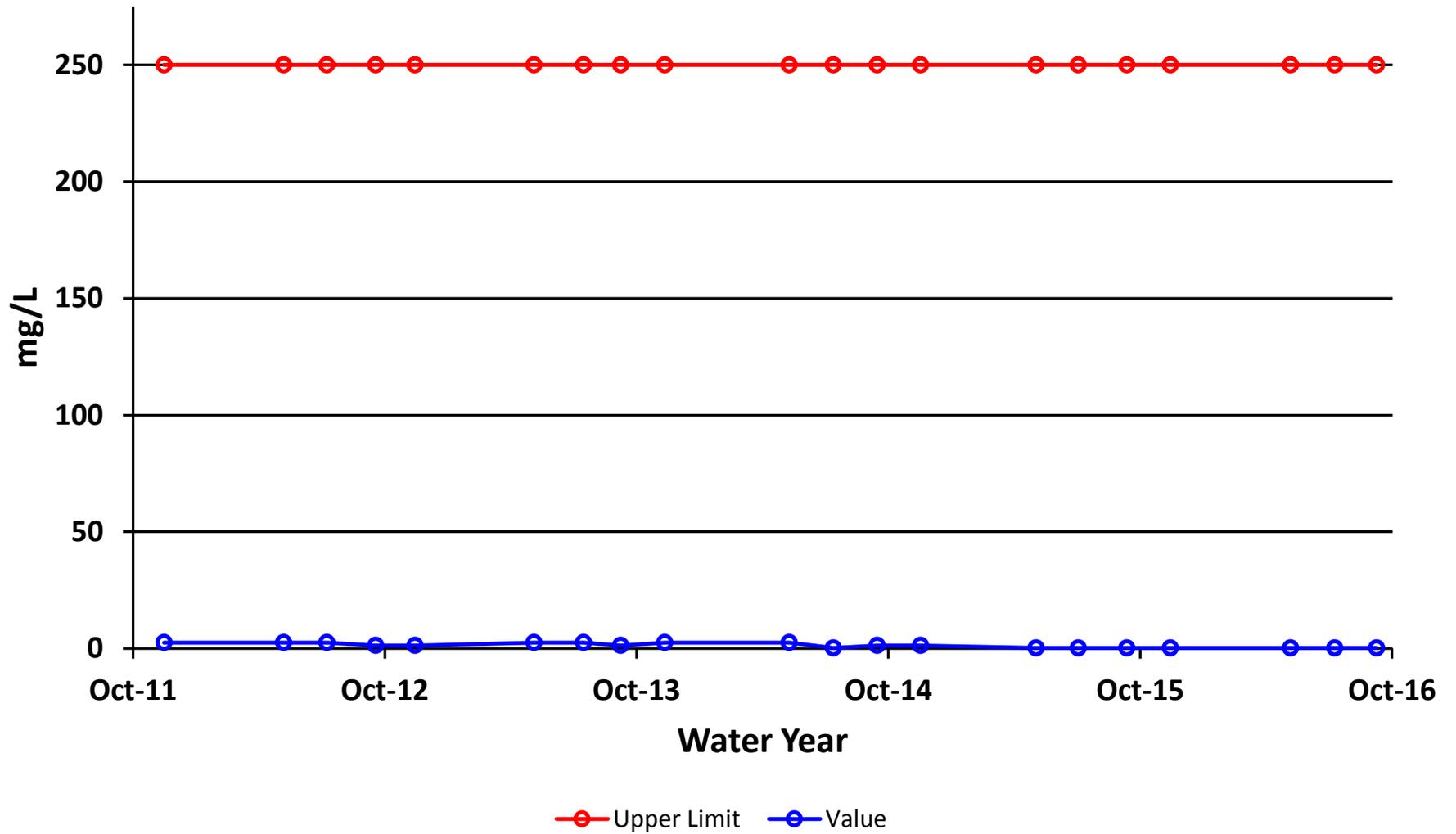
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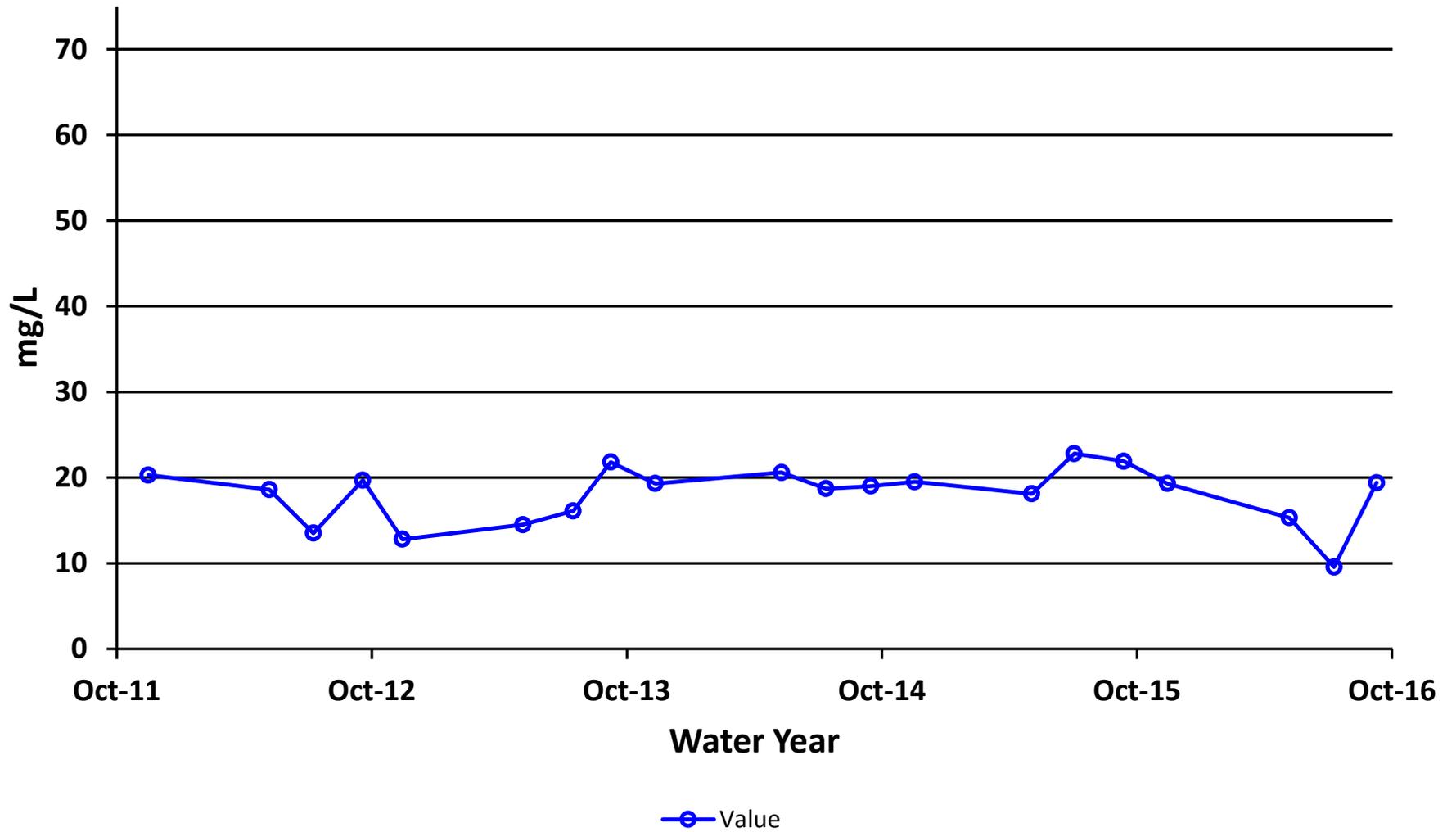
# Site 29 - Alkalinity



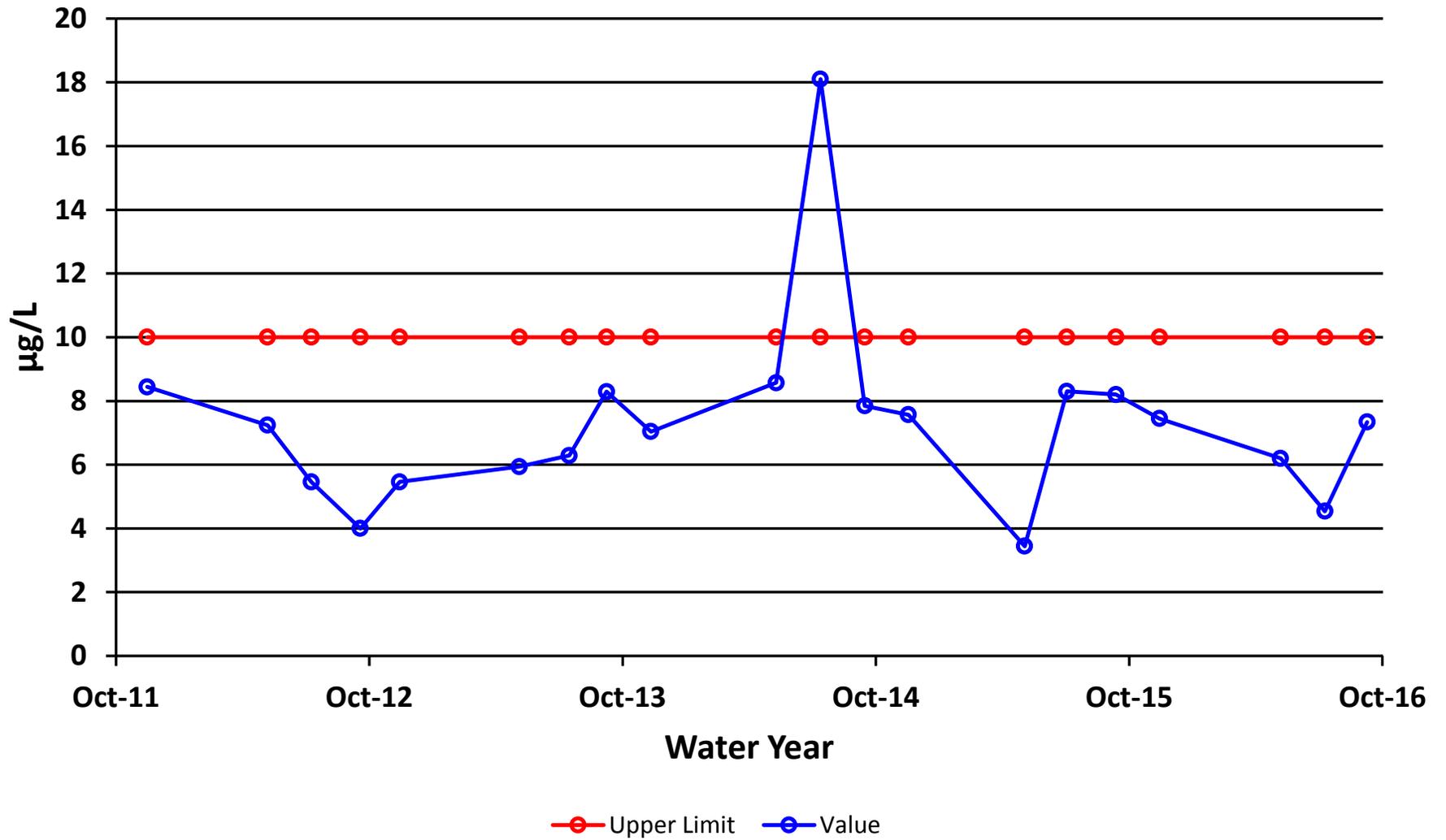
# Site 29 - Sulfate



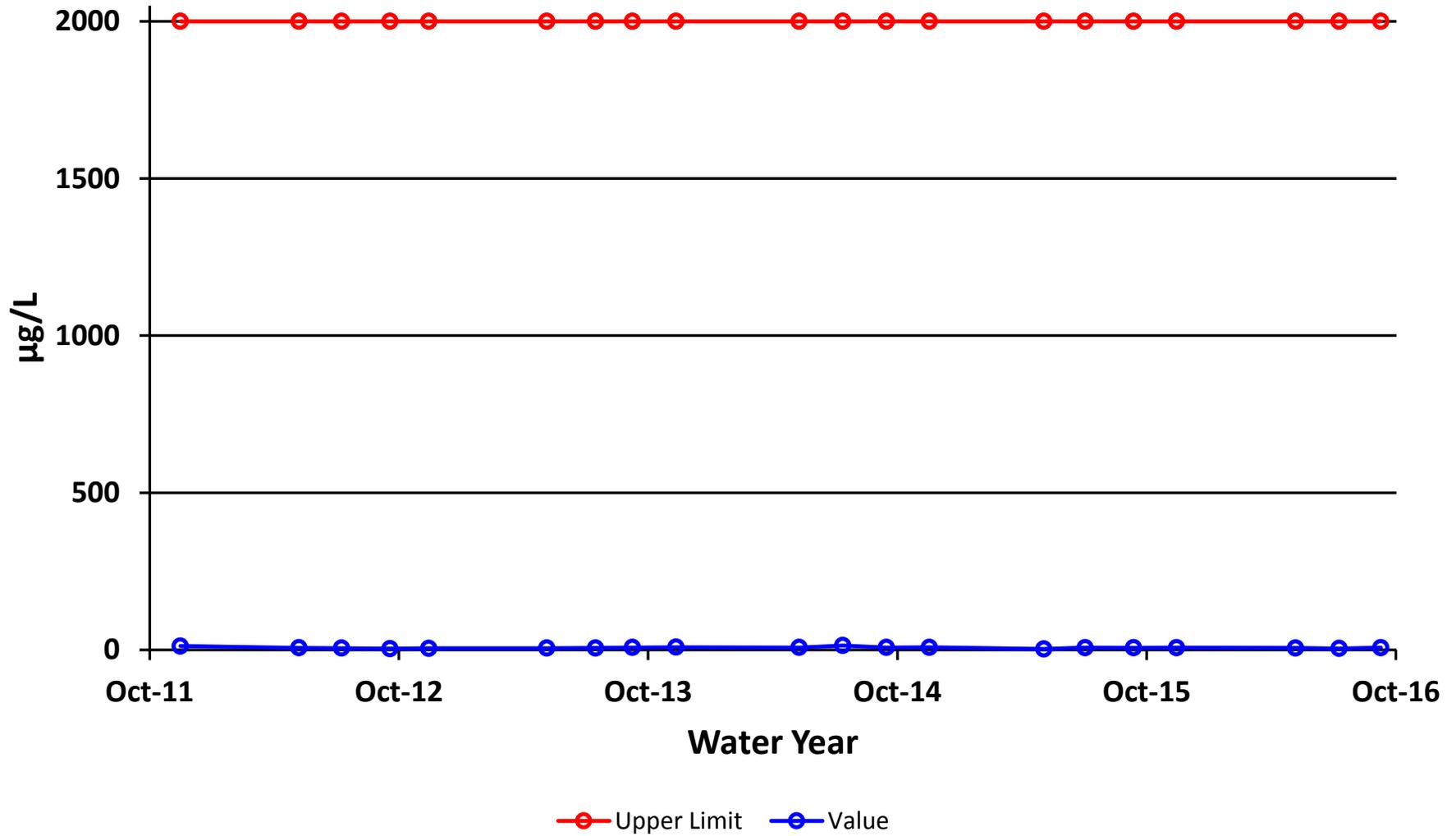
## Site 29 - Hardness



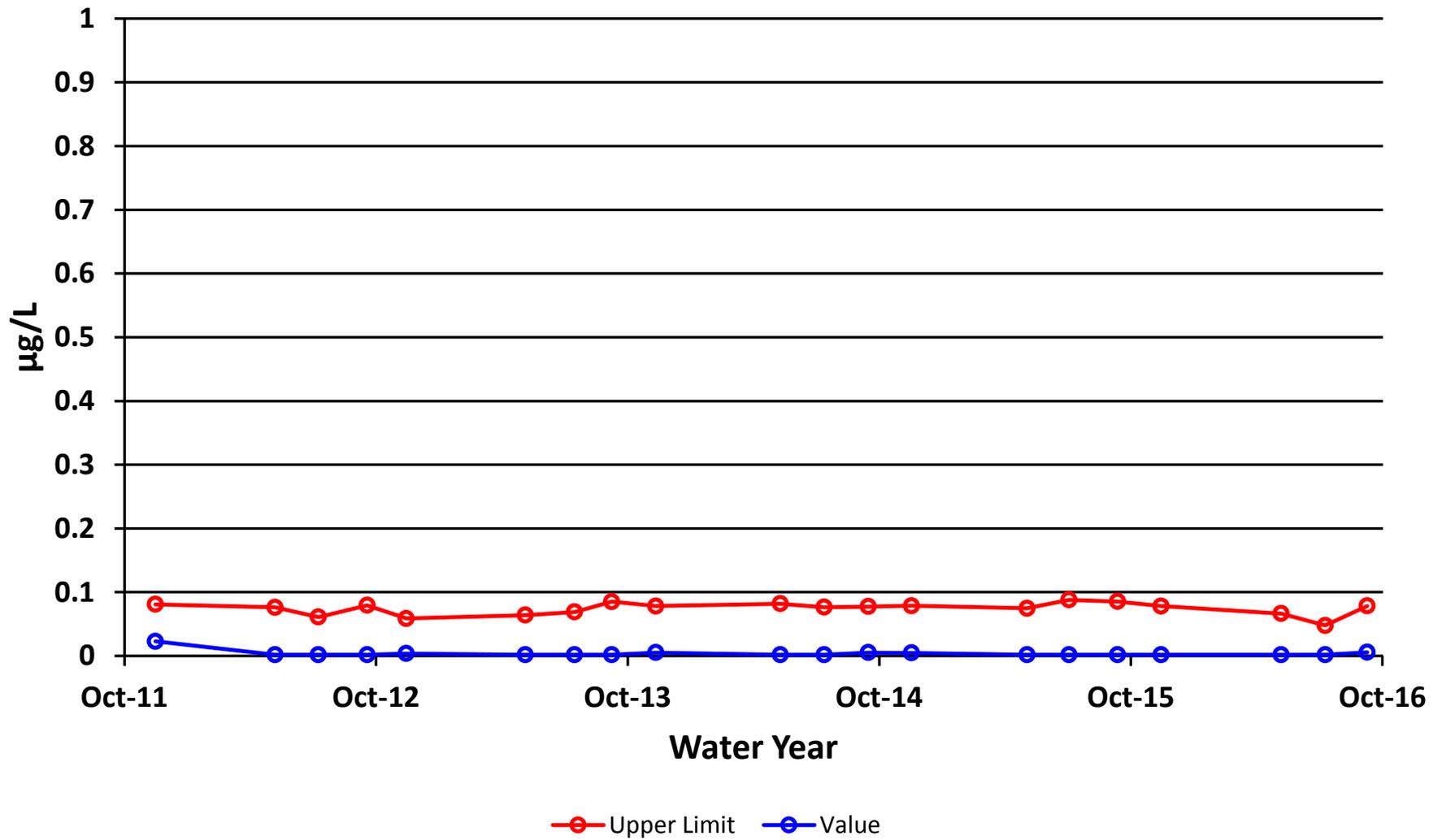
## Site 29 - Arsenic Dissolved



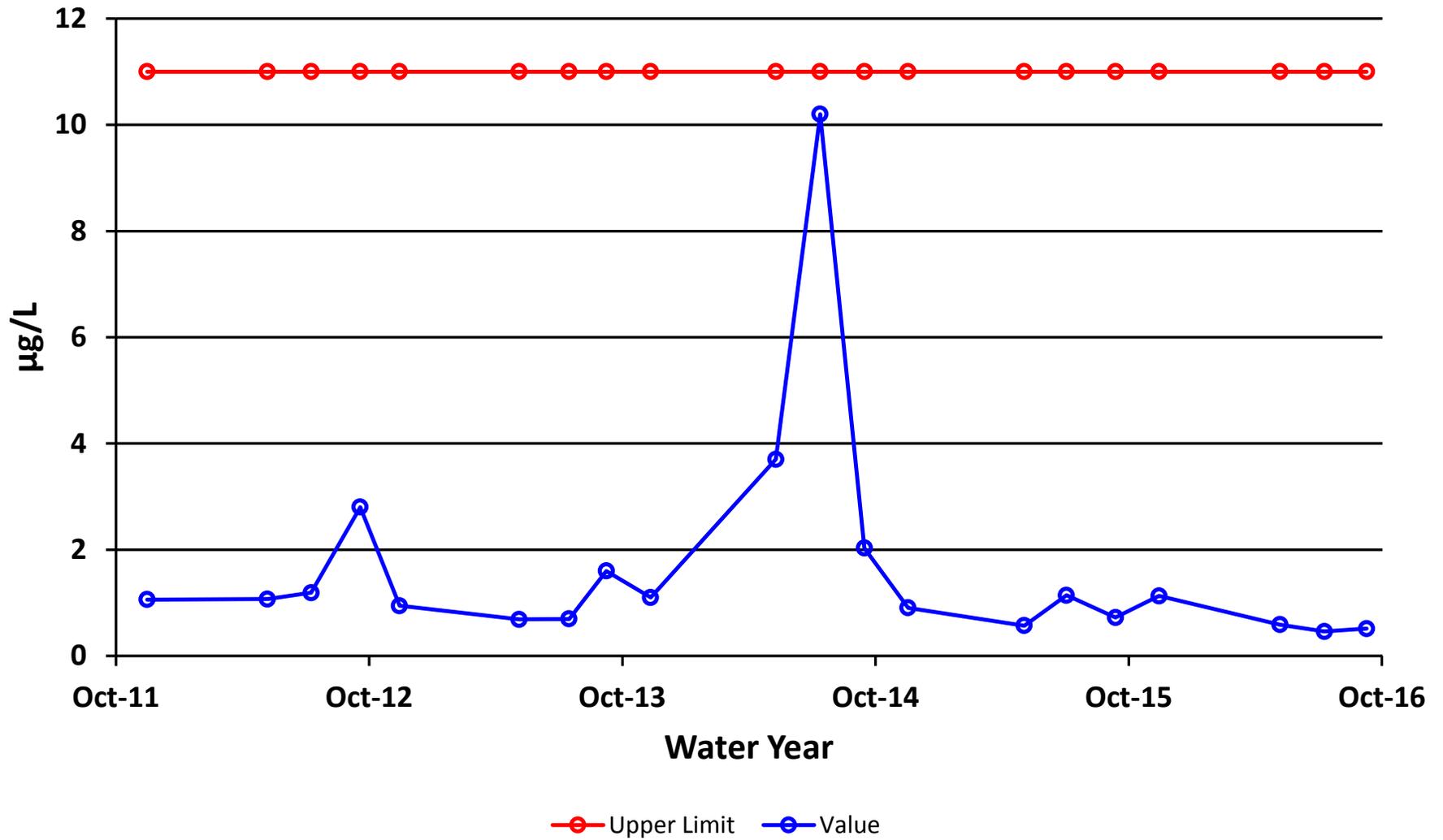
# Site 29 - Barium Dissolved



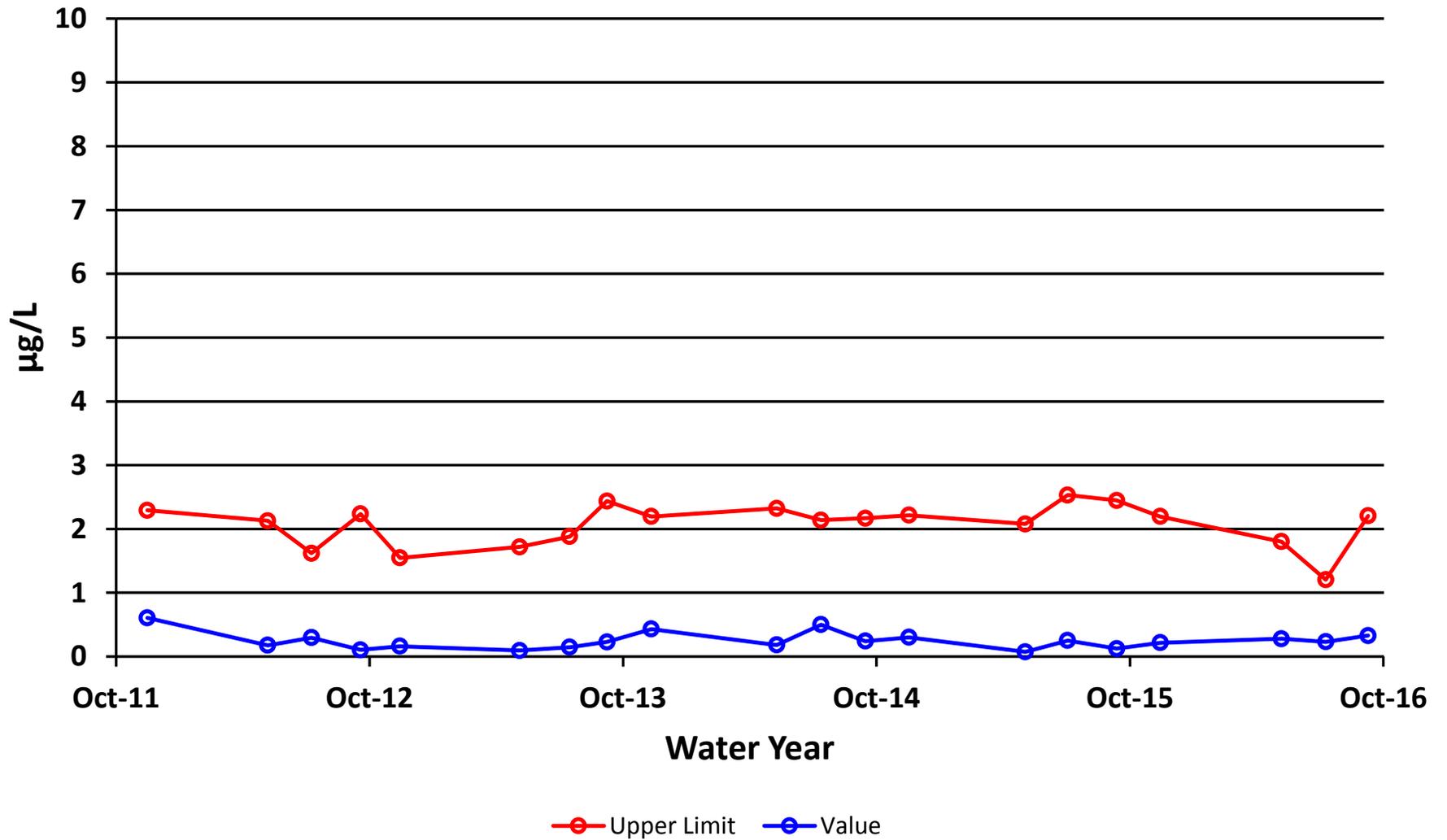
## Site 29 - Cadmium Dissolved



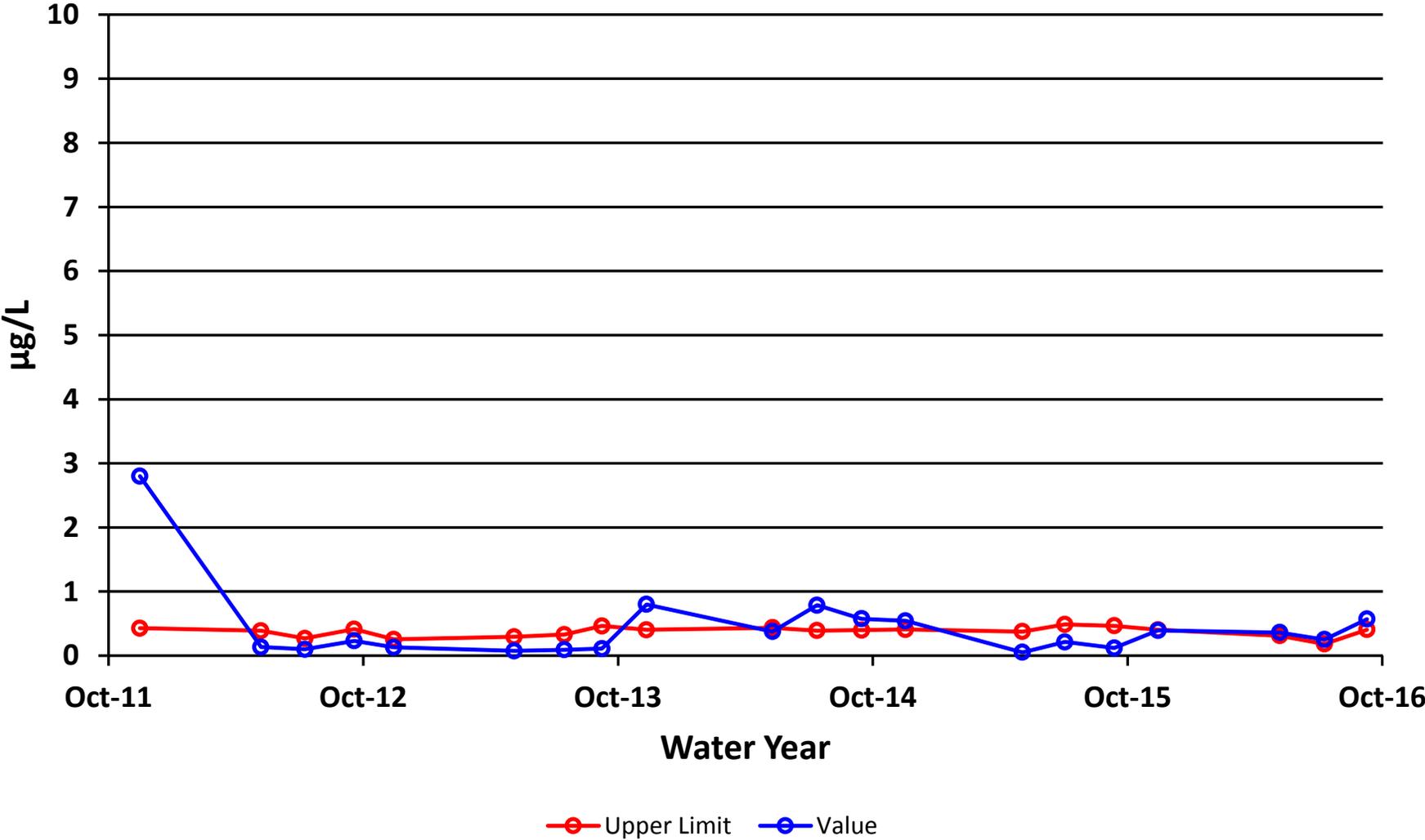
# Site 29 - Chromium Dissolved



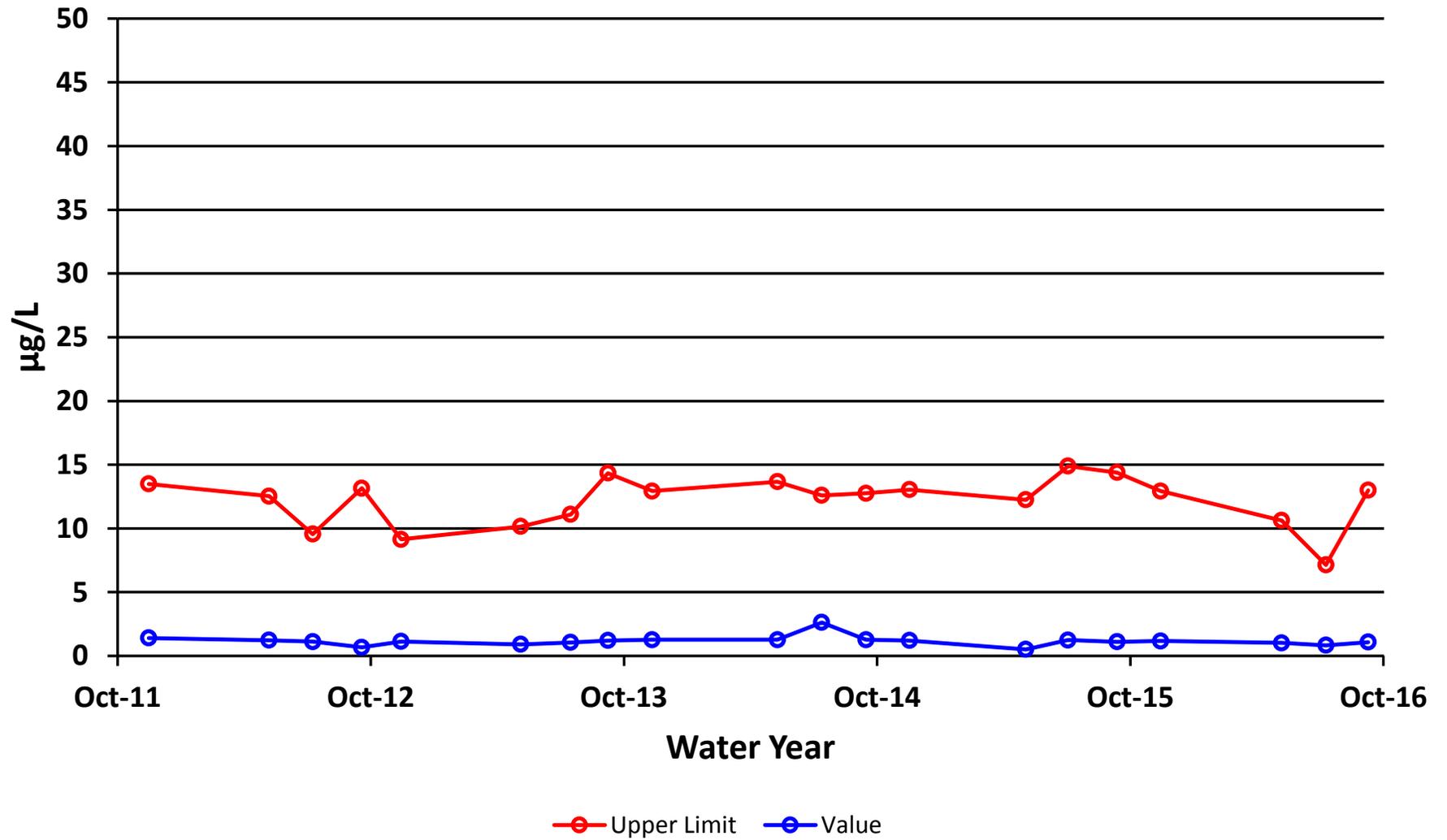
## Site 29 - Copper Dissolved



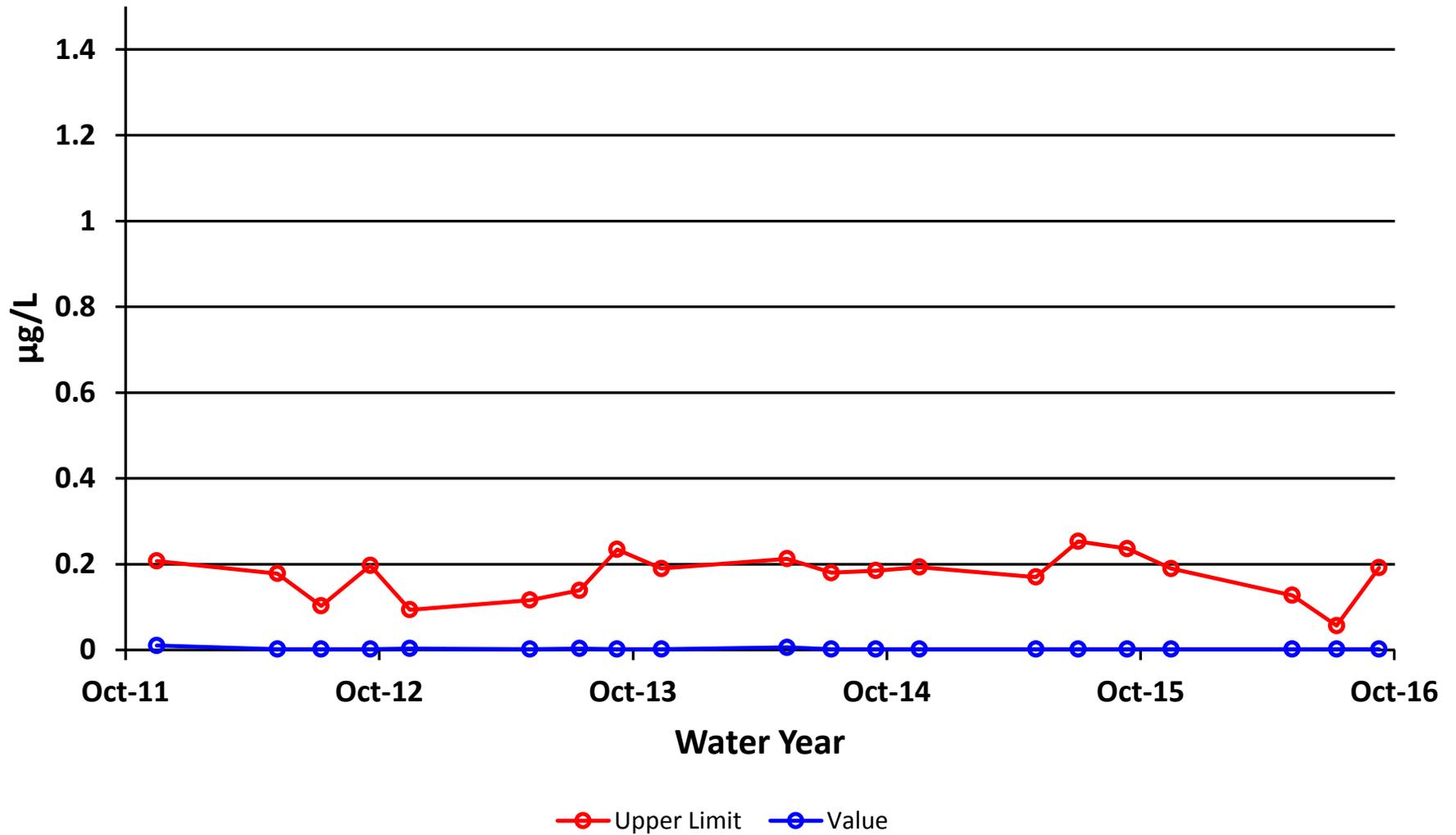
# Site 29 - Lead Dissolved



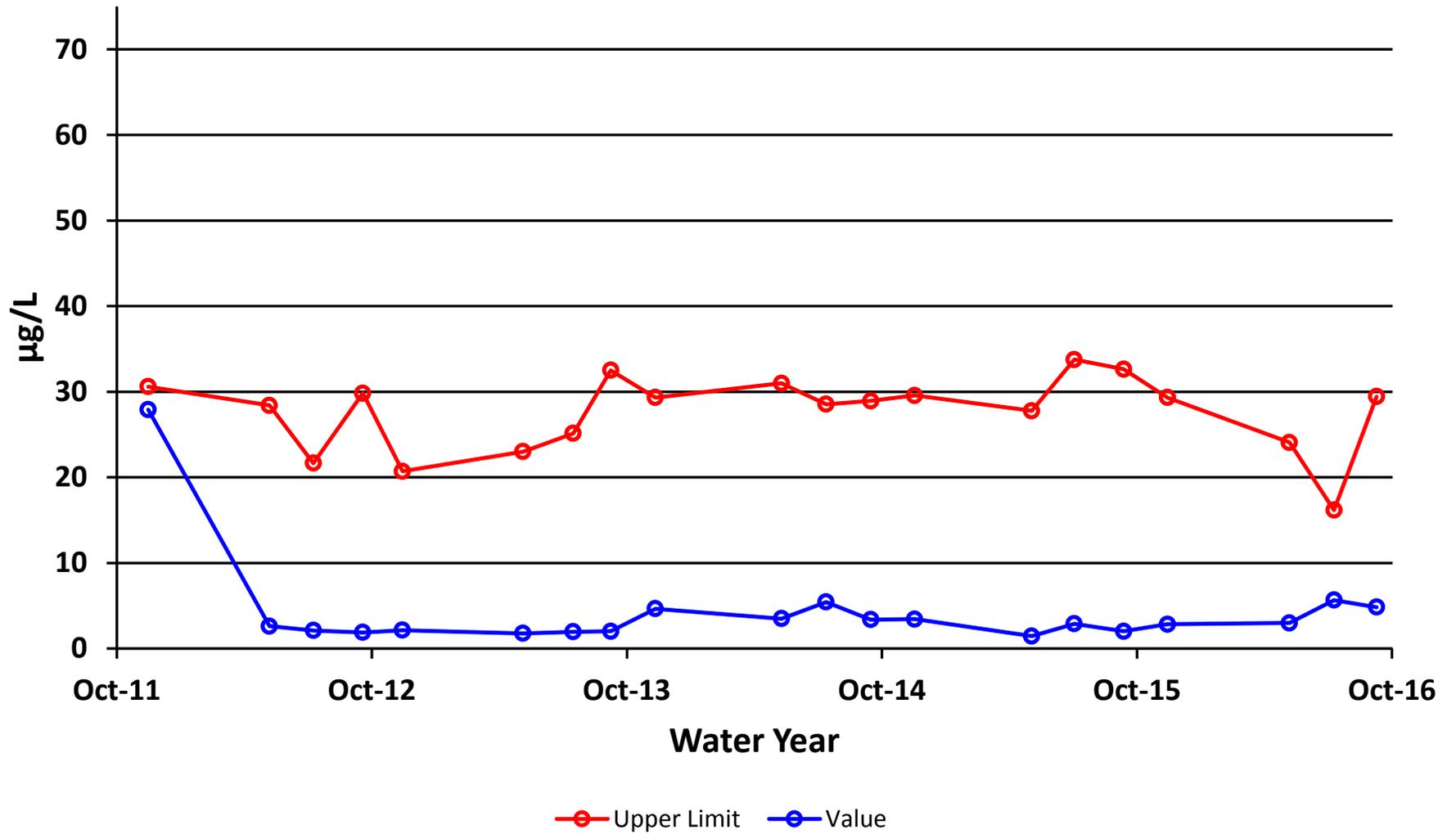
## Site 29 - Nickel Dissolved



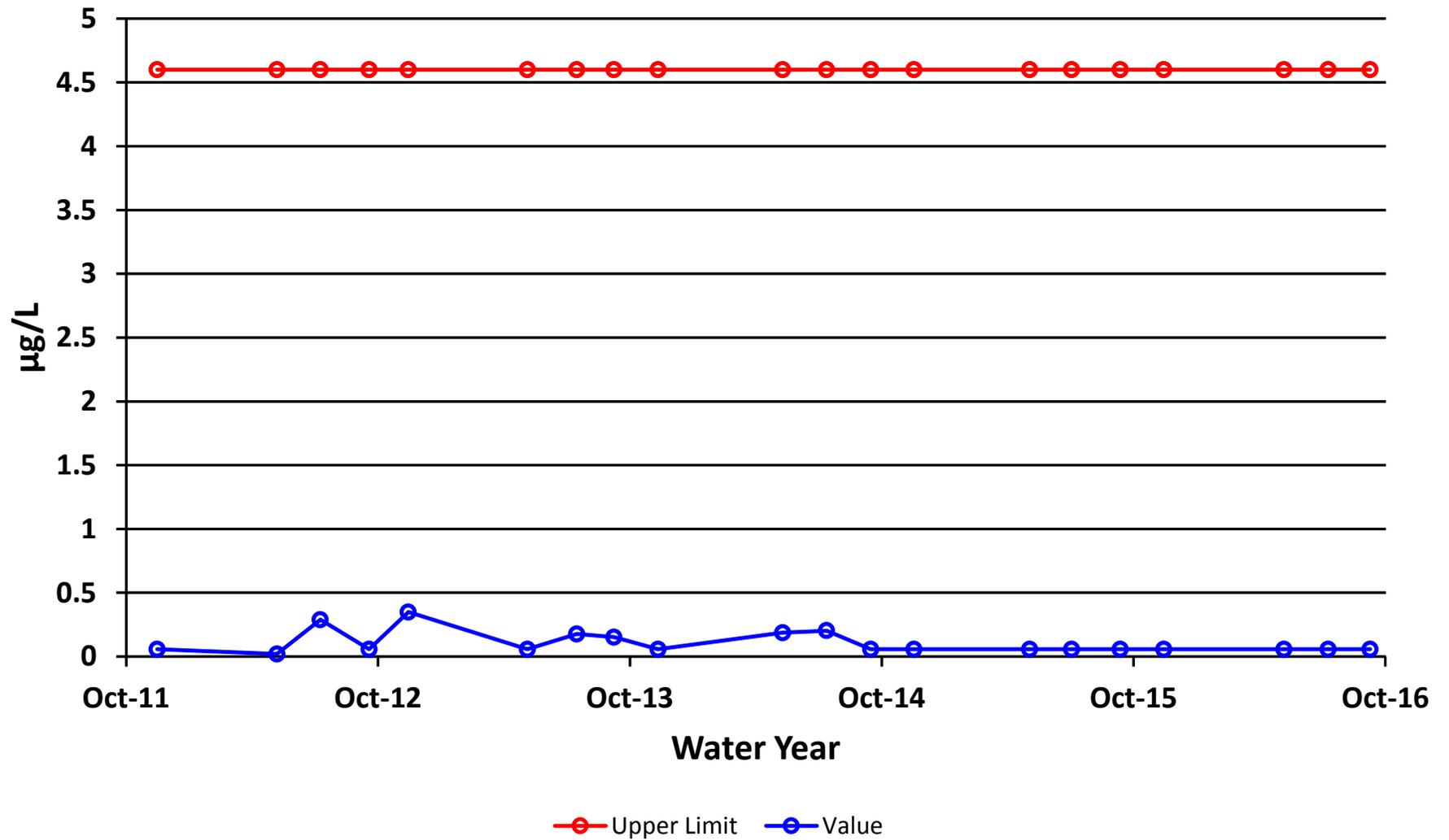
## Site 29 - Silver Dissolved



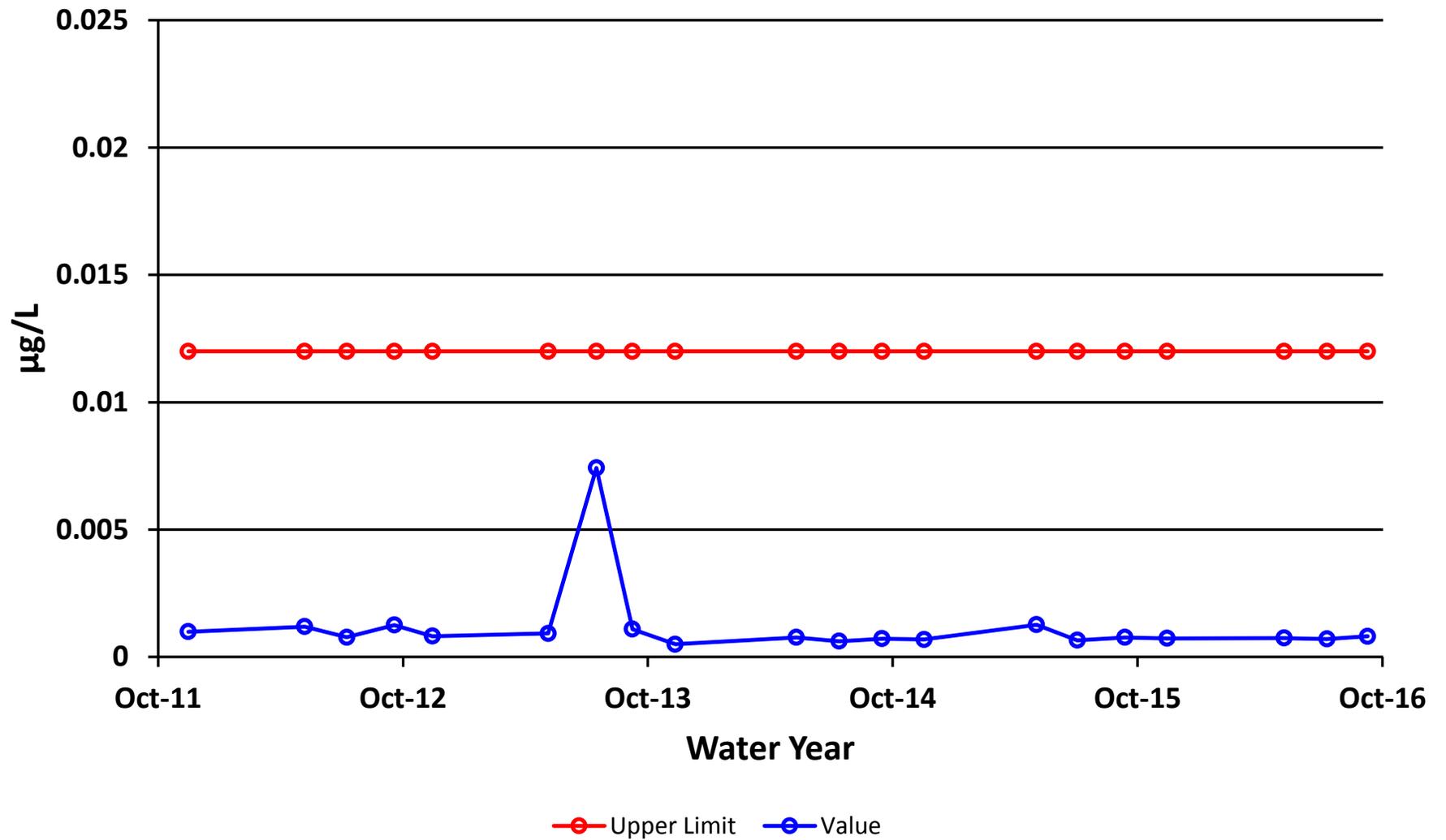
## Site 29 - Zinc Dissolved



## Site 29 - Selenium Dissolved



## Site 29 - Mercury Dissolved



## INTERPRETIVE REPORT

### SITE 32

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past six years are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. Thirteen results exceeding these criteria have been identified as listed in the table below.

**Table of Exceedance for Water Year 2016**

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
17-Nov-15	Alkalinity	14.6 mg/L	20		8.41 mg/L
10-May-16	Alkalinity	15.2 mg/L	20		8.08 mg/L
13-Jul-16	Alkalinity	15.3 mg/L	20		7.61 mg/L
12-Sep-16	Alkalinity	15 mg/L	20		8.08 mg/L
17-Nov-15	Copper Dissolved	1.31 µg/L		1.08	8.41 mg/L
17-Nov-15	Lead Dissolved	1.70 µg/L		0.16	8.4 mg/L
10-May-16	Lead Dissolved	1.18 µg/L		0.15	8.08 mg/L
13-Jul-16	Lead Dissolved	1.12 µg/L		0.14	7.61 mg/L
12-Sep-16	Lead Dissolved	1.34 µg/L		0.15	8.08 mg/L
17-Nov-15	pH Field	4.9 su	6.5	9.0	8.41 mg/L
10-May-16	pH Field	5.1 su	6.5	9.0	8.08 mg/L
13-Jul-16	pH Field	5.2 su	6.5	9.0	7.61 mg/L
12-Sep-16	pH Field	5.2 su	6.5	9.0	8.08 mg/L

All four of the annual sampling events were in exceedance for total alkalinity, dissolved lead, and field pH. Due to the low hardness for this site, 54 of the past 55 samples have returned lead values higher than the AWQS. As noted in the interpretive section for Site 29 fugitive tailings dust may be contributing to the elevated lead levels monitored at Site 32.

The dissolved copper value for the November 17, 2015 exceeded the AWQS value of 1.08µg/L, by 0.23 µg/L. The average dissolved value, over the past 5 years, was 0.72 +/- 0.24µg/L, and the last exceedance was recorded in November 2011. Given the magnitude of the average value, the four years between exceedances, and the lack of a visual increasing trend HGCMC does not feel the issue with dissolved copper at Site 32.

Dissolved chromium concentrations for the current water year, which were in exceedance during the May 2009 and May 2010 sampling, were well below the AWQS limit. A mechanism has yet to be established to explain the two elevated chromium results in those years.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. These plots have been visually analyzed for the appearance of any trend in concentration. No obvious visual trends were noted.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The adjacent table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.09			
pH Field	6	0.77			
Alkalinity, Total	6	0.61			
Sulfate, Total	6		Inconsistent detection limits		
Zinc, Dissolved	6	0.05			

\* Number of Years \*\* Significance level

Trend analysis was not performed on the total sulfate dataset because of a change in the method detection limit used by analytical laboratories. A primary assumption of the Mann-Kendall test is "... only one censoring threshold exists. When more than one detection limit exists, the Mann-Kendall test cannot be performed without further censoring the data." In order to prevent this from occurring HGCMC has worked to establish a consistent MDL for sulfate from the laboratory.

With the discontinuation of sampling at Site 58 during Water Year 2013, an inter-well comparison is no longer feasible. Instead an intra-well analysis was performed using combined Shewhart-CUSUM charts for conductivity, dissolved zinc, and alkalinity. Table 1 contains a summary of the baseline statistics along with the control limits used.

Site 32 was installed in 1988 and has an extensive sampling history, however establishing a baseline has been difficult. Since the installation of the well a number of the monitored parameters (*i.e.* alkalinity, specific conductance, total sulfate, and etc....) have been in constant

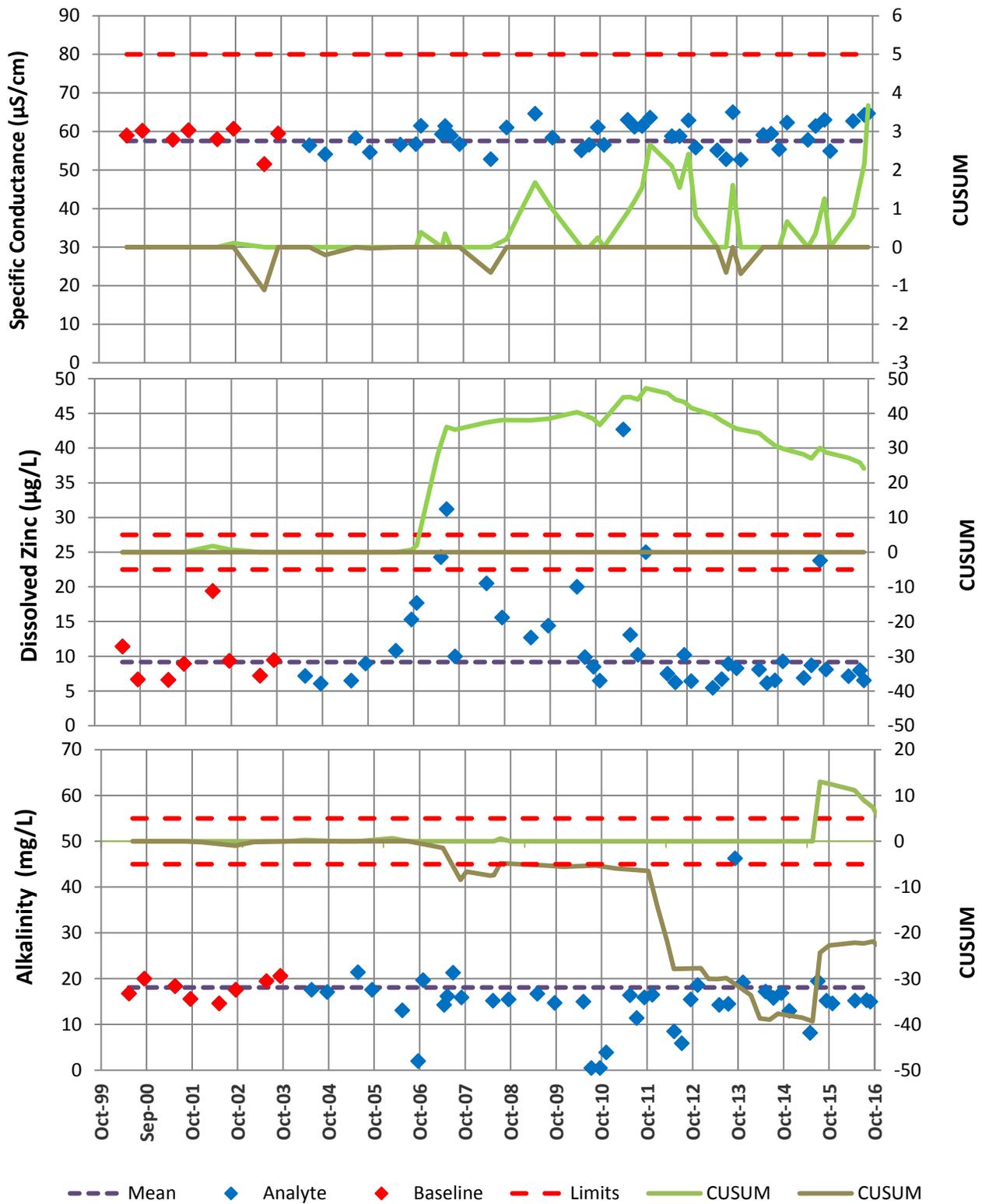
flux. Because the CUSUM process compares the mean and standard deviation of the chosen baseline to the collected data it is possible to detect continual changes in the analytes without having a background data set. After reviewing the data for the three parameters, data periods were chosen based upon the data having a period of minimal flux. This period was then used for the calculation of the baseline statistics.

**Table 1. Specific Conductance, Dissolved Zinc, and Total Sulfate Baseline Periods, Summary Statistics and Various Control Limits**

	Site 32 Conductivity ( $\mu\text{S}/\text{cm}$ )	Site 32 Diss. Zinc ( $\mu\text{g}/\text{L}$ )	Site 32 Alkalinity ( $\text{mg}/\text{L}$ )
<b>Baseline Statistics</b>			
Baseline Period	09/18/95-09/10/03	05/11/00-09/15/05	04/27/95-09/13/00
Number of Samples	12	12	12
Mean ( $\bar{x}$ )	57.5	9.17	18.7
Standard Deviation	2.86	3.72	2.02
<b>Shewhart-CUSUM Control Limits (SCL)</b>			
Control Limit (mean $\bar{x} + 2s$ )	63.3	16.6	22.1
Control Limit (mean $\bar{x} + 3s$ )	66.1	20.3	24.1
Control Limit (mean $\bar{x} + 4s$ )	69.0	24.0	26.1
Control Limit (mean $\bar{x} + 4.5s$ )	70.4	25.9	27.1
<b>CUSUM Control Limits</b>			
Cumulative increase (h)	5	5	5

Two of the three parameters examined (Figure 1) eventually went out of control with respects to the chosen baseline data statistics. If the pore/contact water from inside the tailings facility was not contained, the well water would have high conductivity, high dissolved zinc, and high alkalinity. Specific conductance has shown the least amount of variability, never going out of control. Total alkalinity went out of control because there has been a minor decrease in the parameter concentration. Because alkalinity and specific conductance do not have a similar pattern to going out of control as compared to dissolved zinc, it is not thought that these changes are a result of contact water leaching from containment. Dissolved zinc has periodically had higher values than the mean. As previously discussed, it is hypothesized that the increase in dissolved zinc results from the accumulation of fugitive dust in the snow pack during the winter. In the spring when the snow pack melts this material is released as a pulse. Most years the deposited material is not present by the fall sampling. With the implementation of additional best management practices, HGCMC expects to decrease the amount of fugitive dust leaving the tailings disposal facility.

**Figure 1. Observed Measurements for Specific Conductance, Dissolved Zinc, and Alkalinity from Site 32 Compared to the Shewhart-CUSUM Control Limits From Table 1**



## Table of Results for Water Year 2016

### Site 032FMG - 'Monitoring Well - 5S'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		6.9						8		9.3		10.1	8.7
Conductivity-Field(µmho)		54.9						62.7		64.3		64.7	63.5
Conductivity-Lab (µmho)		50						56		54		55	55
pH Lab (standard units)		5.01						4.97		4.98		4.9	4.98
pH Field (standard units)		4.93						5.1		5.19		5.21	5.15
Total Alkalinity (mg/L)		14.6						15.2		15.3		15	15.1
Total Sulfate (mg/L)		0.3						0.3		0.3		0.3	0.3
Hardness (mg/L)		8.4						8.1		7.6		8.1	8.1
Dissolved As (ug/L)		4.37						4.39		4.36		4.32	4.365
Dissolved Ba (ug/L)		16.4						13.5		13.1		13.6	13.6
Dissolved Cd (ug/L)		0.0101						0.0111		0.0112		0.0154	0.0112
Dissolved Cr (ug/L)		3.5						1.25		1.24		1.02	1.245
Dissolved Cu (ug/L)		1.31						0.71		0.79		0.883	0.837
Dissolved Pb (ug/L)		1.7						1.18		1.12		1.34	1.2600
Dissolved Ni (ug/L)		4.9						2.89		2.74		2.85	2.870
Dissolved Ag (ug/L)		0.002						0.002		0.002		0.002	0.002
Dissolved Zn (ug/L)		8.08						7.12		8		6.53	7.56
Dissolved Se (ug/L)		0.327						0.156		0.195		0.141	0.176
Dissolved Hg (ug/L)		0.00108						0.00122		0.00121		0.0018	0.001215

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

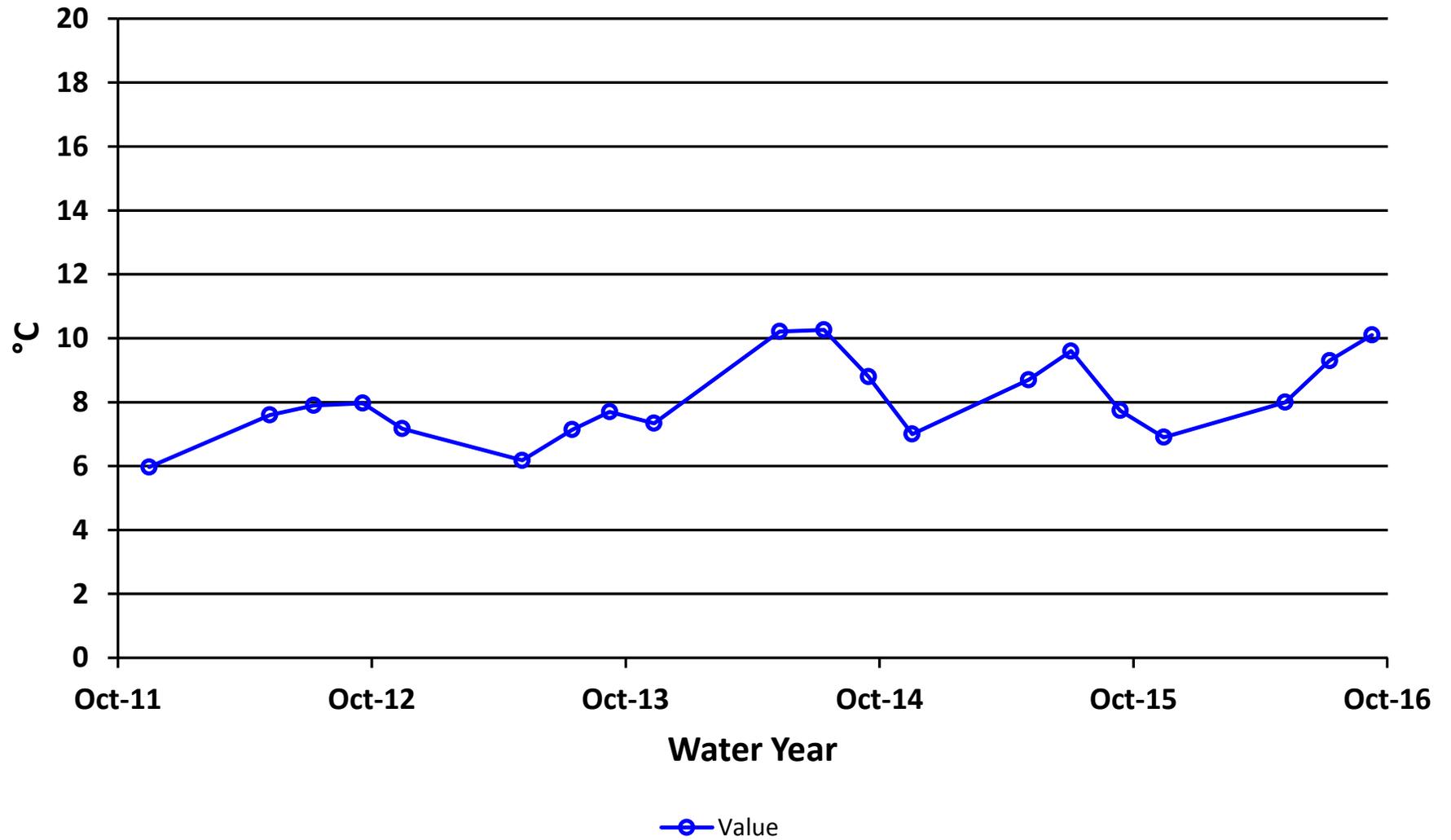
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

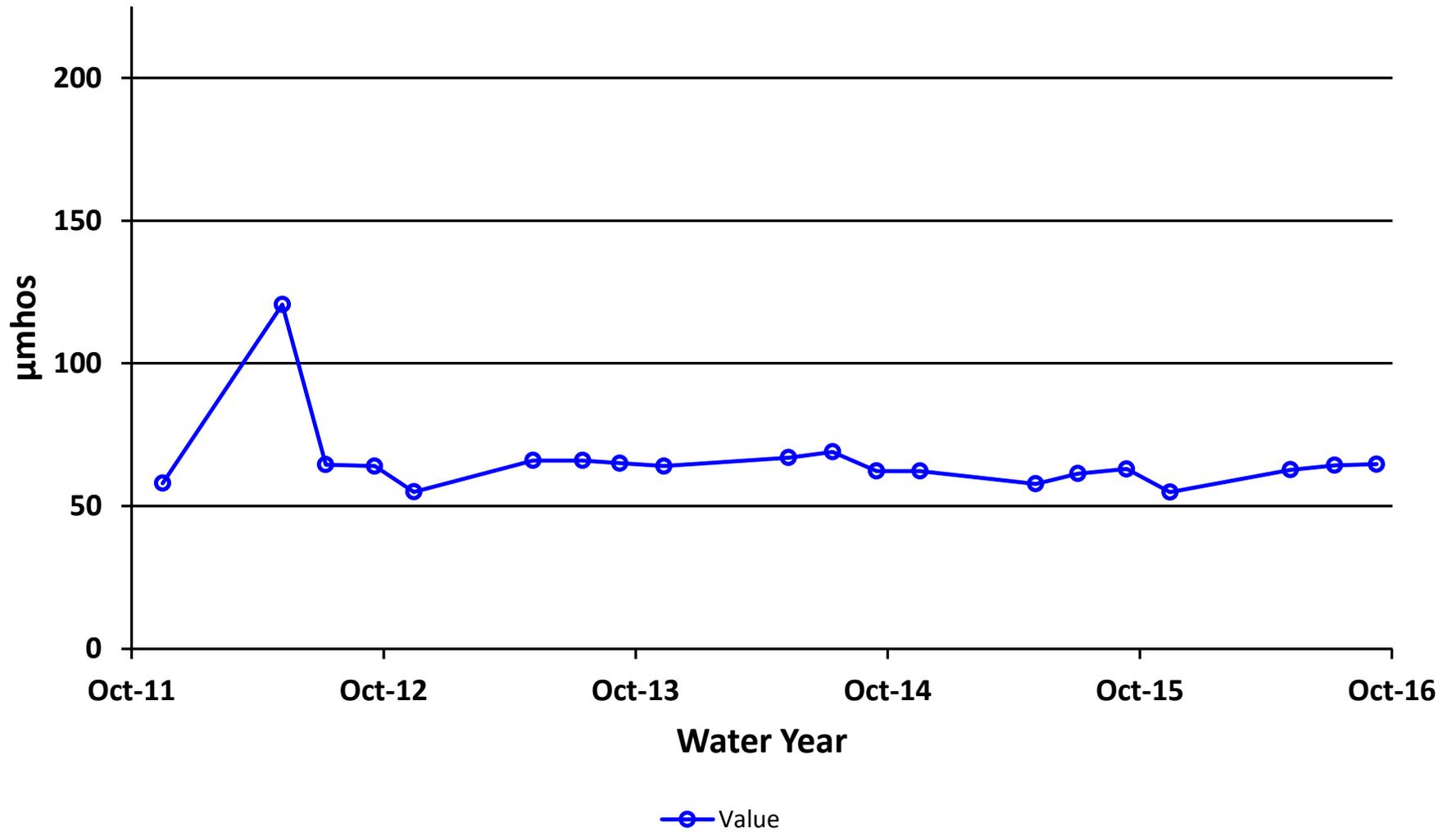
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
032FMG	11/17/2015	12:00 PM	Diss. Cd-ICP/MS	0.01	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.32	µg/L	J	Below Quantitative Range
	7/13/2016	12:00 PM	Diss. Se-ICP/MS	0.19	µg/L	J	Below Quantitative Range
			Sulfate	-0.5	mg/L	UJ	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Se-ICP/MS	0.14	µg/L	J	Below Quantitative Range
			Sulfate	-0.5	mg/L	UJ	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

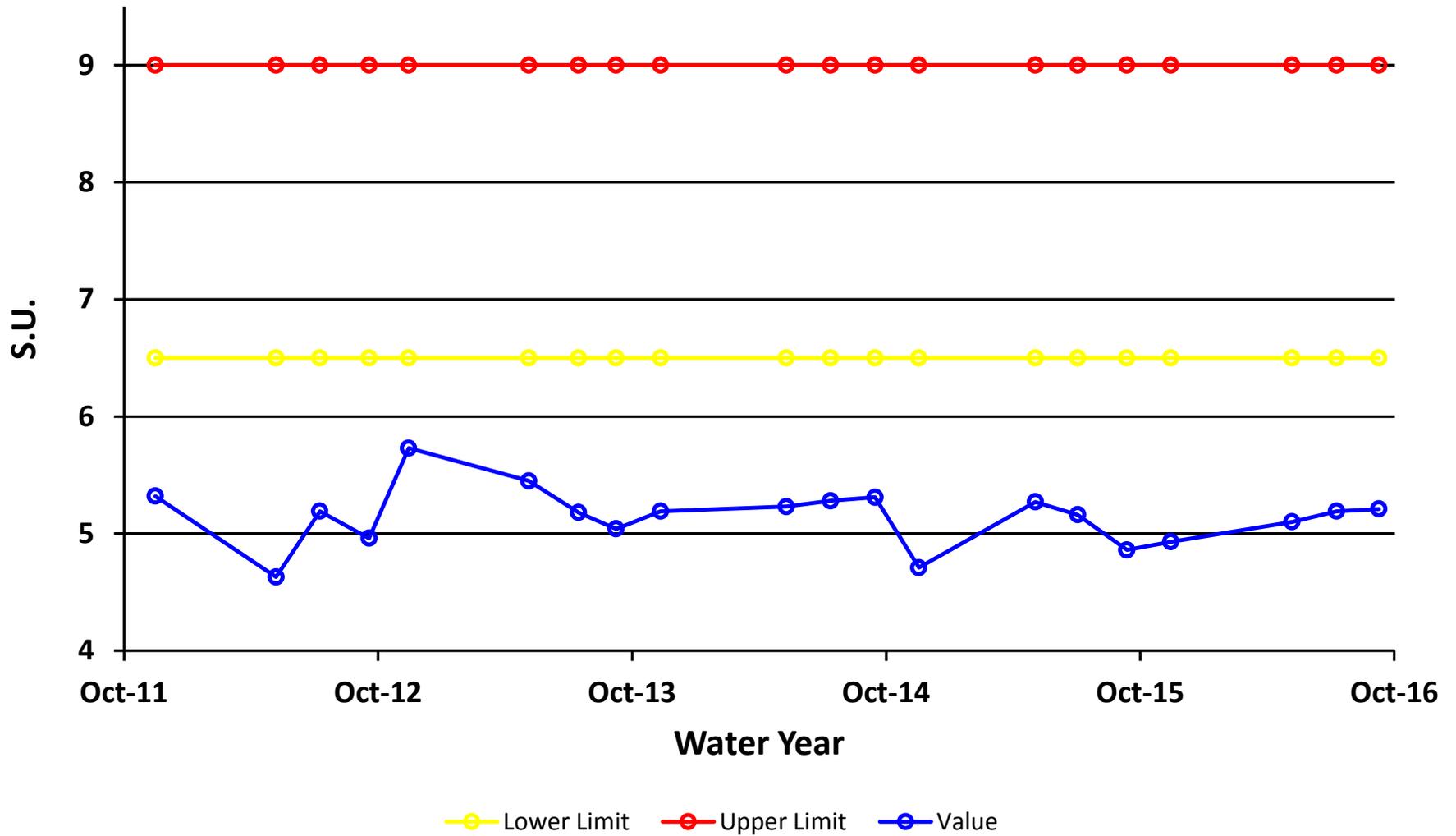
## Site 32 - Water Temperature



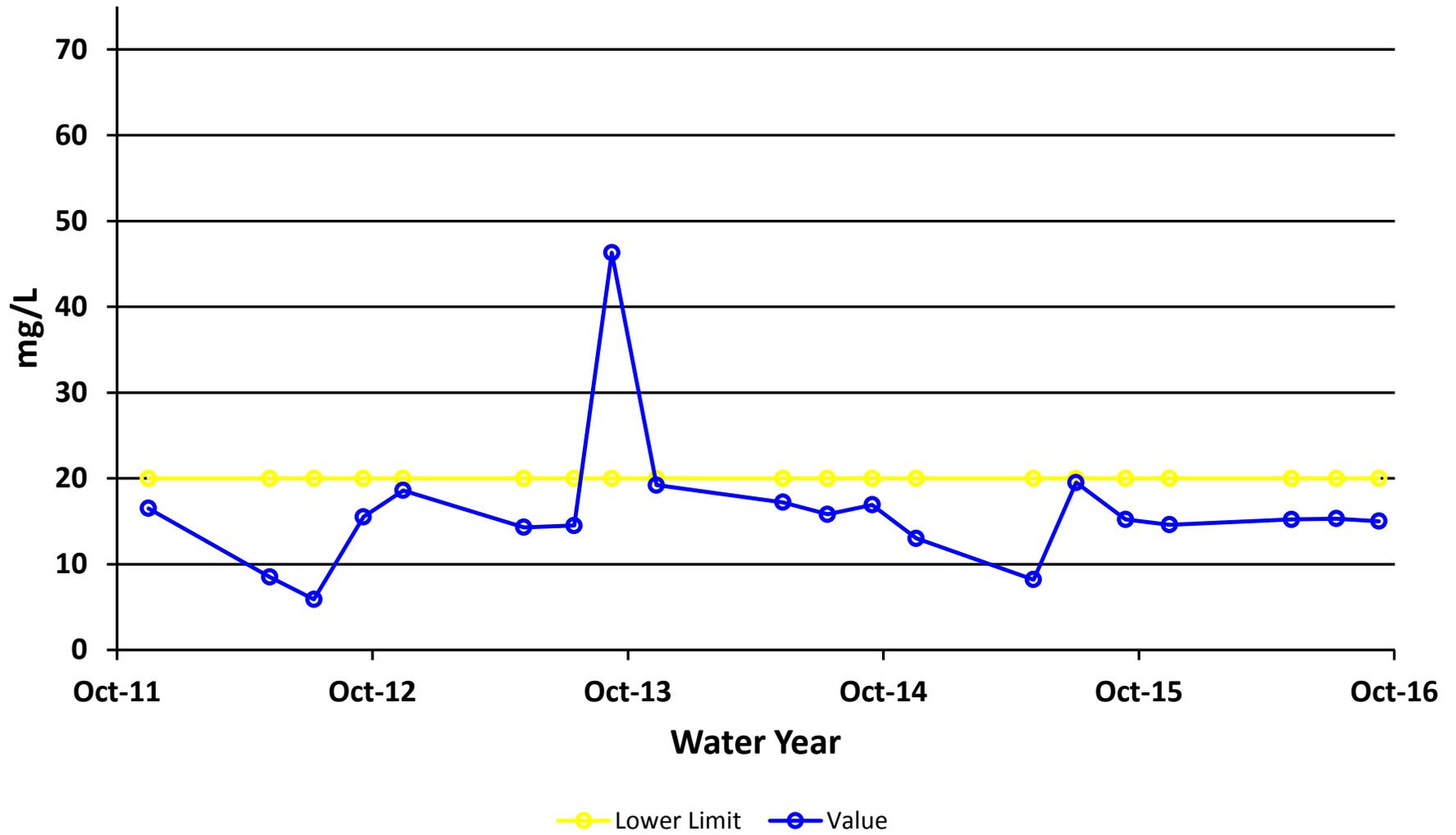
## Site 32 - Conductivity Field



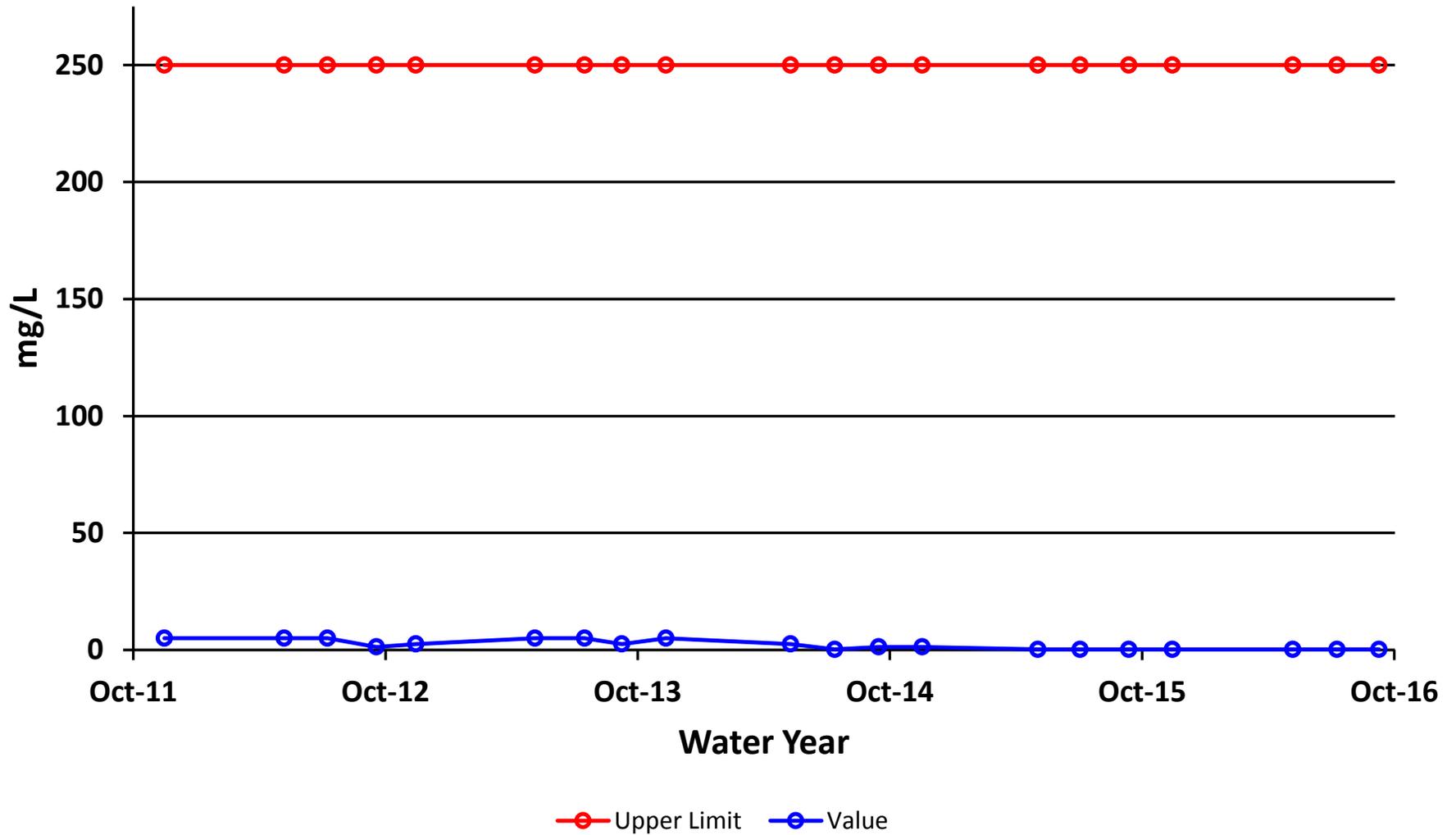
# Site 32 - pH Field



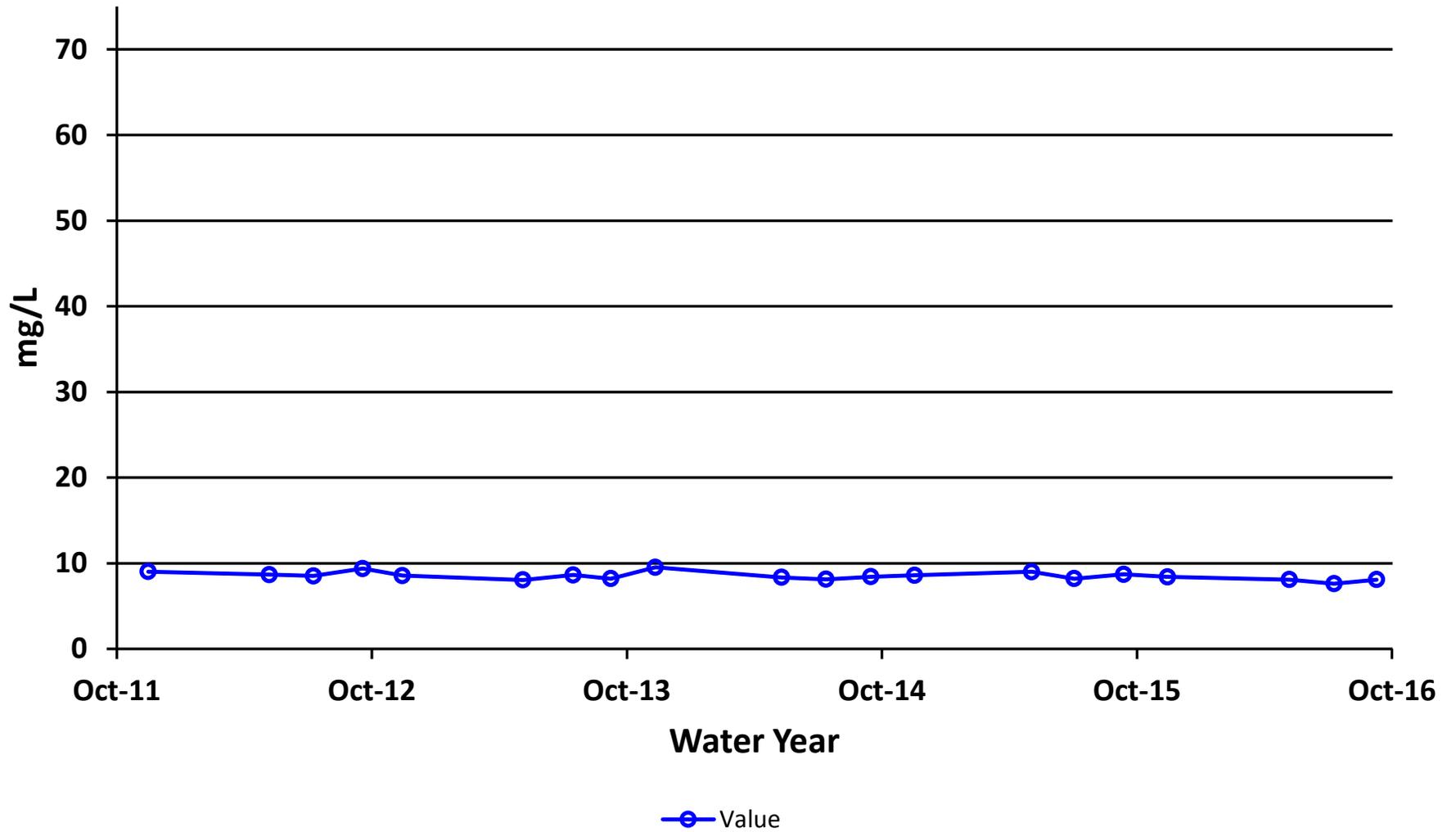
# Site 32 - Alkalinity



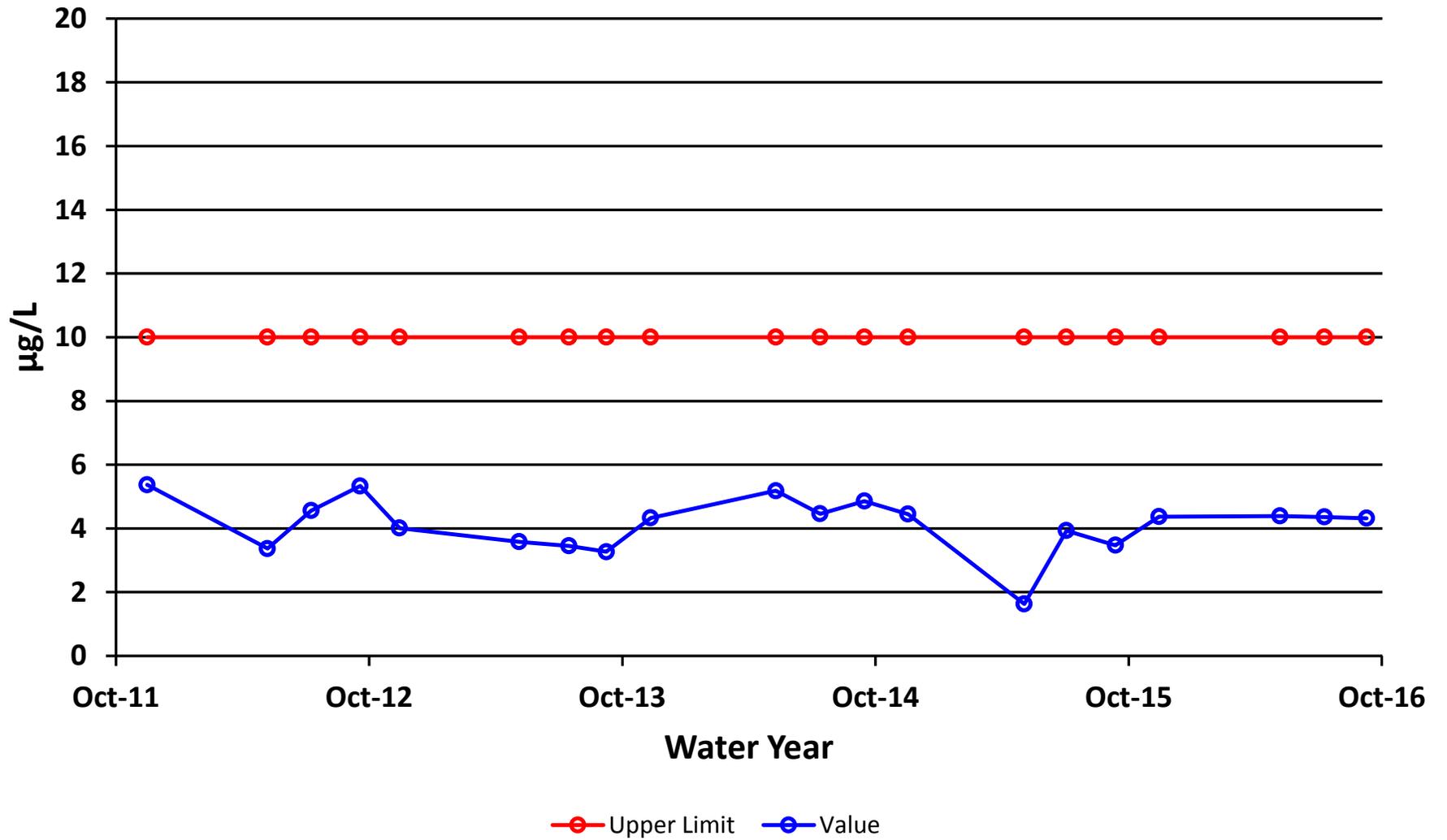
# Site 32 - Sulfate



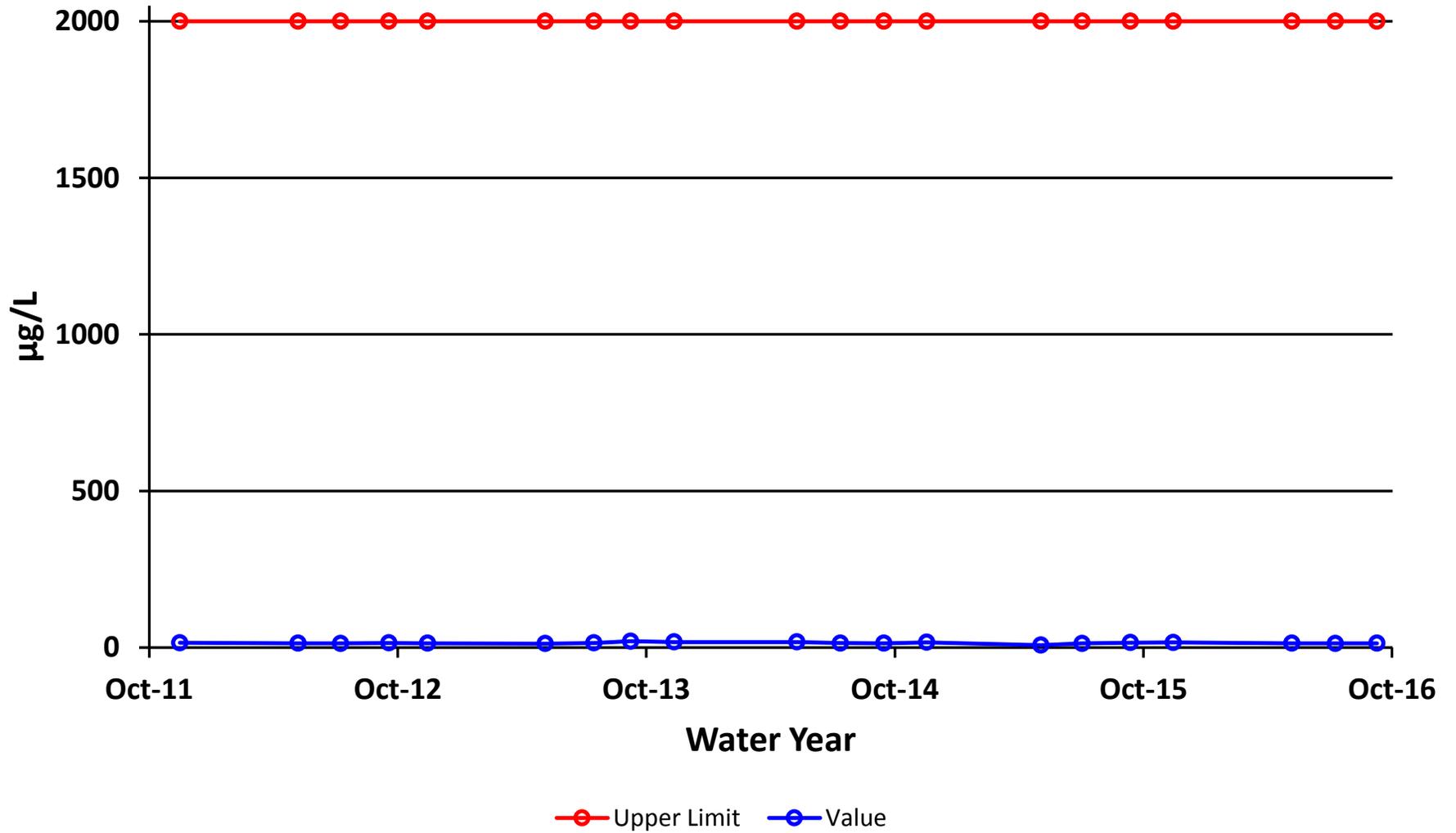
## Site 32 - Hardness



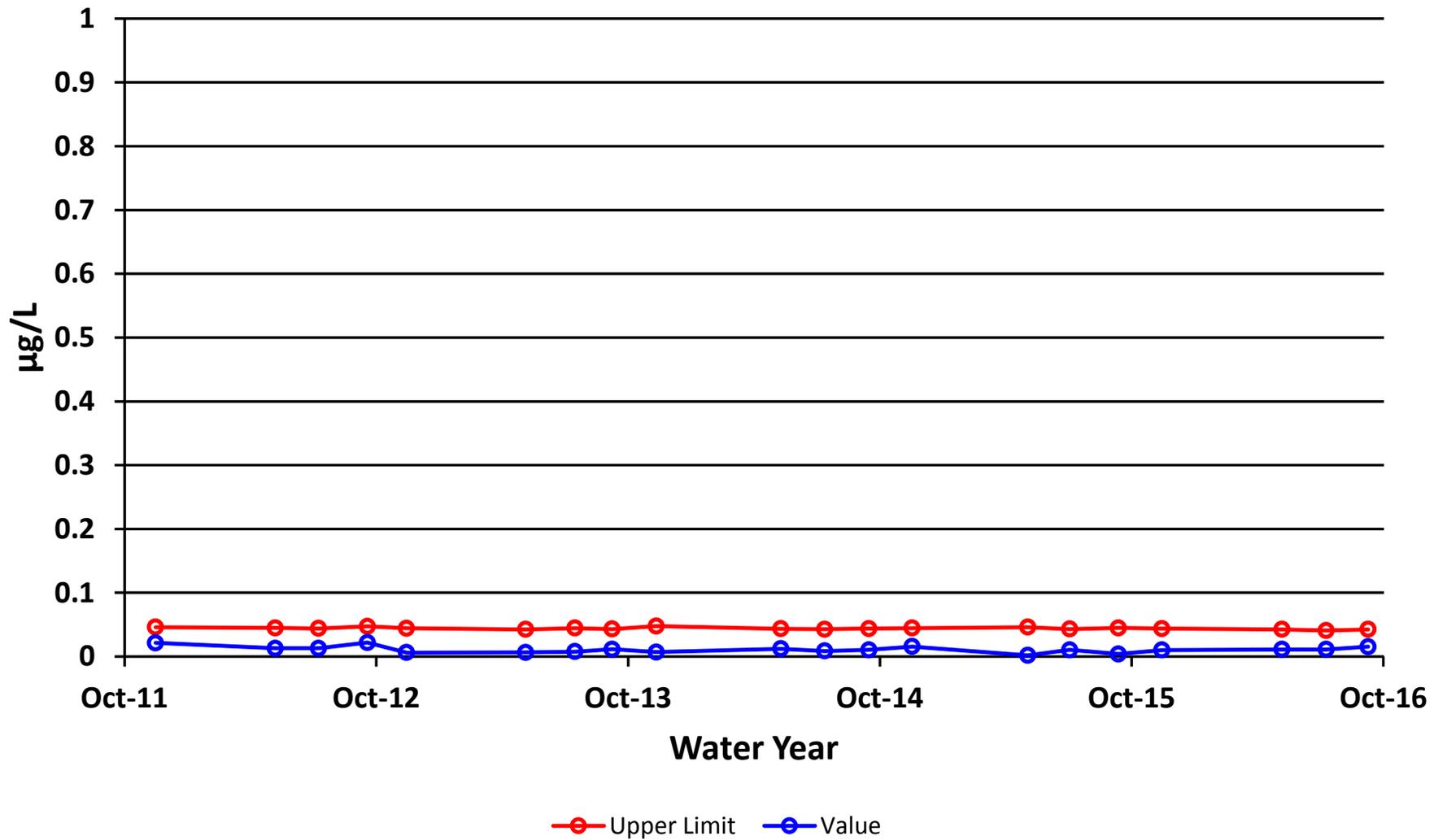
# Site 32 - Arsenic Dissolved



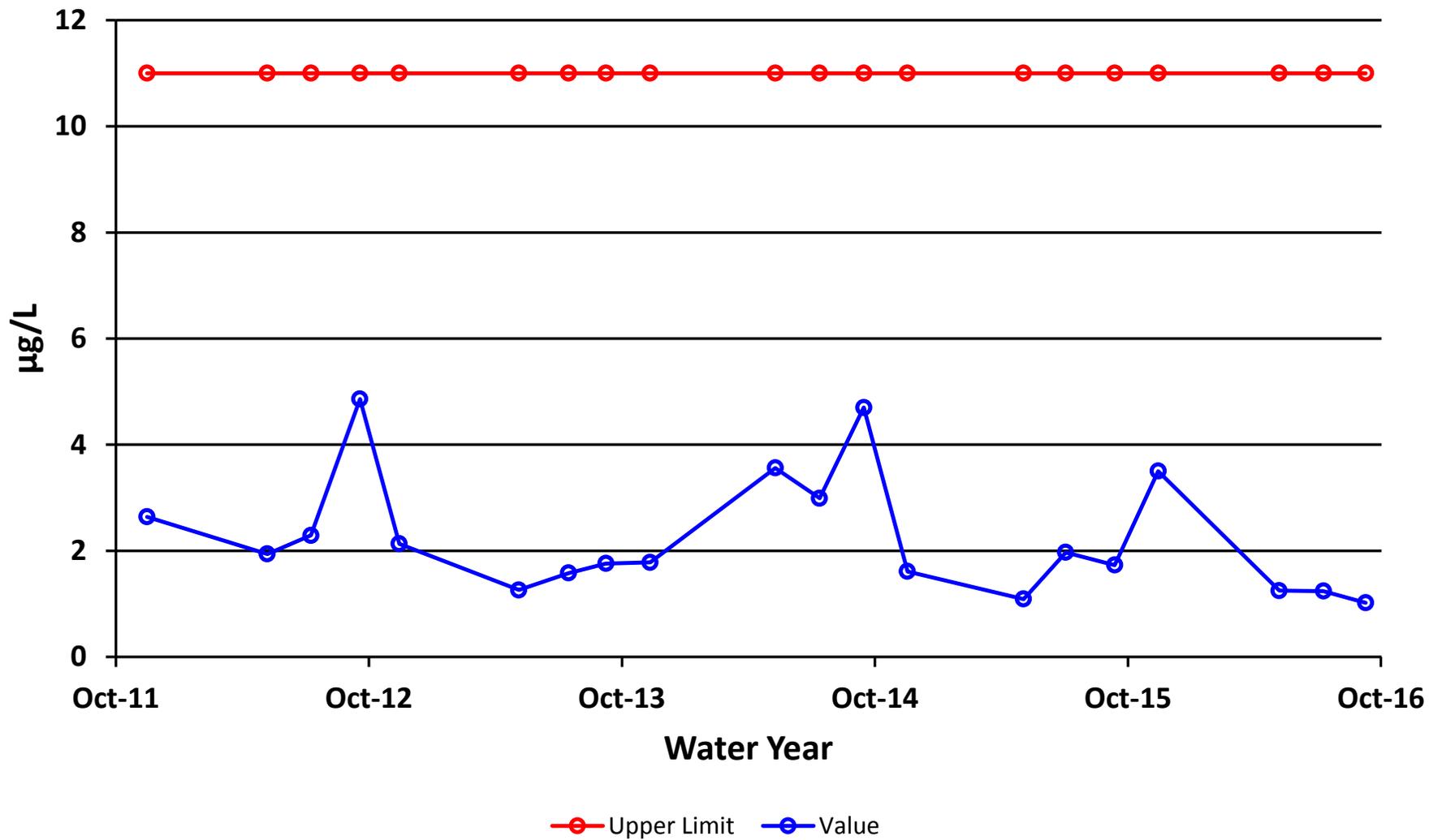
# Site 32 - Barium Dissolved



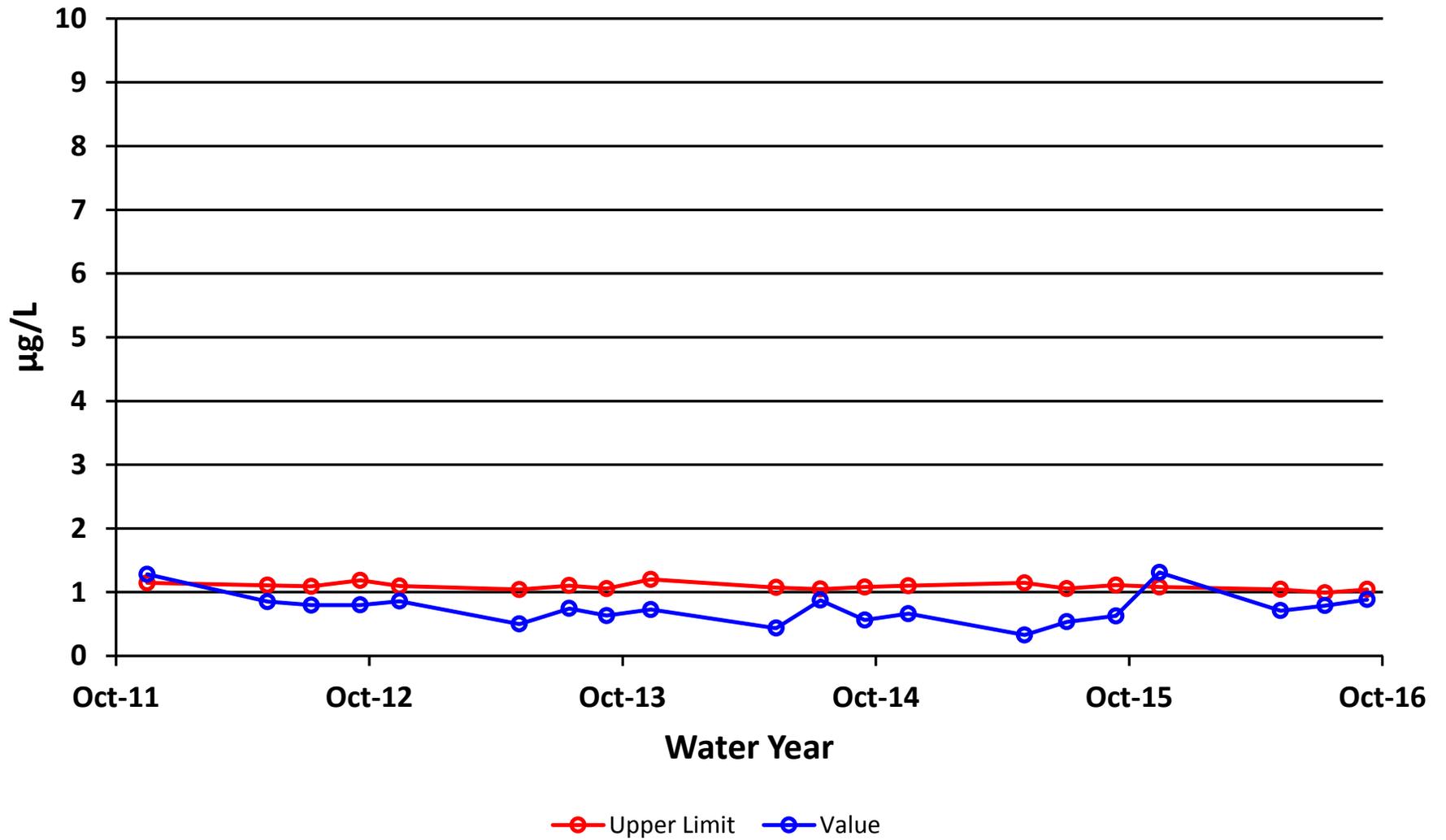
## Site 32 - Cadmium Dissolved



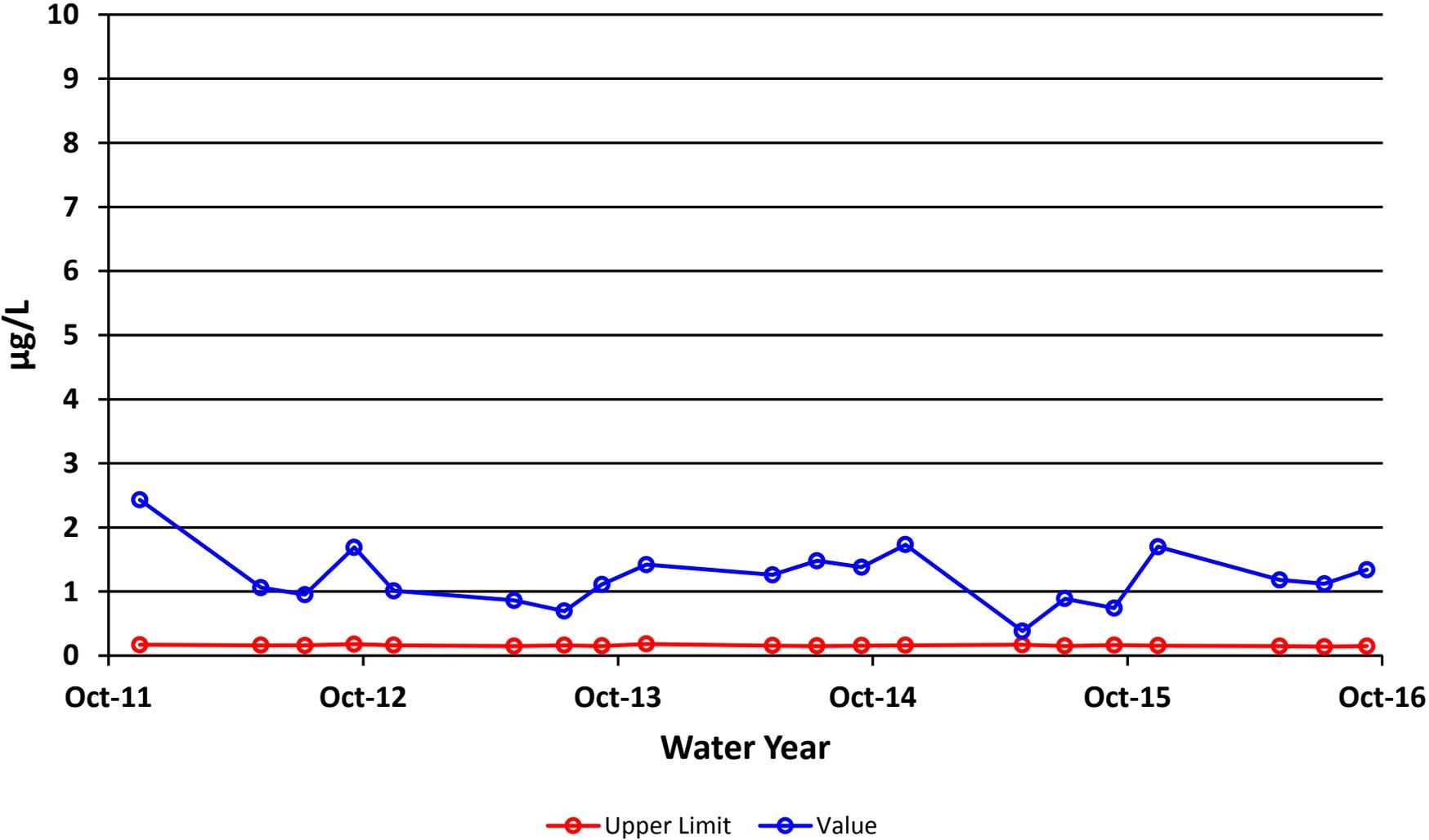
## Site 32 - Chromium Dissolved



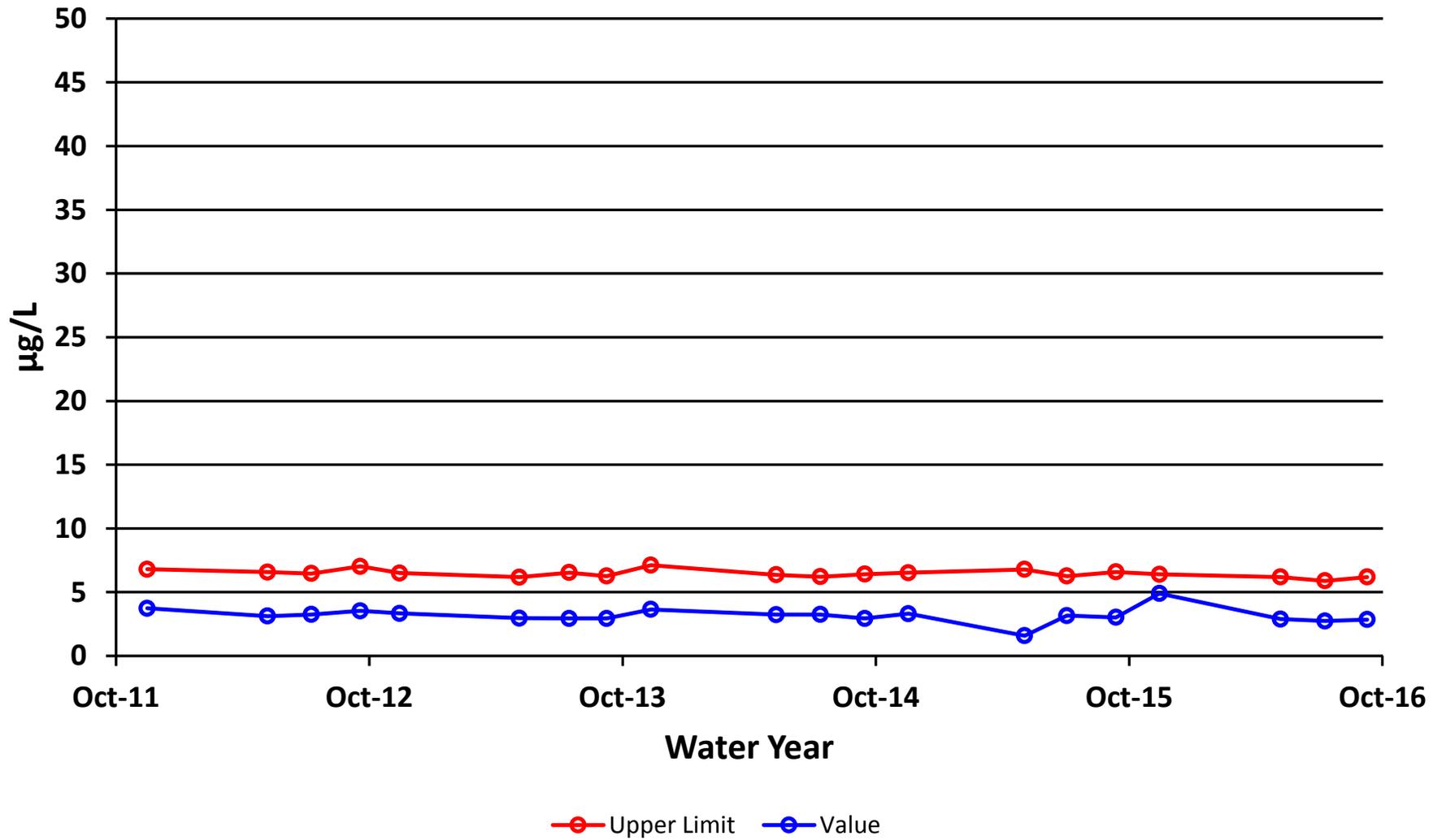
# Site 32 - Copper Dissolved



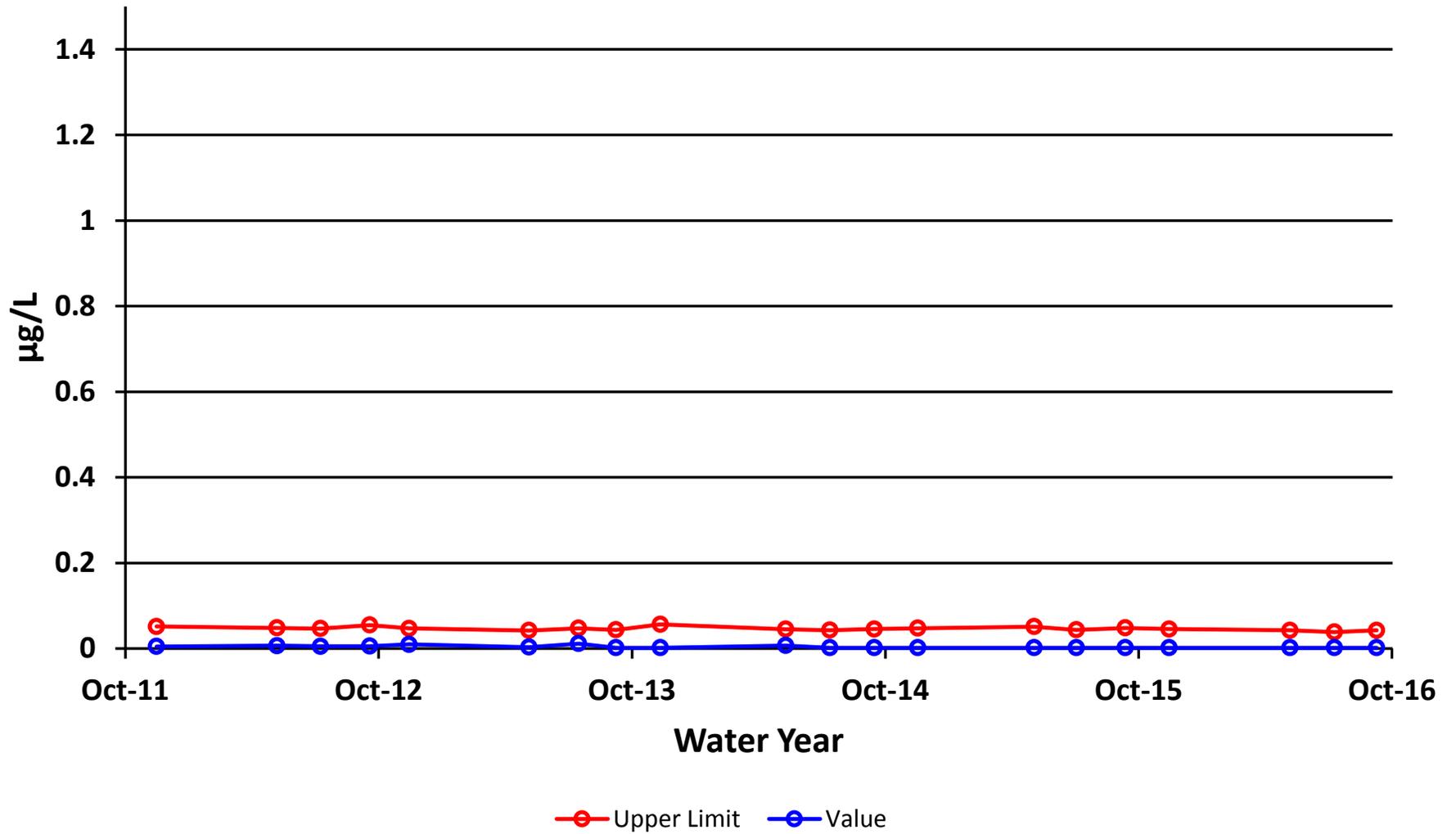
# Site 32 - Lead Dissolved



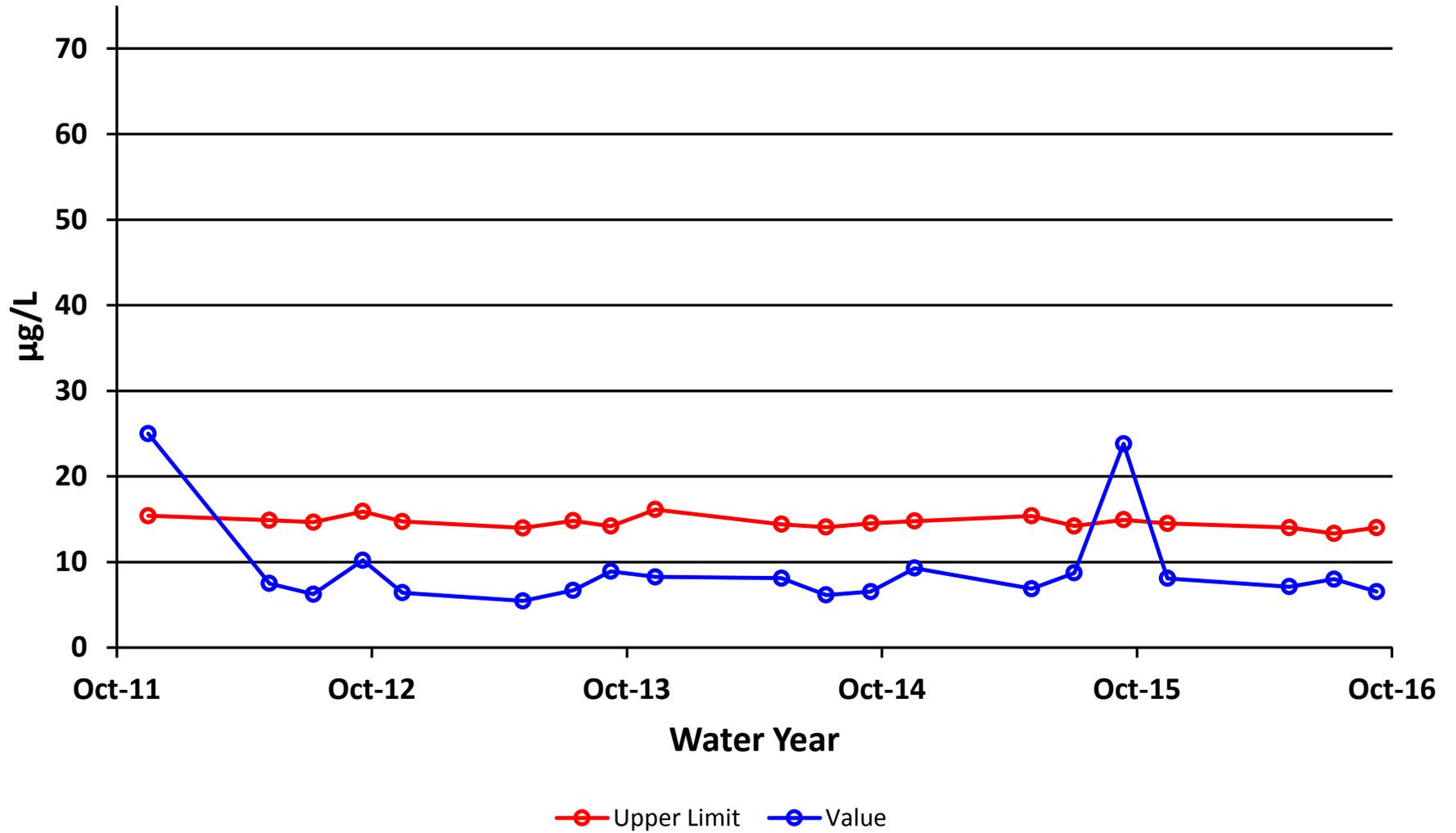
# Site 32 - Nickel Dissolved



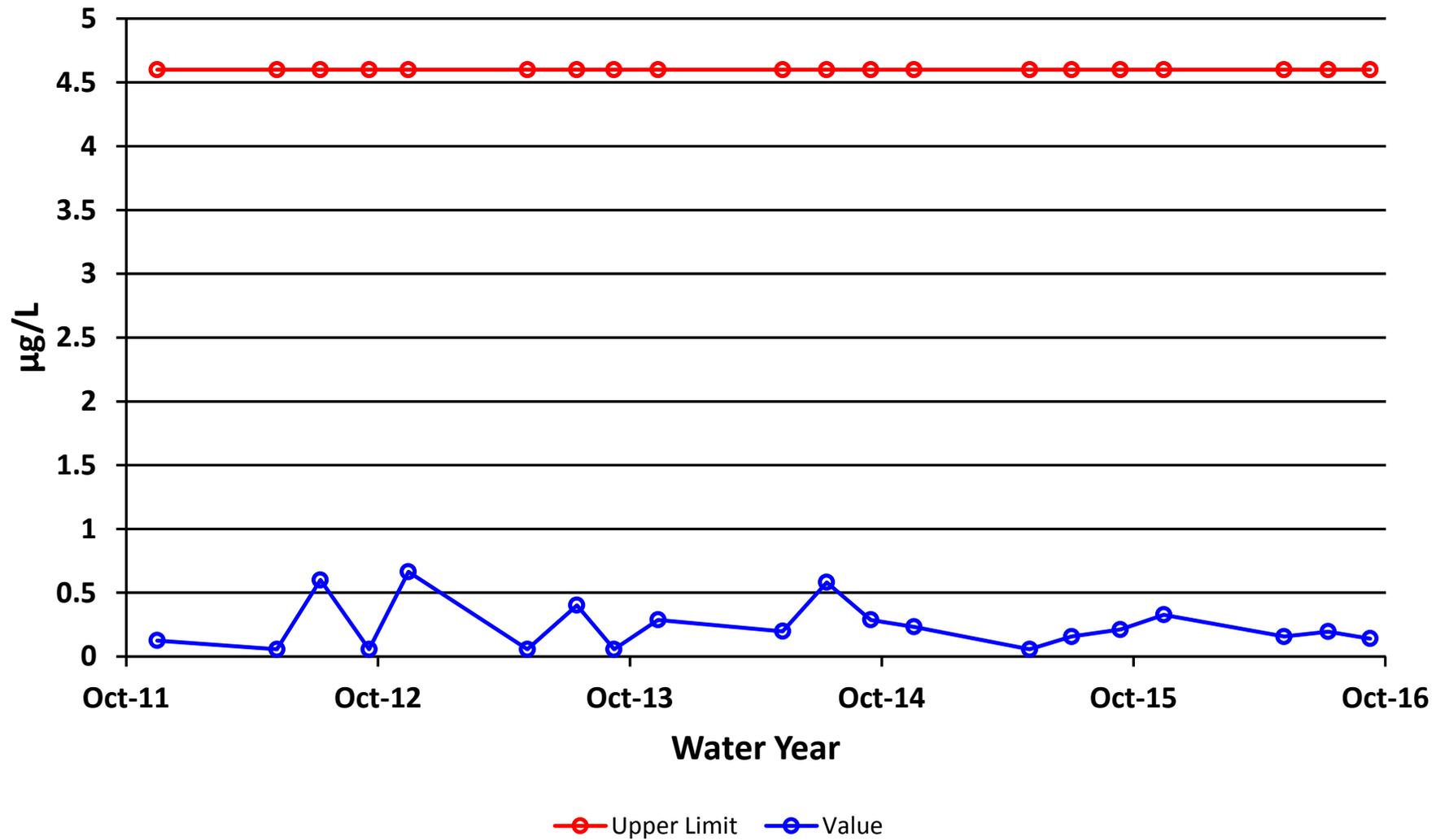
## Site 32 - Silver Dissolved



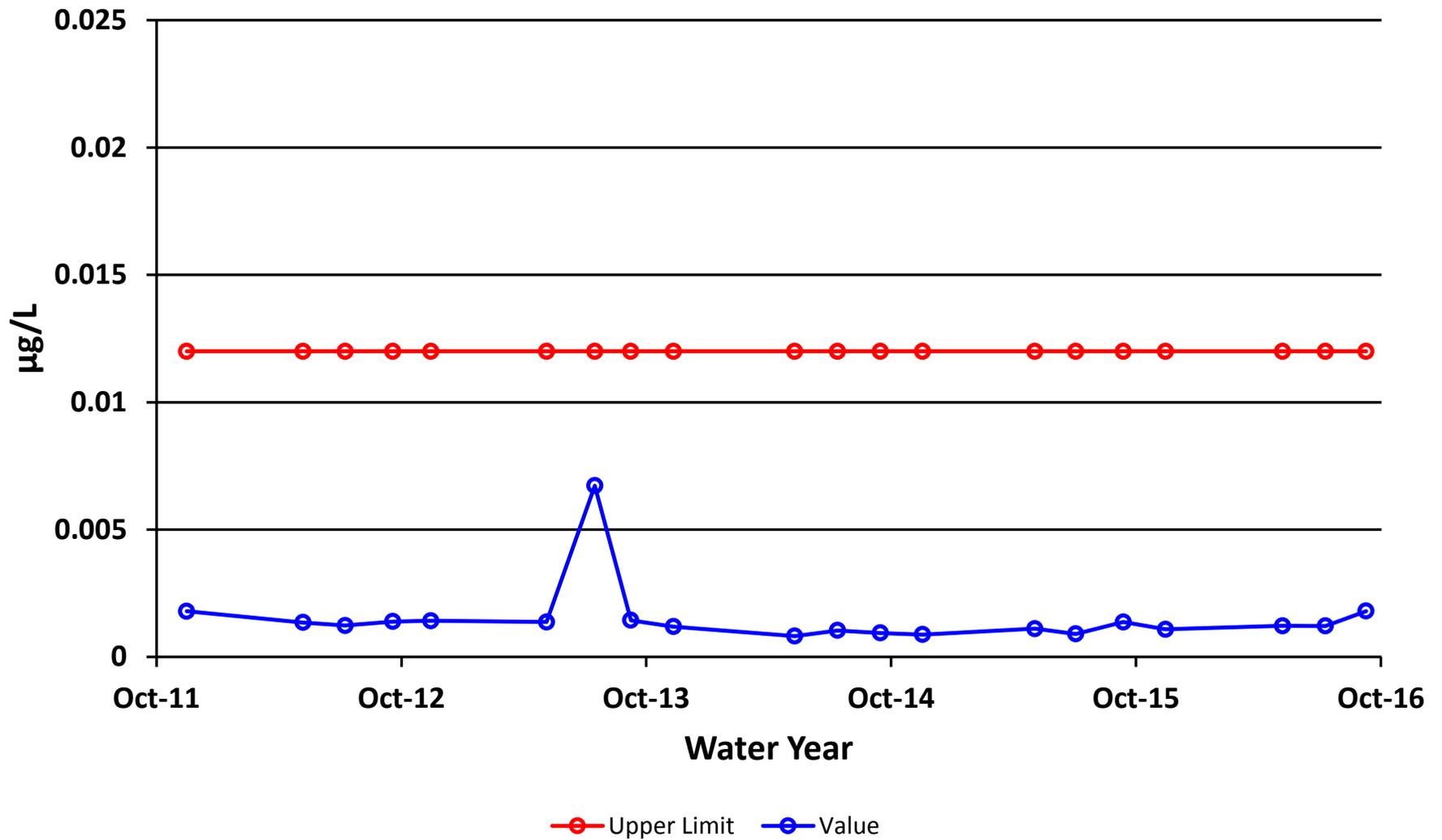
# Site 32 - Zinc Dissolved



## Site 32 - Selenium Dissolved



## Site 32 - Mercury Dissolved



## INTERPRETIVE REPORT SITE 9

The Tributary Creek site was initially chosen to monitor the effects on water quality caused by the originally planned, larger slurry tailings impoundment. It is approximately one mile downstream from the present dry stack tailings site. The site was monitored from 1981 – 1993 when it was temporarily suspended by administrative agreement with the USFS. The site was re-activated in 2001 as a biological monitoring site for the Tailings Pile. HGCMC recommenced collection of water chemistry samples after receiving a suggestion to do so from ADNR personnel. It was noted that should the required annual biomonitoring show significant changes, an understanding of any related water chemistry variations would enhance the interpretation of those results.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

Routine water chemistry data collection was reinstated May 2006. All data collected at the site since then are included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. One results exceeding these criteria has been identified, and is listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
12-Sep-16	Alkalinity	15.3 mg/L	20		33.5 mg/L

X-Y plots have been generated to graphically present the data for each of the analytes that are listed in Suite Q. Total alkalinity has a slight increasing visual trend starting in Water Year 2013.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following

table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016). There were two statistically significant ( $\alpha/2=2.5\%$ ) trends identified for the current water year. Trend analysis revealed statistically significant trends in total alkalinity and dissolved zinc. Total alkalinity has a positive slope of 2.2 mg/L/yr and dissolved zinc has a negative slope of 0.69  $\mu\text{g/L/yr}$  (similar to Water Year 2015 value of -0.58  $\mu\text{g/L/yr}$ ).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.60			
pH Field	6	0.80			
Alkalinity, Total	6	0.99	+	2.2	12.2
Sulfate, Total	6	0.36			
Zinc, Dissolved	6	<0.01	-	-0.69	-12

\* Number of Years \*\* Significance level

HGCMC continues to monitor Site 9 during May, July, September, and November for the Suite Q analytes. This sampling is in addition to the already scheduled July biomonitoring. HGCMC feels that this schedule will continue to adequately characterize the water quality parameters, while addressing safety concerns associated with winter access down the steep slope that leads to the site and the increased potential for bear encounters during salmon spawning season.

## Table of Results for Water Year 2016

### Site 009FMS - 'Lower Tributary Creek'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		2.4						7.7		14.8		10	8.9
Conductivity-Field(µmho)		100.8						101.9		88.1		84.8	94.5
Conductivity-Lab (µmho)		92						97		90		84	91
pH Lab (standard units)		7.31						6.88		7.01		6.79	6.95
pH Field (standard units)		7.07						7.15		*		6.79	7.07
Total Alkalinity (mg/L)		27.9						27.8		35.1		15.3	27.9
Total Sulfate (mg/L)		16						18.2		8		16.8	16.4
Hardness (mg/L)		44.5						42.4		41.4		33.5	41.9
Dissolved As (ug/L)		0.799						0.724		1.44		1.13	0.965
Dissolved Ba (ug/L)		38.1						47.1		50.3		55.5	48.7
Dissolved Cd (ug/L)		0.024						0.0222		0.041		0.0416	0.0325
Dissolved Cr (ug/L)		0.481						0.454		0.681		0.619	0.550
Dissolved Cu (ug/L)		1.29						1.34		1.96		2	1.650
Dissolved Pb (ug/L)		0.365						0.396		0.74		0.544	0.470
Dissolved Ni (ug/L)		1.84						1.53		2.99		2.51	2.175
Dissolved Ag (ug/L)		0.006						0.006		0.015		0.013	0.010
Dissolved Zn (ug/L)		3.42						3.22		4.27		5.96	3.85
Dissolved Se (ug/L)		0.162						0.146		0.2		0.18	0.171
Dissolved Hg (ug/L)		0.0031						0.0033		0.0042		0.005	0.0038

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

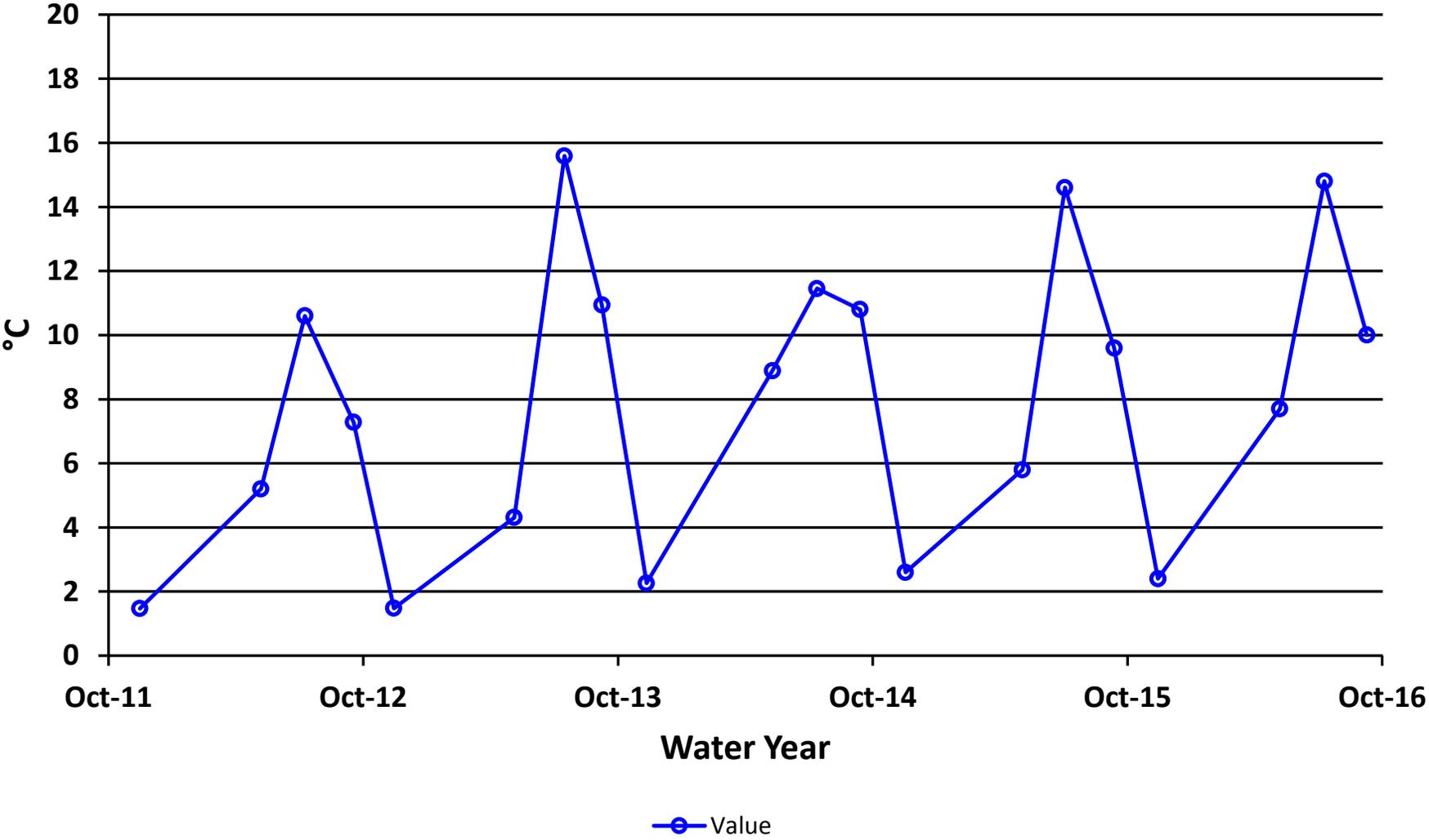
## Qualified Data by QA Reviewer

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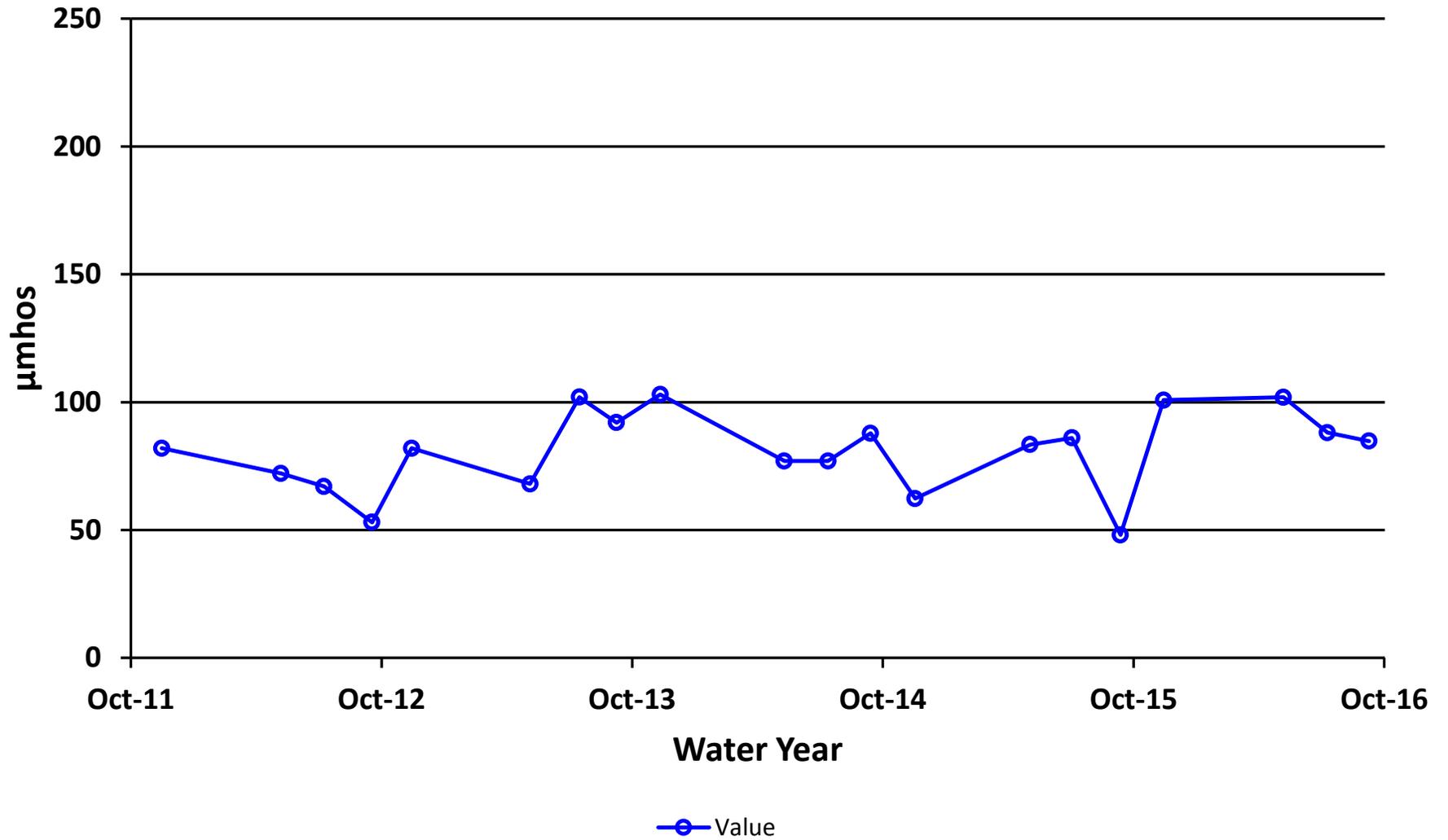
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
009FMS	11/17/2015	12:00 PM	Diss. Ag-ICP/MS	0.00602	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.16	µg/L	J	Below Quantitative Range
	7/13/2016	12:00 PM	Diss. Se-ICP/MS	0.2	µg/L	J	Below Quantitative Range
			Sulfate	8.01	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Se-ICP/MS	0.18	µg/L	J	Below Quantitative Range
			Sulfate	16.8	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

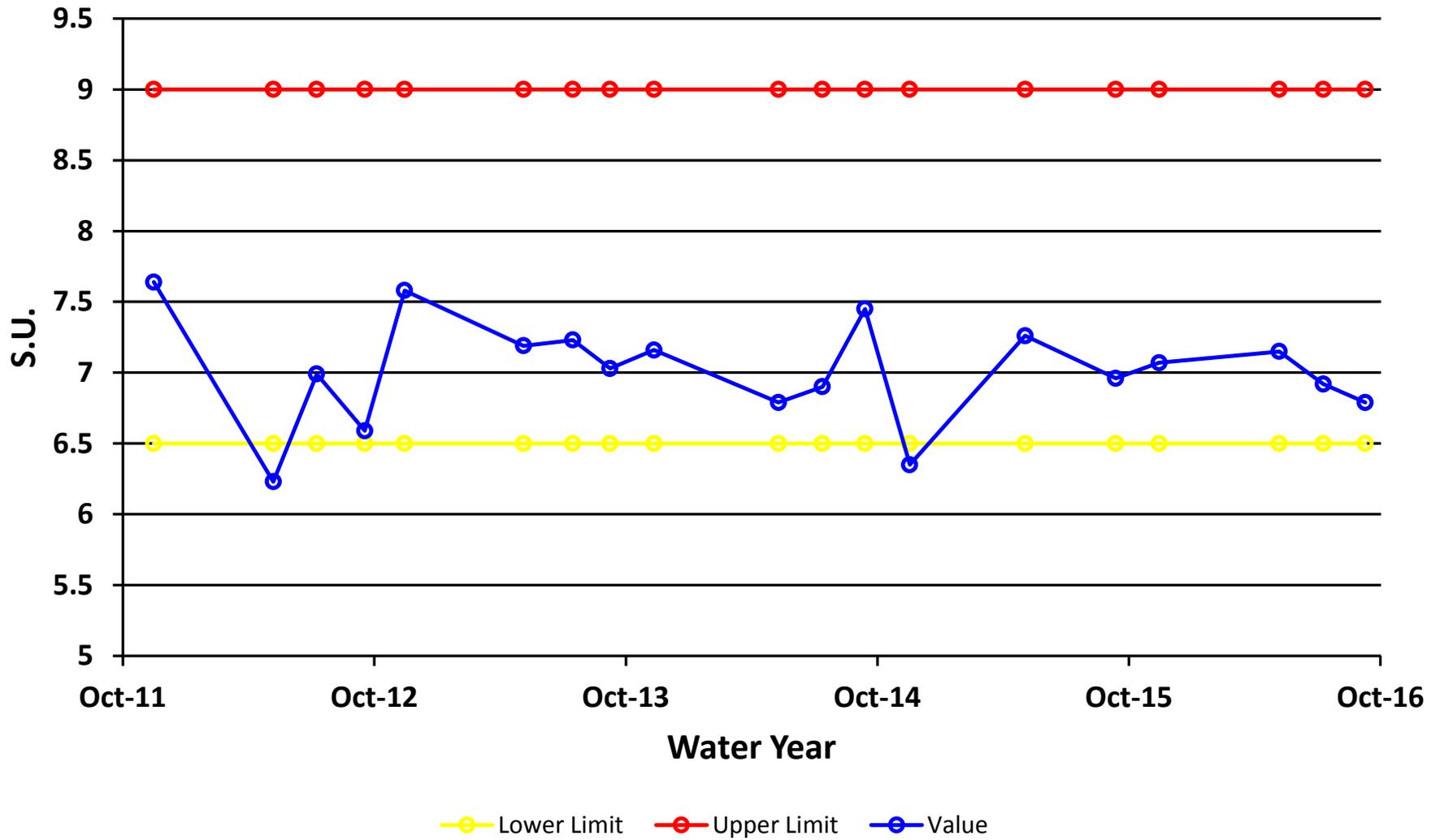
# Site 9 - Water Temperature



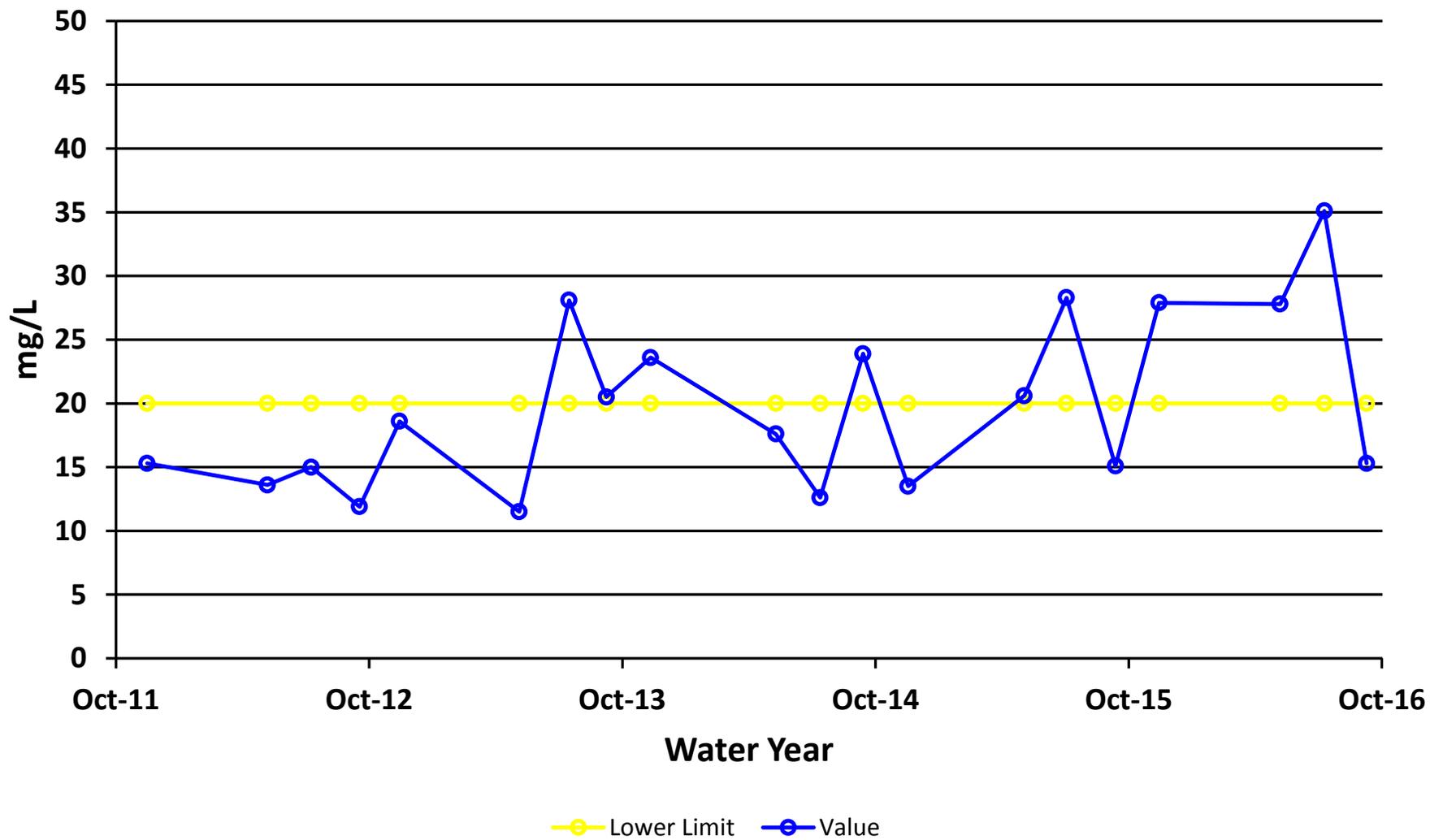
## Site 9 - Conductivity Field



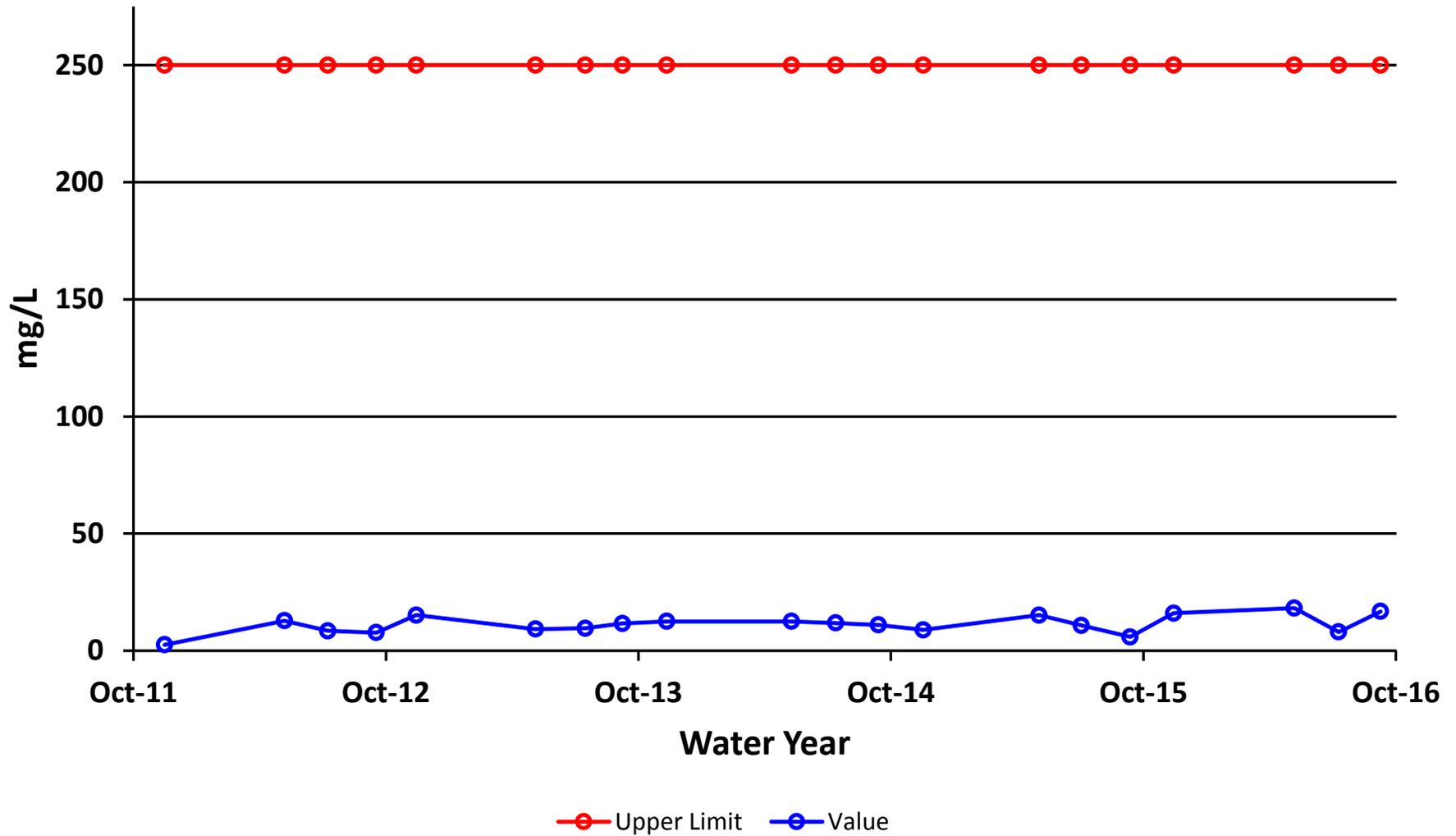
# Site 9 - pH Field



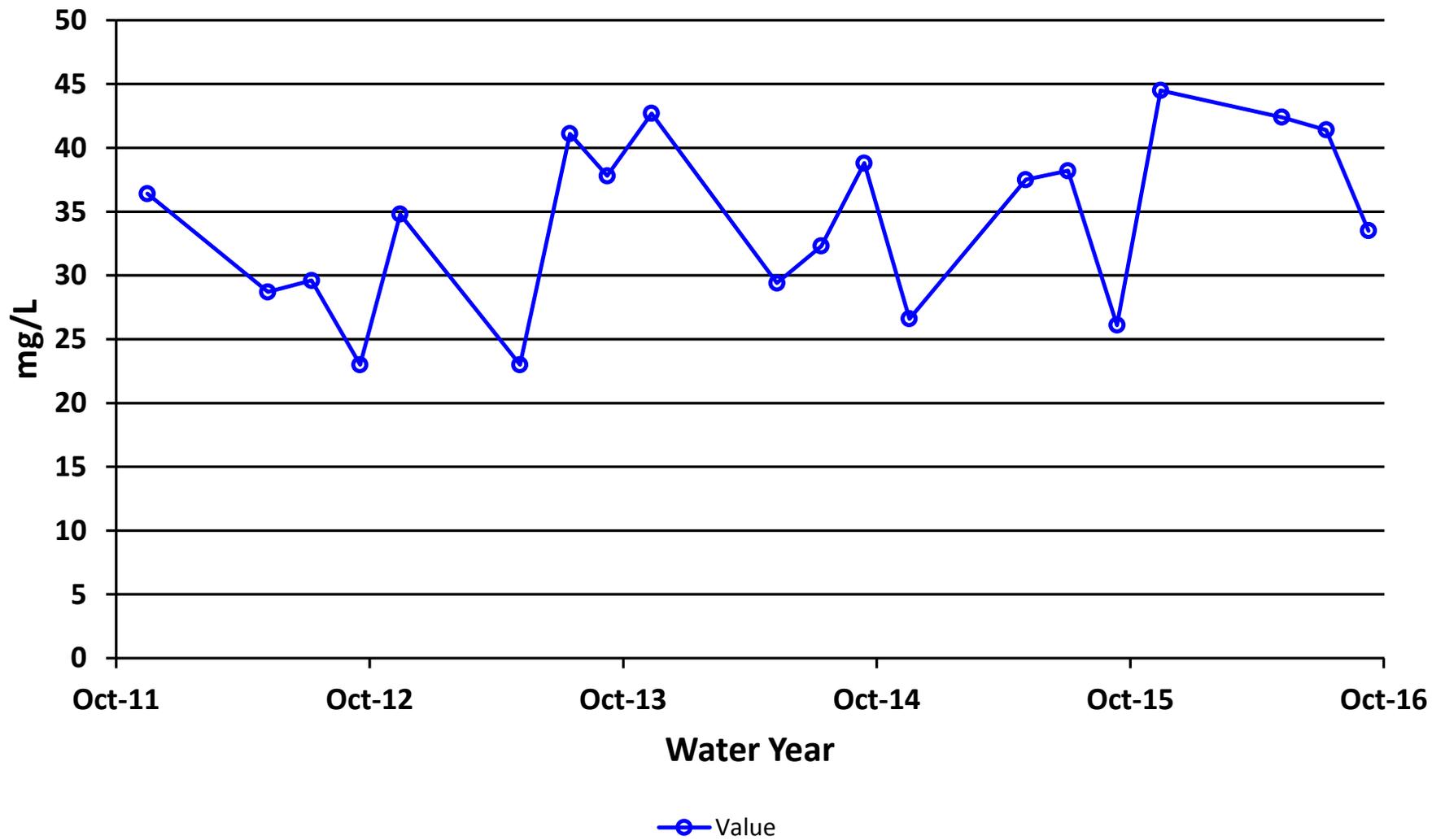
# Site 9 - Alkalinity



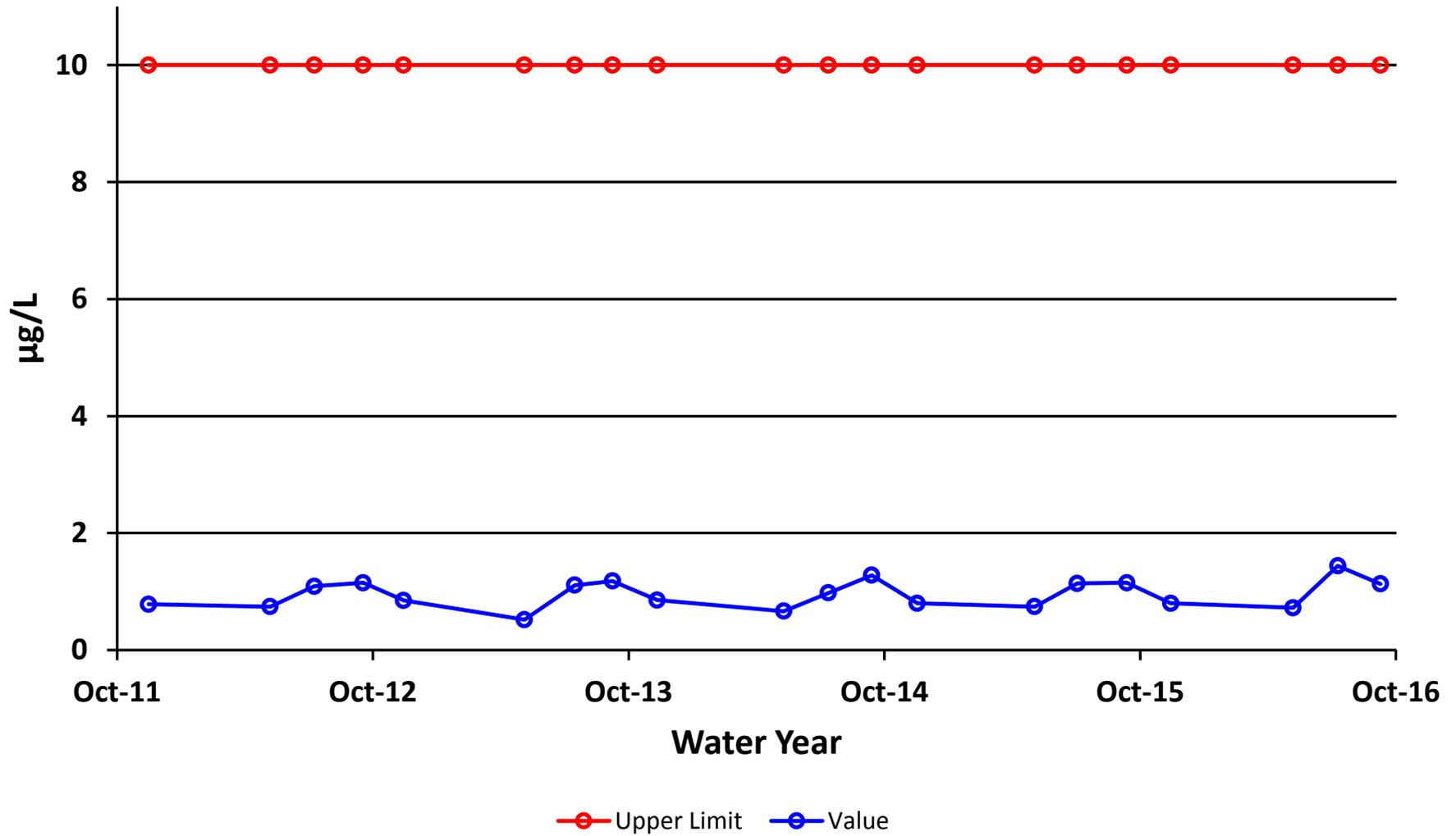
# Site 9 - Sulfate



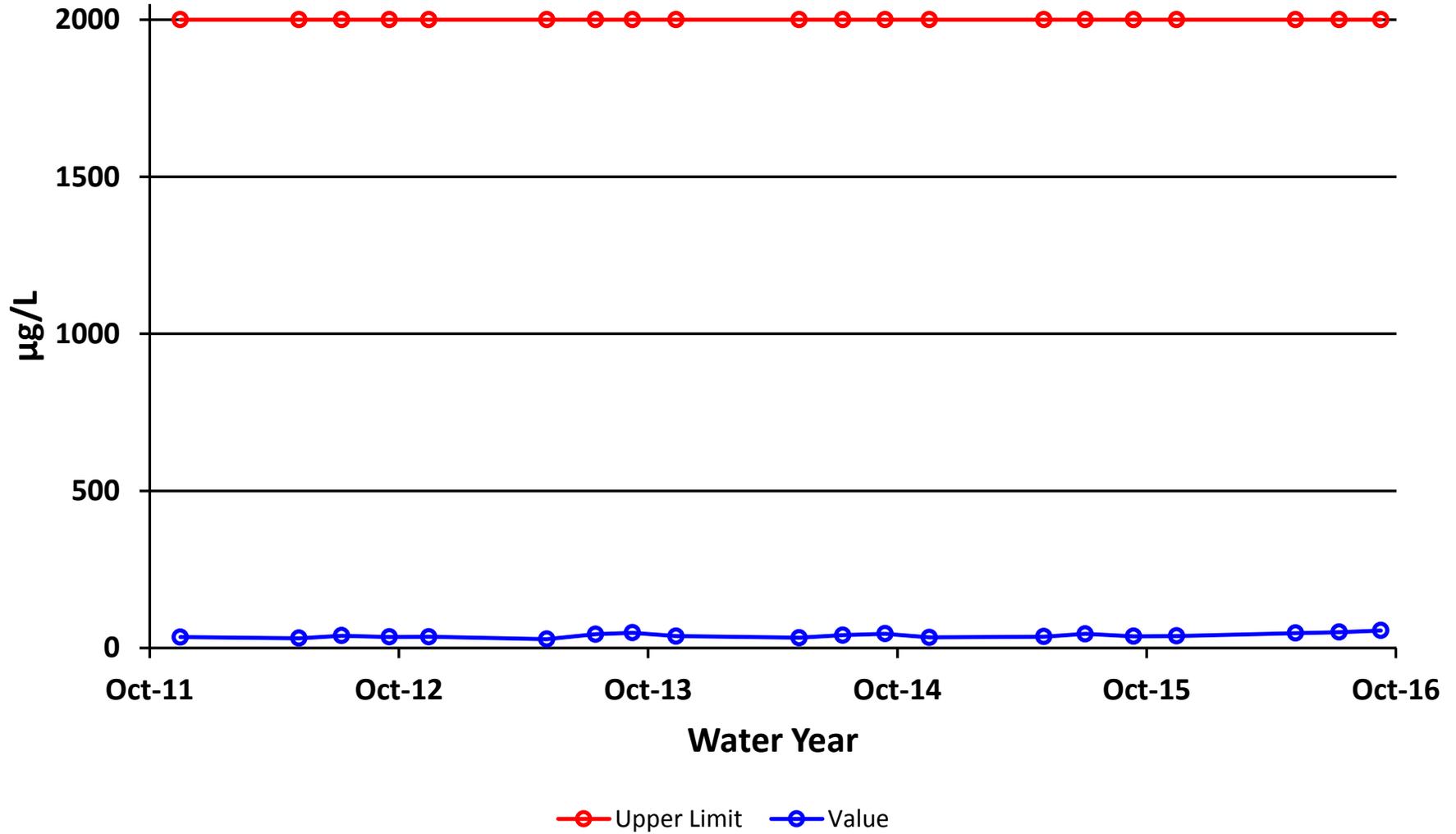
## Site 9 - Hardness



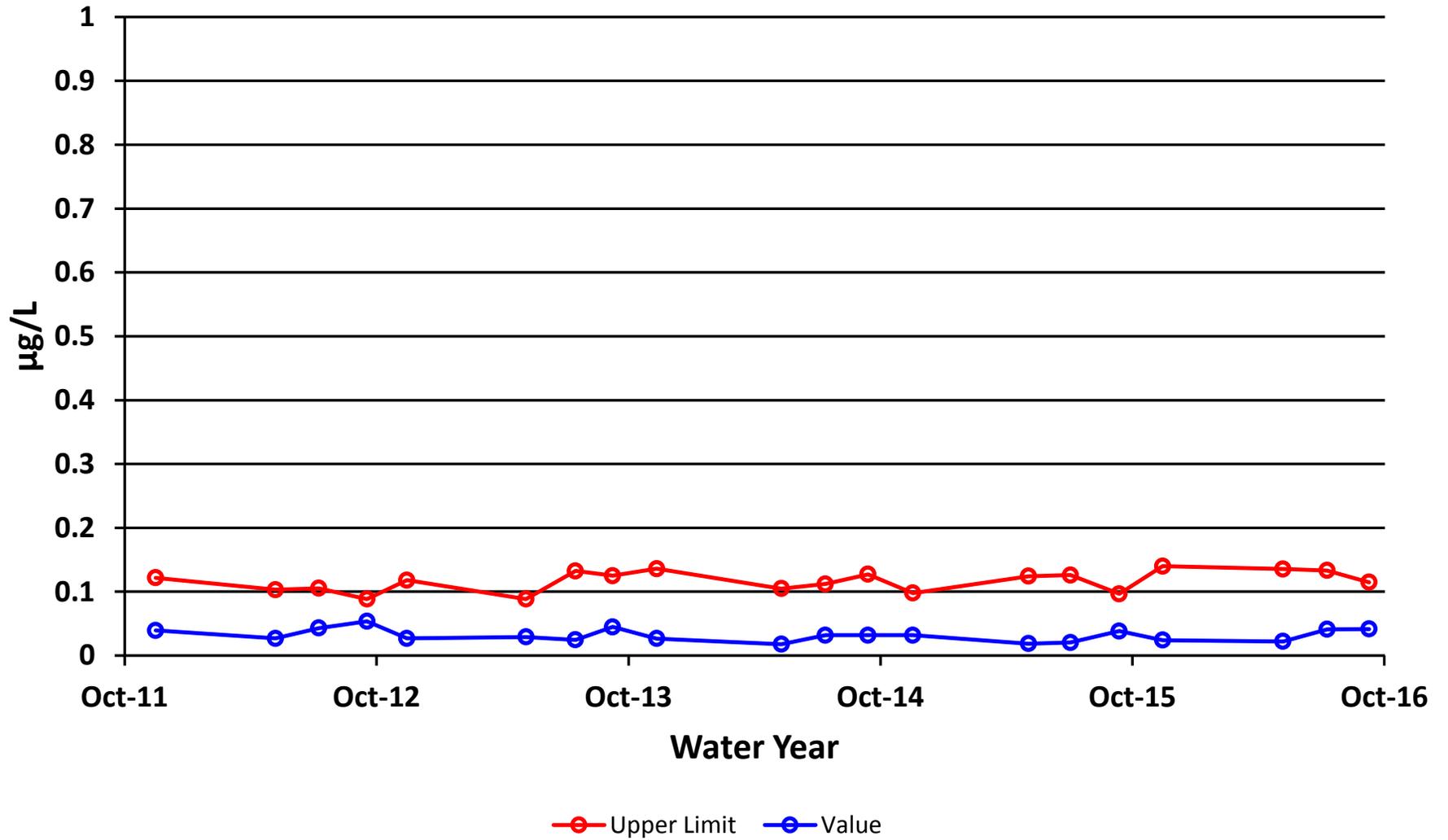
# Site 9 - Arsenic Dissolved



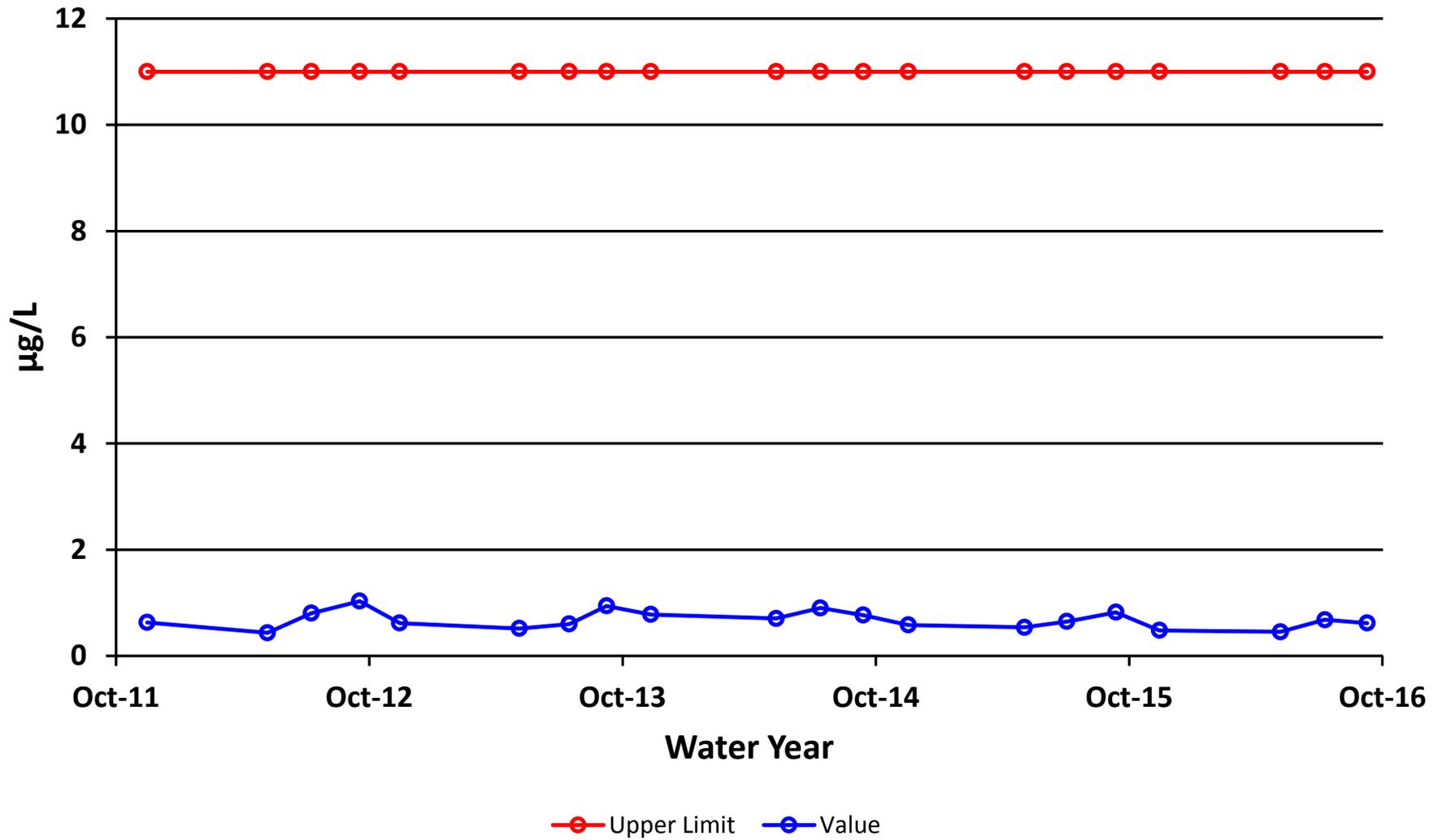
# Site 9 - Barium Dissolved



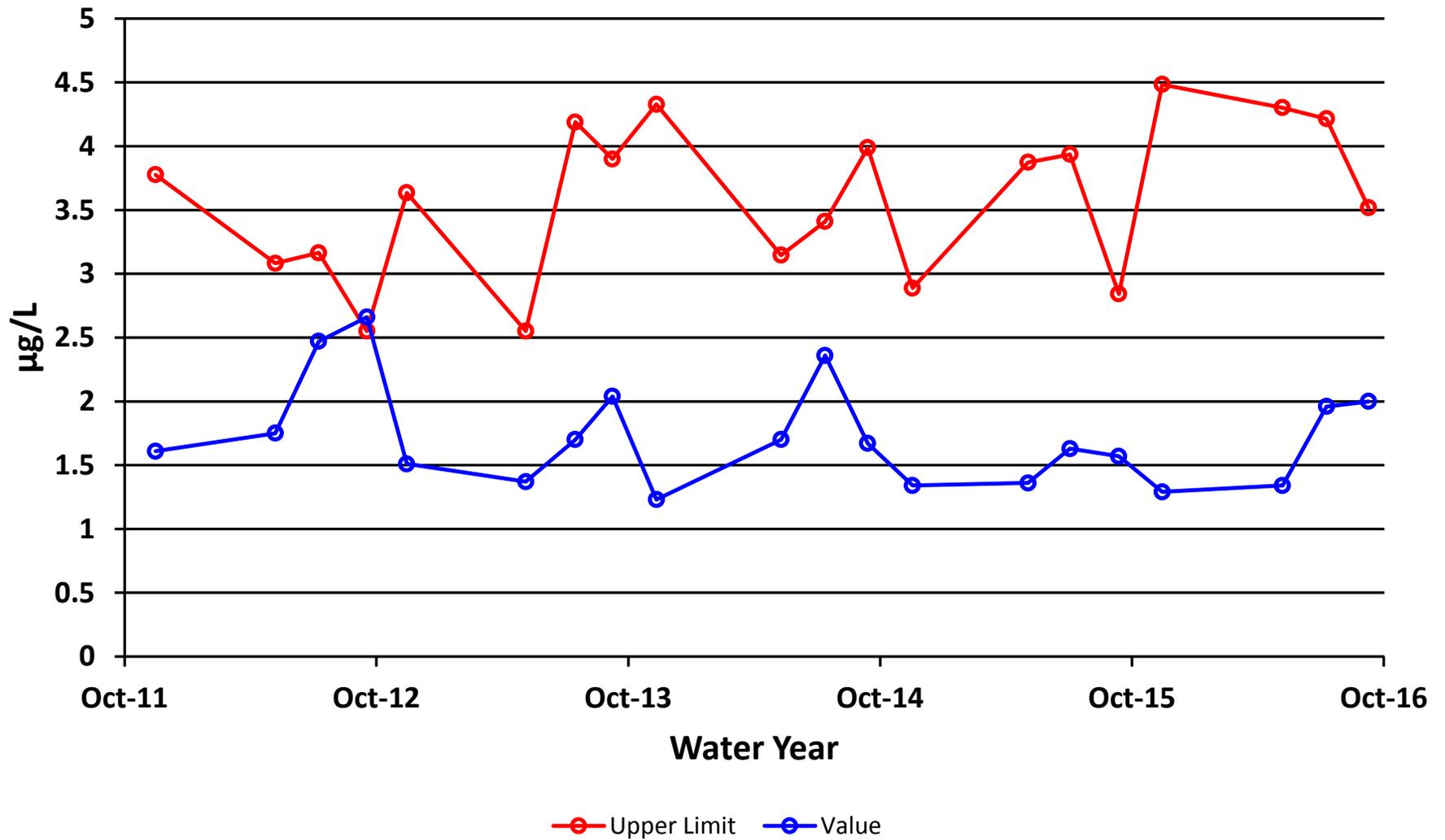
## Site 9 - Cadmium Dissolved



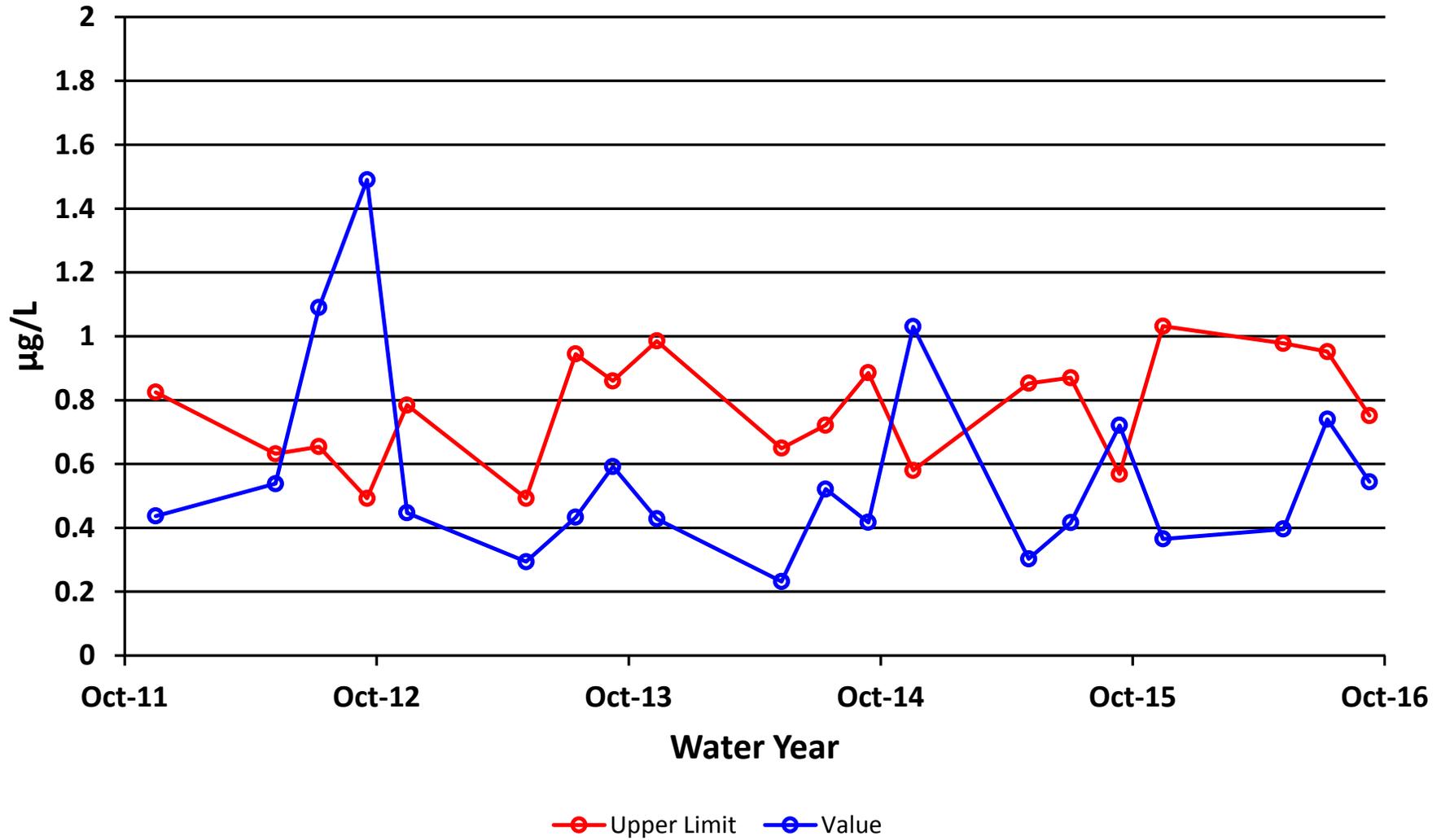
## Site 9 - Chromium Dissolved



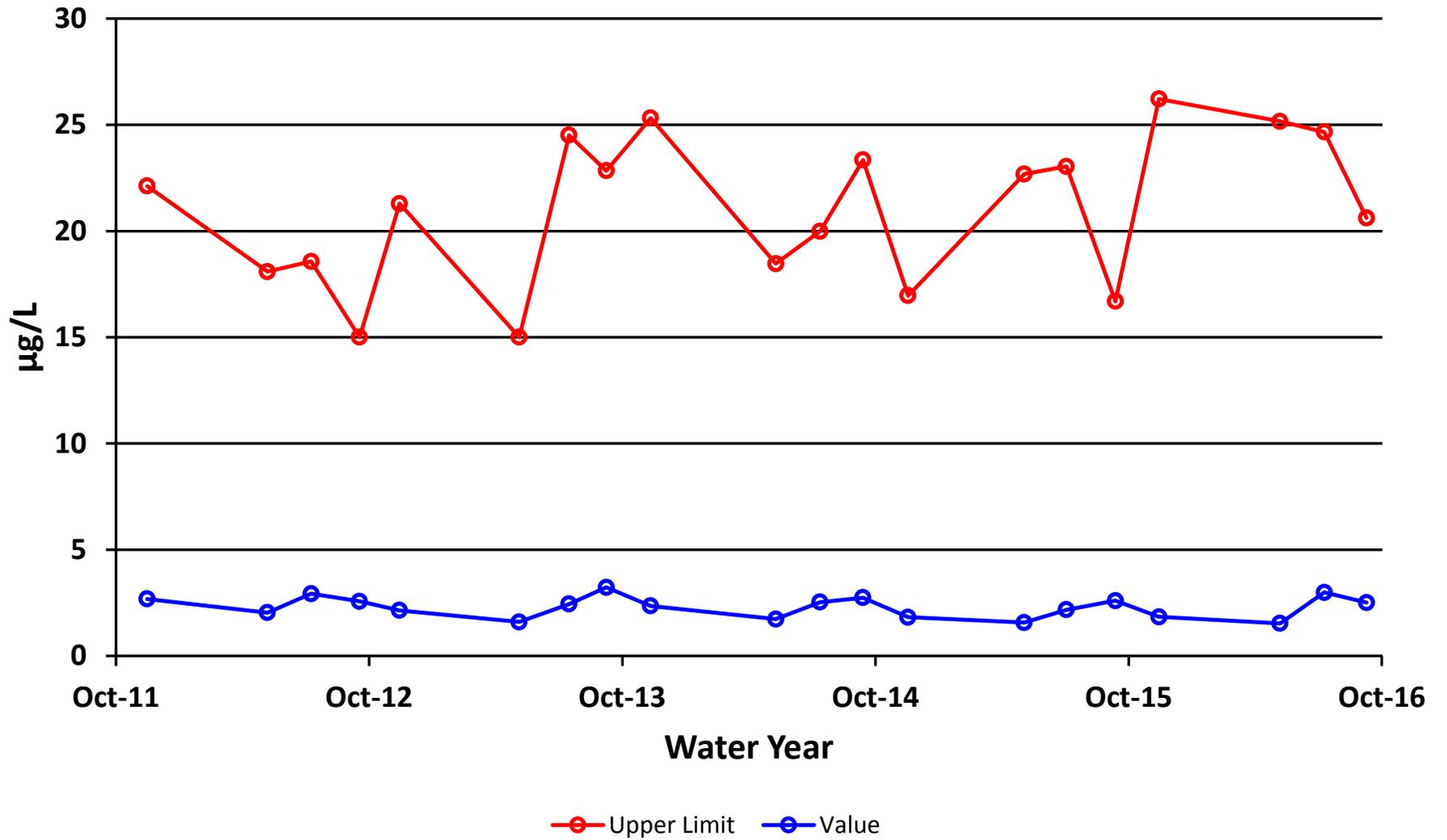
# Site 9 - Copper Dissolved



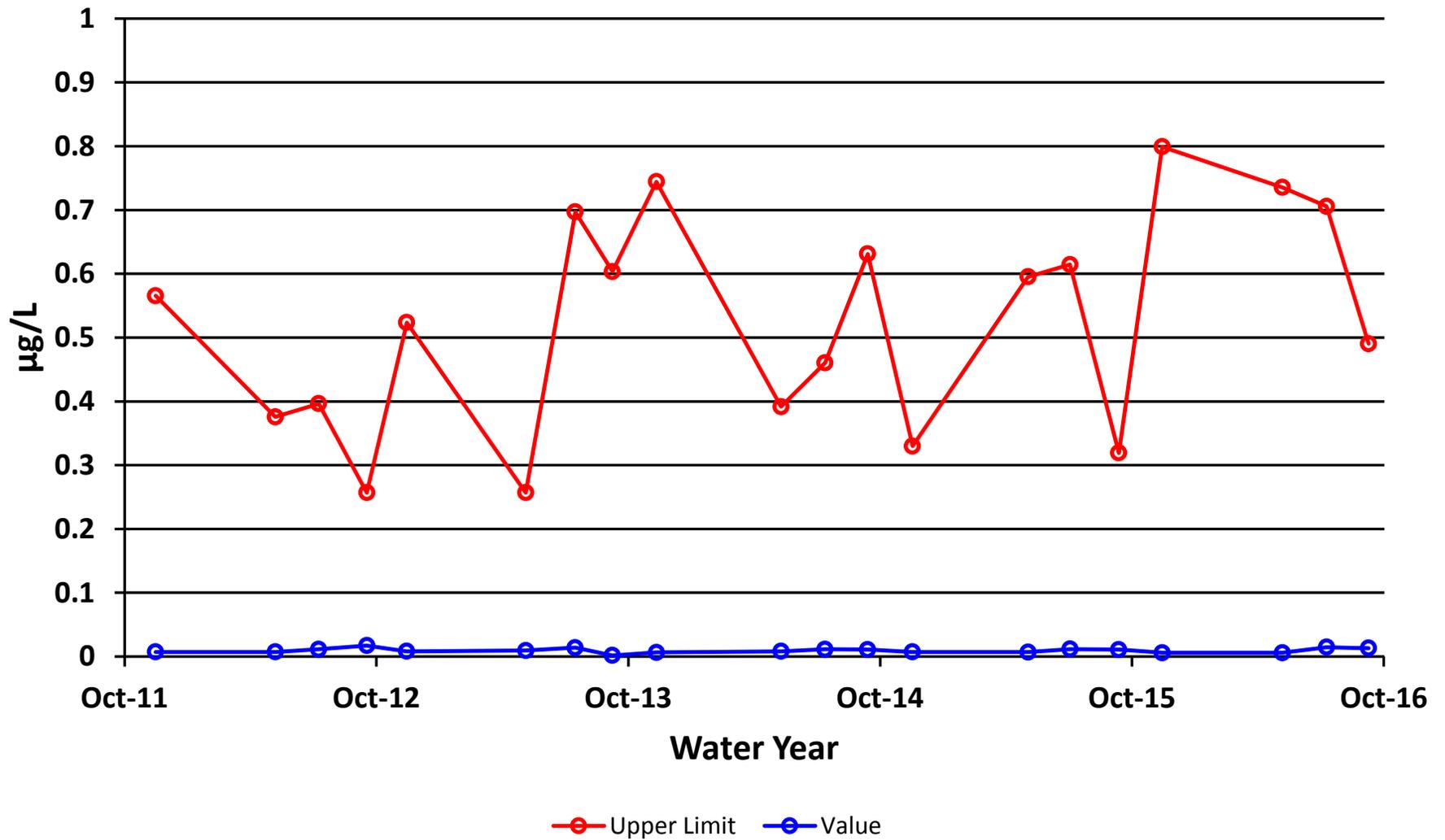
# Site 9 - Lead Dissolved



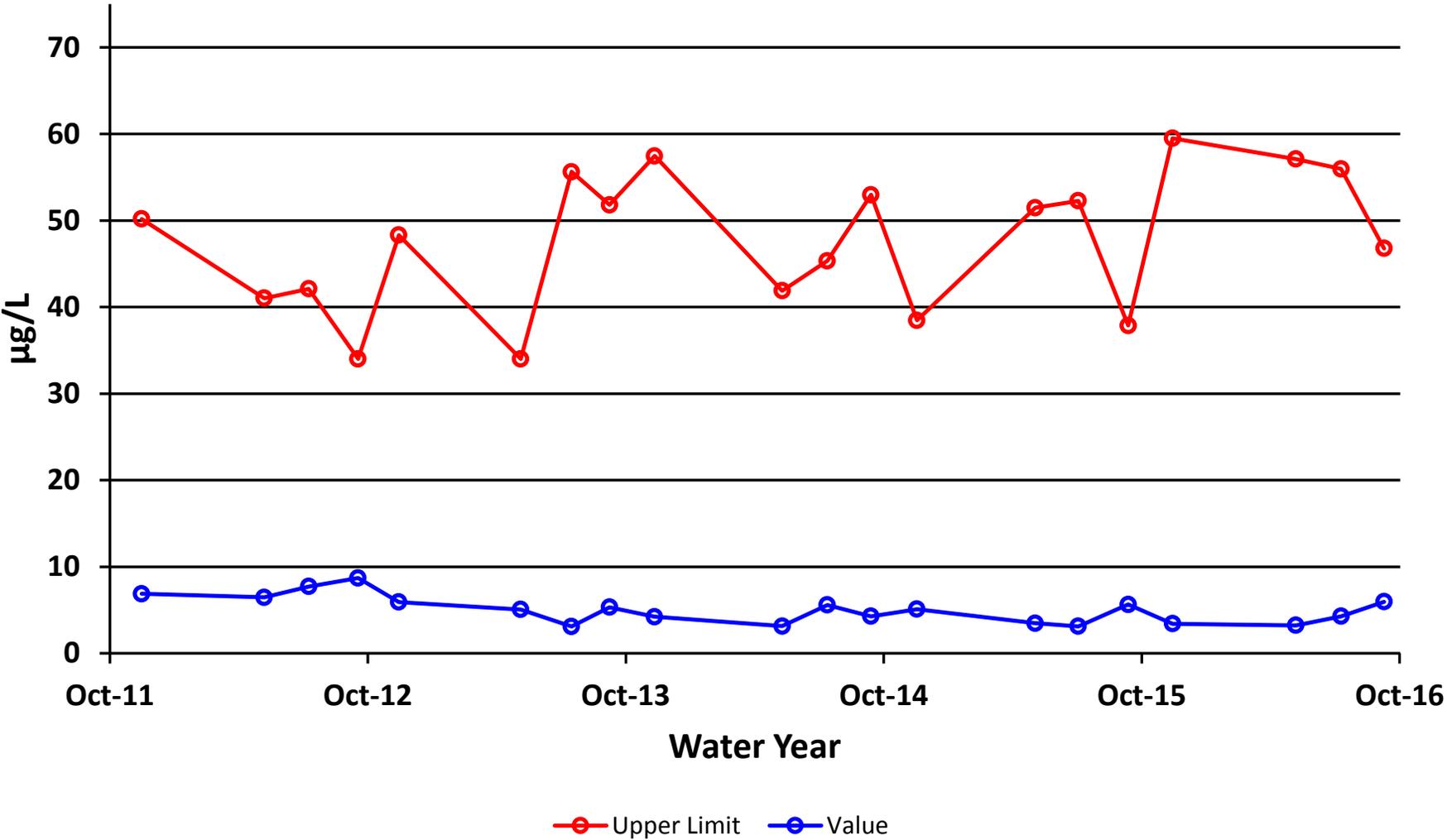
### Site 9 - Nickel Dissolved



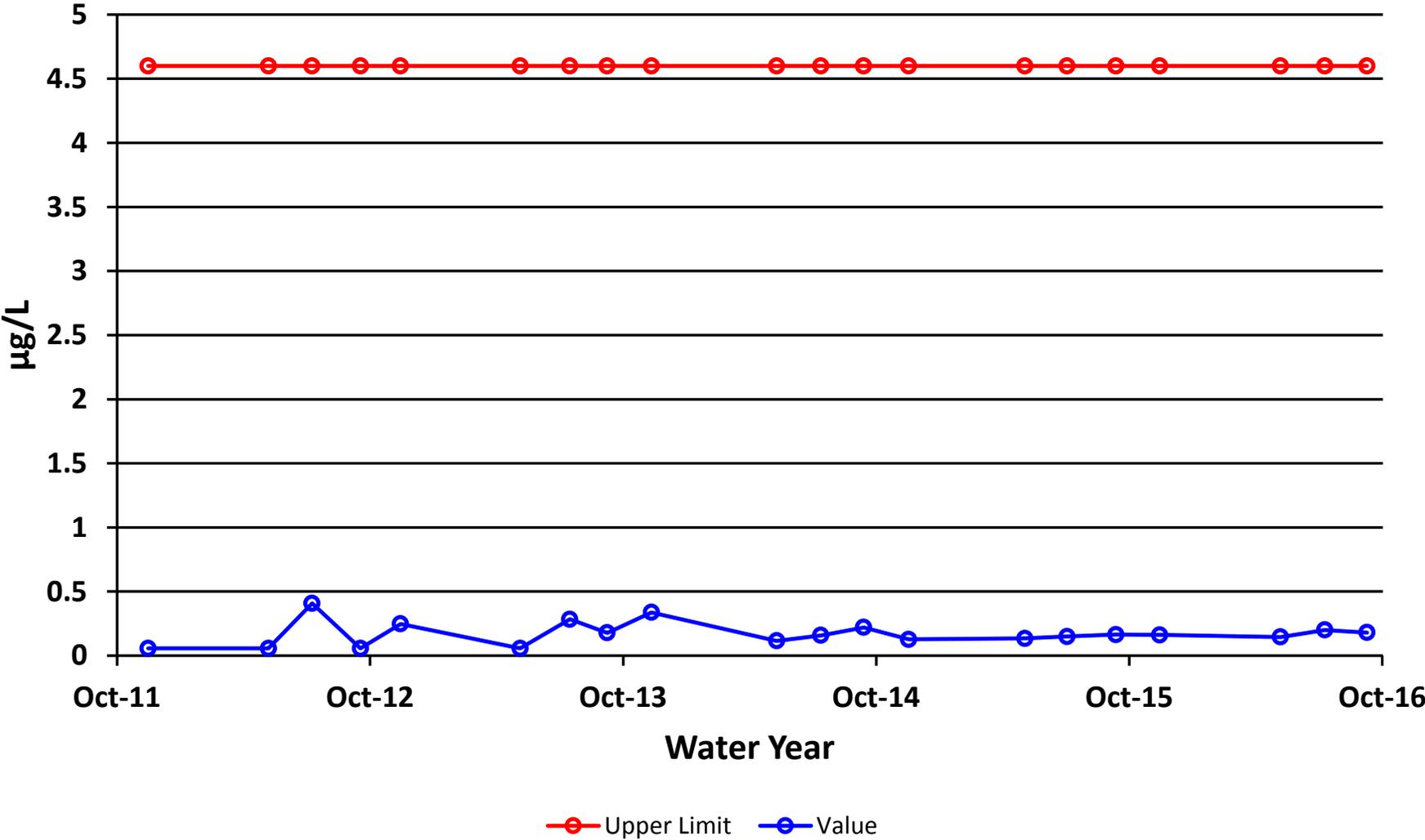
### Site 9 - Silver Dissolved



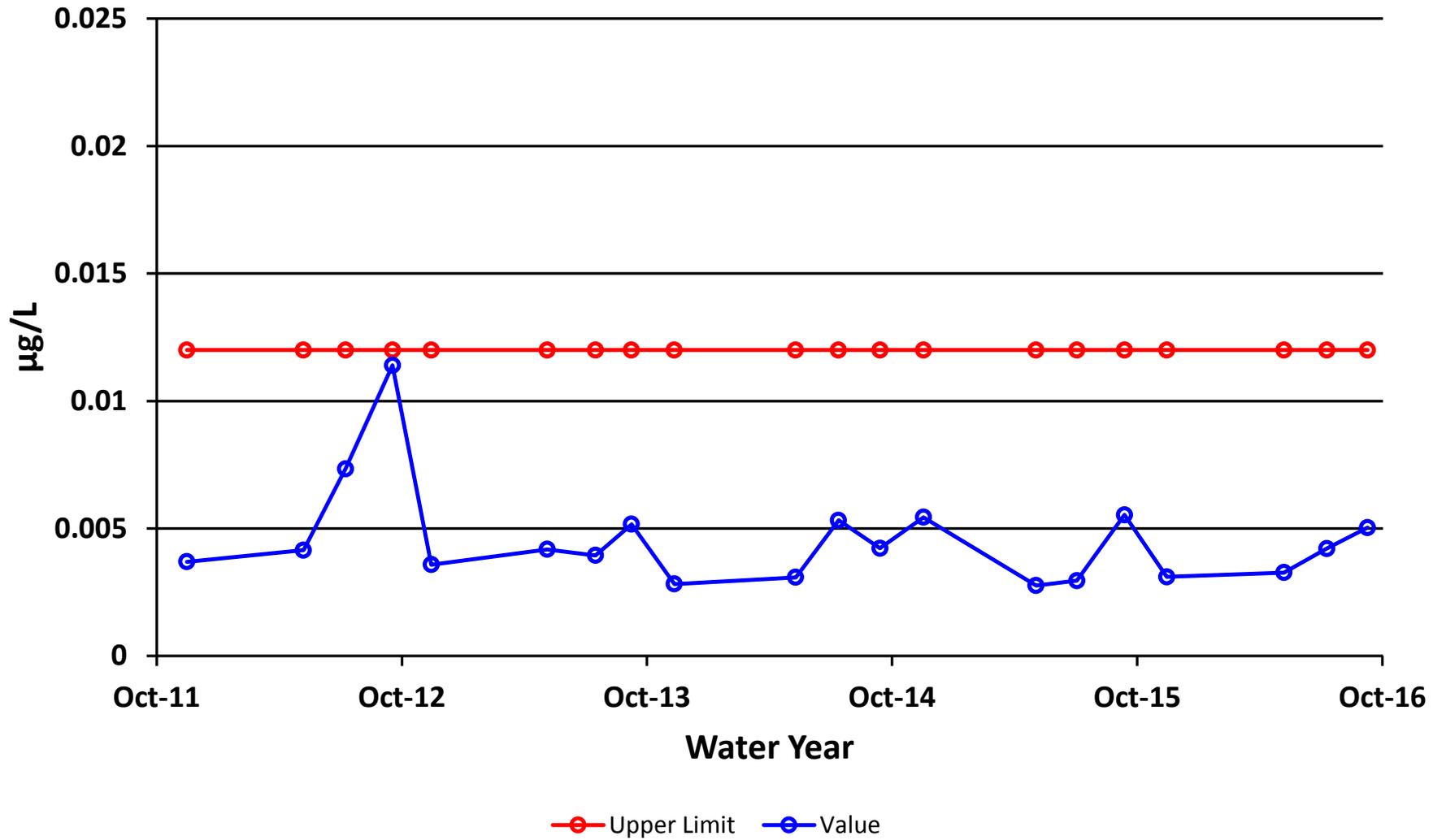
# Site 9 - Zinc Dissolved



# Site 9 - Selenium Dissolved



# Site 9 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 60

Sampling at this site was initiated during background investigations conducted by HGCMC for the Stage II Tailings EIS. The two sampling events that occurred in 2003 were submitted to Analytica Alaska Laboratories for analysis and subject to standard QAQC procedures. The detection limits achieved during this analysis were slightly higher for some analytes than are currently achieved under FWMP sampling protocols. The two sample events that occurred in the 2006 water year were analyzed in parallel with standard FWMP samples and thus subject to the same analytical procedures.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

Both ADEC and the USFS requested during the WY2006 annual meeting that an additional monitoring point be added to monitor potential impacts from Pond 7 on the western downgradient drainage. Greens Creek proposed the current site and after review by ADEC and USFS during a site visit (June 2, 2007 – USFS Inspection #259) the new site was added to the routine monitoring schedule.

As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers, in the past six years, have been identified by HGCMC.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. Six results exceeding these criteria have been identified, as listed in the table below. Two of the exceedances were for field pH, for three of the four sampling events total alkalinity was in exceedance at Site 60, however these values are similar to those recorded prior to disturbance activities. The remaining two exceedances were for dissolved mercury, see discussion below.

**Table of Exceedance for Water Year 2016**

Sample Date	Parameter	Value	Limits		Hardness
			Lower	Upper	
17-Nov-15	Alkalinity	14.9 mg/L	20		27.4 mg/L
10-May-16	Alkalinity	17.5 mg/L	20		30.5 mg/L
12-Sep-16	Alkalinity	10.0 mg/L	20		27.2 mg/L
13-Jul-16	Mercury Dissolved	0.016 µg/L		0.012	41.4 mg/L
12-Sep-16	Mercury Dissolved	0.013 µg/L		0.012	27.2 mg/L
17-Nov-15	pH Field	6.2 su	6.5	9	27.4 mg/L

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Site 60 was added to the FWMP as a monitoring point for potential impacts from Pond 7. There appears to be no obvious visual trends.

Dissolved mercury levels have been elevated slightly above the AWQS of 0.012 µg/L, intermittently for the past few years. Following construction of Pond 7, the alkalinity and pH at Site 60 increased, likely as a result of fill material that was placed in the drainage area during pond construction. HGCMC believes that the increase in pH and alkalinity increases the potential for adsorption of mercury on sediments and soil particles in the drainage. The pH of the Site 60 drainage now fluctuates seasonally and from year to year and may control the storage and release of mercury from the adsorbed fraction. Dissolution of tailings dust particles, which contain small amounts of mercury, and atmospheric deposition of mercury from natural (e.g. volcanoes) and anthropogenic sources (e.g. coal fired power plants in Asia) are potential sources of this metal in the drainage area. Additional sampling in adjacent drainages during water year 2009 and Water Year 2012 showed that this issue was isolated to only the Site 60 watershed.

A non-parametric statistical analysis for trend was performed for specific conductivity, field pH, total alkalinity, total sulfate, and dissolved zinc. Calculation details of the Seasonal Kendall analyses are presented in detail on the pages following this interpretive section. The following table summarizes the results on the data collected between Oct-10 and Sep-16 (WY2011-WY2016).

**Table of Summary Statistics for Trend Analysis**

Parameter	Mann-Kendall test statistics			Sen's slope estimate	
	n*	p**	Trend	Q	Q(%)
Conductivity Field	6	0.64			
pH Field	6	0.87			
Alkalinity, Total	6	1.00	+	1.38	13.6
Sulfate, Total	6	0.99	+	0.64	61.4
Zinc, Dissolved	6	0.50			

\* Number of Years \*\* Significance level

A statistically significant ( $\alpha/2=2.5\%$ ) trend was identified for the current water year, associated with an increasing trend in total sulfate with a Sen's slope estimate of 0.64 mg/L/yr, sulfate values were approximately 4% of the AWQS. Another increasing trend was identified for total alkalinity with a Sen's slope estimate of 0.64 mg/L/yr. HGCMC feels that the current sampling schedule adequately characterizes the water quality parameters at this site.

## Table of Results for Water Year 2016

### Site 060FMS - 'Lower Althea creek'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		3.3						7.4		12.3		10.2	8.8
Conductivity-Field(µmho)		50.6						62.1		79.6		54.9	58.5
Conductivity-Lab (µmho)		45						58		79		54	56
pH Lab (standard units)		6.98						6.64		7		6.13	6.81
pH Field (standard units)		6.2						6.87		7.08		6.51	6.69
Total Alkalinity (mg/L)		14.9						17.5		28.6		10	16.2
Total Sulfate (mg/L)		4.5						7		4.9		5.4	5.2
Hardness (mg/L)		27.4						30.5		41.4		27.2	29.0
Dissolved As (ug/L)		2.03						2.01		2.47		3.18	2.250
Dissolved Ba (ug/L)		24.6						27.2		36.1		31.6	29.4
Dissolved Cd (ug/L)		0.0174						0.0158		0.0229		0.0262	0.0202
Dissolved Cr (ug/L)		1.09						0.96		1.36		1.56	1.225
Dissolved Cu (ug/L)		0.862						0.851		0.953		2.08	0.908
Dissolved Pb (ug/L)		0.278						0.259		0.314		0.562	0.2960
Dissolved Ni (ug/L)		1.04						0.945		1.25		1.61	1.145
Dissolved Ag (ug/L)		0.007						0.009		0.015		0.011	0.010
Dissolved Zn (ug/L)		10.2						4.66		4.44		7.75	6.21
Dissolved Se (ug/L)		0.158						0.057		0.222		0.153	0.156
Dissolved Hg (ug/L)		0.0108						0.0115		0.0162		0.0127	0.012100

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

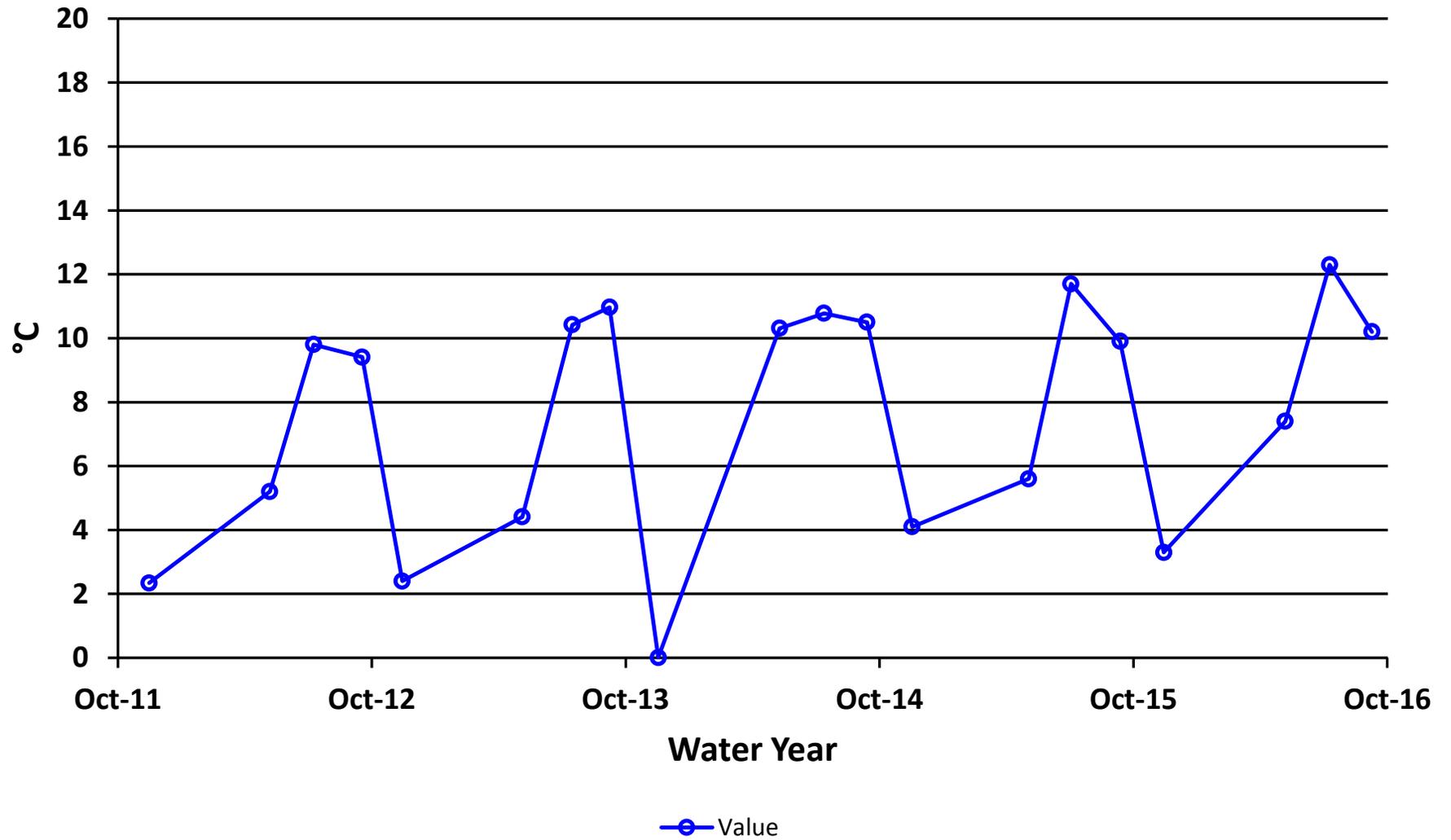
## Qualified Data by QA Reviewer

Date Range: 10/01/2015 to 09/30/2016

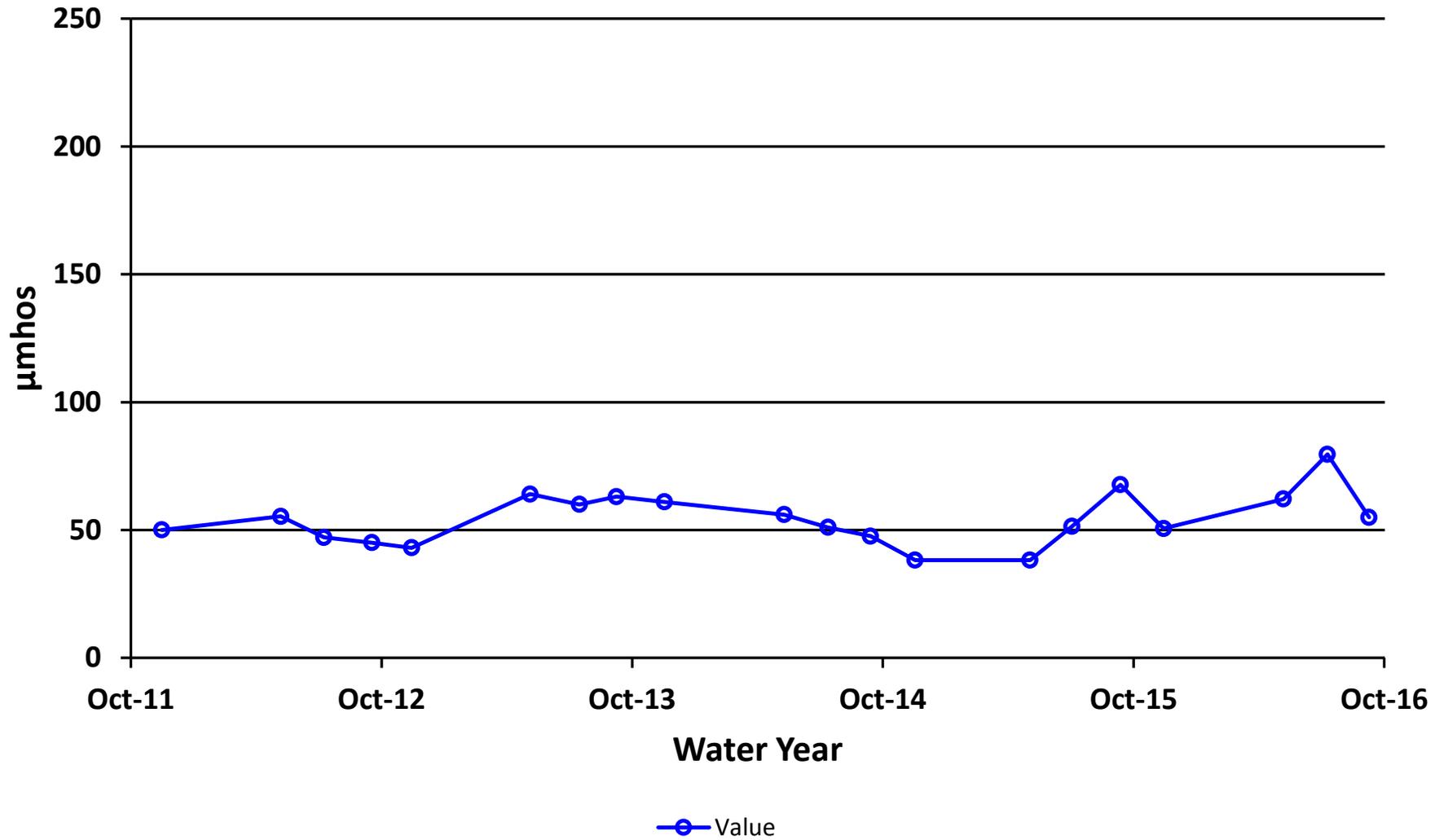
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
060FMS	11/17/2015	12:00 PM	Diss. Ag-ICP/MS	0.00669	µg/L	J	Below Quantitative Range
			Diss. Se-ICP/MS	0.15	µg/L	J	Below Quantitative Range
	7/13/2016	12:00 PM	Diss. Se-ICP/MS	0.22	µg/L	J	Below Quantitative Range
			Sulfate	4.86	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Se-ICP/MS	0.15	µg/L	J	Below Quantitative Range
			Sulfate	5.37	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

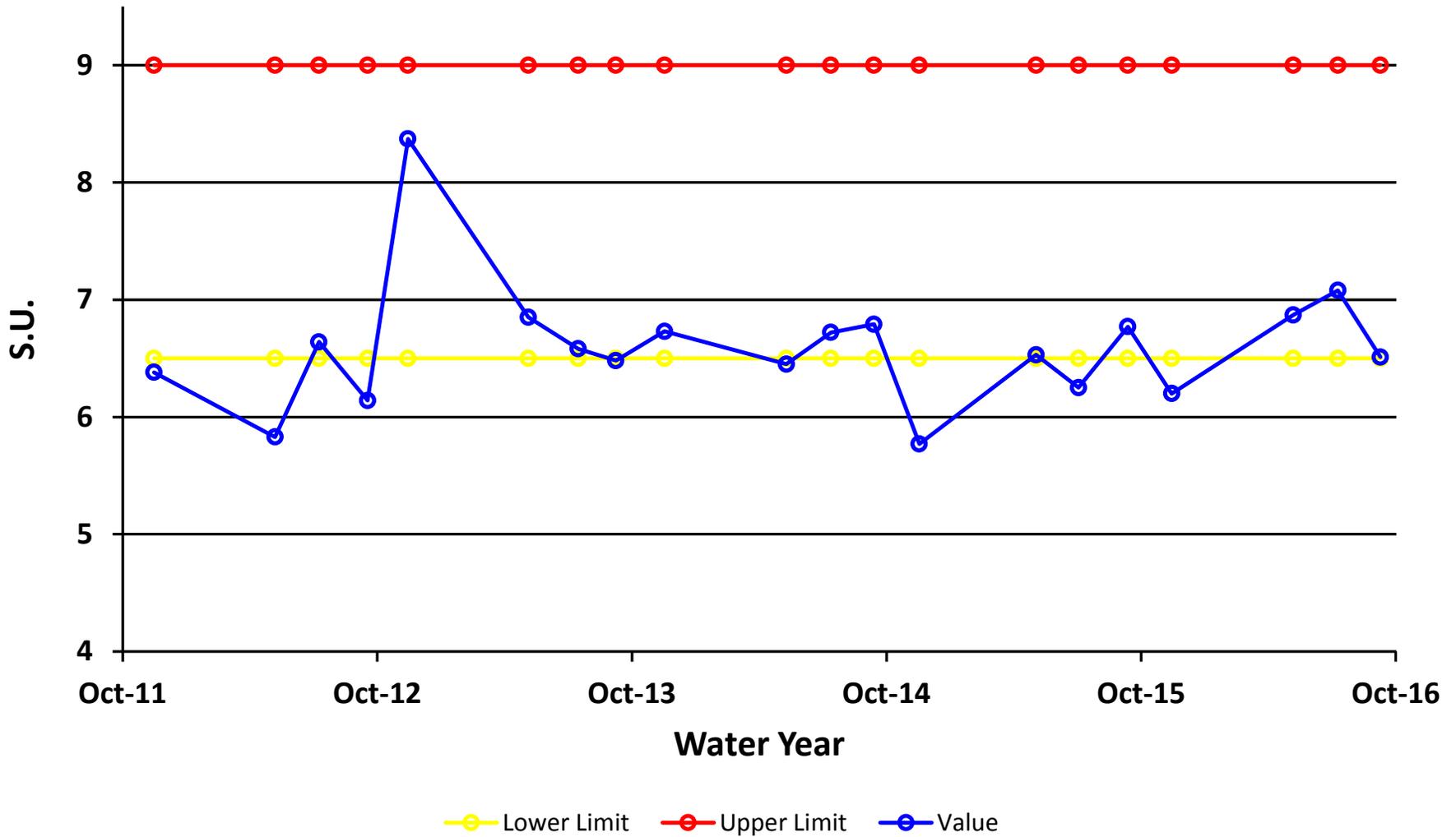
## Site 60 - Water Temperature



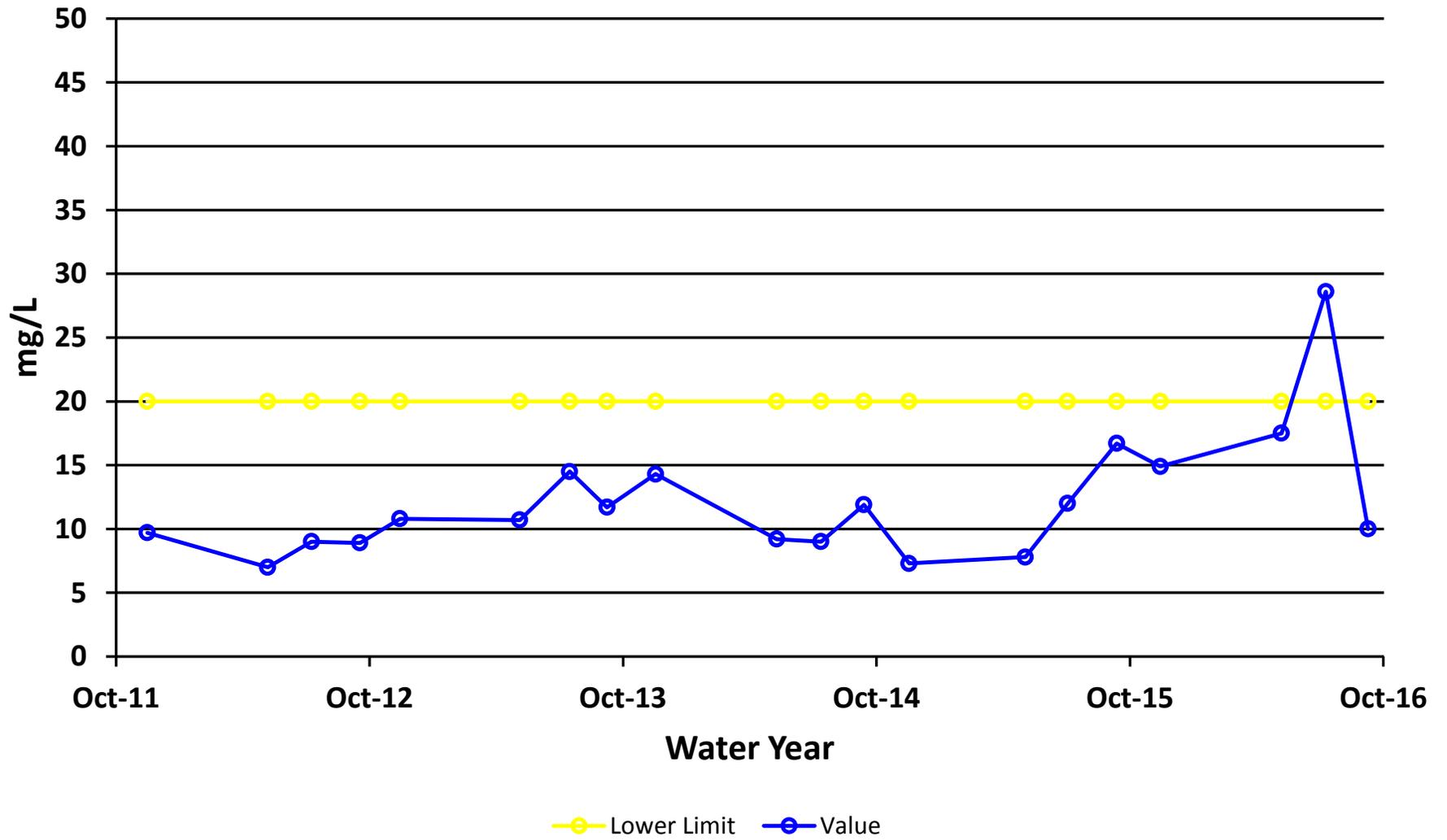
## Site 60 - Conductivity Field



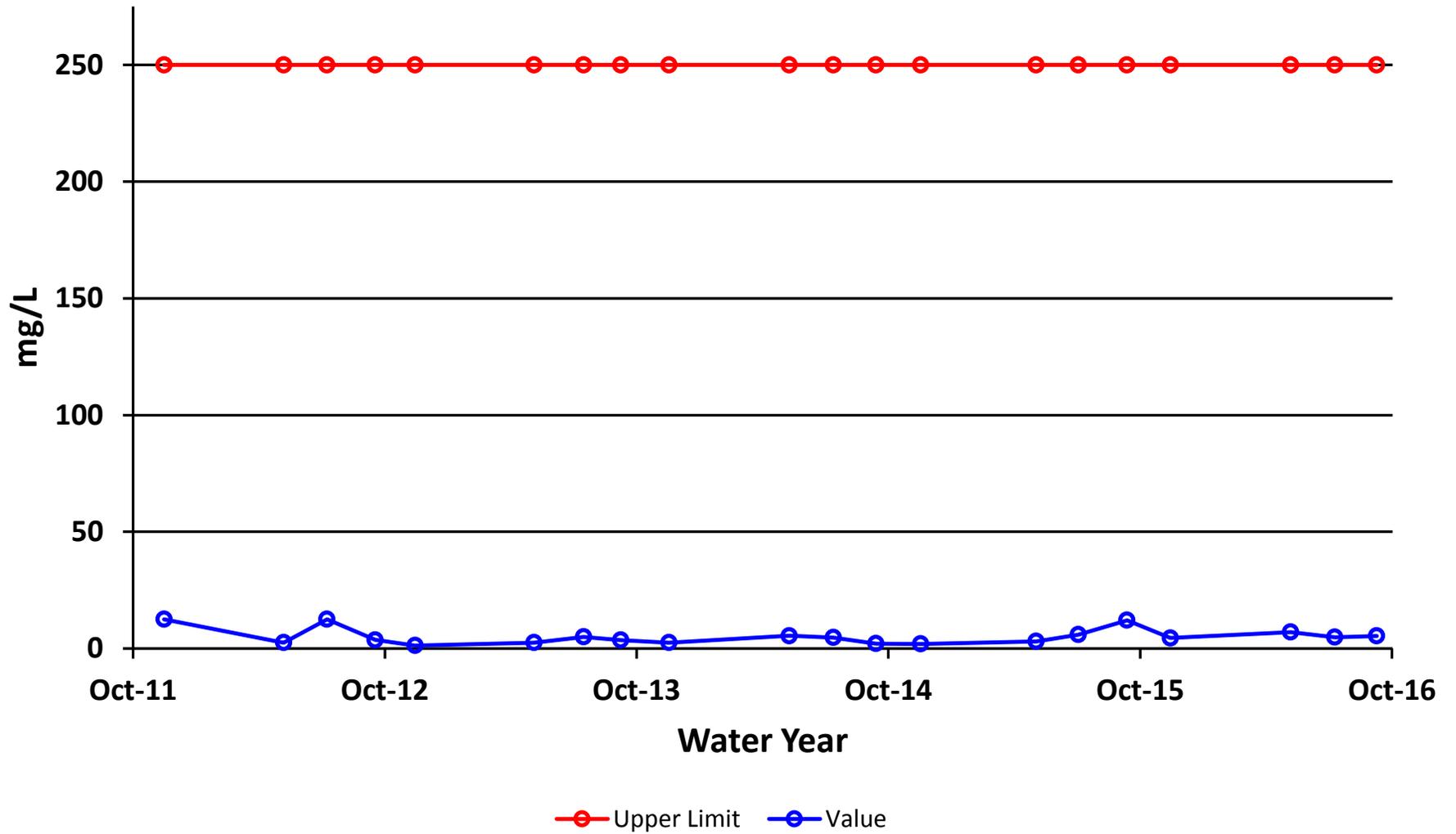
# Site 60 - pH Field



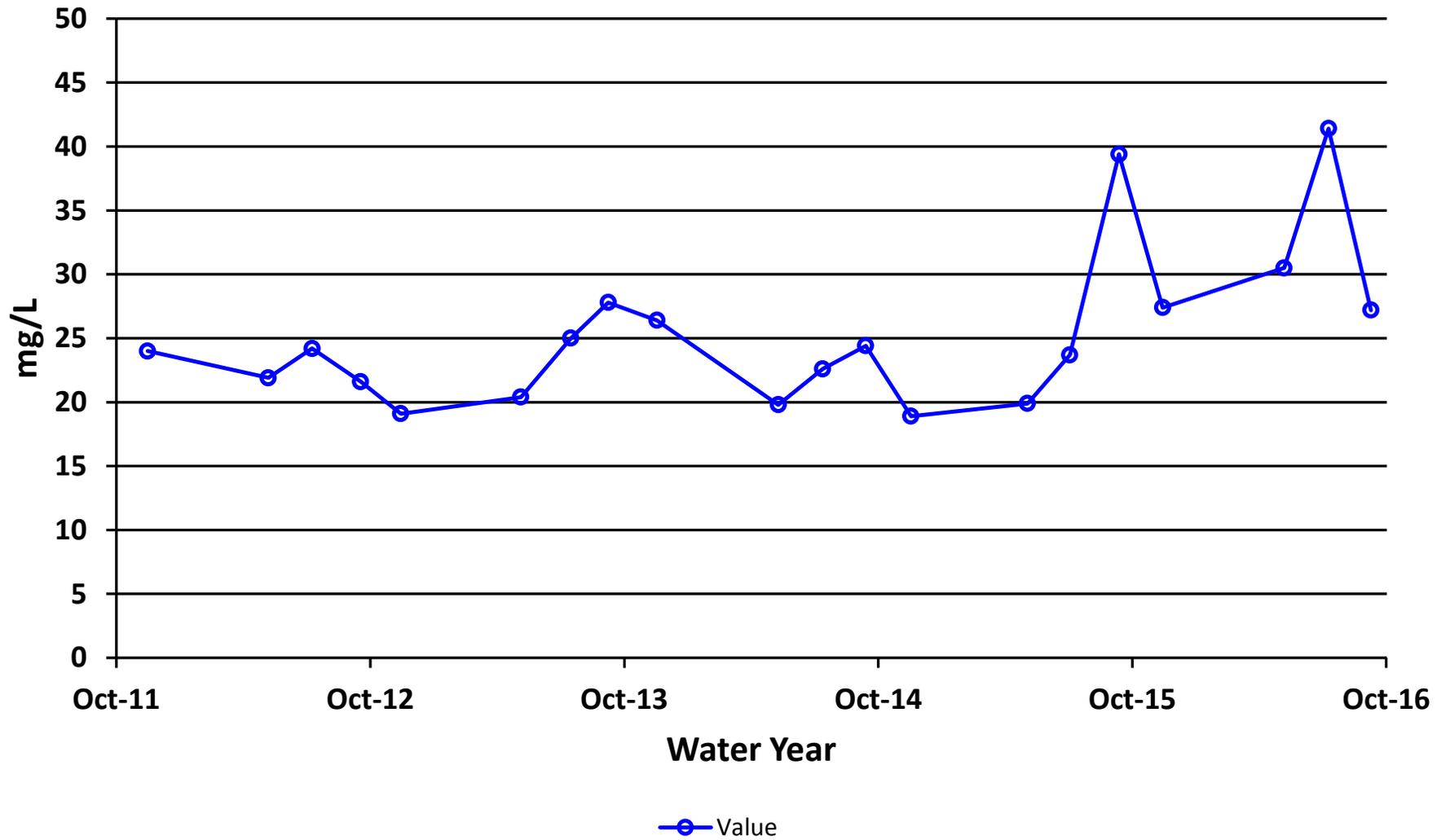
# Site 60 - Alkalinity



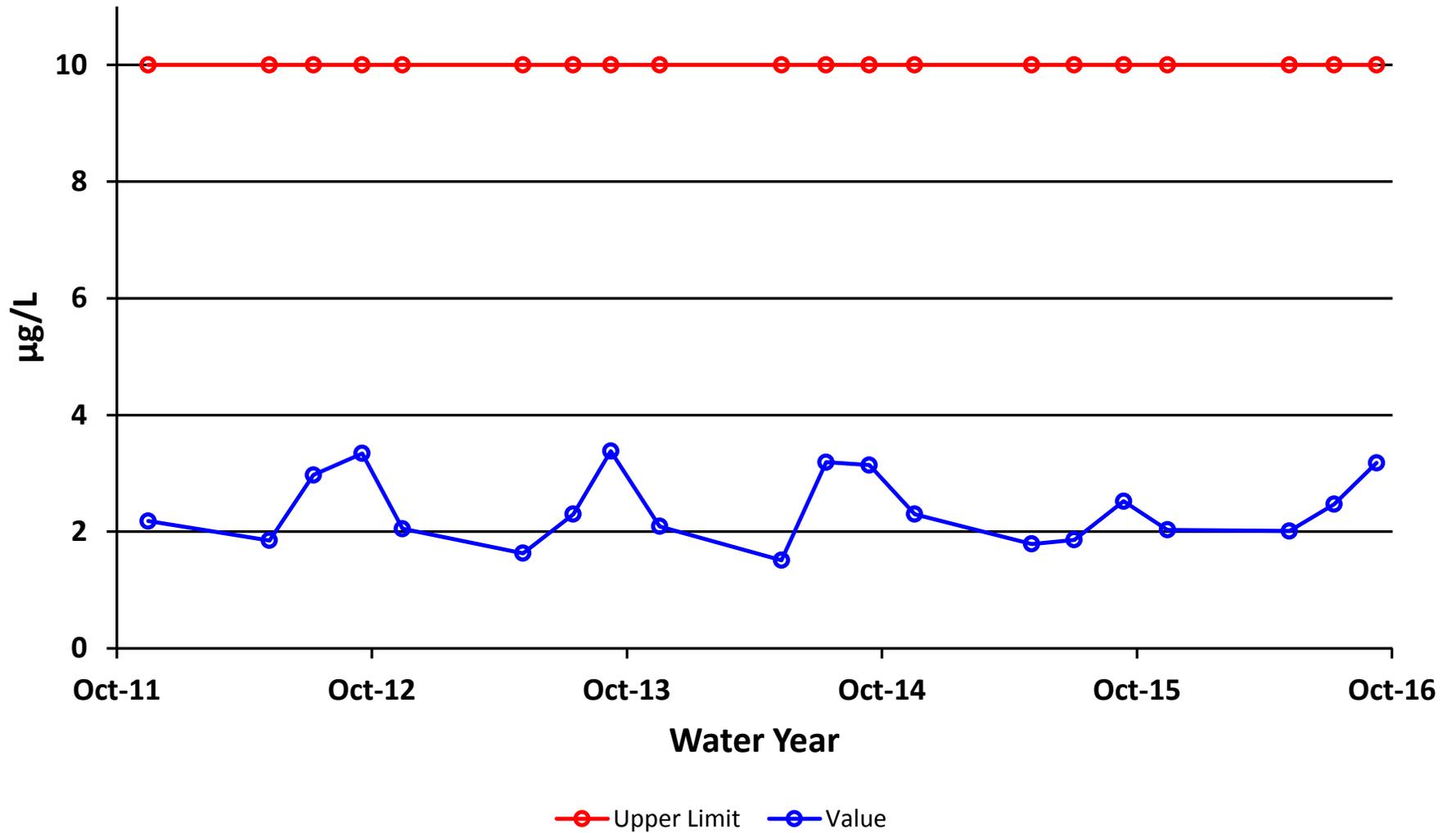
# Site 60 - Sulfate



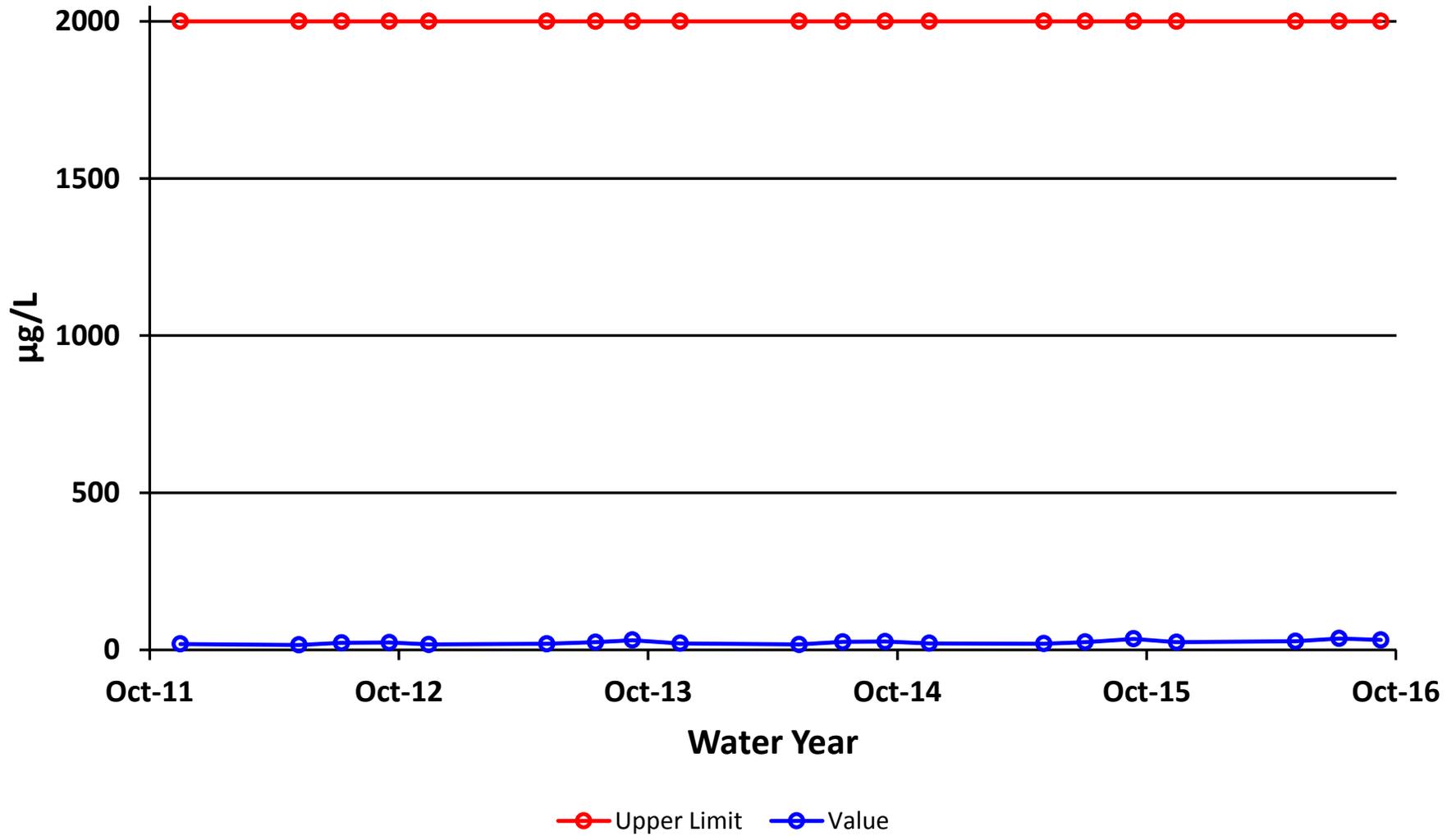
## Site 60 - Hardness



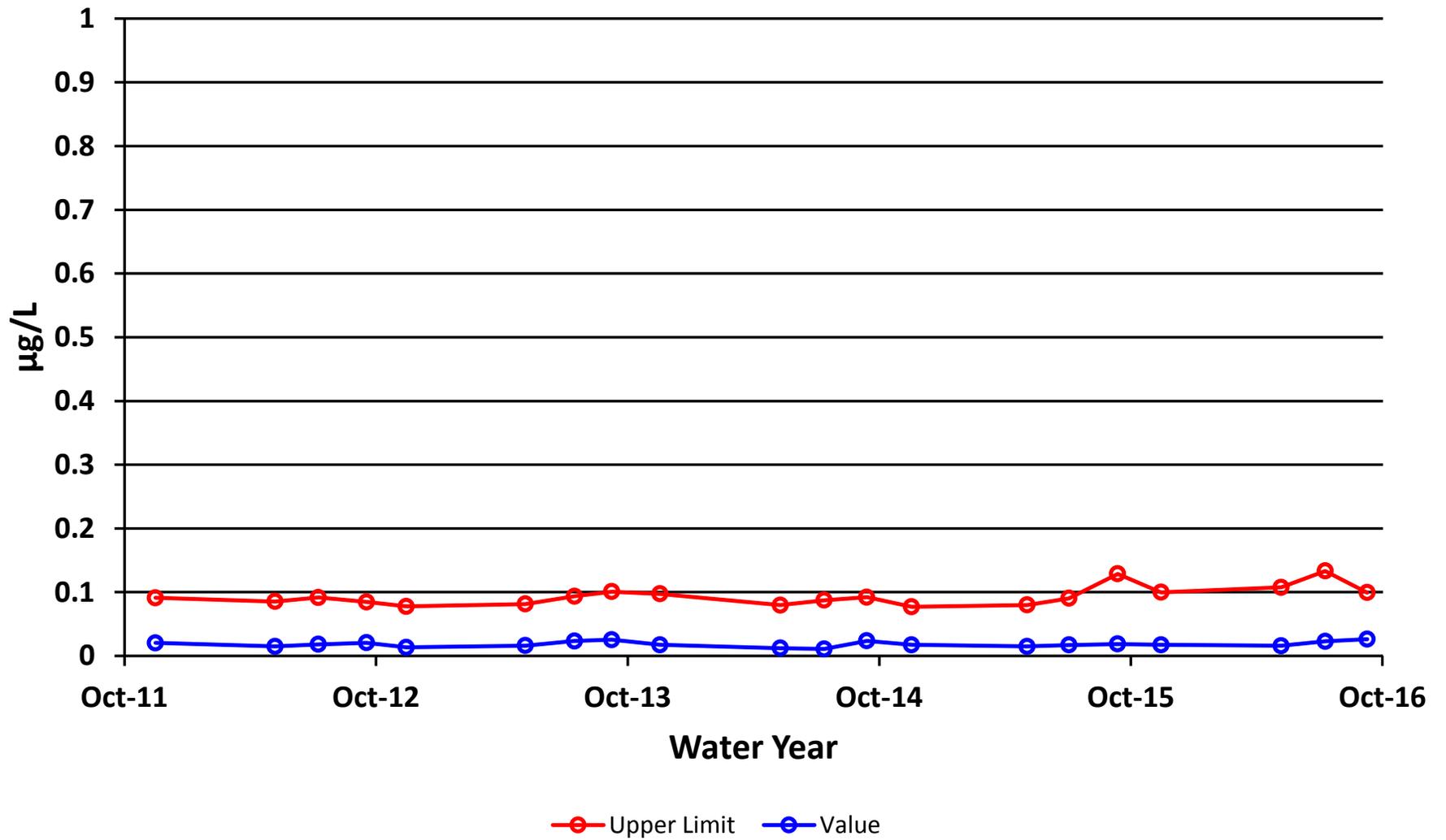
# Site 60 - Arsenic Dissolved



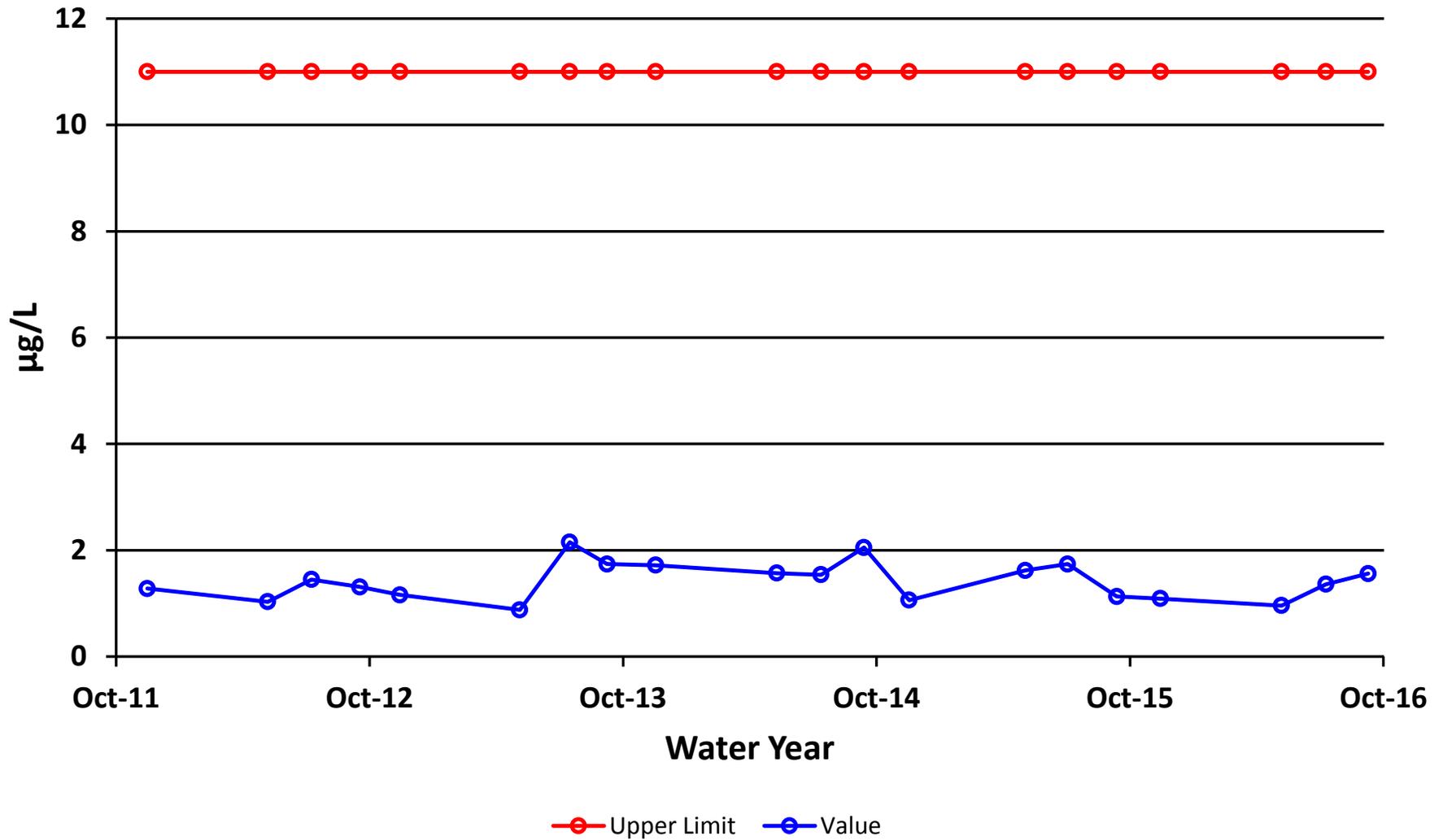
# Site 60 - Barium Dissolved



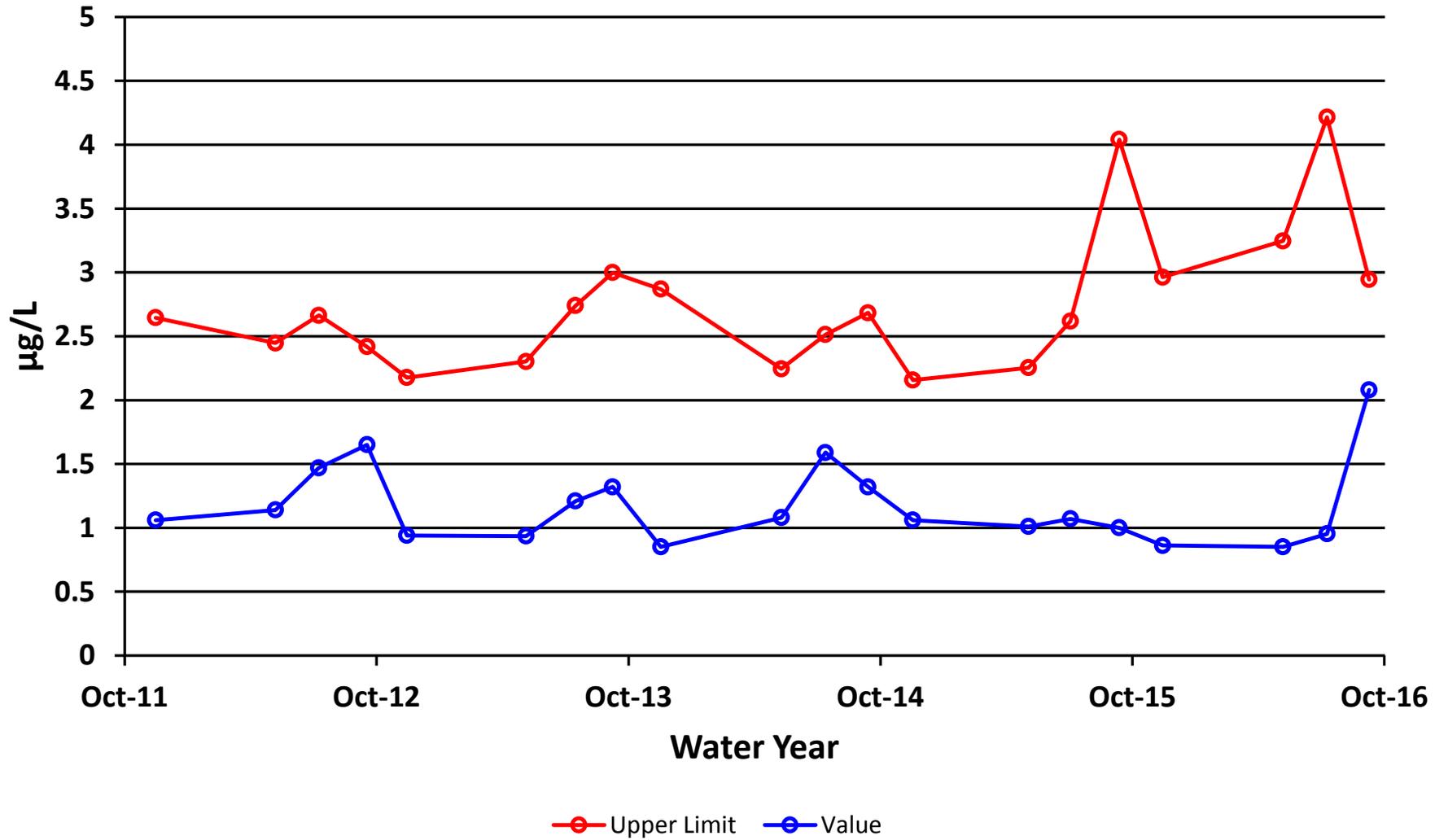
## Site 60 - Cadmium Dissolved



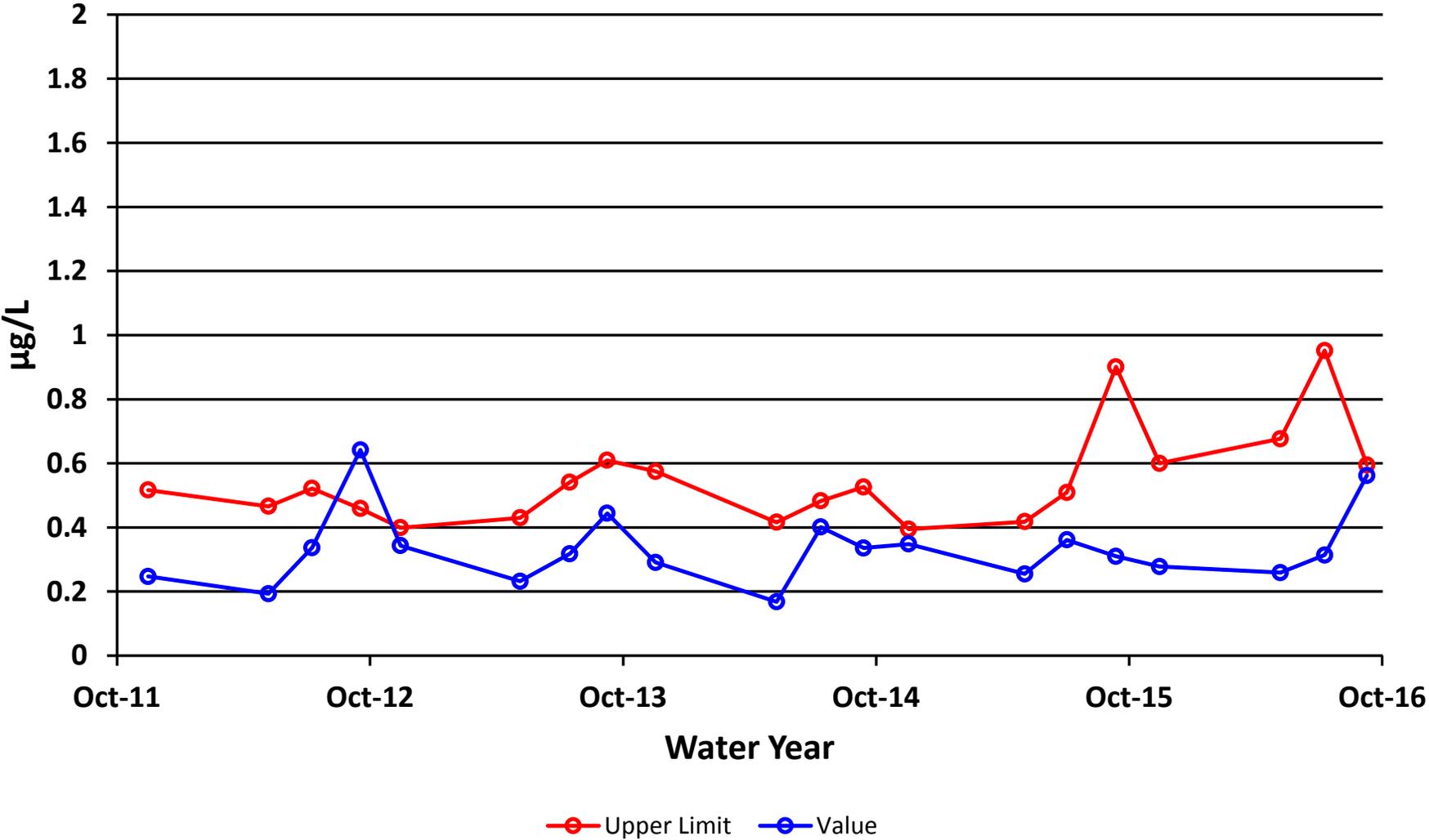
# Site 60 - Chromium Dissolved



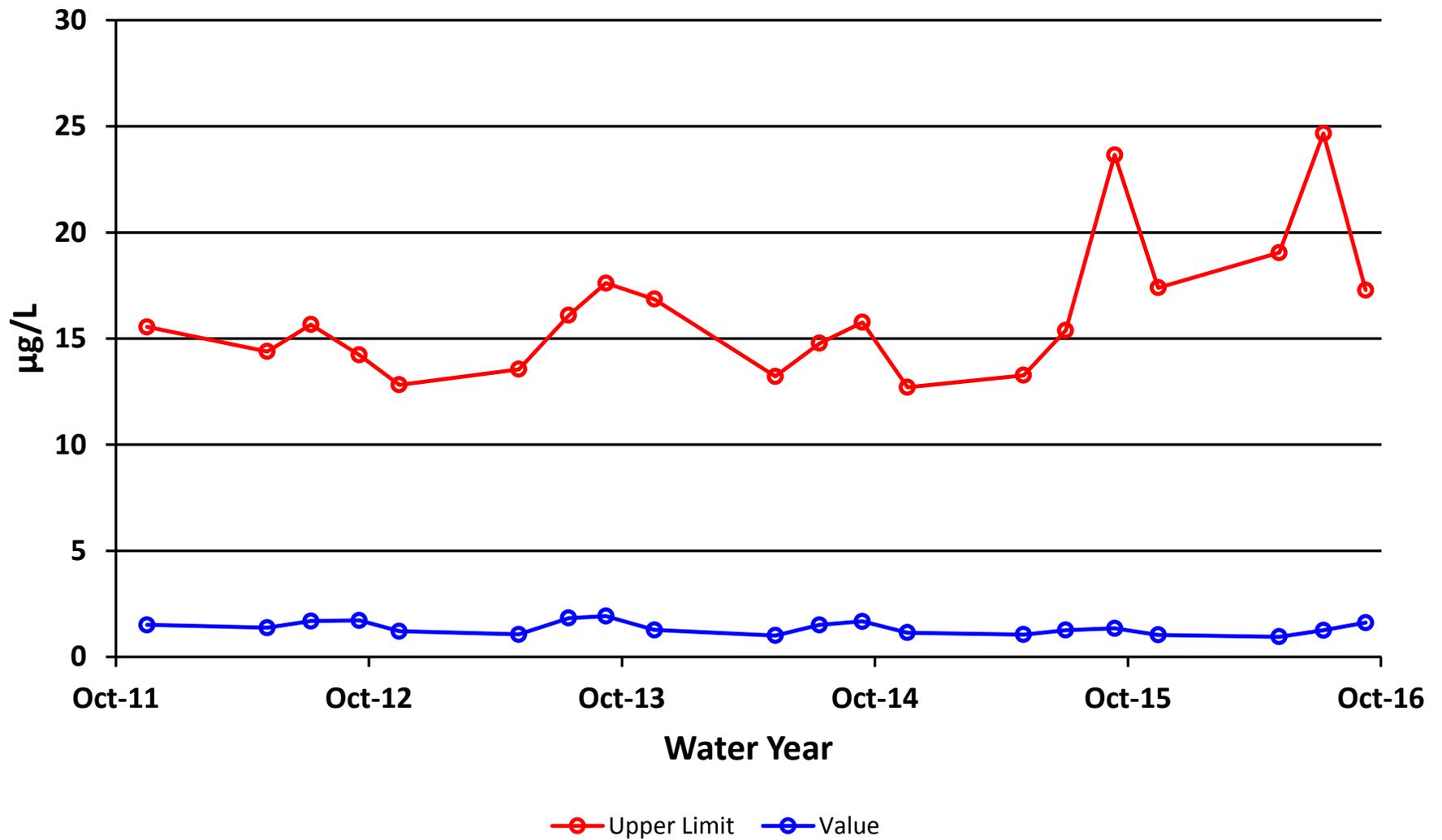
# Site 60 - Copper Dissolved



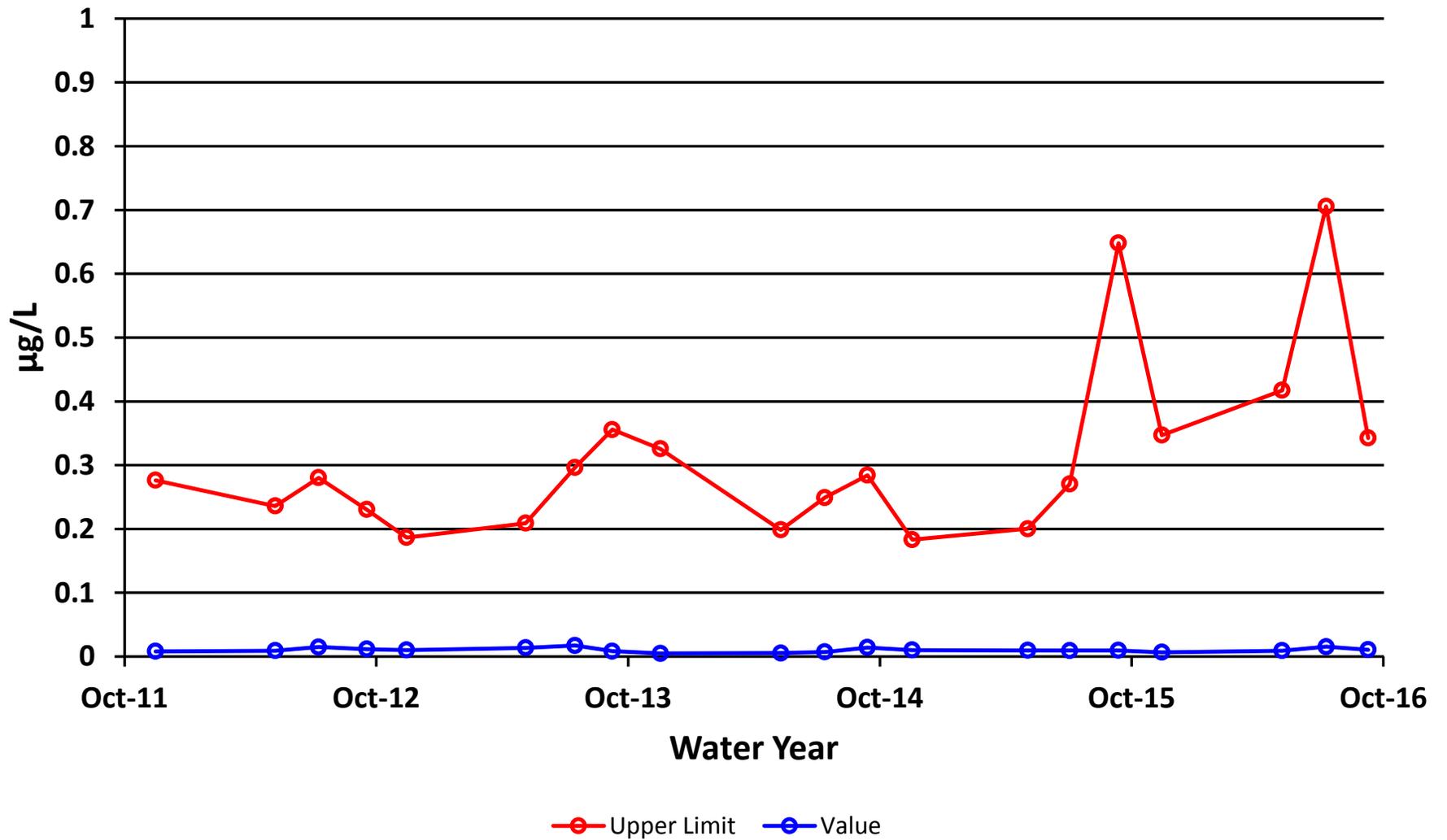
# Site 60 - Lead Dissolved



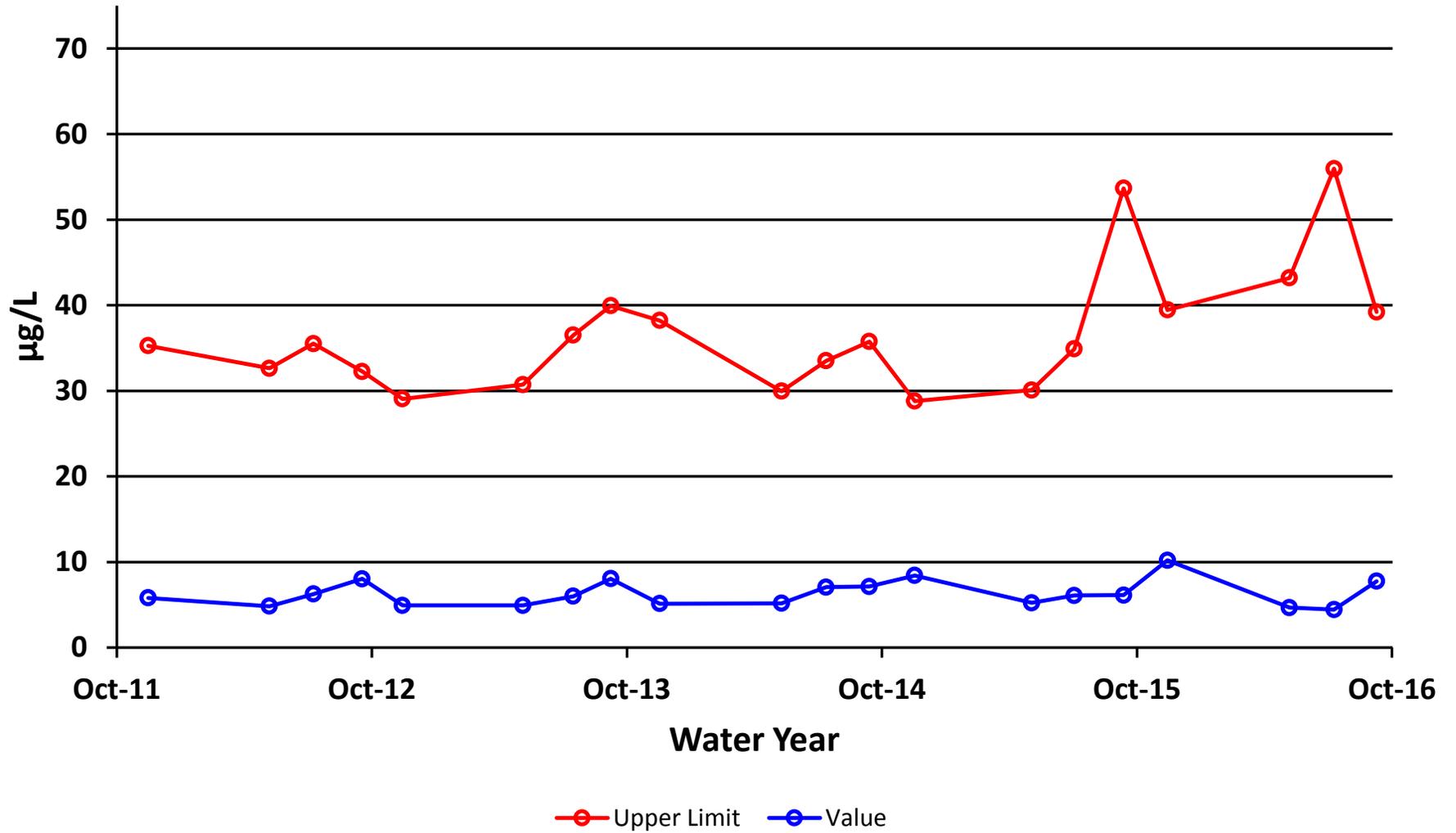
# Site 60 - Nickel Dissolved



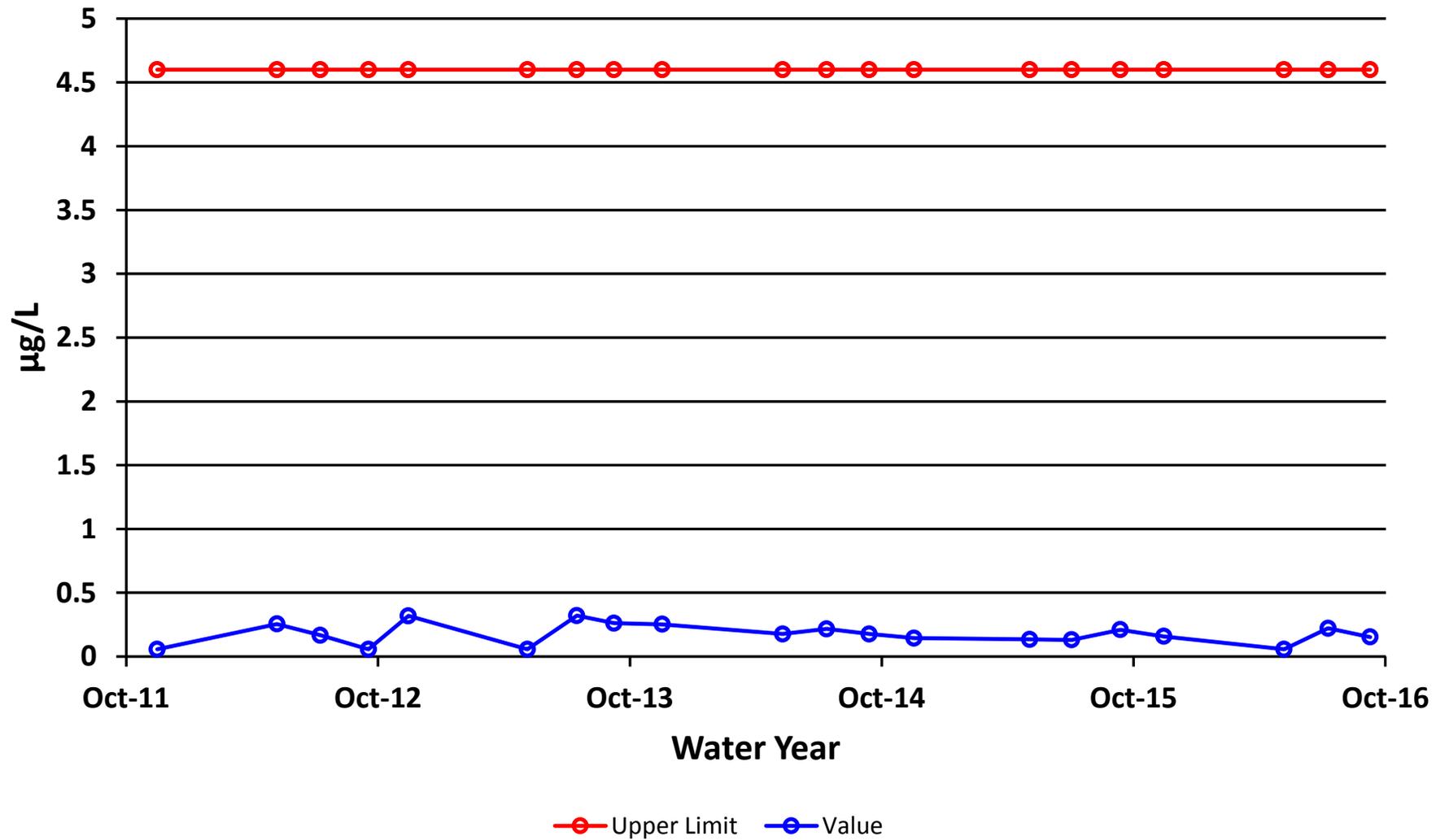
## Site 60 - Silver Dissolved



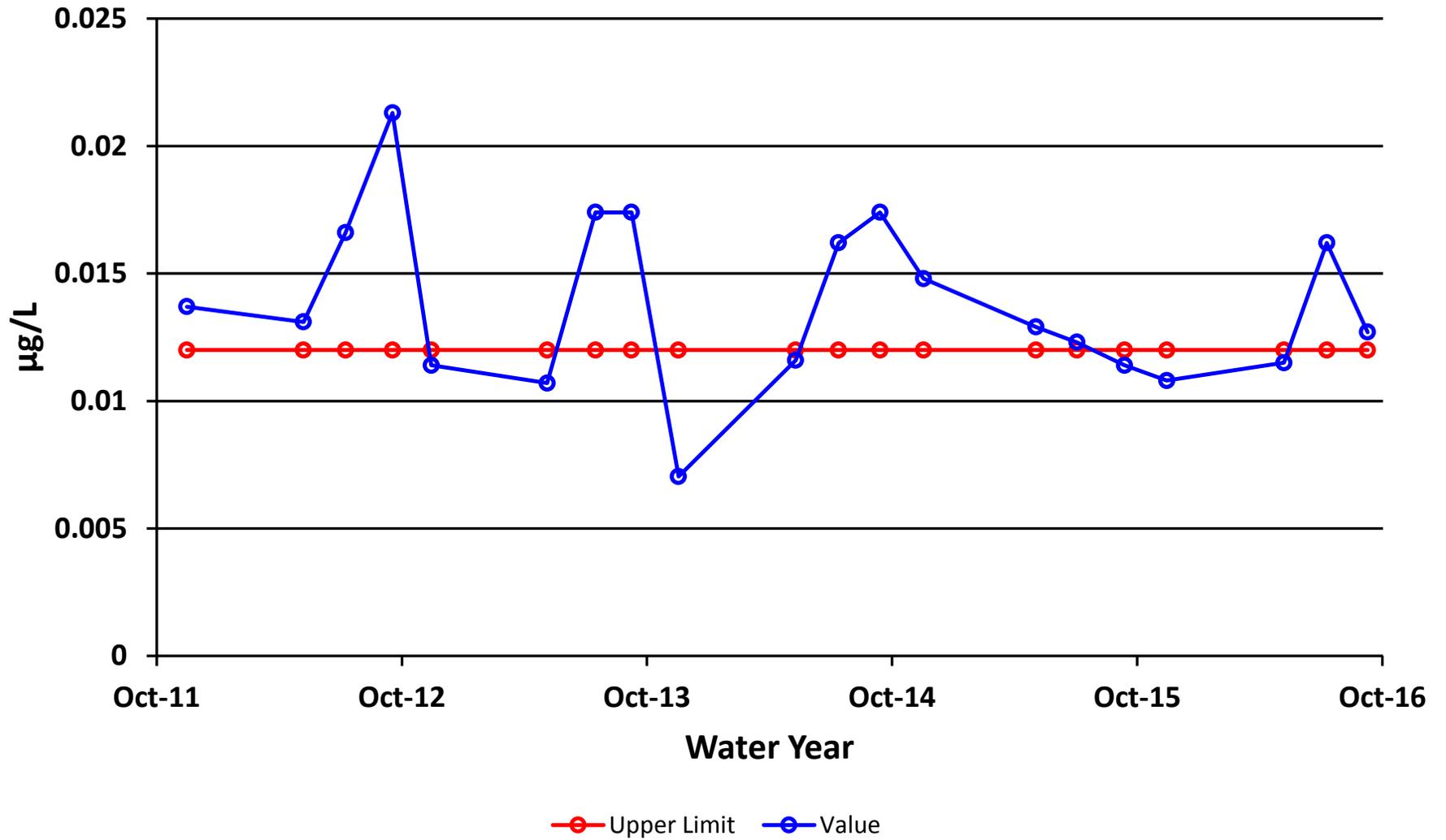
# Site 60 - Zinc Dissolved



## Site 60 - Selenium Dissolved



# Site 60 - Mercury Dissolved



## INTERPRETIVE REPORT SITE 609

Sampling at this site was initiated during the spring of Water Year 2013. This site was added to the FWMP at the request of the state and federal regulators. Site 609 is located west of the tailings disposal facility on a small surface drainage. The sampling location is near the bottom of the drainage, therefore monitoring a larger expanse upgradient from the site.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past year is included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers have been identified by HGCMC for the period of October 2013 through September 2016.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. One result exceeding these criteria was identified as listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
17-Nov-15	pH Field	6.47 su	6.5	9	199 mg/L

Field pH was slightly lower than the AWQS in November 2015

## Table of Results for Water Year 2016

### Site 609FMS - 'Further Creek Lower'

Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)		3.7						7		13.1		10.1	8.6
Conductivity-Field(µmho)		415						462		361		564	438.5
Conductivity-Lab (µmho)		374						433		349		554	404
pH Lab (standard units)		7.31						7.1		6.96		7.11	7.11
pH Field (standard units)		6.47						7.32		6.79		6.95	6.87
Total Alkalinity (mg/L)		32						36.5		34.2		30.5	33.1
Total Sulfate (mg/L)		152						178		138		241	165.0
Hardness (mg/L)		199						224		177		285	211.5
Dissolved As (ug/L)		1.16						1.14		1.6		1.55	1.355
Dissolved Ba (ug/L)		39.8						43.7		42		63	42.9
Dissolved Cd (ug/L)		0.153						0.163		0.175		0.171	0.1670
Dissolved Cr (ug/L)		0.878						0.837		2.61		1.19	1.034
Dissolved Cu (ug/L)		0.757						0.584		1.17		0.716	0.737
Dissolved Pb (ug/L)		0.338						0.315		0.435		0.456	0.3865
Dissolved Ni (ug/L)		4.17						3.42		5.36		4.41	4.290
Dissolved Ag (ug/L)		0.003						0.002		0.025		0.006	0.005
Dissolved Zn (ug/L)		70.7						54.4		55		68.1	61.55
Dissolved Se (ug/L)		1.14						1.46		0.385		2.06	1.300
Dissolved Hg (ug/L)		0.00329						0.00304		0.00836		0.00405	0.003670

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

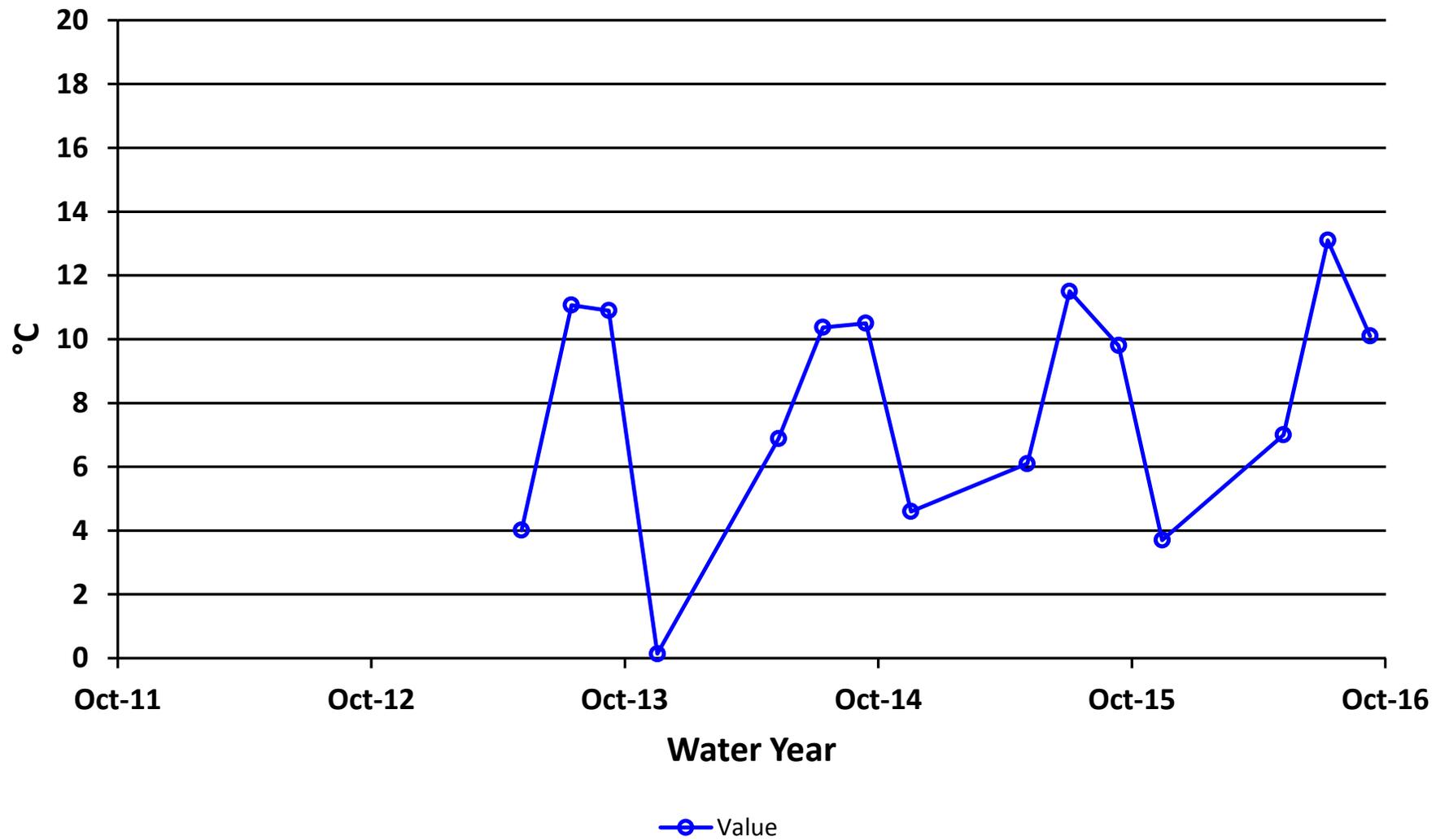
## Qualified Data by QA Reviewer

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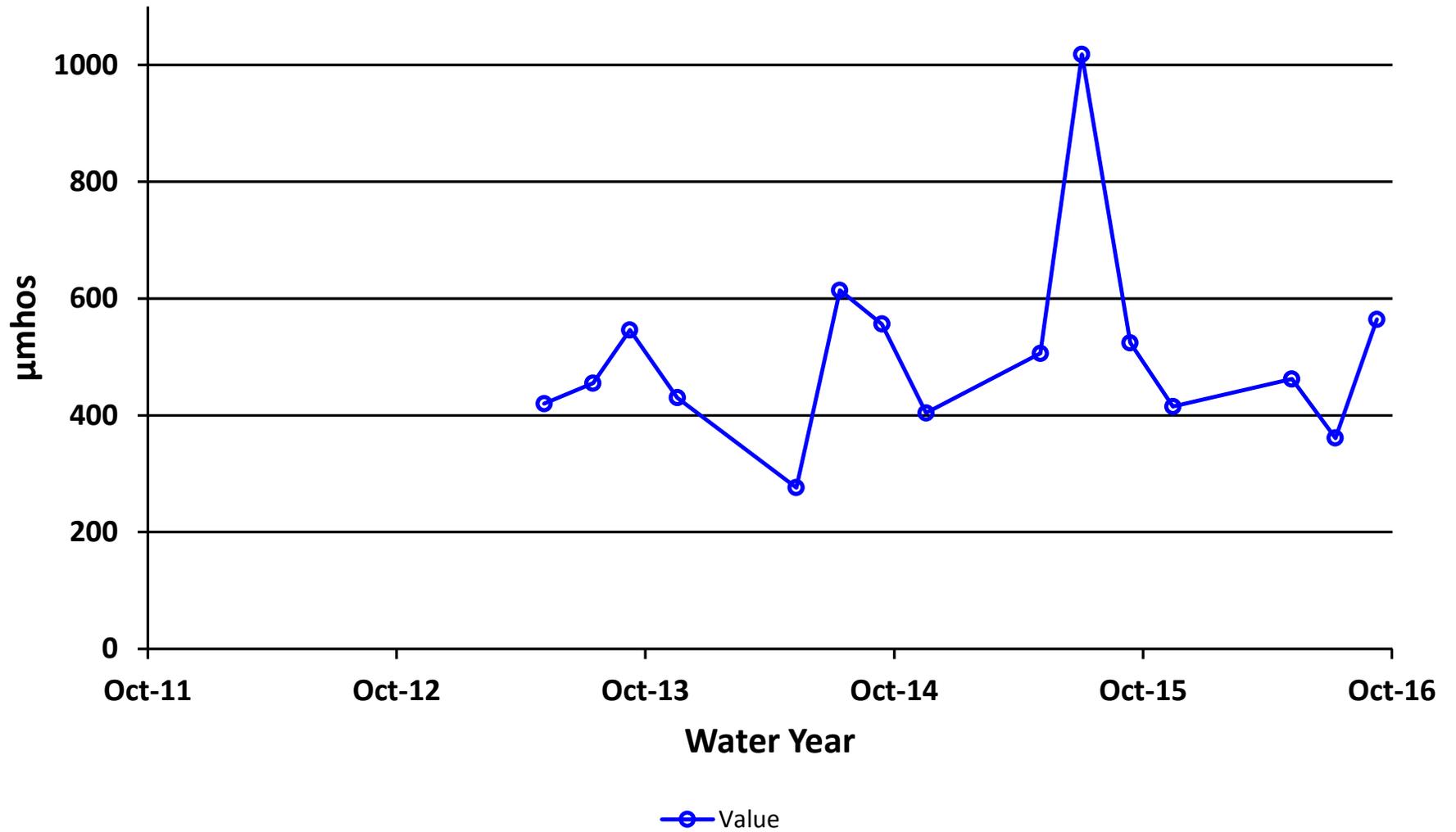
Site No.	Sample Date	Sample Time	Parameter	Value		Qualifier	Reason for Qualifier
609FMS	11/17/2015	12:00 PM	Diss. Ag-ICP/MS	0.00329	µg/L	J	Below Quantitative Range
	7/13/2016	12:00 PM	Sulfate	138	mg/L	J	Sample Receipt Temperature
	9/12/2016	12:00 PM	Diss. Ag-ICP/MS	0.00574	µg/L	J	Below Quantitative Range
			Sulfate	241	mg/L	J	Sample Receipt Temperature

Qualifier	Description
J	Positively Identified - Approximate Concentration
N	Presumptive Evidence For Tentative Identification
NJ	Tentatively Identified - Approximate Concentration
U	Not Detected Above Quantitation Limit
UJ	Not Detected Above Approximate Quantitation Limit

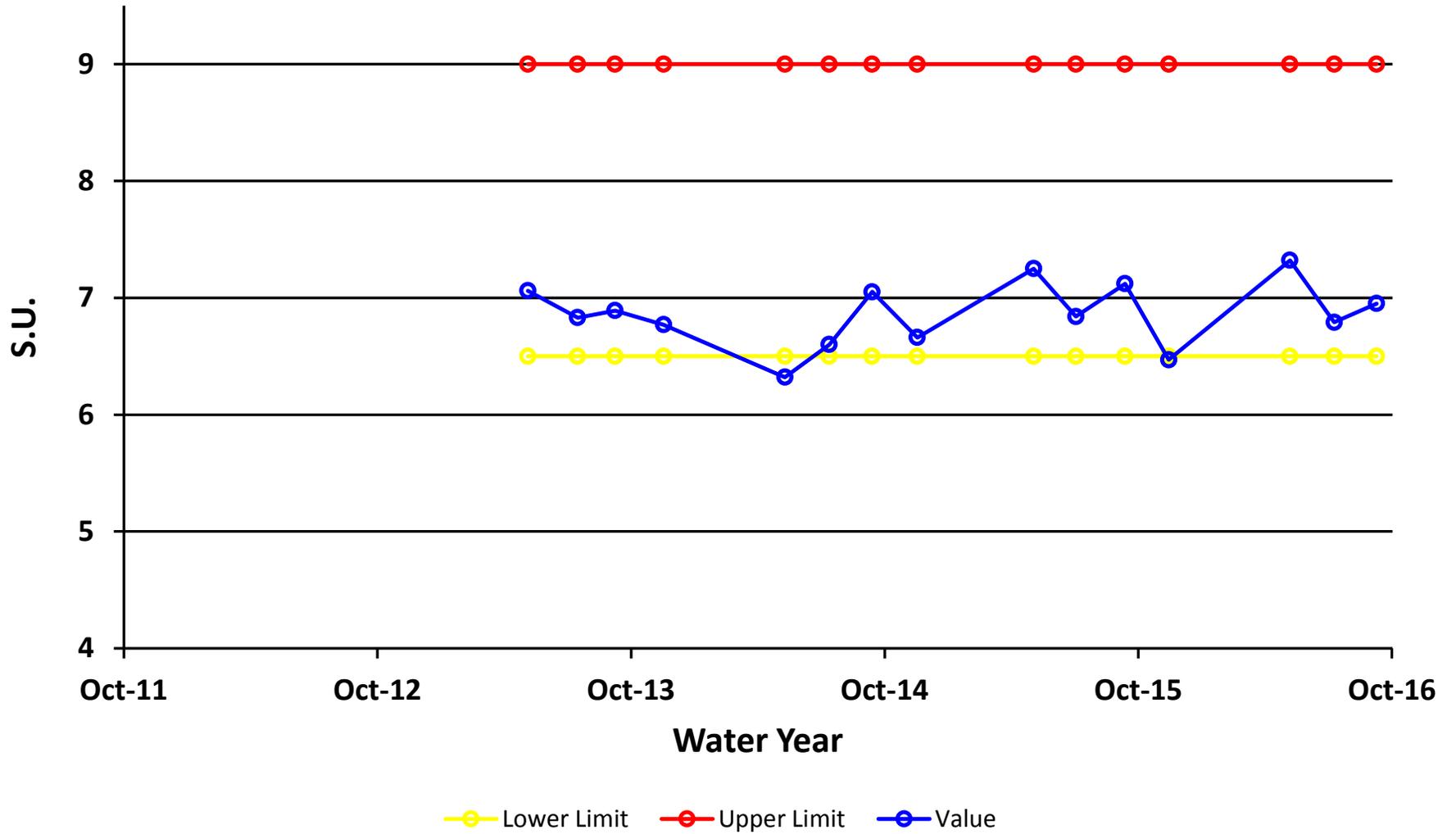
# Site 609 - Water Temperature



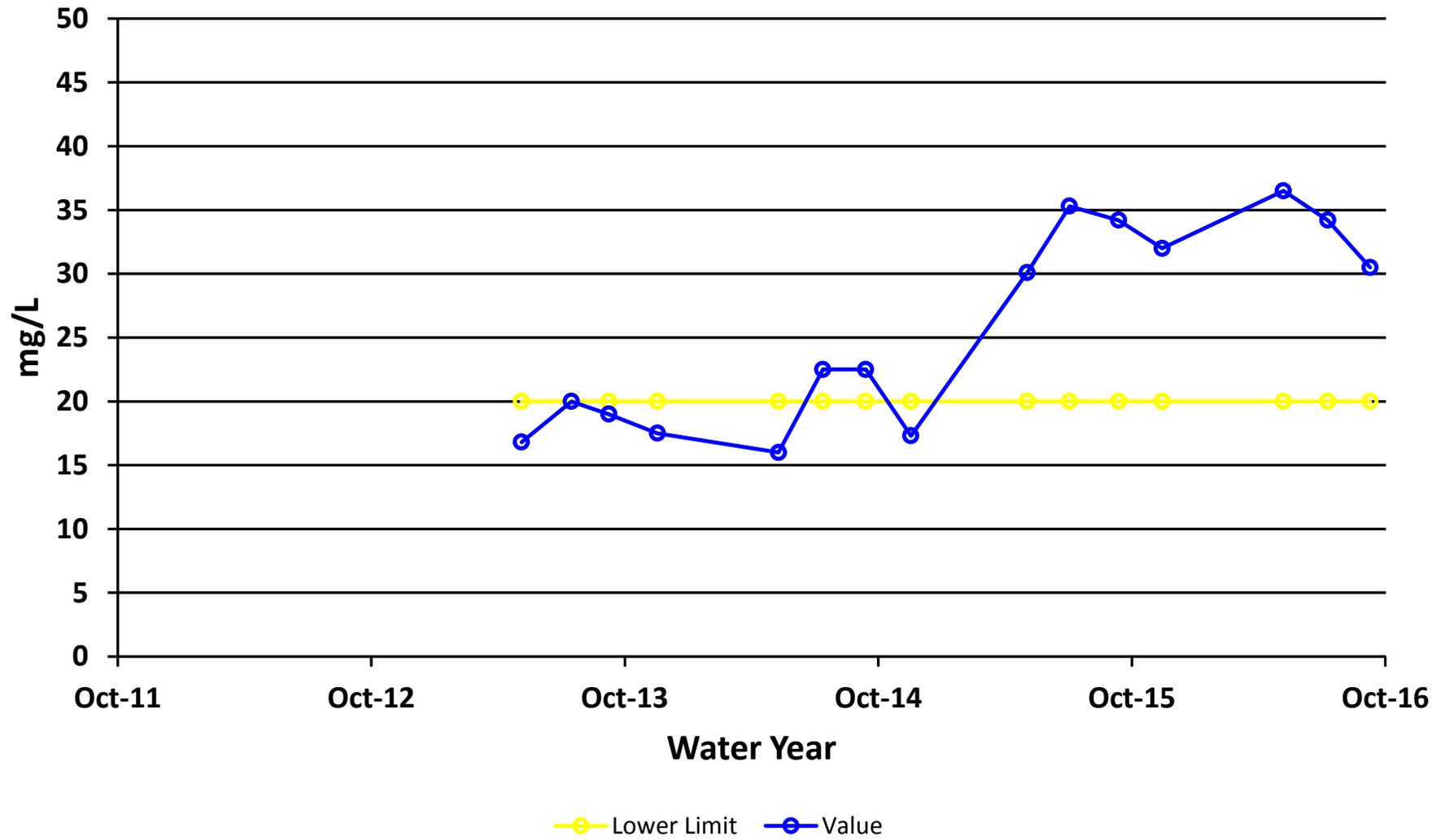
## Site 609 - Conductivity Field



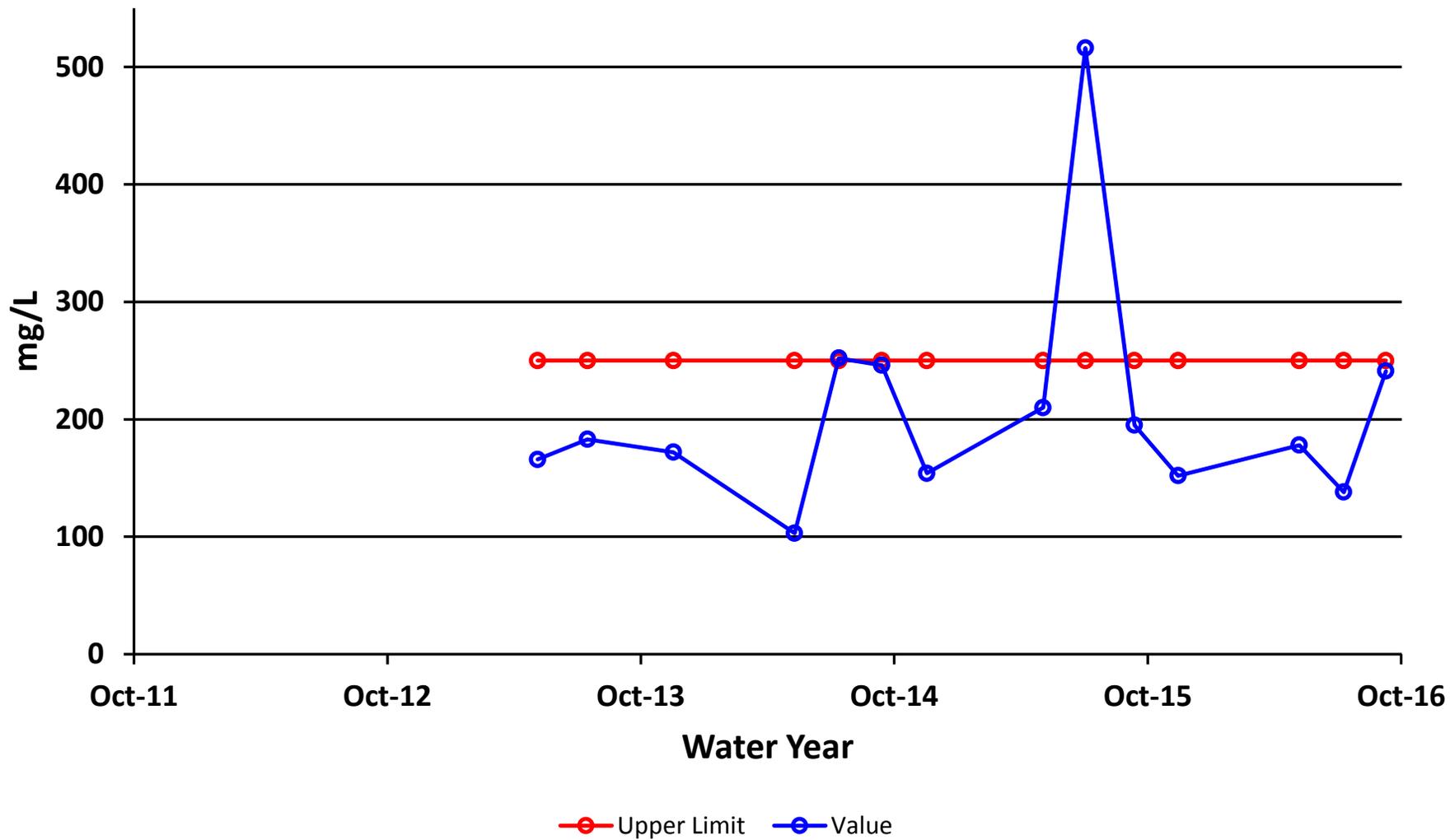
# Site 609 - pH Field



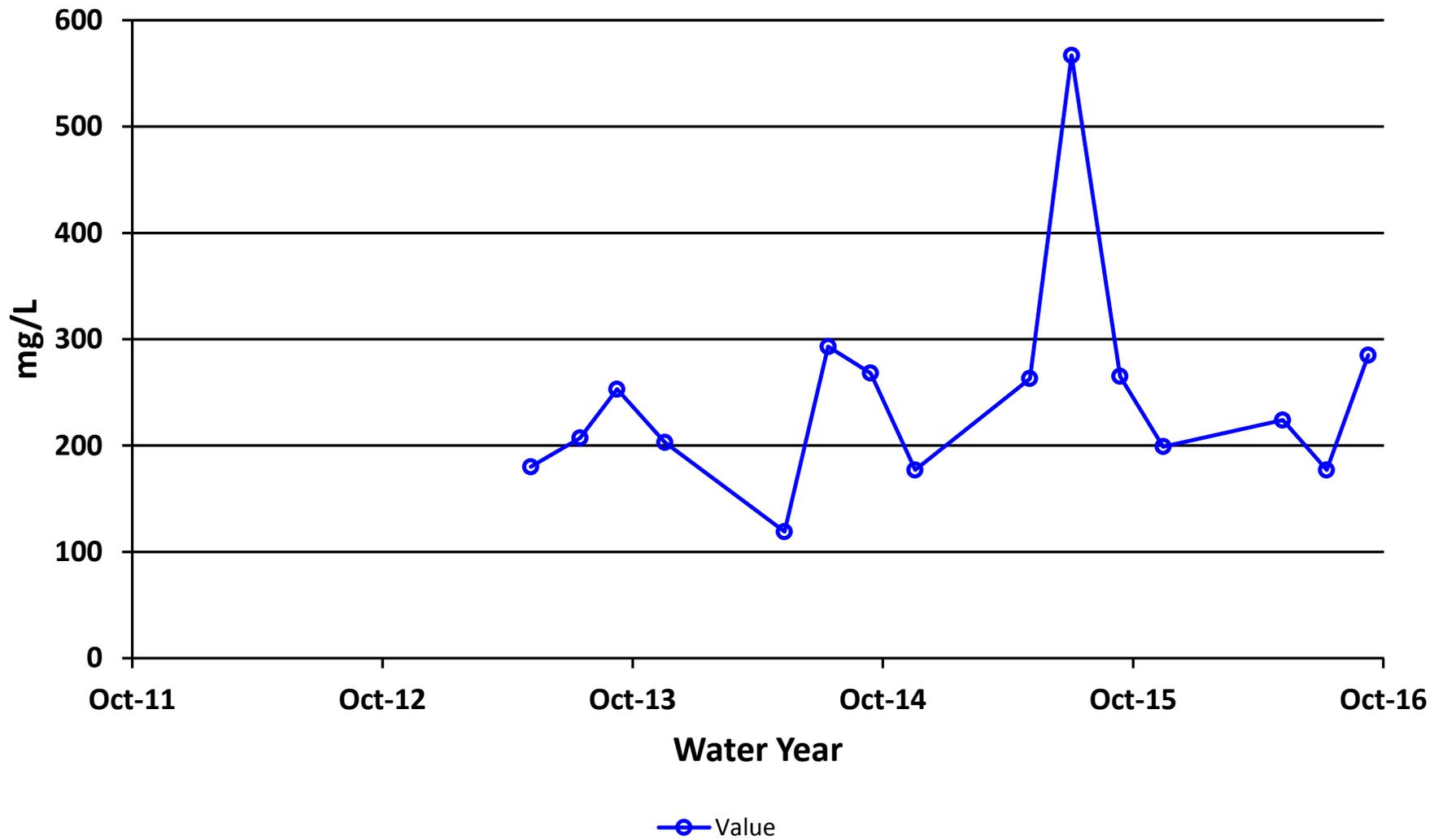
# Site 609 - Alkalinity



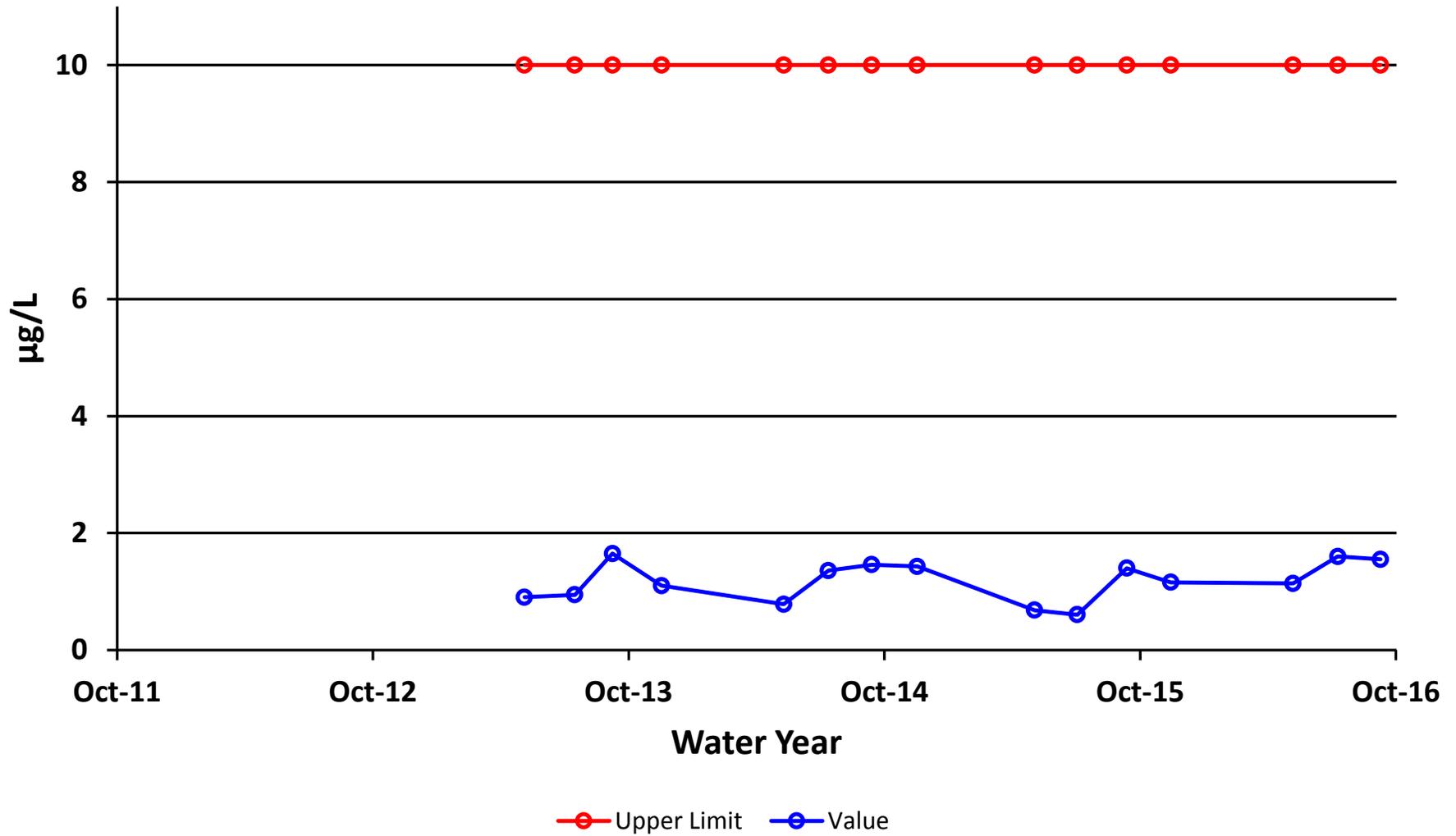
# Site 609 - Sulfate



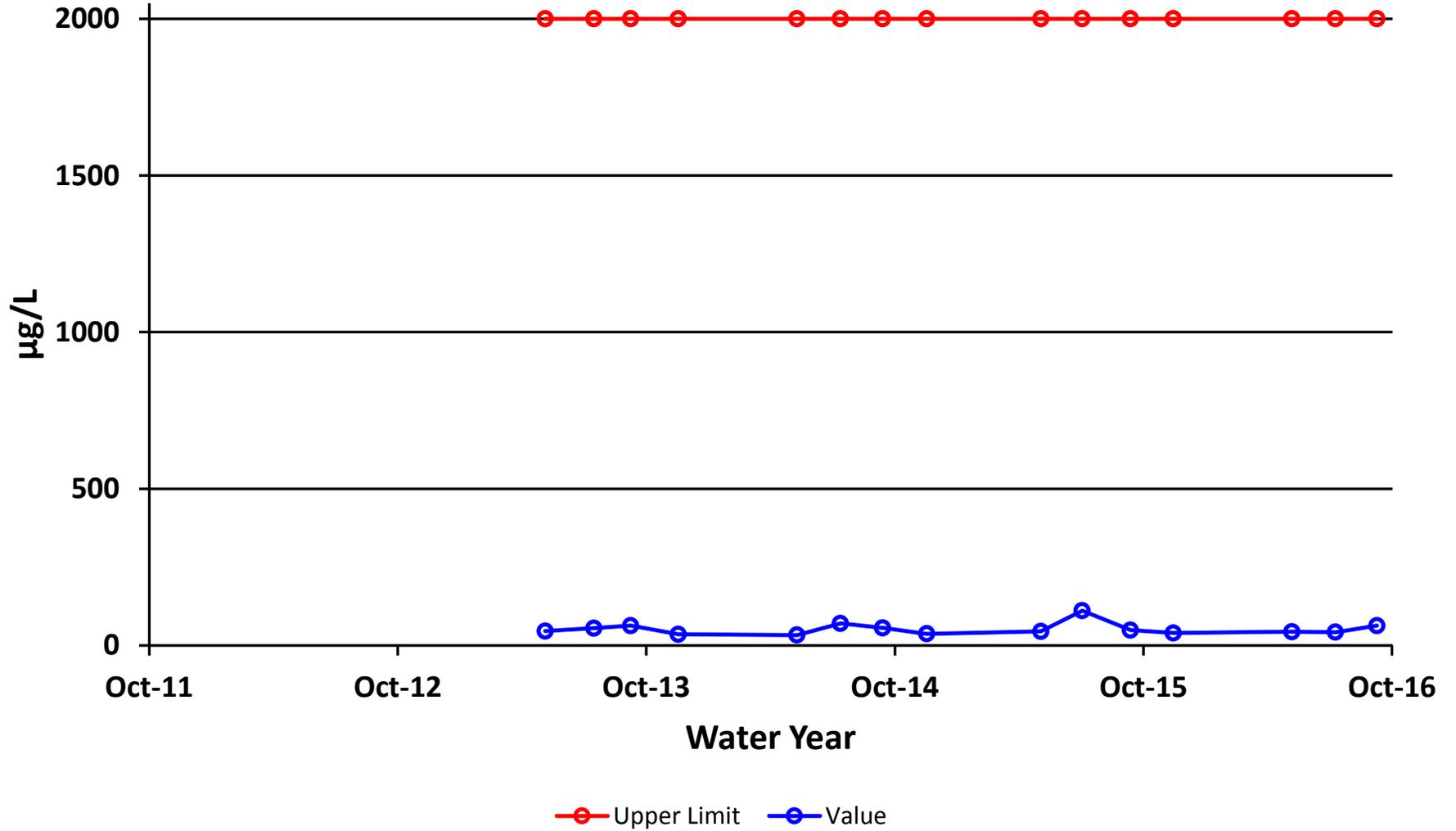
## Site 609 - Hardness



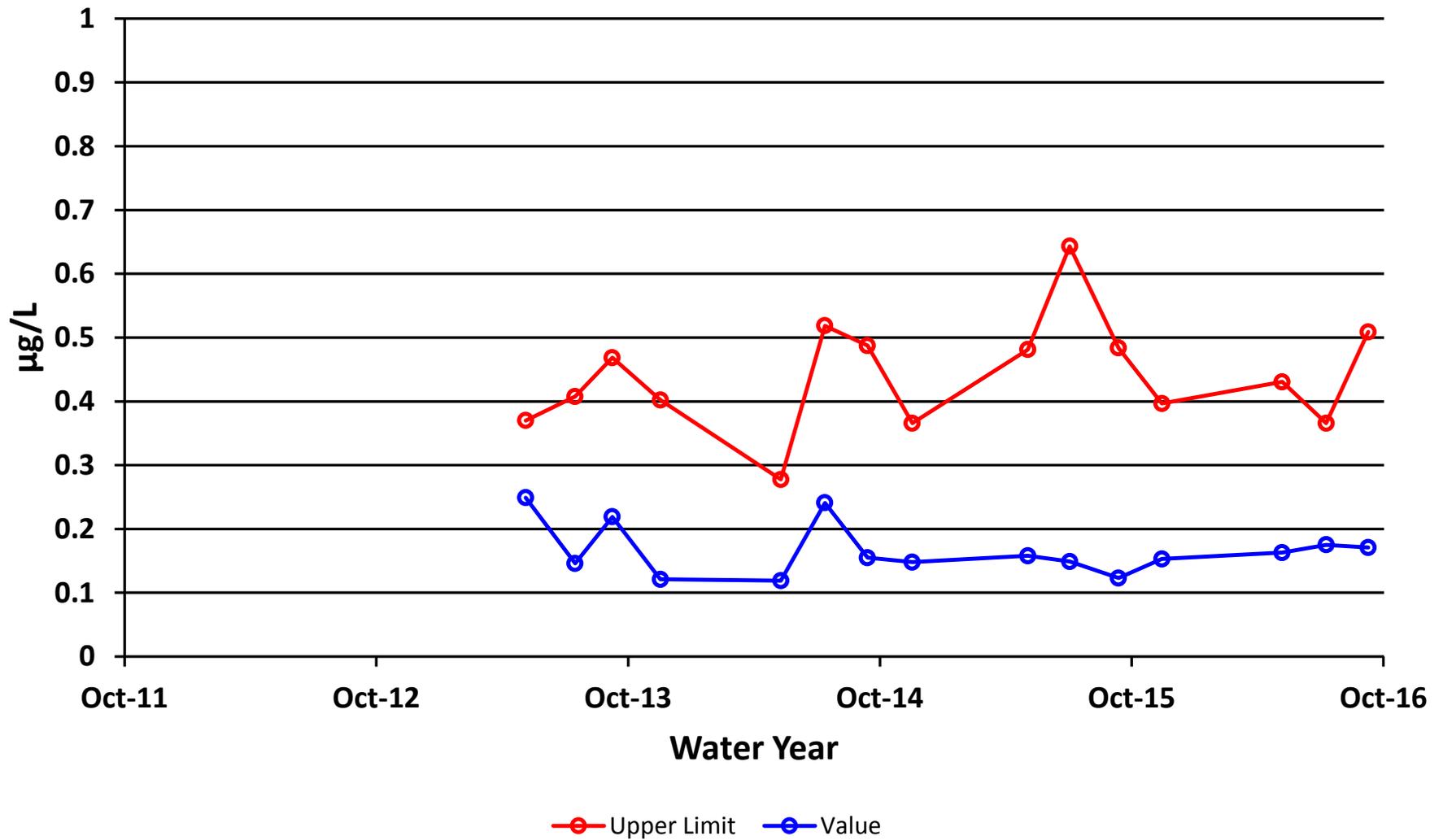
# Site 609 - Arsenic Dissolved



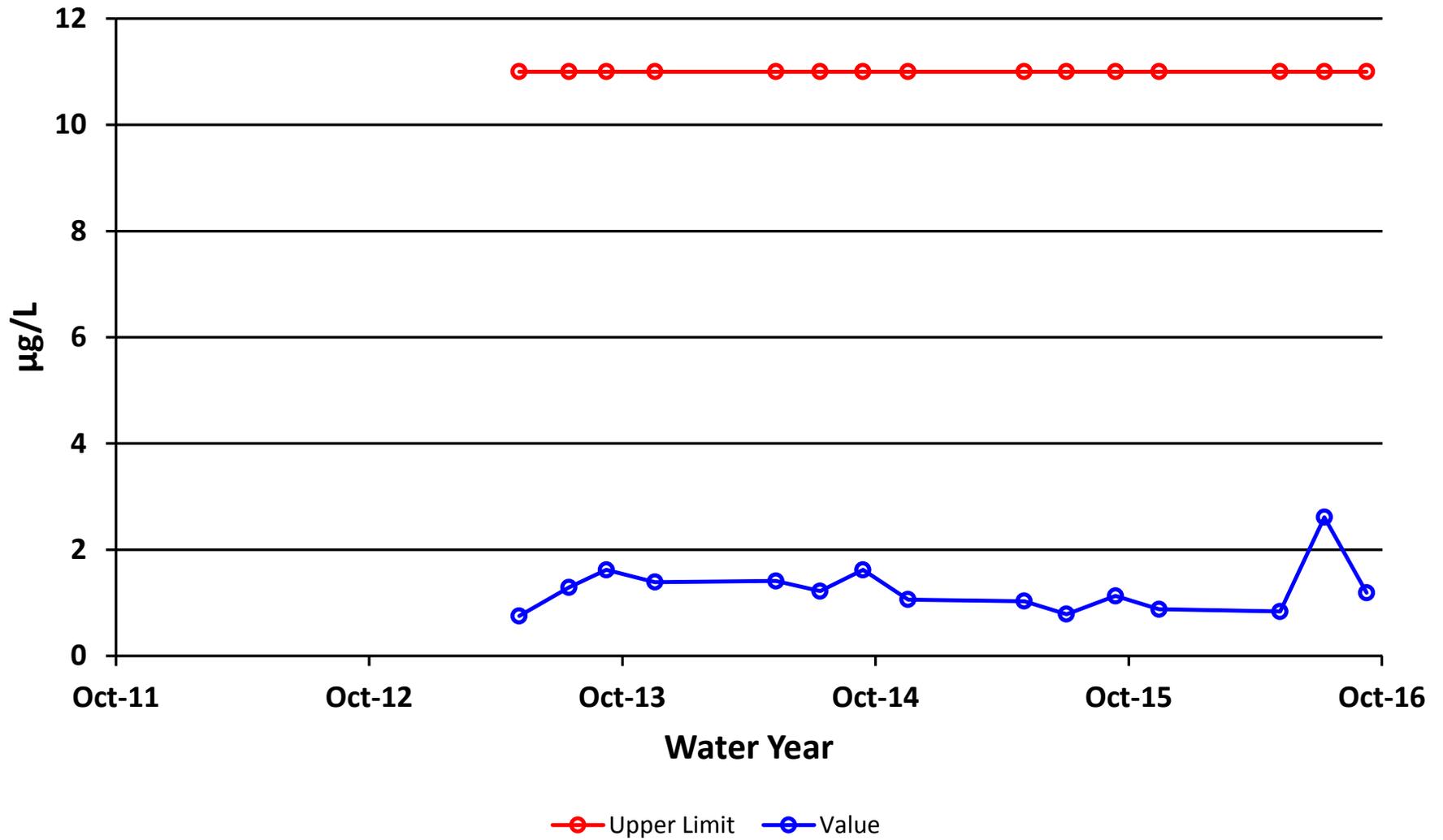
# Site 609 - Barium Dissolved



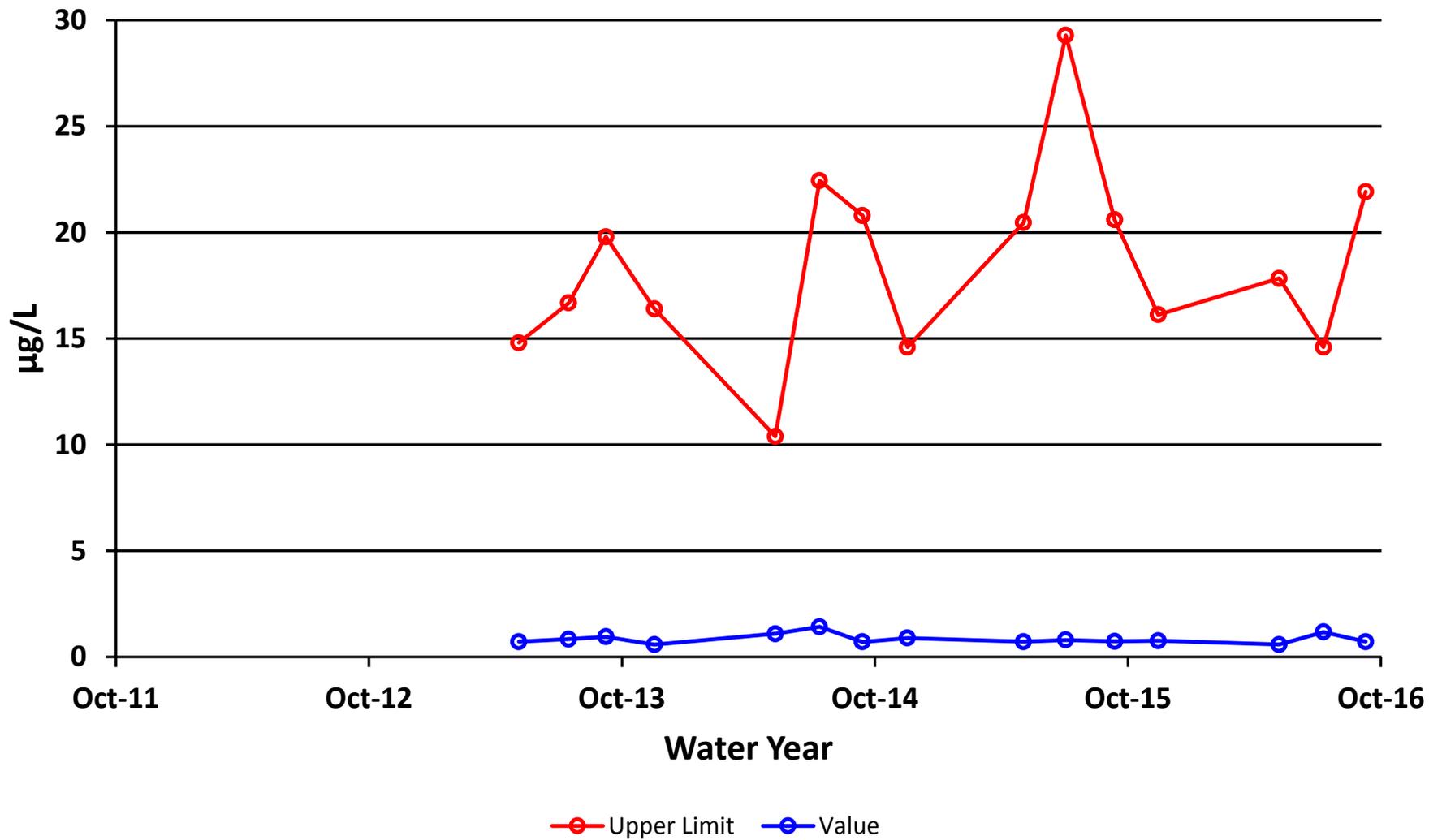
# Site 609 - Cadmium Dissolved



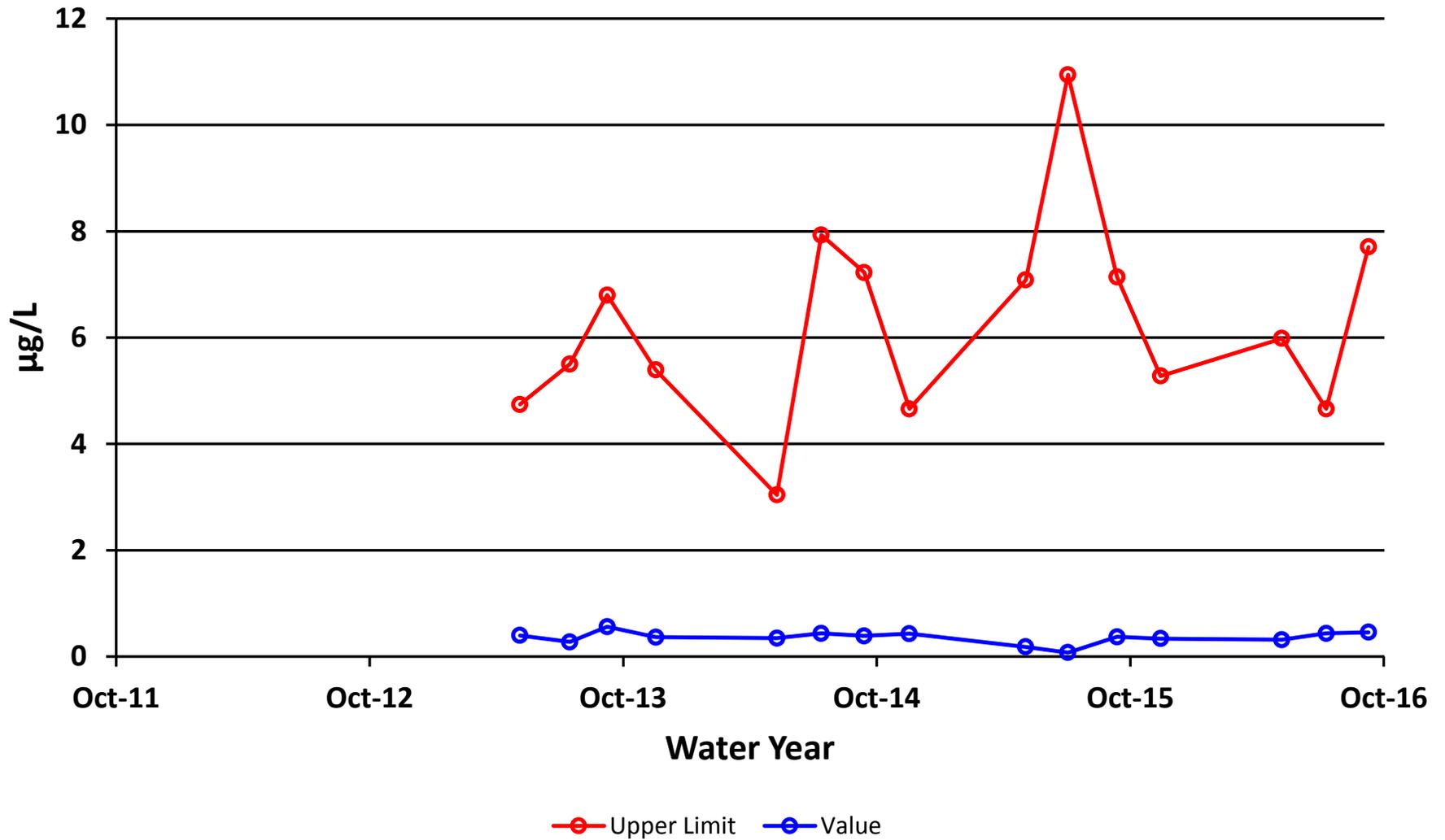
# Site 609 - Chromium Dissolved



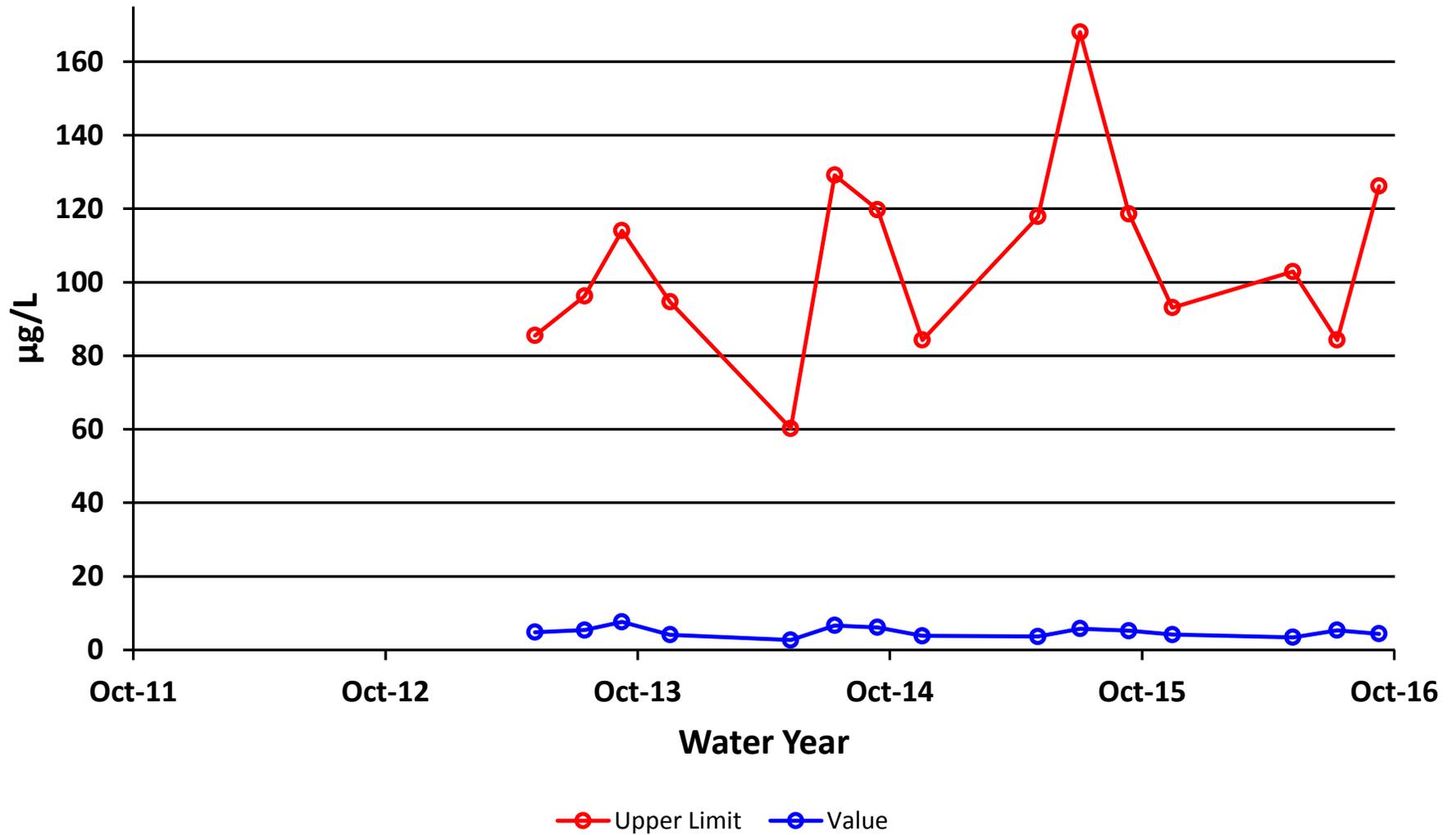
# Site 609 - Copper Dissolved



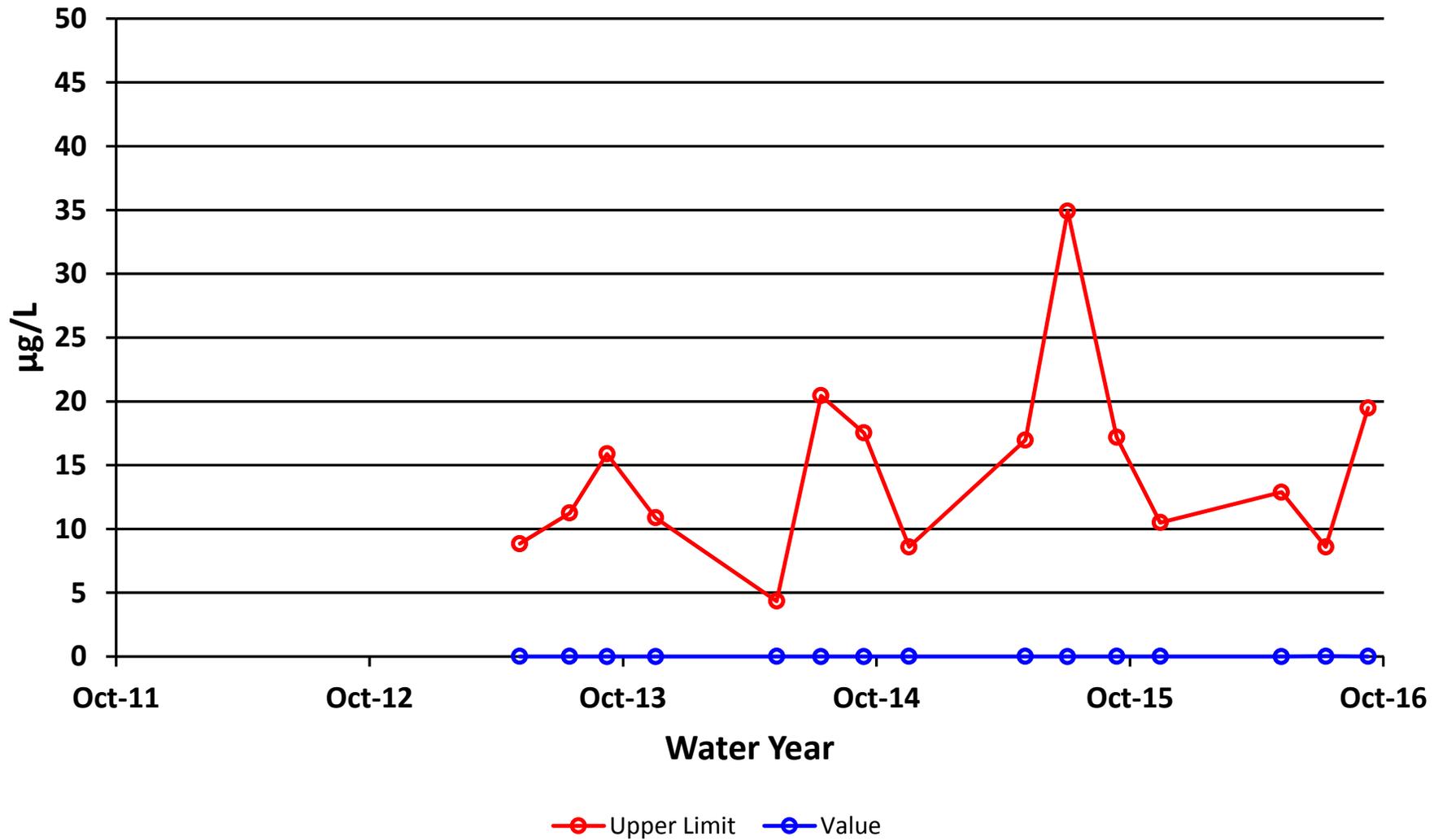
# Site 609 - Lead Dissolved



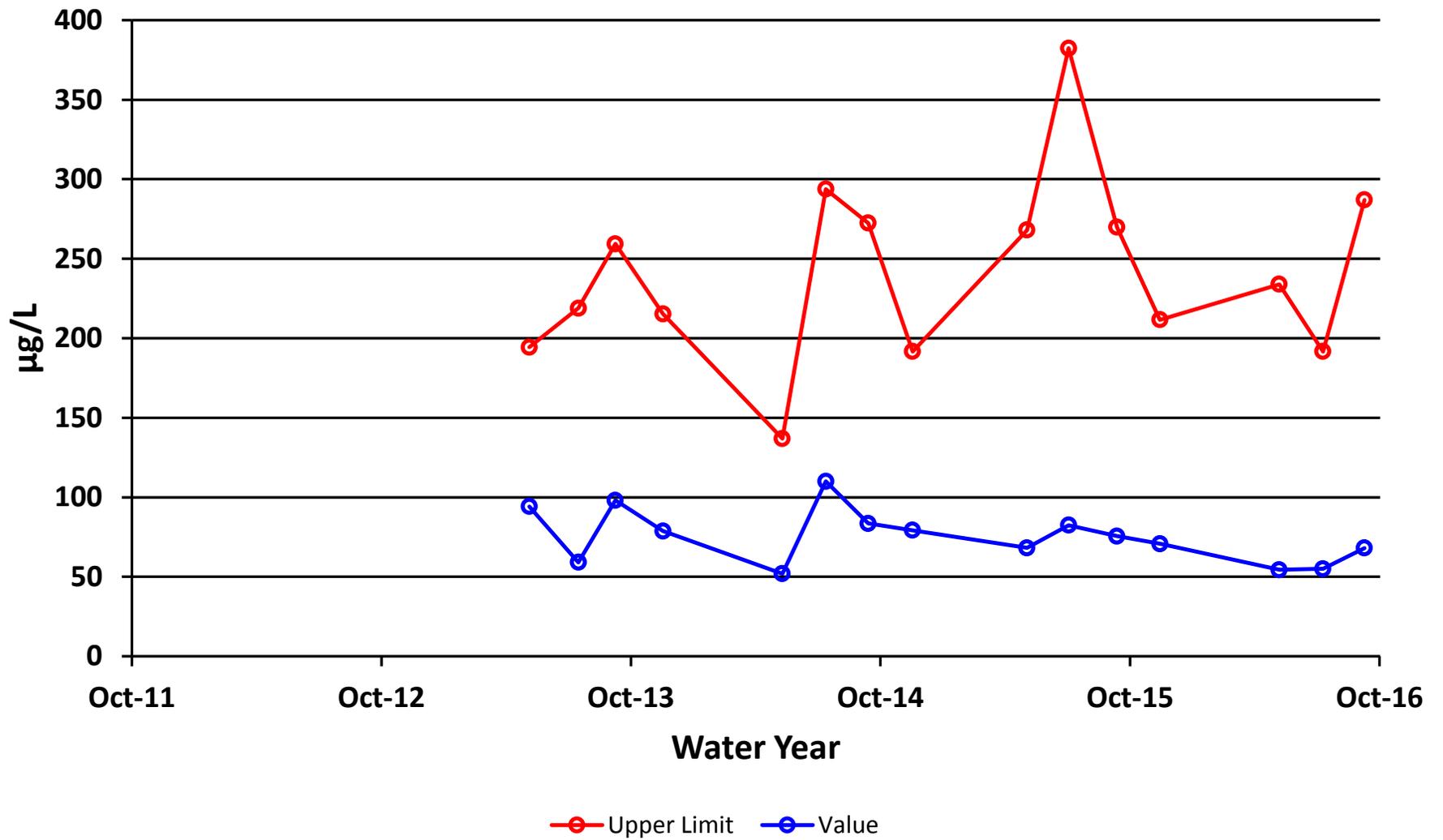
# Site 609 - Nickel Dissolved



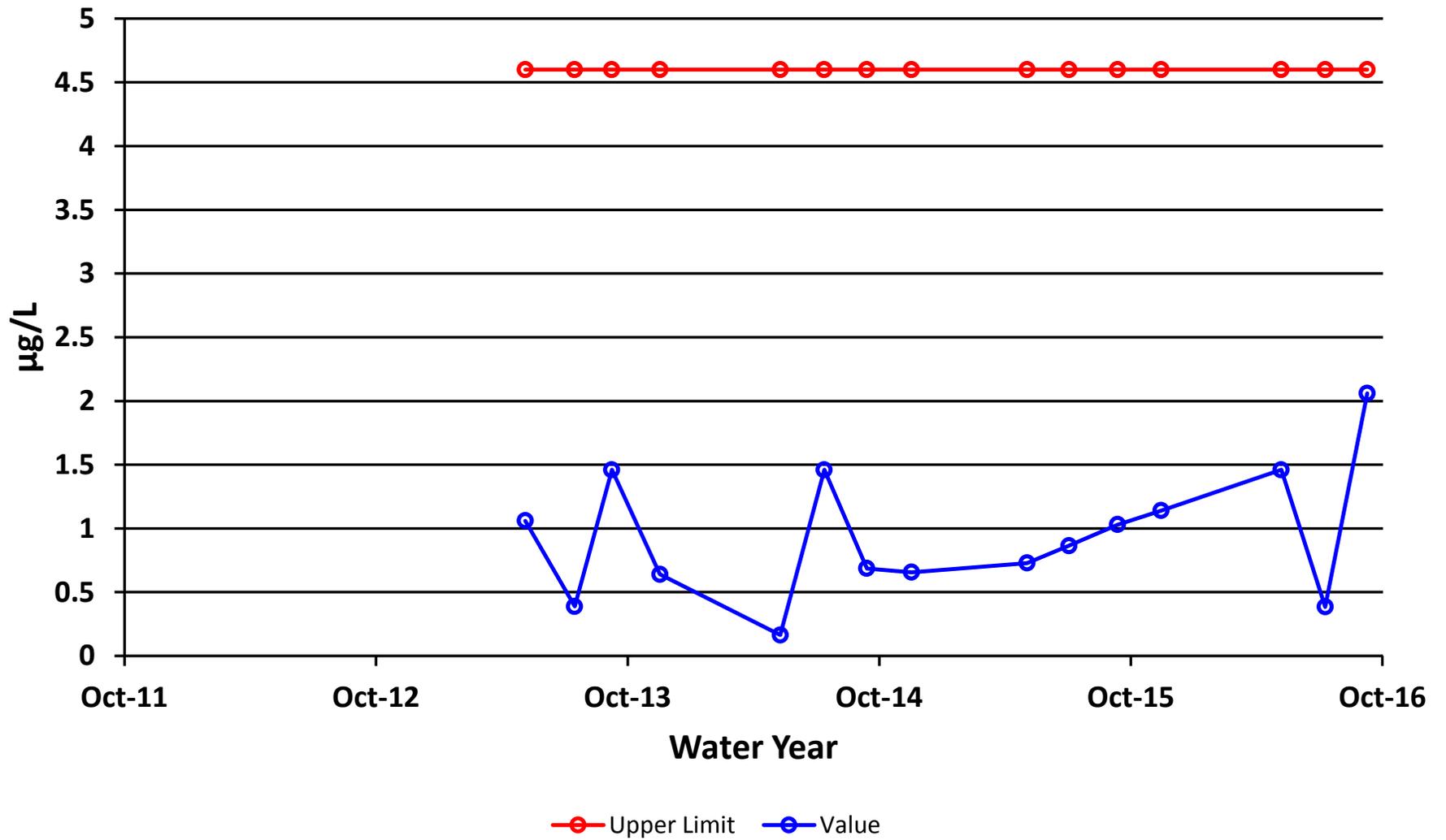
# Site 609 - Silver Dissolved



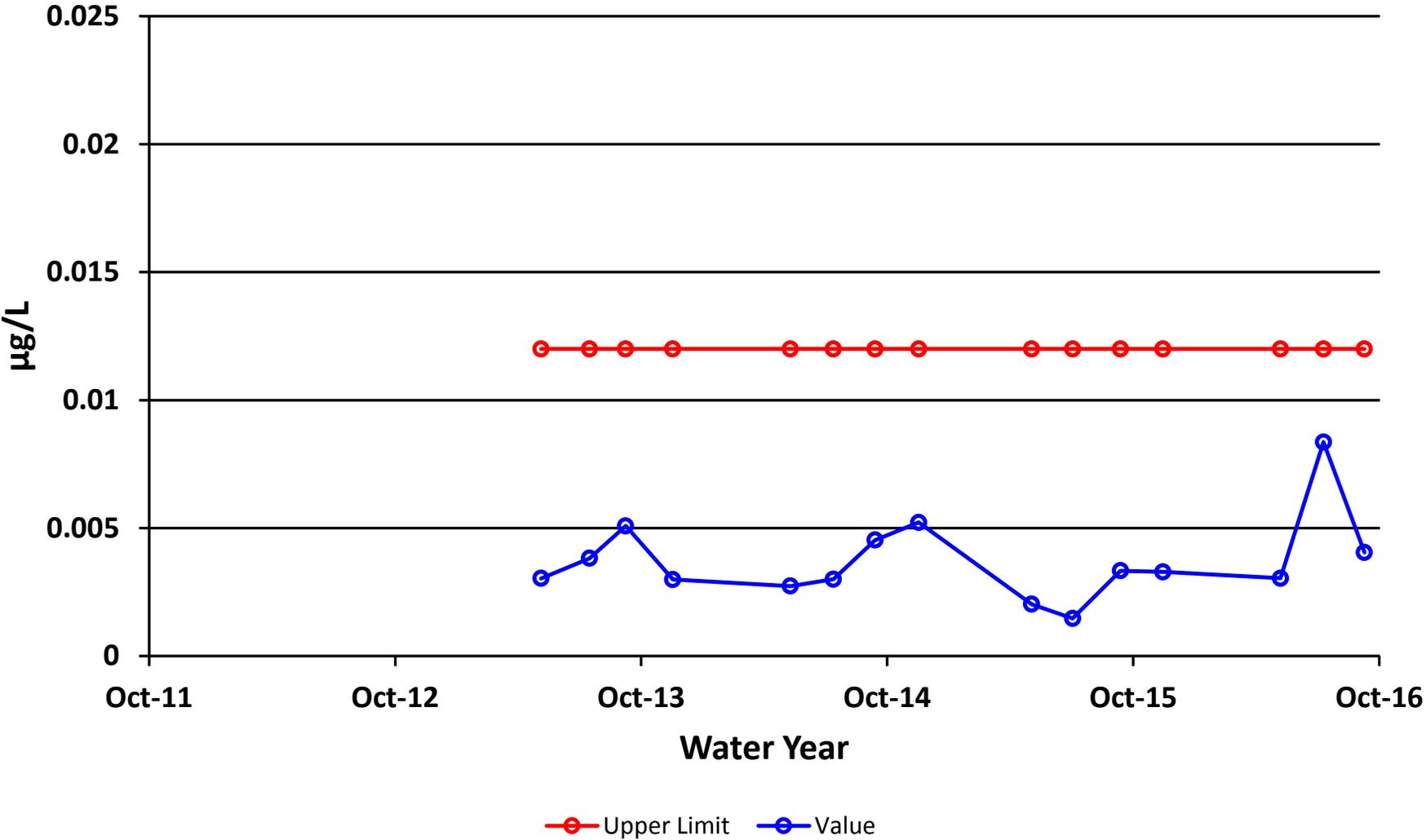
# Site 609 - Zinc Dissolved



# Site 609 - Selenium Dissolved



# Site 609 - Mercury Dissolved



# INTERPRETIVE REPORT

## SITE 711

Sampling at this site was initiated during the spring of Water Year 2014. This site was added to the FWMP at the request of the Forest Service. Site 711 is located on Greens Creek upgradient to any drainage from Site E, a waste rock disposal area.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past year is included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers have been identified by HGCMC for the period of October 2013 through September 2015.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeding these criteria were identified as listed in the table below.

### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

Only one of the two scheduled samples was collected during the 2016 Water Year. Sampling at Site 711 and Site 712 is to occur in the spring and fall, a specific month has not been assigned to the fall sample event. The fall sample can be taken in September, October, or November this can result in only one sample being collected. The 2017 Water Year FWMP report will include the fall 2016 water sample.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Because of the limited amount of data, visual trend analysis and statistical analysis of the data was not performed.

## Table of Results for Water Year 2016

### Site 711FMS - 'Greens Creek Above Site E'

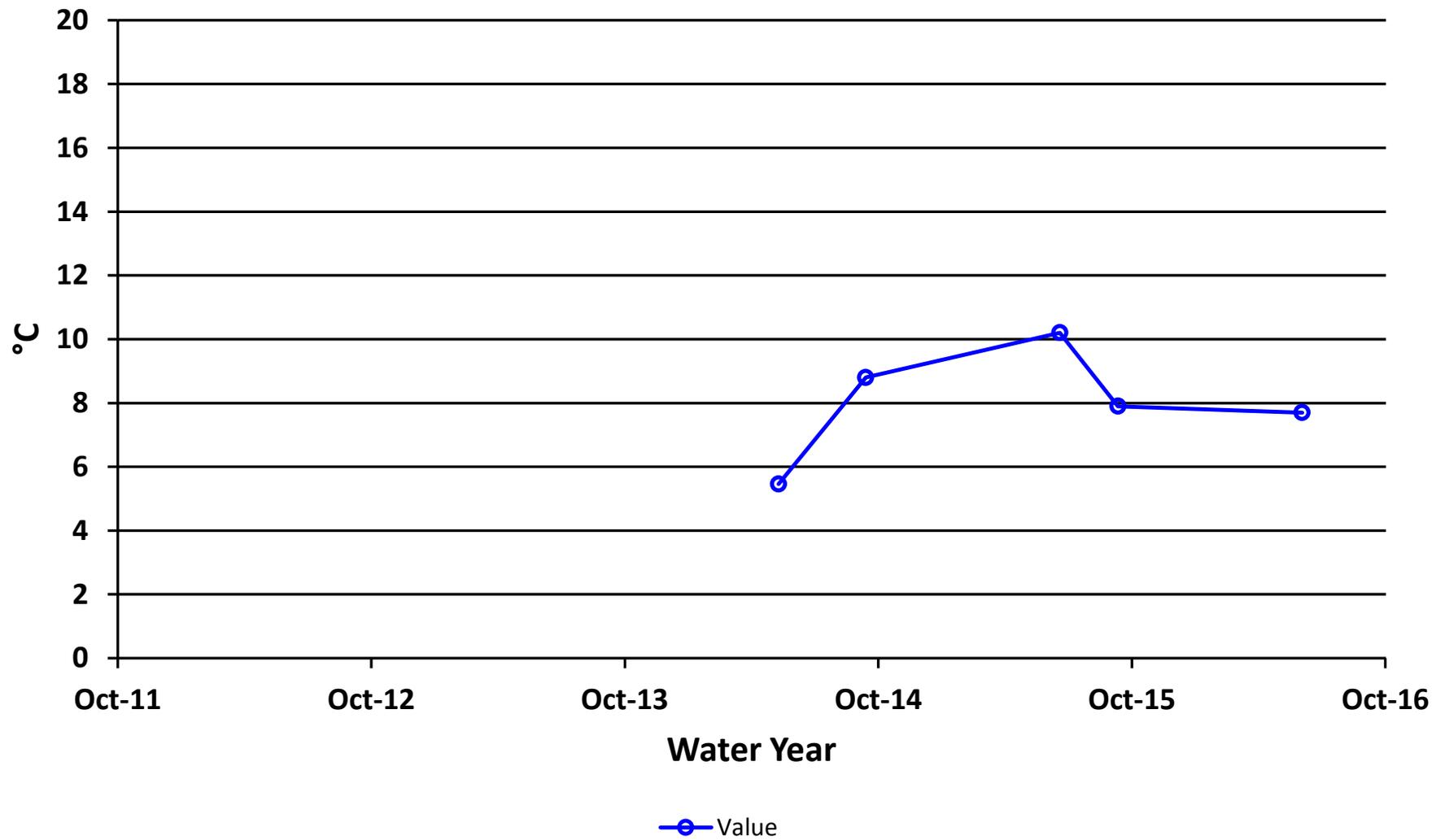
Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)									7.7				7.7
Conductivity-Field(µmho)									97.9				97.9
Conductivity-Lab (µmho)									98				98
pH Lab (standard units)									7.7				7.70
pH Field (standard units)									8.08				8.08
Total Alkalinity (mg/L)									42.5				42.5
Total Sulfate (mg/L)									9.6				9.6
Hardness (mg/L)									47.2				47.2
Dissolved As (ug/L)									0.2				0.200
Dissolved Ba (ug/L)									29.8				29.8
Dissolved Cd (ug/L)									0.0268				0.0268
Dissolved Cr (ug/L)									0.114				0.114
Dissolved Cu (ug/L)									0.42				0.420
Dissolved Pb (ug/L)									0.0173				0.0173
Dissolved Ni (ug/L)									0.347				0.347
Dissolved Ag (ug/L)									0.002				0.002
Dissolved Zn (ug/L)									2.43				2.43
Dissolved Se (ug/L)									0.615				0.615
Dissolved Hg (ug/L)									0.000716				0.000716

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

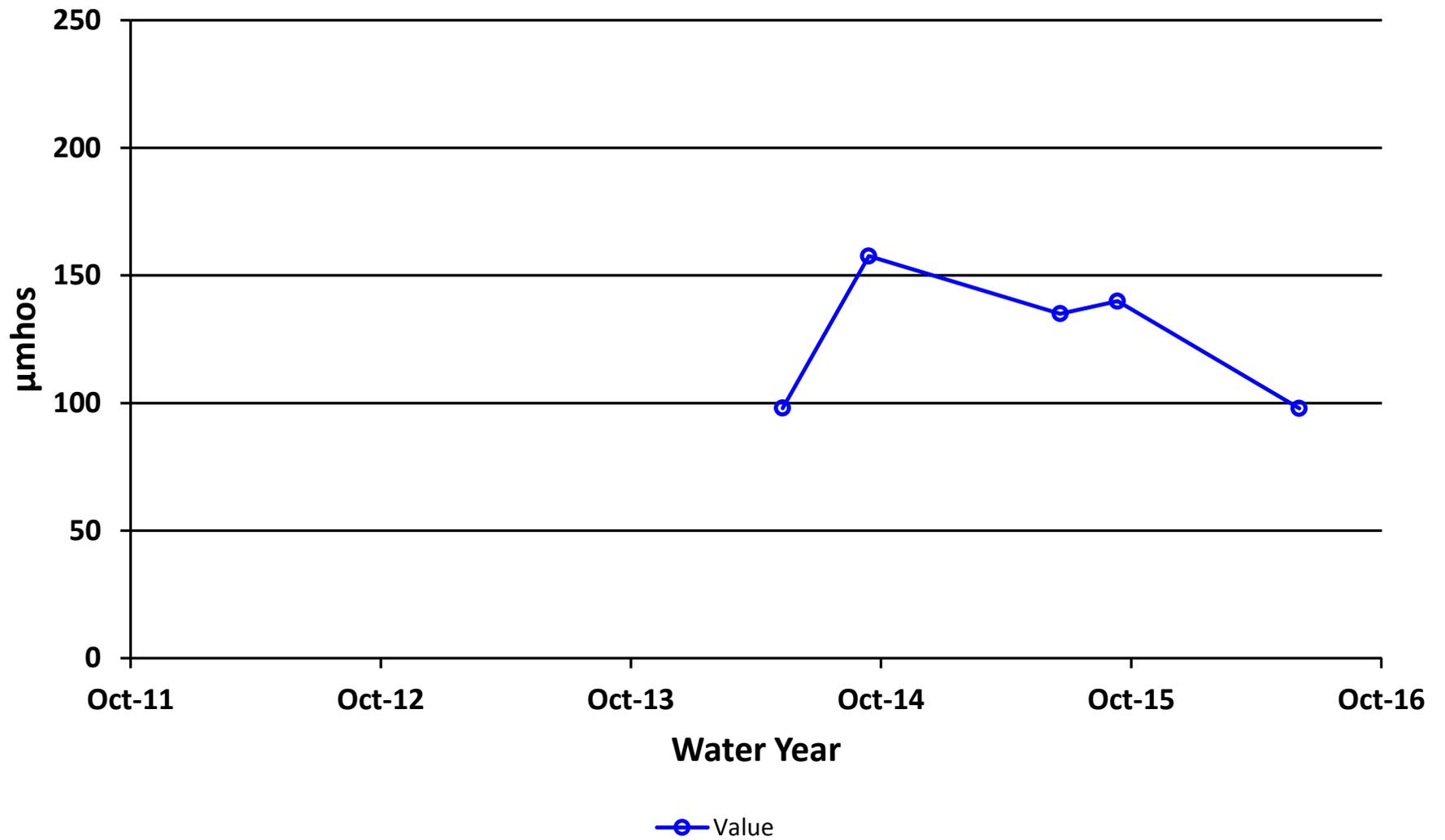
Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

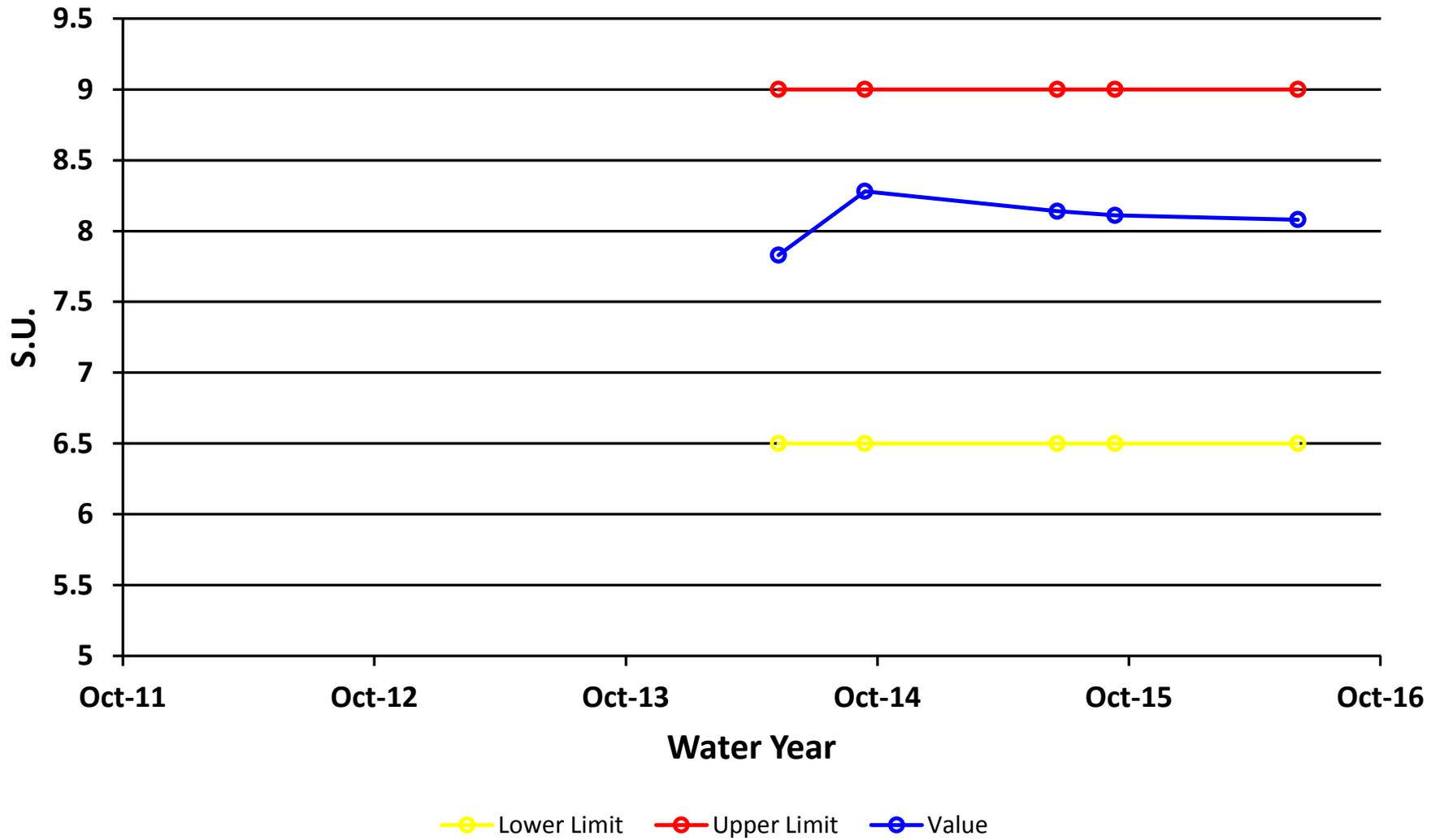
## Site 711 - Water Temperature



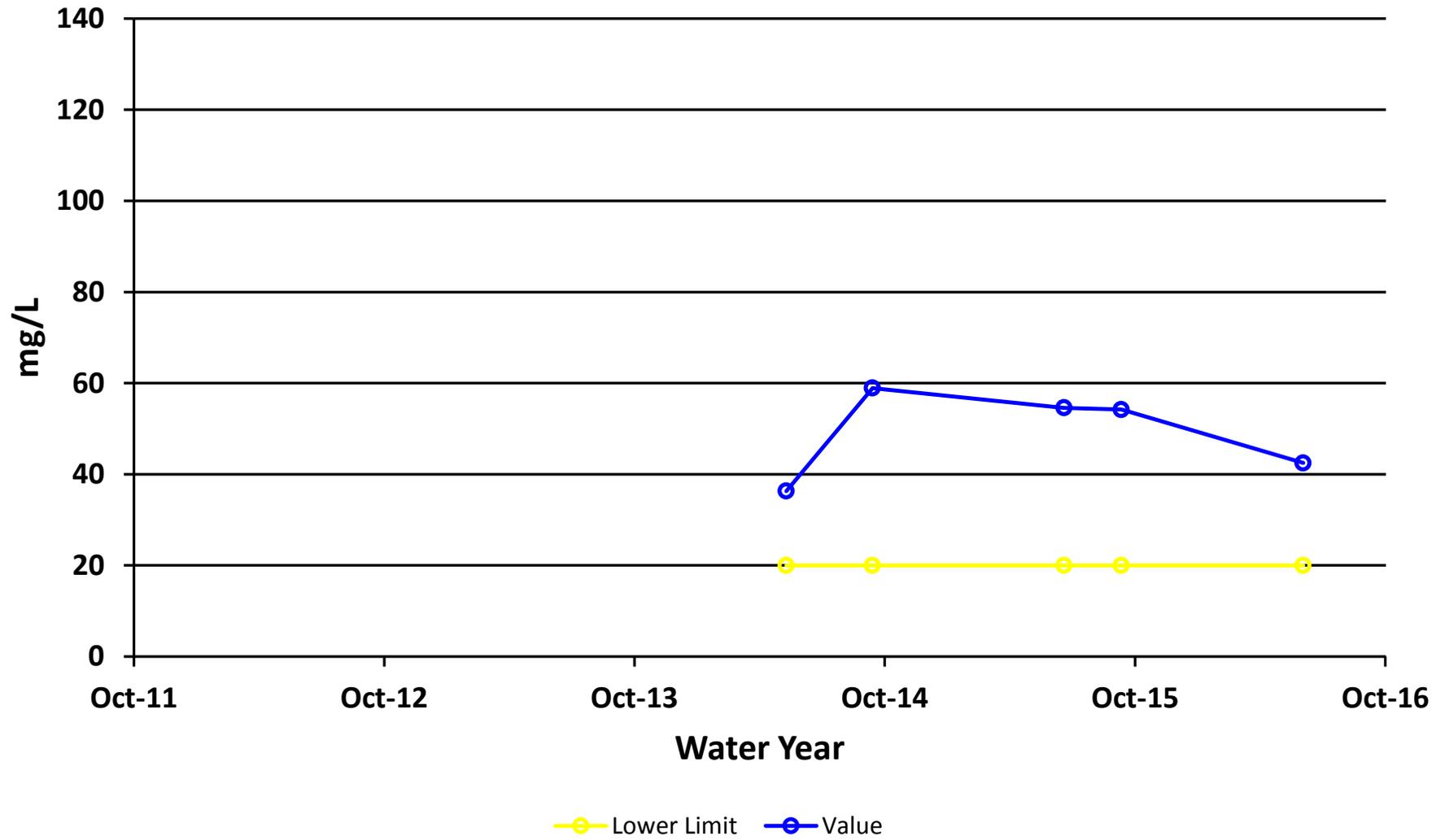
## Site 711 - Conductivity Field



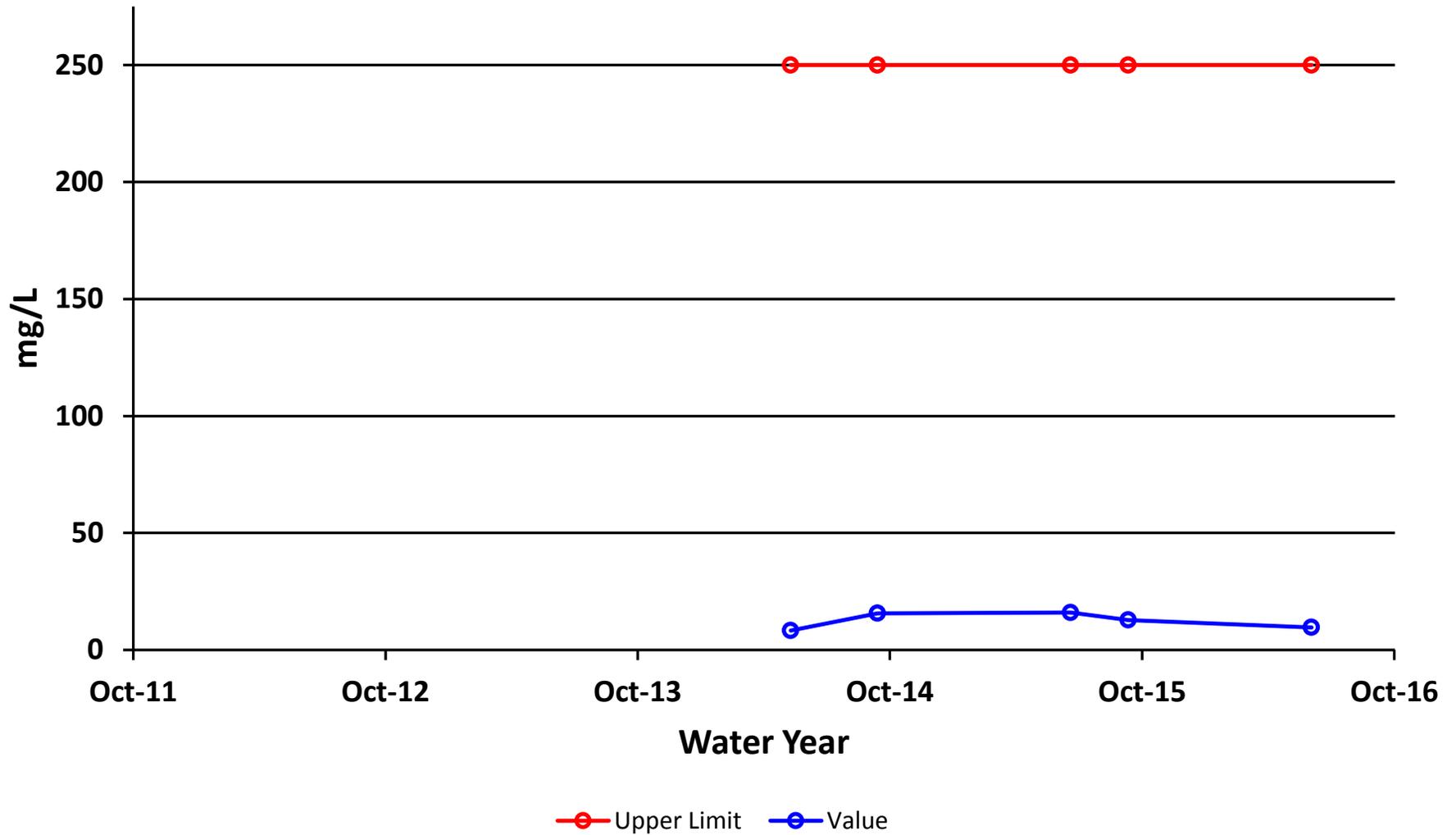
# Site 711 - pH Field



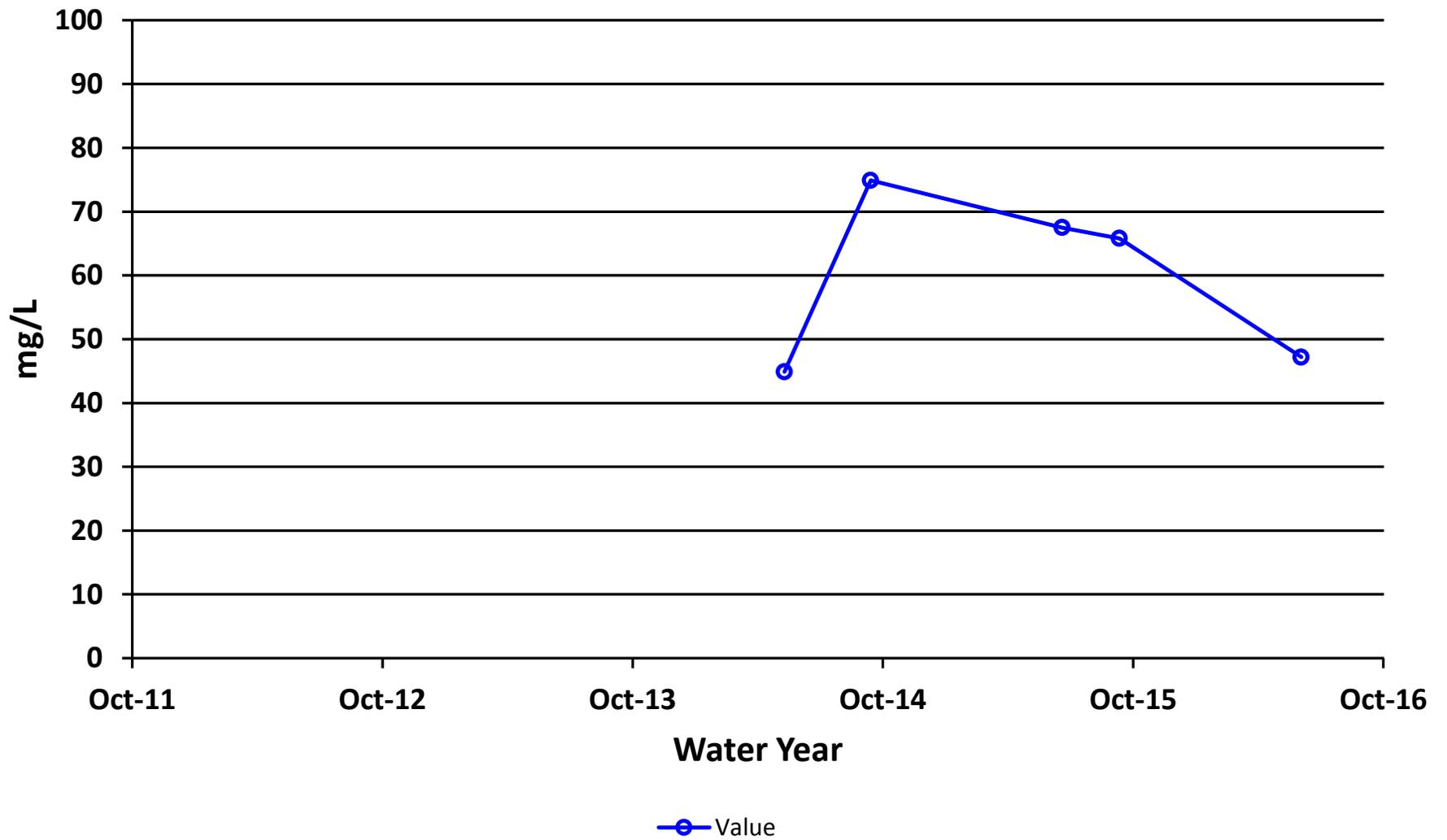
# Site 711 - Alkalinity



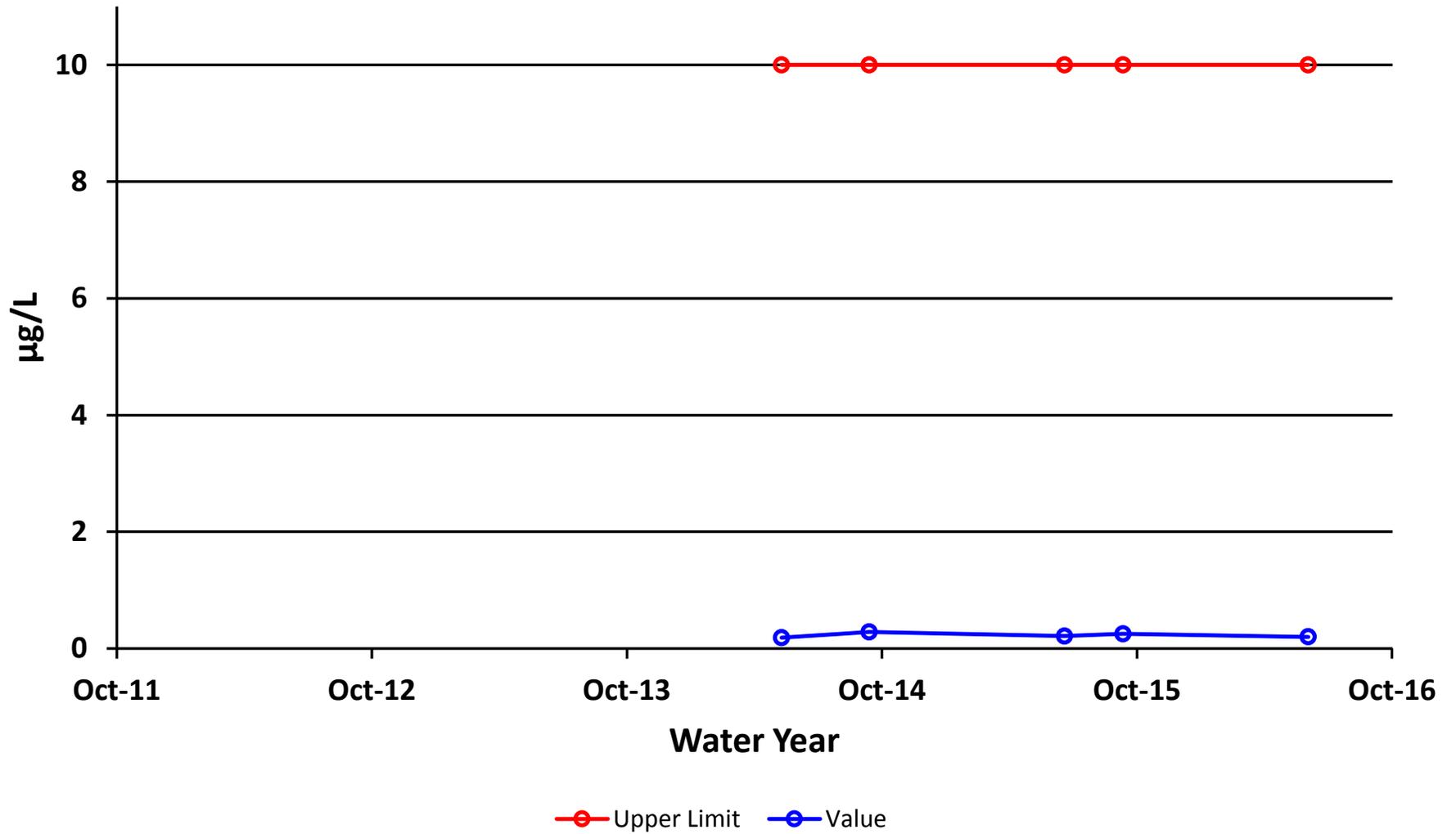
# Site 711 - Sulfate



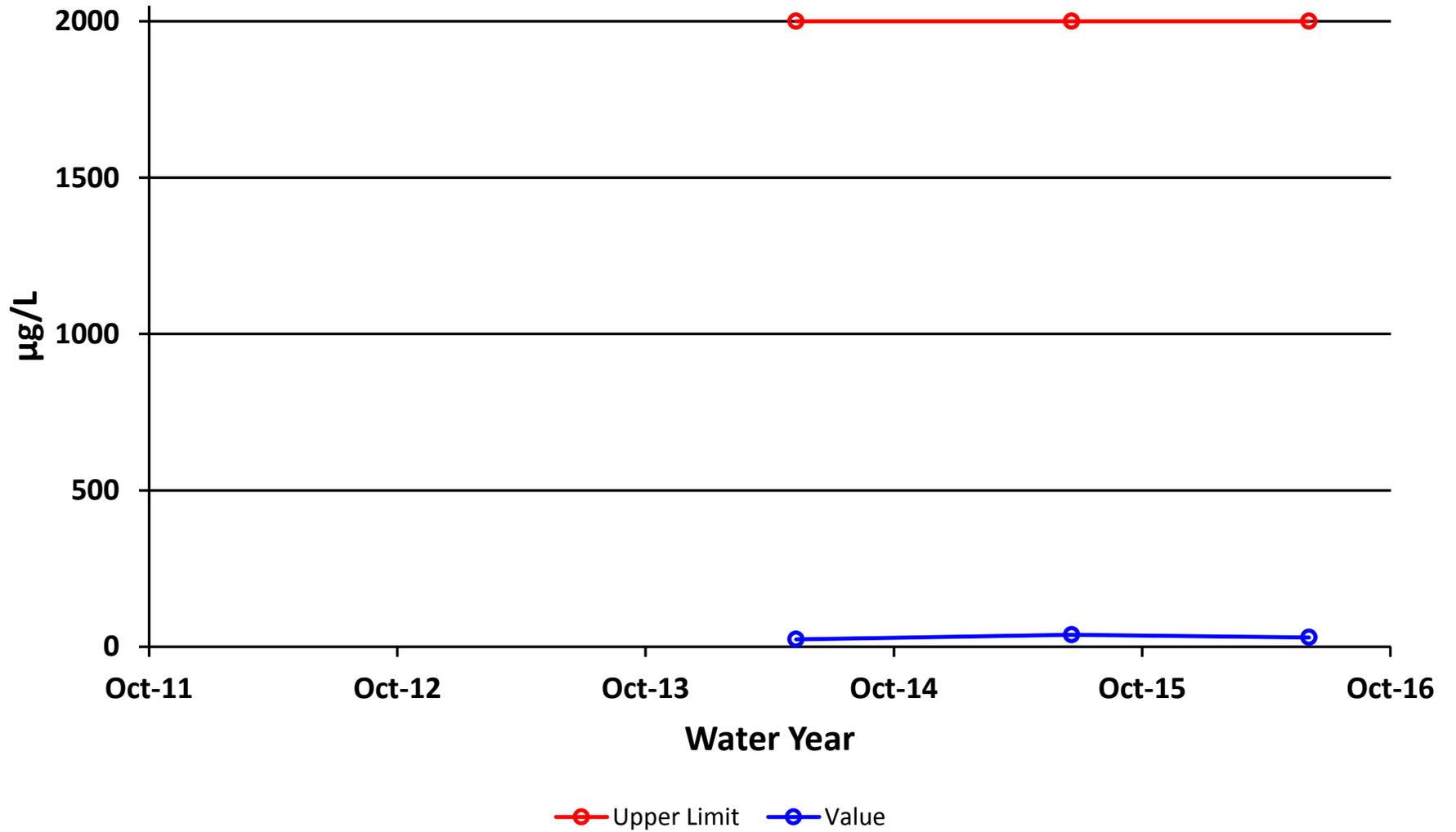
## Site 711 - Hardness



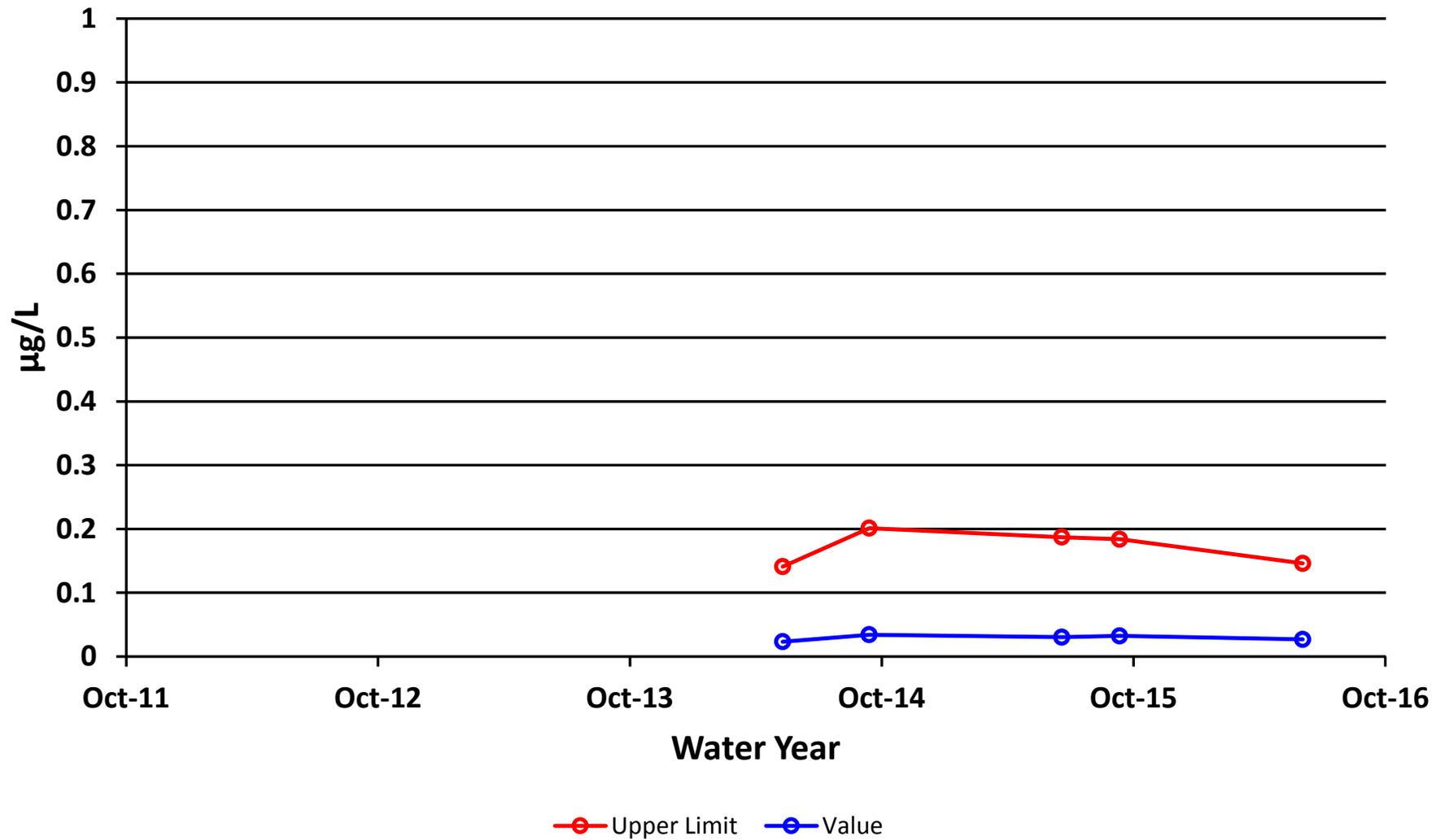
# Site 711 - Arsenic Dissolved



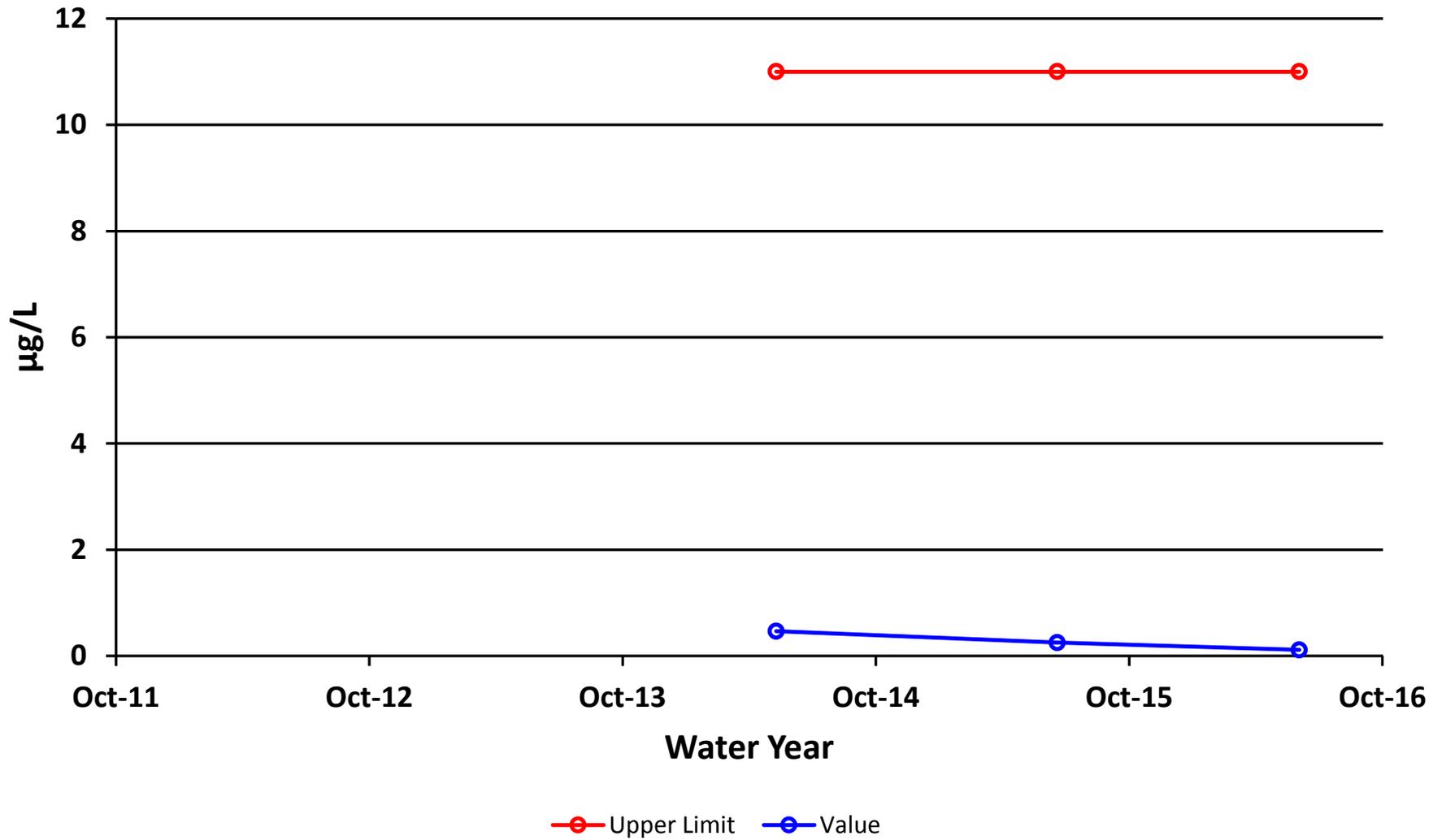
# Site 711 - Barium Dissolved



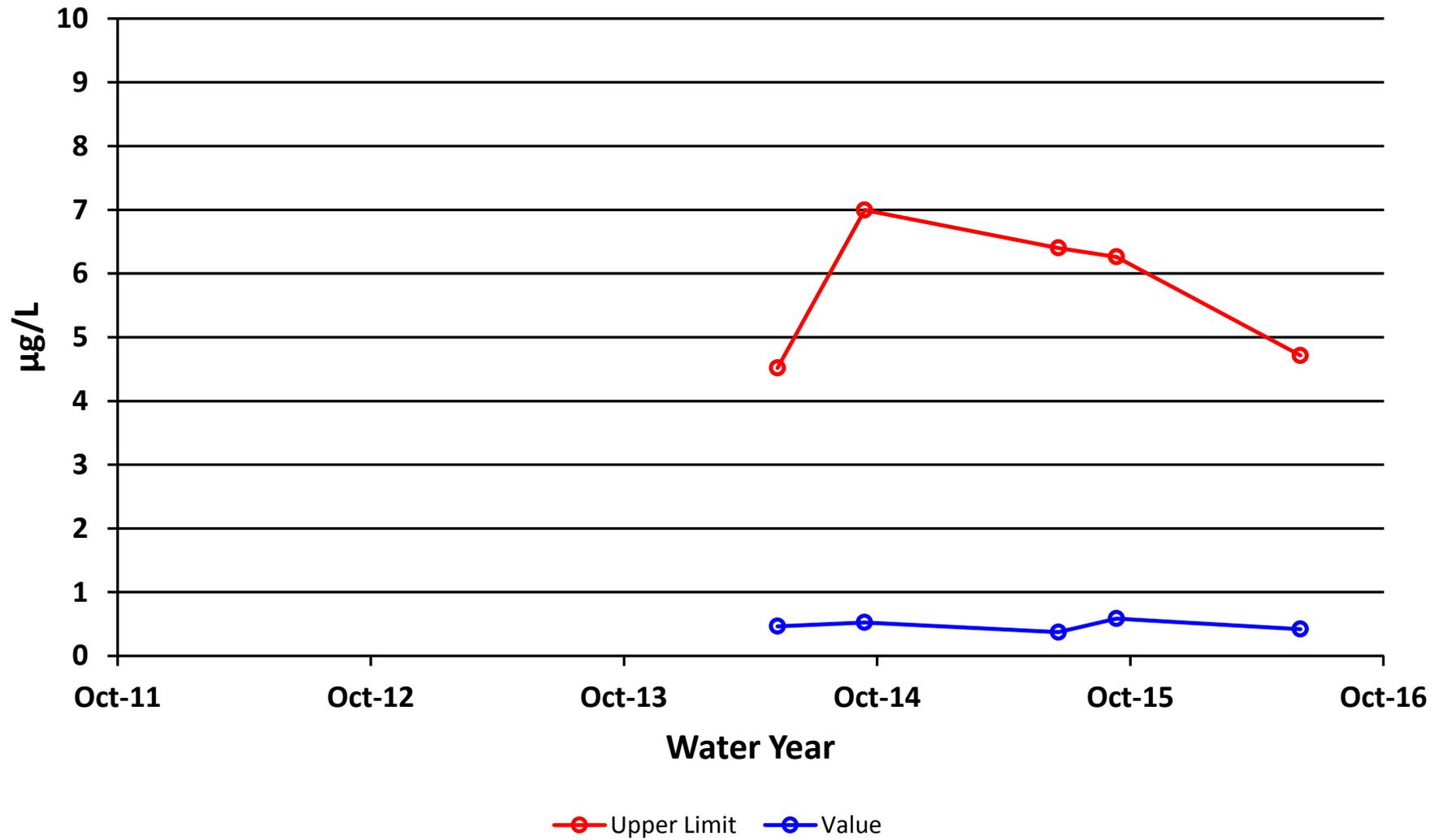
# Site 711 - Cadmium Dissolved



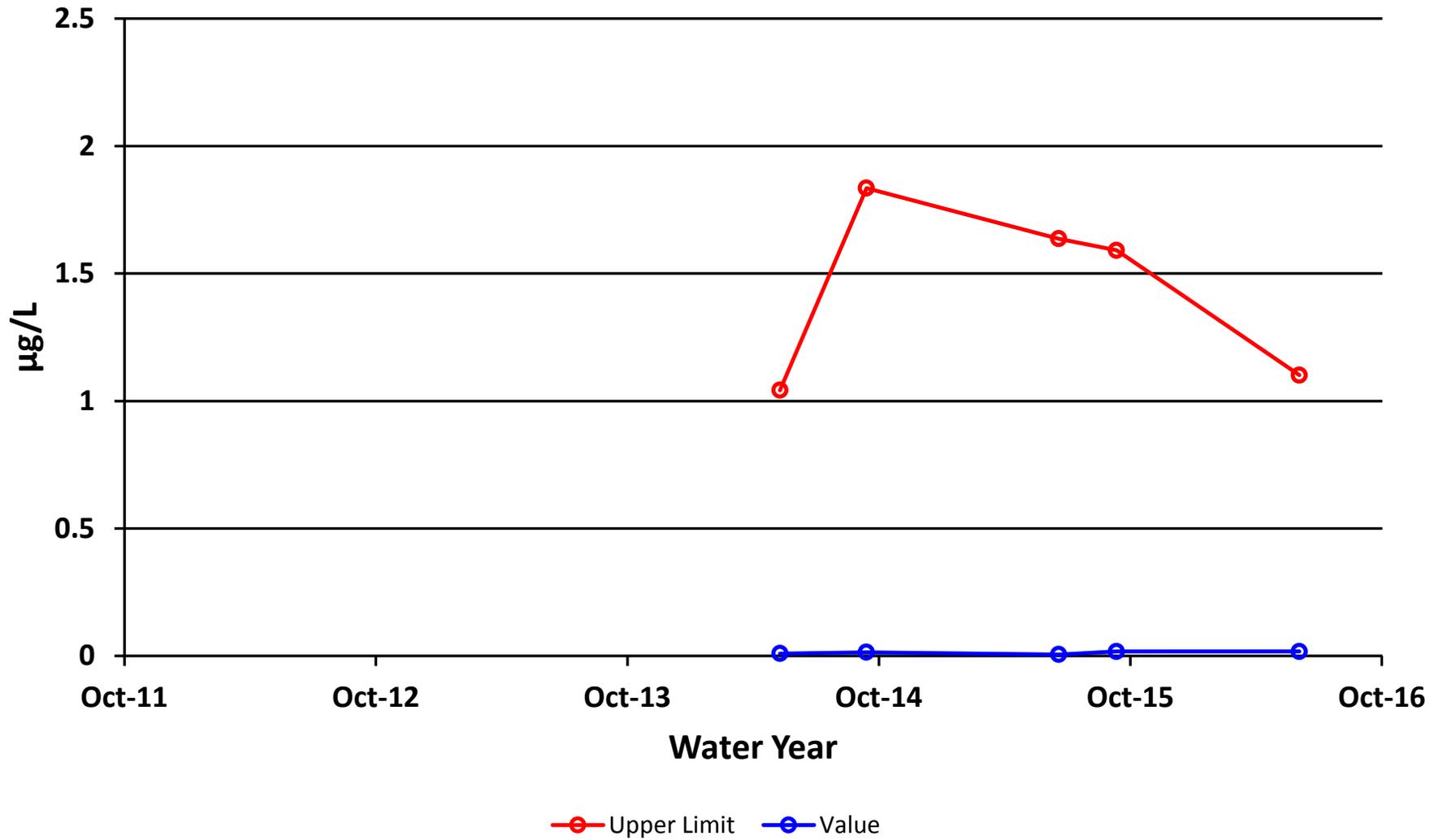
# Site 711 - Chromium Dissolved



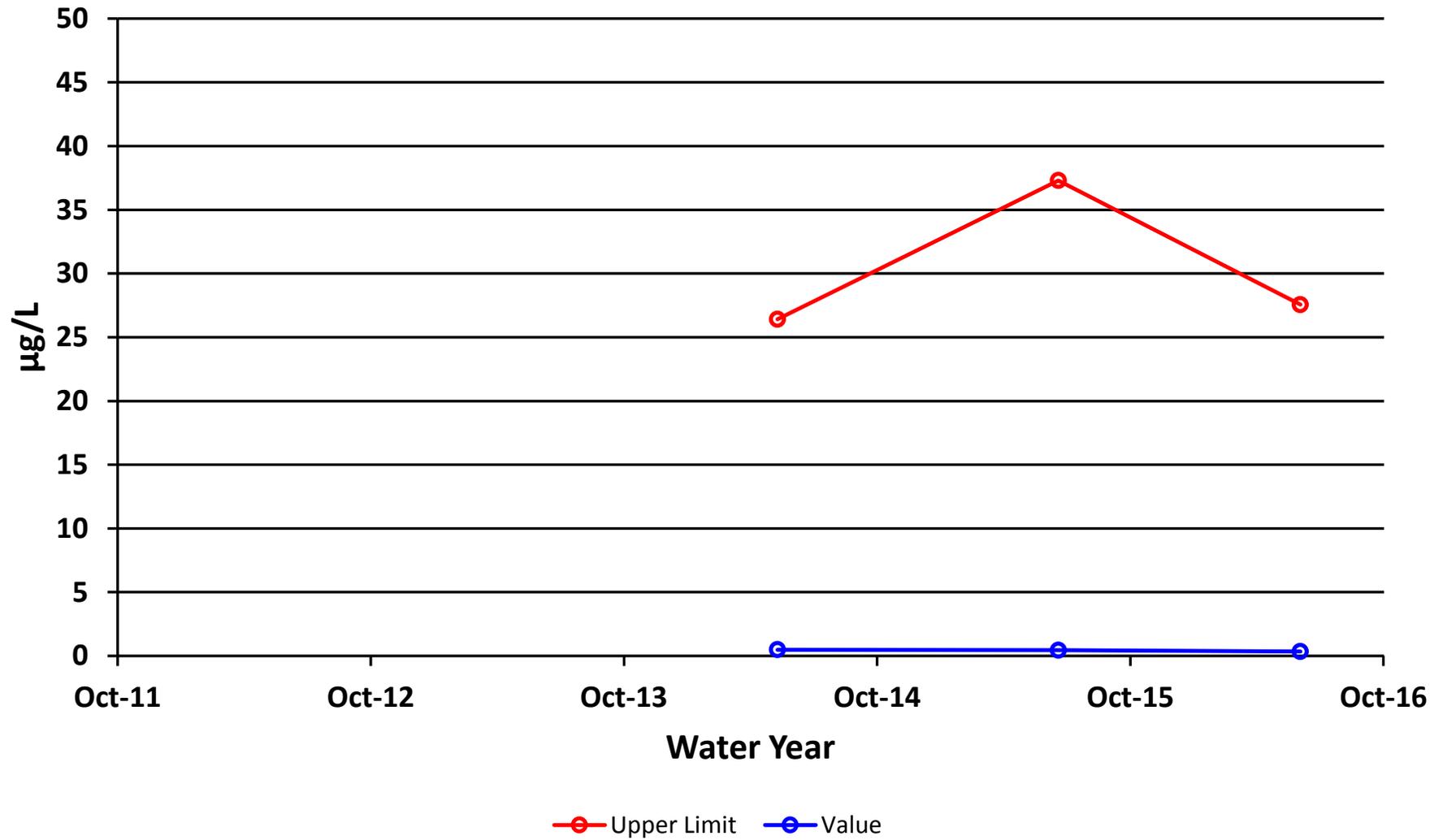
# Site 711 - Copper Dissolved



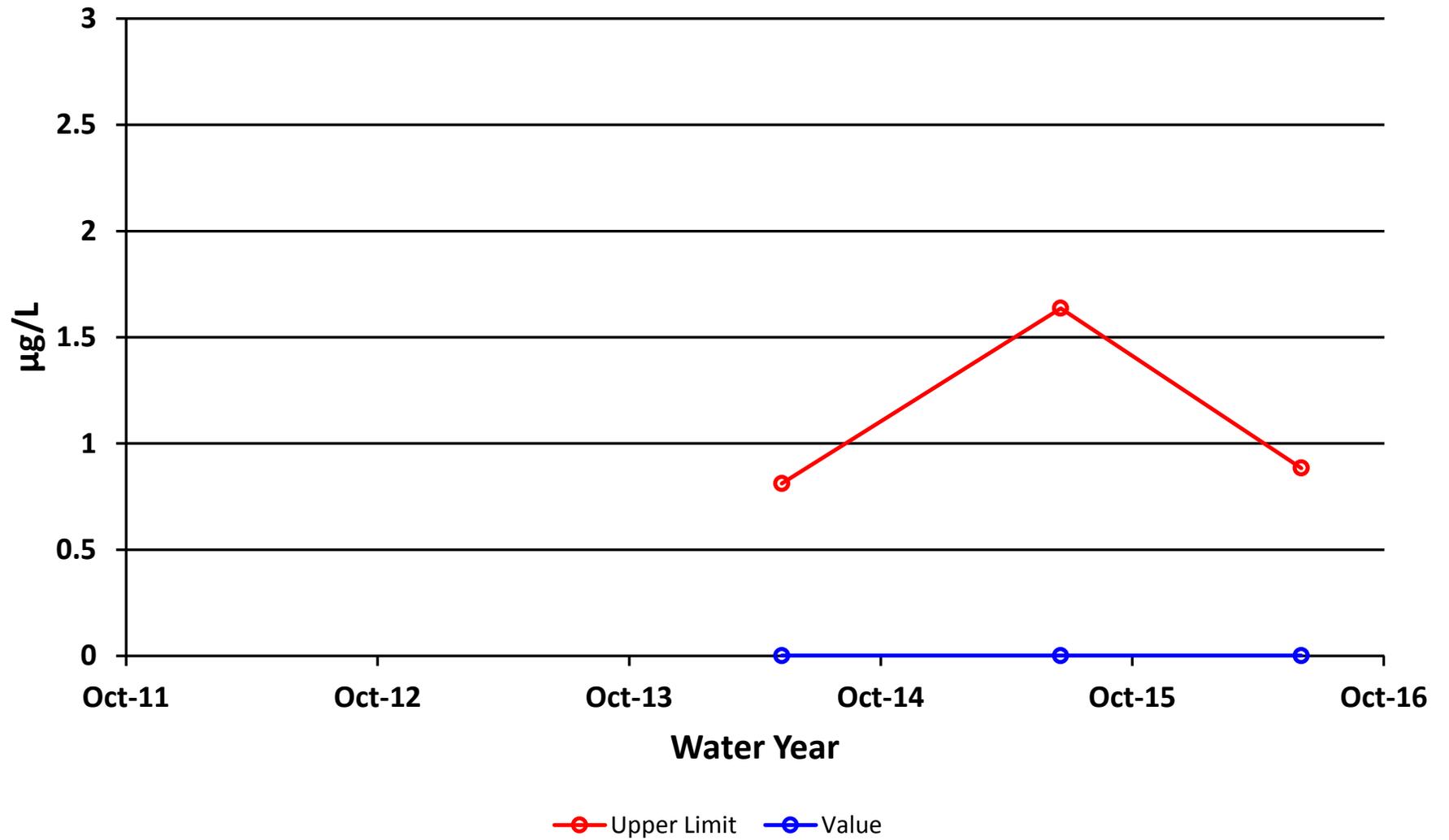
# Site 711 - Lead Dissolved



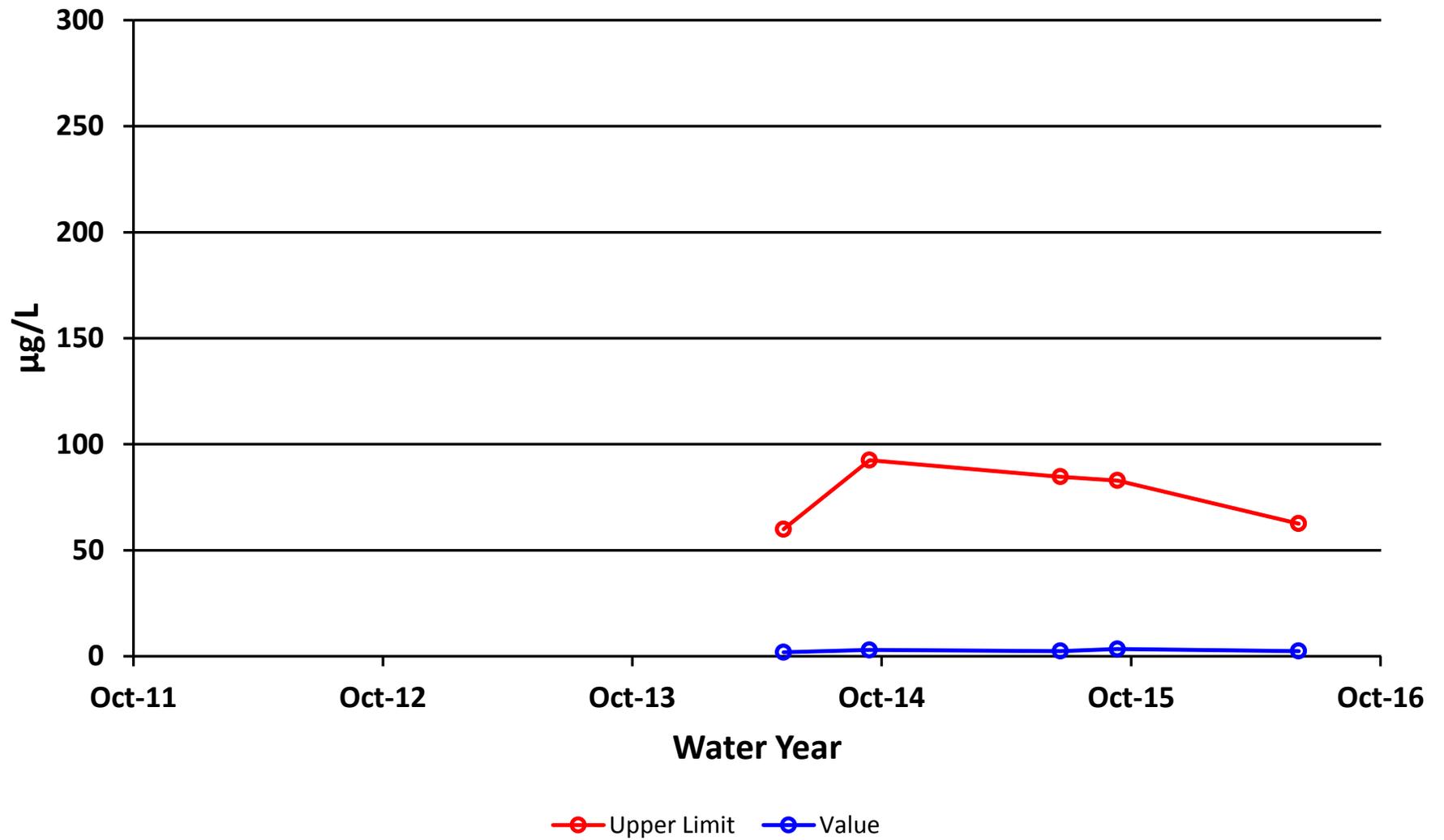
## Site 711 - Nickel Dissolved



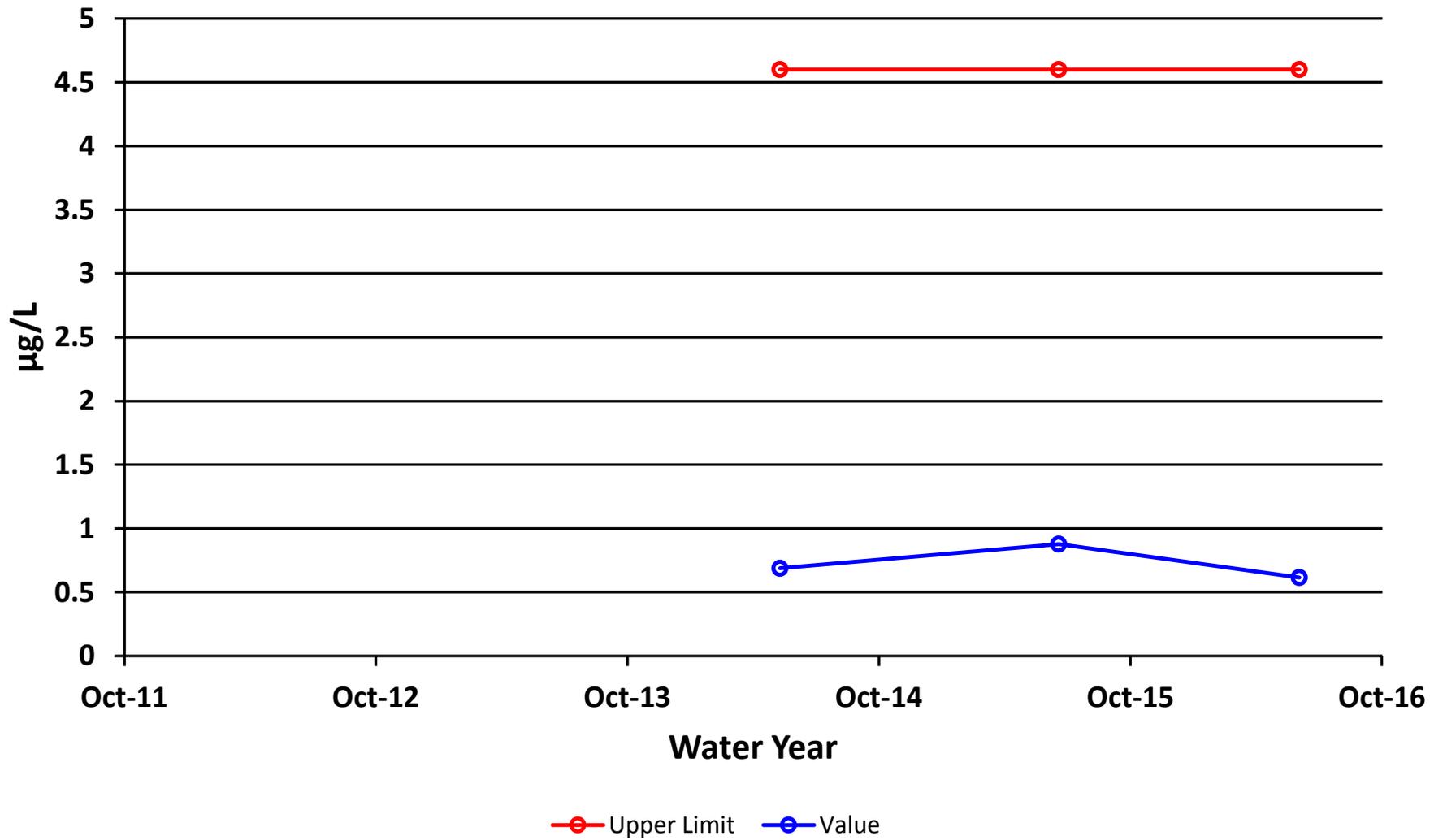
# Site 711 - Silver Dissolved



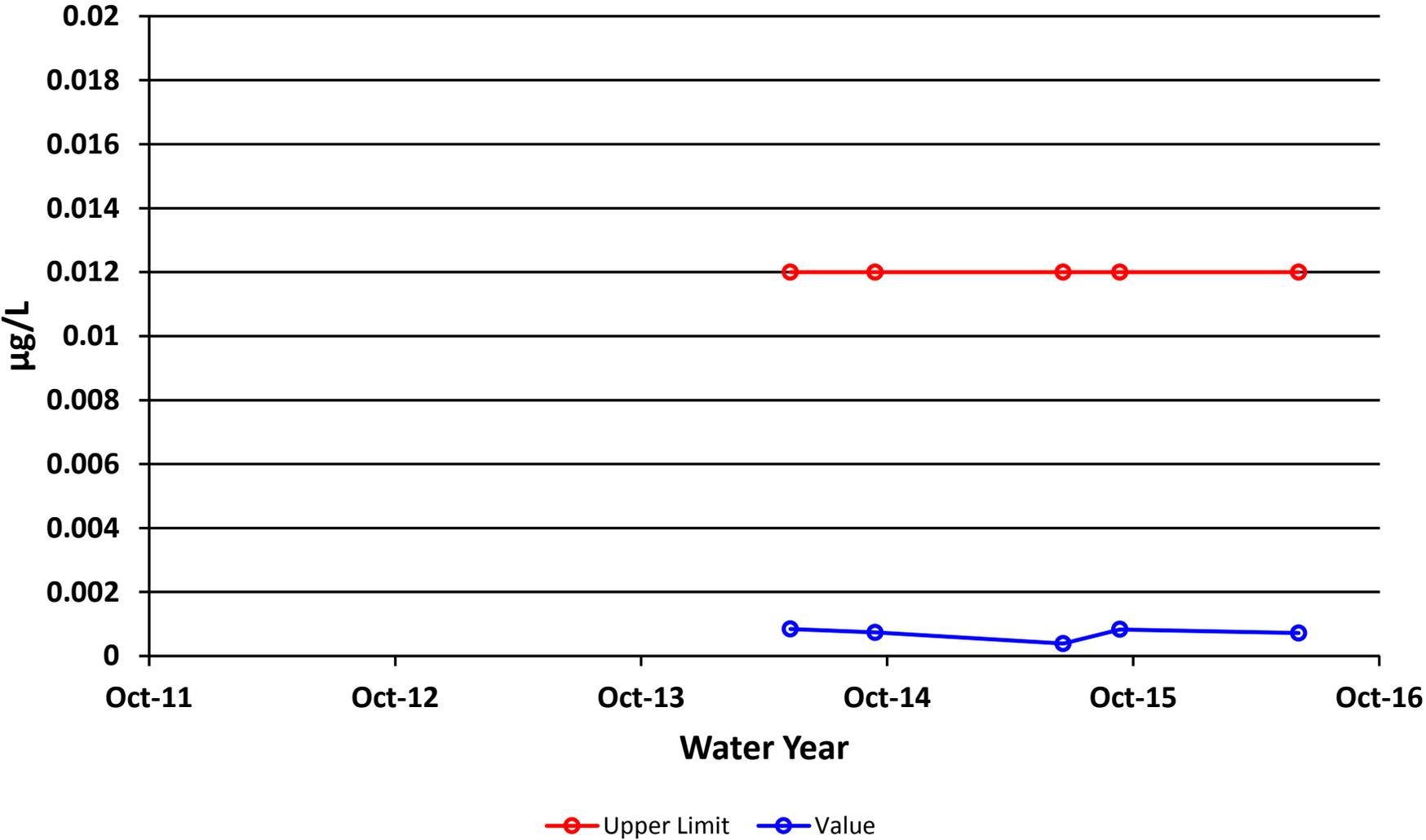
# Site 711 - Zinc Dissolved



# Site 711 - Selenium Dissolved



# Site 711 - Mercury Dissolved



## INTERPRETIVE REPORT

### SITE 712

Sampling at this site was initiated during the spring of Water Year 2014. This site was added to the FWMP at the request of the Forest Service. Site 712 is located on Greens Creek down gradient to any drainage from Site E, a waste rock disposal area.

The data collected during the current water year are listed in the following “Table of Results for Water Year 2016” report. The table includes all the required FWMP analyte data (field and laboratory) collected for the current water year and a series of flags keyed to the summary report “Qualified Data by QA Reviewer”. The QA report lists any associated data limitations found during the monthly QA reviews of laboratory data for this site. Median values for all analytes have been calculated and are shown in the right-most column of the table of results. Any value reported as less than MDL has been replaced with a value of ½ MDL for the purpose of median calculation.

All data collected at this site for the past year is included in the data analyses. As shown in the table below, there were no data outliers.

Sample Date	Parameter	Value	Qualifier	Notes
No outliers have been identified by HGCMC for the period of October 2013 through September 2015.				

The data for Water Year 2016 have been compared to the strictest fresh water quality criterion for each applicable analyte. No results exceeding these criteria were identified as listed in the table below.

#### Table of Exceedance for Water Year 2016

Sample Date	Parameter	Value	Limits		
			Lower	Upper	Hardness
No exceedances have been identified by HGCMC for the period of October 2015 through September 2016.					

Only one of the two scheduled samples was collected during the 2016 Water Year. Sampling at Site 711 and Site 712 is to occur in the spring and fall, a specific month has not been assigned to the fall sample event. The fall sample can be taken in September, October, or November this can result in only one sample being collected for the Water Year. The 2017 Water Year FWMP report will include the fall 2016 water sample.

X-Y plots have been generated to graphically present the data for each of the analytes requested in the Statistical Information Goals for this site. Because of the limited amount of data, visual trend analysis and statistical analysis of the data was not performed.

## Table of Results for Water Year 2016

### Site 712FMS - 'Greens Creek Below Site E'

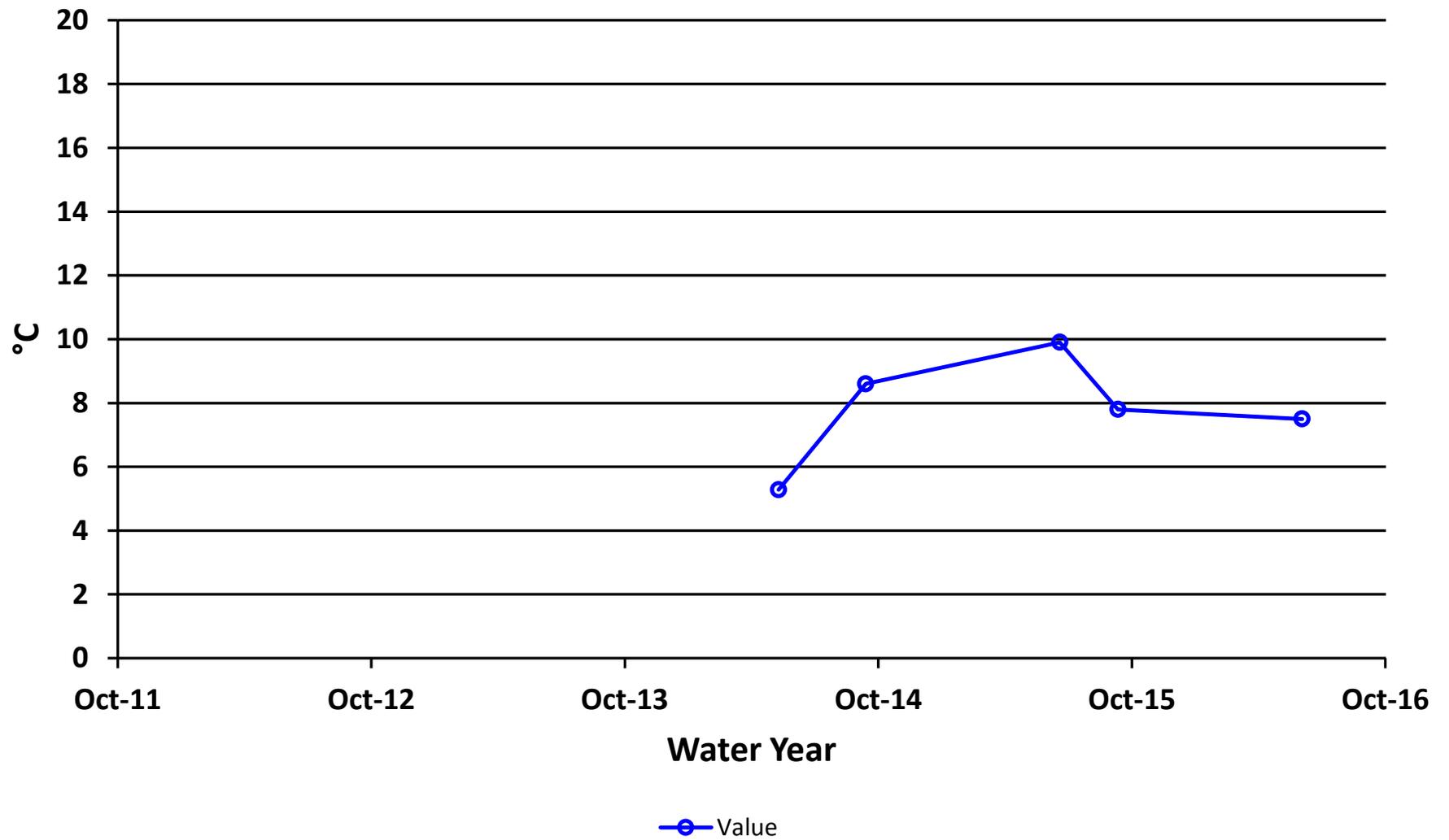
Sample Date/Parameter	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Median
Water Temp (°C)									7.5				7.5
Conductivity-Field(µmho)									100.3				100.3
Conductivity-Lab (µmho)									101				101
pH Lab (standard units)									7.67				7.67
pH Field (standard units)									7.97				7.97
Total Alkalinity (mg/L)									43.1				43.1
Total Sulfate (mg/L)									10.3				10.3
Hardness (mg/L)									48.3				48.3
Dissolved As (ug/L)									0.198				0.198
Dissolved Ba (ug/L)									30.3				30.3
Dissolved Cd (ug/L)									0.0297				0.0297
Dissolved Cr (ug/L)									0.116				0.116
Dissolved Cu (ug/L)									0.453				0.453
Dissolved Pb (ug/L)									0.0179				0.0179
Dissolved Ni (ug/L)									0.389				0.389
Dissolved Ag (ug/L)									0.002				0.002
Dissolved Zn (ug/L)									3.85				3.85
Dissolved Se (ug/L)									0.641				0.641
Dissolved Hg (ug/L)									0.000682				0.000682

For individual sample/analyte qualifier descriptions see "Qualified Data by QA Reviewer" table.

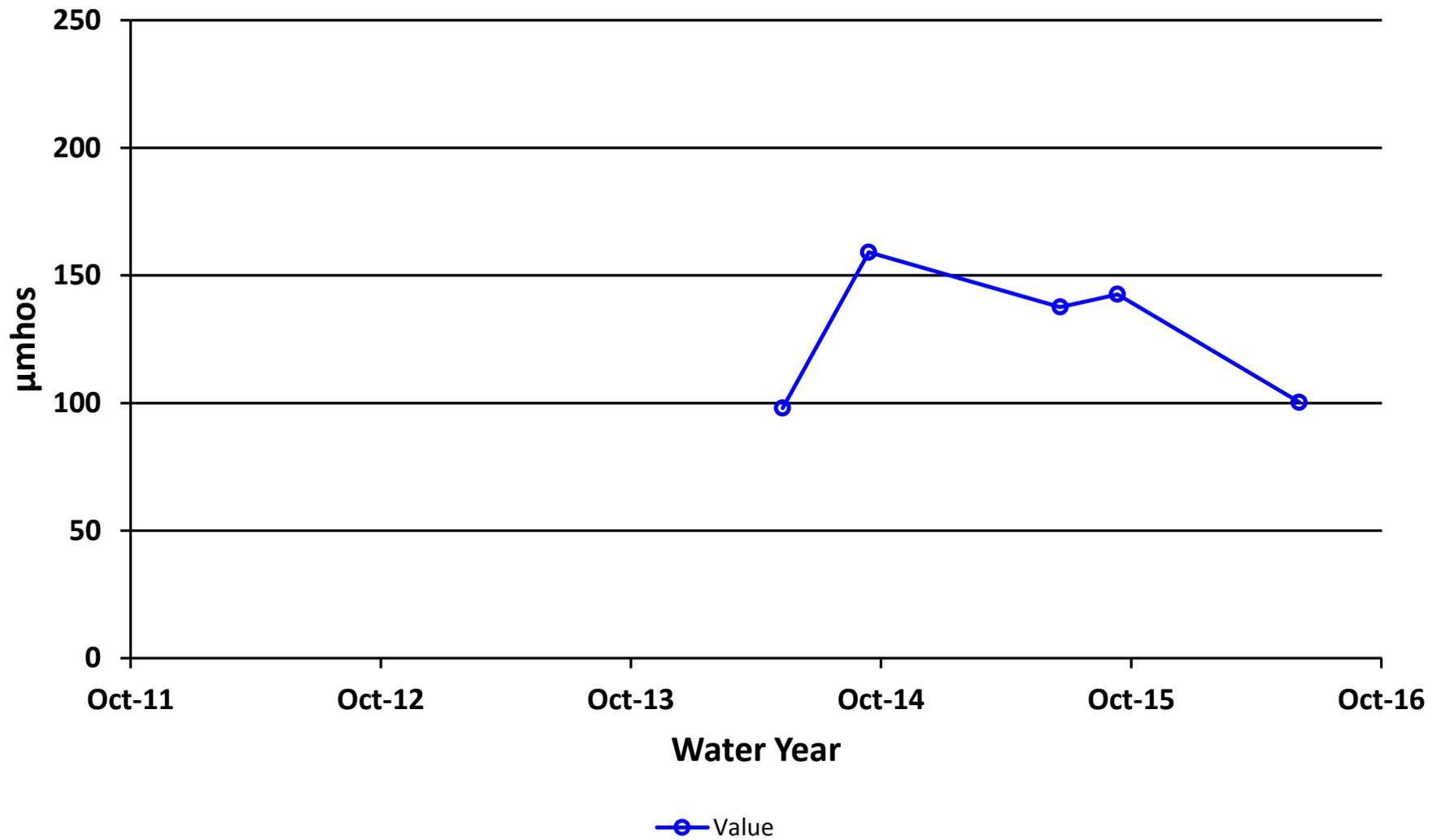
Values reported as less than MDL are replaced by 1/2 MDL for median calculation purposes.

Shaded data has been qualified as an outlier by HGCMC and removed from any further analysis and is not included into the calculation of the median

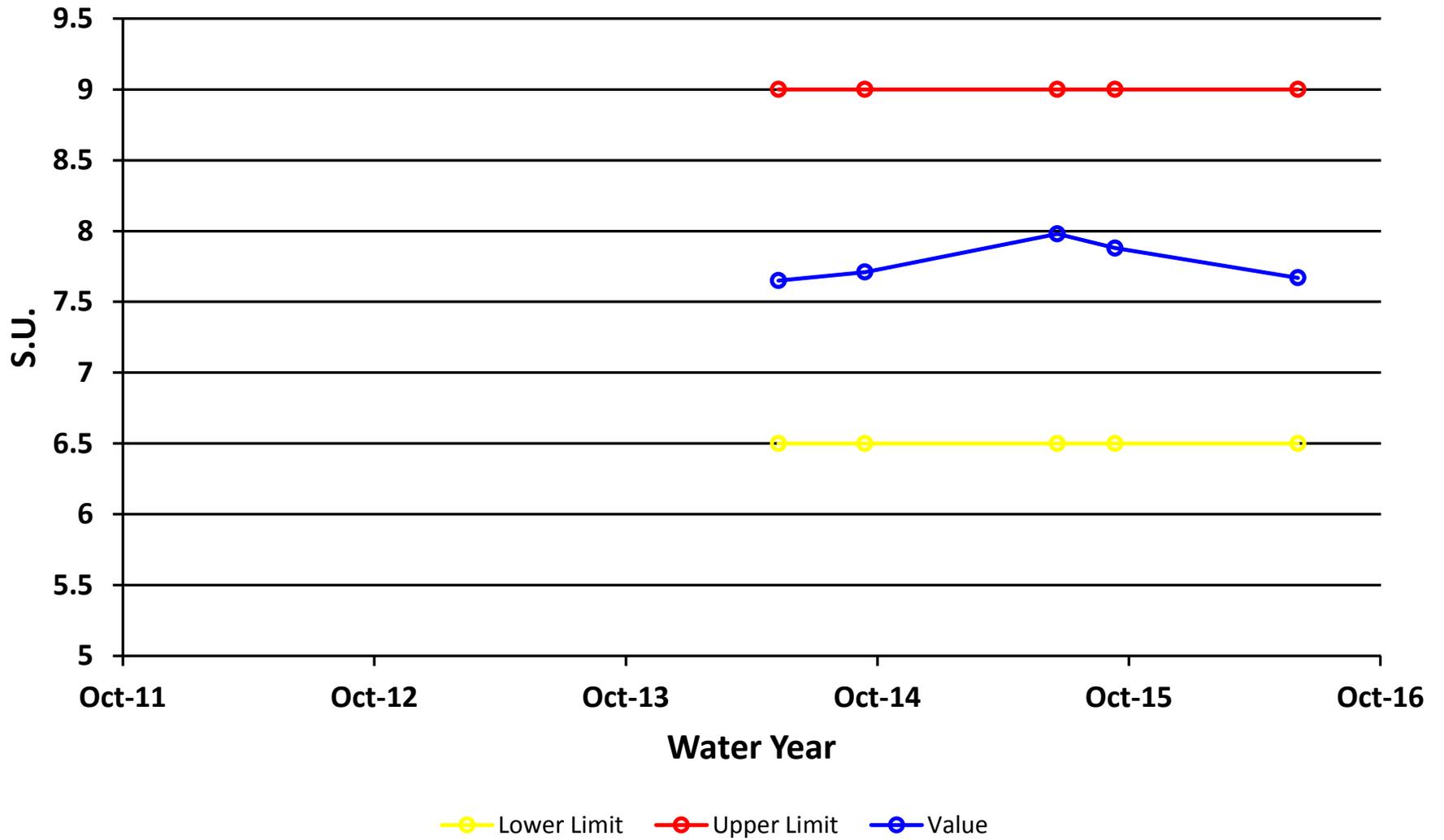
## Site 712 - Water Temperature



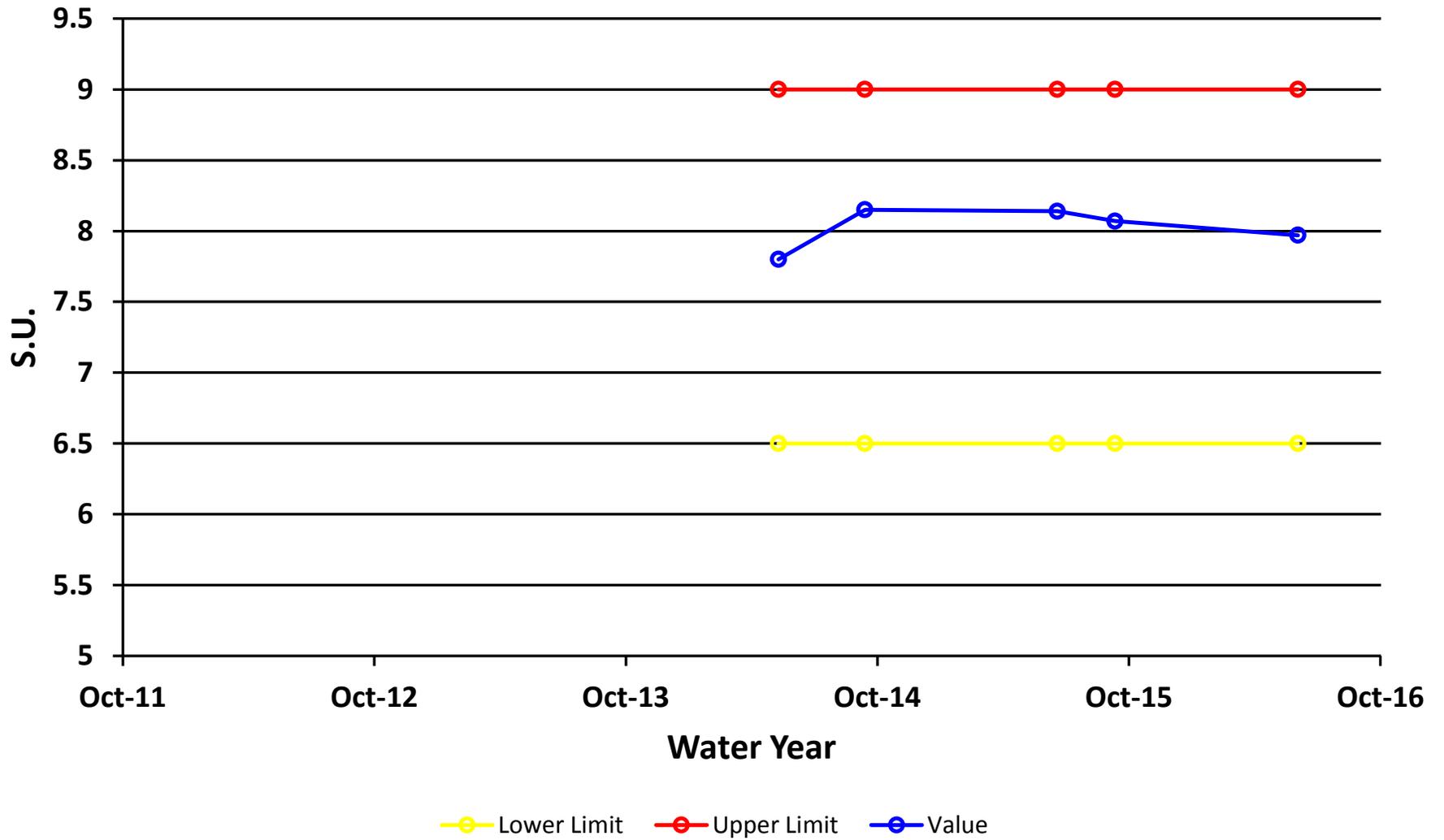
## Site 712 - Conductivity Field



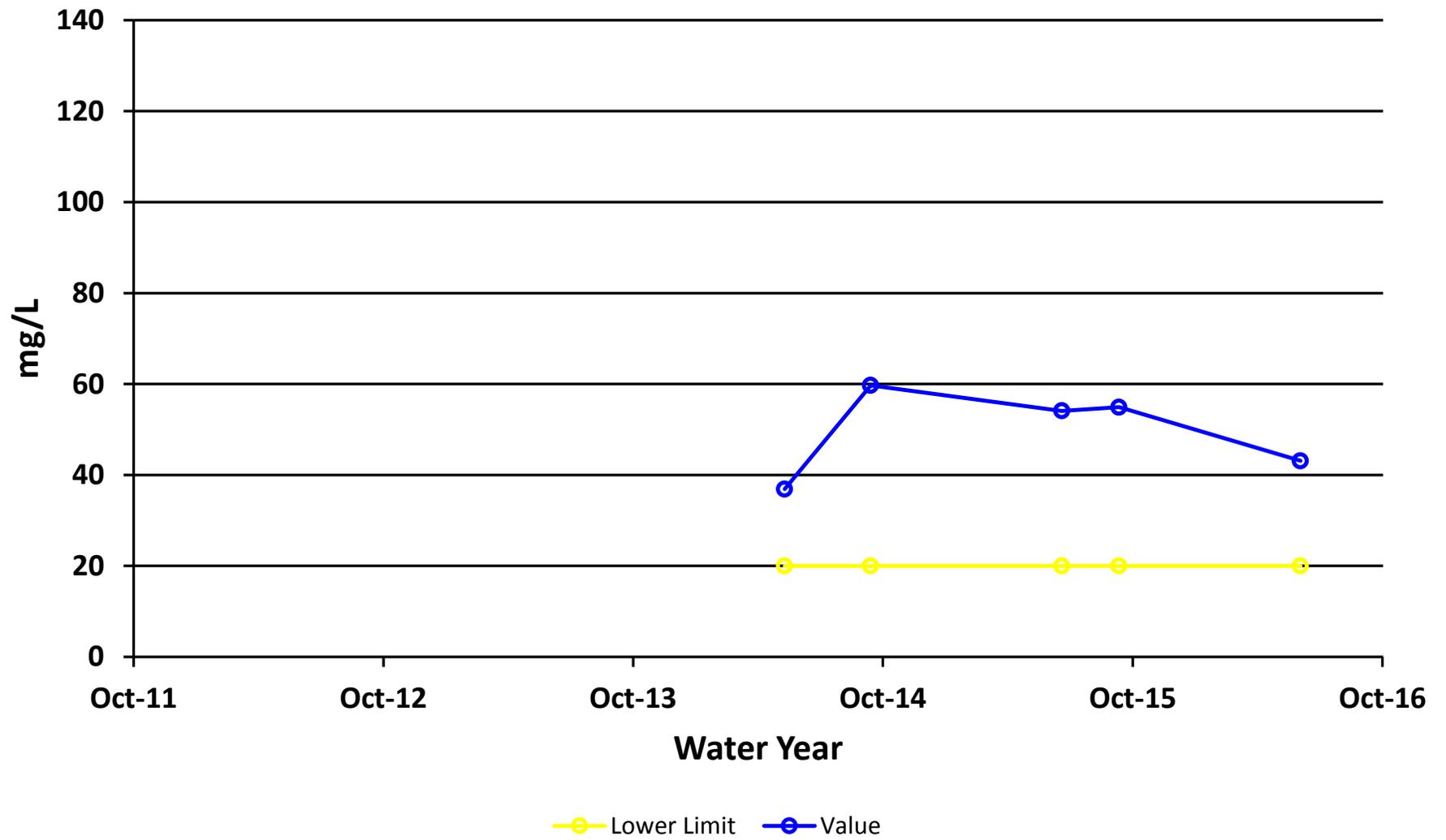
# Site 712 - pH Laboratory



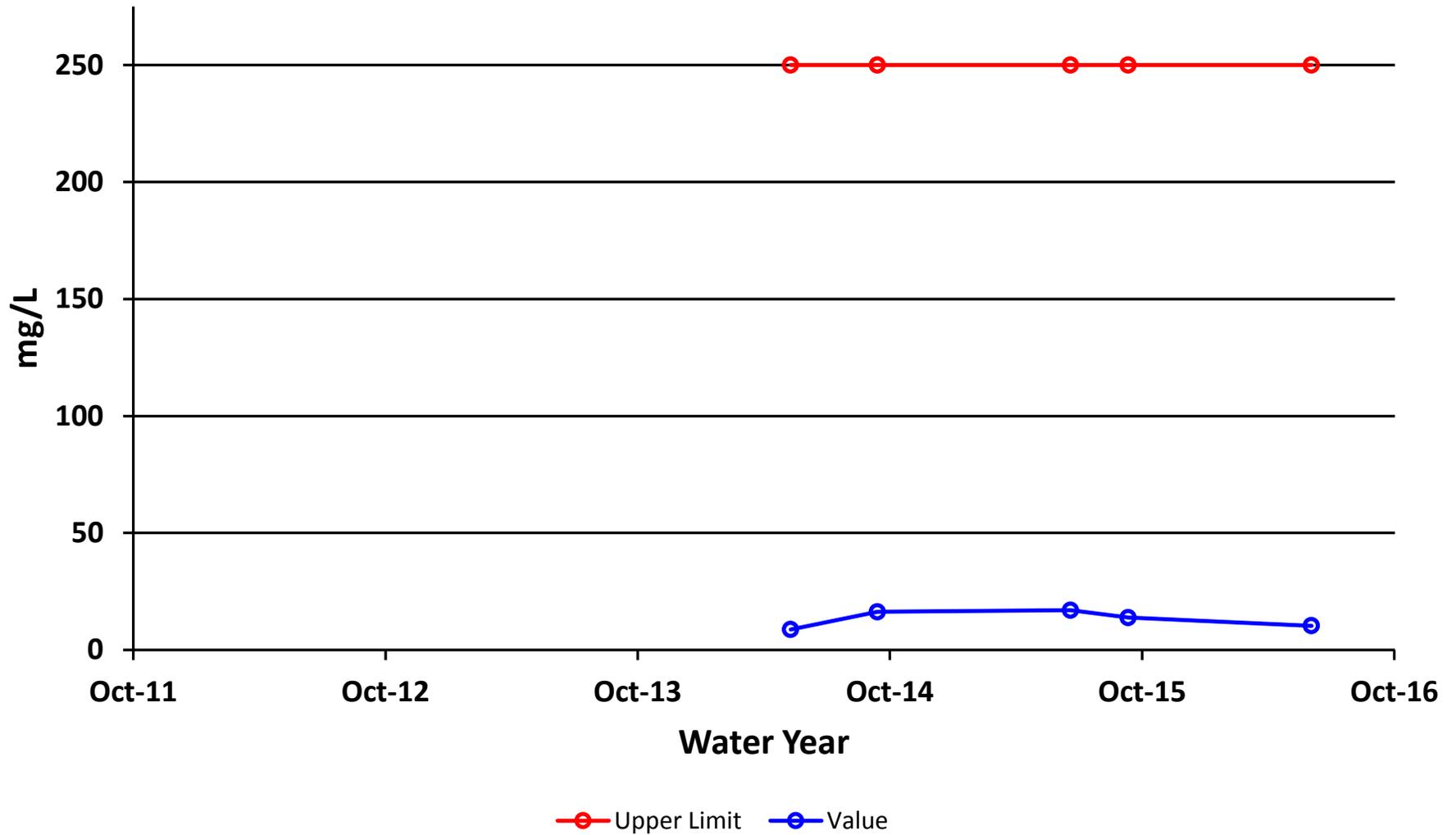
# Site 712 - pH Field



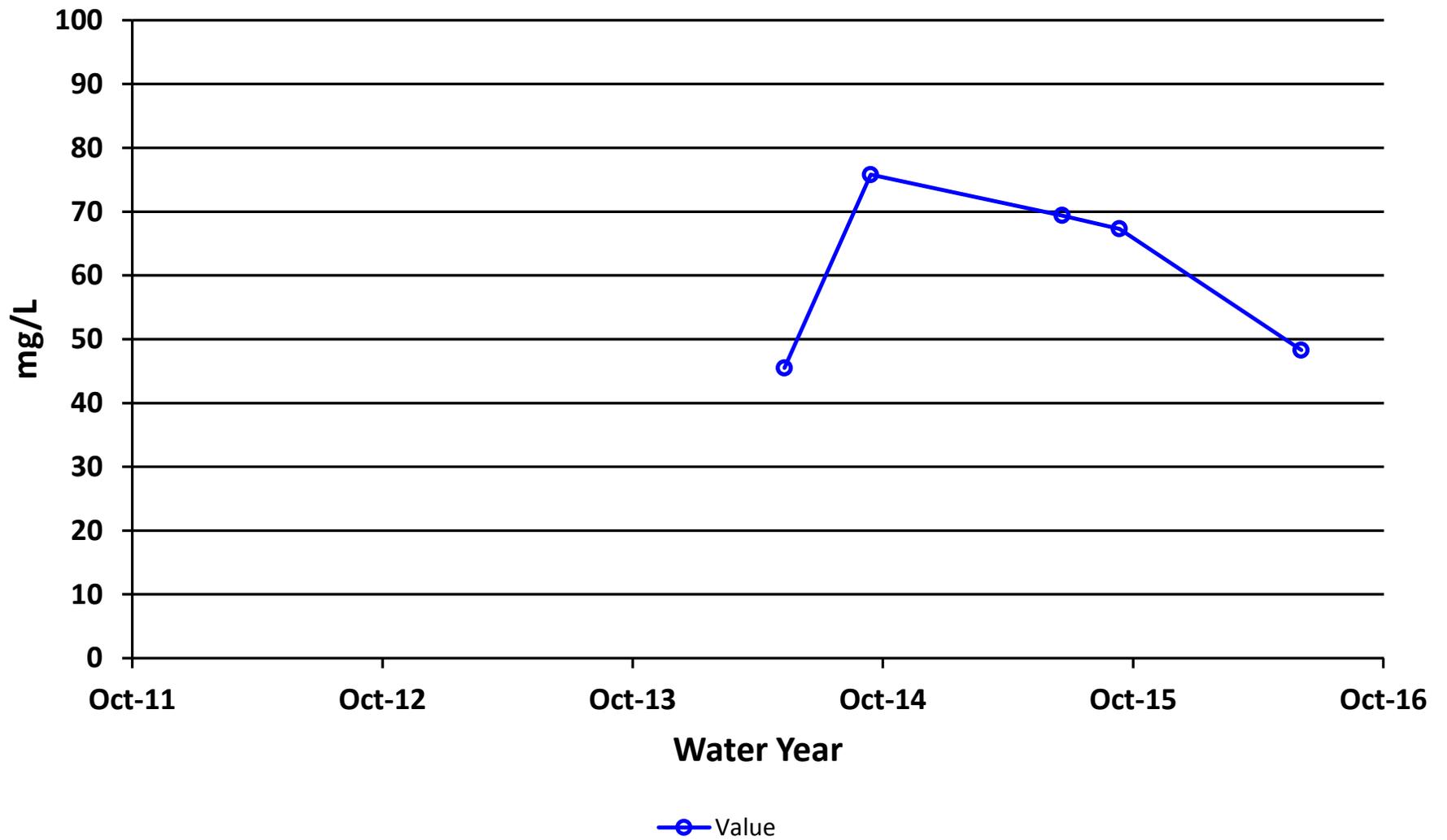
# Site 712 - Alkalinity



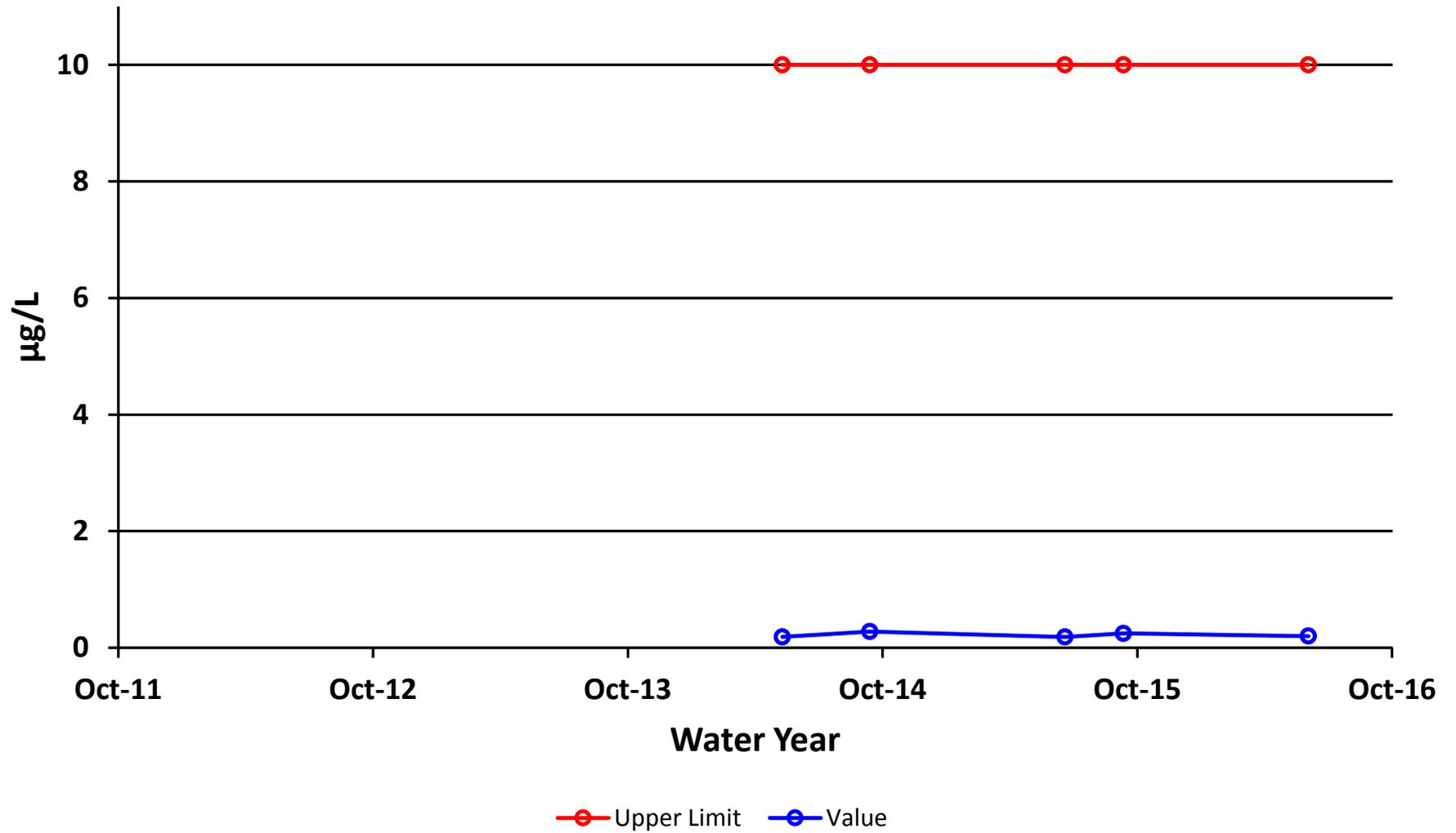
# Site 712 - Sulfate



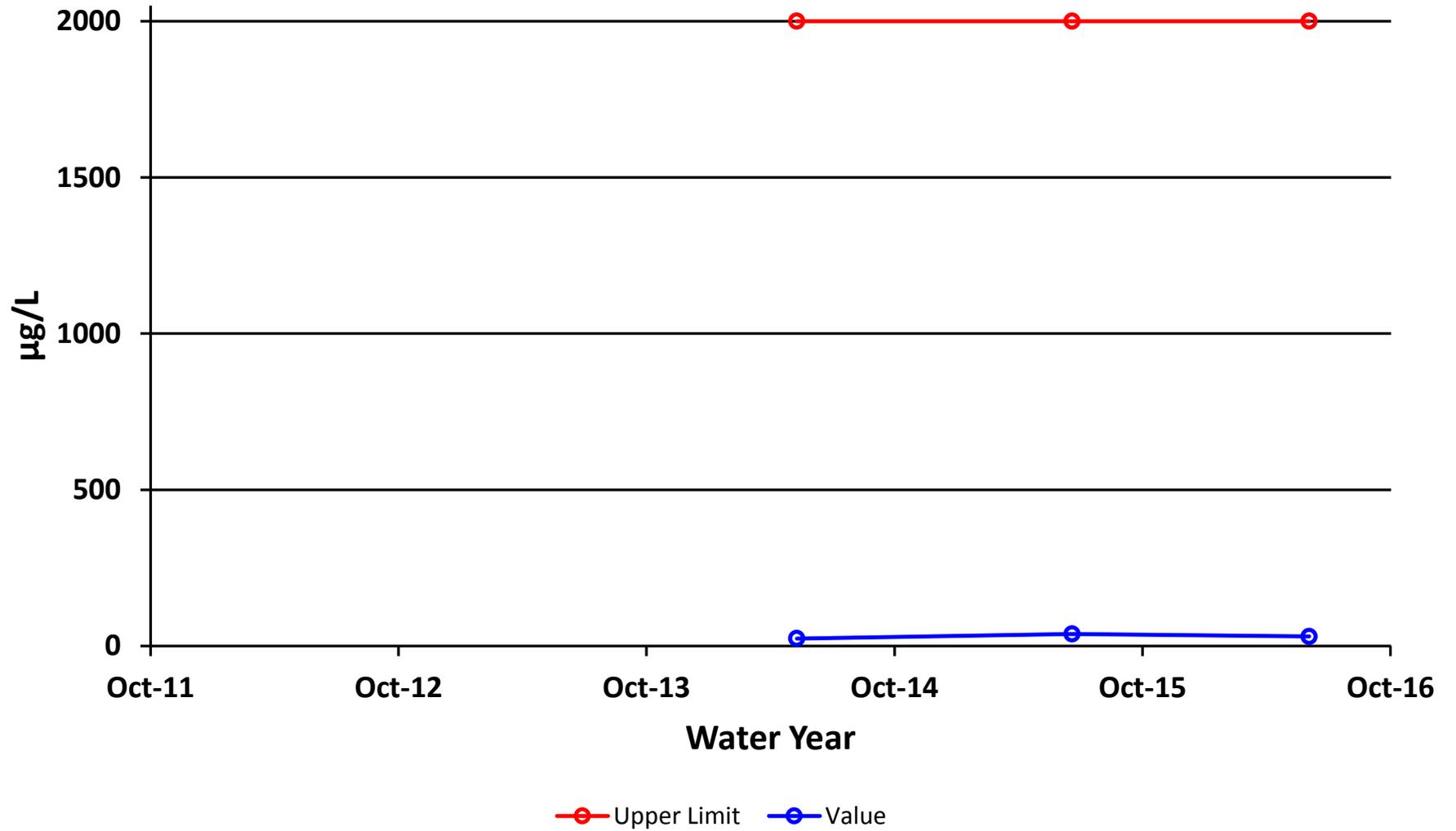
## Site 712 - Hardness



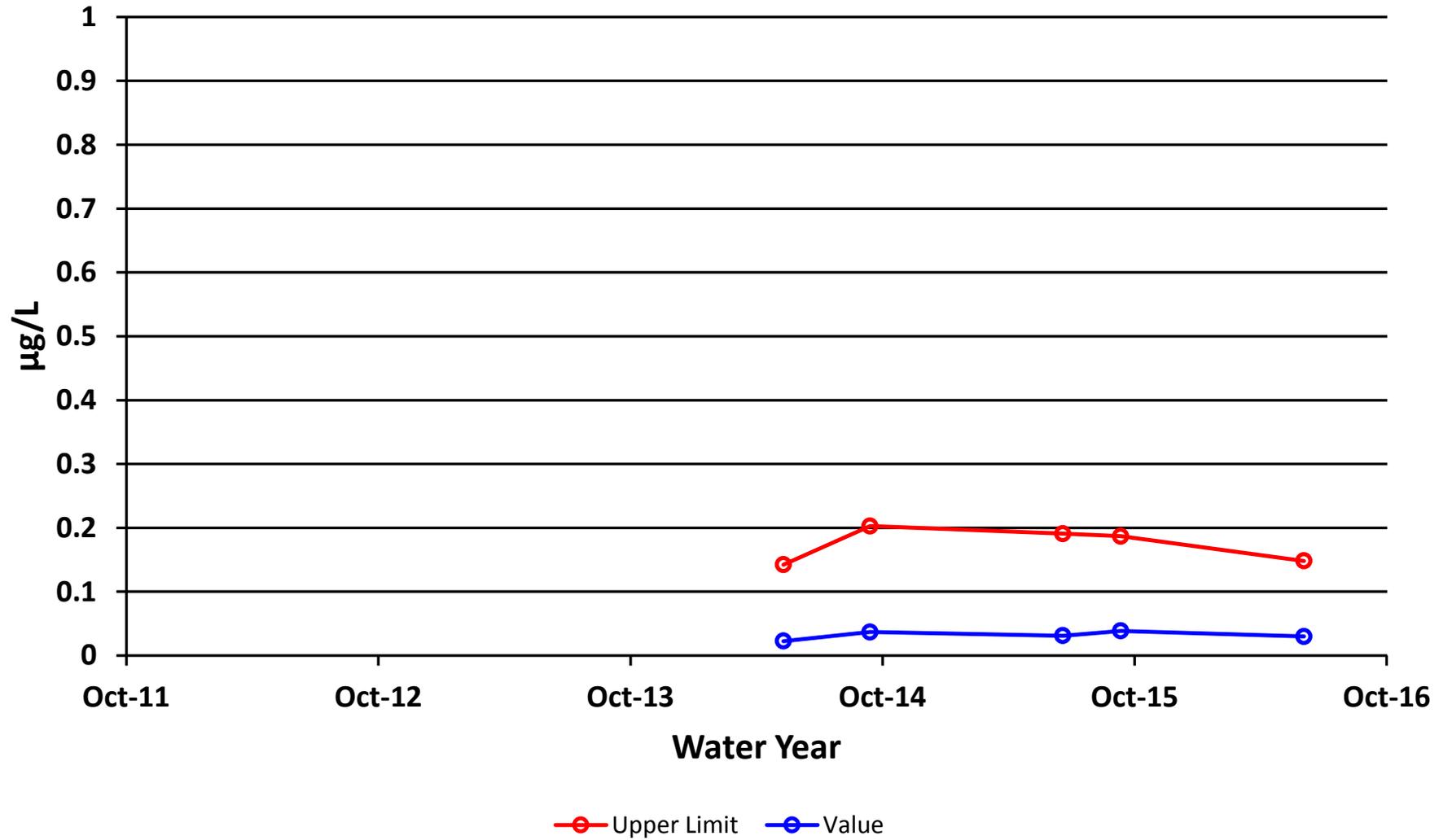
# Site 712 - Arsenic Dissolved



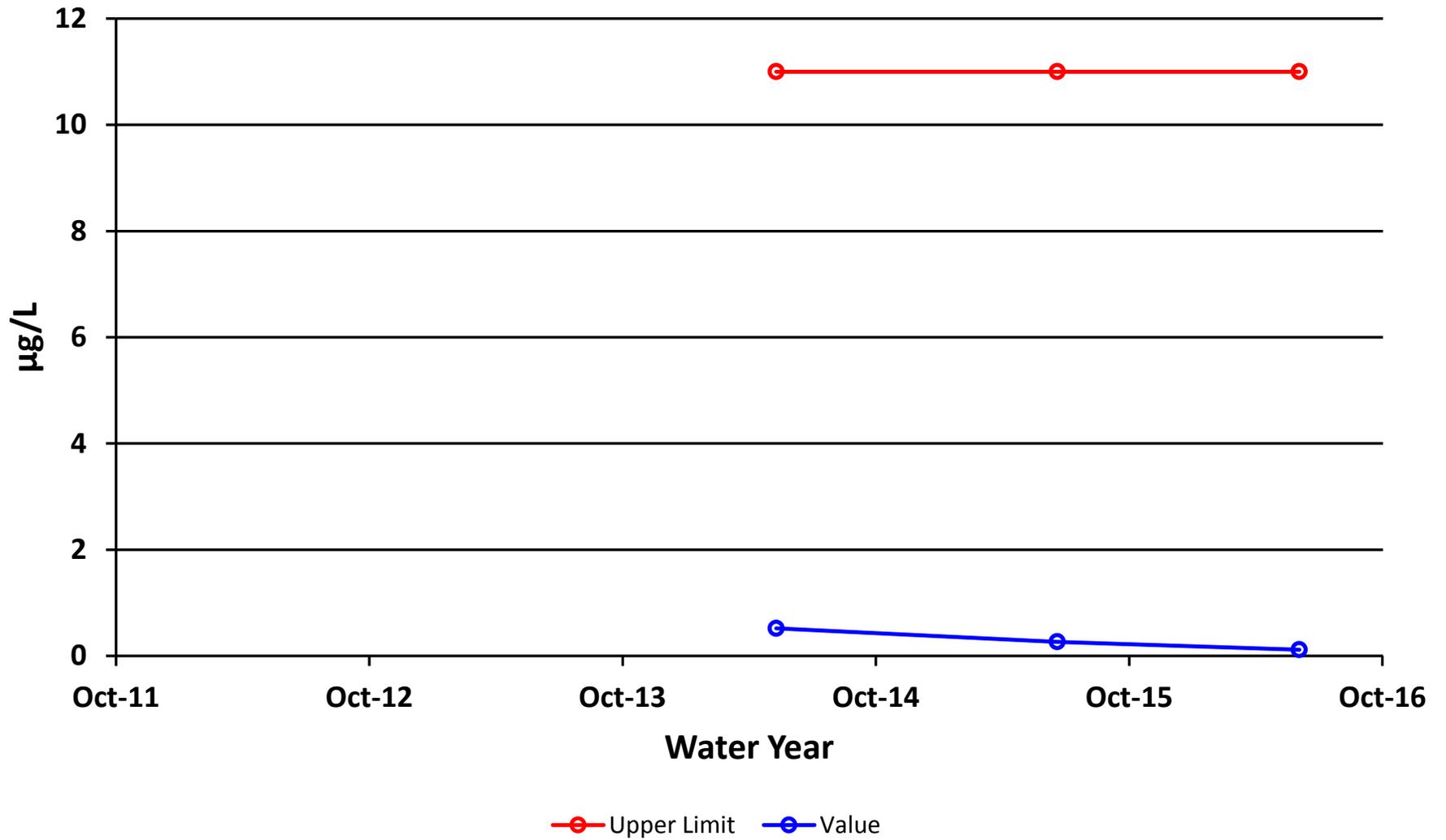
# Site 712 - Barium Dissolved



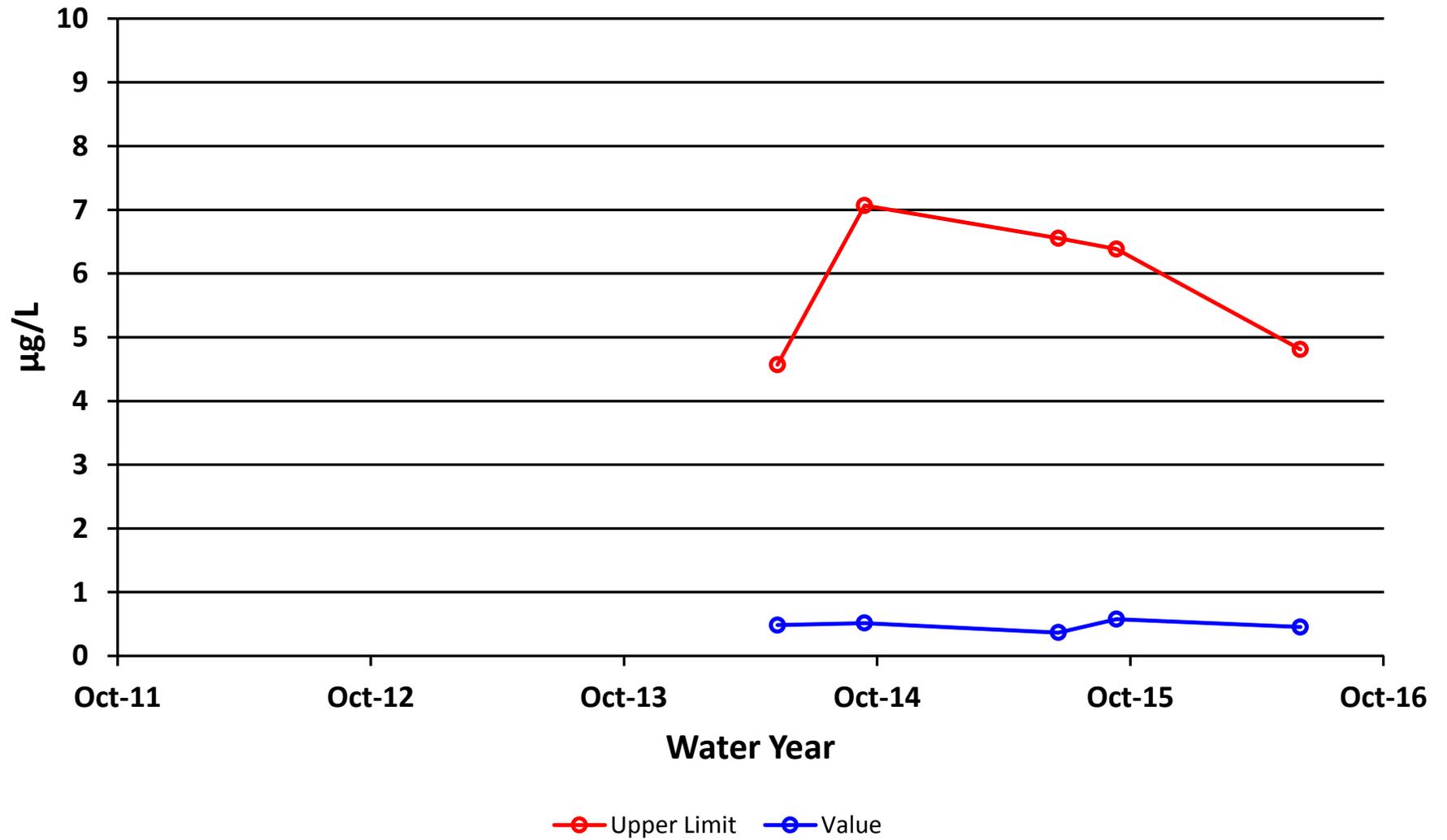
# Site 712 - Cadmium Dissolved



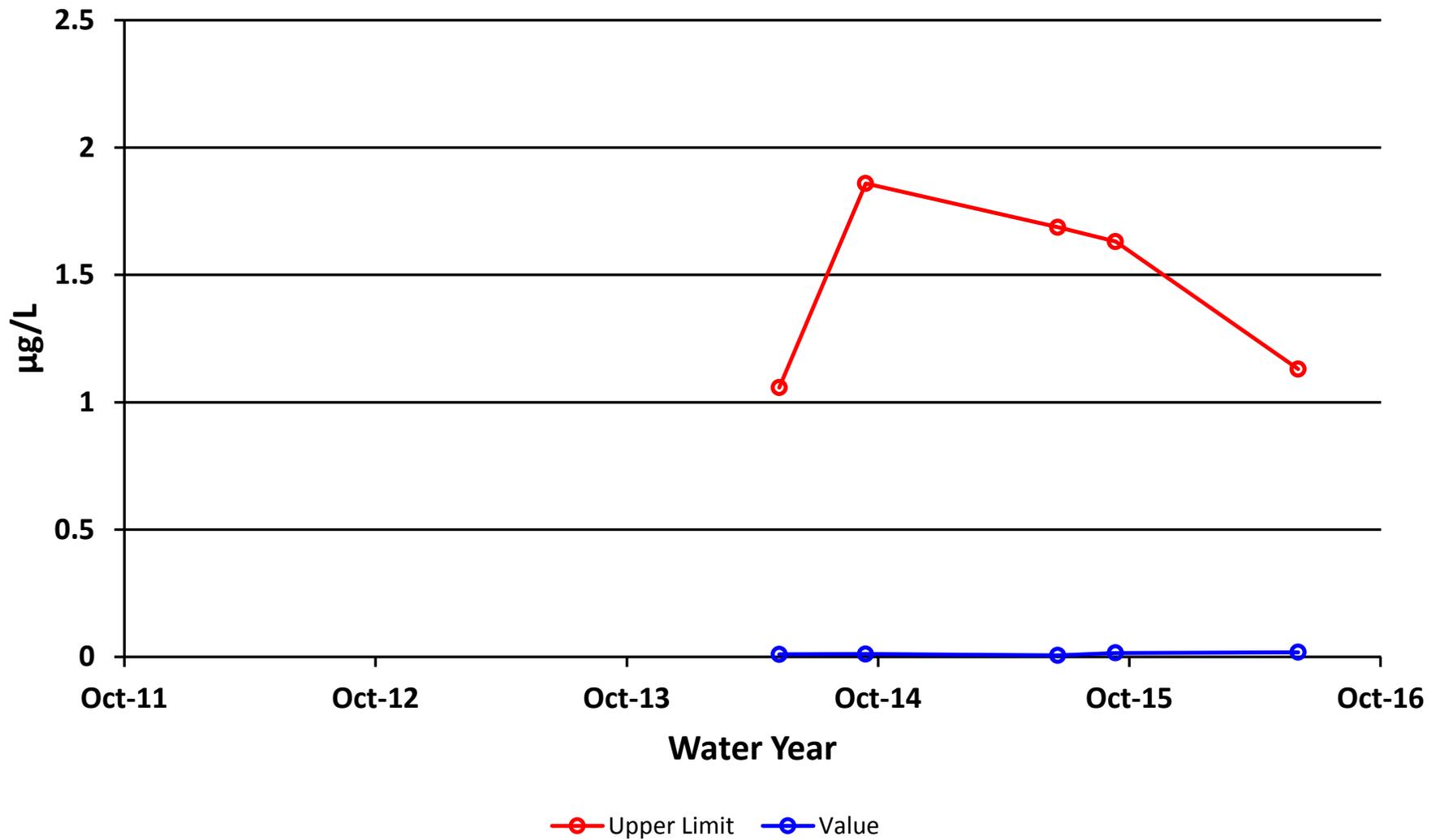
# Site 712 - Chromium Dissolved



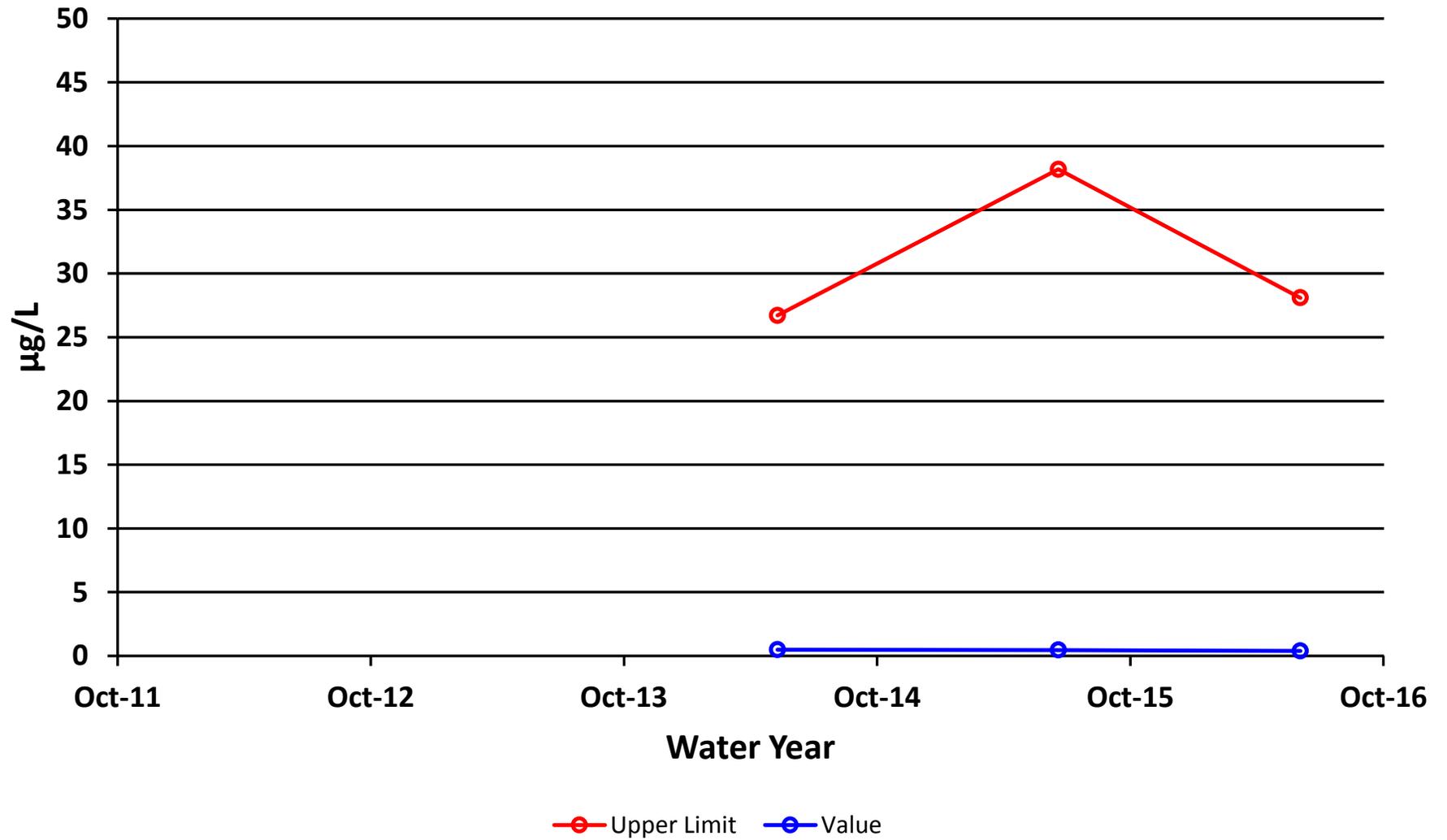
## Site 712 - Copper Dissolved



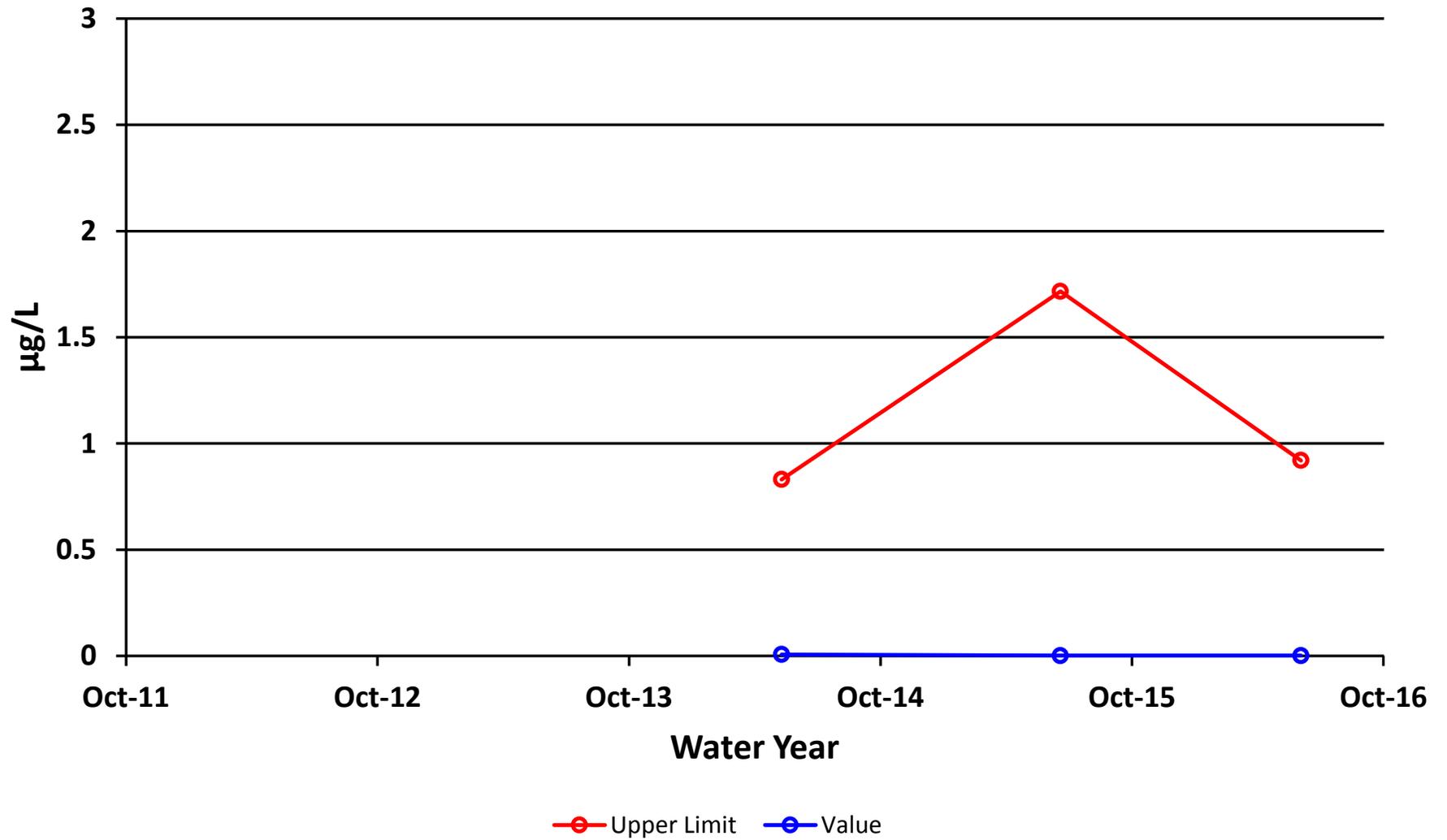
# Site 712 - Lead Dissolved



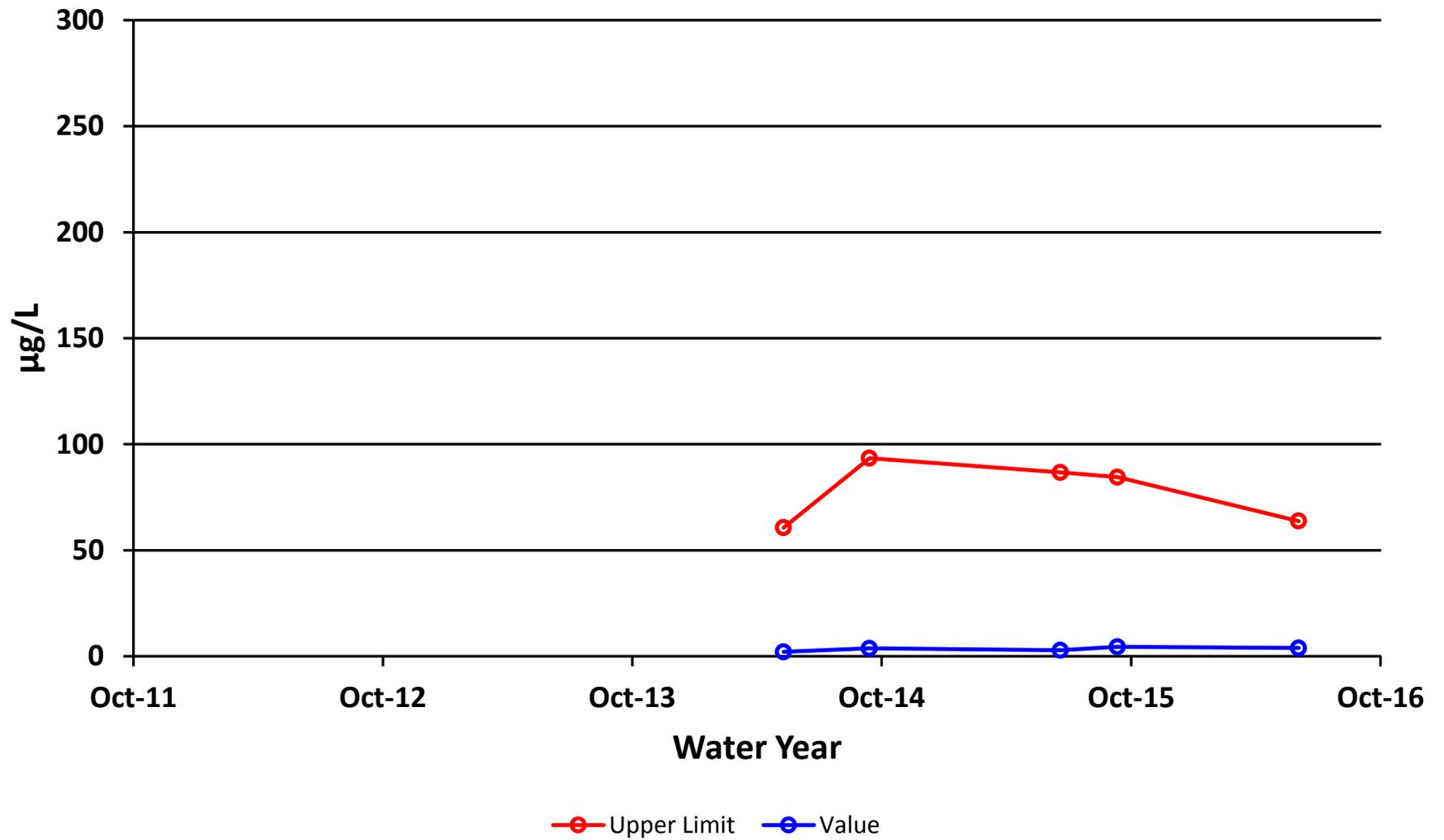
## Site 712 - Nickel Dissolved



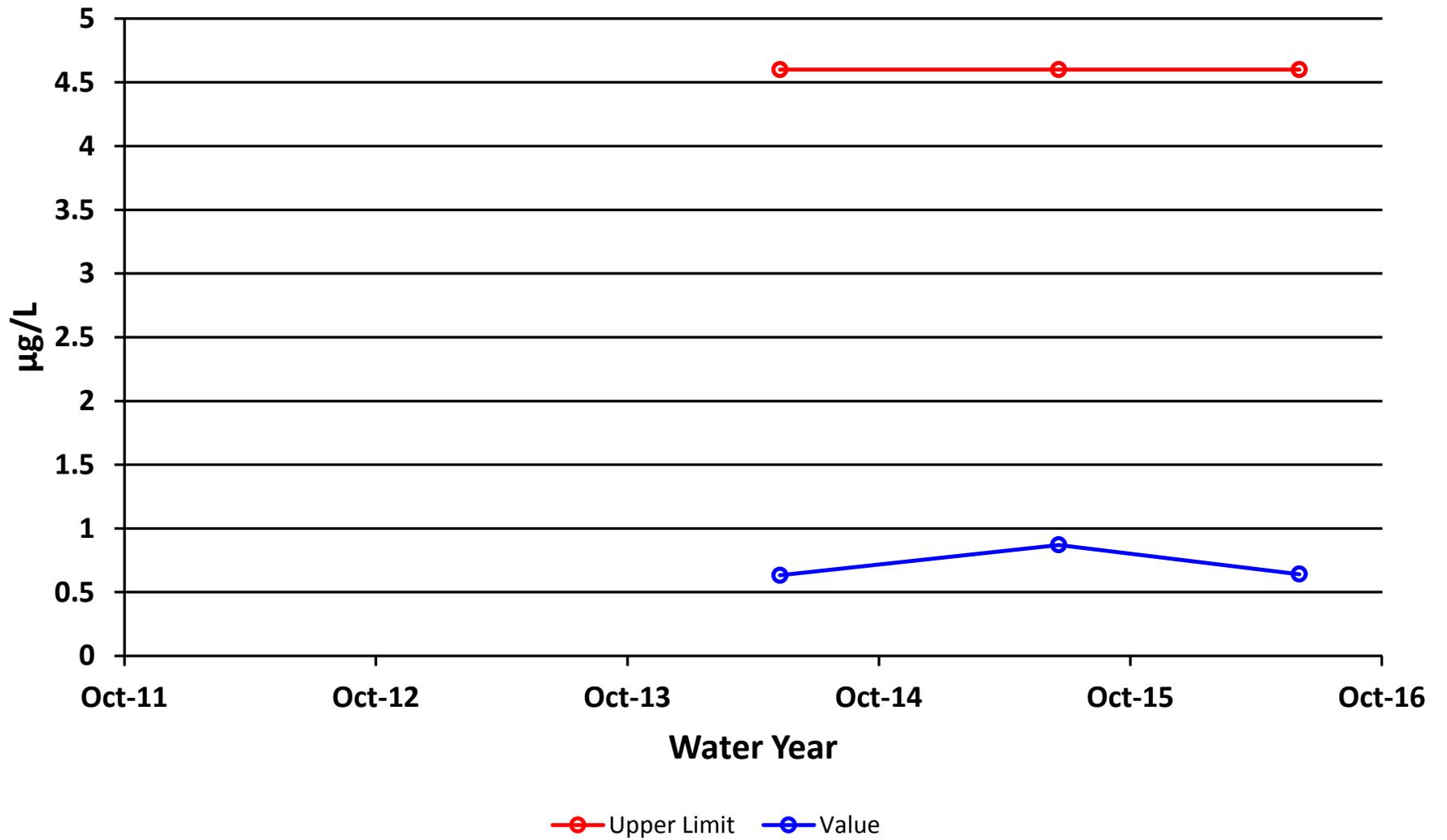
## Site 712 - Silver Dissolved



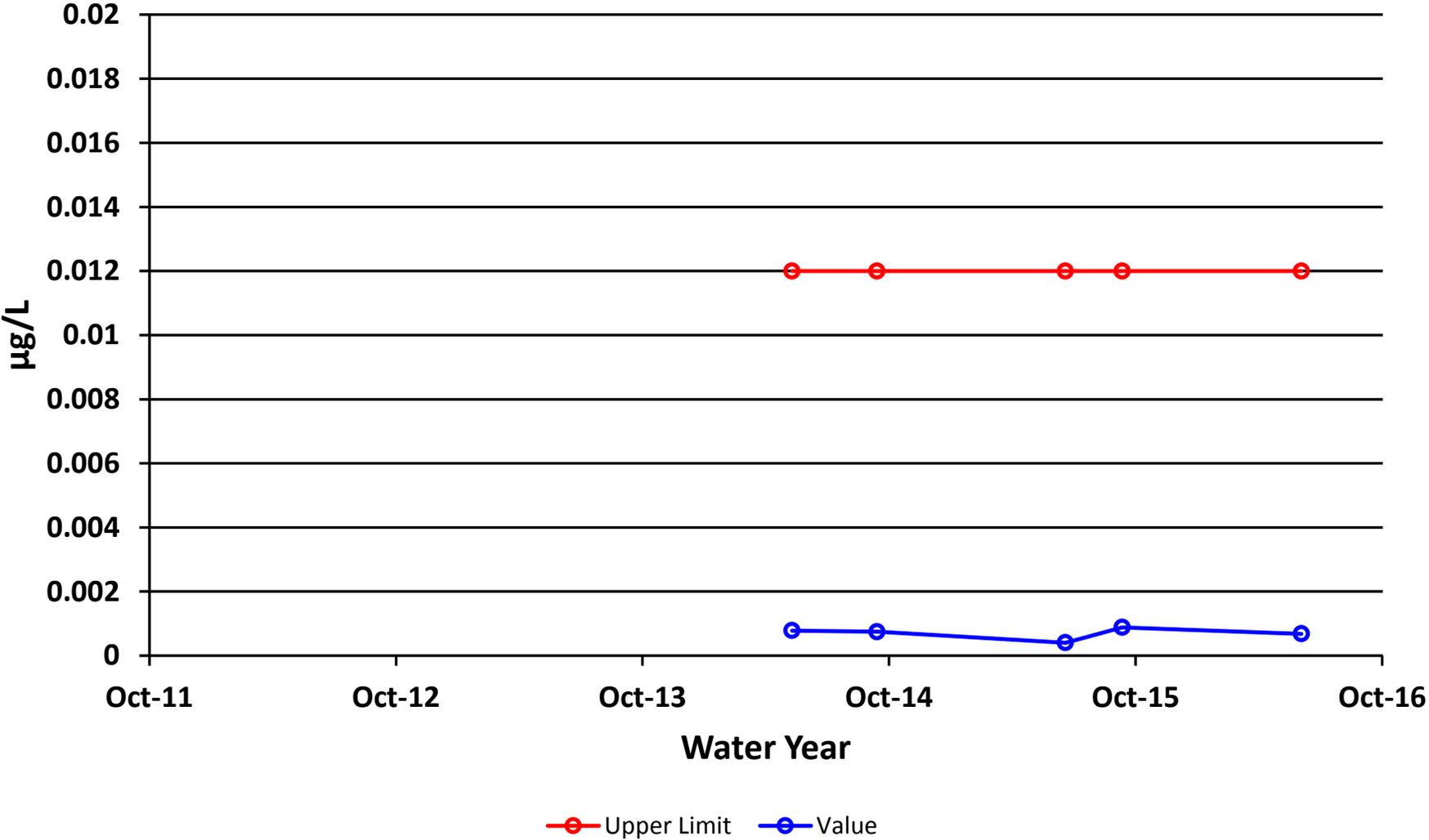
# Site 712 - Zinc Dissolved



# Site 712 - Selenium Dissolved



# Site 712 - Mercury Dissolved



APPENDIX A

Parameter	Drinking Water	Stockwater	Irrigation Water	Aquatic Life-Fresh Water								Human Health Criteria for NonCarcinogens	
				Acute				Chronic				Water + Aquatic Organisms	Aquatic Organisms Only
				criteria	as	multiply by conversion factor	to convert to	criteria	as	multiply by conversion factor	to convert to		
alkalinity									<b>20,000 minimum</b>				
As	<b>10</b>	50	100	340	TR	1	D	150	TR	1	D		
Ba	<b>2,000</b>												
Cd	5	10	10	$e^{1.0166(\ln \text{hardness})-3.924}$	TR	$1.136672-[(\ln \text{hardness})(0.041838)]$	D	$e^{0.7409(\ln \text{hardness})-4.719}$	TR	$1.101672-[(\ln \text{hardness})(0.041838)]$	<b>D</b>		
Cr	100												
Cr(total)			100										
Cr(III)				$e^{0.819(\ln \text{hardness})+3.7256}$	TR	0.316	D	$e^{0.819(\ln \text{hardness})+0.6848}$	TR	0.860	D		
Cr(VI)		50		16	D			<b>11</b>	<b>D</b>				
Cu			200	$e^{0.9422(\ln \text{hardness})-1.700}$	TR	0.960	D	$e^{0.8545(\ln \text{hardness})-1.702}$	TR	<b>0.960</b>	<b>D</b>	1,300	
Pb		50	5,000	$e^{1.273(\ln \text{hardness})-1.460}$	TR	$1.46203-[(\ln \text{hardness})(0.145712)]$	D	$e^{1.273(\ln \text{hardness})-4.705}$	TR	$1.46203-[(\ln \text{hardness})(0.145712)]$	<b>D</b>		
Hg	2			1.4	D			<b>0.012</b>	TR			0.05	0.051
Ni	100		200	$e^{0.846(\ln \text{hardness})+2.255}$	TR	0.998	D	$e^{0.846(\ln \text{hardness})+0.0584}$	TR	0.997	<b>D</b>	610	4,600
Se	50	10	20	$1/[(\text{selenite})/185.9+(\text{selenate})/12.83]$	TR	0.922	D	<b>5</b>	TR	<b>0.922</b>	<b>D</b>	170	11,000
Ag				<b><math>e^{1.72(\ln \text{hardness})-6.52}</math></b>	<b>TR</b>	<b>0.850</b>	<b>D</b>						
Zn			2,000	$e^{0.8473(\ln \text{hardness})+0.884}$	TR	0.978	D	$e^{0.8473(\ln \text{hardness})+0.884}$	TR	<b>0.986</b>	<b>D</b>	9,100	69,000

all units in micrograms per liter (ug/L)

TR total recoverable  
D dissolved

H some of the criteria for this parameter are hardness dependant

**DENOTES STRICTEST CRITERIA**

FWA Fresh Water Acute  
FWC Fresh Water Chronic

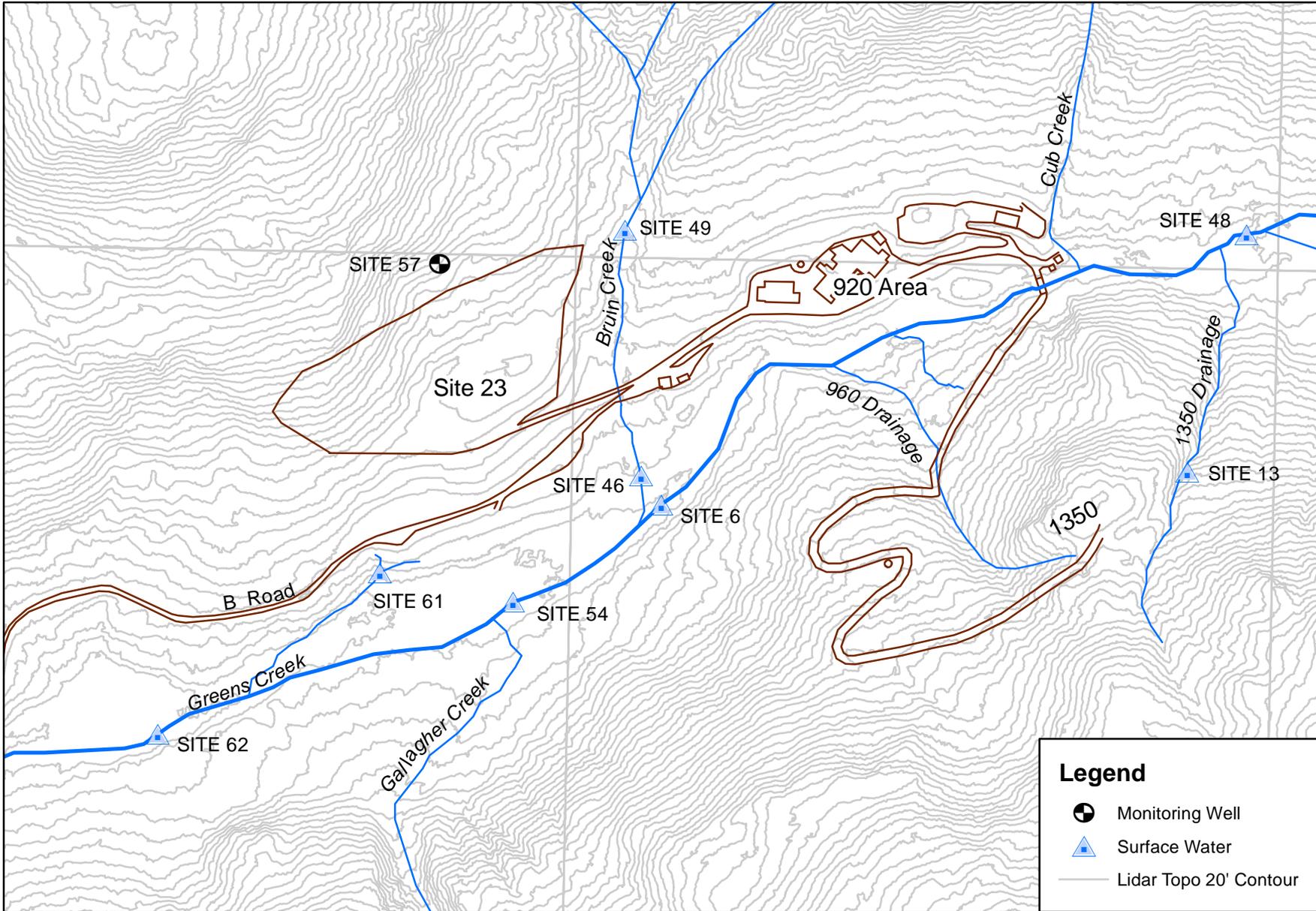
Source: <http://www.dec.state.ak.us/water/wqsar/wqs/toxicsbook.xls>

Table formatting was modified by HGCMC to include only parameters include in Suite P and Q and to highlight the strictest standard.

## **APPENDIX B**

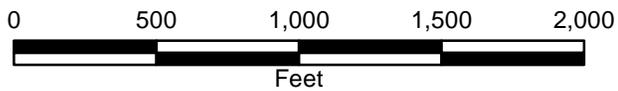
### **Map Sheets**

Map 1-920 Area FWMP Sites  
Map 2-Tailings Area FWMP Sites  
Map 3-Site 9, Tributary Creek



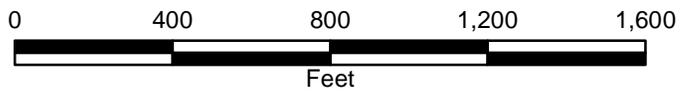
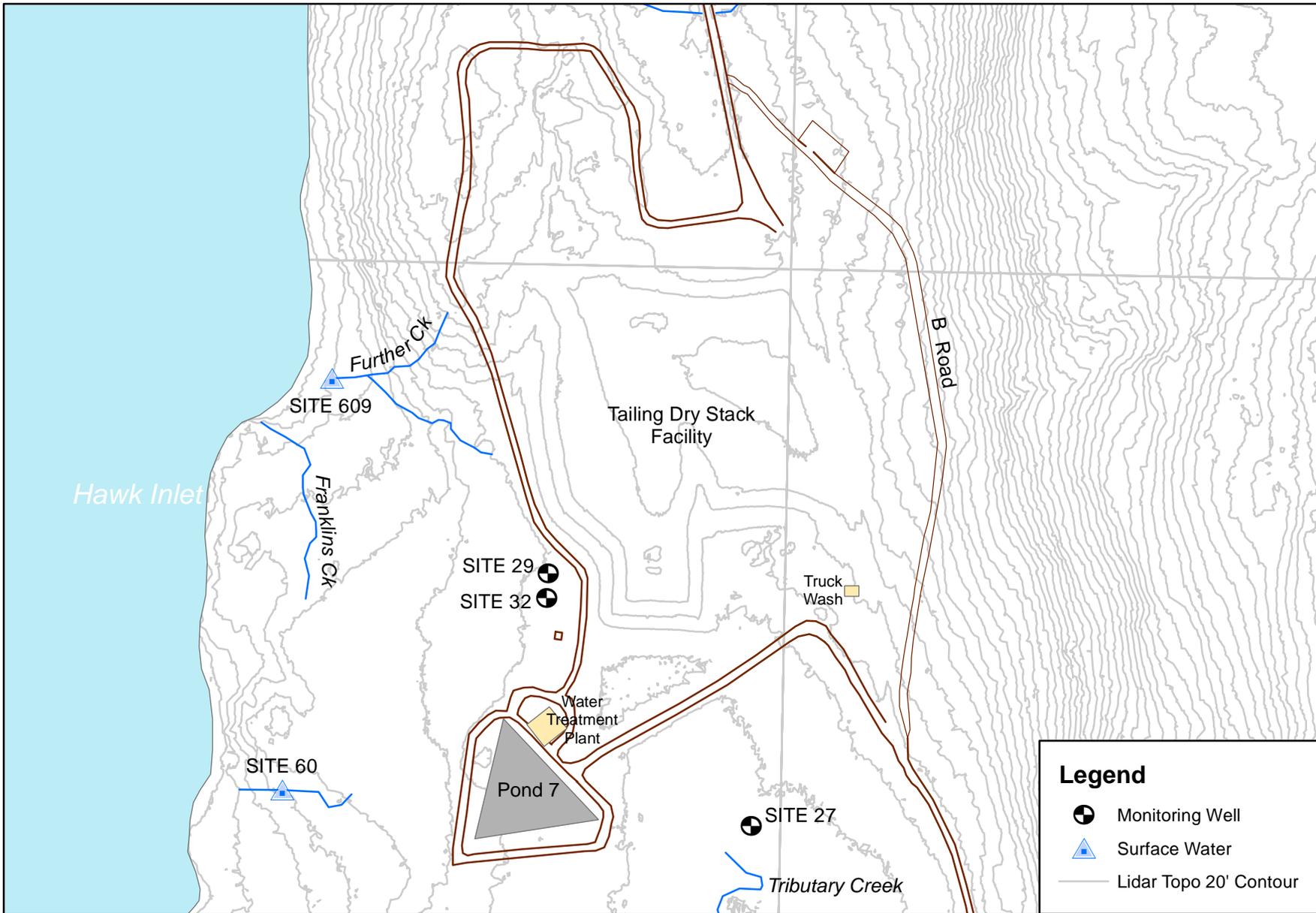
**Legend**

-  Monitoring Well
-  Surface Water
-  Lidar Topo 20' Contour



Map 1  
FWMP Sample Sites in the 920 Area





Map 2  
FWMP Sample Sites in the Tailings Area

**Legend**

-  Monitoring Well
-  Surface Water
-  Lidar Topo 20' Contour



