

**ZUNI
INDIAN RESERVATION**

ENGINEERING STUDIES

OF

LAND AND WATER RESOURCES

ZUNI PUEBLO AND RESERVATION LAND AND WATER RESOURCES

GENERAL

The Zuni Pueblo and Reservation is located in McKinley and Valencia Counties of New Mexico with the Arizona-New Mexico line forming the western boundary. Zuni Village is about thirty miles south of Gallup.

The irrigated lands are included in five separate units. These are Nutria, Pescado, Zuni, Tekapo and Ojo Caliente.

WATER SUPPLY

Water for irrigation of lands of the Zuni Pueblo Indians are obtained from surface streams and springs. Each unit has a somewhat different source and supply of water available as is shown in Table 1. Storage has been developed for all of the units except Nutria but the reservoirs on the main streams rapidly fill with sediment. At the present time, the combined storage capacity of the entire reservation is probably less than 5,700 acre-feet.

The U. S. Geological Survey has published streamflow data for the Zuni River at Blackrock for the period 1904 to 1930 as shown in Table 2, and presented graphically on Figure 1. These data show that streamflow is highly variable from year to year as well as within each year.

Measurements and estimates of spring flows were made on September 14, 1956 ^{1/} as follows:

Ojo Caliente

Measured spring flow	1.76 second-feet
Additional estimated	0.24 " "
Total	<u>2.00 second-feet</u>

Pescado

Large spring measured	0.54 second-feet
Second spring "	0.29 " "
Total	<u>0.83 second-feet</u>

Nutria

Measured above diversion dam	0.32 second-feet
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Growing season, May-September, and total annual precipitation for the period 1931 through 1955, are shown on Table 3. These values are presented graphically in Figure 2, and show a normal annual precipitation of about 12 inches with about one-half occurring during the growing season.

^{1/} Normally spring flows as of this date would have been near the low of record based on other hydrologic data.

LAND AREAS

The areas irrigated on the Zuni Pueblo and Reservation have been reported intermittently by the Indian Irrigation Service since the beginning of this century. The 1902 Annual Report of the Commissioner, reports 1,720 acres as being irrigated. Since that time, the area reported as irrigated has varied considerably from year to year, probably because of the variation in water supply. The available records on irrigated acreage and population are given in Table 4.

The irrigated and irrigable lands of the Zuni Pueblo Indians were mapped and classified in 1956. A summary of the results are given in Table 5.

WATER REQUIREMENTS

The irrigated and irrigable lands of the Zuni Pueblo and Reservation are in an area of relatively short growing season with considerable summer rainfall. In years of favorable precipitation, reasonably good crops of grain and corn can be grown without much irrigation. However, irrigation is needed most years for such crops and for the longer growing period crops, it is needed each year.

Water requirements were computed using the Blaney-Criddle method. It was assumed that cropping practices and yields will be improved in the future and that sufficient water will be made available so that a reasonable acreage of

alfalfa and other soil building crops can be included in the crop rotation. Soil building crops are considered necessary to maintain soil fertility and a permanent agriculture in any irrigated area.

It is assumed that non-agriculture uses of water on, and adjacent to the irrigated units will consist largely of culinary and stockwater. Approximately one percent of the water needed for irrigation was assumed required for this purpose.

Additional water will be consumed through evaporation from the storage reservoirs. The estimated annual quantities that will be lost from each reservoir is shown in Table 6.

A small part of the irrigation water supply comes from springs and is stored in small reservoirs. With the use of this stored water fairly close to the lands to be irrigated, conveyance losses should not be excessive. However, most of the lands do not have reservoirs close by to draw on. Thus, an overall project efficiency of 45 percent is considered reasonable under the conditions found on this reservation.

The computed water needs of Zuni Pueblo irrigated lands are given in Table 7.

Table 1. ZUNI PUEBLO AND RESERVATION
Summary of reservoir storage capacity

Unit	Water Source	Reservoir	Original storage constructed		Estimated reservoir capacity			
			Date	Capacity Ac.ft.	1940 Ac.ft.	1941 Ac.ft.	1954 Ac.ft.	1956 Ac.ft.
Nutria	Upper Nutria River		1932 ^{1/}	-	-	-	-	Over-night
Pescado	Springs and flood water diversions from Pescado Creek.	Pescado	1931	400	368	640	-	600
Zuni	Zuni River and tributaries including Nutria Creek.	Blackrock	1909	14817	2868	-	-	2000
		Nutria #2	1932	3062	3050 ^{2/}	-	-	1000
		Nutria #3	1934	1500	1067	-	-	700
		Nutria #4	1938	880	-	-	-	800
Tekapo	Zuni River and tributaries.	Tekapo	1937	400	330	-	-	200
Ojo Caliente	Ojo Caliente Springs	Ojo Caliente	1937	273	273	-	325	325

Note: Pescado, Blackrock and Nutria No. 2, have been partially reconstructed causing changes in capacity. Silt accumulations have decreased the water storage capacity on all except Ojo Caliente which is spring-fed.

^{1/} Originally constructed as a diversion dam later raised some but only limited storage capacity.

This replaced an earlier structure built at another point on the stream in 1922.

^{2/} This capacity was increased from 2000 to 3050 in 1939 with the raising of the dam.

Table 2. ZUNI PUEBLO AND RESERVATION

Runoff of Zuni River at Blackrock, New Mexico
From USGS Water-Supply Paper 1313

699, Zuni River at Blackrock, N. Mex.

Location.--Lat 35°06', long. 108°47', in sec. 18, T. 10 N., R. 18 W., at dam forming Blackrock Reservoir on Zuni River, at Blackrock on Zuni Indian Reservation, 4 miles northeast of Zuni, and 4 1/2 mi downstream from Nutria Creek.

Drainage area.--682 sq mi.
Determination of discharge.--Prior to July 1, 1905, records obtained by the usual methods of stream gaging. Runoff for years ending June 30, 1906-8, estimated by Office of Indian Affairs. Records after July 1, 1905, based on change in contents of Blackrock Reservoir, taking into account the quantity of water released from reservoir, but not taking into account seepage and evaporation.

Average discharge.--27 years (1903-30), 26.8 cfs (years 1903-10 are from July 1 to June 30).

Extremes.--1903-30: Maximum discharge observed, mean flow of 1,300 cfs for 21 hr Sept. 5-6, 1906; no flow for long periods each year.

Remarks.--Storage in basin above Blackrock Reservoir was reduced from a maximum of more than 20,000 acre-ft to less than 5,000 acre-ft by 1944 as a result of flood damage and sedimentation. Storage in Blackrock Reservoir began in 1908; original capacity of the reservoir was 15,800 acre-ft, but this had been reduced to about 2,600 acre-ft in 1944. Diversions for irrigation of about 700 acres above Blackrock Reservoir in 1944.

Cooperation.--Records of monthly and yearly acre-feet furnished by Office of Indian Affairs.

Monthly and yearly mean discharge, in second-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1911	0	0	0	21.6	21.6	04.6	0	0	145	27.0	19.8	28.7	
1912	21.2	0	0	0	0	2.7	4.7	0	0	29.3	17.9	0	0.9
1913	2.8	0	0	0	1.6	22.4	24.7	0	0	22.4	4.9	00.5	11.7
1914	25.8	2.0	0	28.5	28.8	24.4	13.4	10.5	3.4	117	13.0	8.4	31.7
1915	7.3	0	2.1	0	22.3	43.4	251	22.6	32.8	22.4	12.4	16.0	77.0
1916	0	0	0	21.5	149	229	20.3	1.0	0	23.4	22.8	22.2	20.9
1917	288	0	0	7	12.8	20.0	2.2	2.2	1.8	0	0	0	36.6
1918	1.7	0	0	7	15.8	20.2	0	0	0	14.5	12.8	3.6	6.7
1919	2.8	0	0	1.6	7	2.5	22.5	17.5	0	0	240	11.7	23.2
1920	2.3	0	16.2	42.3	47.6	7.8	22.4	0	16.5	5.5	10.2	8.3	10.2
1921	0	0	0	3.1	2.3	1.0	0	3.6	0	23.5	3.7	4.7	2.4
1922	0	0	0	0	6.1	1.1	3.1	3.1	2.8	3.4	12.1	4.5	3.2
1923	2.5	0	0	3.0	14.8	22.4	1.7	0	0	6.0	23.4	144	24.4
1924	1	11.4	32.9	0	12.0	2.8	22.0	7.4	0	3.3	19.5	3.5	12.4
1925	.3	0	0	0	1.3	2.2	2.2	2.0	1.0	22.4	22.6	17.0	7.1
1926	1.4	0	0	7	4.3	11.7	11.2	2.0	0	10.3	11.1	22.2	6.9
1927	0	0	1.0	2.5	33.1	112	0	2.7	0	12.2	12.5	70.5	22.2
1928	0	0	0	0	72.2	223	245	5.0	0	22.2	2.8	0	72.2
1929	0	0	0	0	3.1	30.9	35.0	3.4	0	0	32.8	5.9	2.6
1930	120	1.8	0	0	1.6	22.4	0	0	11.2	12.2	2.4	0	21.3

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1911	0	0	0	1,340	1,200	5,200	0	0	0	2,220	1,250	750	12,000
1912	1,540	0	0	0	0	350	400	0	0	1,500	1,100	0	5,040
1913	380	0	0	0	20	1,320	1,470	0	0	1,320	200	3,420	6,480
1914	2,200	120	80	1,750	2,220	5,100	200	1,200	200	7,200	200	500	22,940
1915	450	0	130	42	1,600	22,220	13,740	5,020	1,940	1,300	700	955	52,770
1916	0	30	10	2,010	2,270	20,220	4,720	60	0	1,440	1,220	1,320	42,720
1917	22,070	28	0	40	712	1,220	324	134	22	22	22	22	22,722
1918	102	0	0	40	220	1,240	0	22	22	22	22	22	4,220
1919	240	25	100	40	140	2,020	1,040	0	0	22,220	14,720	227	42,770
1920	220	0	220	2,220	2,720	22,220	1,210	0	220	342	220	372	11,020
1921	0	10	10	120	220	22	22	220	122	2,120	227	220	2,720
1922	0	0	0	220	220	22	22	222	222	222	222	222	2,220
1923	122	22	122	122	222	1,220	102	0	0	222	2,720	2,220	17,020
1924	7	220	2,220	0	222	2,020	222	222	222	222	222	222	11,020
1925	12	0	27	0	70	220	10	122	22	1,220	1,220	1,020	2,120
1926	22	0	0	40	222	222	222	222	0	222	222	1,220	2,020
1927	0	0	22	222	1,240	7,220	0	222	0	222	222	4,220	12,020
1928	0	0	0	0	4,220	34,020	14,220	222	0	1,220	222	0	22,220
1929	0	0	0	0	171	1,220	2,020	207	0	0	2,220	320	2,220
1930	2,010	22	0	0	22	2,220	0	0	222	1,040	222	0	12,420

Yearly discharge, in second-feet, of Zuni River at Blackrock, N. Mex.

Year	U.S.P. no.	Water year ending Sept. 30				Calendar year		
		Momentary maximum		Minimum day	Mean	Runoff in acre-feet	Mean	Runoff in acre-feet
		Discharge	Date					
1904	152	-	-	-	19.3	11,000	-	-
1905	152	-	-	-	127	41,600	-	-
1906	159	-	-	-	7.5	2,500	-	-
1907	159	-	-	-	2.1	2,200	-	-
1908	159	-	-	-	7.7	2,600	-	-
1909	159	-	-	-	17.5	12,700	-	-
1910	159	-	-	-	15.5	11,200	-	-
1911	159	-	-	-	26.2	12,220	22.1	20,370
1912	159	-	-	-	6.9	2,220	5.6	4,010
1913	159	-	-	-	11.7	2,220	11.5	10,470
1914	159	-	-	-	31.7	22,220	29.2	21,220
1915	159	-	-	-	77.0	52,770	74.3	52,220
1916	159	-	-	-	22.9	22,710	22.3	22,220
1917	159	-	-	-	12.7	22,720	12.7	22,220
1918	179	-	-	-	2.7	2,220	2.7	2,220
1919	159	-	-	-	22.2	22,770	22.2	22,220
1920	159	-	-	-	12.2	11,020	12.2	9,660
1921	229	-	-	-	9.2	2,720	9.2	2,720
1922	229	-	-	-	1.2	2,220	1.2	2,220
1923	229	-	-	-	22.4	12,220	22.2	20,120
1924	229	-	-	-	16.4	11,220	12.2	22,220
1925	229	-	-	-	7.1	2,120	7.1	2,120
1926	229	-	-	-	6.9	2,020	6.9	2,220
1927	229	-	-	-	22.2	12,020	22.2	12,020
1928	229	-	-	-	72.2	52,220	72.2	52,220
1929	229	-	-	-	9.6	2,220	20.2	12,070
1930	722	-	-	-	21.3	12,420	-	-

a For year ending June 30.

Table 3. ZUMI PUEBLO AND RESERVATION

Growing season rainfall by months and total annual precipitation at Zuni CAA Airport ^{1/}
in inches, 1931-1955

Cal. Year	May	June	July	Aug.	Sept.	Total May-Sept.	Total annual
1931	.12	.82	3.29	1.75	2.17	8.15	16.84
1932	.08	.08	3.64	1.98	.28	6.06	12.79
1933	.25	.77	2.94	.92	1.70	6.58	12.46
1934	1.70	.33	1.18	3.68	1.01	7.90	14.21
1935	1.27	.02	1.15	2.14	.61	5.19	11.43
1936	.68	.49	1.14	4.15	1.13	7.59	13.89
1937	.77	.89	3.15	.61	1.19	6.61	11.60
1938	.42	1.36	.35	.80	1.30	4.23	8.87
1939	.02	T	.75	.66	1.39	2.82	7.84
1940	.49	.67	1.00	2.09	2.89	7.14	17.26
1941	1.19	.35	1.09	1.16	3.34	7.13	19.53
1942	0	0	.99	1.59	1.26	3.84	9.60
1943	.48	1.17	1.02	1.64	.54	4.85	9.38
1944	.49	.06	1.62	1.89	1.48	5.54	9.43
1945	T	.10	1.53	2.27	.05	3.95	8.63
1946	0	0	1.07	-	1.82	-	-
1947	1.40	.52	1.43	-	.36	-	-
1948	.34	.64	1.27	.73	1.49	4.47	10.60
1949	.11	1.21	2.14	1.22	1.42	6.10	11.22
1950	T	.18	1.39	.07	.74	2.38	4.41
1951	.12	T	.88	1.70	.40	3.10	7.67
1952	.17	1.16	1.54	2.67	.88	6.42	12.65
1953	.35	.31	.57	.73	T	1.96	5.24
1954	.88	.09	2.12	.63	1.48	5.20	9.76
1955	.20	.74	2.68	2.64	.02	6.28	9.31
Normal ^{2/}	.54	.45	2.19	1.80	1.30	6.28	11.96

Source: Climatological Data Summaries published by the Weather Bureau, U.S. Department of Commerce.

^{1/} Known as Black Rock prior to July 1949.

^{2/} As published in 1955 Annual Summary, Climatological Data, New Mexico.

Table 4. ZUNI PUEBLO AND RESERVATION
Summary of land areas, population and irrigation water diversions

Year	Total population No.	Families No.	Total area 2/ irrigated Acres	DUIT							
				Zuni		Nuhria		Pocampo		Tekeop	Ojo Caliente
				Area 1/ irrigated Acres	Irrigation water div. 4/ Ac.ft.	Area 2/ irrigated Acres	Area 3/ irrigated Acres	Irrigation water div. 6/ Ac.ft.	Area 2/ irrigated Acres	Area 2/ irrigated Acres	Area 2/ irrigated Acres
1902	1540	-	1720	-	-	-	-	-	-	-	
1903	1547	-	1720	-	-	-	-	-	-	-	
1909	1666	-	-	800	-	-	-	-	-	-	
1910	1640	-	-	1800	-	-	-	-	-	-	
1911	1570	300	-	2400	-	-	-	-	-	-	
1912	1589	400	-	3000	-	-	-	-	-	-	
1913	1616	400	-	4000	-	-	-	-	-	-	
1914	1602	400	-	5000	5874	-	-	-	-	-	
1915	1603	900	-	5060	4818	-	-	-	-	-	
1916	1805	900	-	5120	1656	-	-	-	-	-	
1917	1803	600	-	3532	4544	-	-	-	-	-	
1918	1815	900	-	3640	-	-	-	-	-	-	
1919	1816	900	-	5120	-	-	-	-	-	-	
1920	1813	-	-	4190	-	-	-	-	-	-	
1921	1863	-	-	3897	1442	-	-	-	-	-	
1922	1902	-	7/	2972	5846	-	-	-	-	-	
1923	1911	-	-	3910	4170	-	-	-	-	-	
1924	1949	-	5085	3885	-	-	-	-	-	-	
1925	1932	-	-	1783	-	-	-	-	-	-	
1926	1884	-	3748	2523	4766	-	-	-	-	-	
1927	1883	216	-	2686	-	-	-	-	-	-	
1928	1888	387	-	2687	4321	-	-	-	-	-	
1929	1932	387	-	2701	-	-	-	-	-	-	
1930	1952	246	2697	1010	-	-	-	-	-	-	
1931	1963	218	-	1383	1915	-	-	-	-	-	
1932	1991	220	2116 8/	1443	2226	256	379	314	0	-	
1933	2021	220	2114	1380	2772	261	388	161	0	285	
1934	2051	512	1608	1018	4223	199	228	244	0	163	
1935	2055	480	2241	-	-	-	-	-	-	-	
1936	2100	480	2116	-	2767	-	-	286	-	-	
1937	2080	444	2391	1347	4852	159	385	-	225	275	
1938	2180	592	2410	1285	3400	175	408	189	239	303	
1939	2220	672	2485	1326	1895	180	421	541	241	317	
1940	2205	570	2511	-	-	-	-	-	-	-	
1941	2252	570	2725	-	-	-	-	-	-	-	
1942	2279	487	2833	1525	-	313	424	-	203	368	
1943	2320	487	2673	-	-	-	-	-	-	-	
1944	2406	487	2217	-	-	-	-	-	-	-	
1945	2443	487	2143	-	-	-	-	-	-	-	
1946	2475	487	2139	-	-	-	-	-	-	-	
1947	2575	487	2372	1272	-	196	358	-	119	427	
1948	2700	487	2740	1523	-	211	386	-	142	478	
1949	2843	-	2904	1620	-	239	402	-	153	490	
1950	2922	-	2735	1531	-	223	383	-	136	462	
1951	2989	-	-	-	-	-	-	-	-	-	
1952	3099	-	2297	-	-	-	-	-	-	-	
1953	3204	-	1770	-	-	-	-	-	-	-	
1954	3316	-	-	-	-	-	-	-	-	-	
1955	3439	-	2475	-	-	-	-	-	-	-	

Sources:

- 1/ 1911 to 1919 from Annual Reports of Commissioner of Indian Affairs.
- 1927 to 1928 from Miscellaneous Irrigation Data of Indian Irrigation Projects.
- 1939 to 1948 from United Pueblos Agency Annual Reports.
- 2/ 1902 and 1903 from Annual Reports of Commissioner of Indian Affairs.
- 1930 from Miscellaneous Irrigation Data of Indian Irrigation Projects.
- 1924 and 1926 partially estimated from Annual Irrigation Crop Reports.
- 1932 to 1938, 1940 to 1945, 1947 to 1950, 1952, 1953, and 1955 from Annual Irrigation Crop Reports.
- 1939 and 1946 from United Pueblos Agency Annual Reports.
- 3/ 1909 to 1916 and 1919 from Annual Reports of Commissioner of Indian Affairs.
- 1920 from Miscellaneous Irrigation Data of Indian Irrigation Projects.
- Remaining values from Annual Irrigation Crop Reports.
- 4/ 1914 to 1917, 1931 to 1934, and 1936 to 1939 from records on file at United Pueblos Agency.
- 1921 to 1923, 1926 and 1928, from District 35 Annual Reports.
- 5/ From Annual Irrigation Crop Reports.
- 6/ From records on file at United Pueblos Agency. Values shown for storage water only. In addition, springs supply continuous flow (0.83 cfs measured September 14 & 15, 1956).
- 7/ Total area cultivated was 7,075 acres, part of which was dry farmed.
- 8/ Does not include acreage for Ojo Caliente Unit.

Table 5. ZUNI PUEBLO AND RESERVATION
Irrigated and irrigable lands of various units

Unit	Irrig- gated <u>Acres</u>	Irrig.under cons.works <u>Acres</u>	Irrigable no works <u>Acres</u>	Total <u>Acres</u>
Nutria	562	140	0	702
Pescado	827	253	0	1080
Zuni	3260	815	818	4893
Tekapo	275	1	0	276
Ojo Caliente	973	646	0	1619
Total	5897	1855	818	8570

Table 6. ZUNI PUEBLO AND RESERVATION

Summary of reservoir data

Reservoir	Water surface area		Net evaporation rate per year 3/	Net evaporation loss annually
	Maximum 1/	Yearly av. 2/		
	Acres	Acres	Feet	Acre-feet
Nutria No. 1	39	20	3.4	68
Nutria No. 2	400	200	3.4	680
Nutria No. 3	264	140	3.4	476
Nutria No. 4	88	75	3.4	255
Ojo Caliente	42	35	3.4	119
Pescado	140	50	3.4	170
Tekapo	127	50	3.4	170
Blackrock	413	100	3.4	340
			Total	2278

1/ Planimetered from project maps.

2/ Rough estimate.

3/ Estimated evaporation minus effective rainfall.

Table 7. ZUNI PUEBLO AND RESERVATION

Computed water requirement

Item	Unit					Total
	Nutria	Pescado	Zuni	Tekapo	Ojo Caliente	
1. Irrigated & irrigable area, Ac.	702	1080	4893	276	1619	8570
2. Consumptive use, acre-feet						
a. Irrigation requirement <u>1/</u>	913	1404	6361	359	2105	11142
b. Non-agricultural use <u>2/</u>	9	14	64	4	21	112
c. Sub-total <u>3/</u>	922	1418	6425	363	2126	11254
d. Reservoir evaporation (Net) <u>4/</u>	68	170	1751	170	119	2278
e. TOTAL	990	1588	8176	533	2245	13532
3. Diversion requirement						
a. Irrigation and non-agr. <u>6/</u>	2049	3151	14278	807	4724	25009
b. Reservoir evaporation	68	170	1751	170	119	2278
c. TOTAL	2117	3321	16029	977	4843	27287

1/ Assumes a net consumptive irrigation requirement of 1.30 acre-feet per acre.

2/ Considered to be one percent of irrigation needs.

3/ Evaporation minus effective rainfall.

4/ Nutria No. 1 only.

5/ Includes Blackrock and Nutria Nos. 2, 3 and 4.

6/ Overall project efficiency = 45 percent

Figure 1. ZUNI PUEBLO AND RESERVATION
 ANNUAL RUNOFF, ZUNI RIVER AT BLACKROCK, NEW MEXICO

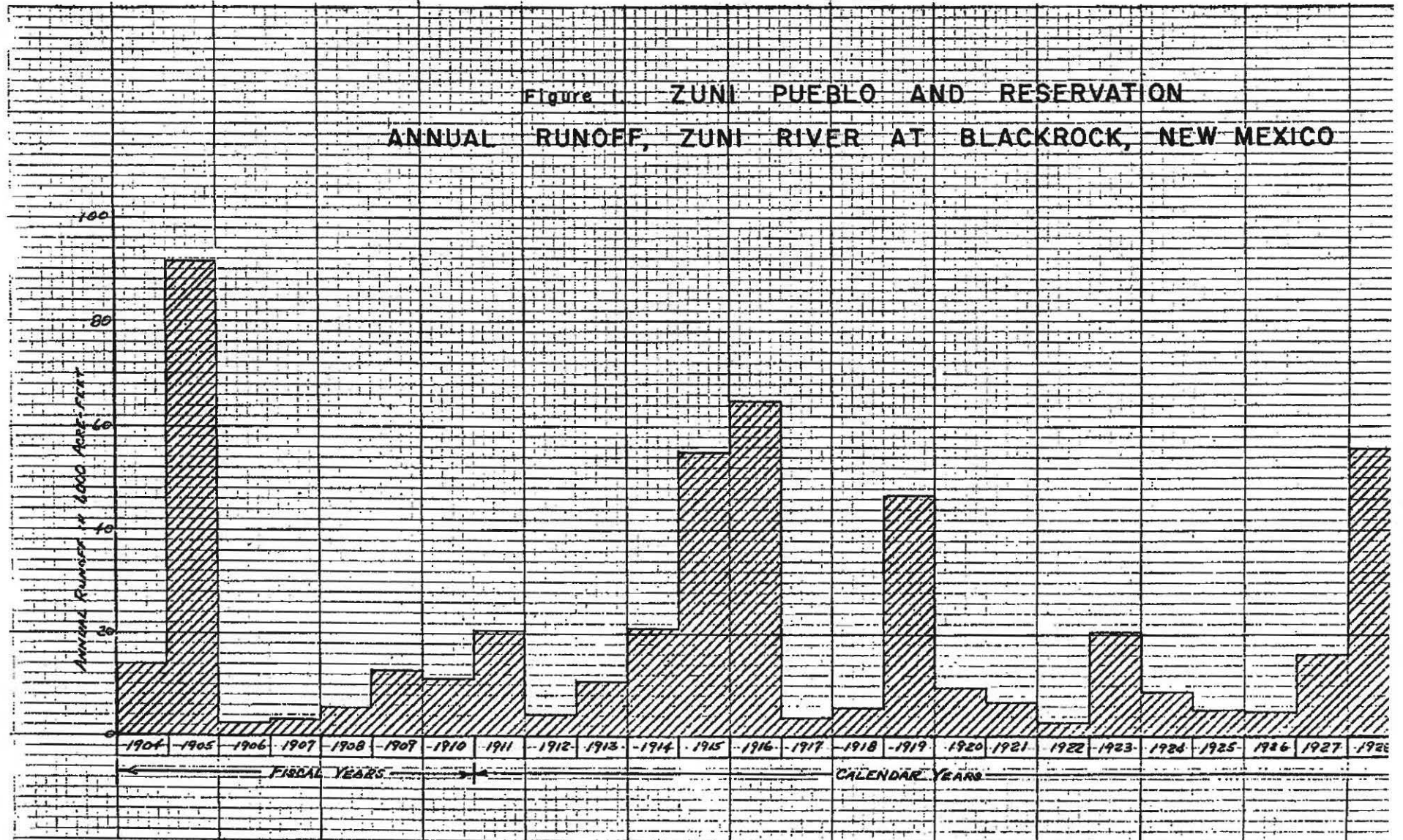


Figure 2. ZUNI PUEBLO AND RESERVATION
 GROWING SEASON AND TOTAL ANNUAL PRECIPITATION
 ZUNI CAA AIRPORT

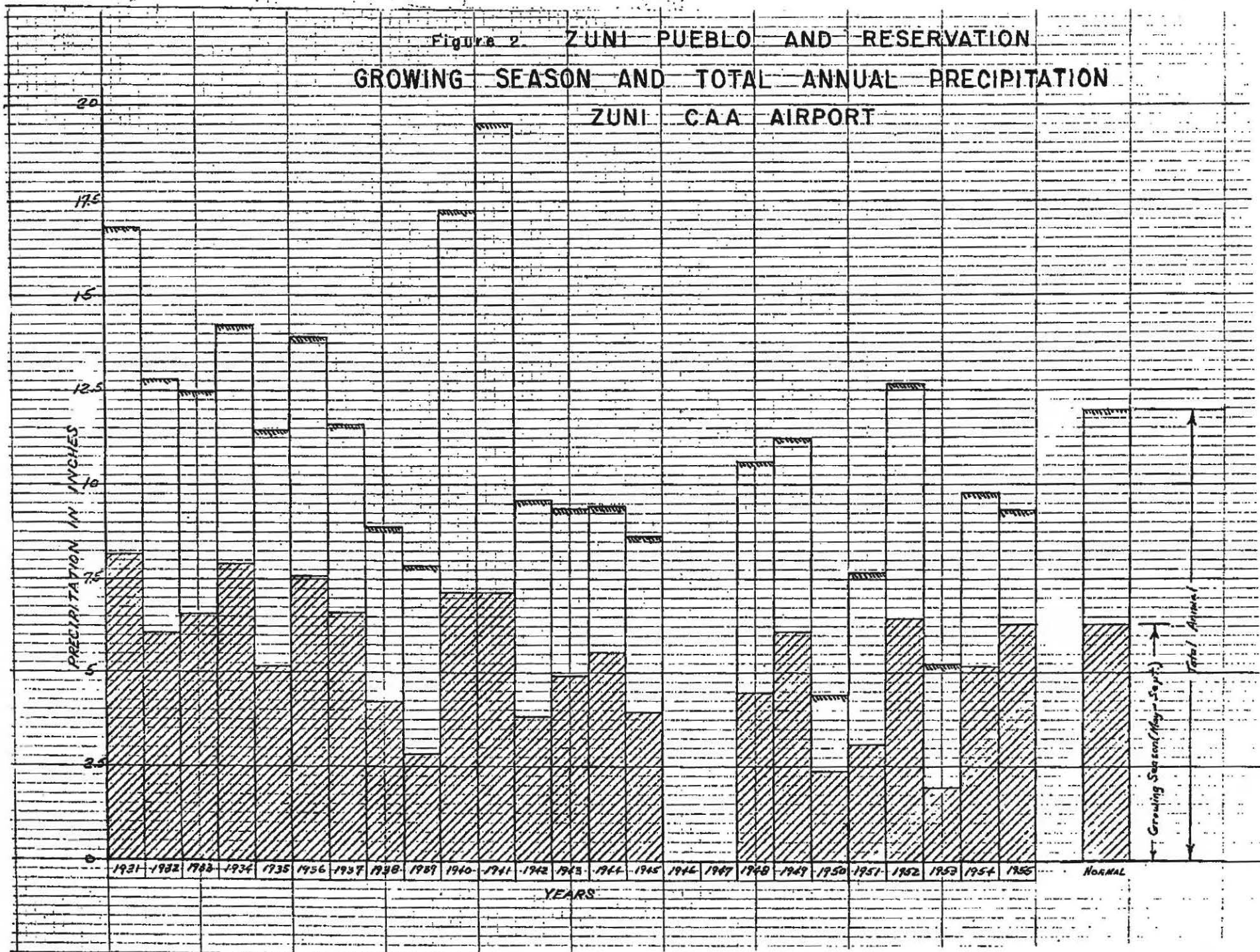
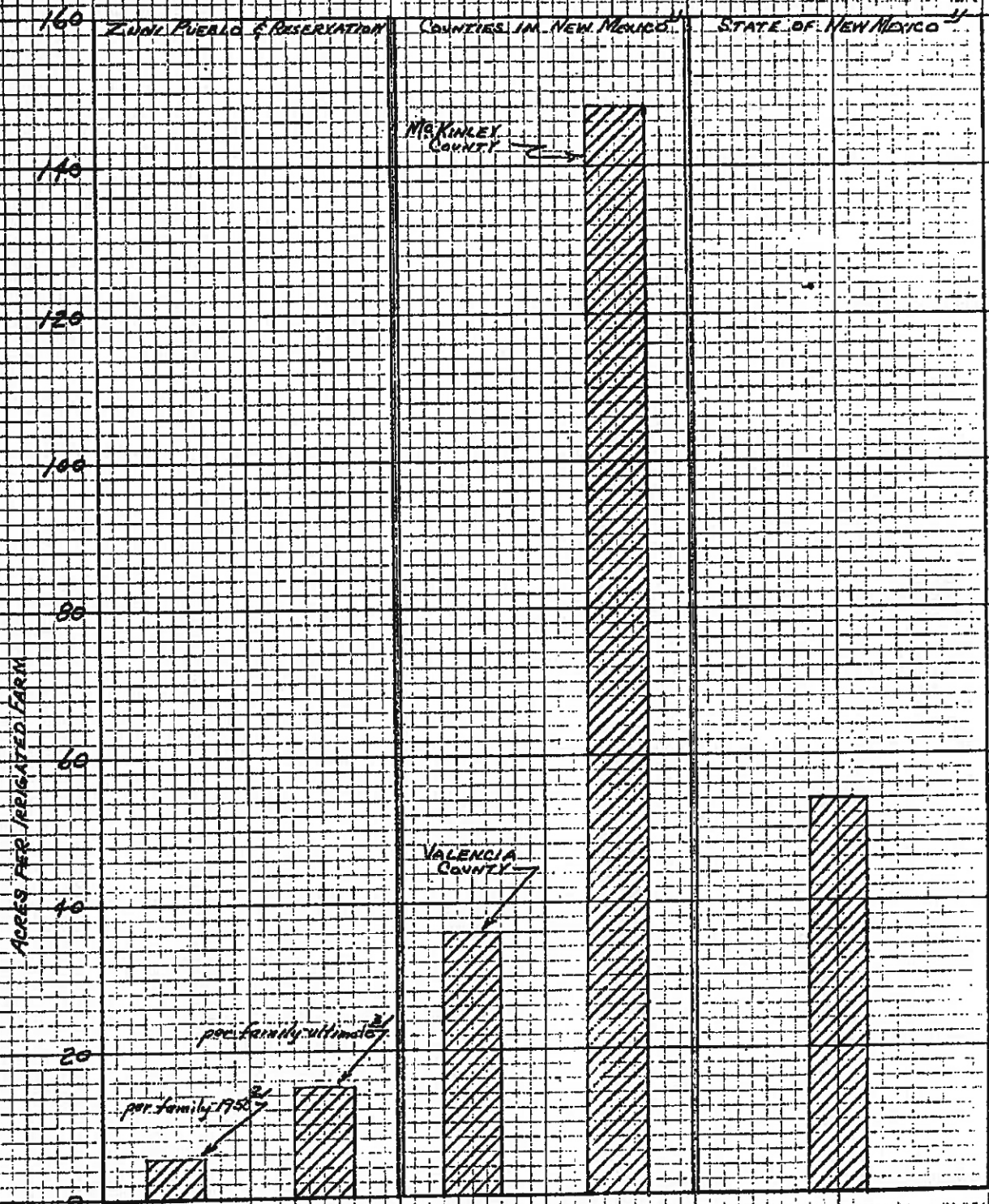


Figure 3. ZUNI PUEBLO AND RESERVATION
Comparison of size of irrigated farms



1) From 1950 Census of Agriculture
 2) Irrigated acreage of 2,735 in 1950 & population of 2922.
 3) Population in 1955 @ 6 per family and ultimate acreage of 8570.