NEW MEXICO INTERSTATE STREAM COMMISSION

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MEMORANDUM

February 14, 2017

TO: Kevin Flanigan
THROUGH: Ali Effati
FROM: Helen Sobien

Re: Possible use of existing flood control dams in Cliff-Gila Valley for aquifer recharge

The Interstate Stream Commission has broad powers to investigate, protect, conserve, and develop New Mexico's waters including both interstate and intrastate stream systems. The Commission is authorized by statute to investigate and develop the water supplies of the state and institute legal proceedings in the name of the state for planning, conservation, protection and development of public waters. The following concept was developed in response to a request for contingency plans in the face of drought and/or climate change.

There are 12 earthen dams, equipped with outlet works, crossing side canyons along a five (5) mile stretch of the Gila River, near the town of Gila, NM. This memo explores the possibility of using them to retain flood flows for a longer period of time than currently practiced, hence allowing them to function as infiltration ponds to recharge the aquifer. Further detail about the sizes and locations of the dams is provided in Table A1 and Figure A1 in the attachment at the end of this memo.

Stretches of the Gila River occasionally go dry for months at a time under current conditions. Climate change is expected to affect streamflow in the Gila River. A much greater fraction of cold season precipitation will become runoff immediately instead of accumulating as winter snowpack, then melting in a well-defined snowmelt runoff event. (Gutzler 2013). If the flood flows could be used to recharge the aquifer, it might alleviate some of the issues caused by the lack of snowpack.

The USGS stream gauge at Gila near Gila indicates that the highest sustained flow occurs during the snowmelt runoff period. It extends for a 122-day period from January 27 through May 28 and contains some of the highest mean daily flows (Horner and Dahm

2014). Figure 1, below, illustrates the average and median flows based on data from 1927 to 2013. If winter precipitation were to fall as rain instead of snow, the hydrograph for the period from January through May would be similar to that of the period from September through December. This would be a significant deviation from the existing natural flow regime, and possibly would have deleterious effects on the environment and the agriculture in the area. This gage is located upstream of the reservoirs considered in this document.

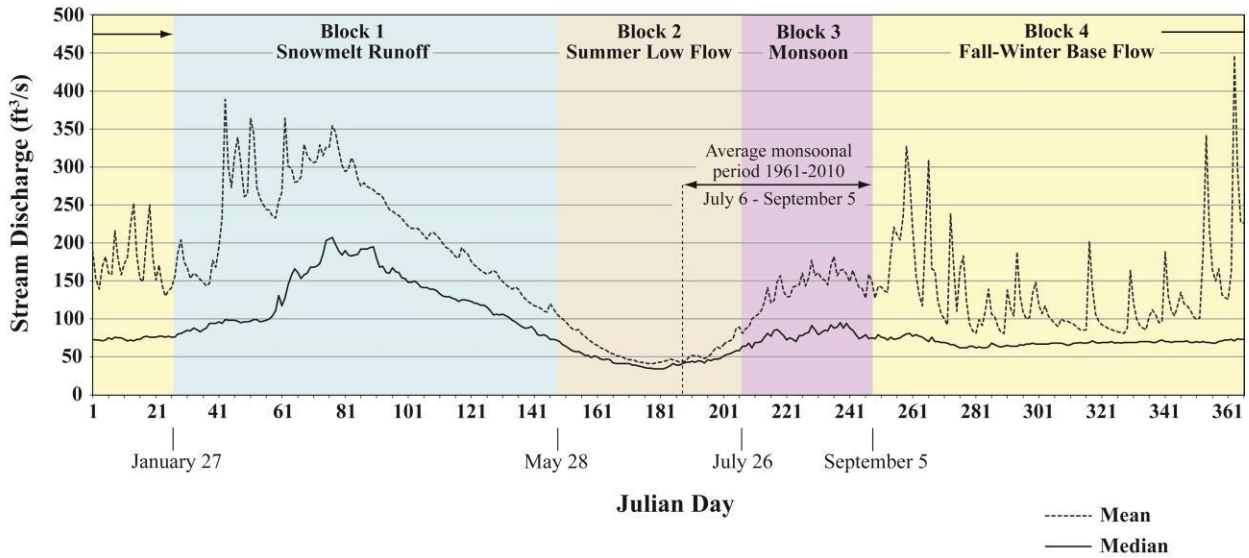

Figure 1: Daily mean and median discharge at the USGS Gila near Gila stream gage (USGS 09430500) for the Gila River unaltered hydrograph (Horner and Dahm 2014).

The *1964 Arizona v. California Decree* limits New Mexican consumption from the Gila River, its tributaries or underground water sources , extending from the Upper Gila area to Red Rock to less than 16,000 acre-feet per year.

Some of the irrigators near Virden operate under the *Globe Equity Decree*. They also face the lack of surface water at the times they need it and have the right to take it and must resort to pumping groundwater.

However, there is not always enough wet water available to satisfy even this much demand. Without reliable water, farmers risk serious financial loss if they plant crops such as grapes or pecans that would die in a dry year.

If flood waters were to be retained in the reservoirs considered by this document for twelve (12) days instead of four (4) days, the reservoirs could function as passive infiltration ponds allowing for recharge of the groundwater. The water could either be pumped and used locally, or be allowed to flow back to the Gila River for environmental purposes and/or use by irrigators downstream, to satisfy demands allowed by the *1964 Decree* and/or *Globe Equity Decree,*

These dams were built by the US Department of Agriculture, Soil Conservation Service (now Natural Resources Conservation Service (NRCS)) between 1960 and 1965. According to the NM Dam Inventory Database, all 12 Upper Gila Valley Dams are owned by the Upper Gila Valley Watershed District. Sites #2 and #5 were removed from New Mexico Office of the State Engineer (NM OSE) jurisdiction on June 19, 2009. The properties upon which the dams are located may be owned by private individuals and companies that allow easements for use by the Upper Gila Watershed District. The purpose of the dams is flood control and sediment control. Several of the reservoirs are quite full of sediment and need cleaning and maintenance.

The dams are operated according to the NM OSE Dam Safety regulations. Specifically, all flood water is released within ninety-six (96) hours.

Table A2 lists the average monthly precipitation for the area. Figures A2 and A3 provide Depth-Duration-Frequency and Intensity-Duration-Frequency information. It is realistic to expect a 4-day rain event that would yield 2 inches of precipitation each year.

However, not all of the precipitation would accumulate in the reservoir. Some would be captured by the soil, plants and evaporation. While field surveys and soil samples would be required for deeper analysis of this abstraction of precipitation, applying the Curve Number method to Figure A4 or Equations A1 and A2, the possible accumulations at each reservoir can be calculated for isolated events as shown in Table 1 and Figure 2, below. (Wurbs 2002.)

Precipitation	2"	2.5"	
Run-off	.25"	.45"	
Volume of accumulation			
Northrup	14.54	26.48	AF
Rodriguez	2.54	4.63	AF
Dominguez	4.40	8.00	AF
Garcia	26.88	48.94	AF
Celso	6.13	11.15	AF
Maldonado	28.79	52.43	AF
Woodrow	13.54	24.66	AF
Clark	10.67	19.42	AF
Doyle	10.94	19.92	AF
Winn	188.79	343.79	AF
Bell	57.88	105.39	AF
Kartchner	16.13	29.36	AF

Table 1. Possible accumulations of storm water in each reservoir, from an isolated event, based on a Curve Number of 70.

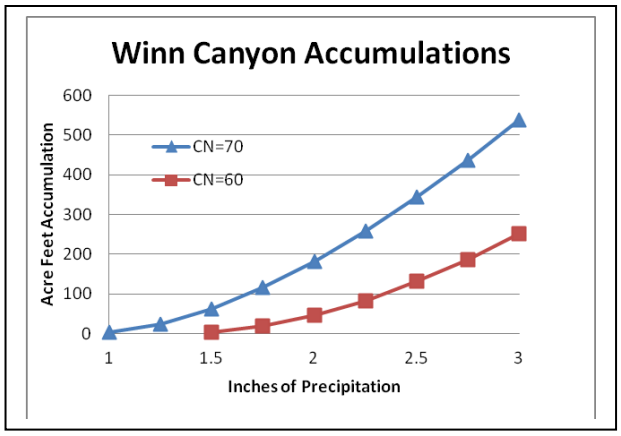

Figure 2. Accumulation of water in Winn Canyon as precipitation varies from 1" to 3" assuming different Curve Numbers.

Lower Curve Numbers would yield less accumulation. An isolated precipitation event of less than 1" yields negligible accumulation.

A pulse of flood water that passes the USGS Gila near Gila streamflow gage will pass the New Mexico - Arizona state line several hours later. Figure A5 shows the locations of four USGS streamflow gages on the Gila River and Figures A6 and A7 show their respective responses to a flood events.

If this concept of using the existing dams to retain water longer were to be pursued, issues which must be considered further include, but are not limited to:

1- A hydrological feasibility study would be required to determine what benefits would be gained, e.g., how much water could be recharged to the aquifer, what effect it would have on the groundwater level, what effect it would have on river flow and sediment. The hydrology might indicate a need for ecological studies.

2- A storage permit would be required. Water rights would be required[1]. An ASR permit might be required. This would require the results of the hydrological study mentioned in Item 1 plus work by the NM OSE Hydrology Bureau. Any application would probably be protested. The NM OSE District 3 office would have to research detail regarding how 1964 Decree water and/or Globe Equity water rights could be used.

3- Some of the irrigators near Virden already own storage permits.

4- The existing outlet works do not have gates. These would have to be added. This would require funds for design and construction.

5- The dams might not be physically capable of holding water for longer than 4 days. They are at the end of their design life. They were built 1960-65 and designed to last 50 years. NRCS has hinted that it would like to sever its responsibility to the dams. An engineering analysis of the design of the dams, the current conditions and a planning level cost estimate of what would be needed to enhance them adequately to hold water longer than 4 days would be required.

[1] According to the OSE Dam Safety Regulations, "flood control dams that do not drain within 96 hours require a water right for water permanently stored beyond the 96-hour drain time requirement and for associated losses due to evaporation and other potential depletions to the system unless a waiver in accordance with 19.25.12.11 NMAC is obtained" from the state engineer.

References:

***Arizona v. California*, 376 U.S. 340, 348 (1964)**

Gutzler, D. S., 2013. Streamflow Projections for the upper Gila River Prepared for the New Mexico Interstate Stream Commission, UNM Contract No. 37675.

Horner, M., Dahm, C., 2014, Ecohydrology and Recent Climatology of the Gila River, Gila Flow Needs Assessment, Chapter 2, The Nature Conservancy.

Wurbs, R.A., James, W. P. (2002), *Water Resources Engineering*, Upper Saddle River, NJ, Prentice Hall.

Conversation with Charles Thompson, *Bureau Chief,* WRAP Technical Division, Dam Safety Bureau, NM Office of the State Engineer. December 16, 2016.

Conversation with Valentine, Lloyd, *District Manager,* WRAP Water Rights Division, District 3 – Deming, NM Office of the State Engineer. December 16, 2016.

Email conversation with David Heber*, Civil Engineer,* WRAP Technical Division, Dam Safety Bureau, NM Office of the State Engineer. November 23, 2016.

Dam locations and sizes

Table A1, below, lists the dams, and details about their reservoirs, as provided by the As-Built drawings. The "Max. Volumes" listed include sediment pools. Site numbers refer to the Office of the State Engineer (NM OSE) Upper Gila Watershed Dam Site identification system. Figure A1, below, indicates the locations of the dams.

Site #	Canyon	Max. Surface Area (acres)	Max. Volume (acre feet)	Drainage area (acres)
1	Northrup	10	81	698
2	Rodriguez	2.5	17	122
3	Dominguez	3.7	29	211
4	Garcia	16	168	1290
5	Celso	6	37	294
6	Maldonado	14	158	1382
7	Woodrow	6	70	650
8	Clark	6	60	512
9	Doyle	6	65	525
10	Winn	53	795	9062
11	Bell	28	240	2778
12	Kartchner	8	84	774

Table A1

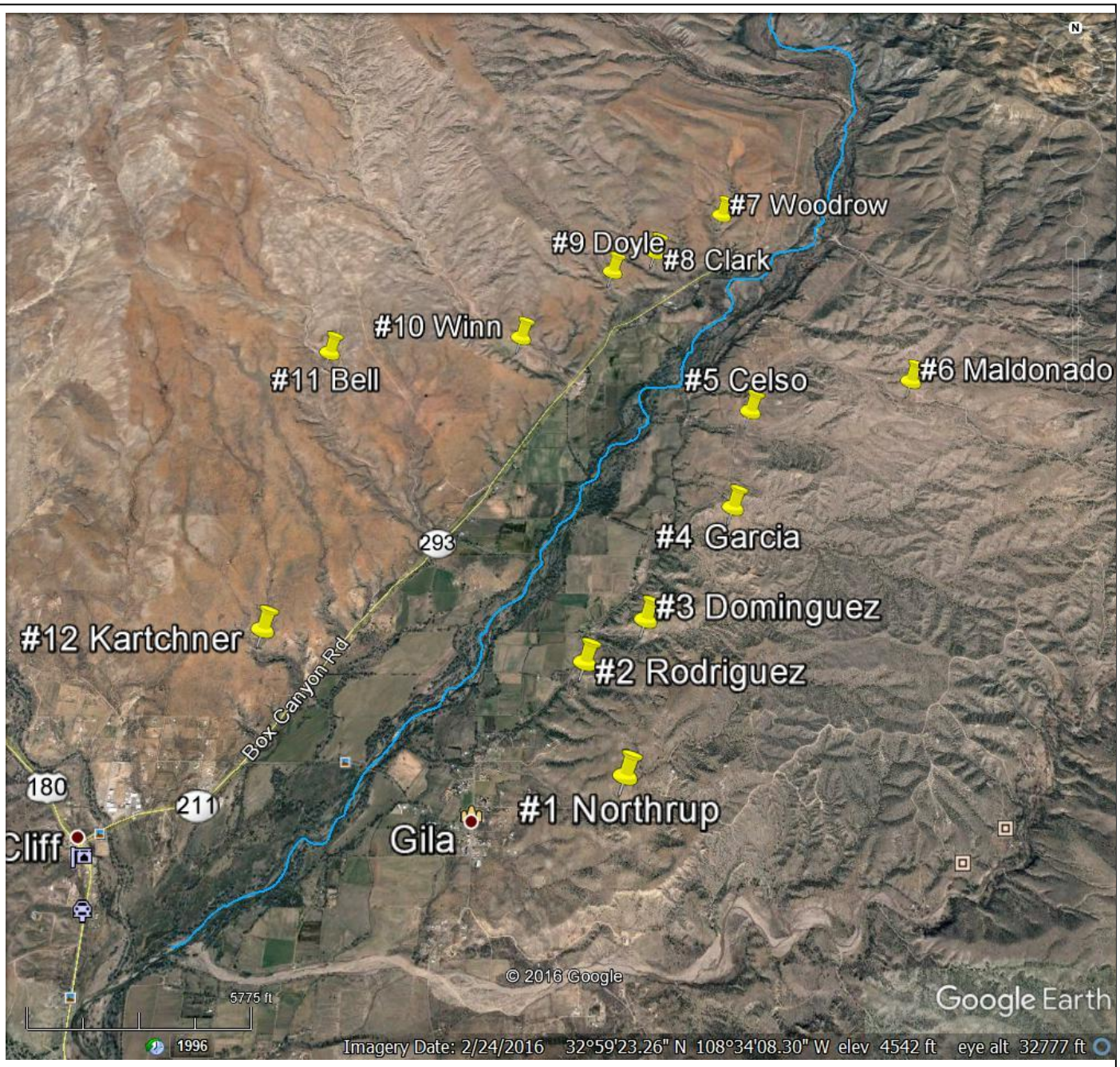

Figure A1. Google Earth image showing location of each dam. The towns of Cliff and Gila, NM are shown near the bottom of the picture. The blue line indicates the main channel of the Gila River.

Precipitation

Month	Average Precip	
January	1.15	inches
February	1.12	"
March	0.9	"
April	0.36	"
May	0.5	"
June	0.5	"
July	2.8	"
August	2.78	"
September	1.91	"
October	1.59	"
November	0.97	"
December	1.26	"
Total	15.84	"

Table A2. Average precipitation at Cliff, NM, based on over 50 years of data.

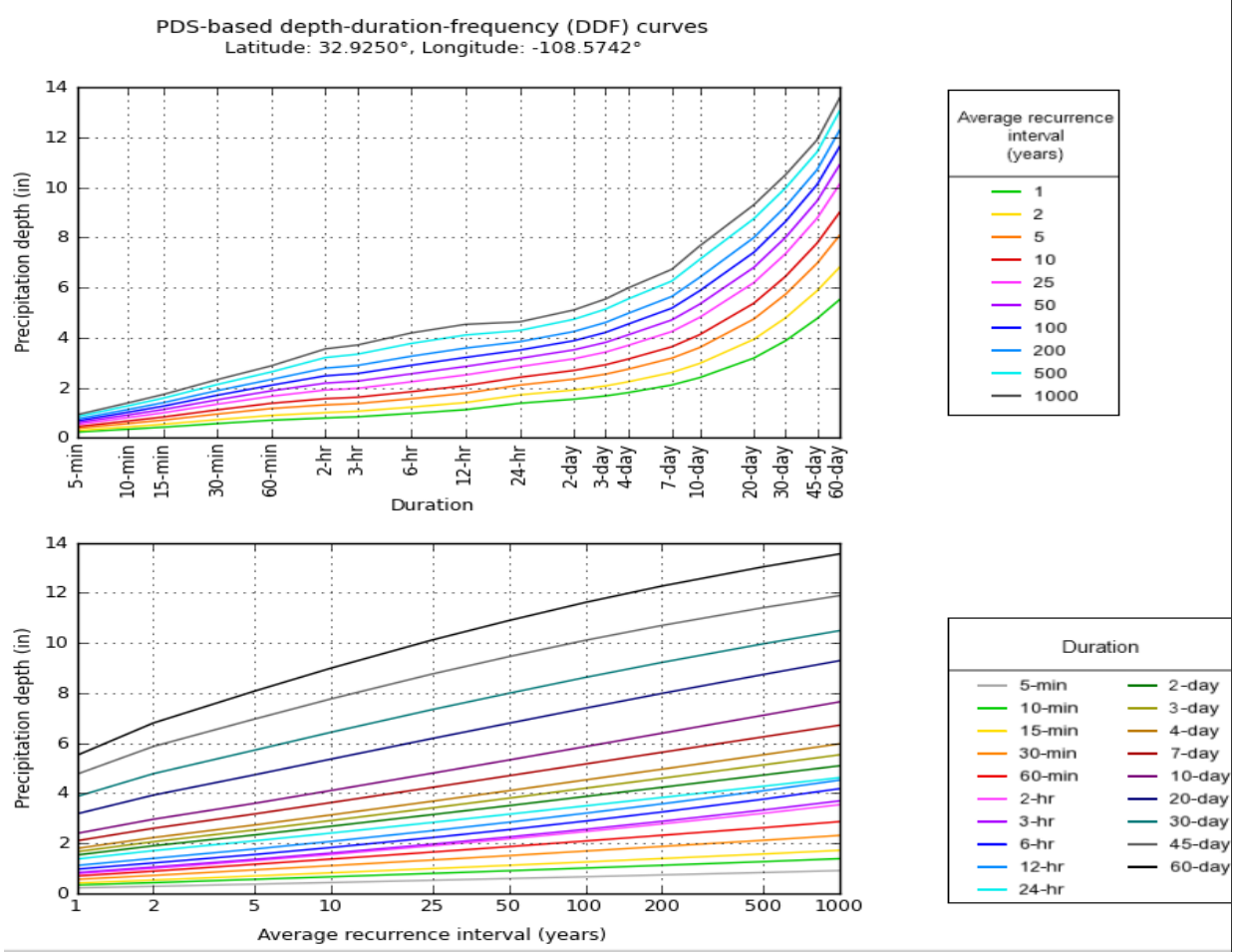

Figure A2. Depth-Duration-Frequency (DDF) curves from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

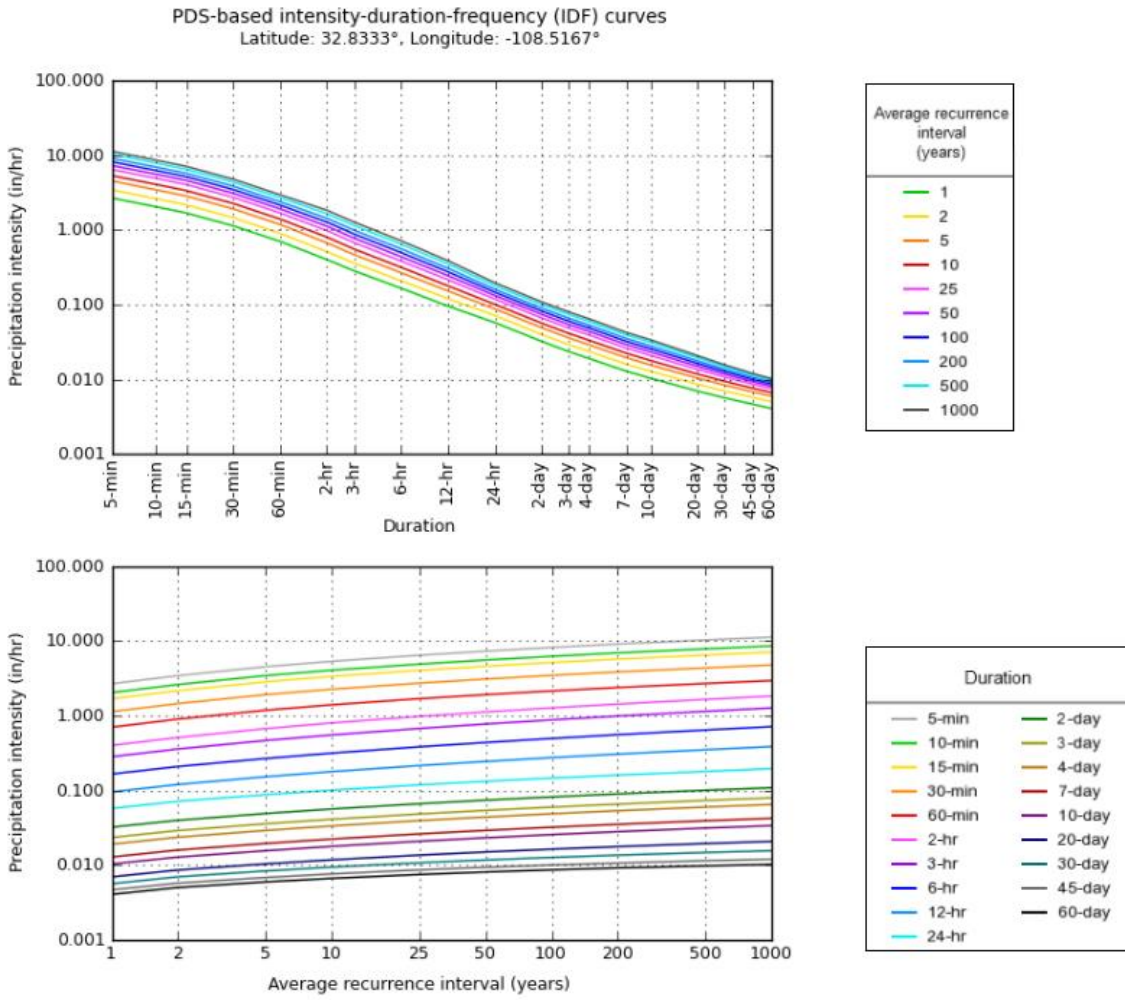

Figure A3. Intensity-Duration-Frequency (IDF) curves from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

Abstraction

Runoff curve numbers are used to quantify rainfall losses such as infiltration, interception and depression storage. Curve numbers are required input for the SCS rainfall runoff models used in the NMSHTD Drainage Manual: Simplified Peak Flow and SCS Unit Hydrograph methods. In practice, curve numbers range from about 40 to 100, with larger curve numbers representing more runoff. Factors such as land use, ground cover type, hydrologic condition and hydrologic soil group are used to select a curve number.

For each of the reservoirs in question, the following assumptions were used and the curve number is estimated to be between 63 and 77.

1. Ground cover density is 20%. With ground cover less than 30%, the condition would be considered "Poor."
2. Ground cover is primarily desert brush
3. Soil Group = A or B. Mostly sand with clay mixed in. Some rock.

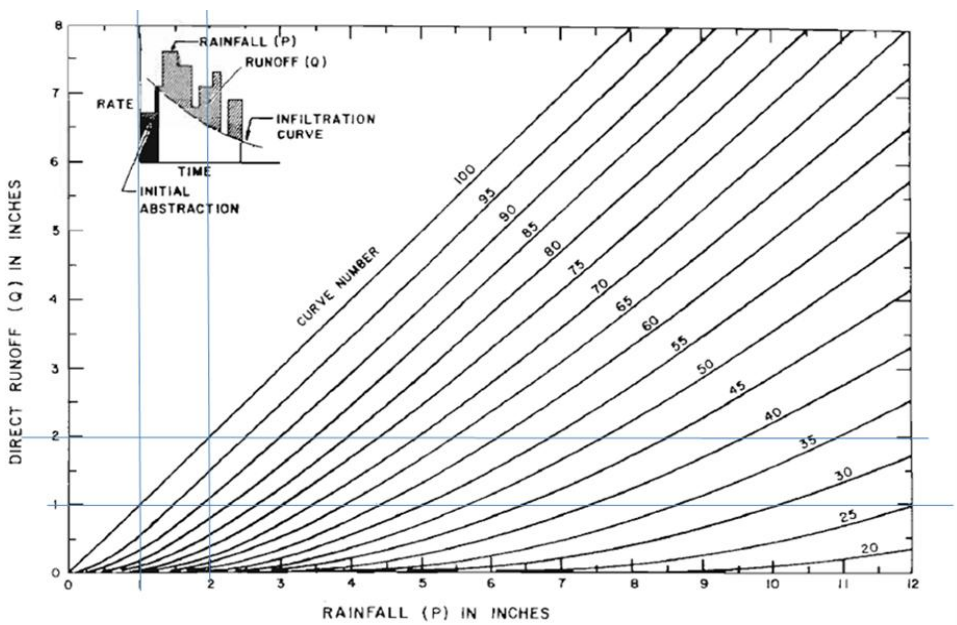

Figure A4. Curve numbers.

A different approach to applying the curve number method is to use the equations:

Equation A1 Equation A2

$$S = \frac{1000}{CN} - 10 \qquad V = \frac{(P - 0.2S)^2}{P + 0.8S}$$

For P>0.2S

Where S = abstraction, P= precipitation and V = volume of runoff. (Wurbs 2002).

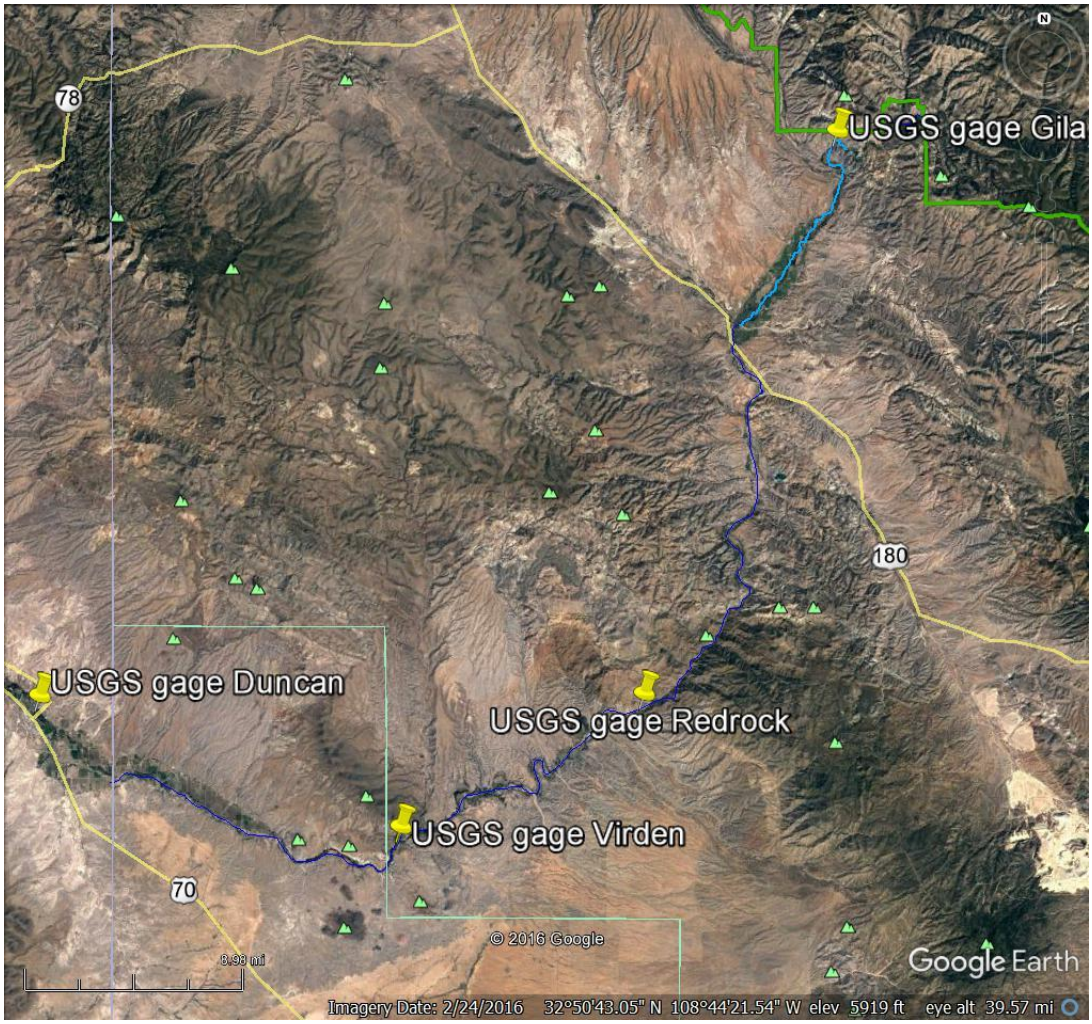

Figure A 5. Locations of gages. The USGS Gila Gila gage is located near the top of the image. The USGS Redrock gage is on the Gila River about 30 miles downstream from the Gila gage. The USGS Duncan gage is also on the Gila River, 30 miles downstream from Redrock. The reservoirs in consideration are located along the reach of river shown in turquoise. There are several creeks entering the Gila River downstream of the Gila gage, including Mogollon, Bear, Duck, Mangas, Sycamore and Blue. The only creek with a gage is Mogollon, and it is 11 miles from the confluence with the Gila.

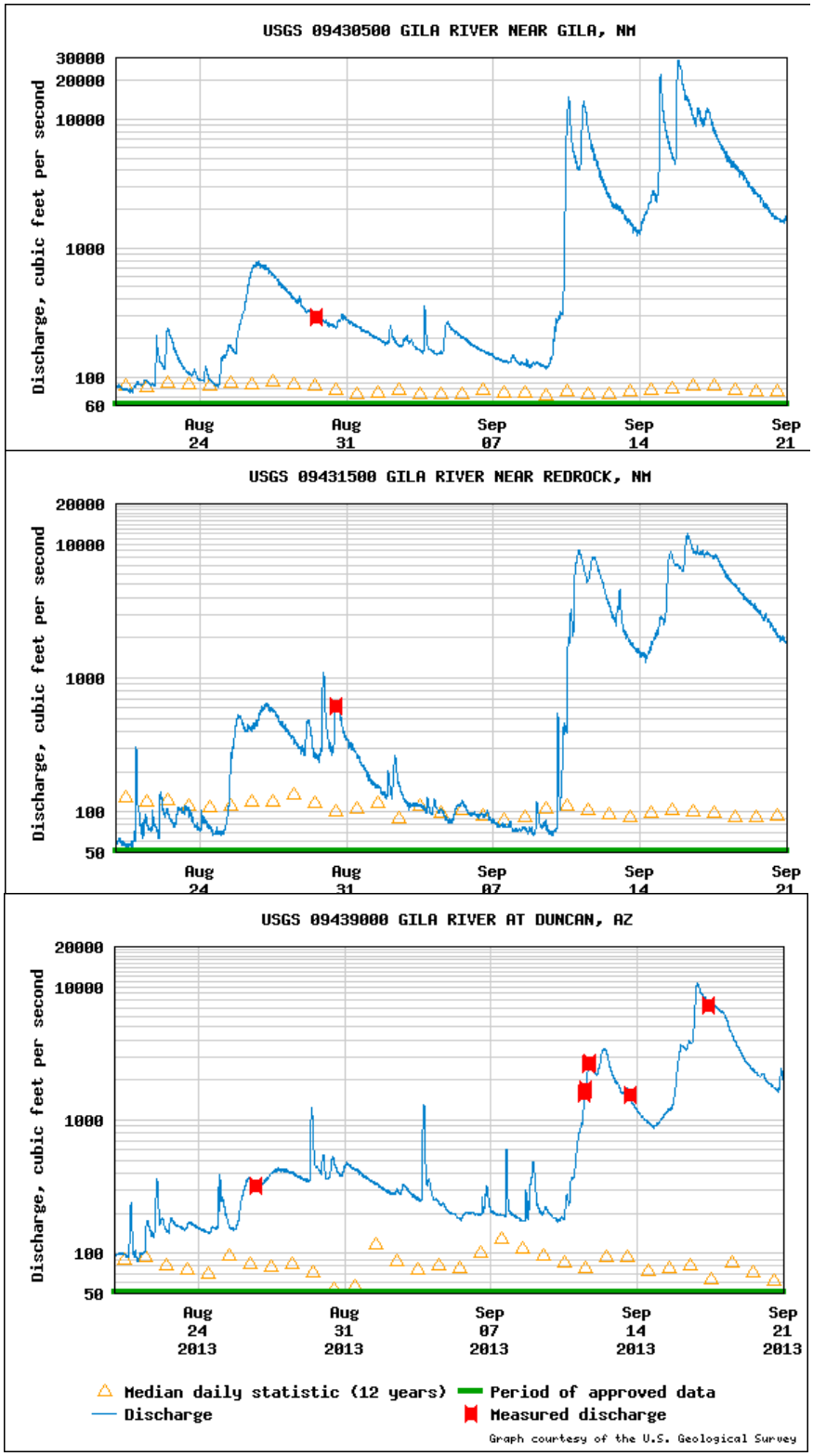

Figure A6 . Hydrographs from three (3) gages. In September 2013, record rain caused an extreme flood event reaching from Colorado to southern New Mexico. Three streamflow gages, covering sixty (60) miles , each show similar hydrographs.

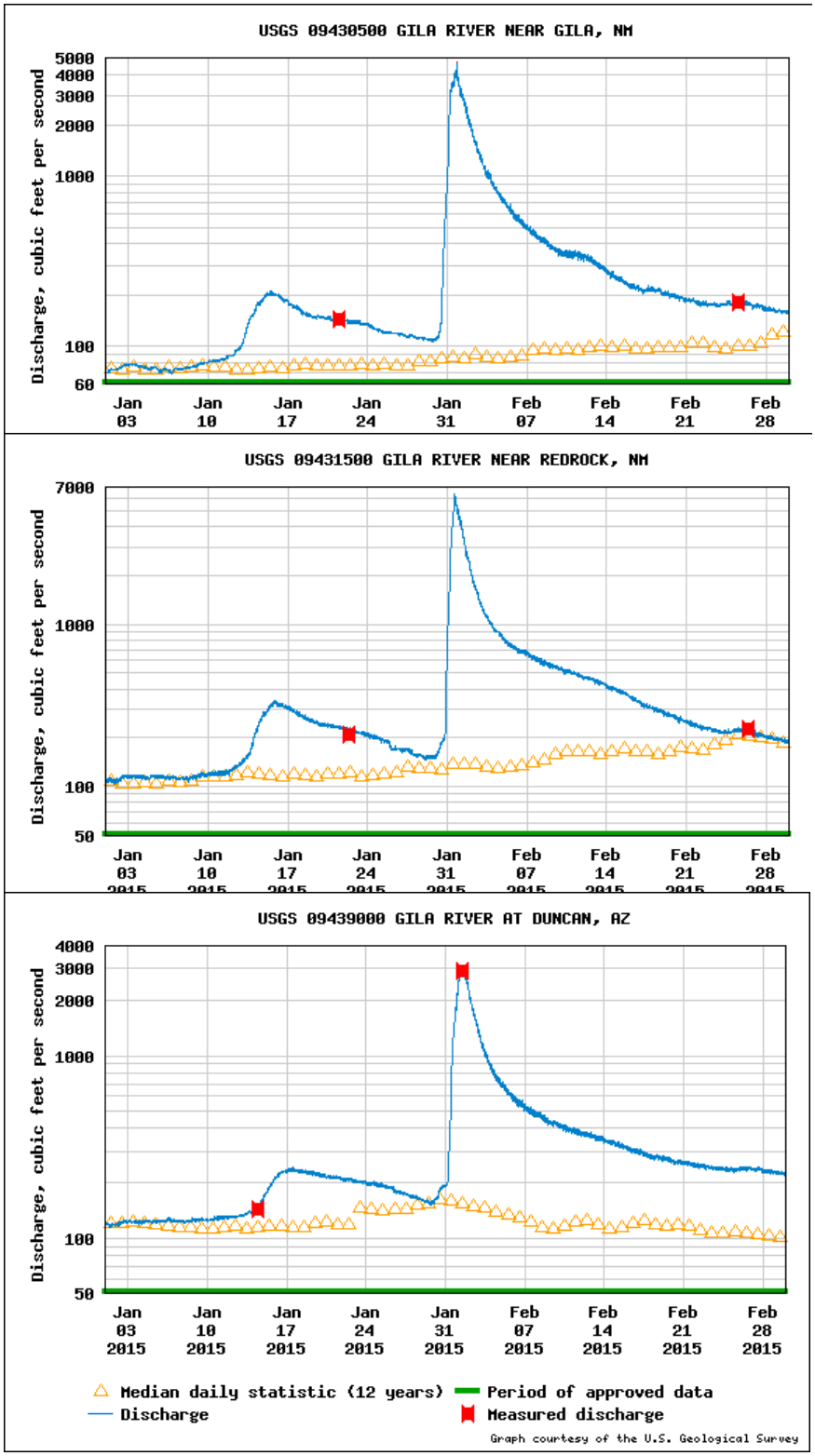

Figure A7 . Hydrographs from three (3) gages. In a rain event Jan 29-Feb 1, 2015, Solomon, AZ (thirty (30) miles from Duncan) received almost 2" of rain. Parts of southern NM received about 1". This was a more isolated event, both geographically and temporally, than the 2013 floods. Note how the hydrographs are still very similar in shape. (Wunderground.com)