

## MEMO

To: Craig Roepke

From: Helen Sobien

Date: September 21, 2016

This memo is in response to a request for a brief investigation of diverting water from Mogollon Creek and conveying, by gravity, to storage in Winn Canyon. This study considers a diversion structure located on the property of the 916 Ranch or the State of New Mexico, just downstream of the Gila Wilderness.

The map shown on the last page of this document details topography and property ownership near the west side of Mogollon Creek in Grant County, NM.

1. The contours illustrated focus on elevations between 1560 and 1540 meters.
2. Property ownership is shown in red. Names have been abbreviated to enhance the legibility of the map. While county maps provide good approximations of property boundaries, they are occasionally off by several yards. The heavy red line indicates the boundary of Wilderness and Roadless areas.
3. The dark area curving from the top left to the bottom right is the Mogollon Creek. In the bottom right corner, the dark, ox-bow loop of the Gila River is shown to help orient the reader. Also, the colored contours on the east side of the Creek are shown to help orient the reader.
4. The contours shown in pink and maroon indicate 1560 to 1550 meters elevation (5117 to 5084 feet.)
5. The contour shown in dark blue indicates 1540 meters elevation (5051 feet).

All of the following analysis would require ground surveys and geotechnical study for verification. Distances offered could vary considerably depending on the amount of earthwork done.

A possible location for a wier-type diversion structure is indicated by a yellow bar at the top left of the map, on State property near Lat-Lon coordinates 108°36'26.1"W 33°7'0.3"N. This location is far enough from the Wilderness Area to allow work to be done. It is about 4 ½ miles downstream from the USGS "Mogollon near Cliff" streamflow gauge.

If water was diverted from the Mogollon, at this location, it could be conveyed by buried pipe, along the west side of the Creek, through private property, by gravity, to Winn Canyon, which is indicated by the bright blue vertical line on ZBAR property and the white label.



Weir type diversion structure located near Virden, NM

The USBR Final Appraisal Level Report, dated July 2014, states that a reservoir that could hold 2750 acre feet could be built at Winn Canyon for \$83 million in Table ES-3 on page xv, including a contingency of 107%.

BHI Preliminary Engineering Report, April 2014, on page 5, and its Appendix G, states that a reservoir that could hold 6000 acre feet could be built for under \$25 million. This includes a 20% contingency. From the two estimates, the \$50 million estimate, shown below, was derived.

This same USBR Final Appraisal Level Report, on page 60, states that a 1200 foot long, 7 foot tall diversion structure could be built on the Gila River for \$9.3 million. From this, the estimate of \$8 million for a diversion on the Mogollon was derived.

	Cost/foot	Miles	Feet/mile		
pipe	\$ 500	10	5280		\$ 26,400,000
tunnel	\$ 3,000	0.25	5280		\$ 3,960,000
				Total Conveyance	\$ 30,360,000
				Diversion	\$ 8,000,000
				Reservoir	\$ 50,000,000
				<b>Total</b>	<b>\$ 88,360,000</b>

To avoid crossing the boundary into Wilderness or a Roadless area, one tunnel, about ¼ mile long, would be required. The location of this is shown with a light green line labeled “3.”

This conveyance would be about 10 miles long. Elevation drop required would be calculated by multiplying  $10 * 5280 * 0.0003 = 16$  feet, which could be accommodated in the contours shown. This alignment could be shortened to 7.3 miles by using tunnels indicated on the map.

- The yellow line labeled “1” indicates a possible tunnel 0.35 miles long which would eliminate 1.5 miles of pipeline.
- The bright green line labeled “2” indicates a possible tunnel 0.55 miles long which would eliminate 2.75 miles of pipeline.

Use of tunnels would allow for a steeper grade and possible cost savings. The route could be straightened further by using pipeline bridges across some of the gullies.

Further engineering design work should be done to determine the optimum balance of cost vs. capacity. A concrete pipeline with a smooth inner surface would allow water to flow faster. A steeper slope

would also allow the water to flow faster, but the elevation should not be allowed to drop below 5080 feet until the pipeline is very near Winn Canyon. The depth and velocity of the flow must also be considered to avoid supercritical flow conditions.

A preliminary calculation suggests that flow of 90 cfs could be achieved with a 6.5 foot diameter corrugated pipe, flowing 5.25 feet deep, at a slope of 0.00112. The flow velocity would be 3.1 feet per second, which is well below critical velocity. The elevation drop would be 59 feet if the 10 mile alignment was used, less if tunnels were employed.

Similar calculations with a 7 foot diameter pipeline yields 103 cfs with a flatter slope of 0.0009. Again, the flow velocity would be well below critical.

Pipeline costs, including excavation, backfill, compaction, and appurtenances, based on 2014 data:

- 48" diameter - \$304 per foot, or \$16,051,200 for 10 miles
- 60" diameter - \$379 per foot, or \$20,011,200 for 10 miles
- 72" diameter - \$420 per foot, or \$22,176,000 for 10 miles
- 78" diameter - \$473 per foot, or \$24,974,400 for 10 miles

Cost estimates for tunneling through hard rock in a remote area is \$3200 per foot. The area considered for this pipeline is easily accessible and the rock is not hard. However, there might be other challenges to tunneling in this area. Using this estimate, a 0.55 mile long tunnel would cost \$9,292,800. 2.75 miles of pipeline, would cost \$2 million less. However, by shortening the pathway, the pipeline alignment could be steeper, allowing for use of a smaller diameter pipeline to achieve the same flow rate.

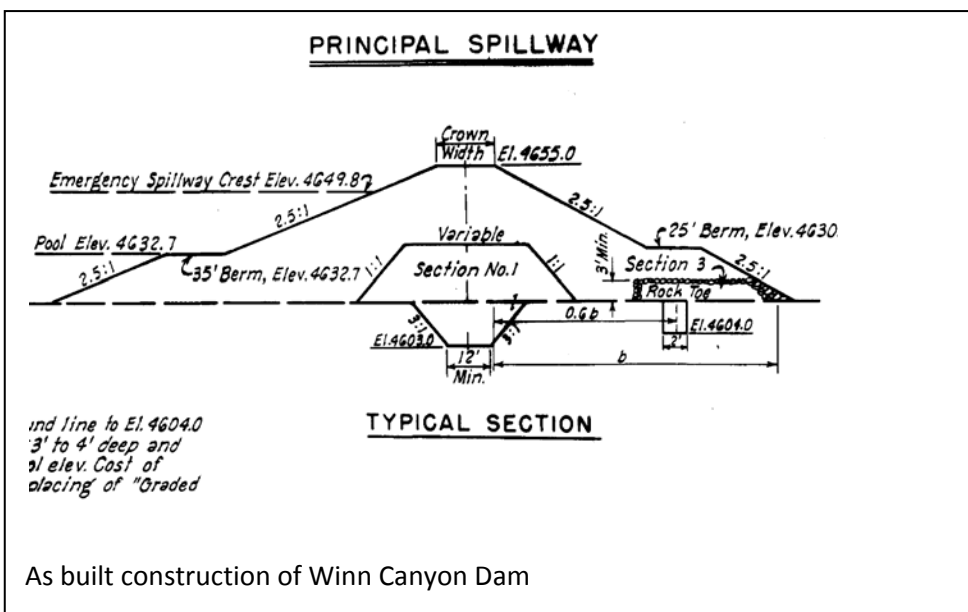
Data on the existing dam at Winn Canyon: It was designed to contain a 50-year flood with no discharge.

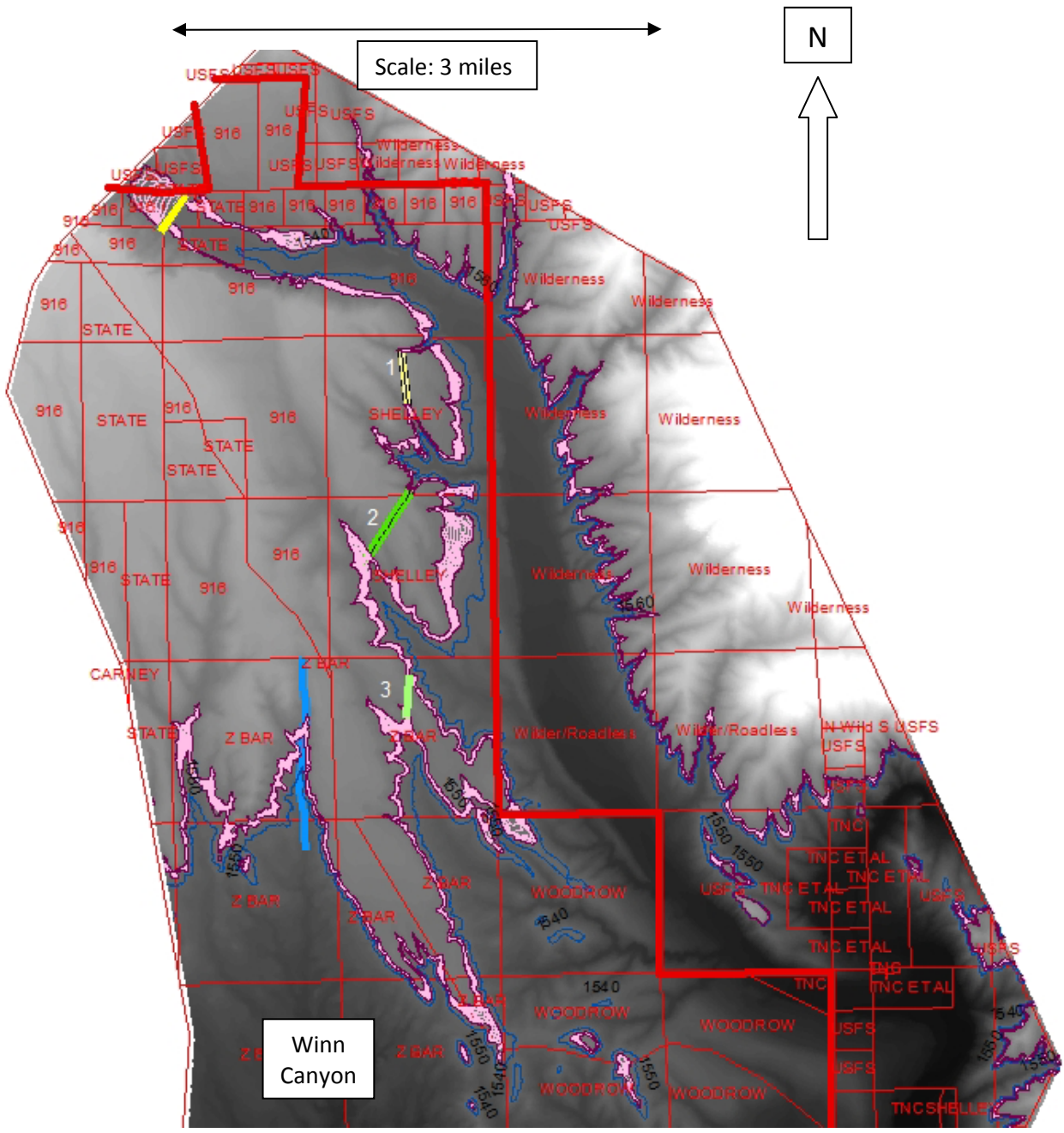
Built in 1962	Principal spillway invert (1 <sup>st</sup> port) elev. = 4613'
Height = 49'	Capacity at spillway = 795 acre feet
Length = 625'	
Crest width = 17'	
Emergency spillway width = 500'	
Emergency spillway elevation = 4649'	
Principal spillway elevation = 4633'	

RESERVOIR AREA - CAPACITY TABLE			
Elevation	Water Surface		Cumulative Storage
	Acres	Ac. Ft.	Inches Runoff
4656.0	65.09	1173.28	1.55
4652.5 *High Water Line	57.40	950.00	1.26
4652.0	56.67	929.76	1.23
4648.8 *Emergency Spillway	52.80	795.60	1.05
4648.0	48.97	718.48	.95
4644.0	40.66	539.24	.71
4640.0	29.83	396.30	.53
4636.0	25.59	287.46	.38
4632.7 *Sediment Pool	20.60	206.00	.27
4632.0	19.89	186.50	.25
4628.0	16.11	114.50	.15
4624.0	11.27	59.76	.08
4620.0	5.96	25.32	.03
4616.0	2.68	8.52	.01
4612.0	.75	1.48	.002

\*From curve

Area Capacity table from the As-Built drawings of Winn Canyon Reservoir provided by NRCS.





This map is based on NAD1927 terrain data and Grant County, NM tax records for 2016.