

EXCERPT from "THE COLORADO RIVER"  
Interim Report of the Secretary of the Interior  
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United States Department of the Interior  
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Bureau of Reclamation  
Michael W. Straus, Commissioner

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Little Colorado Division

Flowing northwest to join the Colorado River midway in its long course to the sea, the Little Colorado River drains 25,000 square miles in northeastern Arizona and west - central New Mexico. Crystal - clear tributary streams rising in the mountains are rapidly absorbed by the thirsty sands of the lower channels. Rain is infrequent but sometimes falls with great intensity. At such times the streams become raging, chocolate-colored torrents, carrying to the main Colorado in 1 year the equivalent of 9 inches of top soil from an entire township.

Vegetation over the basin as a whole is scant. Luxuriant growths, however, are found along river courses where water is available throughout the year, and they consume large quantities of water. It is estimated that over 98 percent of the rain falling in this division is consumed by plants, is lost by evaporation, or percolates underground and does not reappear within the basin.

Water Resources

Surface water. - The following table summarizes the average annual flows past those points where sufficient information is available to permit their computation.

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Table LXXIV - Average annual stream flows in the Little Colorado division

Station	Period of Record	Average Annual Flows (Acre-feet)	
		For period of record	For 1931-40 period
Little Colorado River at Grand Falls, Arizona.....	1926-43	236,700	199,000
Chevelon Creek near Winslow, Arizona.....	1930-43**	38,800	37,300
Clear Creek near Winslow, Ariz..	1930-43**	69,300	61,600
Moenkopi Wash near Tuba, Ariz...	1927-43	16,600	13,700

\*\* Records incomplete.

The foregoing stations, except that on Chevelon Creek, are downstream from all diversions and represent the surplus flows of the streams in question. During the period of record the irrigated acreage within the basin has been virtually constant.

Stream-flow characteristics over the basin as a whole are similar. The channels contain water the year-round in the higher elevations but receive only intermittent flows in the lower altitudes. Flows over the entire area are erratic and subject to flash floods of great magnitude. The larger part of the annual run-off from the northern tributaries usually occurs during the summer months, while that from the south is somewhat retarded by the heavily vegetated highlands of the Mogollon Rim.

Approximately 55 percent of the average annual flow of Little Colorado River at Grand Falls, Ariz., down-stream from all major tributaries except Moenkopi Wash, occurs during the months of February, March, and April, while only 35 percent comes during July, August, and September. Extremes in fluctuation occurred in 1938 when there was no flow in the stream for 213 days, while in March of that year a flood of 38,000 second-feet was recorded. Undependable stream flows make hold-over storage a prerequisite for maximum

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irrigation development.

Ground water. - Little is known about the ground water resources of the basin. The scarcity of existing wells and the absence of accurate data on wells preclude definite conclusions as to the location and extent of ground waters. The very fact that no exploitation has been made of this resource in a country where water is such a valuable commodity would indicate the lack of possibilities.

Small artesian areas are known to exist in some portions of the basin. Two such areas are found south of the Little Colorado River, one southwest of Holbrook, Ariz., and the other northwest of Hunt, Ariz. In the absence of more complete geological and water level information, it is impossible to determine accurately the extent of these areas or the existence of other artesian belts, or to predict potential yields. It appears, however, that the artesian water resources are small and cannot be expected to furnish any large quantities of irrigation water.

Nonartesian water is often found in sandstones, in lava flows, and in sands and gravels along major streams. Frequently water is at great depths, particularly when found in the sandstones. All known pumped wells are used for domestic, public, stock watering, or railroad purposes. Irrigation with pumped water is not practiced to any appreciable extent in the division. There is no evidence which indicates that the ground-water resources of this basin are of sufficient importance to be considered as a potential source of water for irrigation development.

Quality of water. - Surface flows of water in this division are of good quality near their points of origin. As the water progresses downstream, however, it flows through formations that are high in soluble salts, thus

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becoming unsuited for irrigation use near the mouths of the streams. Mineral springs, in places, contribute large quantities of dissolved salts to the waters of the streams. Near Winslow, Ariz., several springs discharge an average of 20 tons of salts daily into the flows of both Chevelon and Clear Creeks. Salt concentrations in the waters range from virtually zero near the headwaters to as high as 3,000 and 4,000 parts per million in the lower Little Colorado River. Waters of the Little Colorado are of questionable quality between St. Johns and Holbrook, Ariz., and are entirely unsuited for irrigation use below the latter town.

The quality of the ground water in the basin varies widely with location. Chemical analyses show water from different wells varying from 100 to 6,000 parts per million total dissolved solids. The more saline water is not suitable for irrigation use. In general, wells containing the poorest quality water are located in shale-sandstone formation or in the sands and gravels of Cottonwood Wash, Leroux Wash, or the Little Colorado River bottoms.

#### Present Development of Water Resources

General. - Early settlers in the division learned through bitter experience that it was impossible for them to control the rivers except in a few selected localities. Settlers gradually migrated to the more readily irrigated areas, and development progressed without a coordinated plan and without knowledge of the wide variations in annual stream flow to which the rivers are subject. During wet periods far more land was brought under irrigation than could possibly be supplied during periods of drought. Subsequent years of deficient stream flow brought economic and even physical suffering. This was especially true in the upper Little Colorado River area, where over-development progressed

to the point where a court decree was necessary to establish relative priorities. As a result, virtually all of the waters of this area have been apportioned. Only during extreme floods does any water escape the region.

Development of the surface water resources on the Indian reservations has followed a somewhat different pattern. Irrigation projects have been planned, constructed, and operated under the supervision of the Office of Indian Affairs. Agricultural development has been adapted, insofar as possible, to the needs and temperament of the Indians. Individual holdings are small, and dry farming is practiced to some extent with little success. Flood-irrigated lands, or areas which receive water only during times of flood, are extensively cultivated. Despite the planning, supervision, and assistance of the Office of Indian Affairs, serious problems have arisen because the Indian population is continually increasing.

Irrigation. - The climate of the basin is such that irrigation is essential for successful agriculture.

The principal areas irrigated in the division are:

	Acres irrigated
Little Colorado River above St. Johns . . . . .	15,180
Silver Creek Basin . . . . .	4,360
Woodruff area . . . . .	520
Holbrook-Joseph City area . . . . .	1,520
Winslow area . . . . .	610
Upper Zuni River . . . . .	6,770
Scattered areas . . . . .	<u>19,040</u>
 Total . . . . .	 * 48,000

\* Includes Indian lands: 5,560 acres in the upper Zuni River Basin, 2,540 acres in scattered areas, and 16,500 acres under flood irrigation.

Irrigation is accomplished chiefly by gravity diversions from the main stream. About three-fourths of the white irrigated land is served through

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the facilities of 13 irrigation companies. The remaining one-fourth is irrigated by individuals.

There is no import or export of water by transmountain diversions.

Power Development. - The character of the stream flow in the area does not lend itself to the development of power. In addition, there is little market for power owing to the scattered population and the lack of industrial development. There are only two hydroelectric generating plants in the Little Colorado division capable of producing firm power. The combined installed capacity of these plants is 125 kilowatts. Steam and Diesel plants scattered through the area have a total installed capacity of approximately 3,000 kilowatts.

Drainage. - Some areas of the division have become waterlogged and have been taken out of production. As these areas should never have been in production, no effort has been made to drain them. On a whole the topography has reduced drainage problems to a minimum on most of the irrigated areas.

Flood control. - Most of the lands lying in the flood plains of this division are undeveloped and unimproved. Hence, the rampant floods to which the area is subject cause relatively little damage except for occasional removal of diversion dams. In only a few independent areas do floods endanger developments. The swollen streams, however, transport large quantities of silt into the Colorado River. Existing reservoirs in the Little Colorado division were neither constructed nor are operated for flood control; however, they afford a certain amount of protection.

Summary. - The following tables summarize present development of water resources in the Little Colorado division:

Table LXXV. - Existing reservoirs in the Little Colorado division <sup>1</sup>

Reservoir	Source of water	Location	Purpose served	Capacity (acre-feet)
Lyman. . . . .	Little Colorado River.	Arizona. . . . .	Irrigation . . . . .	21,900
Lake Mary. . . . .	Walnut Creek . . . . .	. . do . . . . .	Municipal. . . . .	18,900
Lone Pine. . . . .	Showlow Creek. . . . .	. . do . . . . .	Irrigation . . . . .	14,000
Udall. . . . .	Carrizo Wash . . . . .	. . do . . . . .	Irrigation, stock. . . . .	9,530
Daggs. . . . .	Silver Creek . . . . .	. . do . . . . .	Irrigation . . . . .	5,170
Upper Lake Mary. . . . .	Walnut Creek . . . . .	. . do . . . . .	Municipal. . . . .	5,080
Soldiers Annex Lake. . . . .	Canyon Diablo. . . . .	. . do . . . . .	Irrigation, stock. . . . .	5,000
Chevelon . . . . .	Chevelon Creek . . . . .	. . do . . . . .	Irrigation . . . . .	4,300
White Mountain No. 1 . . . . .	Hall Creek. . . . .	. . do . . . . .	. . do . . . . .	2,390
River No. 3. . . . .	Little Colorado River.	. . do . . . . .	. . do . . . . .	1,670
New Scott. . . . .	Porter Creek . . . . .	. . do . . . . .	. . do . . . . .	1,200
Lakeside . . . . .	Showlow Creek. . . . .	. . do . . . . .	Irrigation, power. . . . .	1,200
Concho Lake. . . . .	Concho Creek . . . . .	. . do . . . . .	Irrigation, stock. . . . .	1,200
Hog Wallow No. 4 . . . . .	South Fork . . . . .	. . do . . . . .	Irrigation . . . . .	1,000
Fine Lake. . . . .	Showlow Creek. . . . .	. . do . . . . .	. . do . . . . .	1,000
Zuni . . . . .	Zuni River . . . . .	New Mexico . . . . .	. . do . . . . .	13,000
Rescad . . . . .	. . do . . . . .	. . do . . . . .	Domestic, irrigation . . . . .	8,720
Ramah. . . . .	. . do . . . . .	. . do . . . . .	Domestic, stock. . . . .	1,170

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<sup>1</sup> Includes only reservoirs with capacities of more than 1,000 acre-feet.

Table LXXVI. - Present irrigated areas in the Little Colorado division

Area	Acres irrigated		
	Arizona	New Mexico	Total
Silver Creek Basin. . . . .	4,360	0	4,360
Holbrook-Joseph City area . . . . .	1,520	0	1,520
Winslow area. . . . .	610	0	610
Other . . . . .	32,740	8,770	41,510
Total. . . . .	39,230	8,770	48,000

Table LXXVII. - Estimated percent average annual depletions in the Little Colorado division

Area	Depletions (acre-feet)		
	Arizona	New Mexico	Total
Silver Creek Basin. . . . .	6,500	0	6,500
Holbrook-Joseph City area . . . . .	2,300	0	2,300
Winslow Area. . . . .	900	0	900
Other . . . . .	49,000	13,000	62,000
Total. . . . .	58,700	13,000	71,700

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### Potential Development of Water Resources

Opportunities for development in the Little Colorado division are largely confined to four areas. One potential project is outlined for each of these areas. The potential Bridge Canyon project on the Colorado River, discussed in this chapter under the Boulder division, would bring power into the Little Colorado division.

Although the Coconino dam site is located on the Little Colorado River downstream from the Little Colorado division, construction of a dam at this site would form a reservoir extending into the division. The Coconino Dam is discussed in this chapter under the Boulder division.

Snowflake project. - This development in Silver Creek Basin would include the diversion of water from Showlow Creek through a 2-mile tunnel into a storage reservoir of 25,000 acre-feet capacity at the Shumway site. At the reservoir the waters of Showlow Creek would be commingled with those of Silver Creek and distributed to about 6,700 acres of new lands lying on both sides of Silver Creek in the vicinity of Snowflake, Ariz. A portion of the 2,000 acres now irrigated would be supplied water through the facilities of the new system. The irrigation structures planned would have some incidental flood-control benefit.

Black Creek project. - Construction of a reservoir at the Black Creek site near Houck, Ariz., would provide 48,600 acre-feet of irrigation storage capacity. Releases to the natural channel of Black Creek would be diverted into a canal north of the Puerco River. A siphon crossing of the Puerco River would convey the water to a distribution system serving 4,000 acres along the south bank of that stream. This project is an alternative to an upstream irrigation development within the Navajo Indian Reservation in Arizona and New Mexico, for which the Office of Indian Affairs holds prior

water rights. Either plan would have about the same depletory effect upon stream flows.

Holbrook project. - Along the Little Colorado River near Joseph City, Ariz., are 1,300 acres of new land and 600 acres now inadequately irrigated which would receive water from this project. Storage would be provided in a reservoir at the Fork site on Little Colorado River just below the mouth of Silver Creek. Of its total capacity of 117,000 acre-feet, 75,000 would be for silt retention. A canal diverting from this reservoir would parallel the river on the south side to a point 4 miles west of Holbrook, where a siphon would carry the water across the river into a canal leading to the project lands. Incidental channel improvements resulting from construction of this project, together with the regulatory effect of silt and irrigation storage, would provide some flood protection for downstream property.

Winslow project. - This development would utilize the waters of Clear and Chevelon Creeks for the irrigation of 19,750 acres of new lands, including 5,000 acres of Indian lands and 14,750 acres of white-owned lands, all on the north side of the Little Colorado River in Arizona. Construction of the Willow Creek Dam on Clear Creek would provide for storage of 45,000 acre-feet of water, and construction of Wildcat Dam on Chevelon Creek would impound another 49,000 acre-feet for irrigation use. Because of the steep-walled canyons in which the streams are entrenched, tunnels heading at diversion weirs would be necessary to convey water to the canals leading to the project lands. In addition, a siphon crossing under the Little Colorado River would be required.

Summary

The following tables summarize potential development in the Little Colorado division, showing various purposes to be served by potential projects, estimated construction costs, potential reservoirs, and present and potential stream depletions.

Table LXXVIII  
Potential projects in the Little Colorado division

Project	Location of project	Source of water supply	Purpose to be served <sup>1</sup>	Estimated construction cost <sup>2</sup>
Snowflake . .	Arizona.	Showlow and Silver Creek	I, F, S	\$2,600,000
Black Creek .	. . do .	Black Creek . . . . .	I, F, S	1,800,000
Holbrook . .	. . do .	Little Colorado River . .	I, F, S, C	1,300,000
Winslow . . .	. . do .	Clear and Chevelon Creek	I, F, S	19,000,000
Total . . . . .	. . . . .	. . . . .	. . . . .	24,700,000

<sup>1</sup>Symbols used: I - Irrigation, P - power, F - flood control, S - silt retention, C - channel improvement.

<sup>2</sup>Preliminary estimates based on construction costs of Jan. 1, 1940.

Table LXXIX.  
Potential reservoirs in the Little Colorado division

Name of site <sup>1</sup>	Source of water supply	Project served directly	Total capacity (acre-feet)
Shumway . .	Showlow and Silver Creeks	Snowflake . . . . .	25,000
Black Creek	Black Creek . . . . .	Black Creek . . . . .	48,600
Forks . . .	Little Colorado . . . . .	Holbrook . . . . .	117,000
Willow Creek	Clear Creek . . . . .	Winslow . . . . .	45,000
Wildcat . .	Chevelon Creek . . . . .	Winslow . . . . .	49,000
Total . . . . .	. . . . .	. . . . .	284,600

<sup>1</sup>All in Arizona.

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Table LXXX. - Potential irrigation development  
in the Little Colorado division

Project <sup>1</sup>	Area to be benefited (acres)		
	New land	Furnished supplemental water	Total
Snowflake . . . . .	6,700	0	6,700
Black Creek . . . . .	4,000	0	4,000
Holbrook. . . . .	1,800	600	2,400
Winslow . . . . .	19,750	0	19,750
Total. . . . .	32,250	600	32,850

<sup>1</sup>All projects in Arizona.

Table LXXXI. - Present and potential stream  
depletions in the Little Colorado division.

State subdivision	Estimated average annual depletion (acre-feet)		
	Present depletion	Potential increase	Total ultimate depletion
Arizona:			
Silver Creek Basin . . . . .	6,500	10,000	16,500
Black Creek Project. . . . .	0	6,000	6,000
Holbrook-Joseph City area. . . . .	2,300	2,700	5,000
Winslow area . . . . .	900	30,000	30,900
Other areas. . . . .	49,000	0	49,000
Subtotal. . . . .	58,700	48,700	107,400
New Mexico (all areas). . . . .	13,000	0	13,000
Total. . . . .	71,700	48,700	120,400

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Chapter VIII

COOPERATING INTERESTS IN THE BASIN

Office of Indian Affairs

"Indian Projects in the Colorado River Basin"

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Arizona

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Navajo. - On the Navajo Reservation within the State of Arizona are about 45 small irrigation developments aggregating 13,740 acres. Twenty of these units totaling about 5,000 acres lie within the Little Colorado River watershed and 25 units with an area of about 8,740 acres are within the San Juan River Basin. It is planned to provide irrigation facilities for an additional 31,530 acres which will make the ultimate irrigable area within Arizona approximately 45,270 acres, about 23,265 acres of which will be in the Little Colorado River watershed and 22,005 acres in the Juan Juan watershed. The water supply is secured by direct diversion from miscellaneous streams and the present annual diversion is estimated at 68,700 acre-feet, of which 25,000 acre-feet is from tributaries of the Little Colorado River and 43,700 acre-feet from tributaries of the San Juan. The average annual diversion requirement for the ultimate area is estimated at 226,350 acre-feet of which 116,325 acre-feet will be from the Little Colorado River watershed and 110,025 acre-feet from the San Juan watershed.

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New Mexico

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Navajo. - Within the Navajo Reservation in New Mexico are about 30 small irrigation developments and several additional small projects are proposed for development. The present irrigated area aggregates 12,000 acres and the

proposed additional developments total 10,500 acres making a total aggregate area of 22,500 acres. The water supply is secured from the San Juan River and numerous miscellaneous streams tributary to the San Juan River. The present average annual diversion is 60,000 acre-feet and the average annual diversion requirement for the ultimate irrigable area is estimated at 112,500 acre-feet. The development cost of these small projects including subjugating the land is estimated at about \$2,000,000. Although additional surveys are required to define the areas and prepare accurate cost estimates, the cost of such additional studies will be approximately \$10,000.

Shiprock. - Within the Navajo Reservation in the vicinity of Shiprock is a compact area of reasonably good land comprising 70,000 acres. Irrigation of this area would require the construction of a storage reservoir on the San Juan River together with a canal and lateral system. The Bureau of Reclamation has studied the possibility of constructing a storage dam on the San Juan River near the Colorado-New Mexico State line to form a 125,000 acre-foot reservoir, a diversion dam near Blanco, and a gravity conduit extending about 75 miles to the land. A pumping lift of about 100 feet would be required to irrigate part of the area which lies above the conduit location. The average annual diversion requirement for this project regardless of the plan adopted would be approximately 350,000 acre-feet. The estimated cost of the development is \$21,000,000 or about \$300 per acre.

Summary - Navajo

The need for the full and early development of all feasible irrigation projects on the Navajo Reservation is acute. Within the Navajo Reservation in Arizona and New Mexico there are approximately 30,000 acres now provided with

irrigation facilities. Some of the many separate developments are merely floodwater projects and are of little value during years of extreme drought. Additional storage is required to provide a dependable water supply. Additional subjugation work also needs to be done in order to conserve water and make it possible for the Indians to carry on farming operations. With the full development of all feasible irrigation units on the Navajo Reservation in Arizona and New Mexico including the Monument Rocks area, the Shiprock area, and the miscellaneous small projects there would be a total of approximately 135,000 to 150,000 acres of irrigable land available for use by these Indians. The estimated cost of the new developments including the subjugation of land is \$27,000,000 or an average of about \$260 per acre for the new acreage.

Living on and adjacent to the reservation are approximately 52,000 Navajo Indians practically all of whom are full-bloods. This population comprises about 11,000 families. It is the obligation of the Government to provide these people with resources sufficient for them to attain economic independence at a reasonable standard of living. The present carrying capacity of the grazing range available to them is estimated at 611,000 sheep units. This would permit the grazing of approximately 70 sheep per family whereas at least 400 sheep per family are required to provide a minimum standard of living. Assuming that 3,000 of these Indian families will find their way into industry or otherwise secure their living off the reservation there remain 8,000 families to be provided for. With the range land divided equally they could each have not to exceed about 75 sheep per family. With the full development of all potentially irrigable lands totaling 135,000 to 150,000 acres it would be possible to assign an average

of 15 to 20 acres of irrigable land to each of the 8,000 families in addition to which each family could graze an average of 75 sheep. This would not solve all the economic problems of the Navajo but would raise his present standard of living considerably. Many of these Indians were in the armed services and many more were engaged in war work. Now the war is over these people must inevitably return to the reservations. Unless detail plans can be developed and construction work started on these proposed irrigation developments immediately, the conditions on this reservation will be such as to require the expenditure of large sums for relief or "made" work; this alternative must be avoided.

Zuni. - Within the Colorado River Basin is the Zuni Pueblo. On the pueblo lands 6,200 acres are now provided with irrigation facilities and it is proposed to expand the irrigated area to 10,000 acres. Water is secured from the Zuni River, a tributary of the Little Colorado River. The present average annual diversion is 31,000 acre-feet and the average annual diversion requirement for the ultimate area is 50,000 acre-feet. Additional surveys and studies are necessary in order to define the ultimate irrigable area and prepare cost estimates.

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