

<u>Memorandum</u>

DATE: June 8, 2020
TO: Vicky Peacey, Resolution Copper
FROM: Ted Lehman, PE, Hydrologist, JE Fuller
RE: USGS Regression Equation Computation Updates for Skunk Camp (Alternative 6)
Queen Creek, Devil's Canyon, & Dripping Springs Wash

Dear Ms. Peacey,

At your request, JE Fuller has updated its previous analysis of flood flow frequency and volumeduration-frequency values for points of interest on Queen Creek and Devil's Canyon for the Skunk Camp tailings storage facility (TSF) location alternative. For this June 2020 update, the impact area for the subsidence impact areas were revised to reflect the actual correct life of mine (LOM) fracture zone polygon and add impact analyses for the 10-, 20-, and 30-year expected fracture zone impacts as the mine develops. The previous analysis used the project area as analogous to the subsidence zone (fracture). Using the actual fracture zone results in a new LOM polygon that shows somewhat smaller impacts to surface water flows for both Queen Creek and to a lesser extent Devi's Canyon than previously reported. Additionally, we have added quantitative estimates for impacts to surface flows on Queen Creek at Magma Avenue in gallons per minute (gpm). This June 2020 update retains most of the framework discussion on the methodology applied to allow this memo to stand alone from work previously delivered.

To accomplish these goals, flood flow frequency and volume-duration-frequency were computed using two sets of regression equations recently published by the United States Geological Survey (USGS) – Scientific Investigations Reports (SIR) 2014-5211 (peak flow frequency) and 2014-5109 (volume-duration-frequency). These reports provide regression equations to estimate the magnitude and frequency of surface water hydrology for unregulated watersheds in Arizona. The statistical analyses presented in these reports were performed for streamflow data collected through 2010 for dozens of stream gaging stations with hundreds of years of cumulative streamflow records to develop regression equations to compute peak flow and volume frequency estimates. As such, they represent an excellent method to quantify surface water hydrology in central Arizona including the watersheds of Queen Creek, Devil's Canyon, and Dripping Springs Wash.

Significant variables used in the USGS regression equations include watershed drainage area, mean annual precipitation, and mean elevation. Equations are presented to compute annual exceedance probability (AEP) for the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent levels for un-gaged basins in Arizona. These reports also present standard error of prediction percentages for each set of equations for each AEP.



Peak Discharge Flow Frequency (SIR 2014-5211)

Regression equations for unregulated watersheds in Arizona were developed by the USGS to estimate magnitude and frequency of floods using peak-flow data through Water Year 2010. Figure 1 shows a map from SIR 2014-5211 of the regions and stream gage locations used in the development of the peak-flow regression equations. The subject watersheds lie within Region 5 – Southeastern Basin and Range. Table 1 shows the regression equations developed for flood region 5. For each annual exceedance probability (AEP), the predicted peak discharge is computed solely as a function of drainage area (DRNAREA).





Figure 1. Map of regions and stream gages used in SIR 2014-5211 regression equations (Figure 4 in SIR 2014-5211)



AEP (percent)	Regression Equation (peak discharge, cubic feet per second)	Standard Error of Prediction (SEP) in percent
50	10^(6.363-4.386* <i>DRNAREA</i> ^{-0.06})	86.6
20	10^(5.868-3.506* <i>DRNAREA</i> ^{-0.08})	61.5
10	10^(5.778-3.218*DRNAREA ^{-0.09})	52.4
4	10^(5.757-2.988*DRNAREA ^{-0.10})	45.8
2	10^(5.696-2.795*DRNAREA ^{-0.11})	43.5
1	10^(5.651-2.634*DRNAREA ^{-0.12})	42.6
0.5	10^(5.761-2.638*DRNAREA ^{-0.12})	42.4
0.2	10^(5.750-2.502*DRNAREA ^{-0.13})	43.2

Table 1. Flood region 5 regression equations from SIR 2014-5211, DRNAREA in square miles

Watersheds to seven (7) key locations on Queen Creek and Devil's Canyon were identified upstream and downstream of the proposed mining impact areas. An additional three (3) key locations on Dripping Springs Wash are also included. Drainage basins were delineated to each from USGS 7.5-minute topographic quadrangles. The drainage area for each location was then computed using GIS.

Impacts from the proposed mining operations were assessed by subtracting the impacted areas from the drainage areas for each watershed. This approach reflects the assumption that surface water drainage will not be allowed to exit the proposed mining impact areas or will be diverted around any impacted areas as shown in the alternatives reports provided to JE Fuller by Resolution Copper. The impacted areas for Queen Creek do not include the roadway areas since drainage off these narrow corridors will continue to contribute to downstream drainages. The fracture zones were updated from previous work as part of this June 2020 update to reflect the subsidence areas after 10-, 20-, 30-years and for the LOM. The ten key locations, watershed boundaries, and proposed mining impact areas area shown in Figure 2.

The results of the peak-flow magnitude and frequency calculations from the SIR 2014-5211 regression equations are shown in Table 2 for the 10-year, 20-year, 30-year, and LOM impact areas for the Skunk Camp TSF alternative. Note that the N-year impacts only differ with respect to the fracture zone changes over time. The TSF and West Plant area impacts are included in total as shown in Figure 2.

In general, the results show that the peak discharge for each frequency (AEP) is reduced by about half the percentage difference in the reduction in drainage area. The reduction in peak discharges is less than the reduction in drainage area because smaller drainage



areas tend to have higher unit peak discharges (cfs/sq.mi.) for a given AEP than watersheds with more drainage area (FCDMC, 2013). One cause for this pattern is that storm intensities tend to be less over larger areas. In other words, spatially large intense storms are less likely (probable) than smaller storms. Or, intense smaller storms occur more frequently than spatially larger, similarly intense storms.



Figure 2. Watershed boundaries and regression equation computation locations



Table 2. Peak-flow frequency computations for selected key locations

Existing Condition

		F	lood Peak	Flows, in c	fs for Ann	ual Exceed	lance Prob	bability (%)
	D.A.								
Location	(sq.mi.)	50	20	10	4	2	1	0.5	0.2
QC at WRD	143.401	1,280	3,246	5,245	8,679	11,949	15,829	20,289	27,415
QC u/s Hewitt Canyon	117.49	1,169	2,975	4,814	7,977	11,001	14,599	18,710	25,326
QC at Magma Ave	10.4	356	914	1,484	2,471	3,433	4,595	5,879	8,029
DC @ US60	10.95	366	940	1,526	2,541	3,531	4,727	6,047	8,260
DC blw Rancho Rio	16.55	454	1,167	1,898	3,163	4,399	5,890	7,538	10,300
DC u/s Mineral Creek	35.63	666	1,713	2,786	4,642	6,447	8,619	11,037	15,054
DC d/s Mineral Creek	90.4	1,037	2,647	4,290	7,122	9,841	13,086	16,768	22,745
DSW u/s Silver Creek	51.16	793	2,036	3,309	5,508	7,638	10,194	13,057	17,778
DSW d/s Silver Creek	78.21	969	2,479	4,021	6,680	9,240	12,301	15,760	21,400
DSW at Gila River	117.3	1,168	2,973	4,811	7,972	10,994	14,589	18,697	25,309
Gila River at DSW	15,473	Not estin	nated due	to influenc	es of San C	arlos Rese	ervoir upst	ream. See	e Note 4.

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Table 2. Peak-flow frequency computations for selected key locations - continued

Proposed Condition – 10	Proposed Condition – 10-year impacts										
QC at WRD	141.38	1,271	3,226	5,213	8,627	11,879	15,739	20,173	27,263		
QC u/s Hewitt Canyon	115.47	1,160	2,952	4,778	7,918	10,921	14,495	18,576	25,149		
QC at Magma Ave	9.77	345	884	1,435	2,389	3,319	4,441	5,681	7,758		
DC @ US60	10.95	366	940	1,526	2,541	3,531	4,727	6,047	8,260		
DC blw Rancho Rio	16.53	453	1,166	1,897	3,162	4,397	5,887	7,534	10,294		
DC u/s Mineral Creek	35.61	666	1,712	2,785	4,641	6,446	8,617	11,035	15,050		
DC d/s Mineral Creek	90.38	1,037	2,647	4,290	7,121	9,840	13,085	16,767	22,743		

10-Year Fracture Zone Impacts

Difference (Existing – Proposed 10-year)/Existing

QC at WRD	-1.4%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%
QC u/s Hewitt Canyon	-1.7%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
QC at Magma Ave	-6.0%	-3.2%	-3.3%	-3.3%	-3.3%	-3.3%	-3.4%	-3.4%	-3.4%
DC @ US60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DC blw Rancho Rio	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
DC u/s Mineral Creek	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DC d/s Mineral Creek	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

20-Year Fracture Zone Impacts

Proposed Condition – 20-year Impacts

QC at WRD	140.85	1,269	3,221	5,205	8,614	11,861	15,716	20,143	27,223
QC u/s Hewitt Canyon	114.94	1,158	2,947	4,768	7,903	10,901	14,468	18,542	25,102
QC at Magma Ave	9.25	335	858	1,393	2,317	3,219	4,306	5,508	7,522
DC @ US60	10.95	366	940	1,526	2,541	3,531	4,727	6,047	8,260
DC blw Rancho Rio	16.24	449	1,156	1,880	3,133	4,356	5,833	7,465	10,200
DC u/s Mineral Creek	35.32	663	1,706	2,774	4,623	6,421	8,584	10,992	14,992
DC d/s Mineral Creek	90.09	1,035	2,643	4,284	7,111	9,827	13,068	16,744	22,713

Difference (Existing – Proposed 20-year)/Existing

QC at WRD	-1.8%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
QC u/s Hewitt Canyon	-2.2%	-1.0%	-1.0%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%
QC at Magma Ave	-11.1%	-6.0%	-6.1%	-6.2%	-6.2%	-6.3%	-6.3%	-6.3%	-6.3%
DC @ US60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DC blw Rancho Rio	-1.9%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
DC u/s Mineral Creek	-0.9%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
DC d/s Mineral Creek	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

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Table 2. Peak-flow frequency computations for selected key locations - continued

30-Year Fracture Zone Impacts

Proposed Condition – 30-year Impacts											
QC at WRD	140.51	1,268	3,218	5,200	8,605	11,849	15,700	20,123	27,197		
QC u/s Hewitt Canyon	114.60	1,156	2,943	4,762	7,892	10,887	14,450	18,519	25,072		
QC at Magma Ave	8.90	328	841	1,364	2,269	3,151	4,216	5,392	7,363		
DC @ US60	10.95	366	940	1,526	2,541	3,531	4,727	6,047	8,260		
DC blw Rancho Rio	15.94	445	1,144	1,861	3,102	4,313	5,775	7,391	10,098		
DC u/s Mineral Creek	35.02	660	1,698	2,762	4,604	6,394	8,548	10,946	14,931		
DC d/s Mineral Creek	89.79	1,033	2,639	4,277	7,100	9,812	13,049	16,720	22,681		

Difference (Existing – Proposed 30-year)/Existing

QC at WRD	-2.0%	-0.9%	-0.9%	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%
QC u/s Hewitt Canyon	-2.5%	-1.1%	-1.1%	-1.1%	-1.1%	-1.0%	-1.0%	-1.0%	-1.0%
QC at Magma Ave	-14.4%	-7.9%	-8.0%	-8.1%	-8.2%	-8.2%	-8.3%	-8.3%	-8.3%
DC @ US60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DC blw Rancho Rio	-3.7%	-1.9%	-1.9%	-1.9%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%
DC u/s Mineral Creek	-1.7%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
DC d/s Mineral Creek	-0.7%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%



Table 2. Peak-flow frequency computations for selected key locations - continued

Proposed Condition – Lif	Proposed Condition – Life of Mine										
QC at WRD	140.36	1,267	3,216	5,197	8,601	11,844	15,693	20,114	27,185		
QC u/s Hewitt Canyon	114.44	1,155	2,941	4,759	7,888	10,881	14,442	18,508	25,058		
QC at Magma Ave	8.75	325	833	1,351	2,247	3,121	4,175	5,340	7,291		
DC @ US60	10.95	366	940	1,526	2,541	3,531	4,727	6,047	8,260		
DC blw Rancho Rio	15.70	442	1,136	1,847	3 <i>,</i> 078	4,280	5,730	7,334	10,020		
DC u/s Mineral Creek	34.78	658	1,693	2,753	4,589	6,373	8,521	10,911	14,883		
DC d/s Mineral Creek	89.55	1,032	2,636	4,272	7,092	9,801	13,034	16,701	22,656		
DSW u/s Silver Creek	39.47	700	1,800	2,927	4,876	6,769	9,045	11,584	15,792		
DSW d/s Silver Creek	66.52	898	2,302	3,736	6,212	8,602	11,463	14,685	19,963		
DSW at Gila River	105.62	1,114	2,838	4,595	7,620	10,518	13,970	17,903	24,254		
Gila River at DSW	15,461	15,461 Not estimated due to influences of San Carlos Reservoir upstream. See Note 4.									

Life of Mine (LOM) Impacts

Difference (Existing – Proposed LOM)/Existing

QC at WRD	-2.1%	-1.0%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.8%	
QC u/s Hewitt Canyon	-2.6%	-1.2%	-1.2%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	
QC at Magma Ave	-15.9%	-8.7%	-8.9%	-9.0%	-9.0%	-9.1%	-9.1%	-9.2%	-9.2%	
DC @ US60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
DC blw Rancho Rio	-5.1%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	
DC u/s Mineral Creek	-2.4%	-1.2%	-1.2%	-1.2%	-1.2%	-1.1%	-1.1%	-1.1%	-1.1%	
DC d/s Mineral Creek	-0.9%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	
DSW u/s Silver Creek	-22.8%	-11.8%	-11.6%	-11.6%	-11.5%	-11.4%	-11.3%	-11.3%	-11.2%	
DSW d/s Silver Creek	-14.9%	-7.3%	-7.2%	-7.1%	-7.0%	-6.9%	-6.8%	-6.8%	-6.7%	
DSW at Gila River	-10.0%	-4.7%	-4.5%	-4.5%	-4.4%	-4.3%	-4.2%	-4.3%	-4.2%	
Gila River at DSW	-0.075%	Not estin	Not estimated due to influences of San Carlos Reservoir upstream. See Note 4.							

Notes:

- 1) Impacts to Devil's Canyon (DC) from subsidence area.
- 2) Impacts to Queen Creek (QC) include West Plant area and subsidence zone.
- 3) DSW = Dripping Springs Wash
- Peak flow rates for the Gila River were not computed due to influence of Coolidge Dam/San Carlos Reservoir upstream which regulate flows. However, the total drainage area reductions are very small (< 0.1%) for the Skunk Camp alternative.

Volume-Duration-Frequency (SIR 2014-5109, v1.1)

The USGS also developed regression equations from streamflow gaging stations to compute magnitude and frequency of flow volumes for five (5) durations – the 1-, 3-, 7-, 15-, and 30-day durations for the same eight (8) annual exceedance probabilities (AEP) as for the peak-flow frequency equations (50, 20, 10, 4, 2, 1, 0.5, and 0.2 percent) yielding 40 separate regression equations. Only one region of the state was found to have statistically significant relationships for the volume-duration estimates – the Central Highland region, which includes the Queen Creek, Devil's Canyon, and Dripping Springs watersheds. Figure 3 shows the location of the Central Highland region and the stream gaging station locations used in the development of the volume-duration-frequency regression equations.

Three variables were found to explain the volume-duration-frequency relationships – drainage area (DRNAREA), mean annual precipitation (PRECIP), and mean basin elevation (ELEV). The resulting equations are shown in Figure 3 (Table 9 from SIR 2014-5109, v1.1). The standard error of prediction for these equations ranges from a little more than 50 percent for the 50-percent AEP equations to a little less than 30 percent for the 15- and 30-day 0.2-percent AEP equations. Drainage areas were computed using GIS from watersheds delineated using USGS 7.5-minute topographic quadrangles. Mean annual precipitation was computed for each watershed area in GIS from the NOAA US PRISM climate data for the 1990-2010 period. Mean basin elevation was computed in GIS from the USGS 10-meter digital elevation models (DEM).

Tables 3 through 11 present the volume-duration-frequency results for the existing and proposed conditions and the differences between the two for the 10-, 20-, 30-year and LOM fracture zone impacts. The results show that the differences are nearly directly proportional to the reduction in drainage area at each location. Note that the N-year impacts are not presented for Dripping Springs Wash as the fracture zone only impacts the Queen Creek and Devil's Canyon watersheds.

Volume-duration-frequency statistics were computed for the USGS Gila River at Kelvin gaging station (0947400) using the US Army Corps of Engineers HEC-SSP software. Gage data for the period of record following completion of Coolidge Dam (Nov. 1928) were analyzed. Those results are presented at the end of Table 3. No direct comparison of the proposed conditions is presented. However, due to very small ratio of drainage area impacts (about 12 square miles) from Skunk Camp (0.075%) alternative, changes to the Gila River are considered negligible. The drainage area at the Kelvin gage is 18,011 square miles of which 12,866 square miles lie upstream of Coolidge Dam and 5,125 square miles below Coolidge Dam, most of which flow from the San Pedro River. The Skunk Camp TSF site is upstream of the San Pedro River.



△ Streamgaging stations with regression-weighted flood-duration flow estimates

Region over which volume regression equations apply

Eight-digit Hydrologic Unit Code (HUC) boundaries

Figure 3. Map showing central highland region and stream gage locations used in SIR 2014-5109

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	1 day
50	0.00759 (DRNAREA) ^{0.882} (PRECIP) ^{2.454} 10(-0.095*ELEV/1,000)
20	0.0692 (DRNAREA) ^{0.836} (PRECIP) ^{2.310} 10(-0.128*ELEV/1,000)
10	0.189 (DRNAREA) ^{0.808} (PRECIP) ^{2.233} 10 ^(-0.131*ELEV/1,000)
4	0.240 (DRNAREA) ^{0.781} (PRECIP) ^{2.422} 10(^{-0.136*ELEV/1,000)}
2	0.619 (DRNAREA) ^{0.765} (PRECIP) ^{2.278} 10(^{-0.138*ELEV/1,000)}
1	1.50 (DRNAREA) ^{0.751} (PRECIP) ^{2.132} 10 ^(-0.139*EIEV/1,000)
0.5	3.44 (DRNAREA) ^{0.739} (PRECIP) ^{1.988} 10 ^(-0.140*ELEV/1,000)
0.2	30.1 (DRNAREA) ^{0.700} (PRECIP) ^{1.503} 10 ^(-0.144*ELEV/1,000)
	3 day
50	0.00597 (DRNAREA) ^{0.875} (PRECIP) ^{1.978}
20	0.0127 (DRNAREA) ^{0.868} (PRECIP) ^{2.516} 10 ^(-0.101*ELEV1,000)
10	0.0524 (DRNAREA) ^{0.847} (PRECIP) ^{2.360} 10(-0.121*ELEV/1,000)
4	0.173 (DRNAREA) ^{0.826} (PRECIP) ^{2.285} 10(-0.144*ELEV/1,000)
2	0.568 (DRNAREA) ^{0.812} (PRECIP) ^{2.081} 10(-0.152*ELEV/1,000)
1	1.68 (DRNAREA) ^{0.800} (PRECIP) ^{1.882} 10 ^(-0.158+ELEV/1,000)
0.5	4.61 (DRNAREA)0.790 (PRECIP)1.68810(-0.163*ELEV/1,000)
0.2	23.6 (DRNAREA) ^{0.753} (PRECIP) ^{1.365} 10 ^(-0.165*ELEV/1,000)
	7 day
50	0.000538 (DRNAREA) ^{0.916} (PRECIP) ^{2.527}
20	0.00314 (DRNAREA) ^{0.877} (PRECIP) ^{2.669} 10(-0.074*ELEV/1,000)
10	0.00820 (DRNAREA) ^{0.871} (PRECIP) ^{2.719} 10(-0.118*ELEW1,000)
4	0.0267 (DRNAREA) ^{0.847} (PRECIP) ^{2.672} 10 ^(-0.147*ELEV/1,000)
2	0.180 (DRNAREA) ^{0.816} (PRECIP)2.28810(-0.161*ELEV1,000)
1	0.298 (DRNAREA) ^{0.816} (PRECIP) ^{2.246} 10(^{-0.168+ELEV/1,000)}
0.5	0.877 (DRNAREA) ^{0.803} (PRECIP) ^{2.041} 10(^{-0.175*ELEV/1,000)}
0.2	3.24 (DRNAREA) ^{0.788} (PRECIP) ^{1.787} 10 ^(-0.183+ELEV/1,000)
	15 day
50	0.0000440 (DRNAREA) ^{0.958} (PRECIP) ^{3.121}
20	0.000508 (DRNAREA) ^{0.908} (PRECIP) ^{3.006} 10(^{-0.065*ELEV/1,000)}
10	0.00209 (DRNAREA) ^{0.884} (PRECIP) ^{2.880} 10(-0.094*ELEV/1,000)
4	0.00652 (DRNAREA) ^{0.860} (PRECIP) ^{2.865} 10(-0.129+ELEV/1,000)
2	0.0217 (DRNAREA) ^{0.844} (PRECIP) ^{2.678} 10(^{-0.144*ELEV/1,000)}
1	0.0668 (DRNAREA) ^{0.829} (PRECIP) ^{2.490} 10 ^(-0.157*ELEV/1,000)
0.5	0.192 (DRNAREA) ^{0.816} (PRECIP) ^{2.305} 10(-0.168*ELEV/1,000)
0.2	1.20 (DRNAREA) ^{0.808} (PRECIP) ^{1.857} 10 ^(-0.172+ELEV/1,000)
	30 day
50	0.00000789 (DRNAREA) ^{0.978} (PRECIP) ^{3.519}
20	0.000512 (DRNAREA) ^{0.889} (PRECIP) ^{2.637}
10	0.000361 (DRNAREA) ^{0.903} (PRECIP) ^{3.208} 10 ^(-0.078*ELEV/1,000)
4	0.000897 (DRNAREA) ^{0.882} (PRECIP) ^{3.255} 10 ^(-0.113+ELEV/1,000)
2	0.00261 (DRNAREA) ^{0.868} (PRECIP) ^{3.103} 10(-0.129*ELEV/1,000)
1	0.00716 (DRNAREA) ^{0.855} (PRECIP) ^{2.942} 10 ^(-0.141+ELEV/1,000)
0.5	0.0187 (DRNAREA) ^{0.843} (PRECIP) ^{2.778} 10(-0.152*ELEV/1,000)
0.2	0.111 (DRNAREA) ^{0.837} (PRECIP) ^{2.327} 10 ^(-0.154*ELEV/1,000)

Figure 4. Volume-duration-frequency regression equations for Arizona central highland region (SIR 2014-5109, v1.1)

[Pct. AEP, percent annual exceedance probability; DRNAREA, drainage areain square miles; PRECIP, mean annual precipitation in inches. ELEV, mean basin elevation in feet]

Regression equation

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Table 3. Volume-duration-frequency results for select locations - Existing conditions

Queen Cre	ek at Whitlow Ran	ch Dam						
	DRNAREA	PRECIP	ELEV					
	143.401	19.44	3435					
	FI	ood Duration	Flows, in c	fs, for Annu	ial Exceedan	ce Probabil	ity (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	415	1,514	2,797	5,230	8,000	11,633	16,266	26,942
3 day	163	743	1,485	2,947	4,625	6,810	9,612	15,456
7 day	91.8	375	778	1,554	2,573	3,559	5,056	7,660
15 day	53.9	206	412	828	1,297	1,915	2,732	4,207
30 day	34.8	105.9	235	459	699	1,013	1,405	2,090
Queen Cre	ek upstream of He	witt Canyon		_				
	DRNAREA	PRECIP	ELEV					
	117.49	19.54	3484					
	FI	ood Duration	Flows, in c	fs, for Annı	ial Exceedan	ce Probabil	ity (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	349	1,279	2,373	4,464	6,842	9,969	13,960	23,234
3 day	138.3	626	1,252	2,488	3,909	5,759	8,132	13,148
7 day	77.5	316	654	1,309	2,173	3,002	4,269	6,472
15 day	45.2	173.6	347	697	1,094	1,615	2,305	3,546
30 day	29.1	89.9	197.8	386	588	854	1,184	1,759
Queen Cre	ek at Magma Ave			_				
	DRNAREA	PRECIP	ELEV					
	10.4	23.09	4289					
	FI	ood Duration	Flows, in c	fs, for Annı	ial Exceedan	ce Probabil	ity (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	52	195	381	782	1,213	1,780	2,501	4,189
3 day	23	96	190	377	583	846	1,174	1,959
7 day	12.8	51	100	200	327	442	619	919
15 day	7.5	28	55	110	169	245	343	496
30 day	4.9	16	33	64	95	135	184	256
Devil's Car	nyon at US60							
	DRNAREA	PRECIP	ELEV					
	10.95	24.37	4773					
	Fl	ood Duration	Flows, in c	fs, for Annı	ial Exceedan	ce Probabil	ity (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	56	200	387	798	1,223	1,778	2,475	4,011
3 day	27	103	197	379	574	818	1,116	1,824
7 day	15.4	57	106	205	322	432	593	860
15 day	9.3	32	61	116	174	246	336	471
30 day	6.2	19.5	37	70	102	141	188	256



Devil's Canyon below Rancho Rio Creek DRNAREA PRECIP ELEV 16.55 24.07 4587 Flood Duration Flows, in cfs, for Annual Exceedance Probability (%) 20 10 4 0.5 0.2 Duration 50 2 1 1 day 81 290 556 1,133 1,730 2,507 3,479 5,592 38 286 551 3 day 149 835 1,190 1,625 2,627 22 155 299 7 day 82 470 632 868 1,260 15 day 13.3 46 169 254 492 692 88 359 30 day 8.9 27 54 101 148 206 275 375 Devil's Canyon upstream of Mineral Creek DRNAREA PRECIP ELEV) 4190 35.63 22.07 Flood Duration Flows, in cfs, for Annual Exceedance Probability (%) Duration 50 20 10 4 2 1 0.5 0.2 1 day 141 507 960 1,892 2,896 4,208 5,864 9,577 499 3 day 62 256 971 1,493 2,157 2,985 4,835 1,134 7 day 35.3 136 266 520 835 1,580 2,333 15 day 21.1 76.2 147 287 438 630 877 1,282 30 day 13.9 42.9 87.7 167 247 474 670 350 Devil's Canyon downstream of Mineral Creek DRNAREA PRECIP ELEV 90.4 22.84 4171 Flood Duration Flows, in cfs, for Annual Exceedance Probability (%) Duration 50 20 10 4 2 1 0.5 0.2 1 day 350 1,203 2,211 4,280 6,422 9,165 12,569 19,471 3 day 149.7 629 1,197 2,279 3,437 4,879 6,648 10,288 7 day 90.4 339 660 1,261 1,944 2,638 3,606 5,208 57.3 197.3 372 710 2,920 15 day 1,060 1,495 2,045 39.0 107.4 227.7 426 30 day 620 864 1,152 1,592 Dripping Springs Wash upstream of Silver Creek DRNAREA PRECIP ELEV 51.2 19.84 3731 Flood Duration Flows, in cfs, for Annual Exceedance Probability (%) Duration 50 20 10 4 0.5 0.2 2 1 2.241 165 615 1,165 3.469 5.099 7.193 12.246 1 day 3 day 68.9 299 600 1,195 1,885 2,787 3,946 6,539 37.6 152 309 621 1,043 1,434 2,046 3,114 7 day 21.4 82.4 165 331 521 771 1,102 1,691 15 day 13.6 44.7 93.9 183 279 405 563 833 30 day

Table 3. Volume-duration-frequency results for select locations - Existing conditions - continued



Dripping S	prings Wash down	stream of Silv	ver Creek							
	DRNAREA	PRECIP	ELEV							
	78.2	21.93	4062							
	FI	ood Duration	Flows, in c	fs, for Annu	ial Exceedan	ce Probabil	ity (%)			
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	285	1,002	1,856	3,584	5,424	7,805	10,788	17,158		
3 day	121.6	514	991	1,911	2,917	4,187	5,766	9,095		
7 day	71.4	273	537	1,038	1,638	2,232	3,086	4,524		
15 day	43.9	155.6	298	576	872	1,247	1,725	2,515		
30 day	29.4	84.8	178.8	338	498	702	946	1,333		
Dripping S	prings Wash at its	confluence w	ith the Gila	River						
	DRNAREA	PRECIP	ELEV							
	117.3	20.8	4090							
	FI	ood Duration	Flows, in c	fs, for Annu	ial Exceedan	ce Probabil	ity (%)			
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	356	1,234	2,269	4,290	6,499	9,370	12,986	20,853		
3 day	156.2	635	1,224	2,345	3,596	5,189	7,189	11,361		
7 day	90.6 336 657 1,258 2,000 2,729 3,794 5,598									
15 day	54.9 191.0 364 696 1,056 1,514 2,103 3,129									
30 day	36.2	105.8	216.5	404	596	842	1,138	1,639		
Gila River	at Kelvin, USGS Ga	ging Station C	9474000							
	DRNAREA	PRECIP	ELEV							
	18,011*									
	FI	ood Duration	Flows, in c	fs, for Annu	ial Exceedan	ce Probabil	ity (%)			
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	2,620	6,373	10,730	19,539	29,496	43,445	62 <i>,</i> 807	99,982		
3 day	1,756	3,975	6,539	11,763	17,740	26,235	38,223	61,754		
7 day	1,171	2,491	3,990	7,006	10,432	15,281	22,104	35,479		
15 day	873	1,766	2,765	4,754	6,997	10,154	14,580	23,228		
30 day	day 757 1,423 2,119 3,422 4,812 6,677 9,175 13,803									
Volume-du	uration-frequency	statistics com	puted usin	g HEC-SSP s	oftware for	period of re	cord Water	Year		
1930 to 20	17. Coolidge Dam	was complet	ed in Nov.	1928.						
Drainage a	rea includes 12,86	6 sq.mi. abov	ve Coolidge	Dam and 5	,125 sq.mi. k	pelow Cooli	dge Dam.			

Table 3. Volume-duration-frequency results for select locations - Existing conditions - continued



Table 4. Volume-duration-frequency results for select locations - Proposed conditions – 10-year impacts

Queen Creek	Queen Creek at Whitlow Ranch Dam										
	DRNAREA	PRECIP	ELEV								
	141.38	19.44	3435								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	410	1,496	2,765	5,173	7,913	11,510	16,096	26,675			
3 day	161	734	1,467	2,913	4,572	6,733	9,504	15,291			
7 day	90.6	370	768	1,536	2,544	3,518	4,999	7,574			
15 day	53.2	204	407	818	1,282	1,892	2,700	4,159			
30 day	34.3	104.5	232	453	690	1,001	1,388	2,065			
Queen Creek	upstream of Hewi	tt Canyon				-					
	DRNAREA	PRECIP	ELEV								
	115.47	19.54	3484								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	344	1,260	2,340	4,403	6,752	9,840	13,782	22,954			
3 day	136.2	617	1,234	2,453	3,854	5,680	8,021	12,978			
7 day	76.2	311	644	1,290	2,143	2,960	4,210	6,384			
15 day	44.5	170.9	342	687	1,078	1,592	2,273	3,497			
30 day	28.6	88.5	194.7	380	580	841	1,167	1,734			
Queen Creek	at Magma Ave										
	DRNAREA	PRECIP	ELEV								
	9.77	23.09	4289								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	49	185	362	745	1,156	1,699	2,388	4,010			
3 day	22	91	181	358	554	805	1,117	1,869			
7 day	12.1	49	95	189	310	420	589	875			
15 day	7.0	27	52	104	161	233	326	471			
30 day	4.6	15	31	60	90	128	175	243			
Devil's Canyo	on at US60			_							
	DRNAREA	PRECIP	ELEV								
	10.95	24.37	4773								
Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)											
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	56	200	387	798	1,223	1,778	2,475	4,011			
3 day	27	103	197	379	574	818	1,116	1,824			
7 day	15.4	57	106	205	322	432	593	860			
15 day	9.3	32	61	116	174	246	336	471			
30 day	6.2	19.5	37	70	102	141	188	256			



Table 4. Volume-duration-frequency results for select locations - 10-year impacts - continued

Devil's Canyo	on below Rancho Ri	o Creek						a:: .
	DRNAREA	PRECIP	ELEV					
	16.53	24.07	4587					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Prol	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	81	290	556	1,132	1,728	2,505	3,476	5,587
3 day	38	149	286	550	834	1,189	1,623	2,625
7 day	22	82	155	299	470	632	867	1,258
15 day	13.2	46	88	169	253	358	491	692
30 day	8.9	27	54	101	148	206	275	374
Devil's Canyo	on upstream of Min	eral Creek						
	DRNAREA	PRECIP	ELEV					
	35.61	22.07	4190					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	141	507	959	1,892	2,895	4,206	5,862	9,573
3 day	62	256	499	970	1,492	2,156	2,984	4,833
7 day	35.3	136	266	519	834	1,134	1,579	2,332
15 day	21.1	76.2	147	287	438	630	877	1,281
30 day	13.9	42.9	87.6	167	247	350	474	670
Devil's Canyo	on downstream of N	Vineral Creek						
	DRNAREA	PRECIP	ELEV					
	90.38	22.84	4171					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Prol	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	350	1,202	2,211	4,280	6,421	9,164	12,567	19,468
3 day	149.6	629	1,197	2,279	3,437	4,878	6,647	10,286
7 day	90.4	339	660	1,261	1,944	2,638	3,605	5,207
15 day	57.3	197.3	372	710	1,060	1,495	2,044	2,920
30 day	39.0	107.4	227.6	426	620	864	1,152	1,592

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant area and subsidence zone.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.

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Γable 5. Volume-duration-frequε	ncy results for select locations	- Difference (Existin	g – Proposed 10-	year)/Existing
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Queen Cre	ueen Creek at Whitlow Ranch Dam										
	DRNAREA	PRECIP	ELEV								
	-1.4%	0.0%	0.0%								
	Flo	od Duration	Flows, in cfs	s, for Annı	ial Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-1.2%	-1.2%	-1.1%	-1.1%	-1.1%	-1.1%	-1.0%	-1.0%			
3 day	-1.2%	-1.2%	-1.2%	-1.2%	-1.1%	-1.1%	-1.1%	-1.1%			
7 day	-1.3%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.1%	-1.1%			
15 day	-1.4%	-1.3%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.1%			
30 day	-1.4%	-1.3%	-1.3%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%			
Queen Cre	eek upstream of He	witt Canyon									
	DRNAREA	PRECIP	ELEV								
	-1.7%	0.0%	0.0%								
	Flo	od Duration	Flows, in cfs	s, for Annu	ial Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-1.5%	-1.4%	-1.4%	-1.3%	-1.3%	-1.3%	-1.3%	-1.2%			
3 day	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.4%	-1.3%			
7 day	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.4%			
15 day	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%			
30 day	-1.7%	-1.5%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%	-1.4%			
Queen Cre	eek at Magma Ave	•									
	DRNAREA	PRECIP	ELEV								
	-6.1%	0.0%	0.0%								
	Flo	od Duration	Flows, in cfs	s, for Annu	ial Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-5.4%	-5.1%	-4.9%	-4.8%	-4.7%	-4.6%	-4.5%	-4.3%			
3 day	-5.3%	-5.3%	-5.2%	-5.0%	-4.9%	-4.9%	-4.8%	-4.6%			
7 day	-5.6%	-5.3%	-5.3%	-5.2%	-5.0%	-5.0%	-4.9%	-4.8%			
15 day	-5.8%	-5.5%	-5.4%	-5.2%	-5.1%	-5.0%	-5.0%	-4.9%			
30 day	-5.9%	-5.4%	-5.5%	-5.4%	-5.3%	-5.2%	-5.1%	-5.1%			
Devil's Car	nyon at US60			_							
	DRNAREA	PRECIP	ELEV								
	0.0%	0.0%	0.0%								
	Flo	od Duration	Flows, in cfs	s, for Annu	ial Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
7 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
15 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
30 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			



Table 5. Volume-duration-frequency results for select locations – Difference 10-year - continued

Devil's Car	nyon below Rancho	o Rio Creek						
	DRNAREA	PRECIP	ELEV					
	-0.1%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
3 day	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
7 day	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
15 day	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
30 day	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Devil's Car	nyon upstream of N	Mineral Creek		_				
	DRNAREA	PRECIP	ELEV					
	-0.1%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 day	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15 day	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
30 day	-0.1%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Devil's Car	nyon downstream	of Mineral Cro	eek	_				
	DRNAREA	PRECIP	ELEV					
	0.0%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
30 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant and subsidence area.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.



Table 6. Volume-duration-frequency results for select locations - Proposed conditions – 20-year impacts

Queen Creek	Queen Creek at Whitlow Ranch Dam										
	DRNAREA	PRECIP	ELEV								
	140.85	19.44	3435								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	<u>6)</u>				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	409	1,492	2,756	5,158	7,891	11,477	16,052	26,605			
3 day	160	732	1,462	2,904	4,558	6,713	9,476	15,248			
7 day	90.3	369	766	1,531	2,536	3,507	4,984	7,552			
15 day	53.0	203	406	815	1,278	1,886	2,692	4,146			
30 day	34.2	104.2	231	451	688	998	1,384	2,059			
Queen Creek	upstream of Hewi	tt Canyon									
	DRNAREA	PRECIP	ELEV								
	114.94	19.54	3484								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	342	1,255	2,331	4,388	6,728	9,806	13,736	22,880			
3 day	135.6	614	1,229	2,444	3,840	5,659	7,992	12,933			
7 day	75.9	310	642	1,285	2,135	2,949	4,194	6,361			
15 day	44.3	170.1	340	684	1,074	1,586	2,264	3,484			
30 day	28.5	88.1	193.9	379	577	838	1,163	1,727			
Queen Creek	at Magma Ave										
	DRNAREA	PRECIP	ELEV								
	9.25	23.09	4289								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	47	177	347	714	1,109	1,630	2,294	3,859			
3 day	21	87	172	342	530	770	1,070	1,794			
7 day	11.5	46	90	181	297	402	564	838			
15 day	6.7	25	50	100	153	222	312	451			
30 day	4.4	15	29	57	86	122	167	232			
Devil's Canyo	on at US60			_							
	DRNAREA	PRECIP	ELEV								
	10.95	24.37	4773								
Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)											
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	56	200	387	798	1,223	1,778	2,475	4,011			
3 day	27	103	197	379	574	818	1,116	1,824			
7 day	15.4	57	106	205	322	432	593	860			
15 day	9.3	32	61	116	174	246	336	471			
30 day	6.2	19.5	37	70	102	141	188	256			



Table 6. Volume-duration-frequency results for select locations - 20-year impacts - continued

Devil's Canyo	on below Rancho Ri	o Creek						<u> </u>
	DRNAREA	PRECIP	ELEV					
	16.24	24.07	4587					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	80	286	548	1,116	1,705	2,471	3,431	5,518
3 day	37	147	282	542	822	1,172	1,601	2,590
7 day	21	81	152	294	463	623	855	1,241
15 day	13.0	46	87	167	250	353	484	682
30 day	8.8	27	53	100	145	203	271	369
Devil's Canyo	on upstream of Min	eral Creek		_				
	DRNAREA	PRECIP	ELEV					
	35.32	22.07	4190					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	140	504	953	1,880	2,877	4,181	5,827	9,518
3 day	61	254	495	964	1,482	2,142	2,965	4,803
7 day	35.0	135	264	516	829	1,126	1,569	2,317
15 day	20.9	75.6	146	285	435	626	871	1,273
30 day	13.8	42.6	87.0	165	245	348	471	665
Devil's Canyo	on downstream of N	Aineral Creek						
	DRNAREA	PRECIP	ELEV					
	90.09	22.84	4171					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	349	1,199	2,205	4,269	6,405	9,142	12,538	19,424
3 day	149.2	628	1,193	2,273	3,428	4,865	6,630	10,261
7 day	90.1	338	658	1,257	1,938	2,631	3,596	5,194
15 day	57.1	196.7	371	708	1,057	1,491	2,039	2,912
30 day	38.9	107.1	227.0	425	618	862	1,148	1,588

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant area and subsidence zone.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.

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	Table 7.	Volume-duration-free	quency results f	for select locations -	 Difference 	(Existing – Pro	oposed 20-ye	ear)/Existin
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Queen Cre	ueen Creek at Whitlow Ranch Dam										
	DRNAREA	PRECIP	ELEV								
	-1.8%	0.0%	0.0%								
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-1.6%	-1.5%	-1.4%	-1.4%	-1.4%	-1.3%	-1.3%	-1.2%			
3 day	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.3%			
7 day	-1.6%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%			
15 day	-1.7%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%	-1.4%			
30 day	-1.7%	-1.6%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%			
Queen Cre	eek upstream of He	witt Canyon		_							
	DRNAREA	PRECIP	ELEV								
	-2.2%	0.0%	0.0%								
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-1.9%	-1.8%	-1.8%	-1.7%	-1.7%	-1.6%	-1.6%	-1.5%			
3 day	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%	-1.6%			
7 day	-2.0%	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%			
15 day	-2.1%	-2.0%	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.8%			
30 day	-2.1%	-1.9%	-2.0%	-1.9%	-1.9%	-1.9%	-1.8%	-1.8%			
Queen Cre	eek at Magma Ave										
	DRNAREA	PRECIP	ELEV								
	-11.1%	0.0%	0.0%								
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	-9.8%	-9.3%	-9.0%	-8.7%	-8.6%	-8.4%	-8.3%	-7.9%			
3 day	-9.7%	-9.7%	-9.4%	-9.2%	-9.1%	-8.9%	-8.8%	-8.4%			
7 day	-10.2%	-9.8%	-9.7%	-9.4%	-9.1%	-9.1%	-9.0%	-8.8%			
15 day	-10.6%	-10.1%	-9.8%	-9.6%	-9.4%	-9.3%	-9.1%	-9.0%			
30 day	-10.8%	-9.9%	-10.0%	-9.8%	-9.7%	-9.5%	-9.4%	-9.3%			
Devil's Car	nyon at US60										
	DRNAREA	PRECIP	ELEV								
	0.0%	0.0%	0.0%								
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
7 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
15 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
30 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			



Table 7. Volume-duration-frequency results for select locations – Difference 20-year - continued

Devil's Car	Devil's Canyon below Rancho Rio Creek											
	DRNAREA	PRECIP	ELEV									
	-1.9%	0.0%	0.0%									
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)					
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	-1.7%	-1.6%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.3%				
3 day	-1.6%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%	-1.4%				
7 day	-1.7%	-1.6%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%				
15 day	-1.8%	-1.7%	-1.7%	-1.6%	-1.6%	-1.6%	-1.5%	-1.5%				
30 day	-1.8%	-1.7%	-1.7%	-1.7%	-1.6%	-1.6%	-1.6%	-1.6%				
Devil's Car	nyon upstream of N	Mineral Creek		_								
	DRNAREA	PRECIP	ELEV									
	-0.9%	0.0%	0.0%									
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)					
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.6%	-0.6%				
3 day	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%				
7 day	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%				
15 day	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%				
30 day	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%				
Devil's Car	nyon downstream	of Mineral Cr	eek	_								
	DRNAREA	PRECIP	ELEV									
	-0.3%	0.0%	0.0%									
	Flo	od Duration	Flows, in cf	s, for Annı	ual Exceeda	nce Probab	ility (%)	-				
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.2%				
3 day	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%				
7 day	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%				
15 day	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%				
30 day	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%				

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant and subsidence area.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.



Table 8. Volume-duration-frequency results for select locations - Proposed conditions – 30-year impacts

Queen Creek	Queen Creek at Whitlow Ranch Dam										
	DRNAREA	PRECIP	ELEV								
	140.51	19.44	3435								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	408	1,489	2,751	5,148	7,876	11,457	16,023	26,560			
3 day	160	730	1,459	2,898	4,549	6,700	9,458	15,221			
7 day	90.1	368	764	1,528	2,531	3,500	4,974	7,538			
15 day	52.8	203	405	813	1,275	1,883	2,687	4,138			
30 day	34.1	104.0	231	450	686	996	1,381	2,055			
Queen Creek	upstream of Hewi	tt Canyon									
	DRNAREA	PRECIP	ELEV								
	114.6	19.54	3484								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	342	1,252	2,325	4,378	6,713	9,784	13,705	22,833			
3 day	135.3	613	1,226	2,438	3,830	5,646	7,973	12,904			
7 day	75.7	309	640	1,282	2,130	2,942	4,184	6,346			
15 day	44.2	169.7	339	683	1,071	1,582	2,259	3,475			
30 day	28.4	87.9	193.4	378	576	836	1,160	1,723			
Queen Creek	at Magma Ave										
	DRNAREA	PRECIP	ELEV								
	8.9	23.09	4289								
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Pro	bability (%	6)				
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	45	172	336	693	1,076	1,584	2,229	3,756			
3 day	20	84	167	331	514	747	1,038	1,743			
7 day	11.1	45	87	175	288	390	546	813			
15 day	6.4	24	48	96	148	215	302	437			
30 day	4.2	14	28	55	83	118	161	225			
Devil's Canyo	on at US60			_							
	DRNAREA	PRECIP	ELEV								
	10.95	24.37	4773								
Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)											
Duration	50	20	10	4	2	1	0.5	0.2			
1 day	56	200	387	798	1,223	1,778	2,475	4,011			
3 day	27	103	197	379	574	818	1,116	1,824			
7 day	15.4	57	106	205	322	432	593	860			
15 day	9.3	32	61	116	174	246	336	471			
30 day	6.2	19.5	37	70	102	141	188	256			



Table 8. Volume-duration-frequency results for select locations - 30-year impacts - continued

Devil's Canyo	on below Rancho Ri	o Creek						<u>a: .</u>				
	DRNAREA	PRECIP	ELEV									
	15.94	24.07	4587									
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)					
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	79	281	540	1,100	1,681	2,437	3,384	5,447				
3 day	36	145	277	534	810	1,155	1,577	2,554				
7 day	21	79	150	290	456	613	842	1,223				
15 day	12.8	45	85	164	246	348	477	672				
30 day	8.6	26	52	98	143	200	267	363				
Devil's Canyo	on upstream of Min	eral Creek										
	DRNAREA	PRECIP	ELEV									
	35.02	22.07	4190									
	Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)											
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	139	500	946	1,867	2,858	4,154	5,790	9,462				
3 day	61	252	492	957	1,472	2,127	2,945	4,772				
7 day	34.8	134	262	512	823	1,119	1,558	2,302				
15 day	20.7	75.0	145	283	432	621	865	1,264				
30 day	13.7	42.2	86.3	164	243	345	468	660				
Devil's Canyo	on downstream of N	Mineral Creek										
	DRNAREA	PRECIP	ELEV									
	89.79	22.84	4171									
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)					
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	348	1,196	2,199	4,258	6,389	9,119	12,507	19,379				
3 day	148.8	626	1,190	2,267	3,418	4,852	6,612	10,235				
7 day	89.8	337	656	1,254	1,933	2,624	3,586	5,181				
15 day	56.9	196.1	370	706	1,054	1,487	2,033	2,905				
30 day	38.8	106.8	226.3	423	617	859	1,145	1,583				

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant area and subsidence zone.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.

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Table 9.	Volume-duration-free	quency results for	r select locations -	- Difference	(Existing – Pro	posed 30-ye	ear)/Existing
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Queen Cre	ek at Whitlow Ran	ich Dam						
[DRNAREA	PRECIP	ELEV					
	-2.0%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-1.8%	-1.7%	-1.6%	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%
3 day	-1.8%	-1.8%	-1.7%	-1.7%	-1.6%	-1.6%	-1.6%	-1.5%
7 day	-1.8%	-1.8%	-1.8%	-1.7%	-1.6%	-1.6%	-1.6%	-1.6%
15 day	-1.9%	-1.8%	-1.8%	-1.7%	-1.7%	-1.7%	-1.6%	-1.6%
30 day	-2.0%	-1.8%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%	-1.7%
_								
	DRNAREA	PRECIP	ELEV					
	-2.5%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-2.2%	-2.1%	-2.0%	-1.9%	-1.9%	-1.9%	-1.8%	-1.7%
3 day	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%	-1.9%	-1.9%
7 day	-2.3%	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%	-1.9%
15 day	-2.4%	-2.2%	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%
30 day	-2.4%	-2.2%	-2.2%	-2.2%	-2.1%	-2.1%	-2.1%	-2.1%
Queen Cre	ek at Magma Ave							
	DRNAREA	PRECIP	ELEV					
	-14.4%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-12.8%	-12.2%	-11.8%	-11.5%	-11.2%	-11.0%	-10.9%	-10.3%
3 day	-12.7%	-12.6%	-12.4%	-12.1%	-11.9%	-11.7%	-11.6%	-11.1%
7 day	-13.3%	-12.8%	-12.7%	-12.4%	-11.9%	-11.9%	-11.8%	-11.6%
15 day	-13.9%	-13.2%	-12.9%	-12.5%	-12.3%	-12.1%	-11.9%	-11.8%
30 day	-14.1%	-12.9%	-13.1%	-12.8%	-12.6%	-12.5%	-12.3%	-12.2%
Devil's Car	nyon at US60							
	DRNAREA	PRECIP	ELEV					
	0.0%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
30 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%



Table 9. Volume-duration-frequency results for select locations – Difference 30-year - continued

Devil's Car	yon below Rancho	Rio Creek								
	DRNAREA	PRECIP	ELEV							
	-3.7%	0.0%	0.0%							
	Flo	od Duration I	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)			
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	-3.3%	-3.1%	-3.0%	-2.9%	-2.8%	-2.8%	-2.7%	-2.6%		
3 day	-3.2%	-3.2%	-3.1%	-3.1%	-3.0%	-3.0%	-2.9%	-2.8%		
7 day	-3.4%	-3.2%	-3.2%	-3.1%	-3.0%	-3.0%	-3.0%	-2.9%		
15 day	-3.5%	-3.4%	-3.3%	-3.2%	-3.1%	-3.1%	-3.0%	-3.0%		
30 day	-3.6%	-3.3%	-3.3%	-3.3%	-3.2%	-3.2%	-3.1%	-3.1%		
Devil's Car	nyon upstream of N	Aineral Creek		_						
	DRNAREA	PRECIP	ELEV							
	-1.7%	0.0%	0.0%							
	Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)									
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	-1.5%	-1.4%	-1.4%	-1.3%	-1.3%	-1.3%	-1.3%	-1.2%		
3 day	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.4%	-1.3%		
7 day	-1.6%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.4%		
15 day	-1.6%	-1.6%	-1.5%	-1.5%	-1.4%	-1.4%	-1.4%	-1.4%		
30 day	-1.7%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%		
Devil's Car	nyon downstream	of Mineral Cro	eek	_						
	DRNAREA	PRECIP	ELEV							
	-0.7%	0.0%	0.0%							
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)			
Duration	50	20	10	4	2	1	0.5	0.2		
1 day	-0.6%	-0.6%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%		
3 day	-0.6%	-0.6%	-0.6%	-0.6%	-0.5%	-0.5%	-0.5%	-0.5%		
7 day	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.5%	-0.5%		
15 day	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.5%		
30 day	-0.7%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%		

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant and subsidence area.

3) Impacts to Dripping Springs Wash for LOM shown in Tables 10 & 11.



Table 10. Volume-duration-frequency results for select locations - Proposed conditions – LOM impacts

Queen Creek	at Whitlow Ranch	Dam						
	DRNAREA	PRECIP	ELEV					
	140.36	19.44	3435					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	408	1,487	2,749	5,144	7,870	11,447	16,010	26,540
3 day	160	730	1,458	2,895	4,545	6,694	9,450	15,208
7 day	90.0	368	763	1,526	2,529	3,497	4,970	7,531
15 day	52.8	202	404	813	1,274	1,881	2,684	4,135
30 day	34.0	103.9	231	450	686	995	1,380	2,053
Queen Creek	upstream of Hewi	tt Canyon		_				
	DRNAREA	PRECIP	ELEV					
	114.44	19.54	3484					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	341	1,251	2,323	4,373	6,706	9,774	13,691	22,810
3 day	135.1	612	1,225	2,435	3,826	5,639	7,965	12,891
7 day	75.6	309	639	1,280	2,127	2,938	4,179	6,339
15 day	44.1	169.5	339	682	1,070	1,580	2,256	3,471
30 day	28.4	87.8	193.2	377	575	835	1,158	1,721
Queen Creek	k at Magma Ave							
	DRNAREA	PRECIP	ELEV					
	8.75	23.09	4289					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	45	169	331	684	1,062	1,564	2,202	3,712
3 day	20	83	164	327	507	737	1,024	1,720
7 day	10.9	44	86	173	284	384	539	802
15 day	6.3	24	47	95	146	212	298	431
30 day	4.1	14	28	55	82	117	159	222
Devil's Canyo	on at US60							
	DRNAREA	PRECIP	ELEV					
	10.95	24.37	4773					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	56	200	387	798	1,223	1,778	2,475	4,011
3 day	27	103	197	379	574	818	1,116	1,824
7 day	15.4	57	106	205	322	432	593	860
15 day	9.3	32	61	116	174	246	336	471
30 day	6.2	19.5	37	70	102	141	188	256



Table 10. Volume-duration-frequency results for select locations - LOM impacts - continued

Devil's Canyo	on below Rancho Ri	o Creek						
	DRNAREA	PRECIP	ELEV]				
	15.70	24.07	4587					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	78	278	533	1,087	1,662	2,409	3,346	5,389
3 day	36	143	274	527	800	1,141	1,559	2,525
7 day	21	78	148	286	450	606	832	1,208
15 day	12.6	44	84	162	243	343	471	664
30 day	8.5	26	51	97	141	197	263	359
Devil's Canyo	on upstream of Min	eral Creek						
	DRNAREA	PRECIP	ELEV					
	34.78	22.07	4190					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	138	497	941	1,857	2,843	4,132	5,761	9,416
3 day	61	251	489	952	1,464	2,115	2,929	4,748
7 day	34.5	133	260	509	819	1,112	1,549	2,289
15 day	20.6	74.6	144	281	429	618	860	1,257
30 day	13.6	42.0	85.8	163	242	343	465	656
Devil's Canyo	on downstream of N	Vineral Creek						
	DRNAREA	PRECIP	ELEV					
	89.55	22.84	4171					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	347	1,193	2,194	4,249	6,376	9,100	12,482	19,342
3 day	148.4	624	1,187	2,262	3,411	4,842	6,598	10,215
7 day	89.6	336	655	1,251	1,929	2,618	3,578	5,170
15 day	56.8	195.6	369	704	1,052	1,484	2,029	2,898
30 day	38.7	106.5	225.7	422	615	857	1,143	1,580
Dripping Spr	ings Wash upstrean	n of Silver Creek	< Comparison of the second sec	_				
	DRNAREA	PRECIP	ELEV					
	39.47	19.84	3731					
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	edance Pro	bability (%	6)	-
Duration	50	20	10	4	2	1	0.5	0.2
1 day	131	495	944	1,829	2,843	4,194	5,934	10,207
3 day	54.9	238	481	964	1,526	2,264	3,213	5,376
7 day	29.6	121	247	498	843	1,159	1,660	2,537
15 day	16.7	65.0	131	265	418	621	891	1,370
30 day	10.6	35.5	74.2	145	222	324	452	670



Table 10. Volume-duration-frequency results for select locations - Proposed conditions - LOM impacts - continued

Duinning Cavi												
Dripping Spri		eam of Silver Cr	еек	1								
	DKNAKEA	PRECIP	ELEV									
	66.52	21.93	4062									
Flood Duration Flows, in cfs, for Annual Exceedance Probability (%)												
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	247	875	1,629	3,159	4,793	6,912	9,572	15,321				
3 day	106	447	864	1,672	2,558	3,679	5,075	8,052				
7 day	61.6	237	466	905	1,436	1,956	2,710	3,982				
15 day	37.6	134	258	501	761	1,090	1,512	2,207				
30 day	25.1	73.5	154	293	433	611	825	1,165				
Dripping Spri	ings Wash at its cor	fluence with th	e Gila River									
	DRNAREA	PRECIP	ELEV									
	105.62	20.8	4090									
	FI	ood Duration Fl	ows, in cfs, fo	r Annual Exce	eedance Prol	pability (%	6)					
Duration	50	20	10	4	2	1	0.5	0.2				
1 day	324	1,130	2,085	3,952	5,998	8,660	12,018	19,377				
3 day	143	580	1,120	2,150	3,302	4,772	6,617	10,498				
7 day	82.3	307	599	1,151	1,836	2,505	3,487	5,154				
15 day	49.6	174	332	636	967	1,388	1,931	2,874				
30 day	32.7	96.4	197	368	544	770	1,042	1,501				
				•	•							

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant area and subsidence zone.

3) No proposed condition is presented for Gila River at Kelvin. However, due to very small ratio of drainage area impacts from Skunk Camp (0.075%) alternative, changes to the Gila River are considered negligible.

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Table 11. Volume-duration-frequency results for select locations – Difference (Existing – Proposed LOM)/Existing

Queen Cre	eek at Whitlow Ran	ich Dam						
	DRNAREA	PRECIP	ELEV					
	-2.1%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-1.9%	-1.8%	-1.7%	-1.7%	-1.6%	-1.6%	-1.6%	-1.5%
3 day	-1.9%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%	-1.7%	-1.6%
7 day	-1.9%	-1.9%	-1.8%	-1.8%	-1.7%	-1.7%	-1.7%	-1.7%
15 day	-2.0%	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%
30 day	-2.1%	-1.9%	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.8%
Queen Cre	eek upstream of He	witt Canyon		_				
	DRNAREA	PRECIP	ELEV					
	-2.6%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-2.3%	-2.2%	-2.1%	-2.0%	-2.0%	-2.0%	-1.9%	-1.8%
3 day	-2.3%	-2.3%	-2.2%	-2.1%	-2.1%	-2.1%	-2.1%	-2.0%
7 day	-2.4%	-2.3%	-2.3%	-2.2%	-2.1%	-2.1%	-2.1%	-2.1%
15 day	-2.5%	-2.4%	-2.3%	-2.2%	-2.2%	-2.2%	-2.1%	-2.1%
30 day	-2.5%	-2.3%	-2.3%	-2.3%	-2.3%	-2.2%	-2.2%	-2.2%
Queen Cre	eek at Magma Ave							
	DRNAREA	PRECIP	ELEV					
	-15.9%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-14.1%	-13.4%	-13.0%	-12.6%	-12.4%	-12.2%	-12.0%	-11.4%
3 day	-14.0%	-13.9%	-13.6%	-13.3%	-13.1%	-12.9%	-12.8%	-12.2%
7 day	-14.6%	-14.1%	-14.0%	-13.6%	-13.1%	-13.1%	-13.0%	-12.7%
15 day	-15.3%	-14.5%	-14.2%	-13.8%	-13.6%	-13.3%	-13.1%	-13.0%
30 day	-15.5%	-14.2%	-14.4%	-14.1%	-13.9%	-13.7%	-13.6%	-13.5%
Devil's Car	nyon at US60							
	DRNAREA	PRECIP	ELEV					
	0.0%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
30 day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%



Table 11. Volume-duration-frequency results for select locations – Difference LOM - continued

Devil's Car	nyon below Rancho	Rio Creek						
	DRNAREA	PRECIP	ELEV					
	-5.1%	0.0%	0.0%					
	Flo	od Duration	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-4.5%	-4.3%	-4.2%	-4.0%	-4.0%	-3.9%	-3.8%	-3.6%
3 day	-4.5%	-4.5%	-4.4%	-4.3%	-4.2%	-4.1%	-4.1%	-3.9%
7 day	-4.7%	-4.5%	-4.5%	-4.4%	-4.2%	-4.2%	-4.1%	-4.1%
15 day	-4.9%	-4.7%	-4.6%	-4.4%	-4.4%	-4.3%	-4.2%	-4.2%
30 day	-5.0%	-4.6%	-4.6%	-4.5%	-4.5%	-4.4%	-4.3%	-4.3%
Devil's Car	nyon upstream of N	Aineral Creek		_				
	DRNAREA	PRECIP	ELEV					
	-2.4%	0.0%	0.0%					
	Flo	od Duration	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-2.1%	-2.0%	-1.9%	-1.9%	-1.8%	-1.8%	-1.8%	-1.7%
3 day	-2.1%	-2.1%	-2.0%	-2.0%	-1.9%	-1.9%	-1.9%	-1.8%
7 day	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%	-1.9%	-1.9%
15 day	-2.3%	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%	-1.9%
30 day	-2.3%	-2.1%	-2.2%	-2.1%	-2.1%	-2.0%	-2.0%	-2.0%
Devil's Car	nyon downstream o	of Mineral Cr	eek					
	DRNAREA	PRECIP	ELEV					
	-0.9%	0.0%	0.0%					
	Flo	od Duration	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
3 day	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%
7 day	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.7%
15 day	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
30 day	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
Dripping S	prings Wash upstro	eam of Silver	Creek	_				
	DRNAREA	PRECIP	ELEV					
	-22.9%	0.0%	0.0%					
	Flo	od Duration	Flows, in cf	s, for Annu	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-20.5%	-19.5%	-19.0%	-18.4%	-18.0%	-17.8%	-17.5%	-16.7%
3 day	-20.4%	-20.2%	-19.8%	-19.3%	-19.0%	-18.8%	-18.6%	-17.8%
7 day	-21.2%	-20.4%	-20.3%	-19.8%	-19.1%	-19.1%	-18.9%	-18.5%
15 day	-22.1%	-21.0%	-20.5%	-20.1%	-19.7%	-19.4%	-19.1%	-19.0%
30 day	-22.5%	-20.7%	-20.9%	-20.5%	-20.2%	-19.9%	-19.7%	-19.6%



Table 11. Volume-duration-frequency results for select locations – Difference LOM - continued

Dripping S	prings Wash down	stream of Silv	ver Creek					
	DRNAREA	PRECIP	ELEV]				
	-14.9%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-13.3%	-12.6%	-12.3%	-11.9%	-11.6%	-11.4%	-11.3%	-10.7%
3 day	-13.2%	-13.1%	-12.8%	-12.5%	-12.3%	-12.1%	-12.0%	-11.5%
7 day	-13.8%	-13.2%	-13.1%	-12.8%	-12.4%	-12.4%	-12.2%	-12.0%
15 day	-14.4%	-13.7%	-13.3%	-13.0%	-12.8%	-12.6%	-12.4%	-12.3%
30 day	-14.6%	-13.4%	-13.6%	-13.3%	-13.1%	-12.9%	-12.7%	-12.7%
Dripping S	prings Wash at its	confluence w	ith the Gila	River				
	DRNAREA	PRECIP	ELEV					
	-10.0%	0.0%	0.0%					
	Flo	od Duration I	Flows, in cf	s, for Annı	ial Exceeda	nce Probab	ility (%)	
Duration	50	20	10	4	2	1	0.5	0.2
1 day	-8.8%	-8.4%	-8.1%	-7.9%	-7.7%	-7.6%	-7.5%	-7.1%
3 day	-8.8%	-8.7%	-8.5%	-8.3%	-8.2%	-8.0%	-8.0%	-7.6%
7 day	-9.2%	-8.8%	-8.7%	-8.5%	-8.2%	-8.2%	-8.1%	-7.9%
15 day	-9.6%	-9.1%	-8.9%	-8.6%	-8.5%	-8.3%	-8.2%	-8.1%
30 day	-9.7%	-8.9%	-9.0%	-8.8%	-8.7%	-8.6%	-8.5%	-8.4%

Notes:

1) Impacts to Devil's Canyon from subsidence area.

2) Impacts to Queen Creek include West Plant and subsidence area.

3) No volume-duration-frequency difference is presented for Gila River at Kelvin. However, due to very small ratio of drainage area impacts from Skunk Camp (0.075%) alternative, changes to the Gila River are considered negligible.

Surface water flow impacts to Queen Creek at Superior

As part of this June 2020 update to assist conversations with the Town of Superior, the quantification of impacts to surface water flows in Queen Creek near Magma Avenue in the Town of Superior are presented in a couple of additional ways.

In the case of Queen Creek at Magma Avenue as discussed in the previous section of this memo, the watershed area upstream will be reduced as a consequence of the subsidence crater in the Oak Flat area. Table 12 shows the changes in the effective watershed area after 10-, 20-, and 30-years as well as at the end of mining (life of mine, or LOM). The USGS regression equations suggest that the reduced drainage area will reduce runoff volume from Queen Creek by about the same amount at each time interval as also shown in Table 12. The 50-percent annual exceedance probability (AEP) flow for the 30-day duration is reduced from about 4.9 cfs (2,200 gpm) to 4.1 cfs (1,840 gpm) at the end of mining.



	Existing	After 10 years	After 20 years	After 30 years	Life of Mine				
Watershed Area (sq.mi.)	10.4	9.77	9.25	8.9	8.75				
Difference in Area (%)	0	-6.1	-11.1	-14.4	-15.9				
50% 30-day flow (cfs)	4.9	4.6	4.4	4.2	4.1				
50% 30-day flow (gpm)	2,200	2,065	1,975	1,885	1,840				
Difference in flow (%) 0 -5.9 -10.8 -14.1 -15.5									
Note that due to the precision displayed in the areas and cfs flow rates that the percentage									
differences do not match th	nose compute	ed from the ro	unded gpm va	alues.	-				

Table 12. Changes in flows on Queen Creek at Magma Avenue

Unfortunately, the USGS regression equations do not provide an equation for mean annual flow, but a conservative estimate would be to divide the 50% AEP 30-day flow by twelve (months in a year). Hence, a conservative estimate of the existing mean annual flow in Queen Creek at Magma Avenue is about 0.4 cfs or 183 gpm. For the future condition with the reduced effective drainage area due to the ultimate subsidence crater, the mean annual flow would be about 0.34 cfs or 154 gpm, or a reduction of about 30 gpm.

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