Hydrologic and Water Quality Collection for Colorado's Upper Arkansas River Basin

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Summary

Field data collection and analysis activities for a study region in Chaffee County in the Upper Arkansas River Basin (UARB) (Gates et al, 2016) were conducted per the Scope of Work submitted to Colorado Water Conservation Board (CWCB) in September 2017. The activities and results are summarized below. Locations and methods of measurements and sampling are as described in Gates et al (2016). Data have been entered into the Arkansas River Basin SQL Database at Colorado State University and are summarized in an accompanying Excel file. Results reveal values for water table depth, flow rates, in-situ water quality parameters, and concentrations of selected water quality constituents, which are similar in magnitude and variability to those reported in Gates et al (2016) and in annual reports to Colorado Water Institute (CWI) and CWCB for fiscal years 2016 and 2017.

Monitoring events were conducted in November 2017 and April 2018. The average depth to the water table measured in 17 monitoring wells during the November 2017 sampling event was 6.6 meters, and the average electrical conductivity (EC) of the groundwater was 0.28 dS/m. During the sampling event in April 2018, depth to water table and EC were measured in 15 wells, with two additional wells found dry. Average water table depth was 5.6 meters and average EC of the groundwater was 0.23 dS/m. Groundwater quality samples taken from 13 wells in April 2018 revealed average uranium (U) and total dissolved solids (TDS) concentrations of 4.2 μ g/L and 216.7 mg/L, respectively.

EC was measured in flows at three locations in the Arkansas River and at 18 locations in tributary streams in November 2017. Average EC in both the river and tributary streams was 0.12 dS/m. Acoustic Doppler velocimeters (ADVs) were used to measure flow rates at gaging sites in eight tributaries. During the April 2018 sampling event, EC was measured in flows at three locations in the Arkansas River and at 19 locations in tributary streams. Average EC was 0.12 dS/m in the river and 0.13 dS/m in the tributary streams. ADVs were used to measure flow rates at gaging sites in seven tributaries. Water quality samples collected during the April event at three locations along the Arkansas River revealed average U and TDS concentrations of 1.7 μ g/L and 100.7 mg/L, respectively. In the tributary streams, average measured U and TDS concentrations were 3.9 μ g/L and 123.3 mg/L, respectively. Additional details are provided in the accompanying Excel file.

Activities

9 – 11 November 2017

- Measurement of water table level in 17 groundwater monitoring wells (manual readings and downloading of continuous water level loggers)
- Measurement of in-situ water quality parameters in 17 groundwater monitoring wells using an In-Situ smarTroll
 - o Electrical conductivity (EC)
 - o pH
 - Oxidation reduction potential (ORP)
 - Dissolved oxygen (DO)
 - o Temperature (T)
- Measurement of stream flow at eight sites in tributaries to the Arkansas River using ADVs

 Measurement of in-situ water quality parameters at 19 sites in tributaries to the Arkansas River and at three sites in the Arkansas River an In-Situ smarTroll EC pH ORP DO T
1 – 23 April 2018
 Measurement of water table level in 15 groundwater monitoring wells (manual readings and downloading of continuous water level loggers) Measurement of in-situ water quality parameters in 15 groundwater monitoring wells using an In-Situ smarTroll EC pH ORP DO T
Measurement of stream flow at seven sites in tributaries to the Arkansas River using
ADVs
• Measurement of in-situ water quality parameters at 15 sites in tributaries to the Arkansas
River and at three sites in the Arkansas River an In-Situ smarTroll
o EC
o pH
ORPDO
O DO○ T
• Extraction of water quality samples from 13 groundwater monitoring wells using bladder
pump and low-flow sampling apparatus
Major salt ions

November 2017 – June 2018

o Uranium (U)

- Entry of UARB data into Arkansas River Basin SQL database
- Processing of continuous groundwater level data
- Analysis of stage-discharge relationships for gaging locations within tributaries of the UARB (preliminary results are available upon request)

Reference

Gates, T. K., Steed, G. H., Niemann, J. D., and Labadie, J. W. 2016. "Data for improved water management in Colorado's Arkansas River Basin: Hydrological and water quality studies." Special Report No. 24, Colorado Water Institute, Colorado State University, Fort Collins, CO.

Upper Arkansas River Basin (UARB)

Surface Water Monitoring Data

Re	egion: UARB SW			In-	Situ Readin	ıgs		Flow Rates					Solut	te Concentrations		
Surface Point	Reading Date	Status	EC (dS/m)	T (°C)	рН	DO (mg/L)	ORP (mV)	cfs	Se (ppb)	Se Duplicate (ppb)	U (μg/L)	U Duplicate (μg/L)	Lab pH	Lab pH Duplicate	SAR	SAR Duplicate
Minimum			0.06	-0.84	5.18	6.29	-4.00				0.67		7.30		0.10	
Maximum			0.26	23.12	8.90	10.92	174.00	*Highlighted			16.00		8.90		0.60	
Average			0.14	7.17	7.58	8.44	51.50	= Stream Gage Record*			3.72		7.82		0.23	
CV			0.29	0.74	0.13	0.12	0.69	(NR=Not Reading)			0.89		0.04		0.57	
Surface Point	Reading Date	Status	EC (dS/m)	T (°C)	рН	DO (mg/L)	ORP (mV)	cfs	Se (ppb)	Se Duplicate (ppb)	U (μg/L)	U Duplicate (μg/L)	Lab pH	Lab pH Duplicate	SAR	SAR Duplicate
4MILED	4/21/2018 19:31		0.19	8.28	8.03	8.2	-4	0.9			0.85		7.8		0.4	
	11/29/2017 13:04		0.11	3.87	7.52	8.23	5.8	0.9								
ARKGRNCO	4/21/2018 11:45		0.14	5.39	8.9	8.85	10.8	263			0.67		7.7		0.2	
7111110111100	11/29/2017 9:45		0.10	1.92	5.22	NR	105.5	204								
ARKNATCO	4/23/2018 15:58		0.15	15.51	8.55	6.96	24	311			1.8		7.8		0.3	
7444474760	11/20/2017 16:36		0.18	4.09	7.76	9.78	81.6	NR								
ARKSALCO	4/23/2018 13:20		0.18	13.13	7.89	7.96	35.9	311			2.5		7.9		0.3	
71111071200	11/21/2017 7:45		0.18	3.68	5.35	9.49	138.6	437								
BRNCKD	4/22/2018 19:31		0.15	13.09	8.03	7.09	28.2	NR			5.9		7.6		0.3	
Billions	11/20/2017 14:50		0.12	4.09	8.11	8.42	48.5	9.3								
BRNCKU	4/23/2018 16:59		0.06	13.88	8.41	6.84	28.1	2.7								
	11/20/2017 15:50		0.06	2.3	7.8	9.13	53.4	7.0								
CCBCCRCO	4/21/2018 13:36		0.16	6.18	8.28	8.61	43.3	24.7			1.4		7.7		0.1	
	11/29/2017 12:15		0.16	7.13	6.89	8.27	60.9	2.2								
СНСКИ	4/22/2018 13:26		0.11	12.59	7.7	6.95	20.4	15.8			2.7		7.5		0.1	
Citotto	11/20/2017 12:25		0.12	3.94	7.86	8.74	51.3	28.4								
CHCRNACO	4/22/2018 15:37		0.18	20.5	7.7	6.29	27	5.4			5.1		7.8		0.6	
0.101.1.700	11/19/2017 13:15		0.17	9.02	7.8	8.62	52.5	29.6								
CLRCKU	4/21/2018 12:18		0.19	4.55	8.29	8.57	37	10.4			1.6		7.5		0.1	
	11/29/2017 11:25		0.18	3.43	5.29	8.83	119.8	14.4								
COCRBVCO	4/22/2018 9:33		0.13	9.68	6.29	7.51	64.2	4.1			3.6		7.6		0.3	
	11/20/2017 10:45		0.12	5.09	7.65	8.4	50.1	31.4								
COCRHSCO	4/21/2018 17:39		0.14	8.07	8.19	8.3	51.2	20.6			5.1		7.9		0.2	
	11/19/2017 17:13		0.13	1.92	7.61	9.92	42.1	27.8								
CTMDHDGT	4/21/2018 17:57		0.14	8.88	8.22	8.33	47.1	NR			5		8.1		0.3	
	11/19/2017 8:58	D														
мсоти	4/21/2018 15:33		0.10	6.91	8.44	7.91	20	8.0			3.3		8.2		0.1	
	11/20/2017 15:46		0.10	2.3	7.52	8.91	47.9	20.0								
NCOTD	4/21/2018 18:19		0.09	6.29	8.41	8.31	45.1	3.8			1.9		7.5		0.1	
	11/20/2017 21:01		0.09	1.62	6.01	9.55	105.5	7.2								
NFSOAKCO	4/23/2018 12:06		0.09	13.33	7.38	6.45	4.6	8.5			1.3		7.3		0.2	
	11/21/2017 9:37	_	0.12	3.24	7.28	8.69	64.8	10.8								
RADHDGT	4/21/2018 14:46	D														
	11/29/2017 12:00	D														
RBLRESCO	4/21/2018 16:39		0.11	5.48	8.3	8.56	33.7	NR			3.4		7.8		0.1	
	11/29/2017 17:04		0.11	-0.84	7.73	10.92	44.9	NR								
SALDSTN	4/23/2018 15:28		0.15	23.12	8.61	8.89	15.8	NR			16		8.9		0.3	
	11/20/2017 17:37		0.16	3.84	8.51	10.13	56.6	NR 0.4			4.2		7.0	7.0	0.2	0.2
SARKU	4/23/2018 10:59		0.13	8.85	6.94	7.79	53.7	9.1			4.3		7.9	7.9	0.2	0.2
	11/21/2017 9:00		0.13	3.27	7.84	9.25	80.2	11.3			2.2					
SCOTU	4/21/2018 17:11		0.11	6.03	8.25	8.56	48	NR			2.6		7.7		0.1	
	11/20/2017 9:07		0.11	1.25	5.18	8.81	174	NR			F 4		0.2		0.2	
SOAKTECO	4/23/2018 12:54		0.26	14.41	7.02	6.96	42.1	7.3			5.4		8.2		0.3	
	11/21/2017 10:09		0.18	4.77	7.98	9.62	51.4	76.1								

W Well was destroyed L Surface Point was frozen B Casing was destroyed. Still Readable N No Access D Site was dry O Object found in well. Unreadable K Surface Point was stagnant Z Well could not be found					Status L	egend					
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0.00		K		Surface Point was stagnant		Z		Well could not be found			
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0.00		Adjusted SAR Duplicate		Lab EC Duplicate (mmho/cm)		Sodium Duplicate (ppm)		Potassium Duplicate (ppm)		Calcium Duplicate (ppm)	Magnesium (ppm)
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Adjunct SAR Projects Design Project Design Project											
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Magnesium Duplicate (ppm)		Total Hardness Duplicate (ppm)	Nitrate (ppm)	Nitrate Duplicate (ppm)	Sulfate (ppm)	Sulfate Duplicate (ppm)		Chloride Duplicate (ppm)	
	48.00		0.00		0.00		2.00		0.00
	145.00		0.89		45.00		3.00		3.00
	74.90		0.31		17.18		2.10		0.15
	0.30		0.94		0.70		0.15		4.47
Magnesium Duplicate (ppm)	Total Hardness (ppm)	Total Hardness Duplicate (ppm)	Nitrate (ppm)	Nitrate Duplicate (ppm)	Sulfate (ppm)	Sulfate Duplicate (ppm)	Chloride (ppm)	Chloride Duplicate (ppm)	Carbonate (ppm)
	90		0		21		2		0
	68		0.44268		30		2		0
	78		0.44268		27		2		0
	105		0.88536		27		2		0
	74		0		12		2		0
					0				
	85		0		33		2		0
	63		0.88536		21		2		0
	80		0.44268		27		2		0
	98		0.44268		45		2		0
	65		0.44268		9		2		0
	65		0.44268		9		2		0
	65		0		9		2		0
	53		0.44268		6		2		0
	48		0.44268		9		2		0
	51		0.44268		30		2		0
					0				
	58		0.44268		6		2		0
	71		0		27		2		3
5	76	73	0	0	9	9	3	3	0
	60		0		9		2		0
						·			
	145		0		12		3		0

19.00	Carbonate Duplicate (ppm)	Bicarbonate (ppm)	Bicarbonate Duplicate (ppm)	Total Alkalinity (ppm)	Total Alkalinity Duplicate (ppm)	Boron (ppm)	Boron Duplicate (ppm)	TDS (ppm)
17.90								
Cythonate Duplicate (ppn) Bicorbonate (pun) Bicorbonate (ppn) Bicorbonate (ppn		166.00		139.00		0.00		249.4
Cythonate Duplicate (ppn) Bicorbonate (pun) Bicorbonate (ppn) Bicorbonate (ppn		71.90		59.65		0.00		130.0
102								
43	Carbonate Duplicate (ppm)	Bicarbonate (ppm)	Bicarbonate Duplicate (ppm)	Total Alkalinity (ppm)	Total Alkalinity Duplicate (ppm)	Boron (ppm)	Boron Duplicate (ppm)	TDS (ppm)
62 51 0 127.2 34 77 0 0 127.4 78 64 0 130.9 61 50 0 133.4 61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 86 71 0 140.0 86 71 0 122.0 80 65 0 122.5 76 6 63 0 122.5 76 6 63 0 122.5 80 80 86 71 0 122.0 80 86 71 0 122.0 80 86 71 0 122.0 80 86 87 1 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 86 87 1 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 99.7 80 99.7 80 99.7 81 81 67 0 115.8				84		0		
62 51 0 127.2 34 77 0 0 127.4 78 64 0 130.9 61 50 0 133.4 61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 86 71 0 140.0 86 71 0 122.0 80 65 0 122.5 76 6 63 0 122.5 76 6 63 0 122.5 80 80 86 71 0 122.0 80 86 71 0 122.0 80 86 71 0 122.0 80 86 87 1 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 86 87 1 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 88 88 0 122.0 80 99.7 80 99.7 80 99.7 81 81 67 0 115.8								
94		43		36		0		104.1
94								
78 64 0 130.9 61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 139.0 60 54 0 139.0 0 73 75 61 62 0 0 120.3		62		51		0		127.2
78 64 0 130.9 61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 139.0 60 54 0 139.0 0 73 75 61 62 0 0 120.3								
61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 0 132.0 88 71 0 126.5 89 66 0 0 126.5 47 38 0 0 99.7 76 63 0 0 78.7		94		77		0		171.4
61 50 0 133.4 46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 0 132.0 88 71 0 126.5 89 66 0 0 126.5 47 38 0 0 99.7 76 63 0 0 78.7								
46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 120.3		78		64		0		130.9
46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 120.3								
46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 120.3								
46 38 0 99.6 85 70 0 163.5 50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 120.3								
85 70 0 163.5 85 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		61		50		0		133.4
85 70 0 163.5 85 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6				22		-		
50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 101.6		46		38		0		99.6
50 41 0 140.0 86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 38 0 80.3 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 0 73 75 61 62 0 0 101.6		0.5		70				162.5
86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6 <td></td> <td>85</td> <td></td> <td>/0</td> <td></td> <td>U</td> <td></td> <td>163.5</td>		85		/0		U		163.5
86 71 0 132.0 80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1100</td>								1100
80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		50		41		0		140.0
80 66 0 126.5 76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		0.5		74		_		122.0
76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		86		/1		U		132.0
76 63 0 123.0 62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		90		CC		0		126.5
62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		80		00		U		120.5
62 52 0 94.7 47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		76		62		0		122.0
47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		70		03		0		123.0
47 38 0 80.3 23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		62		52		0		94.7
23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		UZ		32		Ü		54.7
23 19 0 78.7 81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		47		38		0		80.3
81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		77		30		, , , , , , , , , , , , , , , , , , ,		55.5
81 67 0 115.8 60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		23		19		0		78.7
60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		20				Ü		
60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6								
60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6								
60 54 0 139.0 0 73 75 61 62 0 0 120.3 63 52 0 101.6		81		67		0		115.8
0 73 75 61 62 0 0 120.3 63 52 0 101.6								
0 73 75 61 62 0 0 120.3 63 52 0 101.6		60		54		0		139.0
63 52 0 101.6								
	0	73	75	61	62	0	0	120.3
166 139 0 249.4		63		52		0		101.6
166 139 0 249.4			_	_			_	
		166		139		0		249.4
								_

Minimum Separate	Hny	or Arkonea	c Divor E	Pacin (HADD)							Status Legend			
B	орг	Jei Ai Kalisa:	s Kivei E	Dasiii (UAKD)		w		Well was destr	roved		Surface Point was frozen			
Second S							Casing			N				
Supplied Proceedings Supplied Proceeding Supplied Proceeding Proceedi		Ground Wat	er Monito	oring Data								able		
Second S						K	Su			Z				
See 1.2	Sampling	g Event Information			In-Sit	u Readir					Pressure Tansducer Reading			Atmospheric T
Average				WTD GroundSurface (m)	EC (dS/m)	T (°C)	рН	DO (mg/L)	ORP (mV)	T (°C)	Pressure (kPa)	Set Depth (M)	WTD (m)	T (°C)
Average legend 6.5 0.27 13.2 7.10 4.87 5.6.2	Minimum		See	1.2	0.11	7.9	5.21	0.42	28.8					
According Acco	Maximum		status	17.9	0.59	24.0	8.12	9.38	120.2		Transducer readings are from time closest to In Situ N	Massurament		Transducer readings
12797-01 17/19/2019-03 2	Average		legend	6.5	0.27	13.2	7.10	4.87	56.2		Transducer readings are from time closest to in-situ i	vieasurement		In-Situ M
137927-01	CV		at top	4.5	0.11	4.3	0.78	2.51	20.2					
13791-01	Monitoring Well Name	Reading Date/Time	Status											
137911-01 4721/0181503 D	127927-01	4/23/2018 12:00	Z									8.23		
13791-01 11/19/2017 1458	12,32,-01													
137925-01 4/22/2018 12:00 991 0.14 12:59 5.24 5.89 10.04 10.	137911-01		D									5.64		
13/92-01 11/19/2017 15:18 9.69														
11/19/201715:18	137925-01											14.27		
14/882-01 11/9/2017 110-57 2.08 0.16 10.71 7.38 6.86 43.9	10,525 01													
11/19/2017 11:05	147832-01											7.47		
147924-01														
14/92-01 11/19/2017 10-53 3.04 0.2 13.42 6.91 6.86 51.3	147878-01													
11/19/2017/10:53 3.04 0.2 13.42 6.91 6.86 51.3 51.3 147925-01 4/22/2018 10:00 9.56 0.2298 16.12 6.19 6.61 65.4 11/20/017/9:51 8.14 0.25 10.05 6.92 8.17 82.3 157815-01 4/22/2018 14.58 3.90 0.15 18.68 7.38 6.89 43.9 11/20/017/13:03 5.56 0.18 10.9 7.47 6.21 60.0 157823-01 4/22/2018 15.54 2.24 0.24 18.86 7.65 5.38 34.8 11/20/2017 15.18 1.39 0.39 9.12 7.74 1.25 50.7 157824-01 4/22/2018 16.58 6.90 0.30 24 7.59 5.99 39.5 157826-01 1/20/2017 13.32 5.61 0.36 10.76 7.68 3.27 58.8 157826-01 4/22/2018 17.38 1.71 0.22 19 8.12 3.31 28.8 157826-01 4/23/2018 12.34 0 490804-01 4/23/2018 12.34 0 500811-01 4/23/2018 12.34 0 11/20/2017 15.57 9.78 0.32 8.55 7.72 9.38 6.21 500814-01 4/23/2018 13.00 2 11/20/2017 17.18 17.94 0.4 9.55 7.74 7.44 6.11 500822-01 4/23/2018 13.43 1.19 0.32 9.82 6.75 0.42 57.3 500822-02 11/21/2017 10.25 4.07 0.43 10.39 7.38 5.51 29.2 500929-01 4/23/2018 13.43 13.70 0.48 15.05 7.87 0.81 32.7 10.20 1.00	147924-01											7.59		
11/20/2017 9:51														
11/20/2019:51	147925-01											11.11		
15/815-01														
157823-01	157815-01											10.55		
11/20/2017 13:18														
157824-01	157823-01											8.22		
11/20/2017 13:32 5.61 0.36 10.76 7.68 3.27 58.8														
157826-01 4/22/2018 17:38 1.71 0.22 19 8.12 3.31 28.8 11/20/2017 13:53 5.88 0.25 10.81 7.49 2.91 59.1	157824-01											7.96		
11/20/2017 13:53 5.88 0.25 10.81 7.49 2.91 59.1														
490804-01 4/23/2018 12:34 11/20/2017 9:52 D 500811-01 4/23/2018 9:22 11/20/2017 16:57 13.91 0.37 7.94 7.34 4.67 57.4 500814-01 4/23/2018 13:00 11/20/2017 17:18 2 15.56 9.78 0.32 8.55 7.72 9.38 62.1 500812-01 4/23/2018 14:06 11/21/2017 10:30 1.91 0.24 18.55 7.71 3.87 35.9 500822-02 11/21/2017 10:30 1.19 0.32 9.82 6.75 0.42 57.3 500822-02 4/23/2018 14:47 4.33 0.36 22.97 7.79 5.51 29.2 500822-02 11/21/2017 8:25 4.07 0.43 10.39 7.38 5.45 51.9 500929-01 4/23/2018 13:43 13.70 0.48 15.05 7.87 0.81 32.7 500929-01 4/23/2018 13:43 13.70 0.48 15.05 7.87 0.81 32.7 500929-01 11/21/2017 7:57 11.25 0.59 9 6.62 0.66 85.7	157826-01											7.38		
11/20/2017 9:52 13.91 0.37 7.94 7.34 4.67 57.4			-	5.88	0.25	10.81	7.49	2.91	59.1			7.00		
500811-01 4/23/2018 9:22 11/20/2017 16:57 13.46 0.26 14.66 6.29 6.52 49.7 9.38 62.1 49.7 9.38 62.1 500814-01 4/23/2018 13:00 11/20/2017 17:18 7.94 0.4 9.55 7.94 7.44 61.1 7.44 61.1 500822-01 4/23/2018 14:06 11/21/2017 10:30 11/21/2017 10:30 1.19 0.32 9.82 6.75 0.42 57.3 8.7 9.51 29.2 11/21/2017 10:30 11/21/2017 10:30 11/21/2017 10:30 1.19 0.32 9.82 6.75 0.42 57.3 8.7 9.51 29.2 11/21/2017 10:30 11/21/2017 10:	490804-01		D	12.01	0.37	7.04	7.24	4.67	F7.4			7.96		
11/20/2017 16:57 9.78 0.32 8.55 7.72 9.38 62.1												15.50		
500814-01 4/23/2018 13:00 11/20/2017 17:18 Z 17.94 0.4 9.55 7.94 7.44 61.1 61.1 23.15 500822-01 4/23/2018 14:06 11/21/2017 10:30 1.91 0.24 18.55 7.71 3.87 35.9 8.7 500822-02 4/23/2018 14:47 4.33 0.36 22.97 7.79 5.51 29.2 24.41 500822-02 11/21/2017 8:25 4.07 0.43 10.39 7.38 5.45 51.9 500929-01 4/23/2018 13:43 13.70 0.48 15.05 7.87 0.81 32.7 500929-01 4/23/2018 13:43 11.25 0.59 9 6.62 0.66 85.7	500811-01											15.56		
11/20/2017 17:18 17.94 0.4 9.55 7.94 7.44 61.1			7	9.78	0.32	8.33	1.12	9.38	02.1			22.15		
500822-01 4/23/2018 14:06 11/21/2017 10:30 1.91 0.24 1.19 18.55 0.32 7.71 9.82 3.87 6.75 35.9 0.42 57.3 57.3 8.7 500822-02 4/23/2018 14:47 11/21/2017 8:25 4.07 4.07 0.43 0.43 10.39 10.39 10.39 7.38 7.87 7.87 5.51 5.19 0.81 29.2 1.92 24.41 1.92 500929-01 4/23/2018 13:43 11/21/2017 7:57 13.70 11.25 0.48 0.59 9 15.05 6.62 6.62 7.87 0.66 0.81 85.7 32.7 85.7	500814-01		_	17.04	0.4	0.55	7.04	7.44	61.1			23.13		
500822-01 11/21/2017 10:30 1.19 0.32 9.82 6.75 0.42 57.3 4/23/2018 14:47 4.33 0.36 22.97 7.79 5.51 29.2 500822-02 11/21/2017 8:25 4.07 0.43 10.39 7.38 5.45 51.9 500929-01 4/23/2018 13:43 13.70 0.48 15.05 7.87 0.81 32.7 11/21/2017 7:57 11.25 0.59 9 6.62 0.66 85.7												9.7		
4/23/2018 14:47 4.33 0.36 22.97 7.79 5.51 29.2 500822-02 11/21/2017 8:25 4.07 0.43 10.39 7.38 5.45 51.9 500929-01 4/23/2018 13:43 11/21/2017 7:57 13.70 0.48 15.05 7.87 0.81 32.7 500929-01 11/21/2017 7:57 11.25 0.59 9 6.62 0.66 85.7	500822-01											0.7		
500822-02 11/21/2017 8:25 4.07 0.43 10.39 7.38 5.45 51.9 500929-01 4/23/2018 13:43 11/21/2017 7:57 13.70 0.48 15.05 7.87 0.81 32.7 11/21/2017 7:57 11.25 0.59 9 6.62 0.66 85.7												24.41		
500929-01 4/23/2018 13:43 11/21/2017 7:57 13.70 0.48 15.05 15.05 7.87 0.81 0.66 32.7 0.66 32.7 85.7 18.07	500822-02											24.41		
500929-01 11/21/2017 7:57 11.25 0.59 9 6.62 0.66 85.7												18.07		
	500929-01											10.07		
510808-01 4/23/2018 8:19 3.73 0.16 11.29 5.21 5.67 1.20.2 1.674 1.674	510808-01	4/23/2018 8:19		3.73	0.16	11.29	5.21	5.67	120.2			16.74		
4/32/2018 0:00 7:50 0:22 0:77 5:66 1:54 5:0.2														
510808-02	510808-02		N	7.55	0.22],	5.00	1.5.	33.3	ĺ		3.03		
4/22/2018 19:25 2.22 0.20 12:04 7.72 1.78 29:3			.,	2.23	0.29	13.04	7.72	1.78	38.3			12.28		
510810-01 4/22/2018 16.3.5 2.2.5 0.2.5 16.3.5 1.7.2 17.0 36.5 1.7.2 17.0 36.5 1.7.2 17.0 36.5 1.7.2 17.0 36.5 1.7.2 17.0 36.5 1.7.2 17.0 36.5 17.2 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0	510810-01							_				12.20		

opb) Se Duplicate (ppb)	U (μg/L)	U Duplicate (μg/L)											
		U Duplicate (μg/ L)	Lab pH	Lab pH Duplicate	SAR	SAR Duplicate	Adjusted SAR	Adjusted SAR Duplicate	Lab EC (mmho/cm)	Lab EC Duplicate (mmho/cm)	Sodium (ppm)	Sodium Duplicate (mg/L)	Potassium (ppm)
	0.0		5.6		0.2		0.2		0.1		4.0		0.0
	16.0		7.8		2.5		2.6		0.4		56.0		3.0
	4.2		6.8		0.5		0.5		0.3		11.8		1.5
	5.7		0.7		0.6		0.6		0.1		13.6		1.0
	0		5.6		0.3		0.3		0.14		6		2
	0.63		7		0.2		0.2		0.16		4		0
	2.1		E 7		0.2		0.2		0.10		6		2
	1.5		6.3		0.2		0.2		0.25		5		0
	0.56		6.4		0.4		0.4		0.17		9		2
	1.7		7.2		0.5		0.5		0.28		13		2
	11		7.1		0.4		0.4		0.37		11		3
	13		7.5		0.4		0.4		0.28		10		0
	0.7		6.9		0.2		0.2		0.28		6		2
	1.7		7.3		0.3		0.4		0.28		9		2
	NR		7.8		2.5		2.6		0.43		56		1
	1.3		6.1		0.3		0.3		0.16		7		2
	16		7.1		0.4		0.5		0.32		12		2
		5.7 0 0.63 2.1 1.5 0.56 1.7 11 13 13 1.7 NR	0 0 0.63	5.7 0.7 0 5.6 0 0 5.6 0.63 7 2.1 5.7 1.5 6.3 0.56 6.4 1.7 7.2 11 7.1 13 7.5 0.7 6.9 1.7 7.8	5.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0	5.7 0.7 0.6 0 0 5.6 0.3 0.63 7 0.2 2.1 5.7 0.3 1.5 6.3 0.2 0.56 6.4 0.4 1.7 7.2 0.5 11 7.1 0.4 13 7.5 0.4 17 7.5 0.4 17 7.7 7.8 0.3 NR 7.8 2.5	5.7 0.7 0.6 0.6 0.7 0.6 0.6 0.7 0.6 0.6 0.7 0.7 0.6 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	5.7 0.7 0.6 0.6 0 5.6 0.3 0.3 0.63 7 0.2 0.2 2.1 5.7 0.3 0.3 1.5 6.3 0.2 0.2 0.56 6.4 0.4 0.4 1.7 7.2 0.5 0.5 11 7.1 0.4 0.4 13 7.5 0.4 0.4 0.7 6.9 0.2 0.2 1.7 7.3 0.3 0.4 NR 7.8 2.5 2.6	5.7 0.7 0.6 0.2 0.2 0.2 0.2 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.6	5.7	S.7	136	136

Potassium Duplicate (ppm)	Calcium (ppm) 21.0 63.0 38.8 12.5	Calcium Duplicate (ppm)	2.0 8.0 5.2 2.0	Magnesium Duplicate (ppm)	Total Hardness (ppm) 65.0 187.0 118.7 36.9	Total Hardness Duplicate (ppm)	Nitrate (ppm) 0.0 14.6 4.0 4.9	Nitrate N Duplicate (ppm)	9.0 54.0 21.7 12.8	Sulfate S Duplicate (ppm)
	21		3		65 84		0.89		12	
	30		6		100		1.33		9	
	44		6		135 78		14.17		9	
	46		3		128		1.33		27	
	63 43		8		187		3.54		36 18	
	48		6		145		2.66		24	
	46		6		140		0.00		24	
	35		2		96		14.61		54	
	25		5		83		5.75		15	
	51		8		161		0.89		18	

Chloride (ppm)	Chloride Duplicate (ppm)	Carbonate (ppm)	Carbonate Duplicate (ppm)	Bicarbonate (ppm)	Bicarbonate Duplicate (ppm)	Total Alkalinity (ppm)	Total Alkalinity Duplicate (ppm)	Boron (ppm)	Boron Duplicate (ppm)	TDS (ppm)
2.0		0.0		62.0		51.0		0.00		117.9
22.0 4.1		0.0 0.0		194.0		159.0		0.01		320.6
5.5		0.0		125.7 41.4		103.1 34.1		0.00 0.00		216.7 71.9
2.0				1217		¥.112				1 - 10
		-								
2		0		71		57		0		117.9
2		0		97		80		0		145.0
2		2		442		92		0		474.4
2		0		113		92		0		171.4
2		0		136		112		0		217.7
2		0		62		51		0		132.9
2		0		139		114		0		235.0
3		0		183		150		0		320.5
4		0		147		121		0		246.5
6		0		129		106		0		224.4
2		0		155		127		0		245.7
22		0		136		112		0.01		320.6
2		0		72		59		0		135.1
2		0		194		159		0		303.9