

**APPENDIX N. SUMMARY OF EXISTING GROUNDWATER
AND SURFACE WATER QUALITY**

Overview of Existing Water Quality Sampling

While some water quality samples have been collected in the area as early as 1986, water quality sampling conducted by Resolution Copper Mining, LLC (Resolution Copper) began in earnest in 2003 (Garrett 2017a; Rietz 2016a). Groundwater and surface water quality samples have been analyzed for a wide suite of field parameters, general hydrochemistry, metals, isotopes, and radionuclides. Samples used for the environmental impact statement (EIS) analysis extend through the end of 2015.

Groundwater sampling has focused on wells installed in the Apache Leap Tuff aquifer, the deeper groundwater system, and wells associated solely with shallow alluvium, fracture systems, or perched aquifers (see Garrett 2018b). A separate groundwater investigation associated with voluntary closure and reclamation activities at the West Plant Site also has resulted in a number of water quality samples. In addition to wells, a number of springs have also been sampled; flowing springs are by definition associated with groundwater of some type, though it could be localized or regional in nature.

Surface water sampling has focused on stream systems, notably Devil's Canyon, Arnett Creek, Mineral Creek, and Queen Creek, as well as certain tributaries to these systems (Iron Creek, Hackberry Creek, Oak Flat Wash, Number 9 Wash, Rancho Rio Canyon).

The tables included in this appendix are not a comprehensive database of water quality results, but rather a statistical summary intended to provide an overview of existing groundwater and surface water quality, which forms a baseline for analysis of potential effects.

Summary of Existing Groundwater Quality

Existing groundwater quality data are summarized in Table N-1, for the shallow alluvial or perched groundwater, Apache Leap Tuff aquifer, and deep groundwater system. These data were used as one basis for determining the likely water source for various groundwater-dependent ecosystems (Garrett 2018d).

Summary of Existing Surface Water Quality

The following tables summarize the existing surface water quality data:

- Table N-2. Summary of filtered surface water quality samples for major stream systems in the analysis area. Filtered samples represent dissolved concentrations of constituents.
- Table N-3. Summary of unfiltered surface water quality samples for major stream systems in the analysis area. Unfiltered samples represent total concentrations of constituents.
- Table N-4. Summary of exceedances of Arizona surface water quality standards by existing surface water quality

Table N-1. Summary of existing groundwater quality for shallow alluvial or perched groundwater, Apache Leap Tuff aquifer, and deep groundwater system

	Units	Shallow Groundwater (alluvium or shallow bedrock)					Apache Leap Tuff Aquifer					Deep Groundwater System				
		Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median
Electrical Conductivity (Field)	uS/cm	5	208.80	880.00	543.76	525.00	5	479.40	931.00	648.76	560.00	2	513.40	536.10	524.75	524.75
Flow Rate	gpm	1	5.80	5.80	5.80	5.80	1	0.45	0.45	0.45	0.45					
Oxidation-Reduction Potential (Field)	mV											2	65.00	115.00	90.00	90.00
pH (Field)	S.U.	27	5.49	8.21	6.41	6.43	105	6.51	10.17	7.34	7.27	27	6.59	9.75	7.39	7.30
Specific Conductance (Field)	uS/cm	22	199.00	1,020.00	493.54	399.00	100	232.00	736.20	322.84	274.80	25	285.10	4,196.00	1,671.32	1,922.00
Temperature (Field)	C	27	11.11	22.17	17.28	17.10	106	15.00	28.40	24.07	24.20	27	28.80	68.70	43.92	42.70
Turbidity (Field)	NTU						1	4.82	4.82	4.82	4.82					
Carbon 14	PMC	15	85.70	108.50	98.89	97.00	76	55.30	106.29	71.16	67.10	20	0.60	82.45	28.12	24.50
Delta Carbon-13 of DIC	Per mil	15	-20.90	-6.30	-16.75	-18.80	76	-20.10	-7.70	-15.87	-15.80	20	-19.30	-7.30	-13.23	-13.40
Delta Deuterium	Per mil	25	-73.00	-43.00	-60.68	-63.00	92	-79.00	-55.20	-68.80	-69.85	20	-86.00	-67.60	-79.41	-83.05
Delta Oxygen-18 of Sulfate	Per mil	19	-0.70	32.30	8.12	5.60	70	-5.90	23.80	6.24	6.40	16	-1.00	7.60	3.71	3.35
Delta Oxygen-18	Per mil	25	-10.50	-4.61	-8.56	-9.30	92	-11.40	-8.44	-9.92	-9.95	20	-11.96	-9.17	-11.03	-11.51
Delta Sulfur-34	Per mil	20	-5.40	4.60	-0.56	-1.10	70	-3.60	10.00	4.79	4.90	17	-1.20	14.80	5.74	7.70
Strontium 87/86	Ratio	15	0.71	0.72	0.71	0.71	69	0.71	0.73	0.71	0.71	19	0.71	0.72	0.71	0.71
Tritium	T.U.	22	1.22	6.20	3.50	3.25	81	0.30	3.40	1.13	1.00	19	1.00	1.50	1.05	1.00
Alkalinity (as CaCO ₃)	mg/L	26	11.00	289.00	81.57	66.00	107	73.00	299.00	146.92	140.00	20	110.00	337.00	225.85	245.00
Alkalinity, Phenolphthalein	mg/L	3	6.00	6.00	6.00	6.00	44	6.00	6.00	6.00	6.00	18	6.00	33.00	7.50	6.00
Anions (Laboratory)	meq/L						8	2.82	3.76	3.16	3.04	1	11.46	11.46	11.46	11.46
Bicarbonate (calculated by M&A)	mg/L	26	13.00	353.00	99.40	80.50	107	73.80	365.00	177.44	170.00	20	59.00	411.00	271.10	299.00
Bicarbonate Alkalinity (as CaCO ₃)	mg/L	26	11.00	289.00	81.57	66.00	107	60.50	299.00	145.42	139.00	20	48.00	337.00	222.25	245.00
Bicarbonate Ion	mg/L	1	117.00	117.00	117.00	117.00										
Carbonate (calculated by M&A)	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	36.50	0.87	0.00	20	0.00	39.00	2.17	0.00
Carbonate Alkalinity (as CaCO ₃)	mg/L	26	1.00	6.00	5.04	6.00	107	1.00	60.90	6.60	6.00	20	1.00	65.00	8.76	6.00
Cations (Laboratory)	meq/L						8	2.49	3.76	3.01	2.98	1	11.52	11.52	11.52	11.52
Chloride	mg/L	27	3.52	66.70	28.39	27.00	107	4.20	39.90	7.63	5.90	20	5.80	27.00	15.62	17.00
Dissolved oxygen	mg/L	4	1.12	10.61	5.53	5.20	4	1.00	4.60	2.89	2.97					
Fluoride	mg/L	27	0.09	0.48	0.37	0.40	107	0.22	1.05	0.44	0.40	20	0.40	6.26	1.91	0.81
Hardness (as CaCO ₃)	mg/L	17	76.50	431.00	203.15	170.00	81	63.00	444.00	125.99	92.00	20	6.00	700.00	335.10	255.00
Hydroxide Alkalinity (as CaCO ₃)	mg/L	21	2.00	6.00	5.81	6.00	87	2.00	6.00	5.82	6.00	19	6.00	6.00	6.00	6.00
Ion Balance (Laboratory)	%						8	-6.21	0.00	-2.58	-2.12	1	0.26	0.26	0.26	0.26
Nitrate as N	mg/L	22	0.20	16.00	2.04	0.20	65	0.20	1.60	0.52	0.51	10	0.20	1.40	0.53	0.28

	Shallow Groundwater (alluvium or shallow bedrock)						Apache Leap Tuff Aquifer					Deep Groundwater System				
	Units	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median
Nitrate+Nitrite as N (calculated by M&A)	mg/L	22	0.00	16.00	1.93	0.00	65	0.00	1.60	0.52	0.51	10	0.00	1.40	0.43	0.18
Nitrate+Nitrite as N	mg/L	9	0.03	3.63	0.59	0.30	53	0.02	3.46	1.37	2.00	12	0.02	2.00	1.29	2.00
Nitrite as N	mg/L	22	0.10	0.20	0.16	0.20	64	0.10	0.20	0.17	0.20	10	0.03	0.20	0.16	0.20
Ortho-Phosphate	mg/L											1	0.12	0.12	0.12	0.12
pH (Laboratory)	S.U.	24	5.54	8.20	6.82	6.86	98	7.01	9.79	7.74	7.65	19	7.00	9.38	7.63	7.39
Silica	mg/L	25	30.00	52.60	37.19	37.00	106	6.98	88.00	59.34	62.50	20	5.80	87.00	33.31	25.00
Specific Conductance (Laboratory)	uS/cm	24	218.00	1,170.00	519.21	440.00	98	220.00	933.00	332.51	275.00	19	260.00	1,800.00	882.63	570.00
Sulfate	mg/L	27	10.90	547.00	141.63	100.00	107	1.40	228.00	18.07	4.70	20	2.00	840.00	252.28	28.50
Sulfide	mg/L	26	0.04	0.41	0.11	0.04	96	0.04	0.73	0.08	0.05	20	0.02	12.00	0.73	0.05
Temperature (Laboratory)	C	20	17.80	22.20	19.73	19.55	86	17.70	23.00	19.55	19.50	19	17.30	24.10	19.89	19.70
Total Dissolved Solids (calculated by laboratory)	mg/L						8	154.00	275.00	225.25	226.50	1	760.00	760.00	760.00	760.00
Total Dissolved Solids (Laboratory)	mg/L	27	135.00	823.00	364.52	290.00	107	140.00	663.00	247.97	217.00	20	92.00	1,400.00	637.55	410.00
Total Suspended Solids	mg/L	3	10.00	18.00	12.67	10.00	7	10.00	12.00	10.29	10.00	3	5.00	10.00	8.33	10.00
Aluminum	mg/L	26	0.04	1.01	0.21	0.20	107	0.02	0.50	0.21	0.20	20	0.03	4.50	0.40	0.20
Antimony	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.02	0.00	0.00	20	0.00	0.06	0.01	0.00
Arsenic	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.13	0.01	0.01
Barium	mg/L	26	0.01	0.22	0.08	0.09	107	0.00	0.06	0.02	0.02	20	0.01	0.48	0.08	0.03
Beryllium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.00	0.00	0.00	20	0.00	0.00	0.00	0.00
Boron	mg/L	23	0.04	0.20	0.17	0.20	100	0.03	0.50	0.20	0.20	19	0.07	1.50	0.26	0.20
Bromide	mg/L	26	0.05	0.91	0.48	0.50	97	0.07	1.00	0.49	0.50	20	0.07	0.50	0.42	0.50
Cadmium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Calcium	mg/L	27	22.10	130.00	58.33	43.00	107	1.16	130.00	35.22	28.00	20	2.00	270.00	103.16	58.00
Chromium	mg/L	26	0.00	0.01	0.01	0.01	107	0.00	0.01	0.00	0.00	20	0.00	0.61	0.03	0.00
Cobalt	mg/L	23	0.00	0.04	0.01	0.00	100	0.00	0.05	0.00	0.00	19	0.00	0.06	0.00	0.00
Copper	mg/L	26	0.00	0.19	0.02	0.01	107	0.00	0.06	0.01	0.00	20	0.00	1.80	0.10	0.00
Cyanide, Amenable	mg/L	22	0.02	0.05	0.03	0.03	91	0.01	0.05	0.03	0.03	11	0.01	0.05	0.02	0.01
Cyanide, Free	mg/L											1	0.10	0.10	0.10	0.10
Cyanide, Total	mg/L	4	0.00	0.00	0.00	0.00	5	0.00	0.01	0.01	0.00	8	0.00	0.05	0.02	0.01
Cyanide, weak acid dissociable	mg/L											1	0.01	0.01	0.01	0.01
Iron	mg/L	26	0.05	30.00	4.53	0.39	107	0.02	10.00	0.65	0.13	20	0.05	1,100.00	59.07	2.05
Lead	mg/L	26	0.00	0.02	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.43	0.02	0.00
Lithium	mg/L											1	0.10	0.10	0.10	0.10
Magnesium	mg/L	27	2.60	38.10	11.88	9.90	107	0.04	28.80	6.39	4.70	20	0.25	43.00	19.33	20.00
Manganese	mg/L	23	0.00	2.06	0.42	0.30	100	0.00	1.30	0.11	0.03	20	0.01	15.00	0.94	0.16
Mercury	mg/L	25	0.00	0.00	0.00	0.00	105	0.00	0.00	0.00	0.00	20	0.00	0.00	0.00	0.00

	Shallow Groundwater (alluvium or shallow bedrock)						Apache Leap Tuff Aquifer					Deep Groundwater System				
	Units	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median	Number of Samples	Minimum	Maximum	Mean	Median
Molybdenum	mg/L	26	0.00	0.02	0.01	0.01	107	0.00	0.05	0.01	0.00	20	0.00	0.27	0.03	0.02
Nickel	mg/L	26	0.00	0.02	0.01	0.01	107	0.00	0.14	0.01	0.00	20	0.00	0.22	0.02	0.00
Potassium	mg/L	27	0.76	4.37	2.34	2.00	107	0.95	5.80	1.97	2.00	20	2.00	39.00	14.36	6.10
Selenium	mg/L	26	0.00	0.02	0.00	0.00	107	0.00	0.02	0.00	0.00	20	0.00	0.04	0.00	0.00
Silicon	mg/L	1	40.00	40.00	40.00	40.00	1	59.00	59.00	59.00	59.00					
Silver	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Sodium	mg/L	27	7.00	131.00	29.73	22.00	107	16.00	69.30	28.29	25.00	20	13.00	160.00	72.10	33.00
Strontium (by isotope dilution)	mg/L	15	0.17	1.25	0.44	0.29	69	0.09	0.52	0.18	0.15	19	0.03	41.83	5.16	0.61
Strontium	mg/L											1	0.76	0.76	0.76	0.76
Thallium	mg/L	26	0.00	0.00	0.00	0.00	107	0.00	0.01	0.00	0.00	20	0.00	0.02	0.00	0.00
Uranium	mg/L	12	0.00	0.00	0.00	0.00	62	0.00	0.02	0.00	0.00	20	0.00	0.01	0.00	0.00
Zinc	mg/L	26	0.01	1.04	0.15	0.06	107	0.01	1.97	0.26	0.08	20	0.01	1.70	0.16	0.05
Gross Alpha, Adjusted	pCi/L						34	-10.70	7.00	-0.55	-0.11	17	-13.70	49.00	5.24	0.01
Gross Alpha	pCi/L	14	1.00	18.00	4.58	2.10	64	1.00	10.00	2.66	2.00	20	1.80	49.00	13.73	3.20
Gross Beta	pCi/L	14	2.00	14.00	4.62	2.80	64	2.00	9.70	3.68	3.80	20	2.60	56.00	20.17	9.40
Radium 226 + Radium 228	pCi/L	14	0.00	3.39	1.03	0.45	64	0.00	2.70	0.44	0.00	20	0.00	16.00	4.56	1.07
Radium 226	pCi/L	14	0.10	0.60	0.28	0.23	64	0.08	0.69	0.22	0.19	20	0.20	11.00	3.53	0.65
Radium 228	pCi/L	14	0.85	2.80	1.53	1.20	64	0.54	2.70	1.33	1.20	20	0.57	5.30	1.57	1.00
Radon 222	pCi/L						5	130.00	530.00	360.00	470.00	4	24.00	2,400.00	1,781.00	2,350.00
U-234/U-238	Ratio						28	0.40	8.70	2.73	2.25	5	0.60	14.00	6.26	2.80
Uranium 234	pCi/L	12	0.20	0.20	0.20	0.20	63	0.20	7.30	1.62	1.20	19	0.20	46.00	6.41	1.10
Uranium 235	pCi/L	12	0.20	0.20	0.20	0.20	63	0.10	1.30	0.67	0.97	19	0.10	5.00	1.22	0.99
Uranium 238	pCi/L	12	0.20	0.20	0.20	0.20	63	0.20	5.32	1.04	1.00	19	0.10	6.29	1.76	1.10
Uranium Activity (Calc 200_8)	pCi/L						2	0.20	6.10	3.15	3.15					
Uranium Activity (Calc 907_0)	pCi/L	12	0.20	0.20	0.20	0.20	29	0.20	6.40	1.50	1.10	2	0.20	0.30	0.25	0.25

Notes: M&A = Montgomery & Associates

Units: C = degrees Celsius; gpm = gallons per minute; mg/L = milligrams per liter; meq/L = milliequivalents per liter; mV = millivolts; NTU = Nephelometric Turbidity Units; pCi/L = picocuries per liter; per mil = parts per thousand PMC = percent modern carbon; ratio = mathematical comparison of two strontium isotopes; S.U. = standard units; T.U. = tritium units; uS/cm = microSiemens per centimeter

The database of groundwater quality results is extensive; this table is meant to be a summary and necessarily requires assumptions about processing and using reported data. The following assumptions were used when compiling and assessing the data:

- 1) For any samples reported as less than the detection limit, concentrations were set to the detection limit. While other methods could be used (such as setting these values to zero), this method specifically avoids underreporting concentrations.
- 2) For any samples reported as simply "non-detect," without a quantified detection limit, concentrations were set to zero.
- 3) Samples reported with certain data qualifiers were not used. These include samples reported with insufficient sample amount, data not usable, or lost samples.
- 4) The database used to compile this table utilized all available data, regardless of whether the sample had been filtered or not. Therefore this table includes reported results for total, total recoverable, and dissolved concentrations. This method was deemed appropriate because Arizona aquifer water quality standards are not specific to total or dissolved concentrations, unlike Arizona surface water quality standards.

Table N-4. Summary of exceedances of Arizona surface water quality standards by existing surface water quality

PARAMETER	Stream System	Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards									
		DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>	<u>mg/L</u>
Gross Alpha pCi/L		15									
	Upper Devil's Canyon	1									
	Middle Devil's Canyon	0									
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Antimony		0.006 T	0.640 T	0.747 T		0.088 D	0.030 D				
	Upper Devil's Canyon	3	0	0		0	0				
	Middle Devil's Canyon	2	0	0		0	0				
	Lower Devil's Canyon	0	0	0		0	0				
	Upper Queen Creek	2		0		0	0				
	Lower Queen Creek	0	0	0	0	0	0				
	Mineral Creek	1	0		0	0	0				
Arsenic		0.010 T	0.0080 T	0.280 T		0.340 D	0.150 D	0.440 D			0.200 T
	Upper Devil's Canyon	20	21	0		0	0	0			0
	Middle Devil's Canyon	16	18	0		0	0	0			0
	Lower Devil's Canyon	2	2	0		0	0	0			0
	Upper Queen Creek	38	38	0		0	0	0			0
	Lower Queen Creek	10	10	0		0	0	0			0
	Mineral Creek	25	25	0		0	0	0			0
Barium		2.0 T		98.0 T							
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Beryllium		0.004 T	0.084 T	1.867 T							
	Upper Devil's Canyon	0	0	0							
	Middle Devil's Canyon	0	0	0							
	Lower Devil's Canyon	0	0	0							
	Upper Queen Creek	0	0	0							
	Lower Queen Creek	0	0	0							
	Mineral Creek	1	0	0							

Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards											
PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Boron		1.400 T		186.667 T							1.000 T
	Upper Devil's Canyon	0		0							0
	Middle Devil's Canyon	0		0							0
	Lower Devil's Canyon	0		0							0
	Upper Queen Creek	0		0							0
	Lower Queen Creek	0		0							0
	Mineral Creek	0		0							0
Cadmium		0.005 T	0.084 T	0.700 T	0.700 T						50 T
	Upper Devil's Canyon	0	0	0	0	9	24				0
	Middle Devil's Canyon	0	0	0	0	0	2				0
	Lower Devil's Canyon	0	0	0	0	3	21				0
	Upper Queen Creek	0	0	0	0	0	1				0
	Lower Queen Creek	0	0	0	0	1	2		1	2	0
	Mineral Creek	0	0	0	0	0	1				0
Chromium III			75.000 T	1,400 T	1,400 T						
	Upper Devil's Canyon		ND	ND	ND	ND	ND				
	Middle Devil's Canyon		ND	ND	ND	ND	ND				
	Lower Devil's Canyon		ND	ND	ND	ND	ND				
	Upper Queen Creek		ND	ND	ND	ND	ND				
	Lower Queen Creek		ND	ND	ND	ND	ND		ND	ND	
	Mineral Creek		ND	ND	ND	ND	ND				
Chromium VI		0.021 T	0.150 T	2.800 T	2.800 T	0.016 D	0.011 D	0.034 D			
	Upper Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Middle Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Lower Devil's Canyon	ND	ND	ND	ND	ND	ND	ND			
	Upper Queen Creek	ND	ND	ND	ND	ND	ND	ND			
	Lower Queen Creek	ND	ND	ND	ND	ND	ND	ND			
	Mineral Creek	ND	ND	ND	ND	ND	ND	ND			
Chromium (Total)		0.100 T									1 T
	Upper Devil's Canyon	0									0
	Middle Devil's Canyon	0									0
	Lower Devil's Canyon	0									0
	Upper Queen Creek	0									0
	Lower Queen Creek	0									0
	Mineral Creek	0									0
Copper		1.300 T		1.300 T	1.300 T						0.500 T

Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards

PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Upper Devil's Canyon	0		0		29	33				0
	Middle Devil's Canyon	0		0		7	10				0
	Lower Devil's Canyon	0		0		31	40				0
	Upper Queen Creek	0		0		4	8		4	8	0
	Lower Queen Creek	0		0	0	13	18				1
	Mineral Creek	0			0	0	0				1
Cyanide (as free cyanide)		0.200 T	16.000 T	18.667 T	18.667 T	0.041 T	0.0097 T	0.084 T			0.200 T
	Upper Devil's Canyon	0	0	0		3	3	3			0
	Middle Devil's Canyon	0	0	0		2	2	2			0
	Lower Devil's Canyon	0	0	0		0	0	0			0
	Upper Queen Creek	0	0	0		1	1	1			0
	Lower Queen Creek	0	0	0	0	0	0	0			0
	Mineral Creek	0	0		0	0	0	0			0
Fluoride		4 T		140 T	140 T						
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0	0						
	Mineral Creek	0			0						
Iron							1 D				
	Upper Devil's Canyon						2				
	Middle Devil's Canyon						0				
	Lower Devil's Canyon						0				
	Upper Queen Creek						0				
	Lower Queen Creek				0		0				
	Mineral Creek				0		0				
Lead		0.015 T		0.015 T	0.015 T						0.100 T
	Upper Devil's Canyon	0		0		0	36				0
	Middle Devil's Canyon	0		0		0	21				0
	Lower Devil's Canyon	0		0		0	57				0
	Upper Queen Creek	1		1		0	3		0	3	0
	Lower Queen Creek	2		2	2	0	4				1
	Mineral Creek	1			1	0	0				1
Manganese*		0.98		130.667							
	Upper Devil's Canyon	2		0							

Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards											
PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	1		0							
	Lower Queen Creek	1		0							
	Mineral Creek	1		0							
Mercury		0.002 T		0.280 T	0.280 T	0.0024 D	0.00001 D	0.005 D			0.010 T
	Upper Devil's Canyon	0		0		0	29	0			0
	Middle Devil's Canyon	0		0		0	27	0			0
	Lower Devil's Canyon	0		0		0	9	0			0
	Upper Queen Creek	0		0		0	20	0			0
	Lower Queen Creek	0		0	0	0	6	0			0
	Mineral Creek	0		0	0	0	6	0			0
Nickel		0.210 T	0.511 T	28.000 T	28.000 T						
	Upper Devil's Canyon	0	0	0		0	5				
	Middle Devil's Canyon	0	0	0		0	0				
	Lower Devil's Canyon	0	0	0		0	2				
	Upper Queen Creek	0	0	0		0	0		0	0	
	Lower Queen Creek	0	0	0	0	0	1				
	Mineral Creek	0	0	0	0	0	0				
Nitrate*		10 T		3,733.333							
	Upper Devil's Canyon	0		0							
	Middle Devil's Canyon	0		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Nitrite*		1 T		233.333							
	Upper Devil's Canyon	1		0							
	Middle Devil's Canyon	1		0							
	Lower Devil's Canyon	0		0							
	Upper Queen Creek	0		0							
	Lower Queen Creek	0		0							
	Mineral Creek	0		0							
Nitrate + Nitrite		10 T									
	Upper Devil's Canyon	0									
	Middle Devil's Canyon	0									

Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards											
PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Radium 226 + Radium 228		5 pCi/L									
	Upper Devil's Canyon	0									
	Middle Devil's Canyon	0									
	Lower Devil's Canyon	0									
	Upper Queen Creek	0									
	Lower Queen Creek	0									
	Mineral Creek	0									
Selenium		0.050 T	0.667 T	4.667 T	4.667 T		0.002 T	0.033 T			0.050 T
	Upper Devil's Canyon	0	0	0	0		26	0			0
	Middle Devil's Canyon	0	0	0	0		21	0			0
	Lower Devil's Canyon	0	0	0	0		7	0			0
	Upper Queen Creek	0	0	0	0		17	0			0
	Lower Queen Creek	0	0	0	0		1	0			0
	Mineral Creek	0	0	0	0		4	0			0
Silver		0.035 T	8.000 T	4.667 T	4.667 T						
	Upper Devil's Canyon	0	0	0	0	18					
	Middle Devil's Canyon	0	0	0	0	1					
	Lower Devil's Canyon	0	0	0	0	13					
	Upper Queen Creek	0	0	0	0	0					
	Lower Queen Creek	0	0	0	0	1					
	Mineral Creek	0	0	0	0	0					
Thallium		0.002 T	0.001 T	0.075 T	0.075 T	0.700 D	0.150 D		0.700 D	0.150 D	
	Upper Devil's Canyon	21	38	0	0	0	0		0	0	
	Middle Devil's Canyon	17	34	0	0	0	0		0	0	
	Lower Devil's Canyon	7	9	0	0	0	0		0	0	
	Upper Queen Creek	12	34	0	0	0	0		0	0	
	Lower Queen Creek	1	7	0	0	0	0		0	0	
	Mineral Creek	1	27	0	0	0	0		0	0	
Uranium		0.030 D		2.8 T	2.8 T						
	Upper Devil's Canyon	0		0	0						
	Middle Devil's Canyon	0		0	0						
	Lower Devil's Canyon	0		0	0						

Number of Exceedances by Major Stream System, for Arizona Surface Water Quality Standards

PARAMETER	Stream System	DWS	FC	PBC	FBC	A&Ww Acute	A&Ww Chronic	A&We Acute	A&W edw Acute	A&W edw Chronic	AgL
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Upper Queen Creek	0		0	0						
	Lower Queen Creek	0		0	0						
	Mineral Creek	0		0	0						
Zinc		2.100 T	5.106 T	28.0000 T	28.0000 T						25.000 T
	Upper Devil's Canyon	0	0	0	0	0	0				0
	Middle Devil's Canyon	0	0	0	0	0	0				0
	Lower Devil's Canyon	0	0	0	0	0	0				0
	Upper Queen Creek	0	0	0	0	0	0		0	0	0
	Lower Queen Creek	0	0	0	0	0	0				0
	Mineral Creek	0	0	0	0	0	0				0
E. coli†			235 cfu/100 ml	575 cfu/100 ml							
	Upper Devil's Canyon		3	3							
	Middle Devil's Canyon		1	1							
	Lower Devil's Canyon		0	0							
	Upper Queen Creek		1	1							
	Lower Queen Creek		0	0							
	Mineral Creek		0	0							

Note: A&We = aquatic and wildlife ephemeral warm water; A&W edw = aquatic and wildlife (effluent-dependent waters); A&Ww = aquatic and wildlife warm water resource; AgL = agricultural livestock watering; DWS = drinking water standard; FBC = full body contact; FC = fish consumption; ND = no data; PBC = partial body contact; Units: cfu/100 ml = colony-forming units per 100 milliliters; D = dissolved; mg/L = milligrams per liter; pCi/l = picocuries per liter; T = total

* Water quality standards based on dissolved concentrations, but nitrate, nitrite, and manganese exceedances determined based on total concentrations as that was all that was available.

† E. coli data as reported are in units inconsistent with standards

The analyses in section 3.7.2 rely on Arizona surface water and aquifer water quality standards as a comparison to provide context to modeled water quality results. Standards vary by use and in some cases, by hardness. For reference, table N-5 summarizes all numeric surface water and groundwater quality standards (Arizona Administrative Code, R18-11 Article 1), and which standards are applicable to the water bodies of interest.

Table N-5. Summary of numeric Arizona surface water and aquifer quality standards

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgL	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
<i>Gila River</i>	X	X		X		X	X	X					
<i>Queen Creek</i>	X	X		X		X		X					
<i>Donnelly Wash, Potts Canyon, Roblas Canyon, Silver King Wash, Dripping Spring Wash</i>			X		X								
<i>Constituents with Numeric Standards</i>													
Antimony	0.030	0.088	-	0.747	0.747	0.640	-	-	0.030	0.030	0.030	0.747	0.006

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgI	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
Arsenic	0.150	0.340	0.440	0.030	0.280	0.080	2	0.2	0.030	0.030	0.030	0.280	0.05
Barium	-	-	-	98	98	-	-	-	98	98	98	98	2
Beryllium	0.0053	0.065	-	1.867	1.867	0.084	-	-	0.0053	0.0053	0.0053	1.867	0.004
Boron	-	-	-	186.667	186.667	-	1	-	1	1	1	186.667	-
Cadmium*	-	-	-	0.7	0.7	0.084	0.05	0.05	0.0051	0.0049	0.0043	0.2175	0.005
- At hardness = 242 mg/L	0.0043	0.0111	0.1681	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0049	0.0135	0.2045	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0051	0.0144	0.2175	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0062	0.0191	0.2895	-	-	-	-	-	-	-	-	-	-
Chromium, Total	-	-	-	-	-	-	1	1	1	1	1	-	0.1
Copper*	-	-	-	1.3	1.3	-	5	0.5	0.0234	0.0222	0.0191	0.0669	-
- At hardness = 242 mg/L	0.0191	0.0308	0.0535	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0222	0.0366	0.0634	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0234	0.0386	0.0669	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0293	0.0495	0.0859	-	-	-	-	-	-	-	-	-	-
Fluoride	-	-	-	140	140	-	-	-	140	140	140	140	4
Iron	1	-	-	-	-	-	-	-	1	1	1	-	-
Lead*	-	-	-	0.015	0.015	-	10	0.1	0.0083	0.0078	0.0065	0.015	0.05
- At hardness = 242 mg/L	0.0065	0.1665	0.3514	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.0078	0.2013	0.4248	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.0083	0.2136	0.4508	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.0109	0.2808	0.5926	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	130.667	130.667	-	10	-	10	10	10	130.667	-
Mercury	0.0024	0.00001	0.005	0.28	0.28	-	-	0.010	0.00001	0.00001	0.00001	0.005	0.002
Nickel*	-	-	-	28	28	4.6	-	-	0.1343	0.1280	0.1098	10.7379	0.1
- At hardness = 242 mg/L	0.1098	0.9887	8.7803	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.1280	1.1523	10.2327	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.1343	1.2092	10.7379	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.1680	1.5126	13.4319	-	-	-	-	-	-	-	-	-	-
Nitrate	-	-	-	3,733.333	3,733.333	-	-	-	3,733.333	3,733.333	3,733.333	3,733.333	10
Nitrite	-	-	-	233.333	233.333	-	-	-	233.333	233.333	233.333	233.333	1
Selenium	0.002	-	0.033	4.667	4.667	0.667	0.020	0.050	0.002	0.002	0.002	0.033	0.05
Silver*	-	-	-	4.667	4.667	8	-	-	0.0221	0.0201	0.0147	0.0221	-
- At hardness = 242 mg/L	-	0.0147	0.0147	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	-	0.0201	0.0201	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	-	0.0221	0.0221	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	-	0.0349	0.0349	-	-	-	-	-	-	-	-	-	-

	A&Ww Chronic	A&Ww Acute	A&We	FBC	PBC	FC	AgI	AgL	Surface Water Standard for Most Restrictive Use (Queen Creek)	Surface Water Standard for Most Restrictive Use (Gila River at Donnelly Wash)	Surface Water Standard for Most Restrictive Use (Gila River at Dripping Spring Wash)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)	Aquifer Water Quality Standard
Thallium	0.15	0.7	-	0.075	0.075	0.0072	-	-	0.0072	0.0072	0.0072	0.075	0.002
Uranium	-	-	-	2.8	2.8	-	-	-	2.8	2.8	2.8	2.8	-
Zinc*	-	-	-	280	280	5.106	10	25	0.3031	0.2888	0.2477	2.8758	-
- At hardness = 242 mg/L	0.2477	0.2477	2.3508	-	-	-	-	-	-	-	-	-	-
- At hardness = 290 mg/L	0.2888	0.2888	2.7403	-	-	-	-	-	-	-	-	-	-
- At hardness = 307 mg/L	0.3031	0.3031	2.8758	-	-	-	-	-	-	-	-	-	-
- At hardness = 400 mg/L	0.3792	0.3792	3.5985	-	-	-	-	-	-	-	-	-	-
pH	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	-	4.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0	-
<i>Constituents without Numeric Standards</i>													
Sulfate	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes: A&Ww = Aquatic and Wildlife-Warmwater; A&We = Aquatic & Wildlife-Ephemeral; FBC = Full Body Contact; PBC = Partial Body Contact; FC = Fish Consumption; AgI = Agricultural-Irrigation; AgL = Agricultural-Livestock Watering

Standards for A&Ww and A&We are for dissolved concentrations, except for selenium which is for total concentrations. All other standards are for total concentrations.

All values shown in milligrams per liter.

* These constituents have surface water standards that vary depending on hardness, with a maximum hardness of 400 mg/L. The four hardness values shown were chosen as follows:

- 242 mg/L represents the hardness for the Gila River at Dripping Spring Wash, based on a sample collected November 19, 2018, calculated from a calcium concentration of 64.8 mg/L and a magnesium concentration of 19.4 mg/L. This hardness was used for ephemeral tributaries as well.
- 290 mg/L represents the hardness for the Gila River at Donnelly Wash, based on a sample collected November 13, 2018, calculated from a calcium concentration of 77.7 mg/L and a magnesium concentration of 23.4 mg/L
- 307 mg/L represents the hardness for Queen Creek at Whitlow Ranch Dam, based on the lowest calculated hardness from five samples (August 25, 2017), calculated from a calcium concentration of 87.5 mg/L and a magnesium concentration of 21.4 mg/L
- 400 mg/L represents the maximum hardness that can be used to calculate surface water standards. Many of the geochemical samples (synthetic precipitate leaching procedure [SPLP] results, for instance) exceed this hardness.