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University of Arizona, College of Agriculture

**Water Storage and the
Water Code**

By G. E. P. SMITH, *Irrigation Engineer*

Extension Service, E. P. Taylor, Director, Tucson, Arizona, Co-operative Extension Work in Agriculture and Home Economics, University of Arizona College of Agriculture and U. S. Department of Agriculture, Co-operating.

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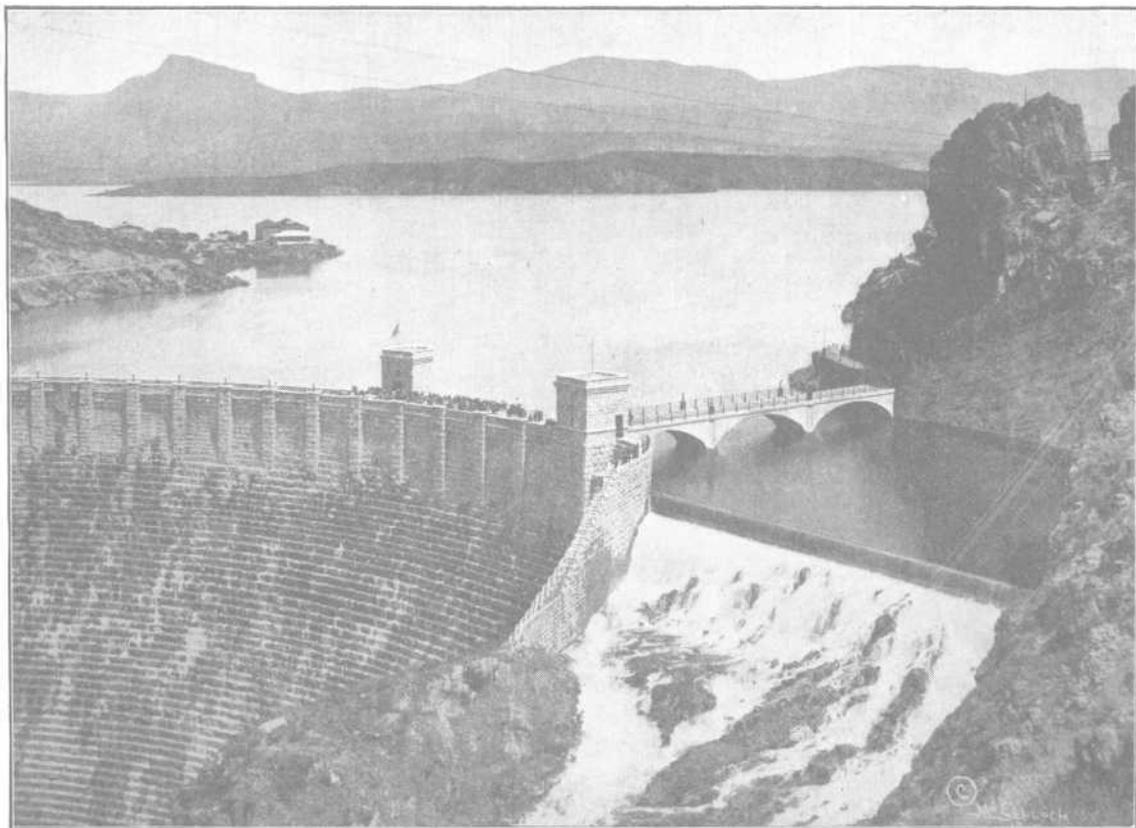
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View of Roosevelt Dam and Lake taken on April 15, 1915, as the water overflowed the spillways for the first time.

WATER STORAGE AND THE WATER CODE

By G. E. P. SMITH, *Irrigation Engineer.*

America is entering upon an era of land reclamation of vast extent. The federal government, thru the U. S. Reclamation Service, is planning for reclamation, in all parts of the country, of arid lands, swamp lands, and cut-over lands. Appropriations of \$200,000 have been made for preparing the plans, and \$1,000,000 more has been asked of Congress for the same purpose. A program far out-distancing that already performed by the Reclamation Service will soon begin.

Impetus is given to this movement by the problems of returning soldiers and the re-location of labor employed in the industries. These problems are engrossing the best thought of other countries also. In Canada the provinces, and in Australia the states, have led in the plans for preparation of land for returning soldiers, and the central governments have supplemented their efforts, particularly in the matter of farm loans. In this country the central government is leading the movement, but the plans contemplate that much of the land shall be provided by the states. A land settlement board is needed in each state.

What can Arizona do? Perhaps no other state has so large a percentage of undeveloped land, but land settlement, as compared with that of the Imperial Valley and other regions, has been slow, retarded in large measure by the isolation of the valleys, the great number of government reservations of various kinds, the size and difficulty of the necessary public works, and the lack of definite, favorable irrigation laws.

Agricultural development in Arizona must depend largely on water storage. The natural flow of streams has been utilized already, and in many valleys even the groundwater supply has been heavily mortgaged. But storage propositions, mostly large projects, offer attractive inducement and will permit of doubling our present irrigated area.

The blessings of water storage for irrigation have been exemplified in the Salt River Valley the past year. The Salt River Project has furnished water for 205,616 acres, and the crop report for the year indicates a production on the farms of not less than \$18,000,000, in addition to a livestock production of comparable value. Of the irrigation water supplied to the farms this year a little more than 75 per cent had been conserved from loss by storage in the Roose-

velt Reservoir and a little over 60 percent had been stored in the reservoir since 1915. Without the reservoir, not more than one-half of the above area could have received any water at all, the yields would have been low, and the crop value would have been not over one-fourth of its value as given above. The past two years have been drouth years, and from Texas to Oregon the water shortage has been felt keenly, but in the Salt River Valley there was no shortage, each farmer decided how much water he wanted and when he wanted it, put in his order, and the zanjeros delivered it at once. In this valley, as well as in the Yuma Valley, the total cost of construction of the projects assessed by the Reclamation Service upon the land owners has been exceeded by the new wealth thereby created during the present year alone. No governmental undertaking, state or federal, at the present time offers so great returns as the reclamation of arid lands, under projects similar to those of the Salt River and Yuma valleys.

STORAGE ON THE COLORADO RIVER

Arizona possesses extensive areas of irrigable land of great potential value lying along the Colorado River. Only 50 percent of the Yuma Valley land is now in cultivation, and the Yuma Mesa, admittedly the finest body of citrus fruit land in America, has been barely touched with the plow. Farther upstream the Parker Valley of about 135,000 acres, bigger and better than the Yuma Valley, and the Parker Mesa, and the Needles Valley of about 40,000 acres, are still awaiting the enterprise and industry of the white man.

However, the rapid development of the Imperial Valley, over 70,000 acres of additional land in the present year alone, has automatically appropriated and exhausted all the normal flow of the river, during the period of low flow, on normal and dry years. Arizona lands, therefore, must participate in the building of one or more great storage reservoirs in Utah, several excellent sites for which have been surveyed. An elaborate system for the storage of the floodwaters of the Colorado has been designed, but serious legal and political difficulties must first be overcome before the plans can be put into execution.

The immediate thing that Arizona can do to facilitate progress toward the utilization of the Colorado floodwaters is to enact water laws as nearly uniform as possible with the laws of the other six states involved in the water problems of this interstate stream. All of those states have adopted the modern system of state control of

the diversion and distribution of river waters. In fact, Arizona is the only one of the states where irrigation is practiced that has not adopted the modern irrigation code. By the lack or absence of suitable water laws in this state, an unnecessary burden has been thrown on the courts, water users are obliged to be ever on the alert to protect their water rights, often at great expense, and new development is throttled or prevented.

The first territorial legislature of Arizona, in 1864, enacted a Bill of Rights, which declared all water supplies capable of being used for irrigation to be public property, and established the doctrines of appropriation, of priority of rights, and of beneficial use. The state constitution, adopted in 1911, is strangely silent on the subject of irrigation; it does deny the common law doctrine of riparian rights and confirms all existing rights *to the use* of waters for beneficial purposes. The state, having adopted fundamental principles in theory, should not hesitate nor delay to enact an adequate system of water laws, with the legal machinery necessary to carry those principles into effect. Kinney, a leading authority on water law, in Vol. IV of his work entitled *Irrigation and Water Rights* (1912) said, "It is to be expected that about the first legislature of the State of Arizona will follow the other states and enact a Water Code governing the subject of waters and water rights within the new state." This has never been done, though three legislatures have come and gone.

Unless prior rights to the floodwaters of the Colorado River are acquired for additional large tracts of land in Lower California and in northwest Sonora, there will be ample water provided by storage ultimately for all the arable land lying along the Colorado in Arizona.

STORAGE ON THE LITTLE COLORADO

On the headwaters of the Little Colorado and of its tributary, Silver Creek, there are many excellent small reservoir sites which have been utilized by canal companies. The great Lyman dam near St. Johns, destroyed by flood in 1914, is being rebuilt, in part by means of a loan of \$150,000 from the state. The Woodruff diversion dam, destroyed at the same time, is now rebuilt and the lands are being reseeded this fall for the first time since 1914. Available storage sites at Woodruff and at other points are adequate for the conservation of all floodwaters of the Little Colorado.

STORAGE ON THE GILA RIVER

The great floods of 1914, 1915, and 1916 have again called attention to the need of storage on the Gila River. During three years the flow through the San Carlos reservoir site amounted to 3,400,000 acre-feet. Practically all of this water was wasted to the sea and irretrievably lost. The Gila is notoriously a flashy stream in which the floods run off rapidly and the river for most of its course is dry in the early summer and until the summer floods begin about the middle of July. The only way to utilize these floodwaters is by means of storage.

The storage possibilities on the Gila have been surveyed and reported by governmental agencies and private organizations. From west to east the reservoir sites are: north of Sentinel, south of Arlington, at the Buttes near Florence, at Riverside near Kelvin, at San Carlos, at the mouth of the San Francisco, at York near Duncan, several above Duncan in New Mexico, and one on the San Francisco tributary.

The best of these storage sites by far is the one at San Carlos. A project involving the construction of a great reservoir at that point was reported most favorably by J. B. Lippincott in 1900 and by a Board of Army Engineer Officers in 1914. Lippincott, basing his judgment on meagre records of river discharge, recommended a dam 130 feet high. The site selected by him has a maximum depth to bedrock of 74 feet. Borings made in 1913 revealed a better dam site about 1,000 feet farther upstream, where the depth to bedrock is only about 20 feet and the character of the bedrock and abutment walls is very superior, being quartzite or quartzitic sandstone. Therefore, the Board of Army Engineers, with stream flow measurements covering 19 years (partly estimated) recommended a dam 180 feet high. The plans must now be revised again. The records of flow since 1914, together with the growing appreciation of long-period storage, the increasing valuation of irrigation water supplies, and the practicability of supplementing the river water with ground-water supplies during long periods of drouth, make a dam of 200 feet in height entirely justifiable. Such a dam would create a reservoir of a million acre-feet capacity, three-fourths of the capacity of the Roosevelt Reservoir. It would assure the irrigation of over a hundred thousand acres of land, a portion of which would lie in the Gila River Indian Reservation.

The second reservoir site on the Gila in value is perhaps the one situated north of Sentinel. A reservoir at this site would impound

the floodwaters of the Verde and the excess or overflow which occurs occasionally from the Roosevelt Reservoir, as well as the waters of the Gila River. The dam site is not so favorable, however, being a quarter mile in width, and the abutments consist of a cap of lava rock which appears to overlie beds of clay. Soil and climatic features, too, are more favorable upstream; and the San Carlos project is more certain of success, because the lands to be irrigated are settled already to a degree which assures the immediate utilization of the water.

Storage on the Gila was discouraged at first by the fear of rapid silt deposition. Measurements of the actual quantity of silt show that the early estimates were too high, and methods of overcoming the silt danger have been found. The percentage of silt in the Gila at San Carlos is about equal to that of the Rio Grande at Elephant Butte. The silt problem is no longer a bugaboo.

The upstream reservoir sites on the Gila are much smaller than the two already discussed, but doubtless one or more of them will be utilized in the future, partly for the purpose of power generation, and partly to equalize the irrigation supplies of the Greenlee County and Graham County valleys. An alternative project for the regulation of the upper Gila watershed has been designed recently, under authority of an act of Congress. It contemplates the construction of thousands of little check dams on the headwaters, and the control of the channel in the Safford Valley. Its main purpose is the protection of alluvial valley lands from destruction by migration of the river during floods. In addition, it would to some extent conserve the run-off during periods of rain, but it could not result in any important increase in the water supply available for irrigation, except for a very limited acreage, mostly in New Mexico.

But storage on the Gila is impossible, so long as the water rights in the Gila waters remain unadjudicated. Recorded appropriations in the various county records are excessive and it would be folly for private or public capital to attempt any large investment prior to a determination of the priorities and the extent of each right. The whole watershed from Duncan to Yuma must be adjudicated in one action. It cannot be done at the present time; there is no adequate legal machinery.

Here again arises the necessity for the modern water code and a state commission or tribunal devised particularly to adjudicate water rights, taking one watershed at a time. In other states the modern water code has facilitated the rapid and equitable settlement

of water rights questions. Arizona does not need to try any experiment, but can follow the methods which have proven so efficacious elsewhere. The modern method of state adjudication and administration of water supplies is supported universally by the best authorities in irrigation matters.

STORAGE ON THE SALT AND VERDE RIVERS

Unquestionably the most valuable structure in Arizona is the Roosevelt dam. The winter run-off is stored for summer use and the floodwaters of the years of heavy rainfall are saved for the normal and dry years.

There are three ways in which the water supply of the Salt River Project can be increased, namely, by storage on the Verde River, by lining the canals, and by means of a great number of auxiliary wells and pumping plants in the valley. The third method has been adopted officially by the Waters Users' Association and drilling rigs are being put at work. The locations of the wells are being determined by a general plan which has a dual purpose, the obviating of an expensive drainage system and an increase in the present irrigation supply.

The Horseshoe Reservoir on the Verde, as designed, will have a capacity of 205,000 acre-feet. It will permit of an increase in acreage of 31,000 acres. Lining of the main canals and laterals, or rather of those portions of them which have been proven to have the greatest loss of water by seepage, will result in the saving of enough water to irrigate an additional 30,000 acres of land, at a cost of about \$40 per acre. The threatening rise of the groundwater plane is due to seepage from the beds of canals more than to over-irrigation of fields, and the lining of canals, therefore, will be the most effectual means of reducing the groundwater menace. Canal lining and pumping operations combined will forestall the necessity for a drainage system. Canal lining should precede the Horseshoe Dam.

The fortuitous circumstance that the irrigated area of the Salt River Valley lies in one county has made possible an early and complete adjudication of the water rights. The Kibbey Decision, a triumph of right principles of irrigation law, and the Kent Decree, reaching down to every water user, have made the distribution of water as orderly as the return of the seasons. The enjoyment of this blessing by Maricopa county must not stand in the way of the proposed State Water Law, which is needed to stabilize water rights equally well in all of the other thirteen counties.

OTHER STREAMS

Lake Watson on Granite Creek, holding seven thousand acre-feet, is in successful use. It was filled in the spring of 1918, and has been emptied during the irrigation season.

Various other reservoir sites in Arizona have been surveyed, including sites on Bill Williams Fork, the Hassayampa, the Agua Fria, the Santa Cruz, and the San Pedro. As the population increases and water becomes more valuable, some of these sites will be utilized.

The immediate and pressing duty of the state is to establish legal machinery for the clearing up of all titles to water rights, for the control of additional appropriations, and for the supervision of the diversion and division of waters. Irrigation is fundamentally of a public character; like law enforcement and tax collecting, the management of rivers should be conducted as a public institution. In his book on the Elements of Western Water Law, Chandler closes his chapter on water right legislation as follows:

"It should be emphasized that the 'new legislation' is dictated solely by good business sense. Instead of endless litigation regarding existing rights and no system worth considering regulating new appropriations, the new plan provides a full determination of existing rights in a single proceeding, the proper distribution of water by state officials according to such determination, and a complete control of the acquirement of new rights by a central office. It rests upon the same legal basis as the old and in no way attempts to interfere with or limit vested rights. It is applicable to any condition of topography or climate, as is illustrated by its acceptance by Nebraska in the east and Oregon in the west, by North Dakota in the north and New Mexico in the south. It leads the way from chaos and strife to order, harmony, and efficiency."