

July 2014

Norwest Corporation (Norwest) maintains three gaging stations for Pioneer Natural Resources USA Inc. (PNR) in the headwaters of the Apishapa River in northern Las Animas County, Colorado. The Apishapa River is a tributary of the Arkansas River. The gaging stations acquire “continuous” data on 15-minute intervals for pressure, temperature, conductivity, calculated SAR, and calculated flow using an In-Situ Aqua Troll. Communication of the near real-time continuous data is accomplished using Iridium satellite telemetry and is available online at www.apishapawatershed.org. Norwest visits the stations every two weeks to download the data, calibrate the equipment, acquire instantaneous flow measurements, collect field parameters of pH, temperature, conductivity and salinity, and collect water quality samples. All monitoring conducted at each station is voluntary and is not required by any regulatory agency.

The three stations on the Apishapa are shown on **Figure 1**. The Belarde station is furthest upstream and has a contributing watershed of 59.3 square miles. The Eichler station is located downstream, and has a contributing watershed of 72.9 square miles. The Lisonbee station is located further downstream, southwest of Aguilar, slightly upstream of the historic USGS gage 07118000, and has a contributing watershed of 141.7 square miles. The Eichler and Lisonbee stations are located downstream of the Apishapa’s confluence with tributaries potentially influenced by coalbed methane discharge waters.

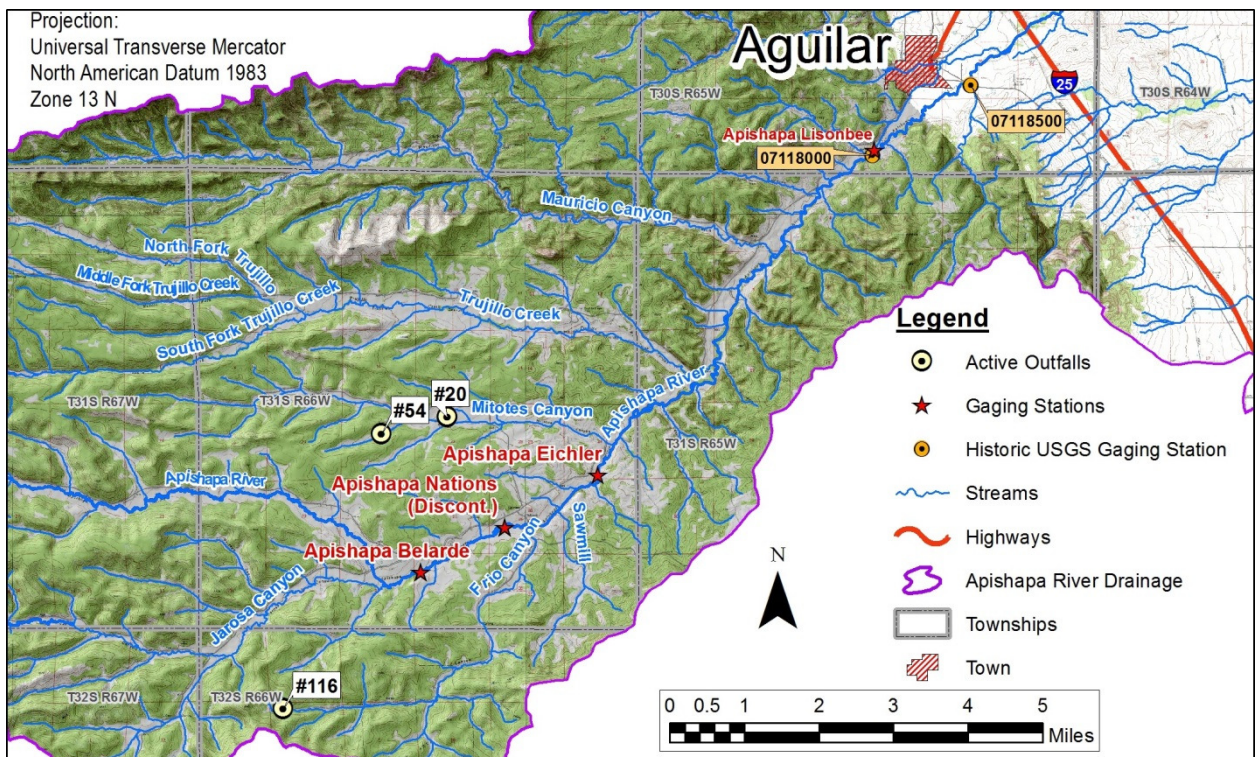


FIGURE 1
APISHAPA WATERSHED

The U.S. Drought Monitor prepares maps weekly for drought conditions throughout the contiguous United States. The U.S. Drought Monitor is produced in partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln (NDMC-UNL), the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. **Figure 2** depicts drought conditions in Colorado for data received as of 7 a.m. EST on July 1, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on July 29, 2014. The western portion of Las Animas County decreased from a combination of D1 and D2 drought conditions in early July to mostly D0 and D1 drought conditions by July 29, 2014. The drought intensity for the central portion of Las Animas County decreased from a combination of D2 and D3 conditions to D1 and D2 drought conditions. The eastern part of the county decreased from D3 drought conditions in the beginning of July to D2 drought conditions by the end of July (Drought Monitor, 2014).

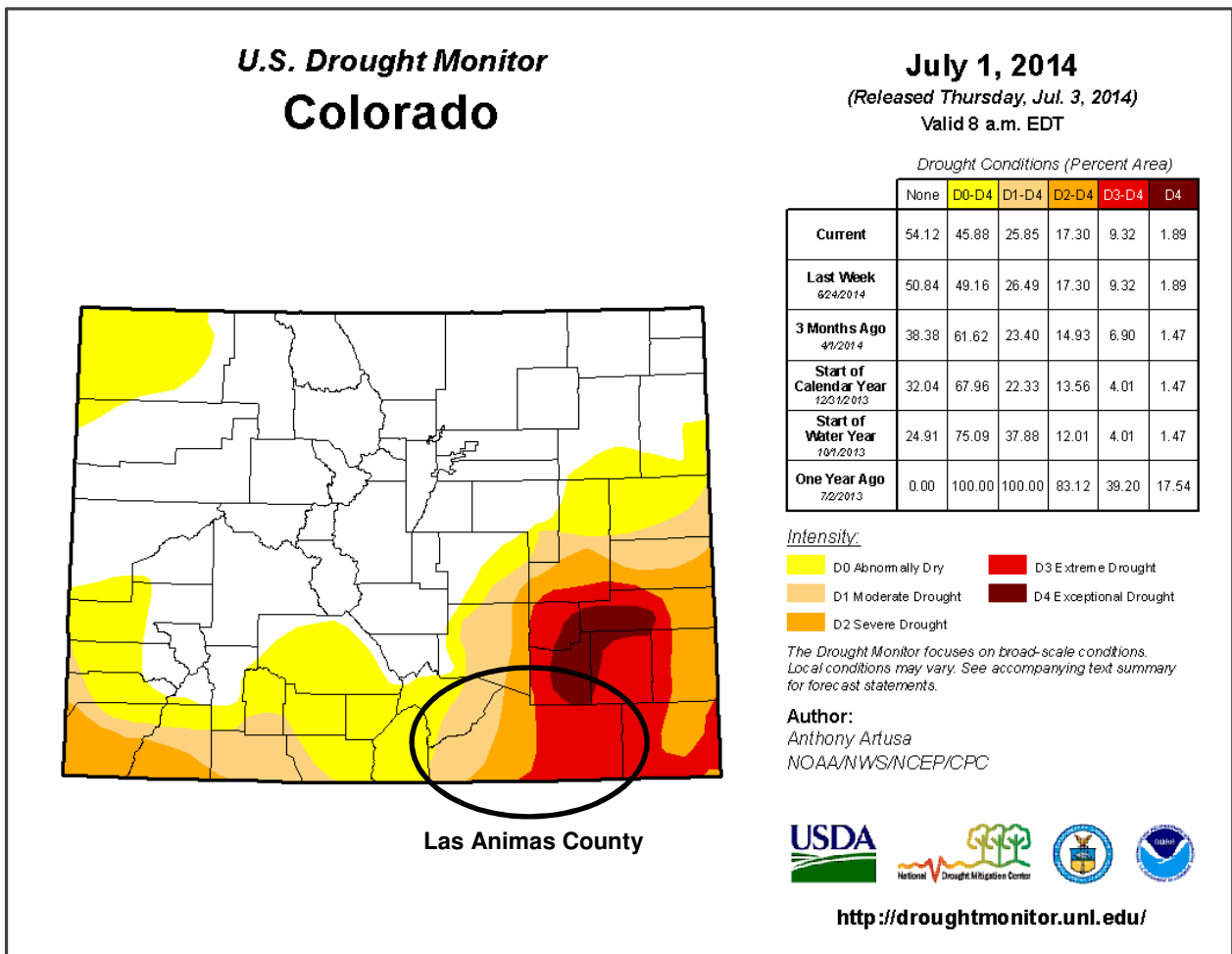


FIGURE 2
U.S. DROUGHT MONITOR COLORADO – JULY 1, 2014

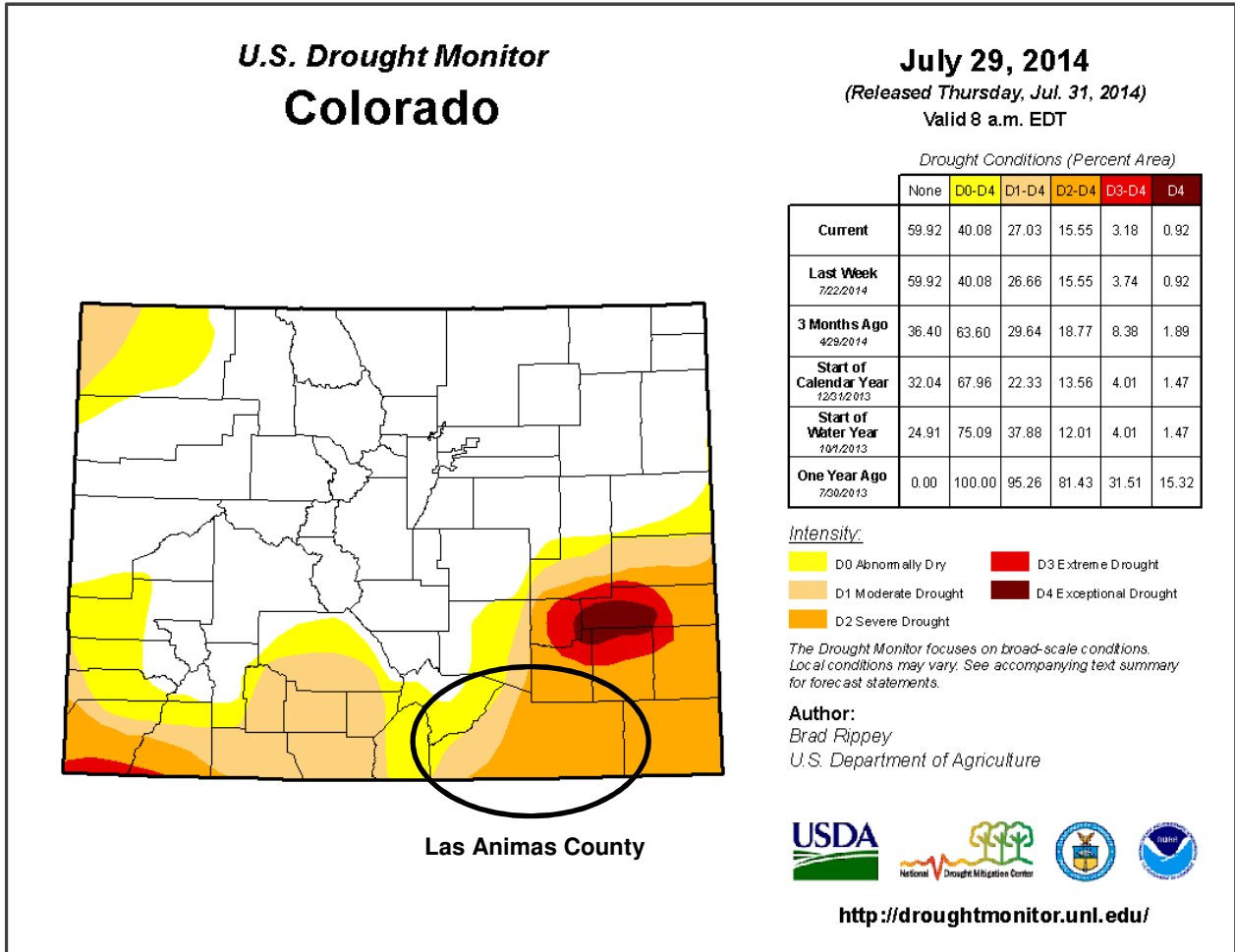


FIGURE 3
U.S. DROUGHT MONITOR COLORADO – JULY 29, 2014

The three gaging stations on the Apishapa River discussed in this report are located in the southwest part of the county with the D0 and D1 drought conditions mentioned above. Recordable flow was present at the Eichler and Lisonbee stations the entire month of July 2014. The Belarde station was dry July 6, 2014 through July 11, 2014. Laboratory water quality samples were collected and streamflow was measured at the Eichler and Lisonbee stations during both July 2014 site visits and at the Belarde station during the July 29, 2014 visit.

July 2014 data exhibited a calculated daily average flow of 1.44 cfs at Belarde, 1.32 cfs at Eichler, and 3.46 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 98 $\mu\text{s}/\text{cm}$ to 385 $\mu\text{s}/\text{cm}$, with a median value of 224 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Eichler ranged from 454 $\mu\text{s}/\text{cm}$ to 712 $\mu\text{s}/\text{cm}$, with a median value of 542 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Lisonbee ranged from 313 $\mu\text{s}/\text{cm}$ to 694 $\mu\text{s}/\text{cm}$, with a median value of 580 $\mu\text{s}/\text{cm}$ (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in July 2014 ranged from 0.29 to 0.71 at Belarde, 0.94 to 1.52 at Eichler, and 0.96 to 2.12 at Lisonbee (**Table 1**).

TABLE 1
JULY 2014 DAILY AVERAGE GAGE DATA

	Average Daily			
	Minimum	Median	Average	Maximum
Belarde - (25 days of flow data)				
Water Level (ft)	0.18	0.49	0.46	0.86
Flow ¹ (cfs)	0.06	1.00	1.44	5.46
Temperature (°C)	14.86	18.06	18.36	21.05
Conductivity (µs/cm)	98	224	238	385
TDS ² (mg/l)	64	145	154	250
Sodium Adsorption Ratio ³ (SAR)	0.29	0.49	0.51	0.71
Eichler - (31 days of flow data)				
Water Level (ft)	0.11	0.52	0.49	0.98
Flow ¹ (cfs)	0.00	0.71	1.32	5.84
Temperature (°C)	16.39	18.57	18.66	21.49
Conductivity (µs/cm)	454	542	563	712
TDS ² (mg/l)	295	352	366	463
Sodium Adsorption Ratio ³ (SAR)	0.94	1.17	1.20	1.52
Lisonbee - (31 days of flow data)				
Water Level (ft)	0.24	0.37	0.37	0.53
Flow ¹ (cfs)	0.49	3.06	3.46	10.12
Temperature (°C)	16.46	18.85	18.83	20.60
Conductivity (µs/cm)	313	580	543	694
TDS ² (mg/l)	204	377	353	451
Sodium Adsorption Ratio ³ (SAR)	0.96	1.78	1.66	2.12
¹ Calculated from pressure data				
² Calculated from conductivity data with a conversion of 0.65 mg/l TDS per µs/cm specific conductance				
³ Derived from a historic multivariate regression analysis of conductivity and flow				

The mainstem of the Apishapa River has been classified by the Colorado Water Quality Control Commission (WQCC) as supporting aquatic life, recreation, water supply, and agriculture (CDPHE WQCC, 2014). During the month of July 2014, the water type at Belarde and Eichler was a calcium bicarbonate water with a calcium-sodium bicarbonate water type at Lisonbee.

July 2014 field measured SC values and laboratory measured SAR values at the Belarde, Eichler, and Lisonbee stations are illustrated in **Table 2** and **Figure 4**. All three stations were below the SC threshold limit of 1300 µs/cm and the SAR threshold limit of 6.8 (**Figure 4**). These SC and SAR threshold limits have been identified by the Colorado Department of Public Health and Environment (CDPHE) for protection of downstream alfalfa crops (CDPHE, 2010).

TABLE 2
JULY 2014 SAR AND SPECIFIC CONDUCTANCE

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Belarde	7/29/2014	0.34	161.9
Eichler	7/10/2014	1.07	457.0
Eichler	7/29/2014	0.78	396.4
Lisonbee	7/10/2014	1.82	507.0
Lisonbee	7/29/2014	1.75	486.1

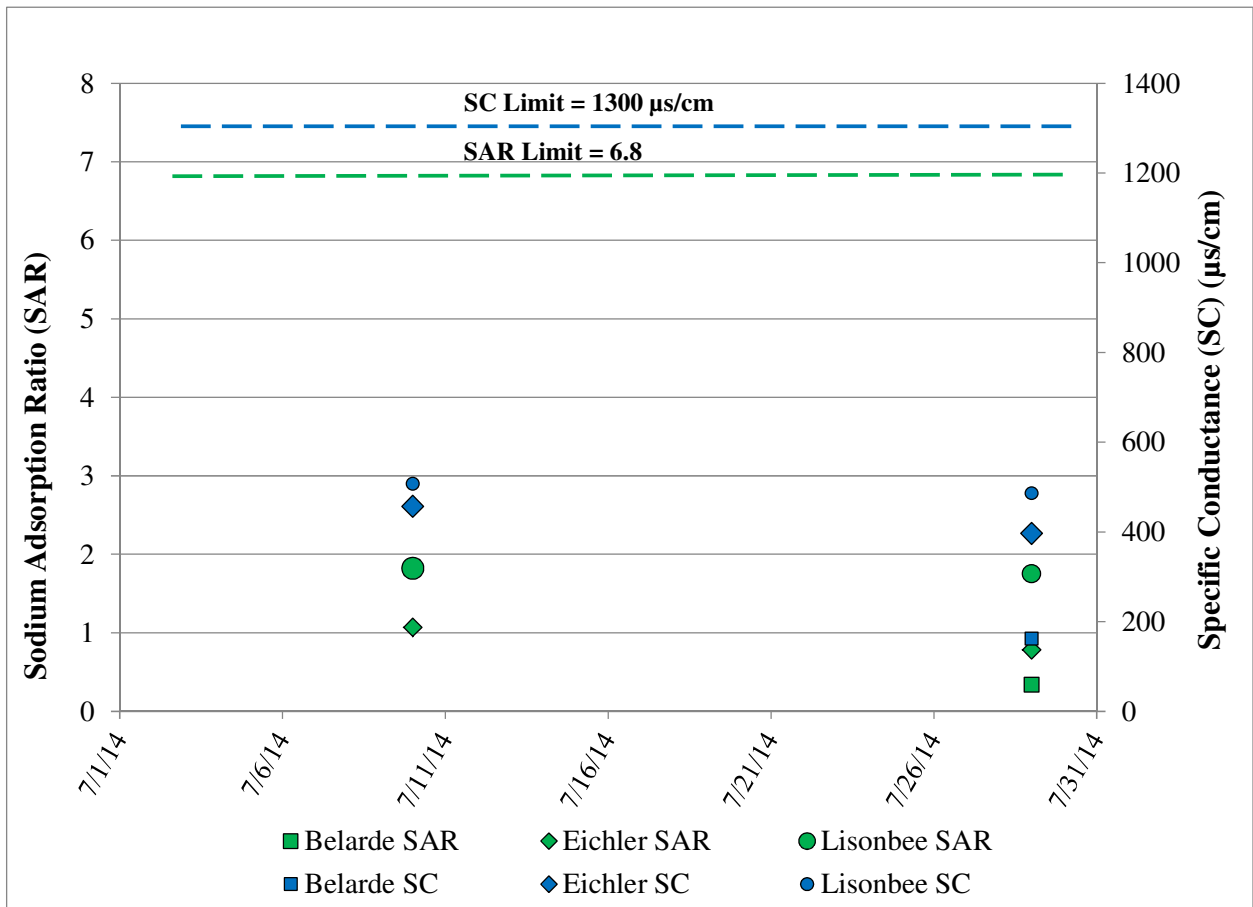


FIGURE 4
JULY 2014 SAR AND SPECIFIC CONDUCTANCE

The water in July exhibits a range of hardness, with Belarde at 70 mg/l CaCO₃ hardness, Eichler ranging from 163 mg/l CaCO₃ to 212 mg/l CaCO₃ hardness, and Lisonbee ranging from 174 mg/l CaCO₃ to 184 mg/l CaCO₃ hardness (**Table 4**). Based on toxicity testing, aquatic species protection from elevated heavy metal concentrations increases as hardness increases (CDPHE WQCC, 2013). Lower hardness values, closer to 25 mg/l CaCO₃, have lower hardness based metal standards to provide aquatic life protection and higher hardness values, closer to 400 mg/l CaCO₃, can afford higher hardness based metal standards to provide aquatic life protection (CDPHE WQCC, 2013).

Stream water quality is affected by the quantity of sediment in the stream. Sediment concentrations increase during storm events or snowmelt runoff. Analyses of the total recoverable forms of metals typically increase with increased sediment concentrations, as the laboratory analytical digestions dissolve the sediment. Total suspended solids (TSS) in July 2014 was 91.3 mg/l at the Belarde station, ranged from 20 mg/l to 75.3 mg/l at the Eichler station, and ranged from 39 mg/l to 39.6 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). Total recoverable iron concentrations were 3.65 mg/l at Belarde, 0.12 mg/l to 5.38 mg/l at Eichler, and 0.471 mg/l to 2.2 mg/l at Lisonbee (**Table 3** and **Figure 5**). Concentrations greater than 1 mg/l exceed chronic aquatic standard for total recoverable iron. This is not unusual when elevated total suspended solids are present.

TABLE 3
JULY 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Location	Sample Date	Iron (T-Rec.) (mg/l)	Total Suspended Solids (TSS) (mg/l)
Belarde	7/29/2014	3.650	91.3
Eichler	7/10/2014	0.120	20.0
Eichler	7/29/2014	5.380	75.3
Lisonbee	7/10/2014	2.200	39.0
Lisonbee	7/29/2014	0.471	39.6

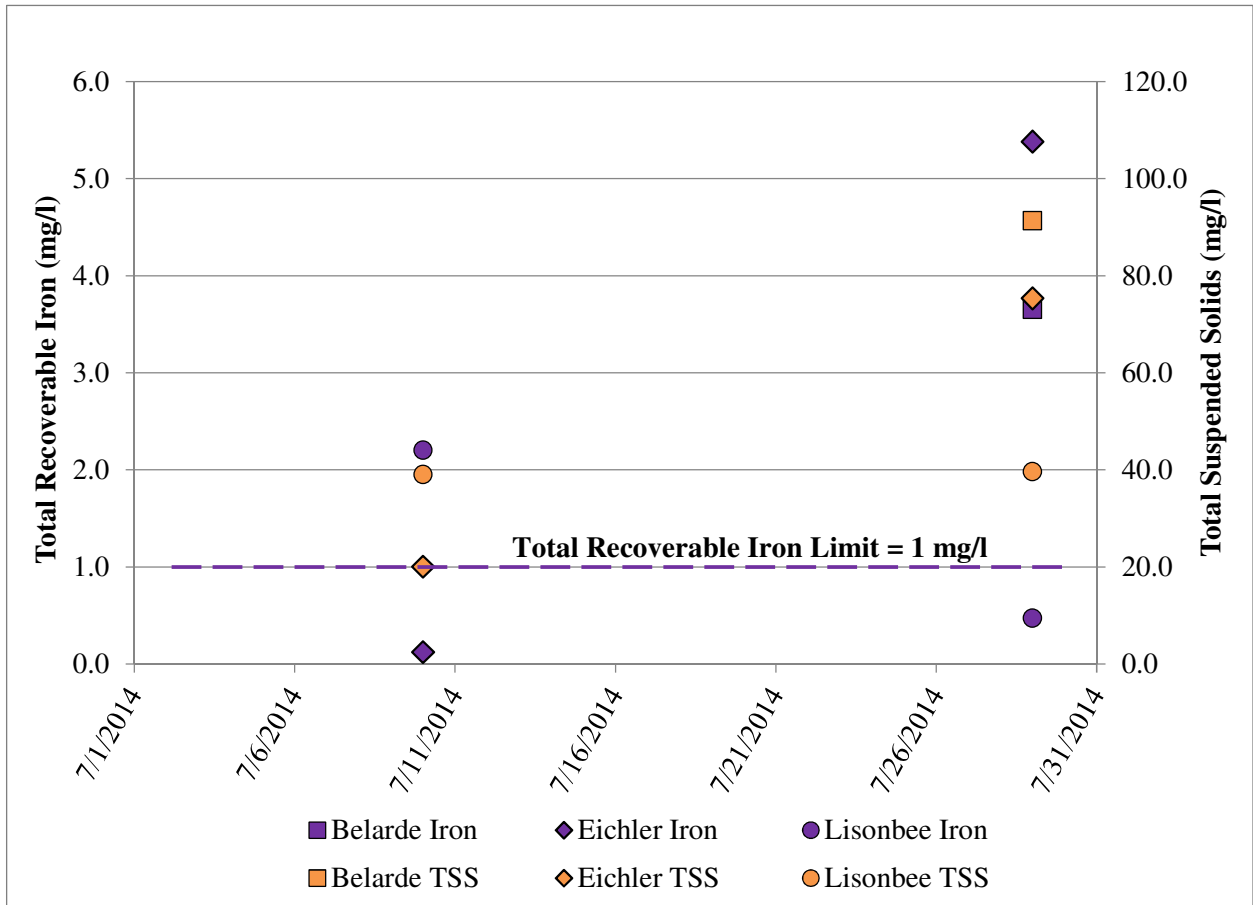


FIGURE 5
JULY 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Constituents below the detection limit at all three stations in July 2014 include arsenic, boron, chromium, copper, and selenium. Measured concentrations of potentially dissolved copper were below the detection limit of 15 µg/l at all three stations (**Table 4**). However, the hardness adjusted stream standard for chronic potentially dissolved copper at all stations except Eichler and Lisonbee on July 10, 2014 and acute potentially dissolved copper at Belarde was lower than the 15 µg/l detection limit (**Table 4**). Measured concentrations of potentially dissolved manganese and potentially dissolved zinc were lower than the hardness adjusted stream standards established by the WQCC (**Table 4**). Chloride and sulfate were below the stream standards at the Belarde, Eichler, and Lisonbee stations (**Table 5**). The field pH values in July 2014 were within the stream standard of between 6.5 and 9.0 at all three stations (**Table 5**).

TABLE 4

HARDNESS BASED STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, JULY 2014 (CDPHE WQCC, 2013)

Site	Sample Date	Stream Segment	Calculated Hardness ¹ (mg/l CaCO ₃)	Acute Copper (Pot. Diss.) (µg/l)	Chronic Copper (Pot Diss.) (µg/l)	Chronic Iron (T-Rec.) (mg/l)	Acute Manganese (Pot. Diss.) (µg/l)	Chronic Manganese (Pot. Diss.) (µg/l)	Acute Zinc (Pot. Diss.) (µg/l)	Chronic Zinc (Pot. Diss.) (µg/l)
Belarde Hardness Based Standards	7/29/2014	3a	70	9.6	6.6	1	2651	1465	116	88
Belarde Maximum July Results			NA	<15	<15	3.65	101	101	20.3	20.3
Eichler Hardness Based Standards	7/10/2014	3a	212	27.3	17.0	1	3835	2119	317	240
Eichler Hardness Based Standards	7/29/2014	3a	163	21.3	13.6	1	3513	1941	250	189
Eichler Maximum July Results			NA	<15	<15	5.38	574	574	<20	<20
Lisonbee Hardness Based Standards	7/10/2014	3a	184	23.9	15.1	1	3658	2021	279	211
Lisonbee Hardness Based Standards	7/29/2014	3a	174	22.6	14.4	1	3591	1984	265	201
Lisonbee Maximum July Results			NA	<15	<15	2.20	81	81	<20	<20

¹ A hardness value of 400 mg/l CaCO₃ is used to calculate the metal standards when the measured hardness values are greater than 400 mg/l CaCO₃

TABLE 5

STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, JULY 2014 (CDPHE WQCC, 2013)

Site	Sample Date	Stream Segment	Arsenic (Total) (µg/l)	Boron (Total) (mg/l)	Acute Chromium (Total) (µg/l)	Chronic Chromium (Total) (µg/l)	Chloride (mg/l)	Acute Selenium (T-Rec.) (µg/l)	Chronic Selenium (T-Rec.) (µg/l)	Sulfate (mg/l)	pH-low (s.u.)	pH-High (s.u.)
Belarde Standards	7/29/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Maximum July Results¹			<15	<0.05	<10	<10	7.3	<4	<4	10.2	8.04	8.04
Eichler Standards	7/10/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	7/29/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Maximum July Results¹			<15	<0.05	<10	<10	21.0	<4	<4	30.0	7.88	8.12
Lisonbee Standards	7/10/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	7/29/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Maximum July Results¹			<15	<0.05	<10	<10	8.7	<4	<4	54.0	8.28	8.33

¹ Minimum result identified for pH-low

References

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2013. 5 CCR 1002-31, Regulation No. 31 The Basic Standards and Methodologies for Surface Water, Amended September 11, 2012, Effective January 31, 2013.

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2014. 5 CCR 1002-32, Regulation No. 32 Classifications and Numeric Standards for Arkansas River Basin, Amended March 11, 2014, Effective April 30, 2014.

Colorado Department of Public Health and Environment (CDPHE), 2010. Apishapa CBM Facility, Water Quality Assessment, Draft Discharge Permit CO0048313, Pioneer Natural Resources, USA, Inc.

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