

Summary of 2017 Animas River Water Quality Monitoring at Rotary Park in Durango, CO



Monitoring Program Overview

Mountain Studies Institute (MSI), an independent research and education center based in the San Juan Mountains, monitored water quality of the Animas River before, during, and after the 2015 Gold King Mine release. MSI has continued to monitor the Animas River at Rotary Park in 2016 and 2017. The results presented in this summary are from one location along the Durango stretch of the Animas River and may not be representative of other reaches of the Animas River.

The 2017 monitoring program was part of a partnership between MSI and the City of Durango to communicate Animas River water quality information to the public. Following the 2015 Gold King Mine release, there was increased concern in local communities about the water quality of the Animas River and whether metal concentrations in the river pose any threat to human health, agriculture, or aquatic life. In 2017, MSI expedited laboratory analysis of samples to get water quality results to the public as quickly as possible.

MSI collected grab samples from the Animas River at Rotary Park at weekly intervals during peak river recreation season from May through August (Figure 1). Additional samples were collected to capture early spring runoff events in March and April. Samples were analyzed by Green Analytical laboratory in Durango, CO, for total and dissolved concentrations of aluminum, copper, iron, lead, and zinc.

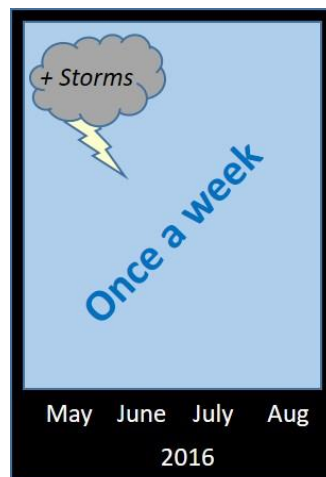


Figure 1: Water quality sampling frequency

MSI's analysis of the 2017 Animas River water quality data centered on three questions:

- How did metal concentrations in 2017 compare to water quality benchmarks?
- Was Animas River water quality in 2017 any different than previous years?
- Do metal concentrations in the Animas River correlate with other water quality parameters such as flow, pH, conductivity, or turbidity?

Water Quality Benchmarks

The Colorado Department of Public Health and the Environment (CDPHE) and the Environmental Protection Agency (EPA) have developed water quality standards and benchmarks that can be used to evaluate whether water quality is sufficient to support uses such as recreation, agriculture, domestic water supply, and aquatic life (CDPHE 2017; EPA 2015). Graphs of each metal in relation to water quality benchmarks can be found in Appendix A at www.mountainstudies.org/animasriver.

Recreation

- All metals analyzed in 2017 were below EPA's recreational screening levels, which are protective of users who accidentally swallow river water (swimmers, rafters, tubers) or users who intentionally ingest river water (backpackers, overnight river users).

Agriculture

All metals analyzed in 2017 were at safe levels for agricultural uses such as irrigation and livestock watering (based on CDPHE water quality standards, CDPHE 2017).

Domestic Water Supply






- All metals analyzed in 2017 were at safe levels for domestic water supply use (based on CDPHE water quality standards, CDPHE 2017).

Aquatic Life

- Most metals analyzed in 2017 were at levels considered safe for aquatic life (based on CDPHE water quality standards, CDPHE 2017). However, MSI did detect high levels of iron and aluminum during spring runoff that approached water quality benchmarks.
 - Acute water quality standards are set by CDPHE to be protective of aquatic life from brief, short-term exposure to a contaminant. The aluminum concentration at Rotary Park on June 6, 2017 (2,480 ug/L) was high enough to surpass the hardness-based acute aquatic life standard (2,119 ug/L). Although the concentration of aluminum in the Animas river at Rotary Park did not surpass the acute aquatic life standard in 2016, the concentration of aluminum did surpass the standard on August 7, 2015 from samples collected during the Gold King Mine release (Roberts 2016).

- Chronic water quality standards are set by CDPHE to be protective of aquatic life from persistent, long-term exposure to a contaminant. During spring runoff, iron and aluminum were close to surpassing the CDPHE chronic water quality standard (aluminum surpassed the chronic water quality standard based on average hardness, but did not surpass the chronic water quality standard based on paired metal-hardness values). Iron concentrations at Rotary Park in 2016 were high enough to surpass the CDPHE chronic aquatic life standard.

Table 1: Water quality benchmarks in 2017

					
Metal	CDPHE Domestic Water Supply Standard	CDPHE Agriculture Chronic	CDPHE Aquatic Life Acute Standard	CDPHE Aquatic Life Chronic Standard	EPA Recreational Screening Level
Aluminum	-	-	Y	n	n
Copper	n	n	n	n	n
Iron	n	-	-	n	n
Lead	n	n	n	n	n
Zinc	n	n	n	n	n
<p><i>n = metal did not surpass water quality benchmark</i> <i>Y = metal surpassed water quality benchmark</i> <i>- = no water quality benchmark available</i></p>					

2017 Water Quality Data in Context of Historical Data

Following the 2015 Gold King Mine release, there was concern that the water quality of the Animas River could be worse than during years prior to the Gold King Mine release. MSI compared 2017 Animas River water quality data to historical data collected as part of the Colorado River Watch program from 2002-2014.

- Statistical analysis indicated that metal concentrations in the Durango stretch of the Animas River were *not* significantly higher in 2017 than in 2002-2014.
- Most metal concentrations at Rotary Park in 2017 were consistent with observations from 2002-2014. Dissolved copper and total zinc were significantly lower in 2017 than from 2002-2014.

Metals and Other Water Quality Parameters

In 2016, USGS began to provide continuous measurement of pH, turbidity, and conductivity at several gauges on the Animas and San Juan Rivers including the Animas River gauge in Durango, CO. MSI examined the relationship between metal concentrations and these additional water quality parameters.

- In 2017, concentrations of several metals correlated at a statistically significant level with discharge, turbidity, pH, and conductivity (Table 2).

So What?

The 2017 water quality data from Rotary Park were encouraging – we have no indication of any threat to human health from Animas River water in Durango and it does not appear that metal concentrations in 2017 were higher than previous years (2002-2014). We did detect elevated metal concentrations during spring runoff when turbidity and discharge rose, and conductivity and pH dropped. However, the elevated levels of metals observed in the Durango stretch of the Animas River during spring runoff were not high enough to pose a threat to human health.

The data did raise concerns for aquatic life in the Durango stretch of the Animas River. These concerns can only be evaluated by continued monitoring of water quality and aquatic life.

For more information regarding MSI's 2017 water quality monitoring analysis, including technical details, tables, graphs, and statistics, please see Appendix B at www.mountainstudies.org/animasriver.

Table 2: Relationship between metal concentrations and discharge, turbidity, pH, and conductivity

				Aluminum		Copper		Iron		Lead		Zinc		
				T	D	T	D	T	D	T	D	T	D	
When...	...discharge...	...increased...	...the following metals...	...increased	X		X	X	X		X		X	
	...turbidity...	...increased...		...increased	X		X	X	X		X		X	
	...turbidity...	...increased...		...decreased										X
	...pH...	...decreased...		...increased	X		X	X	X		X		X	
	...conductivity...	...increased...		...decreased	X		X	X	X		X		X	

Note: X with blue highlight indicates a metal that correlated with a water quality parameter at a statistically significant level.

References:

Colorado Department of Public Health and Environment (CDPHE). 2017. Regulation No. 31 - The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), effective 3/1/17. Available: <https://www.colorado.gov/pacific/cdphe/water-quality-control-commission-regulations>.

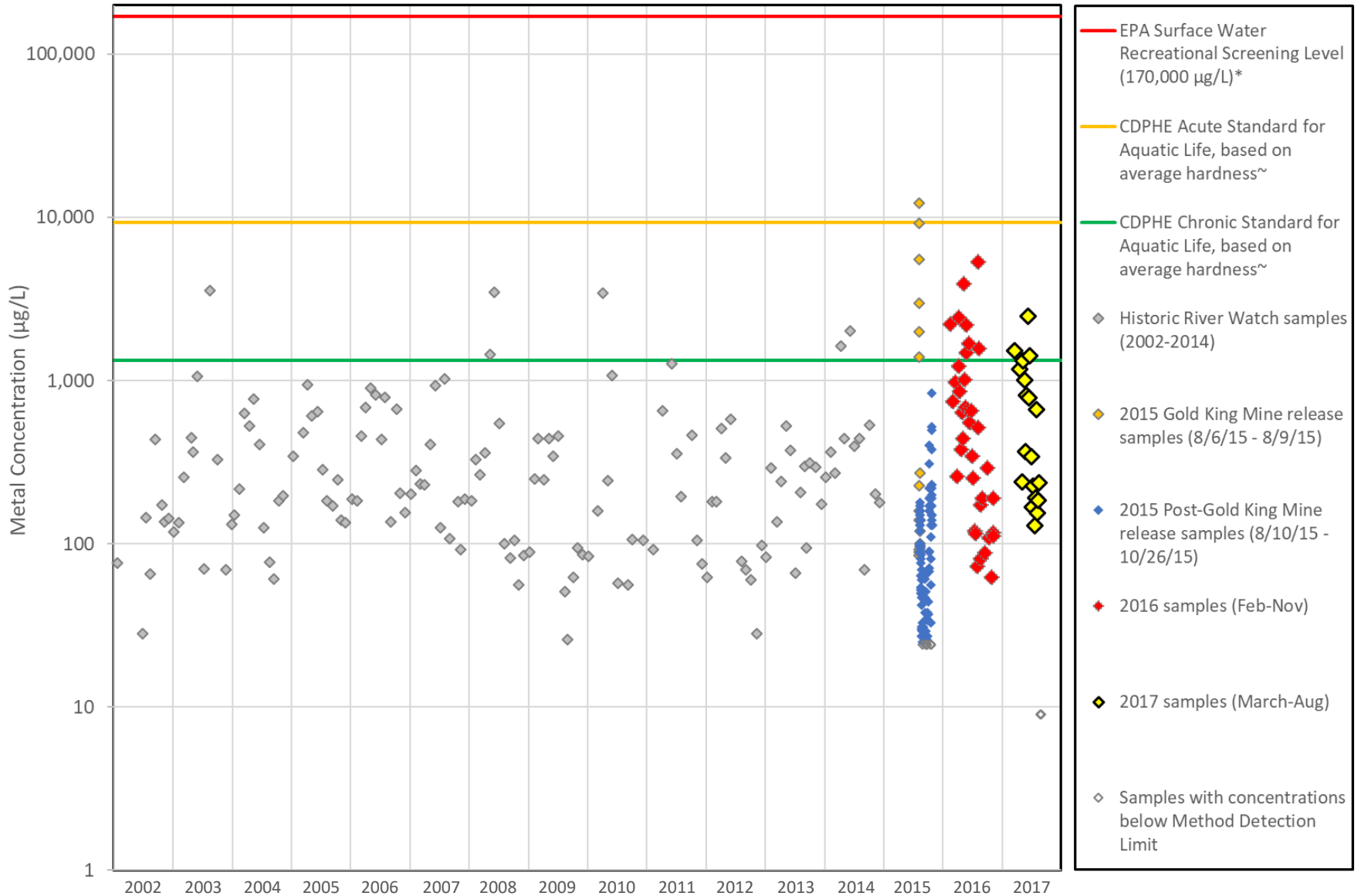
Environmental Protection Agency (EPA). 2015. Memorandum: Screening Levels for Recreational Receptors at the Gold King Mine Site. September 2015.

Roberts, S. 2016. Animas River water quality at Rotary Park, Durango, Colorado. Gold King Mine Release Monitoring. Report prepared for the Environmental Protection Agency. Available: https://static1.squarespace.com/static/53bc5871e4b095b6a42949b4/t/58c1c517e4fcb5954a9e5a38/1489093936833/EPA_RotaryPark_WQReport_20170309.pdf.

Appendix A:

Graphs of Animas River metal concentrations at
Rotary Park in relation to water quality benchmarks

Total Aluminum, Animas River at Durango, CO: 2002-2017

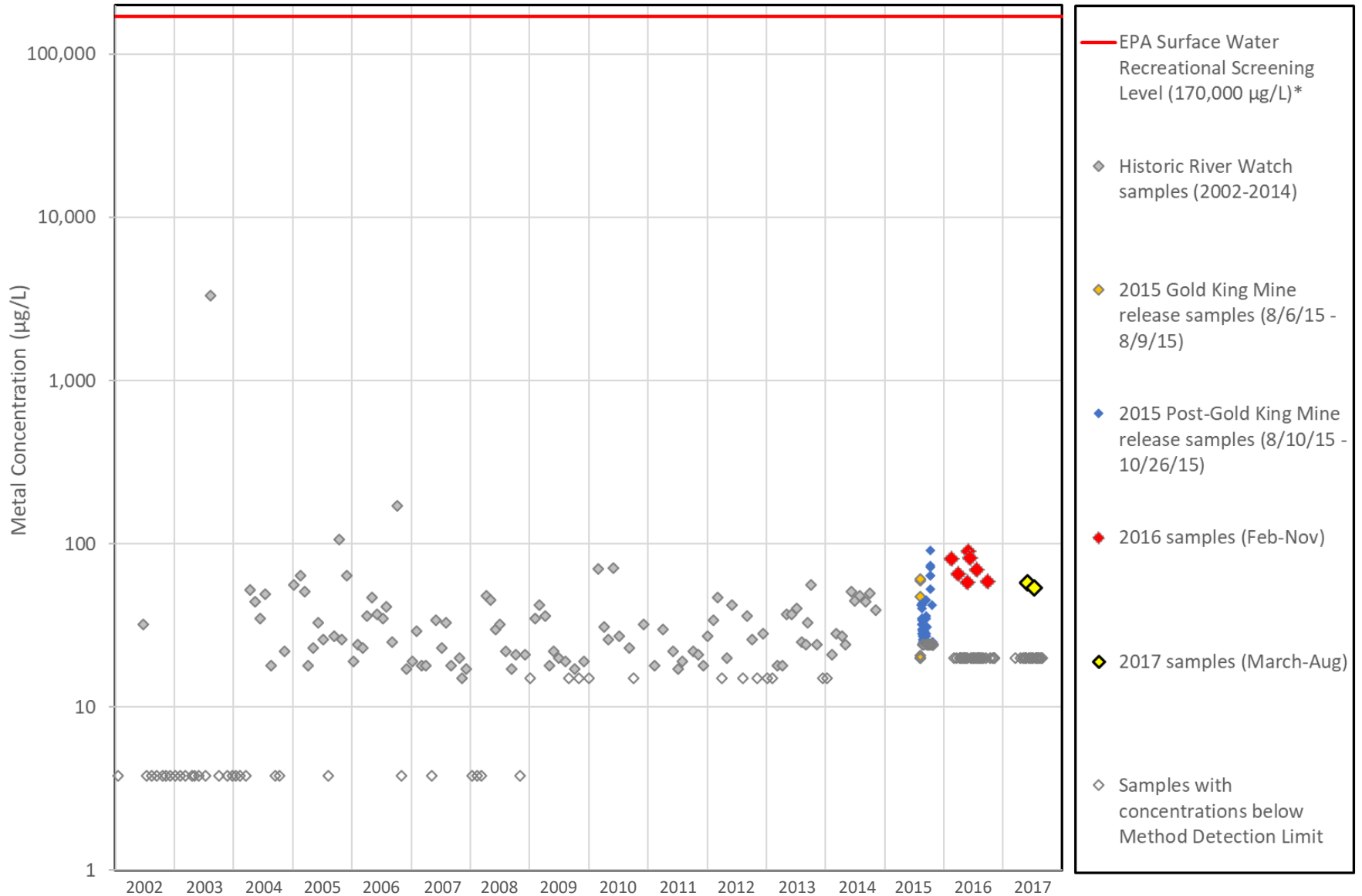


* The recreational screening level represents the level at which no adverse health effects are expected to occur in humans consuming 2L of water per day, from the Animas, orally, for 64 days each year for a total of 30 years.

~Colorado Department of Public Health and the Environment (CDPHE) standards based on Colorado surface water quality classifications and Reg. 31 and 34. Standards vary with water hardness and are plotted here using an average water hardness of the Animas River at this location, 208 mg/L.

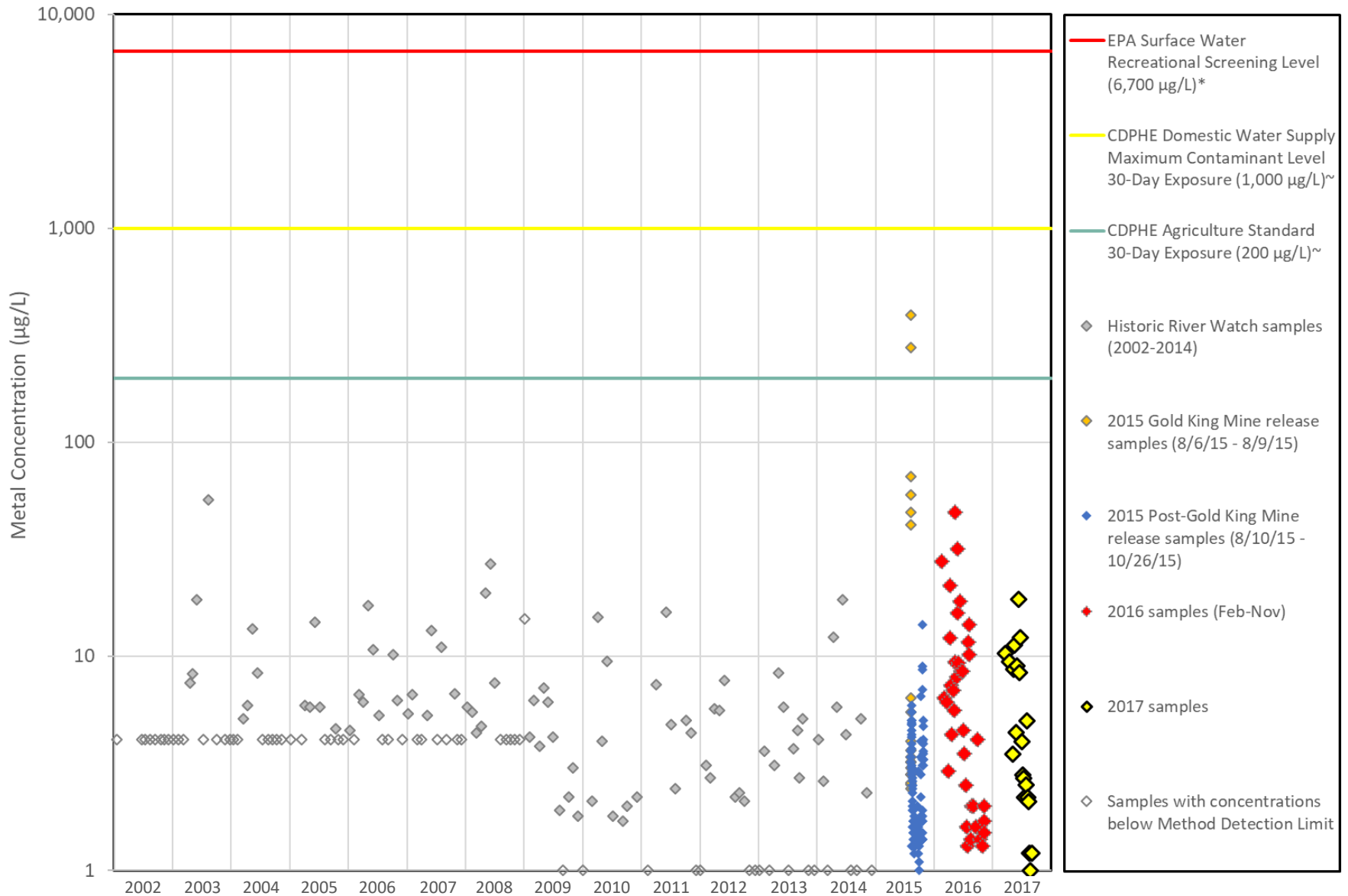
Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Dissolved Aluminum, Animas River at Durango, CO: 2002-2017



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 Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Total Copper, Animas River at Durango, CO: 2002-2017

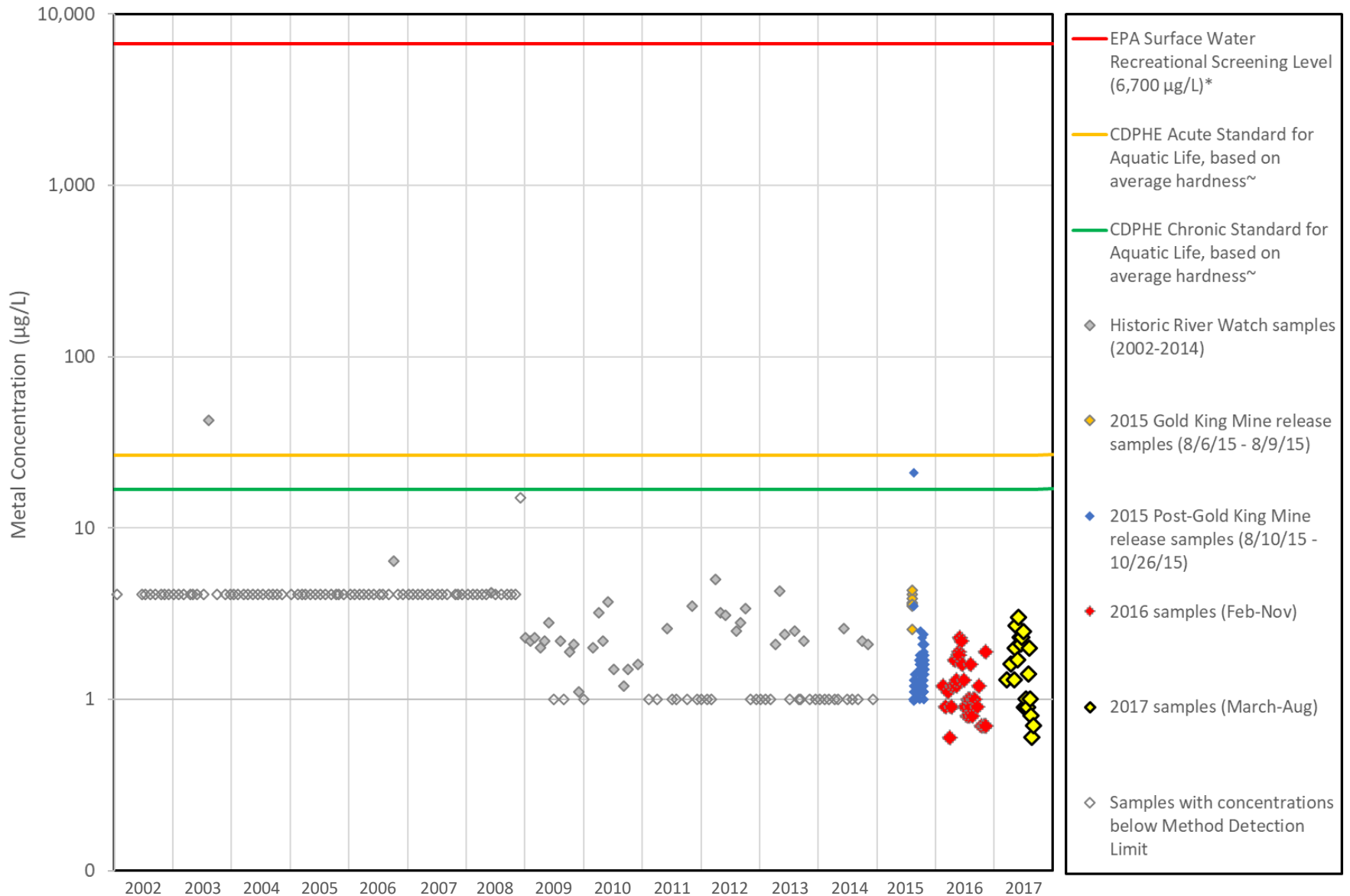


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Dissolved Copper, Animas River at Durango, CO: 2002-2017

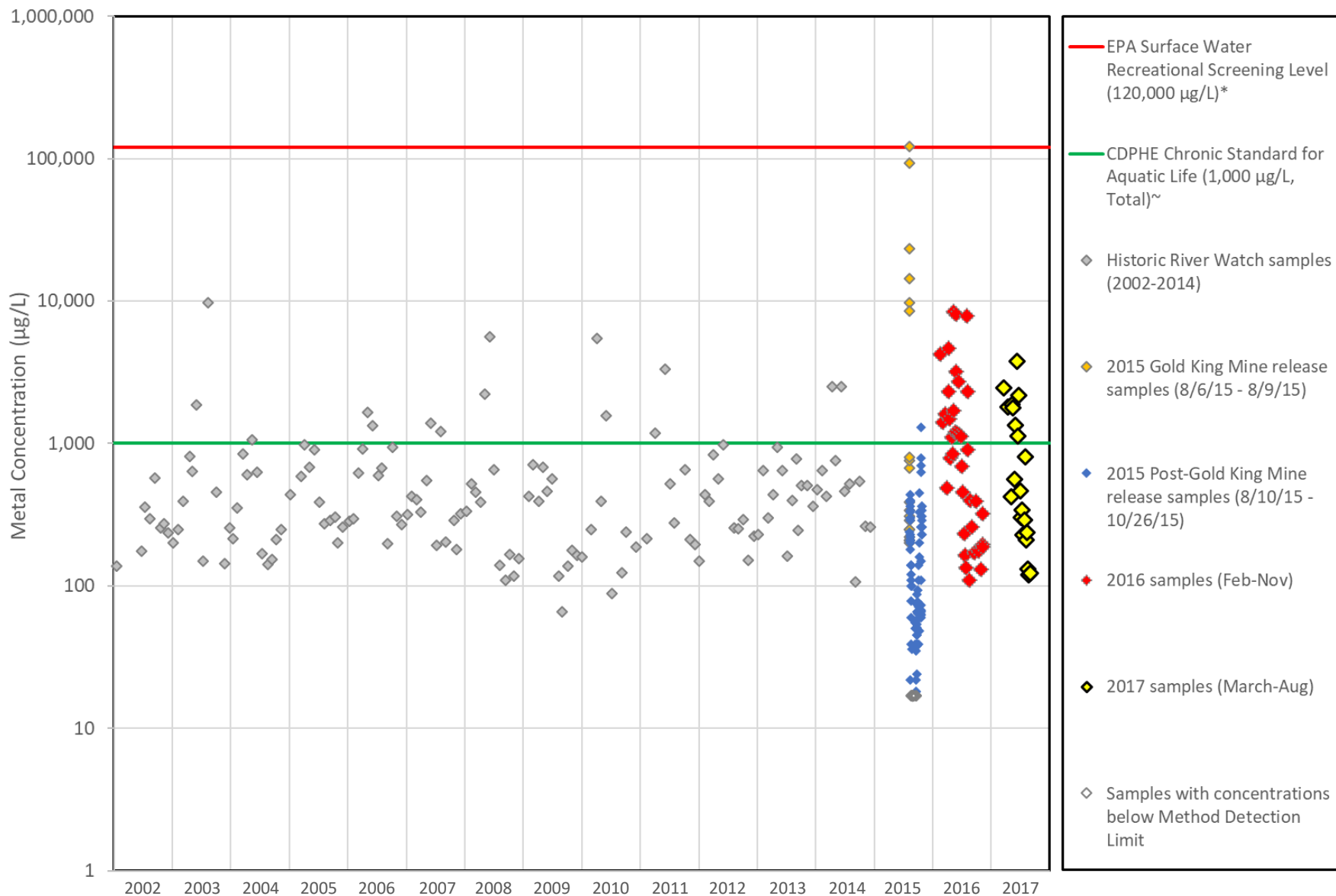


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Total Iron, Animas River at Durango, CO: 2002-2017

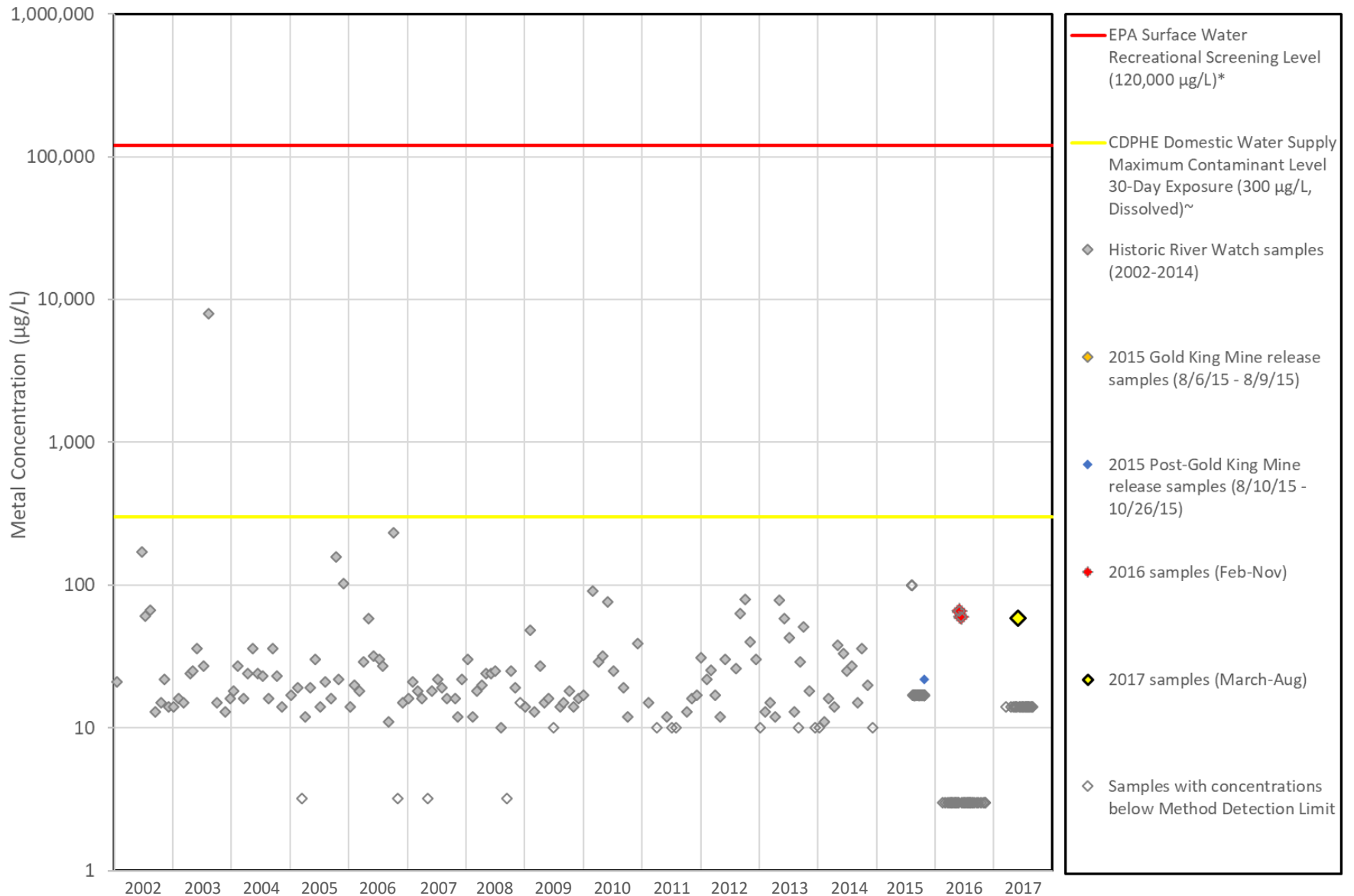


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~Colorado Department of Public Health and the Environment (CDPHE) standards based on Colorado surface water quality classifications and Reg. 31 and 34.

Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Dissolved Iron, Animas River at Durango, CO: 2002-2017

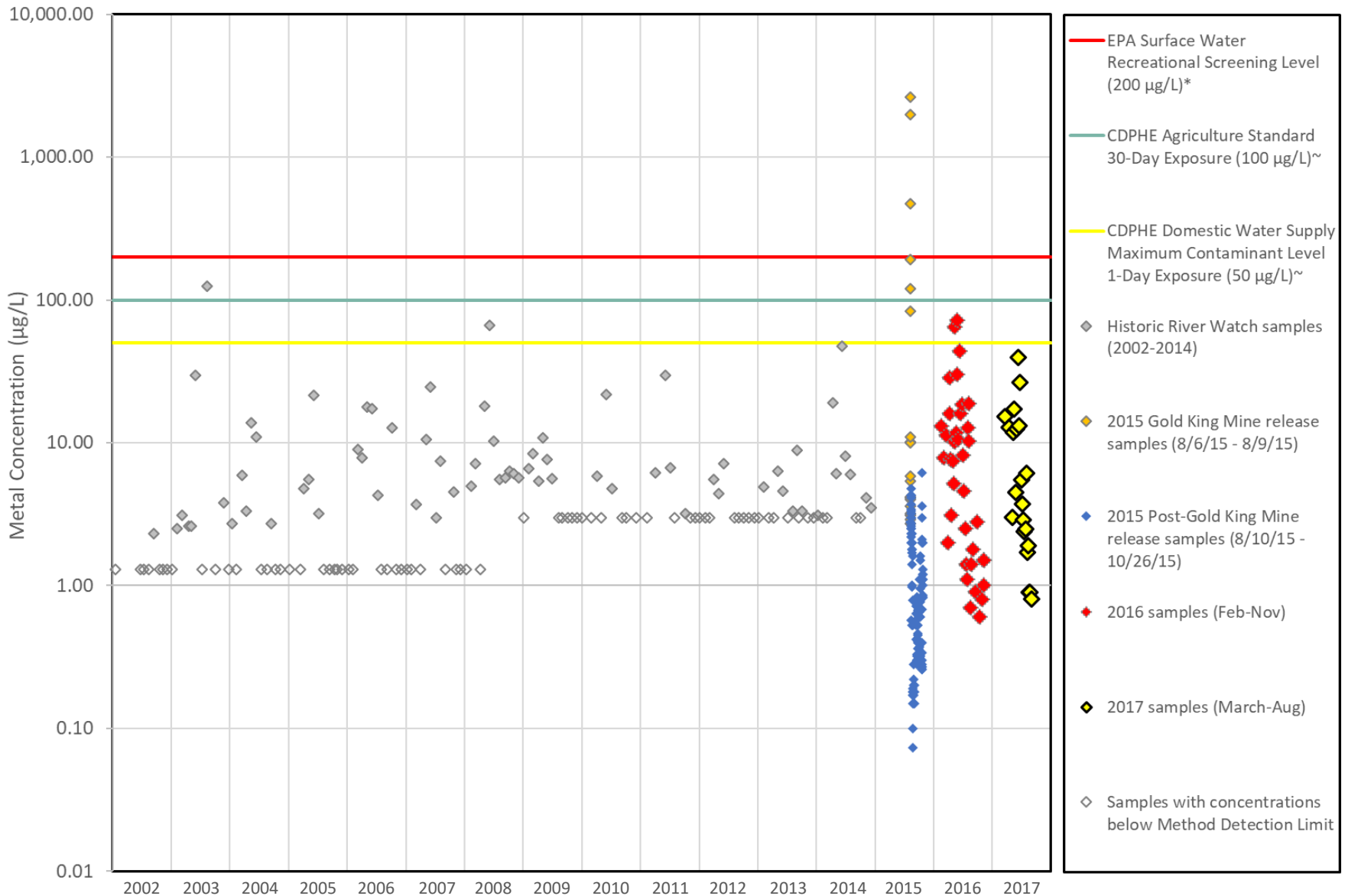


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Total Lead, Animas River at Durango, CO: 2002-2017

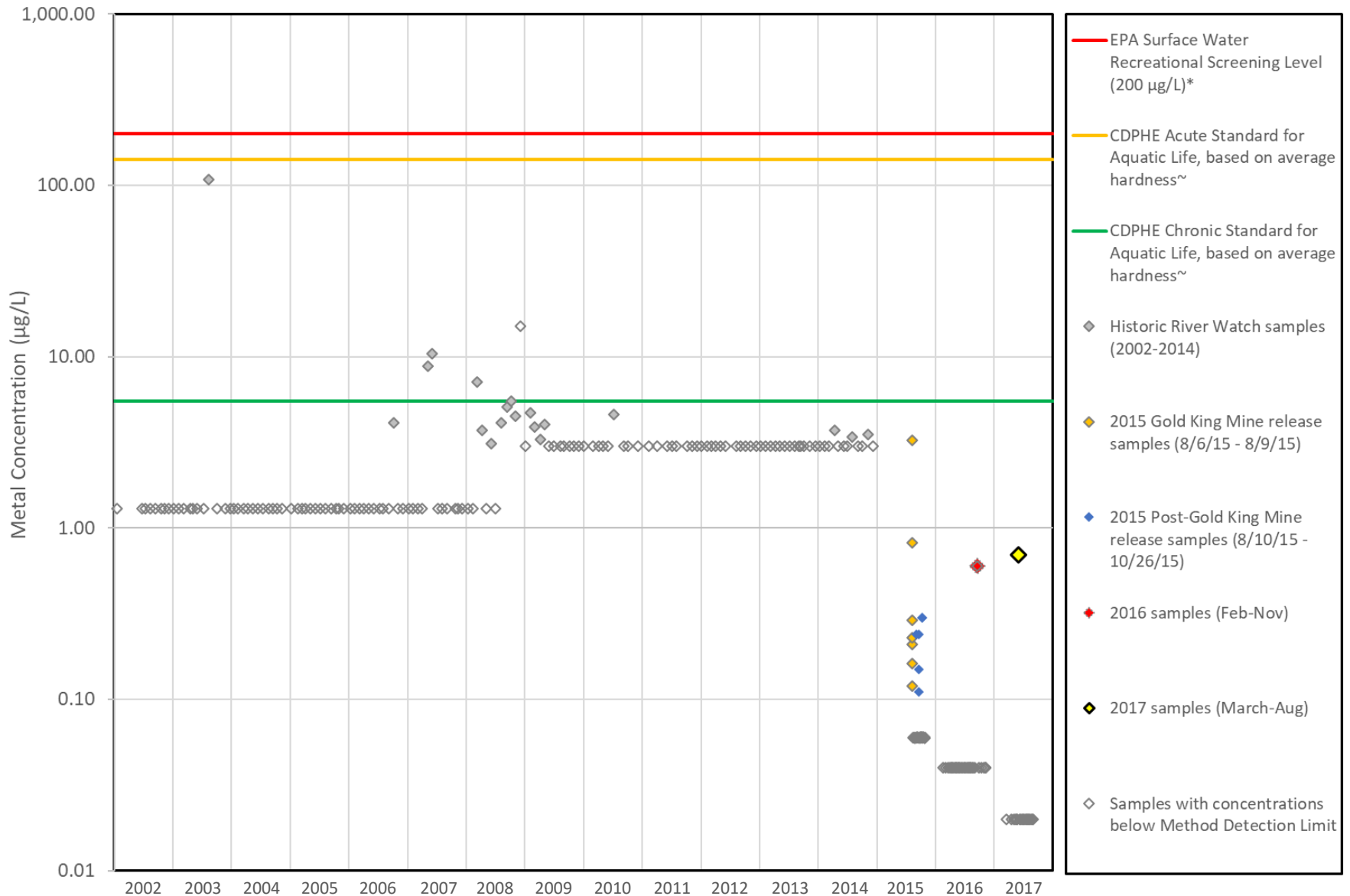


* The recreational screening level represents the level at which no adverse health effects are expected to occur in humans consuming 2L of water per day, from the Animas, orally, for 64 days each year for a total of 30 years.

~Colorado Department of Public Health and the Environment (CDPHE) standards based on Colorado surface water quality classifications and Reg. 31 and 34.

Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Dissolved Lead, Animas River at Durango, CO: 2002-2017

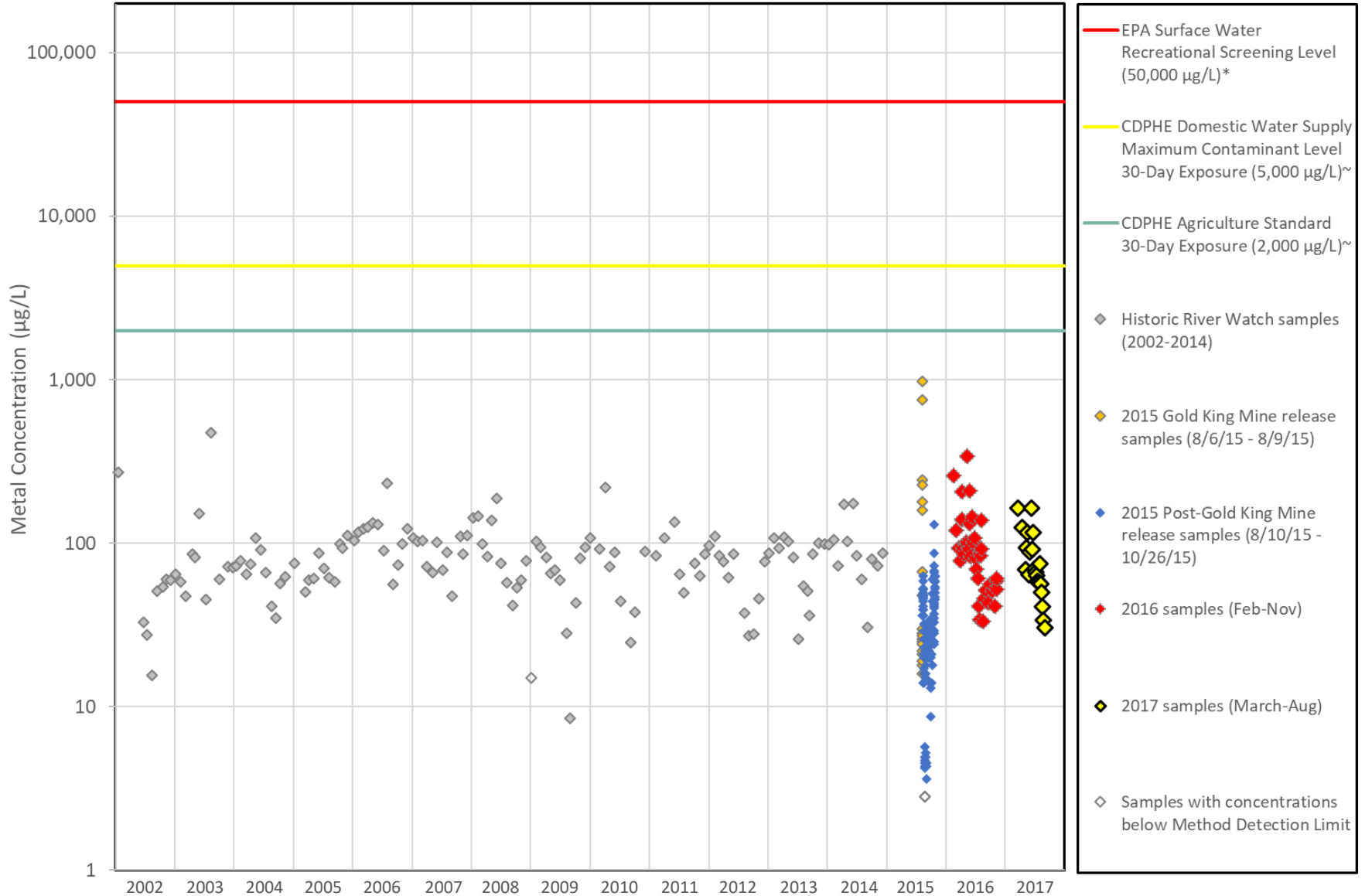


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Total Zinc, Animas River at Durango, CO: 2002-2017

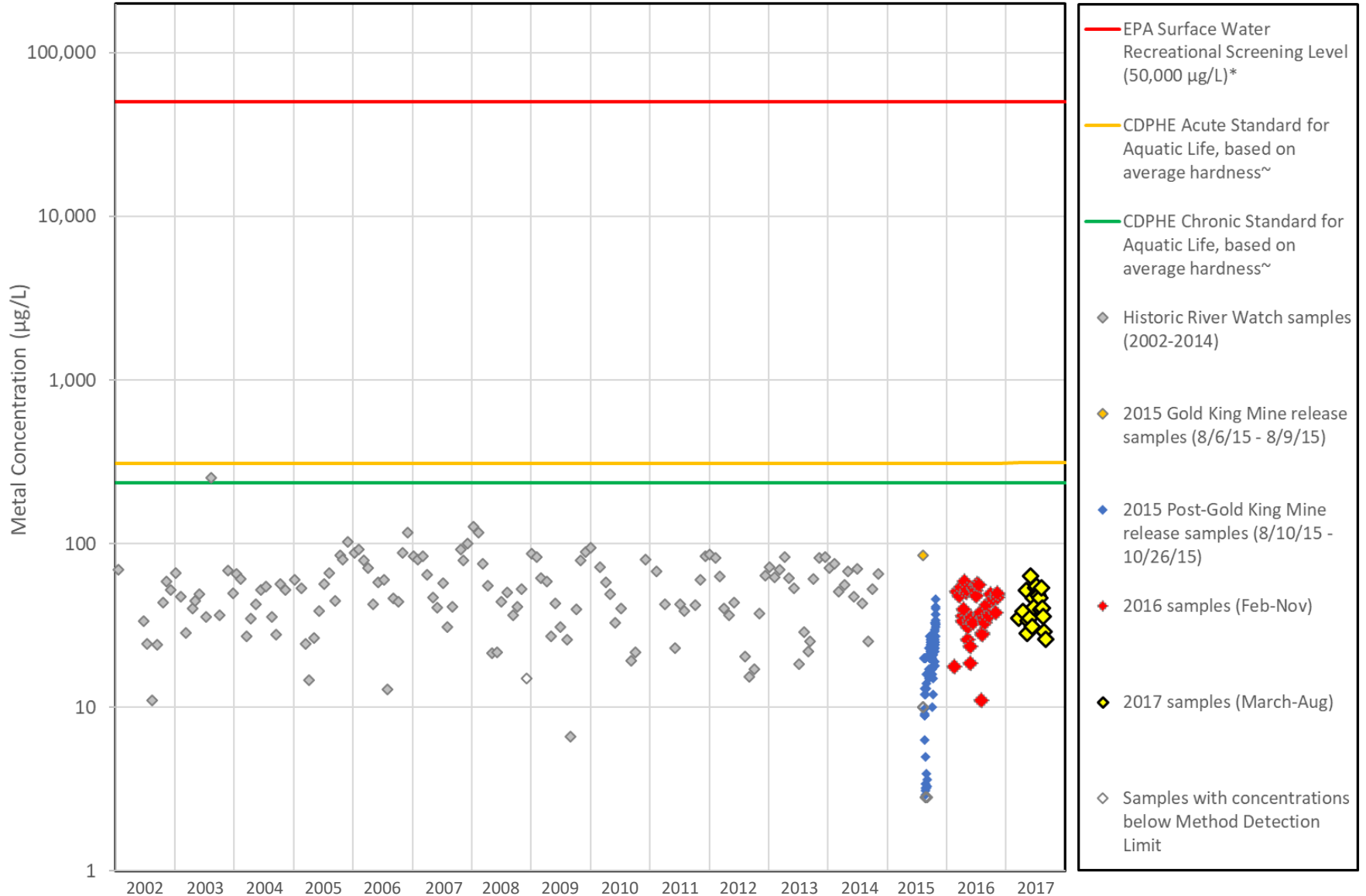


* The recreational screening level represents the level at which no adverse health effects are expected to occur in humans consuming 2L of water per day, from the Animas, orally, for 64 days each year for a total of 30 years.

~Colorado Department of Public Health and the Environment (CDPHE) standards based on Colorado surface water quality classifications and Reg. 31 and 34.

Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Dissolved Zinc, Animas River at Durango, CO: 2002-2017



* The recreational screening level represents the level at which no adverse health effects are expected to occur in humans consuming 2L of water per day, from the Animas, orally, for 64 days each year for a total of 30 years.

~Colorado Department of Public Health and the Environment (CDPHE) standards based on Colorado surface water quality classifications and Reg. 31 and 34. Standards vary with water hardness and are plotted here using an average water hardness of the Animas River at this location, 208 mg/L.

Note: 2002 - 2014 data is River Watch data from the Animas River at the fish hatchery in Durango, CO. 2015-17 data is Mountain Studies Institute data from the Animas River at Rotary Park in Durango, CO

Appendix B:

Additional technical details regarding
Mountain Studies Institute's
2017 water quality monitoring analysis

Appendix B: Additional technical details – Mountain Studies Institute’s 2017 water quality monitoring analysis

Water Quality Benchmarks: Iron and aluminum chronic water quality standards

In 2017, concentrations of iron and aluminum reached levels of concern for long term exposure to aquatic life. CDPHE provides acute water quality standards that are set to be protective of aquatic life from brief, short-term exposure to contaminants. The aluminum concentration on June 6, 2017 (2,480 ug/L) surpassed the hardness based acute aquatic life standard (2,119 ug/L). CDPHE specifies that the paired hardness concentration must surpass the acute standard more than once in a three-year period for a legitimate exceedance of an acute standard to have occurred (CDPHE 2017). Although the concentration of aluminum in the Animas river at Rotary Park did not surpass the acute aquatic life standard in 2016, the concentration of aluminum did surpass the standard on August 7, 2015 from samples collected during the Gold King Mine release (Roberts 2016).

CDPHE provides chronic water quality standards that are set to be protective of aquatic life from persistent, long-term exposure to contaminants. CDPHE evaluates chronic aluminum impairment by two methods (CDPHE 2015). The first method compares the 85th percentile of total aluminum concentration values to a chronic standard based on an average hardness value. For the 2017 Rotary Park data, the 85th percentile was 1,320 ug/L, which surpasses the average hardness based standard of 707 ug/L. The second method assigns a chronic standard for each sample based on the hardness value observed at the time the sample was collected. Impairment is designated if 50% of the samples exceed their paired chronic standard. For the 2017 Rotary Park data, 8 of 21 samples (38%) surpassed their paired chronic standard for aluminum, which is less than the 50% threshold that would designate impairment. CDPHE considers the second method (paired hardness-concentrations) more representative than the first method (based on average hardness) so although total aluminum concentrations were relatively high, they are not high enough to technically surpass the CDPHE chronic aquatic life standard for aluminum. The chronic aquatic life water quality standard for iron is evaluated based on the median observed value. The median value for total iron over the 2017 monitoring period was 466 ug/L, which is lower than the CDPHE chronic aquatic life standard of 1,000 ug/L (CDPHE 2017). Iron concentrations at Rotary Park in 2016 were high enough to surpass the CDPHE chronic aquatic life standard.

2017 Water Quality Data in Context of Historical Data: Summary statistics and statistical analysis

MSI compared Animas River metal concentrations in 2017 to those observed by River Watch from 2002 to 2014 (CDSN 2015) using a statistical test called Wilcoxon rank sum test. The results of the test indicate that there was no significant difference in the concentration of most metals of the Durango stretch of the Animas River in 2017 compared to the 2002-2014 time

period (Table 1). Concentrations of dissolved copper and total zinc were significantly lower in 2017 than during 2002-2014.

[Metals and Other Water Quality Parameters: Correlation statistics and an example graph of the four USGS water quality parameters: discharge, turbidity, pH, and conductivity](#)

In 2016, USGS began to provide continuous measurement of pH, turbidity, and conductivity at their Animas River gauge in Durango, CO (*data available at <https://waterdata.usgs.gov/nwis/uv?09361500>*). MSI examined the relationship between metal concentrations and these additional water quality parameters (Figures 1-4). Spearman correlation coefficients indicate that several metals correlated at a statistically significant level with discharge, turbidity, pH, and conductivity (Table 2).

Table 1: Summary statistics for metal concentrations observed in 2017 and for the River Watch data set (2002-2014). P values are test results of Wilcoxon rank sum test. Gold highlight indicate a statistically significant difference.

	ug/L	Al		Cu		Fe		Pb		Zn	
		March-Aug 2017	March-Aug 2002-2014	March-Aug 2017	March-Aug 2002-2014	March-Aug 2017	March-Aug 2002-2014	March-Aug 2017	March-Aug 2002-2014	March-Aug 2017	March-Aug 2002-2014
Total	n	20	72	9.0	100	20	153	12	89	20	148
	Min	9.0	28	4.4	4.2	120	3.2	3.0	3.1	30	16
	Mean	639	599	10	13	989	1008	14	16	81	110
	Median	291	408	9.4	8.7	445	591	13	10	68	92
	95th	1568	1812	16	30	2526	3244	32	43	163	220
	Max	2480	3555	19	71	3770	9770	39	124	163	472
	p value	0.842		0.817		0.851		0.954		0.027	
Dissolved	n			14	20					20	74
	Min			1.0	1.5					26	11
	Mean			1.9	2.7					42	48
	Median		*	2.0	2.5		*		*	41	43
	95th			2.8	4.3					55	76
	Max			3.0	5.0					63	253
	p value			0.006						0.357	

*Dissolved aluminum, iron, and lead could not be included in statistical analysis due to the limited number of samples where concentrations were detected.

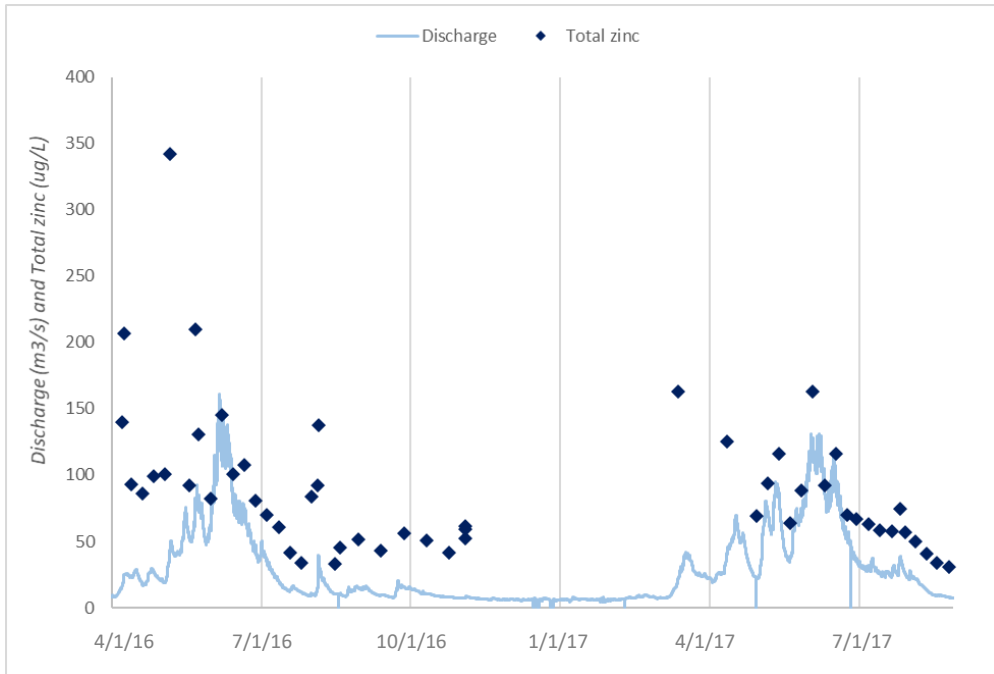


Figure 1: Discharge and total zinc.

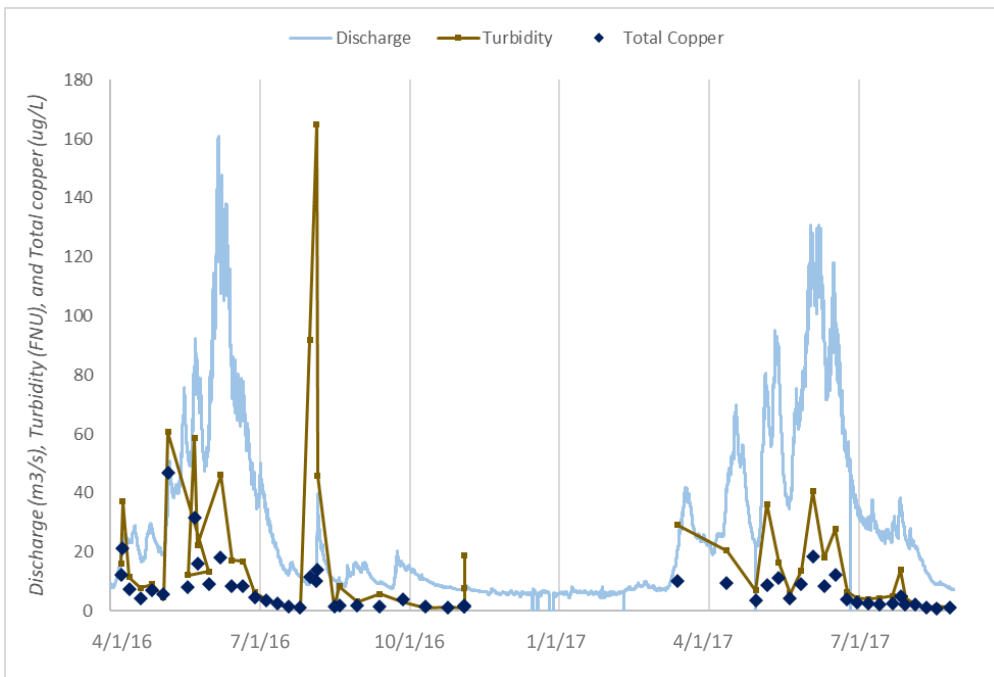


Figure 2: Discharge, turbidity, and total copper.

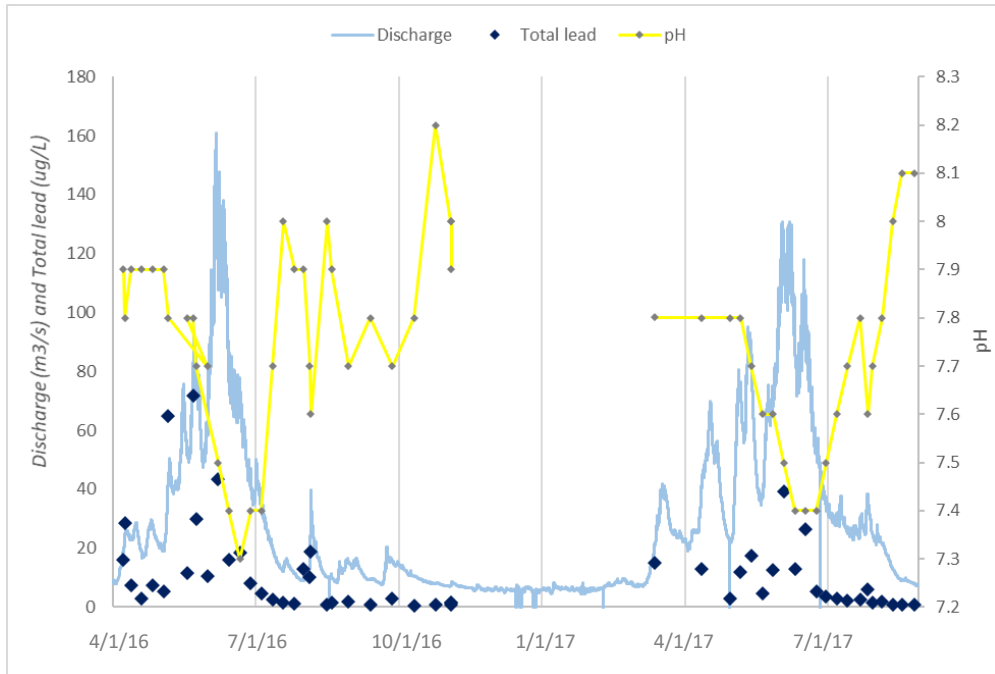


Figure 3: Discharge, pH, and total lead.

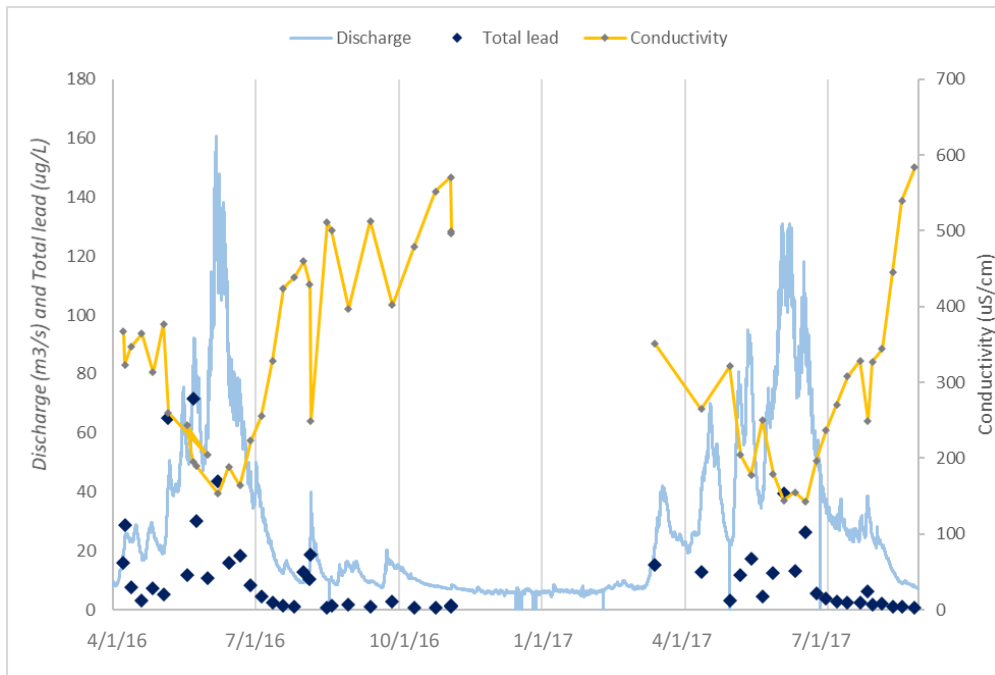


Figure 4: Discharge, conductivity and total lead.

Table 2: Spearman correlation coefficients for metal concentrations and water quality parameters measured in 2016 and 2017. Yellow highlight indicates a statistically significant correlation at the 0.05 alpha level

				Aluminum		Copper		Iron		Lead		Zinc		
				T	D	T	D	T	D	T	D	T	D	
When...	...discharge...	...increased...	...the following metals...	...increased	0.70	*	0.73	0.78	0.69	*	0.81	*	0.70	
	...discharge...	...increased...		...decreased		*				*		*		-0.02
	...turbidity...	...increased...		...increased	0.87	*	0.88	0.58	0.89	*	0.86	*	0.84	
	...turbidity...	...increased...		...decreased		*				*		*		-0.40
	...pH...	...decreased...		...increased	-0.39	*	-0.47	-0.53	-0.40	*	-0.54	*	-0.42	-0.27
	...conductivity...	...increased...		...decreased	-0.66	*	-0.70	-0.77	-0.66	*	-0.79	*	-0.68	-0.07

*Dissolved aluminum, iron, and lead could not be included in statistical analysis due to the limited number of samples where concentrations were detected.

References:

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