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THE YUMA IRRIGATION DAM

(BY DAY ALLEN WILLEY IN SCIENTIFIC AMERICAN)

Within the next year, one of the most notable projects connected with the reclamation of arid lands in the Southwest will probably be entirely completed. While the work includes the storage of water on a large scale and its distribution by means of irrigating canals, the extraordinary difficulties encountered by the engineers in building the necessary dam and in restraining the rivers in the vicinity, have made the undertaking unique among the irrigation enterprises.

In a recent issue, a feature of the Yuma project as it is termed was described in the extensive levee work required to confine the channels of the Gila and the Colorado rivers during high water, to prevent the reservoirs and canals from overflowing during floods, also to check the movement of sediment carried in such enormous quantities when the streams are at high-water mark. The formation of the embankments by means of abatis made from young trees and brushwood holding the earth embankments, also the jetty system for retarding the flow of the water, were detailed and illustrated. Another problem necessary to be solved, however, was how to create a permanent reservoir of sufficient size for irrigation purposes, strong enough to resist flood action, and so constructed that it would not be shallowed or filled with the sediment. The great variation of the volume of water in the Colorado and the depth of the mud and other detritus on its bottom above the rock strata added to the difficulty. A dam across the river was essential, but the question was how to build it so that it would not be washed out, or at least partly demolished. Could it be erected on a solid foundation, and could its ends be securely anchored to the formation on either side?

Preliminary surveys for the general project were made early in 1904. Several different locations were also examined to determine the best place for this structure, and a search was made for bedrock with diamond-ore drilling machinery, at all possible dam sites between Yuma and Piacacho. As a result of these explorations, the Laguna weir site was selected as the most desirable one for the construction of a weir to serve the lands near Yuma, a high dam and high-line canal being considered impossible. The type of weir selected is one that has been tried during the last fifty years at numerous places in India and Egypt under similar conditions, three dams having been constructed on the Nile river within the past fifteen years, on practically the same plan, all having served their purpose efficiently and being in operation today. This type of weir consists of a loose rock structure with a paving of stones 1 1/2 feet in thickness on the downstream slope, the structure being tied together with three parallel walls of steel and concrete run longitudinally between the granite abutments on the two sides of the river, the entire structure being further made secure by an apron of loose rock pitching ten feet in thickness and fifty feet in width at the lower toe of the dam below the sloping pavement. The height of this weir was to be 19 feet above low water, and the slope of the downstream side 12 feet horizontal to 1 foot vertical, with 50-foot apron below. The design called for the upper core wall of concrete to rest up on a row of sheet piling driven into the bed of the river.

The handling of the silt of the Colorado is one of the most difficult features of this undertaking. It is known that its amount is very large. The river is on a grade of approximately one foot to the mile above the Laguna

weir site, so that this weir will make a settling basin of relatively quiet water approximately ten miles in length above it. At each end of the weir, and constructed in solid granite rock, is a sluiceway 200 feet wide excavated to the depth of low water in the river. These sluiceways are closed by large gates operated by hydraulic machinery. The diversion canals for irrigation take their water above these gates from the sides of the sluiceways. The srea of the sluiceways being so great, the water movement toward the canal is slow, and most of the sediment is deposited. It is estimated that the capacity of the sluice gates will be approximately 20,000 cubic feet per second each. This great volume of water passing through the sluiceways when the gates are open, will carry out with the sediment deposited above the intake of the canals. The ordinary low-stage flow of the Colorado river is from 3,000 to 4,000 cubic feet per second, so the capacity of each of these sluiceways will be about five times the low-water flow of the river. The figures are given for purposes of comparison only.

As the result of a number of experiments, it has been found that the principal quantity of silt is carried along near the bottom of the river, and that the surface water is relative free from sediment. It was planned, therefore, to take the water into the canals by a skimming process over a long row of flash-boards, so that the entire capacity of the canal can be furnished by drawing but one foot in depth of water from the surface of the river. As a still further precaution, it was decided to construct the first 3,000 feet of canal on each side of the river of such size that the movement of water through it will be slower than one foot per second. These settling basins, as they are called, will be either excavated from granite, or, where the section is in earth, they will be paved. At the lower end of the settling basins, gates were planned to discharge into the river, so that the water could be drawn to the level of the stream.

The headworks as designed are of rock, concrete, or steel, with the exception of the sheet piling which is driven entirely below the water level, and so will not decay. Every portion of the weir is of what is known as permanent construction.

While the Laguna dam is 4,780 feet, or nearly a mile, in length, its width is especially noticeable, the maximum dimension being no less than 272 feet, although the height as stated is but 19 feet. These proportions are necessary, however, because of the great force of the flood current, and to prevent the water from forcing its way beneath the dam and thus undermining it.

The capacity of the canals at their intakes is 1,200 cubic feet per second on the Arizona side, and 200 cubic feet per second on the California side. The amount of the silt that would be daily delivered into the Arizona canal, if diversion were made directly from the structure, would approximate 17,000 cubic yards of wet mud by volume.

Careful study was made of the existing canals in the vicinity of Yuma and Imperial, to determine the shape that they naturally assume, and the roughness of the bottom and sides, which tends to retard the velocity. Based upon these data, the new canals have been so designed as to carry water at a higher velocity throughout than will be found in the settling basins above their head, and at such velocity as will permit of a minimum loss by seepage and evaporation. The gates and droops of these canals and the Yuma bridges are steel concrete structures. One of the most difficult problems in connection with this project was the crossing of the Gila river. It was considered necessary to make this perfectly safe, and for this purpose a structure was designed that crossed beneath the bed of the river, the top several feet below the lowest point of the stream bed. The structure is of steel and concrete, and some 3,000 feet in length.

The shape of levee adopted was one that has been developed by years of experience along the Mississippi river. It has a slope of three feet horizontal to one

foot vertical on the water side, it is eight feet wide on top, and built five feet above the highest water marks of the year 1903. These levees are 4,000 feet apart (one on each side) along the Colorado river, and 3,200 feet apart along the Gila river.

Because the lands are so flat, and the level of the water in the ground so near the surface, it was considered necessary, for their permanent safe irrigation, to supply a drainage system. A main drainage canal has been designed to run through the central portion of the areas to be irrigated, and when possible the natural drainage lines of the country have been utilized, deepening them with a stream dredger to such depth that they will carry off the water returning from irrigation or seeping through the levees during the high-water stage of the river. When lands in any district tend to become alkaline they may be connected, by means of local drainage canals, with this main drain, and in this manner they can be kept free from alkali by holding down the level of the ground water. During the greater portion of the year, when the river is low, this drainage water is discharged into the stream; but when the river is in flood, its elevation is such as to prevent the discharge into it from the drains. A pumping plant has, therefore, been designed to lift the drainage water from the levees during the flood period of the river to prevent the lands becoming waterlogged.

The total cost of the works will be about \$3,000,000, but they will irrigate 100,000 acres all told by means of 26 miles of main canals and 138 miles of laterals. The most interesting feature, however, from an engineering point of view is the successful control of a stream whose volume of water may rise and fall to the extent of thirty feet in a week, flowing through a channel of soft silt which it has been accumulating for centuries.

PRISON LIFE IN CALIFORNIA PRISONS.

"Crime, Punishment and Reform" is the title of a lecture by Col. Griffith J. Griffith of Los Angeles, who because of a deed done when intoxicated, served two years in the penitentiary at San Quentin. He was a model prisoner. He was inexpressibly shocked at the cruelties of our prison life. Soon after his conviction, he resolved to devote his ample means and talent to working up a reform in the treatment of prisoners, and he is doing it. Notwithstanding his term in prison, he has received a recognition in influential quarters. He appeared before the late legislature and his lecture just received, was delivered in Calvary Presbyterian church in San Francisco, where men and women of prominence welcomed him. Following are a few paragraphs from it:

"Within the state prison walls of Folsom and San Quentin are some hardened, naturally bad and desperate men, but the great majority are not bad men. The average prisoner is not so radically wicked as he is pitifully weak. 'I slept in room A, with 48 others for 14 months, right over the dungeon, where most of the torturing is done. Hundreds of times I heard pitiful cries for mercy, followed by human moans and groans. My heart was sick many times, yet I was helpless. See what I have seen and hear what I have heard, and you, too would be moved to action.

"A great majority of these men, having long been fed on prison slops, are physically run down, leave San Quentin with \$5 and a brand on the body in the shape of a suit of clothes costing \$2.95, which every policeman and detective knows. If there be a man when an unfortunate man needs a helping hand, it is then. He was not allowed to see a state newspaper in prison, consequently he does not know where to turn to look for work, and that \$5 is not going to last very long. Organized society takes him away from his vocation and family ties enslaves him to the state of California for a term of years, and in justice, ought not that man be introduced back to society at the expense of the state, by securing for him a job through her pro-

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Each of the chief organs of the body is a link in the Chain of Life. A chain is no stronger than its weakest link, the body no stronger than its weakest organ. If there is weakness of stomach, liver or lungs, there is a weak link in the chain of life which may snap at any time. Often this so-called "weakness" is caused by lack of nutrition, the result of weakness or disease of the stomach and other organs of digestion and nutrition. Diseases and weaknesses of the stomach and its allied organs are cured by the use of Dr. Pierce's Golden Medical Discovery. When the weak or diseased stomach is cured, diseases of other organs which seem remote from the stomach but which have their origin in a diseased condition of the stomach and other organs of digestion and nutrition, are cured also.
The strong man has a strong stomach. Take the above recommended "Discovery" and you may have a strong stomach and a strong body.
GIVEN AWAY.—Dr. Pierce's Common Sense Medical Adviser, new revised Edition, is sent free on receipt of stamps to pay expense of mailing only. Send 21 one-cent stamps for the book in paper covers, or 31 stamps for the cloth-bound volume. Address Dr. R. V. Pierce, Buffalo, N. Y.

Unofficial Returns Election November 3, 1908

CANDIDATES	COUNTY										TOTAL	
	Yuma	Sonoroma	Doña	Willock	Mohave	Pinal	Yavapai	Yavapai	Maricopa	Coconino		
DELEGATE TO CONGRESS												
Ralph H. Cameron, R.....	376	15	15	1	4	5	13	13	13	13	13	12,509
M. A. Smith, D.....	207	13	13	1	14	6	23	13	13	13	13	18,353
Joseph D. Cannon, S.....	82	13	13	1	14	6	23	13	13	13	13	194
COUNCILMAN												
Donald McIntyre, R.....	278	17	4	1	13	5	20	10	113	7	8	10,589
George W. Norton, D.....	239	17	1	1	13	5	20	10	113	7	8	10,577
John A. Mellon, S.....	69	17	1	1	13	5	20	10	113	7	8	134
REPRESENTATIVE												
Louis B. Carr, R.....	239	8	1	1	4	5	13	13	218	6	10	14,505
W. P. Hightower, D.....	290	1	1	1	4	5	13	13	218	6	10	16,581
J. H. Morrison, S.....	62	1	1	1	4	5	13	13	218	6	10	151
SHERIFF												
Alexander E. MacBeath, R.....	100	1	1	1	3	4	10	10	311	3	5	9,436
Gus Livingston, D.....	89	1	1	1	3	4	10	10	311	3	5	9,436
Ed. Le Crane, S.....	51	1	1	1	3	4	10	10	311	3	5	108
TREASURER												
Lewis W. Alexander, R.....	216	12	4	1	5	7	14	23	212	4	11	12,225
George Michelsen, D.....	128	12	4	1	5	7	14	23	212	4	11	12,225
J. P. Yellen, S.....	48	12	4	1	5	7	14	23	212	4	11	159
RECORDER												
James M. Polhamus, R.....	291	5	5	5	13	1	44	23	635	7	16	13,247
J. M. Alvarado, Jr., D.....	242	11	1	1	13	1	23	21	19	1	1	16,480
John Noble, S.....	62	17	1	1	13	1	23	21	19	1	1	115
DISTRICT ATTORNEY												
Thomas D. Molloy, R.....	224	4	1	1	2	3	22	13	30	7	12	7,352
W. P. Hightower, D.....	253	17	8	4	4	5	42	30	40	12	9	10,569
Fred L. Ingraham, S.....	216	31	1	1	13	19	4	9	13	4	1	343
PROBATE JUDGE												
Joseph H. Gouffrey, R.....	233	11	6	1	16	5	25	26	24	7	12	9,559
D. L. DeVane, D.....	187	11	6	1	16	5	25	26	24	7	12	10,699
Bert L. Nunnally, S.....	46	15	1	1	16	5	25	26	24	7	12	102
SUPERVISORS												
John M. Spence, R.....	358	15	1	1	6	5	3	21	135	6	11	12,322
Warren W. Woodman, R.....	248	11	1	1	6	5	3	21	135	6	11	9,875
J. H. Shannon, D.....	449	13	1	1	6	5	3	21	135	6	11	19,901
W. E. Marvin, D.....	207	18	1	1	6	5	3	21	135	6	11	10,612
George L. Bieks, S.....	54	13	1	1	6	5	3	21	135	6	11	198
Robert D. Gates, R.....	54	13	1	1	6	5	3	21	135	6	11	115
SURVEYOR												
Henry C. Johnson, R.....	191	30	1	1	3	4	26	12	16	4	10	10,548
Jasper Parvin, D.....	291	11	1	1	3	4	26	12	16	4	10	14,636
Robert L. Morrison, S.....	76	25	1	1	3	4	26	12	16	4	10	131

bation officers? I ask not favor, but fair play, for these helpless men. Does not the Bible say, 'Open thy mouth and plead the cause of the poor and needy.' Proverbs 31-9.

"I am deeply in earnest about these reforms, and my knowledge comes from experience, and is ample and profound. I am not discussing these matters for either wealth or notoriety—I have both."

FUN IN THE HOME.

The home should be made the jolliest place on earth for the children. Don't be afraid of a little fun at the family fireside. Don't let the boys think that all mirth and social enjoyment is barred from the home, if you wish to keep them away from places that lead to vice and degradation. Young people must have fun and relaxation somewhere, and if they do not find it in their home, they will seek at other and less desirable places. Parents should not repress the buoyant spirits of their children, but join in their merriment around the home fireside. The children will lose none of their respect for their father or mother if they occasionally loosen their "dignity" and take part in the children's fun and sport. An evening's romp and play with the young folks will drive dull care away and dispel the memory of many an annoyance of the day. Have fun at home.

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The New Legislature.

Complete returns from the entire Territory show that the democrats will be in absolute control of both houses of the Territorial Legislature.

The personnel of the Legislature will be as follows:
Council—Democrats 9, Republicans 3.
Assembly—Democrats 14, Republicans 10.

The personnel of the Council will be as follows:

- Apache—S. E. Day, Republican.
- Mohave—Keen St. Charles, Democrat
- Coconino—Fred Breen, Republican.
- Yavapai—M. G. Burns, Democrat.
- Navajo—William Morgan, Democrat.
- Maricopa—Brady O'Neill, Democrat.
- Pinal—Thomas P. Weedlin, Democrat.
- Yuma—Geo. W. Norton, Democrat.
- Gila—G. E. P. Hunt, Democrat.
- Graham—J. R. Hampton, Democrat.
- Cochise—C. L. Caven, Republican.
- Pima-Santa Cruz—J. B. Finley, Dem.

In the Assembly a partial list of the members is as follows:
Mohave—S. W. Tobey, Democrat.- Navajo—Joseph Petersen, Democrat.
- Yuma—R. A. Hightower, Democrat.
- Gila—John McCormick, Democrat.
- Pinal—G. L. Shaw, Republican.
- Graham—W. W. Pace, Democrat.
- Santa Cruz—F. J. Duffy, Democrat.
- Maricopa—S. T. Webb, Democrat.
- Frank DeSouza, Democrat.
- Pima—John Doan, Rep.; K. Moore, Rep.; G. Hogwood, Dem., or Hill, Rep.
- Yavapai—G. A. Bray, Rep.; Perry Hall, Dem.; G. D. Moore, Dem.

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Wednesday, Nov. 18—Music Recital by Prof. Weber's pupils—Dance follows. Nov. 20—"The Devil."
Everything New—New Music, New Machine, New Pictures, New Singer.
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YUMA, ARIZONA

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