

CONQUEST OF RIVER AND SEA.

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[We are sorry that the work of which Professor Larkin writes in the following article is seriously endangered and may prove a useless expense instead of a victory which at Thanksgiving time could so confidently be predicted. From *The Chicago Tribune* we quote the following dispatch, dated at Los Angeles, Cal., December 10:

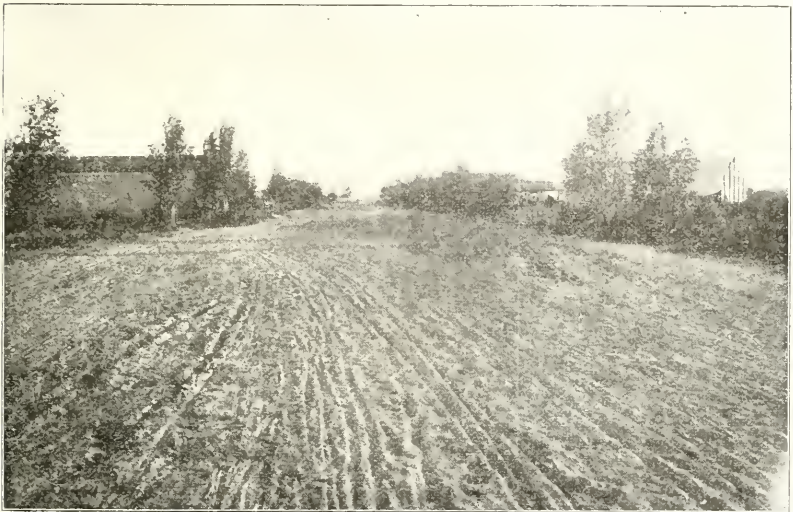
"With the breaking of the Colorado River yesterday through a \$1,000,000 dike, just completed by the Southern Pacific, settlers in the Imperial Valley have given up practically all hope of saving their rich farm lands from inundation. As most of these farms lie from 70 to 200 feet below sea level, there is little prospect of the waters being drained off unless government engineers evolve a plan to turn the river back into its channel. Where to-day are rich towns and prosperous farms, the future seems to portend only a huge salt inland sea, hemmed in by mountains. The city of Imperial will be from fifty to seventy feet under water should the waters not be dammed shortly. The transcontinental line of the Southern Pacific is doomed already. Orders were issued to-day to rush 2,000,000 ties and rails to Mecca to build a new line beyond the mountain ranges for a distance of forty miles. Gangs of men have been ordered to begin operations immediately upon receiving instructions from General Manager Calvin. Southern Pacific officials are of the opinion that the railroad will give up the struggle with the waters, as it is estimated that \$2,000,000 more would be required in a second attempt to turn the river back to its old channel. Even then there is no assurance of the permanency of the work. Should the Southern Pacific abandon the fight the entire region is doomed unless the government will take immediate steps. To add to the gravity of the situation, the river may scour its way back through Deep Cañon and carry away the \$3,000,000 government dam at Laguna, ten miles above Yuma. Should this dam go out no human agency can raise water from the river to irrigate the surrounding lands again, for it will speedily cut a channel from 80 to 100 feet deep through the yielding silt, leaving the farms and fruit orchards high above water."

Steps have at once been taken to save the endangered strip of land. The citizens of Imperial propose to give \$1,000,000, the Southern Pacific Railroad \$1,500,000, and it is expected that the United States Congress will assist with \$2,000,000 to repair the dam and prevent further mishaps.—ED.]

"WATER has stopped pouring into the Imperial Valley," said the telephone in a little hut of poles, thatched with willows on the brink of the subdued river. And the twelve thousand people below heard all about it in an incredibly short time. Almost two years of brooding anxiety had been their fate, but suspense and care turned to joy in the space of one-fifth of a second when the

news came. One of the most remarkable engineering problems of this or any other age had been solved.

If the reader will turn to the account of the great disaster—the bursting out of the Colorado River—in *The Open Court* for *September, 1906*, he will secure a faint idea of the magnitude of this work in skilled hydraulic engineering. Here is the problem, and the engineers in charge were frankly told by some of their brother engineers, that the break in the river bank could not be closed. A stream of water saturated with silt, whose width was 3000 feet had to be cut off. The depth of the water was from 9 to 12 feet, with a



IMPERIAL AVENUE, CALEXICO, CALIFORNIA.

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This street which crosses the International Boundary line and enters Mexico shows fine silt from Colorado Canyon. Tall trees four years of age stand where once the "desert reigned in solitude." This soil is rich beyond comparison, and vegetation grows in almost tropical luxuriance.

velocity of flow of 12 feet per second. But the bottom, banks and adjacent lands for square miles round about are composed of pure silt. This substance is ground as fine as flour, and dissolves almost instantly when water touches it. The silt is of great, but unknown depth, certainly not less than 2000 feet, possibly 5000. It came from Colorado and Utah and was ground in that great mill—the Grand Canyon of the Colorado, during hundreds of millions of years. Piles driven in it to hold up a railroad, could not be depended upon for a day. The stream was growing wider and deeper minute by minute,

and costly fields of grain, grass and fruit were being hurried away to the Salton Sea. Annual floods in the Colorado were sure to come and make the break miles in width, forever beyond hope of filling.

Epes Randolph, H. T. Cory, E. Corillo and Thomas J. Hinds stood on the bank of silt and wondered how the devastating floods could be conquered.

"Central, please." "Hello." "Give me the Southern Pacific, Los Angeles." said Mr. Randolph, speaking into the receiver of the telephone in the now historic hut.

History may never record the words spoken to and fro, but here is what happened right away. Two grand divisions of the Southern Pacific Railroad instantly went out of the goods-carrying business. Every car filled with any kind of freight was unloaded at once, and no more were received for shipment. Telegraphs and telephones everywhere began to speak. Now let us see what other events at once took place.

Thousands of men seized bars and picks, and with steam-drills and great cranes attacked granite mountains in every stone quarry within 350 miles. Dynamite and giant powder thundered at the rocks by night and by day. Every quarry was rushed with cars. Goods-cars, coal-cars, flat-cars, lumber-cars, steel-cars, cars, no end of cars, filled every siding. The entire southwest was stripped of cars. Passenger trains often gave way to monster trains of stone-cars. When the battle with the flood was at its height, stone-laden cars were attached to express trains. Only mail trains had full right of way. Before this, a spur railway from the main line had been laid to the brink of the flood. Before the thousands of cars from the quarries arrived, new sidetracks were put down everywhere on the silt beds on which to store cars for the approaching conflict.

Excitement grew, and so did the width of the river. And then 2200 cords of tall slender willows were cut and piled high on the bank where the end of the enormous dam was to begin. A large flat-boat or barge was anchored by the shore close to the willow heap. A straight row of piles was driven across the stream and five-eighth inch braided wire steel cables were attached to them. These held the barge from going down stream. Twelve "dead-men," great logs, were buried in the silt banks. Twelve colossal spools of cable were placed on the far side of the flat-boat. Skids, or inclined planes, smooth on top, were placed between the spools and edge of the boat near the shore. The ends of the cables were anchored to the "dead-men." Many cords of willows were placed on the boat.

Then hundreds of men made fascines—bundles of willows 20 inches in diameter and 90 feet long bound with wire. Twelve cables nearly eight feet apart were twisted around the bundles in double loops. The fascines were the woof and the cables the warp of a leafy carpet 90 feet wide and 3000 long. When a strip had been woven of suitable length, a steamer pulled the barge into the river. The spools revolved, the cables unwound, the beautiful Brussels carpet slid down the skids, dropped into the water and sank to the bottom, anchored by cables to the row of piles up-stream. A pile driver followed and put down the carpet-tacks—piles from 40 to 60 feet in length—through the willows and tacked this Ax-



WEAVING FASCINE MATS.

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At California Development Company's lower heading, Imperial Canal. The fascines are being woven on the flat-boat. When the boat is drawn across stream, they slide into the water and sink to the bottom where they are pinned down by piles.

minster to the soft floor of silt. And then silt began immediately to settle in between the twigs and leaves. Then two rows of piles were set across the river: heavy timbers were laid on the tops, then the ties and rails of a railroad of great strength were placed on this massive foundation, quite necessary, as will be seen later.

BYPASS AND THE ROCKWOOD GATE.

Before any of these preparations had been made, a bypass 50 feet wide had been cut around the place where the north end of the dam was to start. A massive head-gate was placed in this pass at a cost of \$55,000. The purpose of this cut was to carry part of

the water from the front to the rear of the dam while building, and relieve pressure as the dam rose higher and higher. The gate was to have been kept open until the big dam was completed, and then closed. This and the dam would cause the water to rise and pour into its original bed and go smiling on its way to the Gulf of California.

BUILDING THE GREAT DAM.

When the side-tracks were filled with thousands of cars of rock, activity began. First, a long train moved from the north side of the river across to the south. This was occupied by hundreds of men armed with steel bars and pikes. The huge stones were pried off the cars, when they fell with crash, rattle and roar into the river and settled on the carpet. A train on the north end of the railroad was emptied at the same time; and then more trains, and still more. On they came without cessation, day or night. Thus the dam advancing from both ends kept narrowing the space between the approaching bulwarks of massive stones. When this space contracted the speed of the water began to increase. With more contraction, the river above the dam commenced to rise slowly, and then a little faster.

AN APPARENTLY CRUSHING DISASTER.

The water got its shoulder under the Rockwood gate and away it went with rush and roar. Consternation and dismay filled every mind—except those of the four engineers. Gloom spread throughout the Imperial Valley. It is not known what thoughts raced through the minds of the four; but the 1050 workmen could not detect one trace of fear. Instantly every man left the great dam and attacked this unlooked-for danger-problem. For unless the bypass was closed immediately, the silt banks would vanish and the two cuts would join into a break a mile wide or more, and forever seal the doom of Valley Imperial.

Sleep disappeared, piles were driven, and a railroad was thrown across the bypass in haste. And then rocks rained. Trainload after trainload went out of sight in the boiling flood. And trainloads of gravel, clay and sand. Finally, the heap appeared above the water; and then more trains emptied on the crest to bring it up to level with the banks. The floods in the deep cut were thus conquered, and then they backed around in front.

ALL HANDS BACK TO THE GREAT DAM.

The diverted Colorado River that had been displaying its rage at the dam in low, sullen, but ominous tones, now began to roar. As the ends of the dam drew nearer, the roaring grew louder. The water surged, boiled and seethed in anger. Its speed increased with every trainload of rock hurled into its face. Water weighs 62 pounds to the cubic foot: and when in rapid motion, its momentum becomes one of the most formidable powers in nature. When the gap grew narrower, not only did the velocity of the flood greatly



PILING FOR THE RAILROAD TRACK.
(Photograph by W. J. Lubken.)

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Across the Colorado River, at the California Development Company's dam, just below the old river bed of the Colorado River, which is now 10 feet in elevation above the present channel. The river is to be diverted back into its course again, if possible. Velocity of water as shown striking the piles, is 12 feet per second. The edge of a vast bed of pure silt is seen in the foreground.

accelerate, but the river began to rise: and pressure on the dam became enormous.

At sunset November 3, the time for fear, wavering and faltering came. No hope of help from the bypass; all the water that went through that, now had to be dealt with in the center of the great dam. The destruction of the gate changed every plan. Suppose one to be engaged in building a house by plans made by an architect; and that, when half finished, something should suddenly occur

to prohibit the use of the specifications ; but circumstances were such that the house must be built in haste, or a vast sum of money would be lost. The chances are that the scheme would fail and the loss ensue. The Assyrians and Babylonians in their engineering along the Tigris and Euphrates, and the Egyptians with the Nile, had ample time. But there was not a minute to waste on the Colorado.

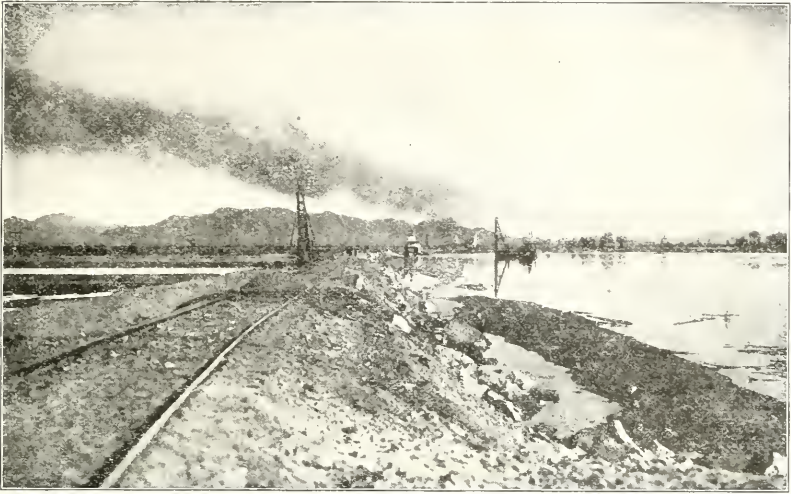
Here is the case: 1,500,000 acres of land in the Imperial Valley, pronounced by U. S. Government experts to be as rich as that in the delta of the Nile, were in danger of reverting back to a desert waste, forever deprived of water. The homes of 12,000 people, square miles of rich grains, grasses and fruits, six little cities, hundreds of miles of railway track, and thousands of domestic animals, these and more, were on the verge of destruction. For already the bottom of the diverted river was lower than its primeval bed by 10 feet; and still cutting lower. The fact stared them in their faces that the costly system of canals would soon be destroyed; and that the awful desert conditions would assume dominion; and that every human being and animal must leave the beautiful vale, never to return.

SHILOH AND GETTYSBURG AT NIGHT.

Rays from the falling sun just before they were cut off by the vast granite rim of the Salton Sink, fell on four faces and brought out lines of determination set and fixed as though cut in flint and adamant. These were the engineers "cumbered with a load of care." For the eyes of every hydraulic engineer were watching from afar every move to see which would come out victor, man or river. And the sun's fainting light fell on the faces of 600 men of the Caucasian race, and 450 Indians—all selected men, trained like soldiers for this dangerous war: Americans, Spaniards, Mexicans, Frenchmen and Germans, together with Cocopahs, Mariposas, Pimas, Diguones, Yumas and Mojaves, who formed the largest number of American Indians ever at work in one body.

When darkness fell the electric lights flashed upon the weird and entirely unique scene. The river was rising and the impetuous flood roared louder than before. The terrific speed of the pent-up water was fearful to look upon, even; to say nothing of man's audacity in attempting to stop its wild career. No shadow of fear, discomfiture or dismay appeared on the bronzed features of the engineers. For, if there had, it is probable that a panic would have ensued at once. It was just before a real battle, fraught with danger. These men had to go out over the awful flood 1500 feet

from either shore. Who could say but that the dam might go when the water came up to the carwheels and sink every train on the tracks? Burning oil under the locomotive boilers roared hot words of defiance to the floods beneath; and the water hurled back derision and scorn to the roar of fire and hiss of steam, to exploding safety valves, and exhausts of monster engines and the hideous grinding of a thousand carwheels on granite grit. No such combine of noises was ever known on earth. "Go," was a word of command. Two



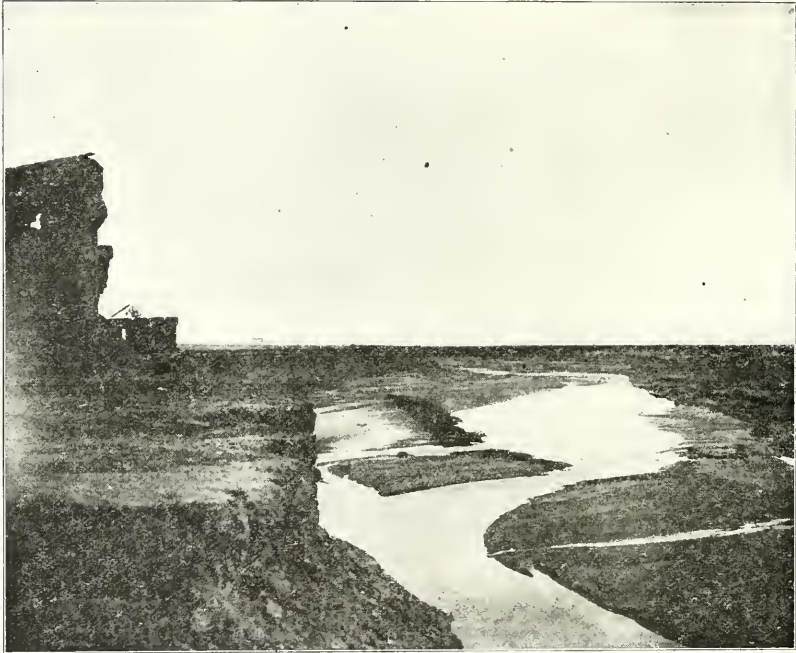
GREAT DAM IN THE BREAK IN THE WEST BANK OF THE COLORADO RIVER, MEXICO.

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Looking north. The distant mountain is Pilot Knob, California. Length of dam 3000 feet; height, 44; width at bottom from 250 to 300; cost \$1,250,000; time of building 86 days. The steamer Searchlight is opposite the final gap closed on Nov. 4, 1906. When the view was taken, Nov. 11, the pumps on board were forcing water through a hose, at high pressure, against a trainload of clay under the upper railroad track. This washed the clay into the interstices between great rocks and small gravel in the main dam. The Colorado River is one mile to the right. The water all passed through the break here shown, to the Salton Sink, to the left at a distance of 76 miles.

entire trainloads of rock hailed into the jaws of the torrent. The floods howled in rage and rose a little higher. The empties moved to shore, and two more long trains came over the gap and hurled their loads into the teeth of the dragon below. Pelee was rivaled in the art of stone-throwing and Vesuvius, for a new Gettysburg was raging. Then long trains of enormous weight, of cars called "battleships" loaded with hundreds of tons of gravel rolled over

the tempest of water. These cars are made of steel; and their sides are suspended on hinges. At the word of command, both sides of both trains flared out and a rain of gravel fell, the like of which was never seen. These small stones filled the interstices between the large. This caused the river to rise faster, and the awful current to increase its fury. And pressure grew apace. At midnight a wonderful word of command was heard, "Faster."



GREAT EXCAVATION IN SILT MADE IN MEXICO BY THE COLORADO RIVER. 5153

(Photograph by Litchfield.)

Width 2000 feet, depth from 50 to 80 feet. The village of Mexicali once stood here. The ruin at the left is 300 feet in Mexico from the boundary line. The flood cut backward through this great cut at the rate of one-half mile in 24 hours. The village of Mexicali cannot be found, its debris is in the bottom of the Salton Sea, 40 miles away. The track of the Southern Pacific Railway is in the deepest part of this "scooped-out place."

More oil went into the fires, steam could do no more. Pikes and bars of steel were grasped with renewed energy by many tribes and kindreds of men. Human hands could not move faster. "We must have large rocks now," was the order at 1 A. M. For rocks now began to be deflected out of a vertical line and go down

stream somewhat. "Bring the five-ton rocks." One of these, weighing $5\frac{1}{2}$ tons was watched when it dropped. The water clutched the mass when it rolled and tumbled over similar rocks down the side of the dam sixty feet. It is still there—a witness to the momentum of running water. "More rocks!" was the incessant cry.

Behold! there was light in the east. It was dawn, the progress of time had not been noticed. More trainloads of heavy rock brought the crest of the dam up to the tracks. Then train after train of "battleships" expanded and thundered down gravel. As the sun rose, so did the river, and faster if possible came the rock and gravel. Here is the record of the battle when at its height. One car of stone was thrown in during each interval of $4\frac{3}{4}$ minutes! This broke the world's record. The throats of *Ætna* and *Cotapaxi* may have done better at times.

"Oh look! The river is not rising," shouted some one. "The water is stationary," said another. And "it is beginning to fall," another. And then a triumphant shout, a shout of victory was heard in the wilderness. What had happened? Nothing but this: The Colorado River had been hurled back into its original bed by the hands of human beings,—and it was then on its way to the Gulf of California, away from the Salton Sink. Imperial Valley—worth \$100,000,000—was saved. And the Southern Pacific Railroad was saved. And now they are getting up a big International Celebration to be held in Calexico in December. The victorious shout rose above the chained and conquered river on Sunday, November 4, 1906, at exact noon. Let this date be written in every history of the United States; and let the plans of the colossal work be placed in every college text-book on engineering, civil, hydraulic, and geological.

ITEMS OF THE DAM.

Length, 3000 feet.

Width at bottom, 250 to 300 feet.

Height when finished, 44 feet.

Cords of willows used, 2200.

Piles 40 to 60 feet in length, 1100.

Feet of railway trestle built, 3800.

Miles of $\frac{5}{8}$ -inch steel cable, 40.

Tons of rock in dam, 70,000.

Cubic yards of earth by cars, 200,000.

Cubic yards of earth by horses and mules, 300,000.

Locomotives employed, 8.
Men employed: Caucasians, 600.
Men employed: Indians, 450.
Cost of dam, \$1,250,000.
Time in building actual dam, 86 days.
Acres of rich land saved, 1,500,000.
Miles of canals saved, 300.
Value of all that was rescued, \$100,000,000.

The latest estimates of damages report 30,000 acres of land washed into the Salton Sink; and 30,000 more acres injured by gullies. Part of the land was under cultivation. Eighty miles of railway tracks were submerged. The town of Mexicali in Mexico was four-fifths washed into the sea. Millions of dollars in value of salt in the bottom of the sink is covered by silt. At this writing—on Thanksgiving day, the area of the Salton Sea is 500 square miles; and its greatest depth is 78 feet. The average rate of evaporation is 7 feet per year at Yuma, Arizona. At Calexico, the evaporation in 1904 was 8 feet 8 inches and in 1905, 7 feet 4 inches. So the sea will be with us for some time. And this is the way that man waged a severe battle with Nature.