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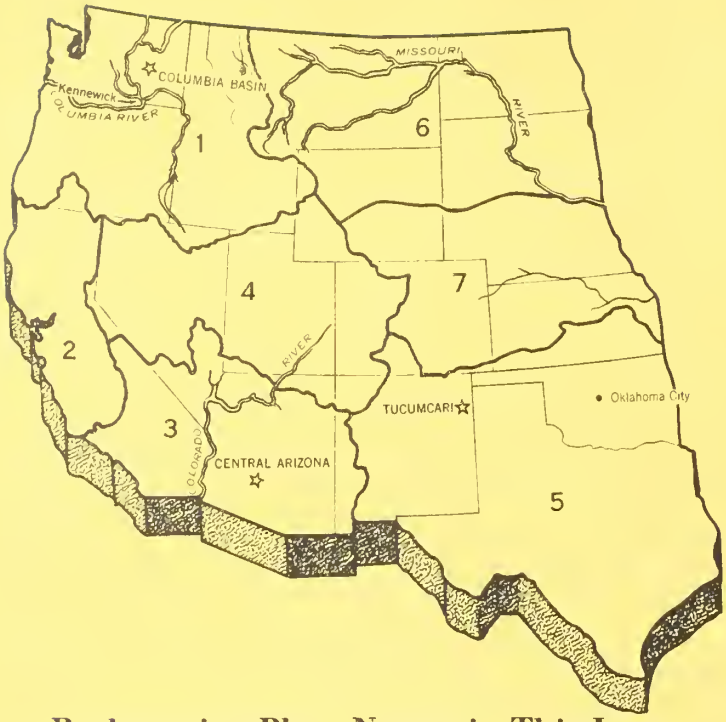

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Ruth F. Sadler, *Editor*

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J. A. Krug, Secretary

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Wishing You

A Happy

And Prosperous

New Year!

OUR FRONT COVER

Kid 1949 is ready for Reclamation's New Year, but he'll have to go some to match Old Man 1948's accomplishments in food production and power generation. The youngster is Charles Logan, son of Mr. and Mrs. Malcolm Logan. Mr. Logan is a geologist in the Region I office in Boise, Idaho. The photo was taken by Stanley Rasmussen.

Alaska—Far-from-forgotten Land

by WILLIAM E. WARNE
Assistant Secretary
of the Interior

Above: Beach on Atka Island, of the Aleutian Chain, (Fish and Wildlife Service photograph.)

At left: The author (center) speculates on the age of the ice he is holding. Dr. Harlan Barrows (left) Consultant to the Department of the Interior, of the Federal Inter-Agency Alaskan Development Committee, and Joseph Flakne, Chief of the Alaska Branch, Division of Territories and Island Possessions, who accompanied Mr. Warne on one of his inspection trips of Alaska, also have their backs turned to the glacier Mendenhall located near Juneau.

ALMOST TOO APPROPRIATELY, THE "FORGET-ME-NOT" is the official flower of Alaska. This plaintive message has been all but ignored in the past.

"Seward's Folly" the "land of perpetual ice and snow" the "frozen North" are among the inaccurate conceptions once widely held of this land which the natives called Alakh-Skhak—Great Country.

World War II revealed the importance of Alaska as a strategically located outpost. Men and women who had been stationed in this land of contrasts, with its surprises of flowering valleys, jewel-like lakes, sturdy forests and mild summers, brought back tales of its untapped resources and unexpected beauties to dispel some of the myths which have surrounded Alaska since it was purchased from Russia for $7,200,000 in 1867.

Postwar emphasis on conservation and development of natural resources, Alaska's proximity to Russia (50 miles away by sea at the nearest point) and its position as a crossroad for ship routes and the new northern airways, is bringing the "great country" into its proper focus. Alaska is vital to our national defense and has important contributions to make to our national wealth.

There is much talk about the United States of America "coming of age." It is said, and most clear thinking people believe, that we have passed the adolescent period of internal conflicts, irresponsible selfishness, and unpredictable eccentricities, and are now embarking on an age of growing awareness of our position in the world scene. Be that as it may, in one respect at least we are approaching maturity, on the Alaskan problem. We are learning to cooperate for the good of the country and the benefit of those people who are living in Alaska, and who we may hope, will choose to live there in the future.

A little over a year ago, the Alaskan program began to get under way. Under the impetus of the world situation and our corresponding need to increase our production and storehouse of natural resources, we began to look at Alaska—our last frontier. It was then we found that, in spite of its 80 years as a Territory of the United States, it is a great nearly vacant area at the present time. It covers about 585,000 square miles—about one-fifth the size of the United States and has a population of about 94,000 people. The distance from Ketchikan in the southeast to the Aleutian Island of Attu in the west is almost as great as the distance from New York to San Francisco. From Ketchikan to Point Barrow in the north is a trip as long as from the Mexican Border to Seattle.

And the people in Alaska? About two-thirds of the total population constitute the white inhabitants, while Eskimos number about 16,000; Aleuts who inhabit the Aleutian Islands, less than 5,000; and native Indians who live for the most part in the south central and southeast areas number 12,000. The Alaska Native Service of the Indian Bureau has worked faithfully with the native inhabitants, and according

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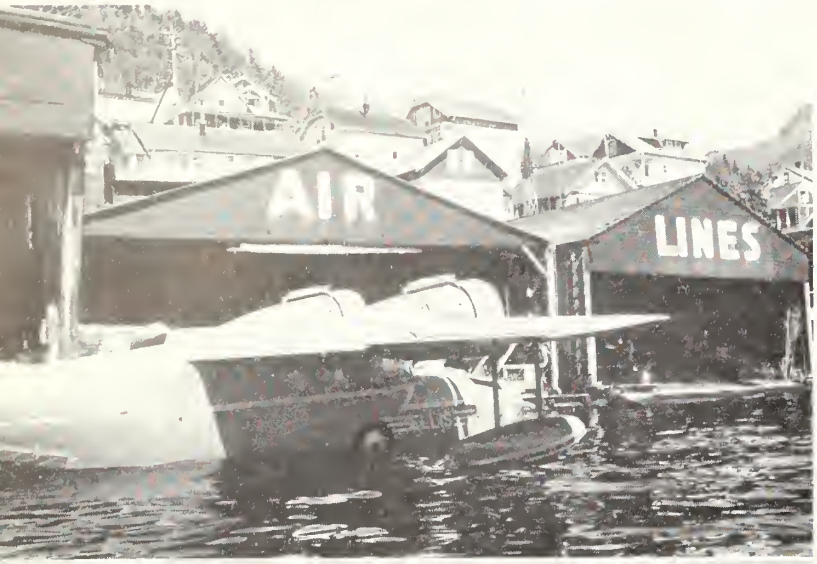
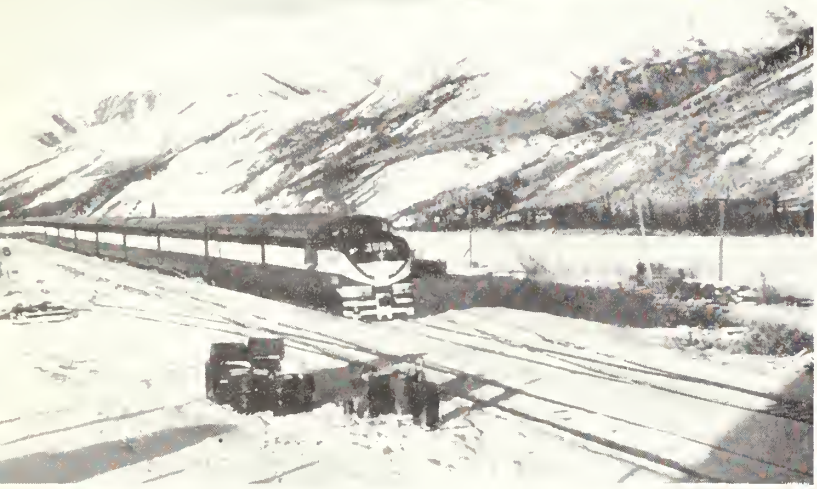
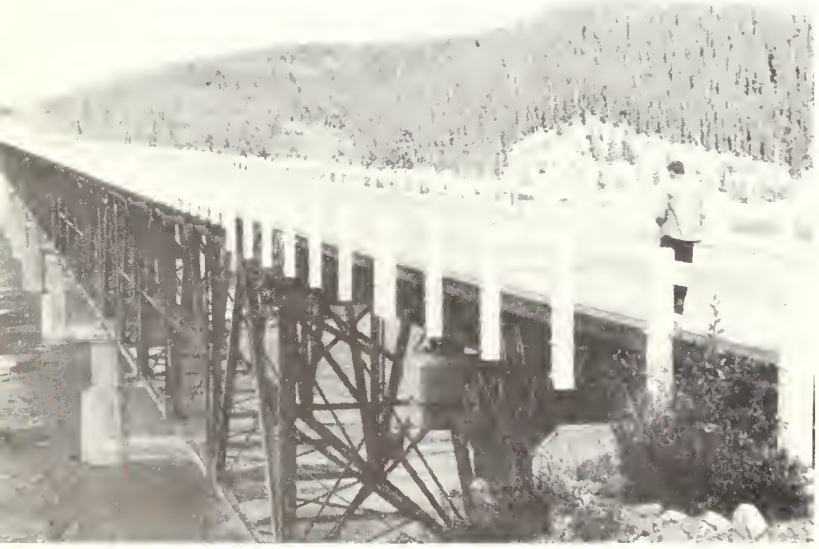
Reindeer and dog sled teams are being crowded out of the picture by modern transportation methods.







Air-minded Alaskans take to planes as easily as this seaplane at the Ketchikan waterfront takes to water. The center photo shows the "Aurora" Diesel train of the Alaska Railroad on her maiden run, and the Robertson River Bridge on the Alaska Highway in eastern Alaska (bottom photo) provides another link in the Great Country's chain of transportation. Two top photos by the Fish and Wildlife Service, others by the author.

to the policy of the Interior Department has protected their interests as natives and first settlers ever since the gold-rush days, when the first waves of American settlement beat against native possessions.

Not only the population, but the extreme variations of the terrain and climate make this a country of contrasts. You can divide Alaska readily into at least five regions: the Arctic Coast, the Bering Seacoast, the Aleutian Chain (these three regions have little immediate opportunity for economic development) and then the great Central or Middle Section and the Southeastern section—the long tail of Alaska down the Pacific from the mainland.

The Central Section is growing more rapidly at the present time under the stimulus of military activities. It has also received a shot in the arm from the Alaska highway and the two great International Airports, which are being built near Anchorage and Fairbanks.

Southeastern Alaska is mostly a long series of islands large and small. This makes up one of the most beautiful areas that I have ever seen anywhere. If you can imagine the Maine coast with mountains 8, 10, or 18 thousand feet high rising immediately behind the shore, you would have some idea of what southeastern Alaska looks like.

The central and southeastern sections are the ones which show the most promise, and are the areas where we shall concentrate most of our efforts.

There are many, many knotty problems in connection with the development of Alaska. The latest land law was made in 1898, and is as out of date as a side-crank, one-lung horseless carriage that was made about the same time.

All the industries of Alaska have been extractive and exploitative in nature, and they have been absentee-owned. There is the fur industry. This attracted Russia and, after the United States took over the country, it was the basis of our use of Alaska until gold was discovered in 1898. Such a complete job was done by the fur industry that for years it was believed that the sea otter had become extinct. In 1934 we began to apply modern game management methods and now we find about 10,000 of them along the Aleutian chain. There must have been one pair that, like the animals off Noah's Ark, escaped and began to rebuild their race. At present, it is a serious offense to kill one of them. The famous Pribiloff seal also almost disappeared under uncontrolled slaughter practices. In 1910 there were only a few over 100,000 of them remaining in the world. We now have a herd of 3,800,000 which has been built up as a result of the conservation activities of the Department of the Interior, and in that interim we have been able to take a million skins without jeopardizing the growth of the herd.

Gold is the only mining that has been extensively practiced in Alaska and it is a safe bet that most of the rich lodes have been thoroughly explored. However, Alaska has not been prospected for most other minerals and metals except in a sketchy way—and it abounds in undeveloped mineral resources: coal, limestone, petroleum, platinum, copper, mercury, zinc, tin, chrome, and antimony. We are trying to improve that condition now through a program of the Bureau of Mines and the Geological Survey. Planes have been flying over the area reconnoitering these resources, and surveys are being made on land. Some enterprising scientists on our staff

were planning to outfit dog-sled and possibly wagonen (a house built on skids, pulled by a tractor) teams for exploring parts of the territory which are being staked out for development.

Fishing was the third great industry to be developed in Alaska, and we are in danger of experiencing a repeat performance of the fur industry's plight—exploitation to near-elimination. The pink salmon catch, which is one of the most important fisheries under our flag, has gone down steadily over 20 years. It is going to take some drastic action to build the salmon runs up to their previous levels in southeastern Alaska. All the fisheries, except for some seine boats and two or three canneries, are absentee-owned.

Workers are flown up during the fishing season (which is very short, only 3 to 6 weeks long) and then they are flown back again. This is a typical exploitative and extractive industry the way it is being carried on. The Fish and Wildlife Service has done the best it could with limited personnel and facilities, and it is hoped that through the teamwork which we are developing a more and more effective job can be done to maintain our fish and wildlife resources at a sensible, economic level in the future.

When you have named those three—furs, gold, and fish—you have named all the industries which have been developed to any great extent up to the present time, although just last year the first of the great timber sales were made by the Forest Service to a pulp company which plans to put in a mill in the Ketchikan area, the extreme southern part of southeastern Alaska. There are great forests in southeastern Alaska and some sections of central Alaska. It is estimated that the Tongess National Forest in the southeast can supply enough pulpwood to meet a fourth of all market demands for paper in the United States and give employment to about 35,000 people.

We hope that the pulp industry, or the forest products industry, whatever it may be called, can be molded in such a way as not to be completely owned and managed and operated by and for the "outside" as Alaskans call non-Alaskans.

It may be hard to believe, but it brings into focus the plight of Alaska, that there is but one brick kiln in all of Alaska—and not a single cement mill.

When it comes to agriculture, it has been estimated that there are from one to two million acres of potential farm lands and another 4 million acres considered suitable for grazing stock. Yet only around 12,000 acres are now being cultivated. The Matanuska Valley is the fastest growing agricultural region in the Territory.

"Want in the midst of plenty" aptly describes Alaska's situation. As varied as it is, and with the greatest untouched forests remaining to us, Alaska still imports its lumber from Seattle for building houses. The ties used on the Alaska Railroad are harvested and treated in the State of Washington—none of them come from Alaskan sources—it would cost too much to send timber to a mill to be made into ties and shipped back to Alaska, and there are no sawmills capable of doing the tie job in the territory.

And that brings us to the great obstacle in the way of Alaskan development—transportation. There are fre-

Furs and fishing—two of the three main industries of Alaska. The other was gold. Later, who knows?

The winsome baby fur seal is but one of the growing younger generation now found flourishing at the rookery at St. Paul shown at its left. The photo of the motorboat approaching the fish cannery at Klawock Harbor in southeast Alaska is a typical scene of that area. The red and arctic fox pelts held by the man in the bottom photo were traded at the Eskimo cooperative trading store at Point Barrow. All photos above taken by the author.

quent tie-ups that last for months and nothing goes to Alaska. During the 1948 West Coast maritime strike it became necessary for the Secretary of the Interior to direct the Alaskan Railroad to start an Alaska barge service to keep the Territory supplied with essential commodities. At present the main highways and roads total around 3,000 miles—about the length of the rural roads in the State of Delaware—for a territory of over 580,000 square miles. The one railroad—the Alaskan Railroad, government owned, extends from Seward to Fairbanks by way of Anchorage for a total distance of 470 miles. The Alaska Highway built by the United States Army during the war extends from Dawson Creek, British Columbia, for a distance of 1,500 miles to Fairbanks, but as yet cannot carry an important share of the transportation burden, because the southern connection below Dawson Creek is bad and because of an insufficient network of feeder roads in Alaska. The biggest contribution toward improved transportation is the airplane. Today, Alaska has 27 major airports with the great International Airports in the making. The number of registered commercial aircraft has jumped from 99 in 1940 to more than 600 today. The air age is opening up Alaska. Bush pilots go anywhere in almost any weather. The dog team is being replaced by ski-planes. The general transportation problem will not be solved, however, until the cost of shipping supplies to Alaska goes down. One reason for the high cost of living in Alaska is that 95 percent of everything Alaska imports from the United States is brought in at the highest freight rates under the American flag. These costs go up according to distances, and are kept up because of lack of backhaul. But Alaskans cannot produce exports without electric energy to power industry.

During the war and since, the armed forces have spent large sums in a defense construction program. While many of these installations will be permanently manned, the present pace of construction cannot continue. Therefore, people of Alaska must be given an opportunity to become self-sustaining, producing wealth for themselves and the territory, and thereby protecting the economy and welfare of the United States.

Two related problems, and maybe more, will be solved through the producing of electric energy in Alaska. One is the lack of small, locally developed industries and the other is the lack of venture capital. For example, if you wanted to go into the cement business in Alaska (and there are raw materials to assure its success) you would not only have to build the cement mill, but build the power plant.

The Federal Inter-Agency Alaskan Development Committee, which was formally organized last year, feels that if we can develop hydroelectric power in Alaska, the edge can be knocked off the high cost of energy. Some industries will be attracted. This would also reduce the size of the requirement for capital in putting small industries into the Territory, and knock down the high cost of living.

Without a new source of energy, a town like Anchorage will have to stop growing. Without a lower-cost source of energy, the same town will have no development of business or basic industry to support it in the long run.

Development Will Be Orderly

There are many plans which have to be woven together to assure an orderly development of this vast and rich territory.

There has been virtually no organized effort, until very recently, on the part of any agency, private or Government, to develop or to stimulate development of Alaskan industry, community life, and agriculture. The Inter-Agency Committee, composed of the representatives of 16 agencies of the Federal Government, is working toward a 5-year coordinated plan and program covering the major developments which the Federal Government should undertake. In addition the Interior Department now has an Alaskan Field Committee, composed of on-the-spot, on-the-job members who will trouble shoot and expedite plans.

Last summer when I visited Alaska I found that nearly all the people in Alaska feel that the program which the Bureau of Reclamation is launching through its power investigations this year is among the most important.

The work got under way last July, and a report on the Eklutna project has already been submitted to the Secretary. Engineers have reconnoitered only the major rivers so far, but already they have found hydroelectric power sites which would produce more than 50 billion kilowatt-hours annually. This represents about one-fifth of the entire power produced by United States utilities in 1947. In all of Alaska only 34½ million kilowatt hours were produced last year.

Like Tantalus in the Greek legend, these resources are

(Continued on page 8)

Mowing clover on a farm near Fairbanks. *Photo by the author.*

CENTRAL ARIZONA PROJECT

Citrus groves on the right, result of irrigation, show contrast to desert land on the left. The scene is in the Salt River Valley. *Photo by William S. Russell, Reg. III.*

Part One—History of Development

by W. S. GOOKIN

Engineer, Office of Project Planning, Washington, D. C.
(*Formerly of the Phoenix Office of Project Planning, Region III, Boulder City, Nevada*)

Before the dawn of the Christian Era, man first joined battle with the forces of nature in an effort to subjugate the unruly streams of Arizona.

This was a battle to water fertile desert waste lands and to nurture a verdant oasis in a region where the climate is such that under natural conditions only the hardiest of desert vegetation can survive. Down through the ages the battle has raged as step by step man has constrained the rivers to flow according to his will and has carved an irrigated empire from the desert. The tide of battle has varied. At times in ages past it has appeared that man's beachhead would be lost entirely and that the desert would reclaim its own forever. At times man has infiltrated far into the enemy territory only to be driven back by the relentless forces of drought.

Today this battle is approaching a crisis. Man has reached a high tide in his efforts to expand his agriculture. However, once again the forces of nature are gathering for a counteroffensive. Man must retreat or fight. Today man fights with weapons never before available. He has developed engineering methods to the point where it is in his power to build developments which would consolidate his present gains for virtually all time.

The Bureau of Reclamation points out these facts in a recently completed report on the Central Arizona project, which reveals that development of this area was begun centuries ago by a people known to us as the Hohokam. At several places in the valley today, a few canals and laterals built by these prehistoric farmers may still be found.

Investigation shows that, all told, something like 250,000 acres were cultivated by these ancient peoples in the course of their existence here. Of course, their irrigation system was rudimentary. Diversions were made by crude brush dams laboriously laid across the river. Between-season storage was unknown.

Despite their crude methods, these farmers had probably the highest-developed economy in North America at that time. They grew their own food and stored it for the future. They raised cotton and wove it into cloth. Socially and economically, they were far advanced in comparison to their wandering neighbors who lived by hunting and pillaging.

These first Gila River Valley farmers disappeared from the valley centuries ago, leaving only crumbling adobe ruins, potsherds, and remnants of their canals overgrown with desert brush and cactus.

Spanish conquistadores, searching for the famed Seven Cities of Cibola entered the Gila River Valley in the second quarter of the Sixteenth Century and found the Papago, Pima, and Maricopa Indians irrigating their lands by diversions through canals in much the same manner as these prehistoric farmers. Jesuit Missionaries followed the early explorers and reportedly aided the Indians' agriculture by giving them new varieties of grain and vegetables. But

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nearly two centuries were to pass before the present agricultural industry of central Arizona began to take shape.

Today's irrigated empire was born shortly after the Civil War when settlers cleared and extended one of the prehistoric Indian canals. The first rich harvests of these desert wastelands were not easily reaped. Depredations of the notorious Apache renegades served to discourage all but the most determined settlers. The mystic lure of easy wealth in California proved far more enticing to many than the prospect of a continual struggle for water in Arizona.

Water to serve the thirsty lands of this new empire was obtained by diverting the unregulated stream flow. During the spring months, when the crops did not need much water, flood after flood boiled down the river channels sweeping away diversion dams, demolishing ranch houses, and destroying lowland farms. When the burning heat of the desert sun scorched the earth there was frequently little more than a trickle of water to serve the parched crops.

Despite these difficulties, the irrigated areas increased year by year. By about 1880 irrigation along the Gila and Salt Rivers was approaching the maximum that could be sustained by the perennial flow. However, the settlers of those days had no way of knowing what this maximum figure might be. Encouraged by past successes and urged onward by a series of years in which the run-off was greater than normal, this maximum was reached and exceeded.

Then came drought. Day after day, month after month, and year after year, the anxious farmers waited in vain for the life-giving rains needed to replenish their depleted streams. Despair invaded the homes and hearts of these people and it seemed that this new agricultural empire was doomed.

The answer to the problem was obvious. Reservoirs were needed to conserve the spring floods for use during the summer. However, no one individual or company was in a position to construct developments of such magnitude. The answer lay with the Federal Government. Realizing this need, the farmers of Arizona played an important part in obtaining passage of the Reclamation Act of 1902.

Floods of 1904 and subsequent years forestalled the immediate threat of drought. However, this relief was recognized as merely a temporary abatement and the havoc wrought by the drought-breaking floods of 1904 served to emphasize the need for harnessing these waters.

The newly created Reclamation Service, now the Bureau of Reclamation, soon began studies of the water supply problems in Arizona. One of the first major developments undertaken was the Salt River project in the vicinity of Phoenix. This development was destined to serve as a nucleus for even greater and more extensive irrigated areas. Creation of storage on the Salt River materially abated water-supply problems in this area.

After completion of Roosevelt Dam, run-off in the streams of the area continued above normal for many years. Farmers watched floods waste down the river channels and dreamed of the additional acreages these waters could irrigate.

Simultaneously the United States was entering a new era. A new source of energy had been found and demands for electricity were increasing by leaps and bounds. Arizona residents undertook to provide additional reservoir storage and to develop new hydroelectric energy as well as irrigation waters. These developments were of necessity based upon inadequate and unduly optimistic records of stream flow.

Another problem of an entirely different nature soon arose. With ample water available most of the time, water seeping into the soil from repeated irrigations began to accumulate. In many areas groundwater levels began to approach the land surface and waterlogging became a serious problem. Pumps were installed to drain the cropped areas.

These pumped waters were discharged into canals and reused to irrigate additional lands. Irrigation by pumping proved to be such a profitable undertaking that wells were drilled with ever-increasing rapidity throughout the area. The water thus obtained was used to serve the ever-expanding irrigated area.

On this basis new acreage was continually being brought under cultivation. Some of this area was watered by surface flows, some by pumped water, and some by a combination of both.

However, beginning the early part of the 1930's, a condition was arising which was to have serious repercussions. A few farsighted citizens saw a specter reappearing on the horizon and foretold disaster but many refused to heed the warnings. Once again the ogre of drought was coming.

Many felt that even though such was the case there was no cause for alarm because water shortages could be supplied by pumping. Underground waters were believed to be virtually inexhaustible. People held firm to the concept of vast underground rivers pouring endlessly to the sea and proceeded to develop more land.

The seriousness of the situation was not generally realized until 1940 when virtually all of the surface reservoirs throughout the central part of the State of Arizona were emptied. An economic disaster seemed imminent. Fortunately the winter of 1940–41 was one of the wettest during the recorded history of the area. Reservoirs were filled and disaster was again forestalled. Some persons believed that the floods of 1940–41 solved the water problem of the area.

However, many residents realized that the flood period merely served to temporarily abate a serious problem.

Once again the content of reservoirs in Arizona has dropped to a dangerously low level. Unless abnormal run-off occurs within a very few months Arizona once again will be faced with economic disaster. Groundwater storages will serve in some degree to alleviate the present drought. But recent experience has proven that wells in this area do not draw from an inexhaustible supply. On the contrary, the groundwater reservoirs underlying central Arizona have very definite capacities and yields. It has recently become increasingly evident that withdrawals from these reservoirs greatly exceed the inflow. The groundwater budget is out of balance. The pump lifts in this area are increasing with alarming rapidity. Unless some steps are taken to forestall such an occurrence, the time will come when the surface reservoirs will again be empty and the underground water storages will be too depleted to maintain sustained overdrafts.

There is a third though more obscure problem arising to threaten the irrigated agriculture of central Arizona. That is the problem of salt accumulation. It has been estimated

that water diverted each year to irrigated lands in this area contains approximately 846,000 tons of salt. Salt outflow from these lands is but a fraction of this amount. Tremendous quantities of salt are remaining in the area and accumulating in the soils and groundwaters.

Mild concentrations of salts of this nature are not deleterious to crop production. However as salts in the soils and groundwaters become more concentrated they become increasingly toxic to plant life. Ultimately enough water must be released to permit sufficient salts to flow out of the area to prevent accumulation in the soils and groundwater. The net effect of this release will be to decrease the water supply available to the agricultural lands.

Unless remedial measures are taken, over one-fourth of the cultivated land in Arizona must revert to desert waste if the remainder is to receive a full water supply. The effects of such an enforced retrenchment would be varied. To some families it would mean displacement—a revival of the jalopy caravans which carried human flotsam away from another drought while dust blotted out the sun over Kansas. Other families would not leave, but would stay on and fight desperately for subsistence. Every family in the State would feel the effects of such a catastrophe and even State boundaries would not restrain the impact of lost production.

It is only recently that the seriousness of this situation has been fully realized. However it is now generally acknowledged that Arizona must find some source of additional water to supplement the supply available to her irrigated lands. The Bureau of Reclamation first began to study this problem in 1940. These studies were interrupted shortly after the advent of World War II and were not resumed again until 1944. At that time the State of Arizona appropriated $200,000 to be used by the Bureau of Reclamation on a cooperative basis to study the water resources of the State and their potential development.

It was readily apparent that stabilization of central Arizona agriculture would necessitate development of some new source of water. Under present conditions the Gila River and its tributaries are virtually fully developed. The entire southern part of the State of Arizona is drained by the Gila River and its tributaries. The extent of development along those streams may be appreciated when it is realized that for the past 7 years the mouth of the Gila River has been completely dry. The only source of supply adequate to solve the water problems in Arizona is the Colorado River.

Diversion of this stream to the central part of the State had been proposed and considered for a quarter of a century prior to the beginning of investigation in this area by the Bureau of Reclamation. Various groups and individuals had proposed numerous alternative projects whereby Colorado River water could be diverted to the central part of the State. However most of these plans were somewhat nebulous. Hampered as they were by inadequate funds, the various individuals and groups had been unable to conduct the necessary investigational work.

Having determined that importation of Colorado River water was essential to solution of the water-supply problems in central Arizona, the Bureau of Reclamation undertook to ascertain which was the most feasible route for bringing this water into the State. Analysis of the situation indicated that every reasonable route had been suggested at one time or another. With the data which were available at the time, the Bureau of Reclamation undertook to determine which might be the most feasible plan. These data were admittedly inadequate and in many cases inaccurate. However, sufficient data were available to permit the elimination from further consideration of some plans for diversion which were materially less feasible than others. From the results of these first studies the Bureau of Reclamation determined that three routes remained which should be analyzed in greater detail.

The Bureau undertook to obtain field data to the extent necessary to make a selection among the three alternate routes.

Selecting the best of these routes proved to be a difficult task. On the basis of studies outlined in a report issued in September 1945, it was possible to narrow consideration to two routes. However, it was not until February 1947 that a report was issued covering studies which supported the recommendation that all further studies be confined to the Parker Route.

A short time prior to this recommendation, Senator E. W. McFarland, of Arizona, submitted to the Senate a bill to authorize construction of the Central Arizona project. In June and July of 1947 the Irrigation Subcommittee of the Senate Public Lands Committee held hearings to consider this project. At those hearings it was decided that the Bureau should proceed with the studies which were then in progress and submit to the committee a more detailed report on the Central Arizona project.

Such a report has been prepared and recently released by Secretary of the Interior J. A. Krug.

The primary purpose of the Central Arizona project would be to deliver supplemental water to approximately 640,000 acres of land now irrigated with an inadequate or insecure

water supply or formerly irrigated, but now idle for lack of water. However, the project would serve many additional purposes. Almost 4½ billion kilowatt-hours of electric energy would be generated each year by the Central Arizona project. Slightly less than one-third this amount would be used to operate project pumping plants. The remainder would flow to the kilowatt-hungry power market of the great Southwest. Features of the project would be located in four States, and thus would directly affect the daily lives of literally millions of people. The users of irrigation water, municipal water, and power, the fishermen, the vacationists, all these and many more would use the project directly.

(Next Month—Plans for the Future)

Alaska—Far-from-forgotten Land

(Continued from page 4)

within reach, but untouched. Engineers report that there are so many of these sites that even the most remote corner of the Territory is easily within modern power transmission distance for any reasonable quantity of power.

As for the Eklutna project, I shall leave that story for Joseph Morgan, Chief of the Alaskan Investigations Office, to tell in a subsequent issue of the ERA.

At the present time it appears that the development to follow the Eklutna project in the railbelt area would be in Devil Canyon on the Susitna River. It is located about 125 miles north of Anchorage and only 10 miles from the Alaska Railroad. The Devil Canyon project would serve not only the Anchorage area but also several large new industries projected for the railbelt. Initial installed power plant capacity would be more than 100,000 kilowatts.

All in all, I am told, there are 30 major potential hydroelectric power sites in southeast Alaska alone, which could have a continuous capacity of more than 300,000 kilowatts. Investigations are now being conducted on major sites near Juneau, Sitka, and Ketchikan.

Two of the potential projects sound especially interesting. One, the largest potential power development in Alaska, would require a dam on the Yukon River near the Ramparts while the second largest would involve a diversion from the headwaters of the same river.

The Yukon is one of the great rivers of North America, ranking fifth in length and basin area. Heading in British Columbia, within 30 miles of the North Pacific Ocean, it flows northwest 900 miles to enter Alaska with a flow of about 50 million acre-feet collected from 120,000 square miles. It crosses and recrosses the Arctic Circle in Alaska near Fort Yukon, veers to the southwest and discharges into the Bering Sea after having covered another 1,400 miles and fallen 879 feet in its course across Alaska. Although the flow at the river mouth has not been officially measured, the United States Coast and Geodetic Survey in 1900 estimated it as being two-thirds that of the Mississippi River. We shall soon know the actual flow as two permanent gaging stations will be installed next summer for that purpose.

At the upper end of the basin (which is far south and east of the mouth), only a few miles from the Pacific Ocean, the glaciers astride the Coast Range that separates Alaska and British Columbia mark the beginning of the Yukon. The melt from these glaciers cascades into a group of parallel valleys to form several of the most beautiful lakes in Canada. These interconnected lakes have a surface area of about 500 square miles. The general elevation of the lakes is 2,100 feet above sea level and their drainage area is 5,000 square miles. Downstream, a low dam in Miles Canyon, in the Canadian Yukon Territory, would raise the water level in the lakes sufficiently for regulatory and hold-over storage. Water thus retained could be diverted through a 15-mile tunnel to the Pacific Slope. An average annual power generation of 3 billion kilowatt-hours could be accomplished without any adverse effect on existing river navigation downstream. An international agreement between the United States and Canada would be a prerequisite.

The Ramparts site, which may prove to have the greatest potentiality in North America, is on the Yukon River near the geographic center of Alaska. A dam 250 feet high would make possible the firm generation of more than 12 billion kilowatt-hours annually. The reservoir created by such a dam would inundate what is known as the "Yukon Flat," a valley 40 to 100 miles wide and 200 miles long. The river, 2 to 20 miles wide in this stretch, has many new and old channels with innumerable islands. At the lower end of the valley the "Yukon Flat" suddenly narrows and ends at the head of a constricted section where canyon walls hug the river, giving rise to the name of "Ramparts." A dam in the narrows would block the mouth of the "Yukon Flat." In contrast to the Columbia River, which has scarcely enough storage sites for complete regulation, the Yukon has here such a large potential reservoir that the long period of years required to fill such a large reservoir actually would limit the height of the dam. Based on inadequate reconnaissance data it would appear that a dam only 250 feet high would create a sufficient storage capacity. Although ice in the reservoir would present a special problem it would not present an insuperable obstacle, according to present information.

These very large projects are not immediately in prospect of development, as are the smaller ones that abound in the Territory. They hold promise, however, for very large-scale developments in such fields as light metals when needed in the future.

Development of Alaska's hydroelectric power potentialities is only one use for multiple-purpose river control systems. Ultimately each major drainage basin in the Territory should receive careful consideration for coordinated and comprehensive development of water resources for such benefits as irrigation, flood control, navigation, power production, and municipal and industrial supplies.

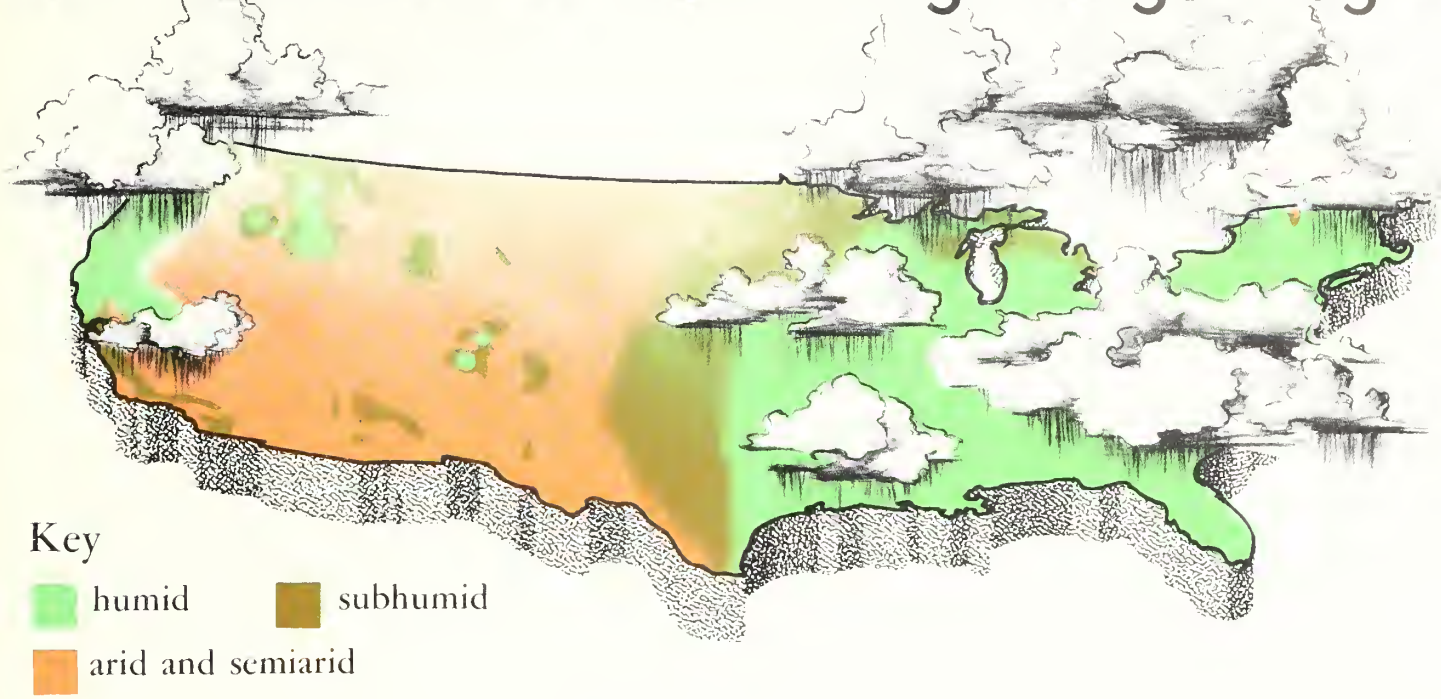
Much has already been accomplished in the relatively short time since the Government began to concentrate upon Alaska's problems. Much more remains to be done, and with the task forces we have assembled, much can be done.

To fail to meet the challenge of Alaska would be to gamble with our safety and curb economic progress in a region rightfully named, the "Great Country."

We cannot afford to forget Alaska, even for a day.

THE END

Reclamation's 1948-54 Long-Range Program



DISTRIBUTION OF RAINFALL

by WALTER SLAVIK,
Reports Analyst, Office of Programs and Finance,
Washington, D. C.

Before World War II, no one—not even the builders themselves—could have anticipated that Reclamation multiple-purpose land-water-power developments in the West would prove so vital to victory. They were built to help meet normal growing western needs. War, and the struggle for national survival, magnified their importance a hundredfold. Without their contribution of food, water, and power, victory would have been grievously delayed, to say the least.

Postwar appropriations for Reclamation indicate that this demonstration of its importance to the national welfare was not forgotten. The annual investment in western self-liquidating multiple-purpose projects has averaged more than 100 million dollars—twice as much as in prewar years. And for 1949 it has been stepped up to 250 million dollars.

It would appear that such an increased rate of construction in Reclamation's work would result in more than satisfactory accomplishments in building up western economy through irrigation, power, and related benefits. But an analysis of the facts do not bear out this hope.

Analysis actually shows that today's rate of progress in developing the West not only is not meeting and will not meet the West's fast-growing demands, but also, and more important, at least a century will elapse before the great natural strength of the West can be added to that of the Nation as a whole.

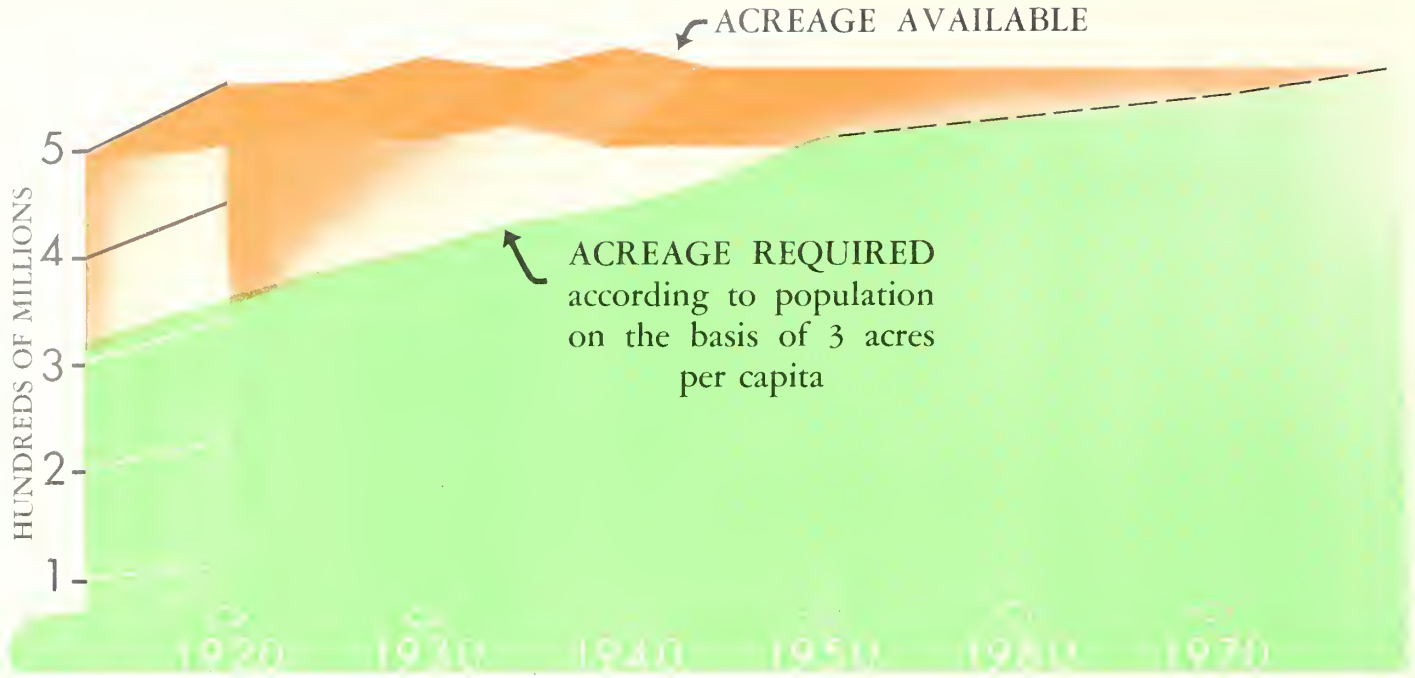
EDITOR'S NOTE.—The author of this article is editor of the publication "The 1948–54 Reclamation Program" and executive secretary of the Bureau's Long-Range Program Committee, consisting of Assistant Commissioner Wesley R. Nelson, executive officer in charge; Arnold O. Babb, chief, Programs Division, Office of Programs and Finance, committee chairman; T. W. Mermel, Assistant to the Commissioner—Engineering; George E. Tomlinson, assistant director, Project Planning Branch; E. D. Eaton, assistant director, Branch of Operation and Maintenance; William L. Newmeyer, chief, Resources and Development, Power Utilization Branch; and alternate members Waldron H. Yarger, Knoland J. Plucknett, LeRoy J. Snyder.

Early in 1947, at the direction of the Commissioner of Reclamation and of the Secretary of the Interior, the Bureau's hydraulic, electrical, and other engineers and technical men such as economists and land-classification experts gathered and summarized information from all over the West on the status of western land and water development.

Sent in to Washington and reviewed and analyzed, this information nailed home the conclusion that had been long suspected and even officially hinted. Reclamation progress was far too slow. And would continue to be too slow—even in a world at peace for the next 2 decades.

Accordingly, the Bureau evolved a long-range program of construction extending over a 7-year period beginning July 1, 1947, and ending June 30, 1954. The program was based on the statistics and other data submitted by field officials as of July 1, 1947.

It was necessary to begin the program as of this date, even though appropriation estimates for the fiscal year 1948 (July 1, 1947, through June 30, 1948) had already been made and were considerably below the amounts of money needed to throw the new long-range program into operation. To query the men in the field for later and more



UNITED STATES POPULATION AND FOOD SUPPLY. Future population increase projected under conditions of medium fertility and mortality and net increase by immigration of 100,000 yearly.

up-to-date information, as of July 1, 1948, for example, would have set the formulation of the program back a good half-year. Furthermore, since congressional appropriations completely govern Reclamation schedules, the program was proposed not as an actual schedule of planned construction but rather as an example of what could be accomplished within a limited time with an allotted sum of money.

The program as set up required appropriations of nearly 4 billion dollars, as follows: For the fiscal year 1948—204 million dollars; 1949—312 million dollars; 1950—535 million dollars; 1951—622 million dollars; 1952—715 million dollars; 1953—782 million dollars; and 1954—720 million dollars.

The immediate benefits of such a program, it should be remarked at the outset, would be impressively substantial. About 2 million acres of newly irrigated farms with their high rate of production would be created, and about 3½ million acres more would be provided with a full season's supply of water for crops. Hydroelectric capacity on Reclamation projects in the West would be nearly trebled, to a total of over 6 million kilowatts. Sorely needed municipal and industrial water supplies would be furnished to towns and cities now hampered in their growth. The danger of destructive floods inherent in western flash rivers would further be reduced.

A detailed estimate was made of the crop production that might be expected as a result of such an accelerated, multiyear program of western land and water development. To offset as much as possible the influence of inflated values, the estimate was made on a 1939–44 price base. On this conservative basis it was determined that the gross value of all crops grown by farmers supplied with irrigation water by Reclamation would show an increase of about 400 million dollars annually.

Not all this increase would be due to programed construction, of course, as over half the land scheduled to receive the water already has an appreciable income from dry farmed and partially irrigated crops. The 400 million dollars, on the other hand, does not completely reflect the crop value increase due to the programed construction, as crop returns from Reclamation construction are usually not completely realized until full development of the projects, which usually requires about 10 years.

The 400 million dollars return more than doubles the dehydrated estimate of the gross crop value for 1947, which on the same 1939–44 price base was figured at around 321 million dollars. Actually, in 1947, the latest year for which returns are available, farmers on Reclamation projects reported a gross crop of 555 million dollars.

These figures represent the estimated value of crops only and do not include livestock and livestock products, the production of which is estimated at 150 million dollars annually.

For the entire 7-year period of programed construction, the cumulative gross value of crops grown on all Reclamation projects, including those already in operation as well as those brought into production during the program, would reach an estimated total of more than 3,000 million dollars, on a 1939–44 price base. The incremental increase over the 1947 value, at the end of the period and on the same base, would total 1,113 million dollars.

The widespread economic benefits that result from increased power output are far more difficult to measure. One yardstick that may be applied is the translation of hydroelectric production into barrels of oil that would be consumed in supplying the same amount of energy for our farms, factories, and homes. In more than doubling hydro output on Reclamation projects the 1948–54 program would displace 25 to 30 million barrels of oil that would be required annually to produce an equivalent amount of energy.

It is an unchallenged fact that modern war is won by production—an overwhelming torrent of planes, armament, scientific instruments, and other equipment that form a part

Statistical Résume

Proposed 1948–54 Reclamation Construction Program, by Years and by Regions

(Subject in all aspects to congressional approval. Should not be regarded as scheduled development and conservation of land and water resources in the West but a projection of practical possibilities based on information assembled June 30, 1947, subject to revision.)

INVESTMENT (IN THOUSAND DOLLARS)

Region	To June 30, 1947	1948 [1]	1949 [1]	1950	1951	1952	1953	1954	1948–54	Balance to complete program
1	360,020	56,600	83,200	152,600	166,200	174,500	166,800	120,000	919,900	348,100
2	190,002	43,400	60,800	107,300	118,300	123,800	162,000	165,000	780,600	442,400
3	265,441	30,900	42,700	64,500	38,200	75,900	95,000	100,800	448,000	543,000
4	57,449	5,400	6,000	24,000	63,900	81,300	62,200	64,600	307,400	445,600
5	71,056	7,500	8,500	18,500	44,100	40,000	60,400	60,300	239,300	97,700
6	61,253	27,600	46,600	93,800	104,400	124,000	146,800	126,700	669,900	539,100
7	78,386	32,800	64,900	74,700	86,900	96,000	88,700	82,800	526,800	957,200
Total	1,083,607	204,200	312,700	535,400	622,000	715,500	781,900	720,200	3,891,900	3,373,100

[1] Actual appropriations by Congress were $149,136,129 for 1948 and $251,541,139 for 1949.

NOTE.—Sums enumerated in this table comprise entire expenditures for all construction, including electric power facilities, flood control, municipal water supply, recreation, and other benefits resulting from multiple purpose works, in addition to irrigation development.

IRRIGATED LAND, FULL AND SUPPLEMENTAL SUPPLY (IN THOUSAND ACRES)

Region	As of July 1, 1947	1948	1949	1950	1951	1952	1953	1954	1948–54	Additional future
1	2,076	63	46	5	5	227	240	936	1,522	398
2	262	3	50	81	345	194	788	194	1,655	1,021
3	930	6	5	17	23	19	33	33	136	779
4	635	0	6	6	39	24	23	90	188	627
5	212	59	29	86	3	588	343	195	1,303	273
6	515	20	39	62	50	55	63	69	358	2,674
7	373	39	20	24	140	125	66	67	481	2,506
Total	5,003	190	195	281	605	1,232	1,556	1,584	5,643	8,278
Cumulative totals		5,193	5,388	5,669	6,274	7,506	9,062	10,646		18,924

NOTE.—The annual acreage increments for 1948 through 1954 represent land that would be served by reclamation works as a result of funds invested as enumerated in table 1. The "Additional future" land would result from the investment of further funds listed under "Balance to complete program" in table 1; it refers to projects comprising the program and does not include any potentially irrigable land which might be served with water as a result of project construction begun after June 30, 1954.

ESTIMATED ANNUAL GROSS CROP VALUES, 1939–44 PRICE BASE (IN THOUSAND DOLLARS)

Region	For 1947	Annual increment over 1947							1948–54	Additional future annual
		1948	1949	1950	1951	1952	1953	1954		
1	130,203	2,376	3,552	5,272	6,124	9,418	15,342	23,048	65,132	53,103
2	28,046	210	3,810	12,210	52,410	72,510	164,780	186,170	492,100	90,094
3	83,351	340	660	2,886	5,756	10,198	15,456	19,609	54,905	56,370
4	23,345	103	228	268	2,007	2,934	4,125	7,184	16,849	21,918
5	28,129	3,005	4,330	7,776	7,960	87,664	92,307	124,538	327,580	18,020
6	11,992	1,020	1,632	2,868	4,149	6,085	7,934	9,684	33,372	69,867
7	16,436	3,141	3,806	4,991	17,012	27,561	31,515	35,605	123,631	127,265
Total	321,502	10,195	18,018	36,271	95,418	216,370	331,459	405,838	1,113,569	436,637
Total annual		331,697	339,520	357,573	416,920	537,872	652,961	727,340		1,063,977

NOTE.—The actual gross crop value on land served from Reclamation works was estimated at $555,420,804 in 1947.

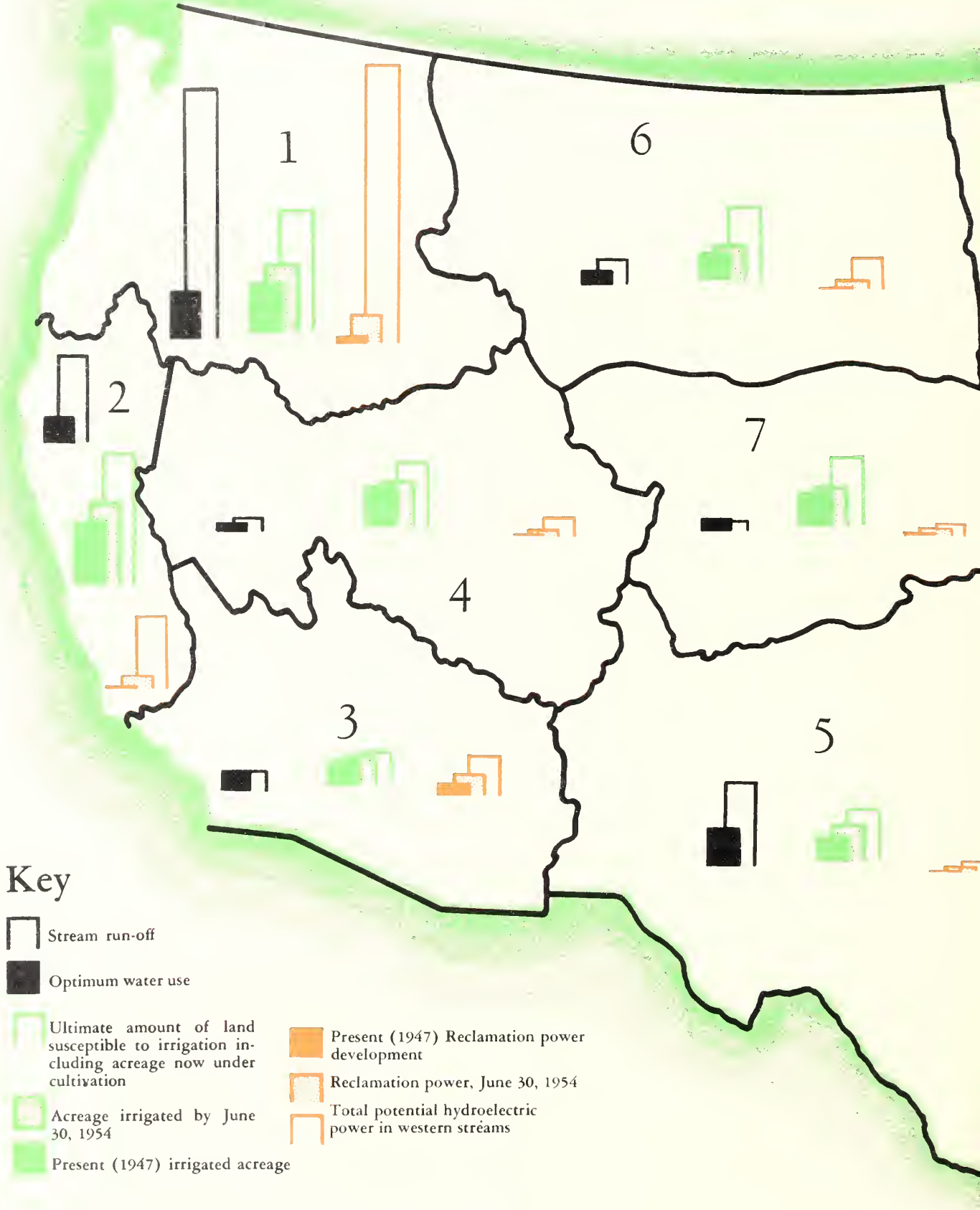
of the total Armageddon of destruction. Production in turn hinges on industry which must have the raw materials, power, and water to fabricate them. And lastly the men and women in the industrial plants must have food, water, shelter, clothing, transportation, recreation.

All these combined needs, whether in peace or war, stem back ultimately to the development of our natural resources—our land and water resources, our minerals and forests. These are the foundation on which rests the complex, pyramidal framework of a free industrial economy which provides the million necessities of modern society. Even in their recreation, men and women under the strain of war production find that natural surroundings—our hills, streams, forests, lakes, and beaches—offer the only real restful and refreshing change from a nervous tension that eventually would wreck their productivity.

The West, where Reclamation builds its multiple purpose projects for the development of natural resources of land and water, has an infinitely varied terrain with one predominant characteristic of climate: dryness. There is a scarcity of rain through most of the area. Except for an isolated section in the northwest corner along the Pacific coast there is generally not enough precipitation for growing crops and, in many sections, because the scant water supply has not been stored and made available for use, hardly enough for the maintenance of civilized life. Consequently the western half of this country has today only a fifth of the country's population, a fourth of its productive farms and a much smaller proportion of its industry. Despite a tremendous natural wealth of land, minerals and forests, the West remains largely undeveloped, and 45 years of construction work by the Bureau of Reclamation and other agencies of the Government have barely tapped this source of great national strength.

An example of the West's vast natural resources is found in its wealth of minerals. In the 17 Western States we find huge reserves of industrial fuels such as coal, petroleum, and natural gas, as well as the promise of substantial metallurgical coke production. Also, these States have the largest known magnesite deposits in the world. They have the country's only commercially valuable manganese; they have almost all the high-grade phosphate reserves; a world mo-

WESTERN WA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Key
Stream run-off
Optimum water use
Ultimate amount of land susceptible to irrigation including acreage now under cultivation
Acreage irrigated by June 30, 1954
Present (1947) irrigated acreage
Present (1947) Reclamation power development
Reclamation power, June 30, 1954
Total potential hydroelectric power in western streams

ER RESOURCES AND USE

BY BUREAU OF RECLAMATION ADMINISTRATIVE REGIONS

BASIC STATISTICS OF WESTERN LAND AND WATER RESOURCES AND USE

Based on Availability of Water, and Not Under Conditions of Unlimited Supply

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Total, 7 regions, 17 States
ACRES								
Land area	179,000,000	65,000,000	125,000,000	162,000,000	300,000,000	200,000,000	137,000,000	1,168,000,000
Forest area	90,000,000	14,000,000	15,200,000	21,400,000	19,000,000	20,000,000	4,000,000	183,600,000
Grazing area	32,400,000	31,500,000	70,700,000	142,000,000	221,000,000	131,000,000	27,900,000	656,500,000
Area that can be dry-farmed	16,000,000	13,000,000	420,000	880,000	60,000,000	53,000,000	99,800,000	243,100,000
Area susceptible of irrigation [1]	8,050,000	9,000,000	2,200,000	4,650,000	3,570,000	5,720,000	4,770,000	[2] 37,960,000
ACRE-FEET								
Water available (average annual run-off)	205,000,000	68,500,000	[3] 15,100,000	[4] 11,100,000	64,000,000	[5] 20,000,000	[6] 9,500,000	393,200,000
Present use of water [7]	26,000,000	10,500,000	8,500,000	[8] 4,800,000	16,500,000	4,500,000	3,800,000	74,600,000
Needs under optimum development [9]	37,200,000	21,400,000	15,100,000	9,350,000	30,100,000	12,300,000	9,650,000	135,100,000
Needs for irrigation alone, optimum development [9]	36,000,000	20,000,000	13,300,000	9,200,000	24,000,000	11,900,000	9,150,000	123,550,000
Needs for domestic, industrial, and other use, optimum [9] [10]	1,200,000	1,400,000	1,800,000	[11] 150,000	6,100,000	400,000	500,000	11,550,000
Unusable or unused water under optimum development plans	167,800,000	47,100,000	([12])	[4] 1,750,000	33,900,000	7,700,000	1,600,000	[13] 258,100,000
IRRIGABLE ACRES [14]								
Present developed area [15]	4,100,000	5,000,000	1,980,000	3,190,000	2,160,000	2,270,000	2,420,000	21,120,000
Area susceptible of future development with full water supply (new land)	3,950,000	4,000,000	220,000	1,460,000	1,410,000	3,450,000	2,350,000	[2] 16,840,000
Area in need of supplemental water	1,570,000	2,400,000	690,000	940,000	1,260,000	430,000	1,630,000	8,920,000
Area programmed for 1948-54	1,520,000	1,660,000	140,000	190,000	1,300,000	360,000	480,000	5,650,000
Full water supply	800,000	360,000	100,000	40,000	270,000	300,000	170,000	2,040,000
Supplemental water	720,000	1,300,000	40,000	150,000	1,030,000	60,000	310,000	3,610,000
KILOWATTS OF POWER								
Capacity installed on Reclamation projects June 30, 1947	694,987	154,000	1,241,750	6,050	24,300	[16] 42,200	60,200	2,223,487
Additional capacity programmed for installation 1948-54	1,914,500	880,500	545,500	199,500	56,000	[16] 439,600	288,850	4,324,450
Hydro potential (based on amount of water available 50 percent of the time)	22,560,000	5,660,000	3,050,000	1,560,000	510,000	2,380,000	700,000	36,420,000

[1] Based on available water.
[2] Excluding range land susceptible of irrigation; insufficient data available.
[3] Including 3,000,000 a. f. (roughly estimated) usable underground water.
[4] Including water for transmountain diversion to Region 7 but not water to go to Region 3 under Colorado River Compact.
[5] Not including possible 500,000 a. f. importation.
[6] Not including the importation of 422,000 a. f. from Region 4 by present systems and 1,328,000 a. f. by future systems.
[7] Including requirements for Reclamation projects under construction or authorized for construction; data as of June 30, 1947.
[8] Not including water exported and used by other regions.
[9] Including present use plus reservoir losses (by evaporation, etc.) chargeable to the use.
[10] Excluding power generation, navigation, and other nonconsumptive uses.
[11] Excluding transmountain diversion for domestic and industrial use (e. g., Denver, Colorado).
[12] Probably small amount unconsumed but used to carry off salts and other wastes; excluding 1,500,000 a. f. Mexican Treaty water.
[13] Not a true total of regions because of export water, etc.
[14] "Irrigable" in the sense of water availability for irrigation regardless of whether land is irrigated.
[15] As of June 30, 1947.
[16] Including United States Army plants in Missouri River Basin whose power is sold by Bureau.

NOTE: Ultimate water supply figures are subject to change, and a greater or smaller amount of water may be diverted than indicated. For example, until the terms of the Upper Colorado Basin compact (now under State negotiation) are known, the water to be exported from Region 4 to 7 cannot be definitely established; some of the waters of the Upper Colorado River may be used within the Upper Colorado Basin (Region 4), or diverted to the Bonneville Basin (also Region 4), or to the eastern slope of the Rockies (Region 7).

Scale

WATER—50,000,000 acre-feet
LAND—5,000,000 acres
POWER—5,000,000 kilowatts

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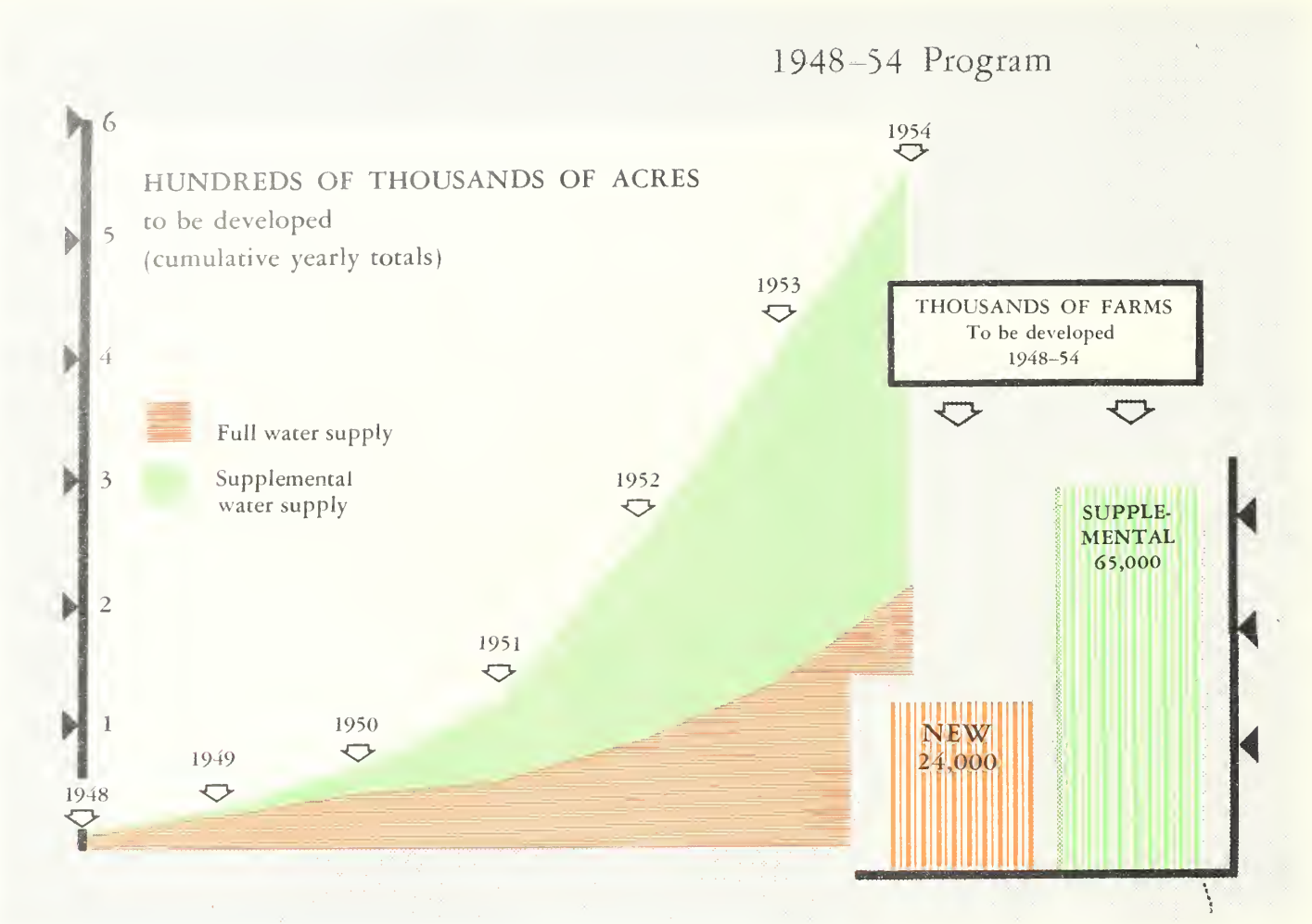


ESTIMATED LAND DEVELOPMENT

nopoly of helium; vast deposits of gold, silver, copper, lead, zinc, and a multitude of other metallic and nonmetallic minerals; and especially important, they have uranium, radium, and other radioactive deposits.

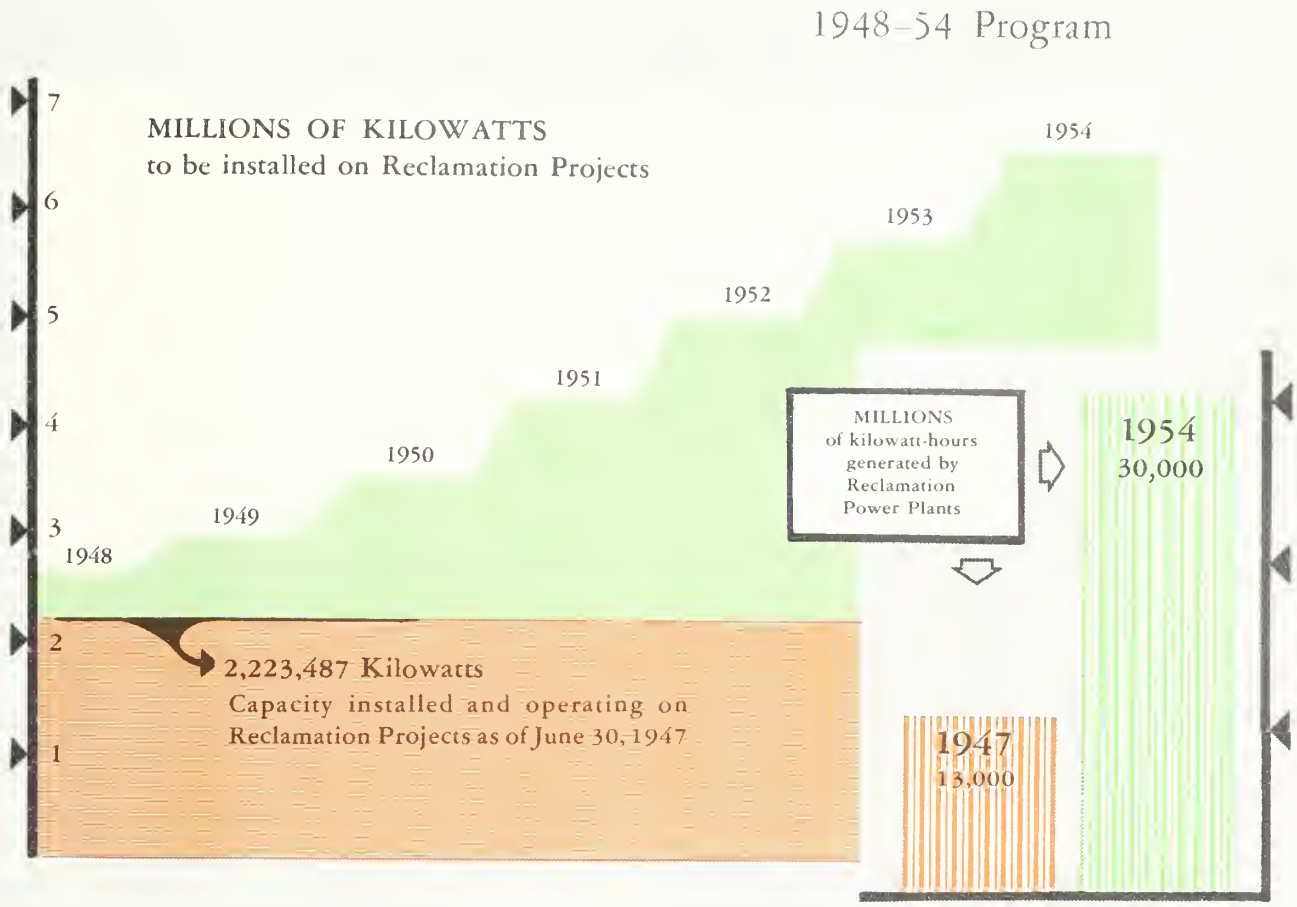
But a much greater unused treasure than minerals in the West is its undeveloped water. Water is the first requisite for permanent development of any natural resource of consequence. The presence of minerals is rarely a sufficient reason for establishing towns and cities that create business and industry and add their vital force to the strength of the Nation. And these towns and cities in the final analysis must have an agricultural hinterland of some kind for their continued existence—a hinterland of farms that will produce the fundamental essentials of life, such as food, shelter, and clothing, which can be produced only by a union of land with water. To make full use of the limited water resources of the West, is the first step in its full economic development.

The basic data assembled in the field, in planning the long-range program, show that the 17 Western States have about 400 million acre-feet of stream run-off annually, only a fifth of which has thus far been developed and put to use, leaving a balance of 320,000 acre feet. Under Reclamation repayment requirements for multiple purpose construction, and with present technical knowledge and facilities, less than half—about 135 million acre-feet—of this undeveloped four-fifths is considered susceptible of development.

With this additional water development, about 16,840,000 acres of land now largely a semidesert waste can be transformed into productive irrigation farms, and about 10 million acres of irrigated farms now crippled by short supply can be thrown into full production. Seventeen million acres of highly productive irrigated farm land is the rough equivalent of about 3 to 5 times as much submarginal dry-farmed land; these irrigated acres could therefore easily retire all the cropland in the United States that has been branded unsuitable for cultivation, estimated at 40 million acres. Farmers now sweating out their energy for a poverty return could raise their families in decent conditions.

Also, this 400 million acre-feet of water could develop more than 36 million kilowatts of hydroelectric capacity. And this estimate is quite conservative. Recently the Federal Power Commission estimated a probable potential development of over 50 million kilowatts in the West, with an average annual generation of about 270 billion kilowatt hours. This is about equal to the total electrical energy used in 1947 in the entire United States—and is enough to displace annual consumption of 600 million barrels of oil.

Inextricably linked with the development of the land in the West is the development of water power. This inexhaustible source of electric energy is one of the most vital resources of the Western States. Not all of the 2 million acres of land scheduled to be reclaimed under the long-



ESTIMATED POWER DEVELOPMENT

range 1948–54 program lie below the storage reservoirs that would be built. In many cases water would have to be pumped to higher lands. The pumping usually must be done with the electric energy developed at the same reservoir. Usually there is surplus power developed at the reservoir available for the development of the vast mineral resources of the West together with new industries. And low-cost electric energy to run farm machinery and furnish present and future farm homes with the conveniences of modern living is indispensable.

Transmission lines also must be constructed to the pumping stations and to areas of agricultural, mineral, and industrial developments for further distribution by retailing utilities, if the power is to be used for the fullest benefit to the West and the country.

The revenue from power developed in this manner not only repays the investment in power facilities with interest within a number of years and covers operation and maintenance expenses but also repays a large portion of the Government's investment in irrigation construction. It is estimated that power revenues must furnish at least 75 percent of the money required to repay the reimbursable investment in future large multiple purpose projects. Power, therefore, is highly important in the development of western resources.

The 1948–54 program, developing 2 million of the 17 million acres susceptible of irrigation in the West and 4 million of its conservatively estimated 36 million kilowatt unused hydro potential (based on water available 50 percent of the time), may be regarded by some as too quick a development, especially in view of the large investment—nearly 4 billion dollars in appropriations over the 7 years. Yet, even if the world situation and need for natural strength is ignored, this rate of development appears disturbingly slow. For example, one of the field regions of the Bureau of Reclamation estimated that at the 1948–54 rate more than a century would elapse before the water supply would be fully utilized in that region.

Eyes that have enough vision to see the magnificent future in store for all Americans, when our land, water, and related resources are fully developed and in use, would regard the 1948–54 program approach to the future as a pedestrian solution in a jet-propelled age. That future is attainable; we need merely to work for it. What Americans desire strongly enough, they can have; if not for themselves, then for their children.

What would nearly 17 million acres of highly productive farmland mean to this country? Or 36 million additional kilowatts of hydroelectric power that could be installed in strategically located plants, singing their endless tune of energy production? Or the flood control, or the much needed municipal and industrial water supplies, the improvement of navigation on our rivers, the creation of new recreational areas and the other benefits that result from

multiple purpose construction in the West?

Economists have made various estimates of the new wealth created by farm production, declaring that the initial value of farm crops and other products is multiplied 7 to 10 times as it enters the channels of trade and industry. According to such estimates the annual addition to our national income would reach perhaps as much as 20 billion dollars.

An impressive figure, perhaps, but again pedestrian in its approach. Far more revealing than a monetary guess, in visualizing the importance of full development of the West's land and water resources, would be an imaginative look at the future—the future that we ourselves will not see, probably, in our own lifetime. With this additional potential food-producing capacity, and additional energy production, five new large cities could be created that would outrank today's largest in size. Those cities would be supplied with all the necessities and comforts of life. Nor would they be earth-bound to miasmic flatlands or river deltas as today, but established perhaps on mountain tops where the atmosphere is healthful, invigorating and stimulating to human productiveness. Jet planes would provide all necessary trade and social connections with other cities; and electric transmission lines, extending to hydroelectric plants perhaps hundreds of miles away, would provide all light and power.

Our mineral and forest reserves would be utilized to the fullest without waste or dissipation. To burn up a gallon of irreplaceable oil in creating energy or motive power that could be supplied by our inexhaustible store of hydro power, would be immoral. To cut down a tree without planting another would be unthinkable. To permit land to lie waste for lack of water, when water was available to make it productive, or to leave it in unproductive swampland unless intended as a wildlife habitat, would be socially criminal. All our natural resources—land, water, mineral, forest—would be a never-ending source of creature comforts and general well being. And the pursuit of happiness would be much less a pursuit and more a realization than it has ever been within man's memory. THE END.

Progress Reports on Weed Control

Solvent naphtha formulations have been tested extensively during the past season as a control for submersed waterweeds. Through these tests conducted in every Bureau of Reclamation region, additional information has been obtained on potential benefits of the chemicals, their limitations and effective methods of application.

Bureau chemists in the Research and Geology Division, working in cooperation with Bureau of Plant Industry officials, originally discovered the value of the naphthas for waterweed control as reported in the May 1948 RECLAMATION ERA. This research group has also supervised many of the extensive field trials in cooperation with regional and project personnel and representatives of chemical companies which supply the material.

Data on the conditions under which the chemical formulations were applied and the results obtained are being compiled and an analysis made. The Bureau of Reclamation and Bureau of Plant Industry will use the findings as a basis for writing an information circular, containing those recommendations which the two agencies believe will be best to follow in this year's control program.

Many irrigation districts have saved money as a result of the Bureau of Reclamation regional weed control programs, together with the research work. They have also been able to catch up on a backlog of weed problems which now require immediate attention. The effective use of naphtha and other waterweed control chemicals and of 2,4–D for ditchbank weed control, are examples of the progress being made. Another is the use of Benoclor, a Cloroben Corporation product which is also a waterweed control formulation and was discussed in the April 1947 RECLAMATION ERA. However, several problems still need more efficient solutions. The cooperative weed control research program is being continued by these two Government agencies and many tests are now under way to solve weed problems more permanently and economically.

Various materials have been submitted by chemical companies to be tested in the laboratory to determine if they may be of any value in the control of weeds. No responsibility is assumed by the research group except to report the results observed from the tests. One chemical formulation recently so tested is known as *Cifon*, a product of Fine Organics, Inc. The laboratory test showed that it displayed a satisfactory emulsion stability and was found to compare favorably in concentrations of 200 ppm (parts per million) with other commonly used waterweed control chemical formulations.

The information circular mentioned above on the use of the solvent naphthas for the control of submersed waterweeds should be ready for distribution early in the spring and can be obtained upon request to the offices of the Commissioner, or Regional Directors, of the Bureau of Reclamation, or to the Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md. THE END.

_____
(Date)

THE COMMISSIONER,
Bureau of Reclamation, United States Department of the Interior.
Washington 25, D. C.

SIR: Enclosed is a check, or money order (no stamps) made out to THE TREASURER OF THE UNITED STATES in the amount of _____ for a _____ year subscription to the RECLAMATION ERA.

Sincerely,

Check (√) if member of water users association ☐

_____
(Name)

_____
(Address)

_____
(Name and address of association)

_____
(Include zone number, if any)

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Special rate of 50 cents for members of water users associations

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Producing Dollars from "Scents"

by J. L. St. John and S. C. Vandecaveye
Divisions of Chemistry and Soils,
Agricultural Experiment Stations, Pullman, Washington

Setting the pace as one of the areas that is helping the Pacific Northwest to become the peppermint oil producing center of the Nation is the lower portion of the Yakima Valley.

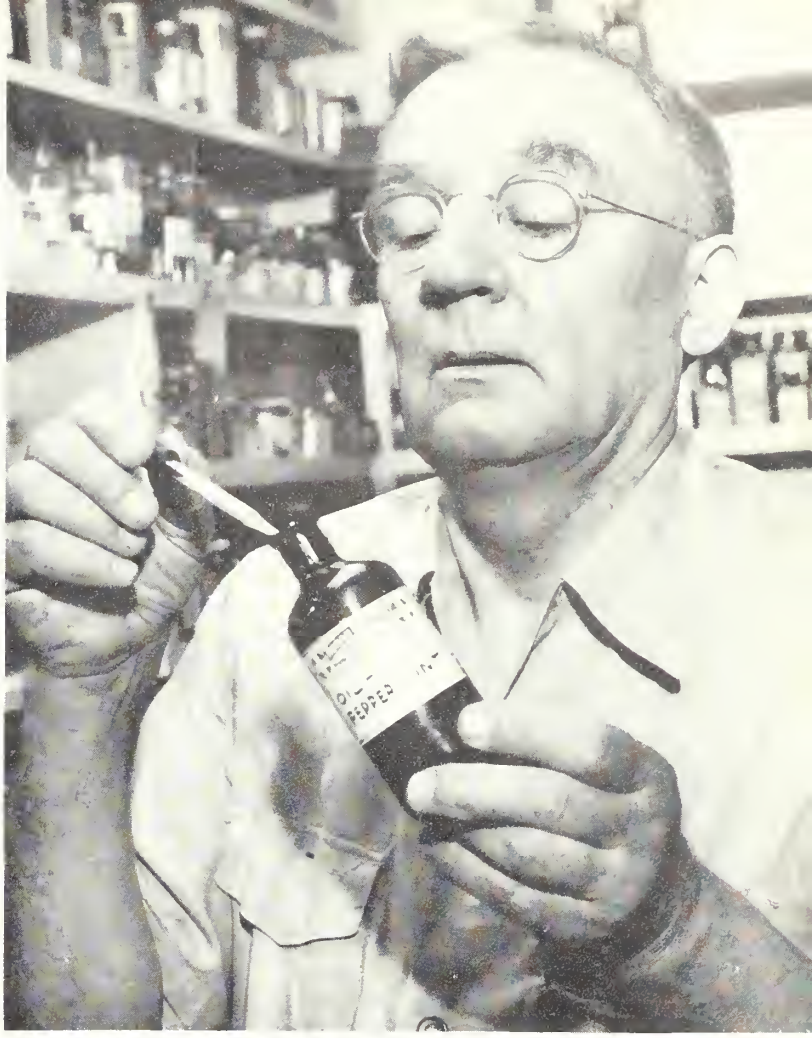
That section, with its reported highest per-acre average yield in the country, has contributed tremendously to the estimated 60 percent of the Nation's peppermint oil that is produced in the Pacific Northwest. During the past 5 years, gross production near Kennewick, Wash., and in other parts of Oregon and Washington has increased sharply.

Over-all, the Northwest production is nearly 50 pounds per acre, or twice that of the country's other mint-producing areas—mainly in the States of Indiana and Michigan, and also small sections of Ohio and Wisconsin. The latter areas have a materially larger acreage of peppermint hay but the production averages only 25 pounds per acre. Many growers in Washington report yields of 75 to 100 pounds per acre. The shift of the center of peppermint oil production to the Northwest States is due partly to these high yields and partly to the serious inroads made on production in the Middle West by mint diseases, such as wilt.

The major part of the peppermint oil produced in Washington comes from 4,000 acres in the irrigated lower Yakima Valley near Kennewick. Production in western Washington west of the Cascade Mountains is centered in one large farm of 600 acres and on Puget Island near Cathlamet. A few other scattered production areas occur in this State. The production in Oregon is mainly west of the Cascades in the Clatskanie area and in the Willamette Valley.

The peppermint plant is grown much the same as alfalfa is raised for hay in the far West or as timothy hay is raised in the Middle West. However, it is produced primarily from root stock, although some mint in the Middle West is grown from plants. Most of the mint is grown in rows to permit cultivation and, in the far West, particularly in the Yakima Valley, to permit irrigation. In the far West the crop is continued in the same field for a number of years. In the Middle West it is produced as row mint the first year and as meadow mint the second year. This is then followed by some other crop following a desirable rotation practice.

Peppermint is produced on a number of different types of soil. Earlier it was considered essential that peppermint be produced on a muck soil. However peppermint is being produced under irrigation in the lower Yakima Valley on mineral soil which is slightly alkaline in reaction. It is in this area that many growers report production ranging from 75 to 100 pounds of oil per acre. It may be that muck soil has been found advantageous in the Middle West and in western Washington and Oregon mainly because of the maintenance of a continuous and adequate water supply. In the lower Yakima Valley, water in adequate quantities is furnished by irrigation. During dry periods in summer, some sprinkler irrigation is practiced in western Washington and Oregon and, on a small scale, by better operators in Indiana.



PURE PRODUCTS PAY OFF. A. C. Smith, druggist, measures out some oil of peppermint for a customer in Pasco, Wash. Farmers on the Kennewick Division of the Yakima project distill this oil from the hay grown on their irrigated farms and find that it is best suited for medicinal purposes.

Careful cultivation of the peppermint and a large amount of hand weeding are necessary to insure freedom from weeds when the peppermint hay is cut. Weeds may seriously affect the odor and flavor of the oil, which is distilled from the hay at harvest. The hay is cut, allowed to cure, loaded on to trucks or portable stills, and hauled to the ranchers' stills.

There are a number of different types of stills but all are based on the process of steam distillation. The majority of stills are made of metal, although some in the lower Yakima Valley are constructed of cement. Occasionally a wooden tub is found. The hay is packed into these stills and steam is introduced. The steam separates the oil from the leaves and carries it into the condenser. The condensed oil and water are separated in special containers, after which the oil is placed in drums ready for the buyer. Ordinarily the distillation is continued for three-quarters of an hour to one

NOT EXACTLY THE UNITED STATES MINT, BUT—Richard Lee's farm near Kennewick ran about 100 pounds of mint oil per acre in 1947. The mint oil sold for about seven dollars a pound which would bring Mr. Lee a gross return of $700 an acre.

hour, although in some stills the distillation is prolonged, probably unnecessarily, for 2, 3, or even 4 hours.

Peppermint oil is used primarily for the flavoring of confections and to a small extent for drug purposes. About one-half of all of the peppermint oil produced is used in flavoring chewing gum. Fifteen percent is used in confectioneries and an equal amount in dentifrices. About one-fifth of the peppermint oil is used for miscellaneous flavorings, extracts, and for soaps. Only about one-half of 1 percent, or 1 pound in 200, is used for drug purposes. Because of these uses for food and related purposes, it is said that cleanliness and purity are vital in the essential oil industries.

During the last 3 or 4 years peppermint oil has brought the grower a price of $6 to $7 per pound at 50 to 75 pounds per acre. This furnishes a rather large gross income, which must be considered, however, in light of the costs of production, including weeding and distillation on the ranch. Even in view of these costs, there are those who believe that the growers of peppermint on Pacific Northwest ranches are doing their own "minting" of money in producing peppermint oil. Not many years ago the price of peppermint oil was $1.50 to $3 per pound. The possibility of a price drop in the future should not be overlooked.

The buyer of peppermint oil that is to be used especially for chewing gum, confectioneries, dentifrices, and various flavorings, evaluates the oil primarily on the basis of flavor and odor rather than on the basis of chemical composition. The grower might be said to produce dollars from "scents." He should use every precaution to insure that his oil is of high flavor and odor quality. He should be extremely "quality conscious," as well as quantity conscious. Since peppermint oil is used largely for foods including flavoring, it should be produced under the cleanest conditions. Cleanliness is essential in the oil industry, particularly in the distillation and handling of the oil. Small changes in cultural, distillation, or handling practices may materially affect the flavor, odor, and color of the resultant oil.

Many factors are believed to affect these qualities. The buyer insists that the hay from which the oil is distilled should be free from weeds, since undesirable flavors, odors, or colors may be extracted from weeds during distillation process and may be carried over and retained by the peppermint oil. The quality of the oil cannot be sacrificed to a large yield per acre. Stills and condensers should be so constructed that they can be cleaned at frequent and regular in-

(Continued on page 24)

THE BEST MINT IN THE UNITED STATES. One reason is split-second operations such as the scene at left of distilling operations on the Henry York farm where they work night and day to keep the mint hay from getting too dry and losing its oil content when it is ready for distilling. At right, Mr. York is using a pipette to run a test for free menthol, with the help of Jim Morton, representative of a commercial firm in Seattle, Wash. According to Mr. Mason, the Kennewick area has the highest average yield of free menthol in the United States. The Government standard is 50 percent. Any mint oil under that cannot be used commercially. *Photographs for this article by Stanley Rasmussen, Region I photographer.*

Jimmy Writes A Letter

EDITOR'S NOTE: This is the story of only one of the thousands of letters which pour into the Department of the Interior each day. There are probably stories like this behind every letter which we receive. But we discovered the Jimmy Becker correspondence as the Secretary was signing the reply, and were able to round up the background material to give our readers an insight into the human side of reclamation—on the project and in Washington, D. C.

by Gene Nicolai, Coulee Dam, Wash.

Last October fourteen-year-old Jimmy Becker, 8th grade student at Moses Lake School in Eastern Washington, heard his English teacher, Mrs. Diana Boettcher, give this assignment:

"Each pupil is to select a very important person to whom to write a business letter. Make it interesting, tell something of yourself, and request that the person to whom you write answers your letter."

The World Series was in the thoughts of many of Jimmy's classmates that day, but Jimmy kept gazing out the window for ideas, and he could visualize that broad stretch of land out in the Columbia Basin turning green under irrigation, just as it has on the outskirts of Moses Lake. You will find dozens of "Jimmies" in irrigation-minded towns in the Basin.

Chewing his pen, Jimmy Becker composed this letter to Secretary of the Interior J. A. Krug in far-off Washington, D. C.

He got a letter . . .

. . . and so did he.

Box 914,
MOSES LAKE, WASH.,
October 24, 1948.

DEAR MR. KRUG: I live in Moses Lake Washington in the Columbia Basin. I was at the dedication of the O'Sullivan Dam. It was very interesting. I am writing this letter to you as part of my English lesson and I would like to ask you a few questions. What do you think of the Columbia Basin? Do you wish its development to be carried through? Why do you take this opinion? Do you think it will amount to much? Please write me an answering letter, I would appreciate it very much.

I see a great future in the Columbia Basin, and the faster it develops the better it will be for the United States—and the whole world for that much. And as a loyal citizen to his town I hope Moses Lake will become the hub of the Basin.

Sincerely yours,

JIMMY BECKER.

A few days later there came to Post Office Box 914, Moses Lake, Wash., an official-looking envelope bearing a Washington, D. C., postmark, something boys of Jimmy's age don't often receive. Jimmy's brown eyes widened in amazement as he realized that here actually was a reply from Secretary Krug.

DEAR JIMMY: It was good to hear from you and find out that you liked the dedication of O'Sullivan Dam. I thoroughly enjoyed my visit in your great State and especially the hospitality of Moses Lake people.

And now for the questions in your letter. What do I think of the Columbia Basin? The Columbia Basin, with its wealth of water and agriculture and other resources, is one of our country's greatest assets. I most certainly want to see its development carried through to completion because I know that such development will be to the best interest of the people in the Northwest and, in fact, to all of us

Jimmy sometimes visits the Moses Lake Development Farm with his father, and on one of his recent visits he tried out the brace and bit at the shop (woodworking is one of his hobbies) and looked over the dairy herd with Kenneth Hampton, World War II veteran who operates the farm under lease from the Bureau of Reclamation. *Photos by John D. Roderick, Coulee Dam.*

in the United States. I promise to do everything I can to further this needed development.

You will be hearing a great deal about plans for full development of the Columbia Basin. This plan, designated by the Bureau of Reclamation in the Department of the Interior, in cooperation with the many Federal, State, and local interests, calls for the construction of scores of dams to store millions of acre-feet of flood waters. These flood waters can be checked and controlled and then used to irrigate millions of additional acres of land and generate billions of kilowatts of much-needed hydroelectric power.

Jimmy, the Columbia Basin plan, which includes your own Moses Lake, is more than just reservoirs, ditches, and powerhouses. These are important just as every irrigated farm is important. But let us stop and think what harnessing of the Columbia River is going to mean to your State and to the other States in the Columbia Basin.

Storage of Columbia River water can reduce flood heights all the way down to the Pacific Ocean. The Columbia River has proved its power time and again in great floods. We want to take this Paul Bunyan energy and put it to work pumping irrigation water, doing chores on the farms, lighting homes, and turning factory wheels in towns and cities. And here's something else important: The sale of Columbia River kilowatts will help to make water bills cheaper. But still more important will be everlasting benefits that come from the irrigation of the vast new areas of land which will assure the growing Northwest and the Nation of more food supplies to meet the needs of the growing population.

Jimmy, you are right in saying the Columbia Basin has a great future and "the faster it develops the better it will be for the United States—and the whole world."

Irrigation, hydroelectric power, flood control, supplies of water for homes and factories, fish and wildlife conservation, development of recreational areas—places where you can fish and swim and go boating—are only a few of the benefits possible from Reclamation developments such as that in your own Columbia Basin. And while the West is enjoying these benefits, the Nation is also better off because of this development.

The people have learned that when the West prospers, the whole Nation prospers. Reclamation projects, such as the Columbia Basin, mean more jobs, more food, more homes—a better standard of living for millions of people everywhere. It means, too, that your home town of Moses Lake will grow with the development of the Columbia River Basin; but what is very important, is the fact that the entire Nation, and, as you have put it, the whole world can benefit by increased production of goods and energy for better living.

Thank you again, Jimmy, for writing me. The future of America depends on the kind of support which you are giving your town of Moses Lake. Your cooperation and that of other loyal citizens like you is what will help this Nation to realize the full development and use of our great land and water resources in the West.

Sincerely yours,

J. A. Krug,
Secretary of the Interior.

Jimmy's ideas are parallel with those of Secretary Krug, only he expresses them in different words:

"Out here in Moses Lake we see everybody waiting for water because we know it will bring more people, it will mean more farms, and it will mean a bigger town. We're pretty big now, but we're going to be bigger. Well, look at this land all around us. Think what it will do when it gets water!"

Jimmy has lived in Moses Lake 3 years, moving with his parents from their part-time farm near Sequim, Wash., west of the Cascades. Over in Sequim they have too much rain in the winter and not enough in the summer. Their 20-acre farm had to be irrigated during the dry summer.

The story of the Becker family is like that of many others. They went to Moses Lake because the health of the parents was affected by the dampness of the Olympic Peninsula. Mr. Becker is not farming now, but Jimmy hopes they will have an irrigated farm in the Columbia Basin.

Jimmy's plans for the future are somewhat vague, except on one point: He's going to have a farm of his own some day.

"The way I've got it figured out, I'm going to be a mechanical engineer. I'll work in town and run about 40 acres under irrigation. It will be what I want. I was born on a farm and like farm life. Working in a city will be okay if, when your day is over, you can head for the farm and make things grow and breathe fresh air. That's not really work, anyway. That's really living!" The End.

Report on the National Reclamation Association's Convention

A resolution adopted by the National Reclamation Association at its seventeenth annual convention at Oklahoma City November 17–19 approved the construction of nonduplicating transmission lines by the Bureau of Reclamation and a speed-up of power developments in the West. Another resolution commended the cooperative program of the Bureau of Reclamation and the Department of Agriculture working through western State colleges in connection with Reclamation developments. Two resolutions sought to provide better credit facilities through the Farmers Home Administration for settlers on reclamation projects, including the Columbia Basin. These resolutions, numbered 6 and 7, had the full support of the representatives of the United States Department of Agriculture and the Bureau of Reclamation who cooperated in their preparation. The steps of the Bureau toward advancing "small projects" were also commended.

No resolutions were adopted on the 160-acre limitation for delivery of irrigation water or questioning the public power policy of the Bureau of Reclamation.

Senator-elect Robert S. Kerr, of Oklahoma, was the principal speaker at the annual banquet.

Assistant Secretary of the Interior William E. Warne on the night of November 17 presented an illustrated address on the Colorado River.

Letters from President Truman and Secretary of the Interior Krug to the Association were read at the banquet on November 18. These, with the annual address of Commissioner of Reclamation Michael W. Straus, were printed in the December issue of the ERA.

At the conclusion of the Commissioner's speech, former Nebraska State Senator C. Petrus Peterson, member of the National Reclamation Association's board of directors, rose and stated that he wanted to make clear to those assembled that the resolution to which Mr. Straus referred had been adopted by the Nebraska Reclamation Association. This resolution urged the State associations and the National Reclamation Association "to safeguard democratic processes in their activities and to avoid undue influence of special interest groups seeking selfish ends."

Officers of the Association were reelected as follows:

Harry E. Polk, Williston, N. D., president.
Clifford H. Stone, Denver, Colo., first vice president.
J. E. Sturrock, Austin, Tex., second vice president.
H. Maurice Ahlquist, Tonchet, Wash., treasurer.
William E. Welsh, Boise, Idaho, field representative.
Don McBride, Washington, D. C., secretary-manager.

State directors were elected as follows:

J. H. Moeur, Phoenix, Ariz.
Charles L. Kampke, Fresno, Calif.
Clifford H. Stone, Denver, Colo.
N. V. Sharp, Filer, Idaho.
Paul W. Applegate, Wakeeney, Kans.
R. C. Bricker, Great Falls, Mont.
C. Petrus Peterson, Hoskins, Nebr.
Alfred Merritt Smith, Carson City, Nev.
Fred E. Wilson, Albuquerque, N. Mex.
Harry E. Polk, Williston, N. Dak.
Clarence Burch, Oklahoma City, Okla.
Robert W. Sawyer, Bend Oreg.
Robert Lusk, Huron, S. Dak.
J. E. Sturrock, Austin, Tex.
William R. Wallace, Salt Lake City, Utah.
H. Maurice Ahlquist, Tonchet, Wash.
Earl Bower, Casper, Wyo.

Summary of resolutions passed at the Convention are as follows:

RESOLUTION No. 1—An "omnibus" resolution, recommended legislation to include 8 points: (1) preserving State water laws and rights; (2) liberalizing, but retaining basic economic principles of formulas for repayment and allocations of costs; (3) expressing clearly and openly how construction costs are to be allocated; (4) clarifying the law to terminate perpetual sale of water by United States under the Reclamation Law; (5) facilitating investigations of financial problems on projects; (6) confining Federal control over irrigation projects to those necessary for the protection of Federal interests and investment; and (7) maintaining and broadening the principles of section 1 of the Flood Control Act of 1944.

No. 2—Authorized the president of the association to appoint a committee of five members to study and take action on legislation affecting reclamation.

No. 3—Opposed any division of the functions of the Bureau of Reclamation among different departments of the Federal Government.

No. 4—Commended the Bureau for its activities in behalf of small projects and urged each State to help and participate actively in the program.

No. 5—Recommended codification and clarification of the Federal laws relating to Reclamation.

No. 6—Recommended amendment of Public Laws 399 (75th Cong.) and 731 (79th Cong.) so that homesteaders could receive financial credit for real estate improvements through Farmers Home Administration.

No. 7—Recommended that Farmers Home Administration be provided with additional loan funds for settlers on reclamation projects.

No. 8—Reaffirmed the National Reclamation Association's opposition to Federal ownership of tideland oil deposits.

No. 9—Requested the President and the Congress to make certain that national defense installations are not located in areas which would hamper present and future resource developments.

No. 10—Urged adjustment and liberalization of reclamation repayment laws.

No. 11—Recognized the need for preservation and propagation of fish and wildlife for recreational purposes, but insisted that in case of conflict, priority be given the demand for water for crop irrigation, domestic and industrial use.

No. 12—Resolved that the "joint liability" clause in future repayment contracts be optional, and if necessary, the existing Federal law be so amended at its next session.

No. 13—Registered and reaffirmed the National Reclamation Association's opposition to the creation of Federal Regional Authorities, but urged the extension of comprehensive basin-wide developments.

No. 14—Urged the speeding up of soil and water conservation.

No. 15—Commended the Bureau of Reclamation and the Department of Agriculture for their policy of mutual cooperation in solving land problems which arise in connection with irrigation projects, and urged extension of this policy, and further utilizing the facilities of the splendid agricultural colleges of the West.

No. 16—Urged the Federal Government to provide sufficient authorizations and appropriations for rapid construction of projects for generation of hydroelectric power and "nonduplicating main transmission lines, where necessary to market such power," in view of serious power shortages and the financial assistance such projects provide to reclamation developments and national security.

No. 17—Urged Congress to provide the Geological Survey with adequate funds to pursue its investigation of surface and underground waters, and also to encourage the long-established principle of 50–50 cooperation between the Geological Survey and the various States in collecting basic water information of common concern.

No. 18—Urged the Congress to appropriate adequate funds for complete topographic mapping of the United States within the next 20 years, in view of the fact that less than 25 percent of the United States is covered with adequate topographic maps, and only 13 percent of the area of the Reclamation States of the West.

No. 19—Recommended and urged Congress to support an adequate snow survey program.

No. 20—Recommended that Congress appropriate sufficient funds to the Department of the Interior for the specific use of the Bureau of Reclamation.

No. 21—Urged Congress to appropriate funds for the rapid completion of authorized flood-control projects.

No. 22—Urged the Bureau of Reclamation to make an immediate study, in cooperation with water users' organizations, of methods of improving operation and maintenance efficiency and economy.

No. 23—Urged Congress to lift its restrictions on appropriations to the Bureau of Reclamation referring to limitations on personnel, amount allocated to the Chief Engineer, and urged that trust funds be exempted from the limitation on expenditures for personal services.

No. 24—Commended the Bureau of Reclamation and the Corps of Engineers for their "forward looking efforts" and pledged the Association's continued cooperation "in working toward the realization of the common objectives which will be attained through the sound development of the Nation's water resources."

No. 25—Directed the Secretary-Manager of the National Reclamation Association to call the resolutions to the attention of the appropriate Federal officers and agencies, members of Congress, Governors and Attorneys General of the Western States, and the officers and staff to carry out the policies declared in the resolutions.

Members of the Resolutions Committee were as follows:

Washington	J. K. Cheadle, *Chairman*, Spokane
Arizona	Charles A. Carson, Phoenix
California	Arvin Shaw, Jr., Los Angeles
Colorado	Gene Breitenstein, Denver
Idaho	Charles H. Welteroth, Jerome
Kansas	John E. Kissell, Portis
Montana	George H. Ebner, Valier
Nebraska	H. G. Greenamyre, Lincoln
Nevada	Hugh A. Shamberger, Carson City
New Mexico	John Gregg, Albuquerque
North Dakota	Roy O. Young, Mandan
Oklahoma	N. R. Graham, Tulsa
Oregon	George Cochran, La Grande
South Dakota	Raymond Lund, Rapid City
Texas	John D. McCall, Dallas
Utah	Arlie S. Campbell, Ogden
Wyoming	L. F. Thornton, Thermopolis

The opening session on Wednesday afternoon, November 17, began with an invocation by Dr. I. L. Yearby, pastor of the Trinity Baptist Church, Oklahoma City, followed by an address, "Welcome to Oklahoma" by the Hon. Roy J. Turner, Governor of Oklahoma, the President's message read by Harry E. Polk, Williston, N. Dak.; the treasurer's report read by H. Maurice Ahlquist, Washington Director and Associate Treasurer of Touchet, Wash.; the secretary-manager's report by Don McBride, Secretary-Manager, National Reclamation Association, Washington, D. C.; the field representative's report by William E. Welsh, Secretary of the Idaho State Reclamation Association, and Field Representative for the Association, and an address, "Reclamation's New Look" delivered by John Haw, Director of the Agricultural Development Department, Northern Pacific Railway, St. Paul, Minn. Victor I. Corbell of Tempe, Ariz., then read the Revenue Application Committee's "Report of Committees."

Thursday was "Water Users Day" and opened with a talk by William E. Welsh, field representative of the National Reclamation Association, followed by a report by Maurice H. Greene, chairman of the water users' committee; Walter A. Duffy, Oregon State FHA director's discussion of farmers home administration experience with settlers on new land; Druw W. Dunn of the W. C. Austin project's exposition on soil conservation and irrigation, and a round-table discussion of operation and maintenance problems, climaxed by an address by Representative Ben F. Jensen of Iowa on "Financing Federal Reclamation." The afternoon session was a "grass roots" discussion presided over by Milton Kidd, dairy farmer and president of the California Irrigation Districts Association of Modesto, Calif., after which A. H. Small, irrigation farmer from Creston, Mont., led a discussion on sprinkler irrigation. The Thursday evening feature was former Oklahoma-governor and United States Senator-elect Robert S. Kerr's address "Water Resources and the Future."

On Friday morning addresses were given and discussions held on topics such as State responsibility for small project development, groundwater problems of the 17 Western States, Reclamation's effect upon national prosperity, coordinating land and water resource development, maintaining a balance between agricultural and industrial development and the Federal Government's program for the West and its effect upon national economy.

As Others See Us

London, England's "The New Statesman and Nation," a world-renowned newspaper, took a look at the Bureau of Reclamation in its October 9 issue under the title "The West Grows Up," by Norman MacKenzie. Here are the concluding paragraphs of the article:

While the liberals debate and dispute, a struggle on which much of California's future depends is being fought out without much participation by them. Water is the sixty-four dollar question. Back over the coastal range of mountains lies the Central Valley, running the length of the State. Here, as for all the State south of San Francisco Bay, water is scarce. For nearly a dozen years, the Bureau of Reclamation has been working on the Central Valley Project, due for completion some time after 1960. The plan is to trap the heavy flow in the northern part of the State behind the enormous Shasta Dam and by subsidiary dams and canals, not merely to provide more power but also to irrigate some three million additional acres—enough for fifty thousand new farms—and improve flood control.

Much of California is owned by large companies; more than half is the property of less than one-tenth of all owners. Yet the original act, under which water will be supplied to farms, stipulates that one owner shall only receive enough to irrigate 160 acres, or twice that amount for man and wife, under the community property law. Water in excess of the amount required by 160 acres will only be supplied under condition that the excess acreage is sold off within 10 years. Naturally, the big land companies do not like the idea of exclusion from the scheme while small farmers get interest-free loans to develop their irrigation systems, nor do they favour the use of this water provision as a means of breaking their land monopoly. So, for years, the large landowners have joined hands with the power interests to fight the project. The full story of this fight is an epic worthy of description by the Lincoln Steffens who muckraked California a generation ago.

The latest engagement ended in victory for the interests when, this summer, they at last pushed through an obscure financial measure in Congress, depriving Mr. Straus, United States Commissioner of Reclamation, and his regional officer in the area, Mr. Boke, of their salaries, on the grounds they were not technically qualified for a job they had been doing for some time, both with skill and with determination that the project was more important than the opposition of powerful utilities and landowners. Gradually, the work forges ahead on this vast scheme, hampered and hamstrung at every stage by as bitter a dogfight as public power and assistance to the small farmer have encountered anywhere, not excepting the Tennessee Valley. This is one of the basic questions for California; the liberals are so busy with their internecine fight that their case is faltering through neglect.

Canada and United States Work Together

As a result of interest in Montana and North Dakota, and in the Canadian Provinces of Alberta, Saskatchewan and Manitoba, plans for utilizing waters of an international character along the boundary between Canada and the United States are being developed. The Governments of the two nations requested the International Joint Commission on January 12, 1948, to investigate the present and potential water uses of all of the streams between the continental divide on the west and including the Red River of the North on the east with the exception of the St. Mary and Milk Rivers in Montana, which had been divided on the basis of the treaty of 1909 between the United States and Great Britain.

The Treaty provides for a total of six Commissioners, three for the United States and three for Canada.

The present Commissioners on the International Joint Commission are: For Canada: Mr. George Spence, chairman, Canadian Section; Vacancy; Vacancy.

For the United States: Mr. A. O. Stanley, chairman, United States Section; Mr. Roger B. McWhorter; Mr. Eugene W. Weber.

The request for joint investigation of the international streams referred to above was divided into two "References" which had been arranged and mutually agreed upon by diplomatic negotiation between our United States Department of State and the Canadian Department of External Affairs. One reference deals with the Waterton and Belly Rivers in northwestern Montana which are tributaries of the South Saskatchewan River in Canada. These two streams discharge annually some 700,000 acre-feet of water across the international boundary into Canada—sufficient water to irrigate perhaps 300,000 acres of land. One of the problems is to arrive at an equitable division of the waters that will serve the best interests of both governments. The second reference deals with all the streams between the eastern boundary of the Milk River Basin and the eastern boundary of the Red River Basin.

At its regular semi-annual meeting, April 7, 1948, the International Joint Commission appointed engineering boards to conduct joint investigations required by the References. Each board had the same number of members, and as appointed was as follows:

For Canada

Mr. Victor Meek, Dominion Water & Power Bureau, Ottawa, Canada.
Mr. A. L. Stevenson, Dominion Dept. of Agriculture, Ottawa, Canada.
Mr. T. M. Patterson, Dominion Water & Power Bureau, Ottawa, Canada.

For the United States

Mr. J. W. Dixon, Bureau of Reclamation, Washington, D. C.
Mr. C. G. Paulsen, Geological Survey, Washington, D. C.
Major General R. C. Crawford, Corps of Engineers, Washington, D. C.

The Board appointed Engineering Committees, one also for each of the references, and made an initial assignment of work to them. The members of the Engineering Committees are:

For Canada

Mr. G. L. MacKenzie, Prairie Farms Rehabilitation Administration, Regina, Saskatchewan.
[b] Mr. O. H. Hoover, Dominion Water & Power Bureau, Calgary, Alberta.
[b] Mr. N. M. Sutherland, Province of Alberta, Edmonton, Alberta.
Mr. G. N. Munro, Prov. of Saskatchewan, Regina, Saskatchewan.
[a] Mr. D. B. Gow, Dominion Water and Power Bureau, Winnipeg, Manitoba.
[a] Mr. D. M. Stephens, Prov. of Manitoba, Winnipeg, Manitoba.

For the United States

Mr. K. F. Vernon, Bureau of Reclamation, Billings, Mont.
Mr. Henry C. Beckman, U. S. Geological Survey, Rolla, Mo.
Col. E. H. Walter, Corps of Engineers, Dept. of Army, Fort Peck, Mont.
[a] Mr. Wm. V. Taylor, Fish and Wildlife Service, Washington, D. C.

In July the Boards and Committees and their assistants conducted a field inspection in southern Alberta and northern Montana and met at Havre, Mont., where the work program was considered and crystallized. The joint Engineering Committees have held other meetings in Great Falls, Mont., in June; in Winnipeg, Manitoba, in September; and at Minot, N. Dak., in November, where progress on the work done so far has been reviewed. At the regular semi-annual meeting of the International Joint Commission held in Ottawa last October 12 and 13, the Engineering Boards rendered their formal reports of work accomplished to date. At that time similar reports were received from other boards charged with investigating various problems along the international boundary, one of which is concerned with the international problems in the Columbia River Basin. The Bureau of Reclamation is represented on the Columbia River Engineering Committee by Mr. Frank Banks, District Manager at Grand Coulee Dam, Wash.

The work now under way is (1) to determine the water requirements arising out of existing projects in both countries, and (2) to determine the need in both countries for further water development. These two tasks will involve primarily the determination of existing and potential water uses and land classification surveys in both countries.

From preliminary inspection it is abundantly clear that the amount of good irrigable land on both sides of the international boundary far exceeds that which can be irrigated with the available water in the Waterton and Belly Rivers.

The work for the Souris-Red River Reference includes consideration of the flood control and fish and wildlife facilities as well as developments in connection with the Missouri-Souris Unit of the Missouri Basin Project.

Field engineers of both countries will continue the work throughout the winter and hold meetings every two months. The next formal meeting of the International Joint Commission and the Engineering Boards will be held in Washington, D. C., in April 1949.

All of the field investigations, as well as the informal and formal conferences and meetings in the field and in the two national capitals have been marked with the greatest of cooperation and friendliness among members from both sides of the boundary, reflecting and cementing the good will that exists between these two great neighboring nations. The International Joint Commission functions at times as an international investigatory agency to make recommendations to the two governments, and under certain conditions it is also an international court on water and other affairs. The Commission historically has followed the comity between the two nations, and has successfully settled one problem after another in a spirit of genuine friendliness and good will. Its membership, both Canadian and from the United States, is to be congratulated, for with this policy it is possible to foresee early and mutually beneficial settlement of important questions which, in some other parts of the world, might have become the source of grave international controversies.

[a] Serves on Souris-Red Rivers Committee only.
[b] Serves on Watertown-Belly Rivers Committee only.

Producing Dollars from "Scents"

(Continued from page 18)

tervals. The hay should not come in direct contact with the steam coils in the still, since burned hay may contribute undesirable flavor, odor, or color. Distilling the hay for a long period after most of the oil has been separated may also carry over into the oil undesirable flavor, odor, and color. All containers in which oil is handled and shipped should be as clean as the dishes from which you eat.

Peppermint hay produced in the Pacific Northwest has, to date, been comparatively free from plant diseases which have presented a serious problem in the Middle West. Comparatively little "wilt" has been found. One or two instances of an unidentified crown rot have been discovered. A minimum amount of insect damage has also been found in this area by the mint flea beetle, strawberry weevil, and wire worm. Every precaution should be taken to avoid the introduction of diseases into the Pacific Northwest fields and the resultant serious damage to peppermint oil production. Any suspicion of plant disease or insect damage should be reported to the experiment station.

Since the production of peppermint oil in the Pacific Northwest is comparatively new and is rapidly expanding there are a variety of problems which need intensive study. For example, when to harvest the crop to get best results? The optimum stage of maturity of the plant for harvest has not been definitely determined. The stage of maturity varies, at cutting, in different areas. Work on the optimum stage of maturity is being done by the Division of Chemistry of the Washington Agricultural Experiment Station. Both commercial and pilot plant stills are being used to determine the botanical stage of maturity which will produce the highest quality of oil consistent with a reasonable yield. Another problem which is being worked on is the operation and construction of the stills, and how different methods affect efficiency and oil quality. Studies have been initiated on the effect of fertilizers on the yield and quality of oil in these areas. Hand weeding of peppermint fields is expensive and cooperative studies are being initiated on the effectiveness and cost of various methods of weed control, including both chemical and mechanical methods.

It appears that all peppermint grown in the United States is of one variety. Other resistant varieties and selections of peppermints developed by the Bureau of Plant Industry at Beltsville, Md., are being tried out at our Irrigation Experiment Station to see how they respond to our climatic, soil, and irrigation conditions.

The undesirable odors and flavors of certain peppermint oils will also be given thorough laboratory analyses, to break them down to their chemical properties, constituents, and composition of the oil. It will then be possible to solve many problems involved in peppermint production both here and in other areas. There is three-way cooperation on this project—industries which refine and use peppermint oil, the growers, and the State are all supporting this work.

The Pacific Northwest seems to be a very suitable area for the production of peppermint oil, and perhaps other essential oils. Specialized crops such as these may well be of much value in the utilization of agricultural lands made available by the development of irrigation through the Columbia Basin project. THE END

THE BUREAU'S 1948 ANNUAL REPORT to the Secretary shows that Reclamation completed the Adams, Prospect Mt. and Ramshorn tunnels (Colo.-Big Thompson), Altus canal (Austin), and the Coachella main canal (All-American) during the year; began three new dams—Hungry Horse, Medicine Creek, and Heart Butte; delivered first water to 34,131 acres; made 18,575 acres available for homesteading, and installed 399,000 kilowatts (not counting a new 15,000 unit at Ft. Peck) of power.

The Bureau let 1,400 contracts totaling nearly $170 million. Every State in the Union except one furnished materials and supplies for Reclamation work. About 60 percent of Reclamation's purchases went to manufacturers in the East and 40 percent West.

Farmers supplied with Reclamation water last year grew crops valued at 555 million dollars, averaging $122 an acre. Power plants operated by the Bureau sold 15,000 million kilowatt-hours for 26 million dollars.

The Colorado River Basin, scene of several major developments by the Bureau of Reclamation, makes up one-twelfth of the land area of continental United States.

Contracts Awarded October 26 to October 31, 1948

Spec. No	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2265	Davis Dam, Ariz.-Nev	Oct. 29	3 potential and 11 current transformers for Mesa Substation, schedule 6.	Standard Transformer Co., Warren, Ohio	$11,071
2314	Colorado-Big Thompson, Colo	Oct. 26	4 indoor-type cubicles containing generator protective equipment, disconnecting switches, and instrument and potential transformers; and four 15-kilovolt-ampere transformers for Marys Lake and Estes power plants, and Granby pumping plant, schedules 1, 2, and 3.	Westinghouse Electric Corp., Denver, Colo	30,727
2343	Columbia Basin, Wash	Oct. 29	One 12,500 kilovolt-ampere generator for station-service unit LS3, Grand Coulee power plant.	Do	170,151
2371	Hungry Horse, Mont	do	Three 96-inch ring-follower gates for Hungry Horse dam, item 3	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	159,000
2374	do	do	3 air compressors for Hungry Horse power plant, schedule 1	Gardiner-Denver Co., Denver, Colo	14,062
2376	Columbia Basin, Wash	do	Furnishing and installing 2 electrically operated elevators for Grand Coulee power plant.	Otis Elevator Co., San Francisco, Calif	157,698
2388	Provo River, Utah	do	One 5 by 5 foot high-pressure gate with 255,000 pound hydraulic hoist for gate structure, Salt Lake aqueduct.	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	25,375
2397	Klamath-Tule Lake, Oreg	do	Construction of earthwork and structures, canal, laterals and drains for Coppock Bay area, second extension, schedule 1.	Natt McDougall Co., Portland, Oreg	267,416
2397	do	do	Construction of earthwork and structures, canal, laterals and drains for N canal system area, first extension, schedule 2.	Ramsey Construction Co., Corvallis, Oreg	145,005
2406	Yakima-Roza, Wash	Oct. 26	Construction of pumping plants for areas 13 and 14	Willett and Sons, Wenatchee, Wash	90,673

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NOTES FOR CONTRACTORS

Contracts Awarded During November 1948

Spec. No.	Project	Award date	Description of work or material	Contractor's Name and address	Contract amount
2261	Davis Dam, Ariz.-Nev	Nov. 5	Two 230,000/196,000-volt circuit breakers for Prescott substation, schedule 2.	Pacific Electric Mfg. Corp., San Francisco, Calif.	$112,656
2275	Columbia Basin, Wash	Nov. 2	Three 5,000-ampere bus structures with current and potential transformers, grounding switches, and generator protective equipment for units R4, R5, and R6, Grand Coulee power plant.	I-T-E Circuit Breaker Co., Philadelphia, Pa	204,432
2348	do	Nov. 22	Six pumping unit control boards for Grand Coulee pumping plant, schedule 1.	Westinghouse Electric Corp., Denver, Colo	39,236
2348	do	do	One 6,900-volt switchgear unit, nine indoor boards, one battery control and distribution board, two 15-kilowatt battery chargers, and five 75-kilovolt-ampere and three 100-kilovolt-ampere transformers for Grand Coulee pumping plant, schedules 2, 5, 6, and 7.	General Electric Co., Denver, Colo	60,523
2348	do	do	Three 6,900- to 460-volt unit substations for Grand Coulee pumping plant, schedule 3.	I-T-E Circuit Breaker Co., Philadelphia, Pa	82,938
2348	do	do	Nine heating and ventilating boards and four unit auxiliary motor boards for Grand Coulee pumping plant, schedule 4.	Zinsco Electrical Products, Los Angeles, Calif	36,993
2353	do	Nov. 9	One 10,000/12,500-kilovolt-ampere autotransformer for Grand Coulee left power plant.	Pennsylvania Transformer Co., Pittsburgh, Pa.	19,007
2364	Boulder Canyon, Ariz.-Calif.-Nev	Nov. 12	Two 168-inch butterfly valves and two upstream flanges for turbine inlet pipes for units A3 and A4, Hoover power plant.	Hardie-Tynes Mfg. Co., Birmingham, Ala	493,300
2370	Central Valley, Calif	do	Six butterfly-valve connection pipes for Tracy pumping plant.	Consolidated Western Steel Corp., Los Angeles, Calif.	27,083
2386	Missouri River Basin, Wyo	Nov. 12	3 ventilating fans for shafts A and B, Boysen railroad tunnel	Robinson Ventilating Co., Zelienople, Pa.	49,312
2392	Central Valley, Calif	Nov. 4	Construction of earthwork, canal lighting, and structures for turnouts at Friant-Kern canal.	Munn and Perkins, Modesto, Calif	254,299
2398	Missouri River Basin, Colo.-Kansas	do	Construction of Bonny dam and access road	Utah Construction Co., San Francisco, Calif	10,301,653
2403	Central Valley, Calif	Nov. 26	6 current and four potential transformers for Tracy switchyard	General Electric Co., Denver, Colo	51,402
2415	Missouri River Basin, Kansas	Nov. 18	One 66-inch diameter outlet pipe for Cedar Bluff dam	Thompson Pipe and Steel Co., Denver, Colo	29,190
2419	Central Valley, Calif	Nov. 24	6 motor protective equipment cubicles and six neutral grounding equipment cubicles for Tracy pumping plant, schedules 1 and 3.	General Electric Co., Denver, Colo	59,964
2419	do	Nov. 26	18 current transformers and 1 synchronous-condenser neutral grounding equipment cubical for Tracy pumping plant and switchyard, schedules 2 and 9.	do	16,737
2429	Missouri River Basin, Nebr	Nov. 18	Six 40,000-pound radial-gate hoists for spillway at Enders Dam	Pacific Coast Engineering Co., Alameda, Calif.	29,900
2430	Mirage Flats, Nebr	Nov. 5	Construction of extension of Cottonwood Creek siphon, Main canal.	Rentlor Co., Inc., Grand Island, Nebr	38,650
2439	Boulder Canyon, Ariz.-Calif.-Nev	Nov. 30	Aluminum railings, curb strips, and steel partitions for Hoover power plant.	George T. Gerhardt Co., Inc., San Francisco, Calif.	23,000
2447	Columbia Basin, Wash	Nov. 24	512,000 barrels of bulk portland cement for construction work near Grand Coulee Dam and Odair and Adrian, Wash., schedule 2.	Superior Portland Cement, Inc., Seattle, Wash.	1,536,000
2449	Boulder Canyon, Ariz.-Calif.-Nev	Nov. 18	Seven 30,000 kilovolt-ampere transformers for units A3 and A4, Hoover power plant.	General Electric Co., Denver, Colo	586,366
2453	do	Nov. 2	Fabrication and installation of one 82,500 kilovolt-ampere generator for unit A4, Hoover power plant.	Allis-Chalmers Mfg. Co., Denver, Colo	1,308,661
RI-YR-1	Yakima-Roza, Wash	Nov. 22	Construction of shop and service building at Sunnyside, Wash	Hall-Atwater Co., Seattle, Wash	51,330

Construction and Supplies for Which Bids Will Be Requested by March 1949

Project	Description of work or material
Boulder Canyon, Nev	Construction of 15 permanent houses at Boulder City.
Do	Furnishing and installing sprinkling system for parks and parkways in Boulder City.
Central Valley, Calif	Distribution boards and miscellaneous equipment for Tracy Pumping Plant and Switchyard.
Colorado-Big Thompson, Colo	Neutral grounding reactors for Estes Power Plant.
Do	Relocation of about 8.5 miles of Colorado State Highway No. 280 (Monarch Lake Road), from Granby Dam toward Monarch Lake, Colo.
Columbia Basin, Wash	Station service unit control board for Grand Coulee Power Plant.
Do	Generator cooling water jet pumps for Grand Coulee right Power Plant.
Do	72-inch diameter station-service ring seal gates for Grand Coulee Power Plant.
Davis Dam, Ariz.-Nev	Constructing and furnishing equipment for Maricopa Substation at Maricopa, Ariz., Electric District No. 5 substation at Eloy, Ariz., and Electric District No. 2 and Electric District No. 4 substations located north of Eloy. Each substation is to have a capacity of 15,000-kva, from 115 kv to 12.5 kv.
Do	Generators voltage bus structure and neutral grounding reactors for Davis Power Plant, Units 1 to 5.
Do	Autotransformers, power circuit breakers, lightning arresters, and instrument transformers for Coolidge Substation.
Gila, Ariz	Construction of 18 miles of the Wellton-Mohawk Canal, extending from Mile 15 on the Gila Gravity Mail Canal to Pumping Plant No. 3, about 20 miles east of Yuma, Ariz.
Do	Construction of Pumping Plants Nos. 1, 2, and 3, located at Miles 8, 14, and 18, respectively, on the Wellton-Mohawk Canal about 20 miles east of Yuma, Ariz.
Do	Ten motors for Wellton-Mohawk Pumping Plants Nos. 1, 2, and 3.
Hungry Horse, Mont	Domestic water pumps and oil pumps for Hungry Horse Power Plant.
Do	Relocation of Forest Service road between Riverside Creek and Elk Park Ranger Station about 30 miles northeast of Kalispell, Mont.
Klamath, Oreg.-Calif	Improving 10 miles of Lost River Channel in Langell Valley, near Klamath Falls, Oreg.
Minidoka, Idaho	34.5-kv. power circuit breakers for switchyard at Minidoka Power Plant.
Missouri River Basin, Mont	Construction of canals and laterals for irrigating 4,068 acres for the N-Bar-N Unit (Montana Pumping) between Fort Peck and Wolf Point, Mont., on the Missouri River.
Missouri River Basin, Mont	Construction of about 8 miles of canal, and construction of laterals and pumping plant for the Savage Unit (Yellowstone Pumping) near Savage, Mont.
Missouri River Basin, Nebr	Construction of earthwork and structures for about 12.5 miles of Superior Canal, near Superior, Nebr.
Missouri River Basin, Nebr	Six 10- by 6-foot and two 20- by 12-foot radial gates; two 20,000-pound and six 3,000-pound radial-gate hoists for Superior-Courtland diversion dam.
Missouri River Basin, Wyo	126-inch diameter penstocks for Boysen Power Plant.
Missouri River Basin, Wyo	161-kv. disconnecting switches for Kortes Switchyard at Kortes Power Plant.
Missouri River Basin, Wyo	Transformers, switching, and protective equipment for Thermopolis Substation.
Ogden River, Utah	Construction of earthwork and structures for an equalizing reservoir for the south Ogden lateral distribution system, near Ogden, Utah.
Palisades, Idaho	Power transformers, oil circuit breakers, disconnecting switches, and lightning arresters for switchyard at Palisades Power Plant.
Parker Dam Power, Calif.-Ariz.	10-ton crane for Parker Dam.
San Luis Valley, Colo	Construction of Platoro earthfill dam, 150 feet high above river bed and 1,500 feet long, located on the Conejos River about 40 miles west of Alamosa, Colo.
Santa Barbara, Calif	Construction of exploratory tunnels and test pits for Cachuma dam site near Santa Barbara, Calif.
Do	Construction of the 8.5 mile Tecolote Tunnel between Cachuma Reservoir site and Glen Ann regulating reservoir, and construction of 1.8 miles of access road near Goleta, Calif.
Shoshone, Wyo	Construction of a 1,000-foot concrete siphon across the C. J. Coulee located on the Willwood Division in Northwest Wyo.
Tucumcari, N. Mex	Construction of last 15 miles of the Hudson Canal and construction of Lateral Unit No. 7, including drains about 15 miles northeast of Tucumcari, N. Mex.
Yakima, Wash	8,700-horsepower turbines and governors for Roza Power Plant.
Do	Two generators for Roza Power Plant.

ALASKA

Far-from-forgotten Land

The Reclamation ERA

February

1949

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Ruth F. Sadler, *Editor*

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DO YOU KNOW . . .

- That Lake Mead, in back of Hoover Dam, largest man-made lake in the world, contains enough water to cover the entire State of New York to a depth of 1 foot?
- That Hoover Dam contains enough concrete to form a monument one city block square which would tower above the Empire State Building (1,248 feet) in New York City?
- That the three highest concrete dams in the world were built by the Bureau of Reclamation? They are Hoover, Arizona-Nevada (726 feet), Shasta, Calif. (602 feet), and Grand Coulee, Wash. (550 feet).
- Today, in the Missouri Basin only 1 in every 16 acres of tillable land is irrigated? Completion of the Missouri River Basin project will reduce this to 1 out of every 8, thus doubling the agricultural production of the region.
- "It is time someone pulled away the screen behind which the private power companies are operating," was said by the late Reclamation Commissioner Dr. Elwood Mead on February 2, 1927?

Reclamation Place Names in This Issue

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J. A. Krug, Secretary

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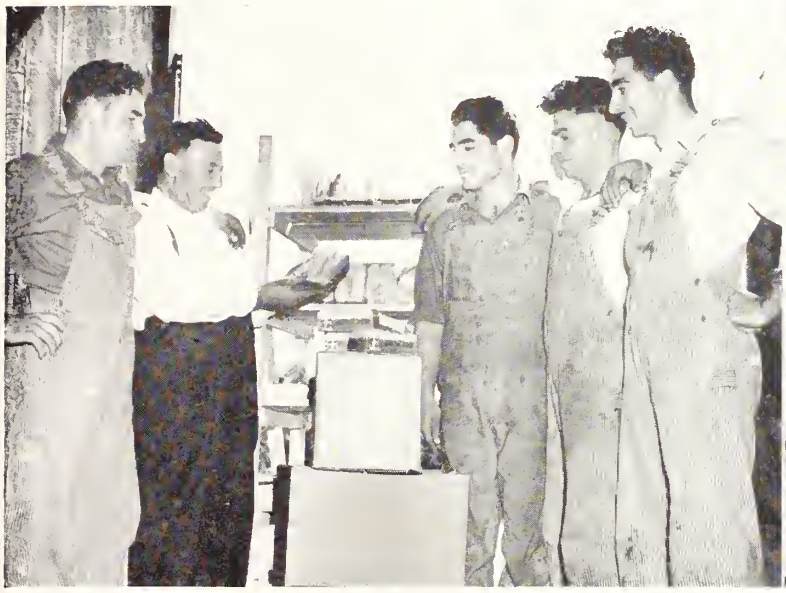
FROM THE BUFFALO RAPIDS PROJECT—The Crisafulli family smilingly admire their prized product. Left to right: Frank, Joe, Sr., Leonard, Joe, Jr., and Angelo. At right: After final inspection of packaged corn on the cob by Joe, Jr., in the quick-freeze room, the sealed packages are packed into cases and transferred to the zero storage room.



Frozen CORN ON THE COB

by JOHN D. ABRAHAMSON

Branch of Project Planning, Region VI, Billings, Montana

No longer is corn on the cob a delicacy to be enjoyed only in the summertime. Joseph Crisafulli, Sr., and his four sons, farmers on the Buffalo Rapids project in eastern Montana, are engaged in making corn on the cob a year-around delicacy. They grow the corn and prepare it for market with a freezing plant on the farm. Chances are that the serving of corn on the cob which you had for dinner recently came from the Crisafulli farm, for the Crisafullis are among the Nation's largest producers of frozen corn on the cob.

Long before the Buffalo Rapids irrigation project was constructed, Joseph Crisafulli, Sr., had grown truck crops near Glendive, Mont., for the work trains of the Northern Pacific Railroad and the limited local market. He had 23 acres of rich Yellowstone River Valley bottomland which he irrigated by pumping with gasoline engines from two wells.

Experience had demonstrated to Crisafulli that superior truck crops could be grown in eastern Montana. When local interest developed for the construction of the Buffalo Rapids irrigation project, Crisafulli was among its most enthusiastic supporters. He foresaw great opportunities for the production of specialty crops. Marketing of such crops was the major problem. His farm was far from densely populated consuming areas. Crisafulli says that he had some ideas on marketing, but they couldn't be put to test until his boys grew up to help him. They had to have an education also to help carry out the ideas.

During the years that the family was growing up and attending school, Crisafulli operated his small farm near Glendive and to help along Mrs. Crisafulli opened a grocery store in Glendive which she still operates.

All of the children, the four sons and a daughter, were graduated from the local high school. Three of the children chose to continue with university study. Joseph, Jr., and Rose were graduated from the University of Montana. Joseph, Jr., returned to Glendive to assist in developing the present family enterprise. Rose remained at the university to teach mathematics and physics for several years. Leonard entered the University of Washington and was graduated in time to serve in the war as a naval officer. He is now attending medical school, but devotes his spare time to assisting his father and brothers. Upon graduation from high school, Angelo and Frank joined their father in farming.

For several years after irrigation water became available on the Buffalo Rapids projects, the father and sons tried out

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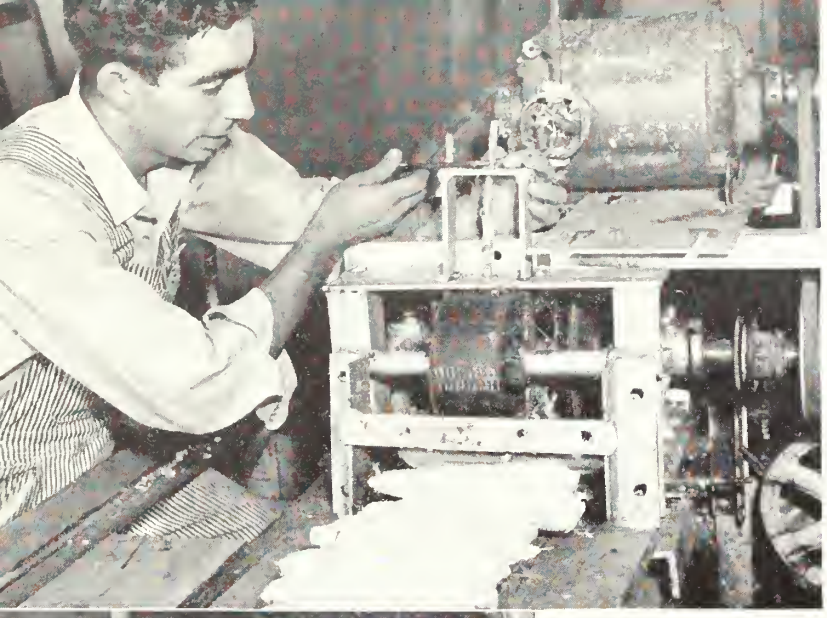
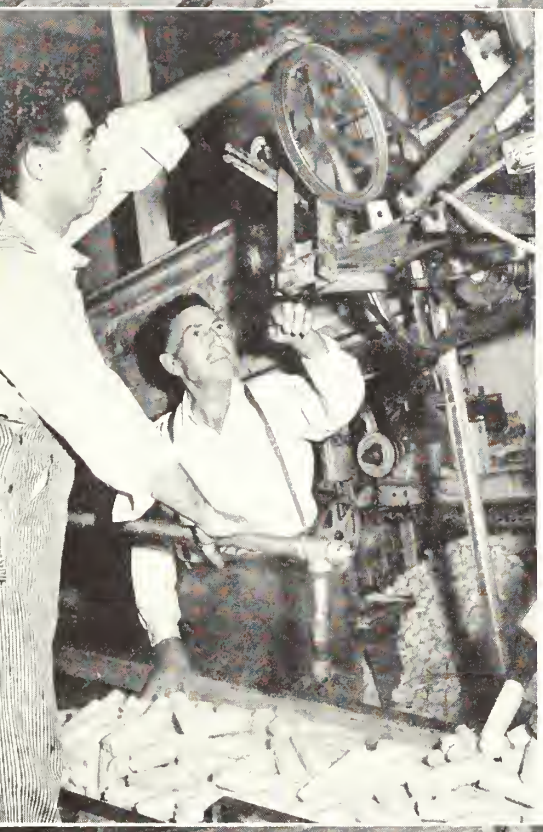




Above: Angelo Crisafulli adjusts corn-trimming machine which he invented for trimming ears to a uniform length of 5½ inches. At left: "Pop" and Angelo blanching corn. Below: Joe, Jr., supervises inspection of corn as it emerges from blanching chamber. Woman at right removes rejected ears while others remove silks and trim ears. *All photos for this article by Charles A. Knell, Sr., Region VII.*

various crops and farming practices. They talked about new marketing methods and about processing techniques from dehydrating to canning. They joined the community in urging a canning concern to locate in Glendive, and they discussed the possibility of establishing a canning plant of their own. Meanwhile they continued to produce vegetables. Without the railroad market, which had disappeared many years previously, they marketed their vegetables themselves under most difficult conditions. A truck would be loaded and one of the boys would drive from town to town selling vegetables from the truck. Sometimes he would travel as far as 300 to 400 miles before disposing of a load.

While facing such hardships and considering various marketing possibilities, they discovered that a variety of sweet corn which they had been testing proved to have superior eating qualities. One of the boys came up with the suggestion that they freeze some of the corn. They froze 3,000 pounds of corn on the cob at a local locker plant. It turned out better than they expected. Joseph, Jr., was dispatched to the East with orders to consult food technologists on freezing and canning and to come back with directions on how to do the job. He covered a lot of territory within a short time. He studied methods, listened intently, made notes on processing, talked to equipment manufacturers, and even located a market in the New York City area.

On his return the father and sons conferred. The 3,000 pounds of corn on the cob which had been marketed on the West coast brought a deluge of orders. They decided to establish a freezing plant at the least possible cost. Above all they wanted to stay out of debt. They already had a huge hillside potato cellar in which they could construct their cold storage plant. The insulation value of its walls would reduce the insulation costs of the storage rooms. They could do most of the work required for a freezing plant. They also had Angelo who could dream up and make many of the machines they needed. Leonard would be available during the processing season as their chemist to run enzyme and bacteriological tests.

In 1945 the boys scoured the country for a few special pieces of equipment and then built the freezing plant on the farm. In 1946 they froze and shipped from the farm five carloads of corn on the cob, which was one-fifth of all corn frozen on the cob in the United States. In 1947 and 1948 they repeated that output.

Through the farm processing plant, the Crisafullis' have obtained latitude in selection of farm enterprises. Furthermore, it has permitted flexibility of enterprise combinations. These are desirable features in an area where climatic conditions and limited marketing opportunities confine agriculture largely to meat and wheat production.

Crisafullis' farm operations are essentially organized around the freezing plant. Each year about 120 acres of sweet corn are planted. Land not in sweet corn is utilized for soil building and other crops. Some of the other crops grown are rutabagas, potatoes, barley, clover, and alfalfa. Barley and clover are usually planted together. The barley serves as a nurse crop for the clover, and the clover is plowed under before the next growing season to provide a green manure. The production of rutabagas and potatoes is a carry-over of Crisafullis' earlier experiences. He has developed

a reputation for the high quality of these crops and consequently continues their production. Potatoes placed on the market are graded, washed, and distributed under their trade name which carries the picture of a grizzly bear.

Livestock fattening is an integral part of the farm's operation. Alfalfa and grain supplemented by residue of husks and corn trimmings from the processing plant are used to fatten about 150 steers and 200 hogs annually. About 100 head of Hereford breeder cattle are maintained. They are kept on the range most of the year. Selected steers from this herd, supplemented by local purchases, are fattened. As harvest proceeds, the feeders are transferred from field to field to clean up harvesting waste and residue. Near marketing time they are placed in a feed lot and fed alfalfa and plant residue.

Hog feeding is geared closely to the amount and kind of feed available through the year. All hogs are purchased so that flexibility in feeding is obtained. If potato and rutabaga culls are available, less mature hogs are purchased and fed cooked culls and grain. For this the sons constructed a cooking tank with a capacity of two tons of feed. As corn residue becomes available from the processing plant, more hogs are purchased and all are finished for market on corn residue and barley.

Soil fertility is kept at an optimum through use of green manure, livestock manure, and commercial fertilizer. Each year the Crisafullis buy a carload of phosphate fertilizer in Tennessee. "This," Mr. Crisafulli, Sr., explains, "is used liberally on every crop on the place."

Planting of sweet corn is staggered so that in the fall its harvesting can be spread over several weeks to meet the processing plant's capacity. The moment that the corn has reached proper maturity it is harvested and rapidly moved to the plant with as little damage to the ears as possible. An ingenious device removes the husks and silk and trims the ears to a uniform length of 5½ inches. The ears then move on to a conveyor belt which carries them through a live-steam chamber where they are blanched. At the end of this chamber a series of fine jets of cold water cool the ears. From there a conveyor carries the ears past an inspector who carefully selects the ears to be packed. Beyond the inspector the corn is placed into small cellophane bags holding two ears or into large aluminum-foil-lined bags holding 30 ears. The packages are then sealed airtight. The packaged corn is rushed into a quick-freeze room having a temperature of 20° below zero. From the quick-freeze room the corn is transferred to storage rooms where a uniform temperature of zero degree is maintained. Throughout processing and on into storage, careful enzyme and bacteriological tests are made.

Possibilities for growing and freezing other crops have not been overlooked by the Crisafullis. They have experimented with squash, peppers, and egg plant. Next year they plan to grow and freeze several acres of strawberries and carrots for market.

The Northern Great Plains where the Crisafullis live is one of America's remaining frontiers. Its unpredictable yet recurring droughts have been unfavorable to intensive development of the land and the growth of a mature economy. However, a bright future for a significant portion of this frontier appears on the horizon. Irrigation water, the foundation on which the Crisafullis have been able to build, will become available to vast areas as the construction of the Missouri River Basin project is advanced.

Crisafullis' endeavors portend future opportunities in the Great Plains. They are demonstrating that its soil and sunshine in proper proportions with irrigation water, ingenuity, foresight, perseverance, and perspiration are remarkably productive. THE END

National Grange Supports Reclamation

Strong support for a vigorous program of resource development, including irrigation, flood control, and Federal power projects, was given by the National Grange at its annual meeting in Portland, Maine, last November. Emphasis was placed upon protection for the family type farm, including acreage limitation under Reclamation law and extension of public power, including transmission lines.

"Contrary to popular belief, the family type farm greatly predominates in the Nation," declared the report of the agricultural committee, adopted by the convention of State Grange Masters and their wives, who form the National Grange.

"Production of these (family type) farms, when added to that of the self-sufficing farms," the report continued, "constitutes by far the great bulk of the farm output of the Nation. Also, contrary to popular belief, increased mechanization has strengthened, and will continue to strengthen, the hold of the family type farm . . . The Grange believes firmly that the family type American agriculture has an outstanding destiny in our democracy and free-enterprise system, and the role these will play in the future of the world and mankind."

The report points out that in areas where mechanization of farming has increased most rapidly the percentage of unpaid family labor which goes into the farming operation also has increased most rapidly. It gives as examples the fact that family labor on farms in the corn belt increased from 70 percent before the war to 85 percent in 1947.

It is this high percentage of family labor that goes into American farming which makes "the American farm the only portion of our free enterprise system that is inherently and at all times an abundantly producing unit," the Grange report said. This is because about 75 percent of all the labor supplied in the farm comes from members of the farmer's family, and therefore is a "fixed charge." On this point the report explains:

"This labor must be used to prevent it from being a clear loss, and it therefore becomes a fixed expense to the farm manager. Other fixed costs, such as taxes, feed for work stock, insurance, etc., bring the total fixed costs of the average farm to 75 percent of all costs of operating the farm. The average American industrial plant, on the other hand, operates almost entirely with hired labor, which is not a fixed cost. Fixed costs average around only 25 percent of the total costs in industry."

(Continued on page 32)

Central Arizona Project

by W. S. Gookin

Engineer, Office of Project Planning, Washington, D. C.

(Formerly of the Phoenix, Ariz., Office of Project Planning, Region III, Boulder City, Nevada)

PART TWO

Plans for the Future

Full development of the Central Arizona project would involve construction of: Bluff Dam on the San Juan River; Coconino Dam on the Little Colorado River; Bridge Canyon Dam on the main stem of the Colorado River; the Havasu pumping plants near Lake Havasu; the Granite Reef Aqueduct extending from Lake Havasu to the Granite Reef Dam; the McDowell pumping plant; the potential McDowell Dam on the Salt River; the Salt-Gila Aqueduct; Buttes and Hooker Dams on the Gila River; the Charleston Dam on the San Pedro; and a pipe-line to the city of Tucson. The project also contemplates improvement of the irrigation system in the Safford Valley and enlargement of the existing Horseshoe Dam. In addition, an irrigation distribution system, an irrigation drainage system, and a power transmission system would be required and provided for under the project plan of development (*see back cover*).

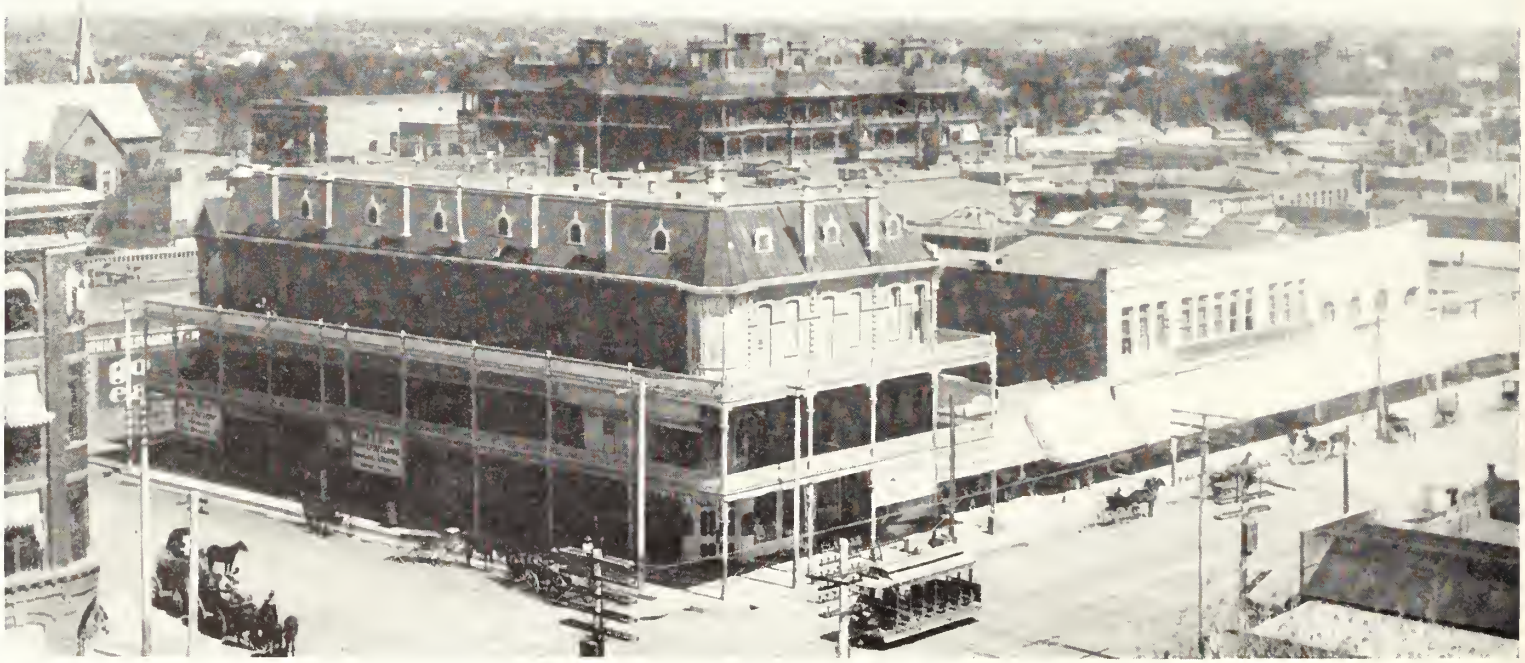
At first glance many of the features contained as a part of the Central Arizona project may seem unrelated. Consideration of these various features individually is needed to see the inter-relationship which each bears to the other and to the project as a whole.

Bridge Canyon Dam on the Colorado River would be located at the upstream end of Lake Mead. Its prime purpose would be to provide energy for the Parker pumping plants. It would, in addition, provide a large block of electric power for commercial sale. The revenue thus derived would represent a sizeable portion of the income necessary to repay project costs. Bridge Canyon Dam would be approximately 740 feet high, 80 feet higher above tail water level than Hoover Dam and requiring 75 percent more concrete.

Despite its height, Bridge Canyon Dam would create a relatively small reservoir of approximately 3,700,000 acre-feet which is only a little more than 10 percent of the capacity of Lake Mead. At the present time well over 100,000 acre-feet of silt passes through the Grand Canyon every year. Such a silt inflow would soon encroach on necessary storage capacity in Bridge Canyon Reservoir, unless some provision were made to prevent such an occurrence. In addition, because of the small available capacity it would be highly desirable to provide upstream flood control and river regulation.

For the foregoing reasons two upstream dams have been considered as essential adjuncts to the Bridge Canyon Dam. Bluff Dam, furthest upstream of these, is on the San Juan River. This structure would be tri-purpose in that it would serve to detain silt, control floods and provide river regulation in addition to incidental uses. Although it is a small unit in the Central Arizona project it would be a sizeable fea-

City of Phoenix in 1907, before construction of Roosevelt Dam.



ture in its own right. It would have a height of 340 feet and a reservoir capacity of 3,000,000 acre-feet.

Coconino Dam on the Little Colorado River would serve the dual purposes of silt detention and flood control. The reservoir thus created would be slightly larger than the lake impounded by Roosevelt Dam which was built as the first unit of the Salt River project shortly after the turn of the Century. Coconino Dam would be approximately 20 feet lower than Roosevelt.

Granite Reef Aqueduct.—Diversion of Colorado River water would be accomplished by pumping from Lake Havasu into the potential Granite Reef Aqueduct. Four pumping plants to be installed along the western end of Granite Reef Aqueduct would lift the water a total of 985 feet. By way of comparison, the Colorado River Aqueduct of the metropolitan district of southern California involves pumping a total of 1,617 feet.

Granite Reef Aqueduct would transport water from Lake Havasu to Granite Reef Dam. It would have a total length of 241 miles. The westernmost 25 miles of the aqueduct would be located in extremely rugged mountain terrain. The remainder would pass through typical desert country occasionally skirting small mountain ranges and crossing a few major drainage channels such as Cunningham Wash, Centennial Wash and Hassayampa, Aqua Fria and New Rivers. By far the major portion of the aqueduct would be open canal. However, siphons would be provided as necessary.

Studies have revealed that maximum efficiency demands that Granite Reef Aqueduct be designed to operate at a continuous rate of flow as now considered. The capacity of the aqueduct has been adopted as 1,800 cubic feet per second.

Diversions from the Granite Reef Aqueduct would serve lands in the northern and western parts of the project area. The aqueduct terminus would be in the diversion pool behind the existing Granite Reef Diversion Dam. Since delivery would be made at a constant rate through the Granite Reef Aqueduct there would be times when the deliveries would exceed the requirements.

McDowell Pumping Plant.—At such times, delivered water would be lifted 88 feet by the potential McDowell pumping plant and delivered by a short canal to the McDowell Reservoir for retention until months of high irrigation demand. The potential McDowell Dam would also regulate floods and provide for some additional regulation of Salt and Verde River flows.

A Power Plant at the McDowell Dam Site would generate electrical energy for the commercial market. McDowell Dam itself would be relatively low, having a maximum height of only 131 feet. The reservoir thus created would impound more than half a million acre feet.

McDowell Reservoir would inundate the intake for the Phoenix Municipal Water Supply System. This intake would be replaced by a pipe line connecting the reservoir to the existing city aqueduct. A filtration and softening plant would be constructed to insure the city of a continuous supply of water equal in quality to that now utilized.

Enlargement of Existing Horseshoe Dam.—To obtain the maximum practical utilization of existing water supply within the Central Arizona Project area the over-all plan of development would provide for enlargement of the existing Horseshoe Dam. The Horseshoe Reservoir now has an active storage capacity of approximately 68,000 acre-feet. Increas-

City of Phoenix forty years later, an agricultural empire.

ing the dam by 40 feet in height and installing spillway gates would permit storage of water to the extent of 298,000 acre-feet. This additional capacity would serve to capture the major portion of the Verde River flood water which now spills uncontrolled over Granite Reef.

Installation of a Power Plant at the Horseshoe Site would permit utilization of Verde River flows for power generation.

Salt-Gila Aqueduct.—Assuming Colorado River water could be exchanged for Salt River water it would then be possible to serve irrigated lands in Pinal County with water diverted from Salt River at Stewart Mountain Dam. Delivery of this water would be accomplished by the Salt-Gila Aqueduct. This aqueduct would also consist primarily of open concrete-lined canal. A few short tunnels would be required in the northernmost end of the aqueduct to transport the water through the exceedingly rugged terrain which lies along the south bank of the Salt River. Major siphons would be required at Queen River and the Gila River. The total length of the aqueduct would be 74 miles. Its capacity has been adopted at 1,275 cubic feet per second. As currently conceived the aqueduct would terminate in the Picacho Reservoir south of Coolidge. Diversion would further be accomplished by a distribution system emanating from Picacho Reservoir.

Buttes Reservoir.—Water delivery through the Salt-Gila Aqueduct would not only provide for the supplemental requirements of the area but also would provide additional water to be used as a basis for exchange to permit increased upstream diversion. In line with the policy of making a full development of the existing water supply the Central Arizona project would involve construction of a dam at the Buttes site. This dam would be virtually the same height as the existing Roosevelt Dam and would also provide for generation of power. Buttes Reservoir would control and conserve the flood water of the San Pedro and tributary washes entering the Gila River below Coolidge Dam. It would also impound silt which is contained in large quantities in the waters which are now diverted to the irrigated lands during the summer months, and which present a serious problem to farmers of the area.

Charleston Dam.—With water from the Salt River provided to lands in the middle Gila area as a basis for exchange, construction of a dam at the Charleston site on the San Pedro River could be accomplished without infringement on the rights of downstream water users. This dam would be located about one-half mile north of Charleston, Arizona. It would provide flood control for the protection of downstream developments. In addition, it would regulate the erratic flows of the San Pedro River, and facilitate diversions to lands now irrigated along the river.

Tucson Aqueduct.—In addition, the Charleston Dam would serve as a diversion structure for the Tucson Aqueduct. The Tucson Aqueduct would consist of approximately 70 miles of closed conduit through which water would be conveyed to the city of Tucson. As a part of the aqueduct, a pumping plant would be installed to lift the diverted water 300 feet for delivery to Tucson.

As a part of the Central Arizona project, certain developments above San Carlos Reservoir would be required to meet

(Continued on page 40)

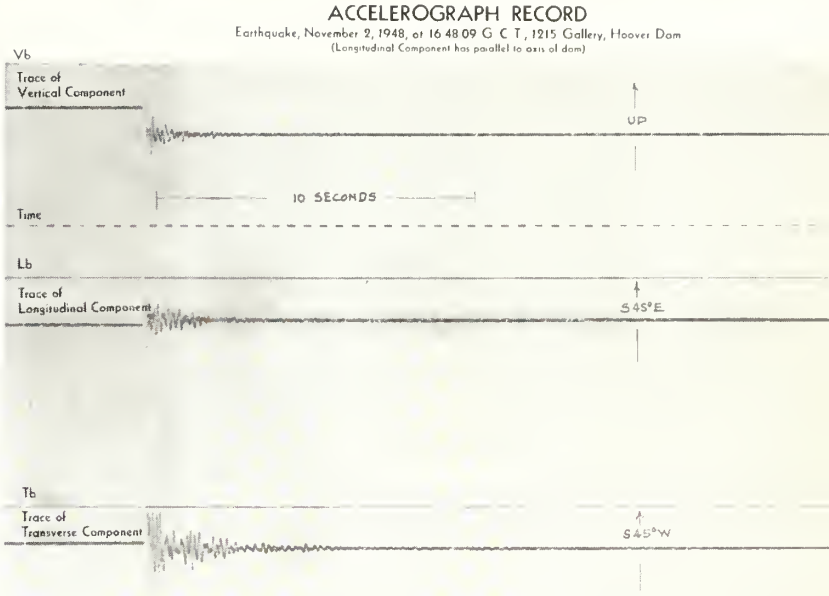
Salt River Valley "before and after irrigation." Note lush irigated lands on left and nonirrigated desert waste at right.

EARTHQUAKE
AT HOOVER DAM

By Engineer Tom C. Mead, Region III

On November 2, 1948 at 9:48 a. m. the workers at Hoover Dam and the people in Boulder City were startled by a much sharper earthquake than usual. Local earthquakes are fairly common. Those who have lived in Boulder City a long time take them as a matter of course. This one provoked numerous wisecracks about an "election landslide" from those who affected an indifference which some may not have felt. Actually real landslides did occur. Dust clouds rose from the steep sides of Fortification Mountain east of Lake Mead where a jar was all that was necessary to start earth slipping. Scattered rocks rolled onto the main highway in spite of the routine maintenance precaution of periodically removing all unstable material from slopes. Lights and electric heaters went off. Some anxious person from Las Vegas called the Government garage in Boulder City inquiring about the cause of the explosion.

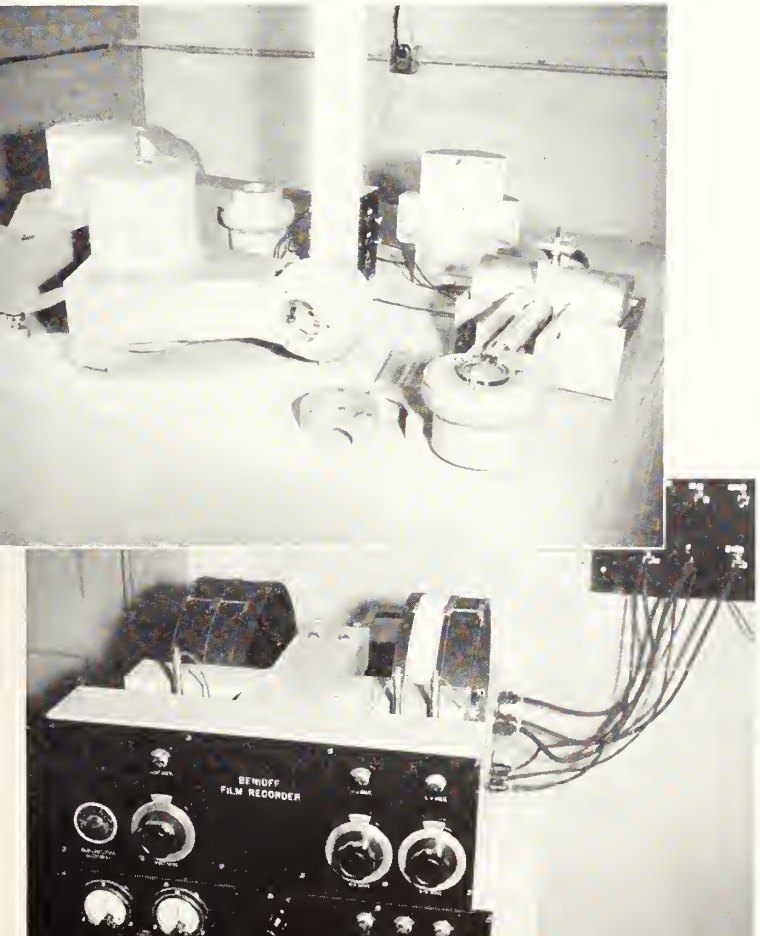
Actually this local shock, and the other hard ones, of which there have been four, was more dramatic than serious. The one of May 4, 1939, was harder but it did no more damage than open up a few cracks in plaster. Dr. Carder of the Coast and Geodetic Survey who had the May 4, 1939, quake in mind, wrote, "However, the earthquakes under discussion are comparatively small; the strongest of them would be considered light or moderate in regions where strong earthquakes occur." Although the November 2 quake was strong enough to cause many landslides in the vicinity of the dam its intensity as measured at the dam was only two-tenths of 1 percent of that measured at El Centro, Calif., for the Imperial Valley quake of May 18, 1940.



Interference with the lighting circuits was the particular distinction of the November 2 quake. In the dry language of the official report, "The Arizona transfer bus differential relay contacts were jarred to closed position by the shock, causing an outage on transformer bank Y for 1¼ minutes." That was what stopped the electric clocks in Boulder City, Henderson, Las Vegas, and Kingman. Other power lines leading from Hoover Powerhouse were unaffected.

The peculiar characteristic of these local shocks whose origin is within, say 20 miles, is their rapidity of vibration. The people in this area have become so accustomed to sudden shocks that if a slow roll were felt it might easily go unrecognized as an earthquake. That actually happened when the destructive Imperial Valley earthquake of May 18, 1940, caused a slow movement up-and-down here; no one thought of it as an earthquake. The lesser local shocks here often sound like distant thunder. The November 2, 1948, shock sounded as if a heavy truck, rumbling alongside the building, suddenly careened over against it.

In the past, geologic time forces of great magnitude were responsible for the major faults in the Lake Mead area. Any change in loading of the earth's crust such as that produced by change in stage of a large reservoir, as Lake Mead, results in either elastic yielding of the crust, or rupture along a line of crustal weakness; that is, along a fault. Both types of adjustment take place, but were it not for these geologic faults already being in existence, rupture of the crust would not occur; the change in lake loading is of insufficient magnitude to produce faulting. Where active faults are found, unbal-



Pictured above at the left are the three "sentinels" (seismometers) on the pier at Boulder City which picked up the Hoover Dam earthquake. They are designed to detect vibrations coming from two directions—at right angles or vertically. The one at the right with its cover off is a vertical component seismometer. Each seismometer transmits its pattern of the earth tremor to a recorder such as the one below where a beam of light traces the form of the earth vibration on 35-millimeter moving picture film. At the top of the page is the Coast and Geodetic Survey's "movie" of the Hoover Dam quake.

anced stresses may build up to the point where breaking occurs and tremendous amounts of energy are suddenly released into the surrounding rock area; we then have literally an "earth quake."

Two varieties of seismographs are used in this area for earthquake recording. At Hoover Dam the Bureau installed three accelerographs, which are rugged seismographs whose natural period of vibration is chosen so that the displacement recorded is a measure of the acceleration caused by the earthquake. From the acceleration, engineers are able to compute approximately the force exerted by the shock on the nearby engineering structures.

Two seismograph stations, one at Boulder City, Nev., and one at Pierce Ferry, Ariz., are used to locate the origin of local earthquakes. A third station at Overton, Nev., temporarily discontinued, will soon be reactivated, to further strengthen this location process.

Before Hoover Dam was built, our geologists made a very careful study of this area and concluded that no evidence existed of an active fault on the particular block on which Hoover Dam was situated. For the last dozen years, earthquakes in this area have been observed instrumentally and the results obtained have confirmed the earlier findings of our geologists. THE END

National Grange Supports Reclamation

(Continued from page 27)

Thus, the farm operates at nearly full production levels under all conditions, good times and bad alike, because the farmer loses less during depressions by maintaining full output than by reducing his output, whereas, industry, with lower fixed costs loses less by curtailing output.

But, when farm prices decline and the farmer is unable to sustain his purchasing power, the markets of industry dwindle and industrial production is curtailed. This, in turn affects the purchasing power of industrial workers, and markets for industrial output further decline. Support prices for farm products and various devices to sustain industrial output must be employed to maintain the economy on a fairly even keel, the Grange report declared.

The resolution backing Reclamation acreage limitation laws read as follows:

"Whereas, some interests have attempted to repeal the so-called acreage limitations in the Reclamation law, and

"Whereas, we believe this provision gives protection to the home owning type of farmer,

"Therefore, be it resolved, that the National Grange reaffirms its support of the acreage limitation provision in the Reclamation law."

Resolutions gave support also to the Reclamation program of power development. One of the resolutions on this subject read:

"Whereas bills introduced in Congress would eliminate the preferential clause for cooperatives, public utility districts and cities in purchase of power from Federal projects and would provide for delivery of power from Bonneville, Grand Coulee, and other Federal projects at the bus bar only, forcing public-utility districts, cooperatives, and municipalities to build transmission lines, which often are beyond their financial ability:

"Therefore, be it resolved by the National Grange, that we go on record opposing all such legislation."

Further supporting this theme the Grange declared "that all natural power sites be retained in public ownership and that the power resources of such sites be developed under Federal appropriation . . . that such power development be fully coordinated with the best and soundest practical use of the water for power, irrigation, industrial, navigational and other uses, and with the most effective, sound, flood-damage prevention of the entire drainage area."

"Revenues from power on a project," the resolution continued, should "be considered as a source of income which may be applied as partial payment for any portions of the project, except navigation, flood control, recreational, and public benefit aspects."

Appropriations should be made by the Government for "all economically sound facilities for power generation," the Grange asserted, "for the transmission of publicly generated power to load centers of the region at a uniform rate which will encourage the widest possible use, with preference given to cooperatives and public bodies."

The Grange also passed a resolution calling for the establishment of farmer committees at the county level which would cooperate closely with all Federal agencies assisting agriculture within the county, in order to help bring about the greatest possible coordination of Government effort. These would clear through State committees. •

Reclamation's Role in United Nations Food and Agriculture Organization

***"Hunger has no nationality; abundance should have none, either"*—President Harry S. Truman**

The Bureau of Reclamation, represented by Assistant Commissioner Wesley R. Nelson, who was appointed adviser by George C. Marshall, then Secretary of State, on the United States Delegation of the Food and Agriculture Organization of the United Nations, is making a major contribution to alleviate one of the world's foremost problems today; namely, The Food Shortage.

At the fourth session of the Conference of the Food and Agriculture Organization of the United Nations, Mr. Nelson, representing the Bureau, participated in the numerous important discussions which took place in Washington, D. C. The following are highlights of work accomplished at the conference:

Annual review and discussion of the world situation in respect to production, marketing and consumption of food and agricultural products, including fish and timber.

Consideration and discussion of the technical activities of the Organization during the preceding twelve months as well as of its program of action for the ensuing year.

Delegates from 55 member nations and 8 nonmember nations totalling more than 300 attended the conference. •

CONTROL LABORATORY for the Friant-Kern Canal

by J. J. WADDEL

Concrete and Earthwork Control Engineer, Friant-Kern Canal, Region II, Sacramento, California

INTRODUCTORY STATEMENT: By Robert F. Blanks, chief, Engineering Laboratories, Bureau of Reclamation, Denver, Colo. Reprinted from the September 18, 1947, issue of *Engineering News-Record*.

Why does the Bureau of Reclamation need laboratories?

To answer the question, one must look backward a bit. There was a time when Reclamation engineers depended solely on their experience and judgment and on the old-established tools and devices of engineering—the transit and level; the slide rule and handbook; the ball of earth rolled in the hand, how far a man in rubber boots would sink in the fresh concrete, or how the hammer rebounded when struck against hardened concrete. Today it would be foolhardy to embark on a major engineering project without taking advantage of the many scientific aids that are available for developing and testing new materials and methods as well as improving past practices. This is the reason why the Reclamation engineers find it necessary to maintain laboratories.

One day early in 1936 a Bureau engineer arrived in the little town of Friant, Calif. He hired a couple of laborers and started to dig a few holes in the ground, taking out sacksful of sand and gravel which he proceded to ship to Denver. This, the commencement of the concrete aggregate investigations for Friant Dam, was the modest beginning of the Friant Laboratory, a very small structure with a very big job. Through the subsequent years, through construction of Friant Dam and Madera Canal, the laboratory has been in nearly continuous operation. With construction of the Friant-Kern Canal, it has expanded to an organization employing 4 engineers, a chemist and physicist, 20 subprofessional aides and several laborers.

Why all this fuss and expense? Doesn't it all add to the cost of reclamation structures? To answer those questions let's look at some actual cases of dollars-and-cents benefits that came from laboratory research and control. For Friant Dam, a saving of $300,000 was realized by the use of pumicite

Top right: Geologist preparing to log 24-inch auger hole. Right center: Application of Stoke's Law on solids in suspension enables operator to determine fineness of soil by means of hydrometer. Immediate right: Hydraulic testing machine is used to determine compressive strength of concrete specimen. Machine has 200,000-pound capacity.

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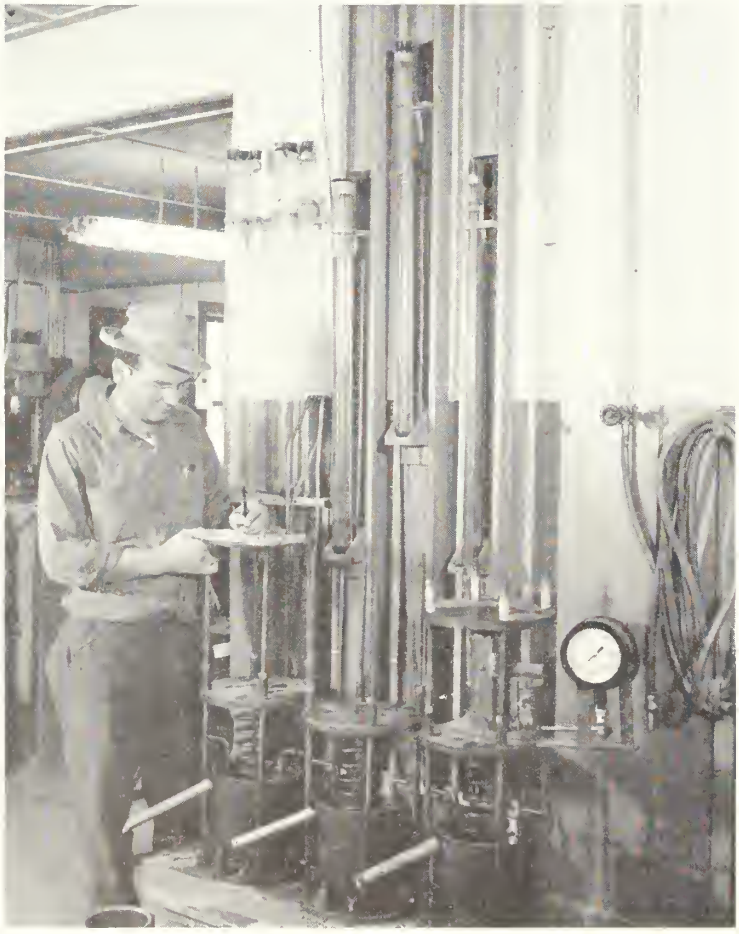
in the mass concrete. Field sampling and investigating were done by the laboratory staff, with the bulk of testing done by the Denver laboratories. Similarly, a claim of $500,000 against the Government was disallowed when Denver laboratory tests, made on samples obtained by the Friant laboratory, disclosed the fallacy of the contention that a stockpile of pumice was worthless. Again, extensive field laboratory tests and investigations, coupled with Denver tests, indicated that one 18-mile stretch of the Friant-Kern Canal need not be lined with concrete. The saving even at that time when prices were lower than they are now, was estimated to be $2,000,000. Finally, mix design and control by the field laboratory based on considerable experience with this type of operation led to the development of means whereby an "air-entraining" agent (a substance which fills concrete with air bubbles, making it, in relation to other concrete, like foam rubber versus solid rubber) could be used in canal-lining concrete. Air entrainment was used in highway construction as early as 1938, and the Friant agency, although not solely responsible for determining means of using air-entrained concrete in canal linings, contributed toward its development, and its efforts resulted in a saving of $14,000 in cement cost alone to date on the Friant-Kern Canal.

Benefits that accrue as a direct result of field control during construction are harder to keep books on. But any construction man knows that uniform concrete, batch after batch, day after day, cannot fail to pay off in decreased construction and maintenance costs. So assisting the construction engineer in obtaining uniformly good concrete or uniformly good earthwork is the principal objective of a field control laboratory such as the one at Friant. Its activities thus center around technical control of concrete and earthwork, with occasional special problems in other fields. Equipment ranges from sensitive laboratory balances to massive earth-drills and concrete mixers. Activities at the headquarters laboratory and its branches along the several divisions of the canal can best be shown by a brief description of procedures representing the several classifications of work done.



Soil percolation apparatus at work. A soil sample has been placed in each of the three steel cylinders, and water is percolating through the samples from the glass head tanks above.

First, there is work of an investigative nature. As early as 1936 a preliminary reconnaissance was made to find possible local sources of concrete aggregates for the Friant-Kern Canal. This consisted of a superficial examination of stream beds, highway cuts, commercial plants and other sources of sand and gravel. A more detailed survey, using the 1936 report as a guide, was made in 1944, and from this latter survey several deposits were selected as being the most promising. From each, several sacks of sand and gravel were shipped to the Denver laboratories for acceptance tests, while samples from the same deposits were made into concrete right at Friant in order to compare the relative qualities of the various materials. Finally, a detailed program of test-pit exploration was made of the few remaining deposits considered suitable. This consisted of making a topographical survey of the surface of the deposit, and excavating test pits to check the amount and sizes of gravel available. To complete the story on each deposit, it was necessary to gather ownership data; check railroad, highway and power facilities and groundwater or stream conditions; to get, in fact, any information that would be of assistance in evaluating the deposit from an engineering or economic standpoint.

Photographs were taken showing the topography and vegetation of the deposit. Detail and location maps were made. In some cases special problems had to be solved. For example, some of the gravel particles at one deposit had a black, sootlike coating which aroused the suspicions of field laboratory personnel. An analysis of this coating on samples submitted to the Denver laboratories showed how to make the gravel suitable for use. All information obtained in the field was then compiled into a report which, with the Denver Laboratory report, gave a complete picture of the deposit. These reports are of great value, now, in assisting both the Government and prospective contractors to locate aggregates for the canal quickly.

In 1946 a soil survey was completed. This survey led to the final decision to use a compacted-earth lining instead of the more expensive concrete lining, on approximately 18 miles of the Friant-Kern Canal. The first stage of this survey was the excavation of test pits at 1-mile intervals along the proposed right-of-way. After a power-driven earth auger was obtained, more holes could be put down for the same cost, sometimes only 100–200 feet apart. Samples were sent to Friant for analysis and an examination was made of the soil in place. Tests determined the permeability of the natural ground and the compacted soil, often through new techniques and testing procedures developed on the spot. One of these was a field permeability test conducted on the natural ground, in which the amount of water flowing out

(Continued on page 44)

Eklutna—

Number-One Job in Alaska

by Joseph M. Morgan,
Chief, Alaskan Investigations Office, Juneau, Alaska

Artist's conception of the Eklutna project. Typical of Alaskan projects, the tunnel provides for year-round delivery of water even when the reservoirs are frozen over. Drawing by Shirley Briggs.

A PILOT, flying his plane into the last stop to the Orient, watches for the beam on his instrument panel—sees it waver into meaninglessness; listens for his landing instructions—hears the hum that means the tower is dead.

A farmer, fighting the dry season, throws the switch for pumping water on his dying crops, glares despairingly as a few left-over gushes dribble to nothingness before his eyes.

A staff sergeant in our armed forces grabs another sweater and with the resignation born of long experience, lights his kerosene lamp, as the lights go out again and the too-familiar click of the heating system tells him it will get colder before it gets warmer.

A businessman, lured by the oft-told-tale of untapped markets in Alaska, grows as cold as a glacier to the idea of investing his capital in Alaska, when he learns that electricity is scarce.

Incidents like these, common to Alaskans, were among the many reasons why we lost no time last July in initiating a swift reconnaissance of ways and means of bringing long-needed electric power to what has been often called our Last Frontier—the Territory of Alaska.

At the last session of the Eightieth Congress, $150,000 was appropriated for the Bureau of Reclamation for "engineering and economic investigations, as a basis for legislation and for reports thereon relating to projects for the development and utilization of the war power resources of Alaska." As soon as the money became available, we went to work.

During the first ten days of the fiscal year 1949 (July 1 through July 10, 1948) we began setting up an organization to carry out the Alaskan mission. On July 12 we opened the Alaskan headquarters office in the city of Juneau, Alaska. Four days later we flew to Anchorage where we opened our field office.

Incidentally, the "real estate" situation is more than acute in Alaska. During the summer our office in Anchorage was located in the schoolhouse. When school opened in Septem-

The boilers and generating equipment of this wrecked tanker at Sackett's Harbor serve as a stop gap in alleviating the power shortage at Anchorage.

ber we were dispossessed, but by that time had lined up an office building to rent.

All this time we were making our plans, working up an itinerary for reconnoitering the entire territory of potential power sites, and accumulating facts, figures, and technical data about the various areas, particularly the number-one job, the Eklutna (pronounced Ek-*loot*-na) project.

The summers of Alaska are very short. We got off to a late start and had to hurry with our reconnaissance to get through before Old Man Winter caught up with us. Most of our reconnaissance work was done by aircraft equipped with pontoons or floats so we could land on the lakes and streams in these far reaches, make our brief reconnaissance and investigations and hurriedly get off again to some other point. As fast as our forces completed their respective jobs at Lake Eklutna, we moved these groups down to a second site at Dorothy Lake, located 20 miles south of Juneau. In all, we (Richmond C. Johnson, assistant chief, and myself) reconnoitered the area from above Fort Yukon westward to a segment on the Arctic Circle to a point only 56 miles from Soviet Russia.

In addition to the usual work which accompanies setting up a headquarters and field offices, our staff, with enthusiastic volunteer help from the many agencies cooperating with the Bureau, was working night and day, Sundays and holidays, gathering, checking and assembling material from the most authoritative sources on the Eklutna area, and here is what we learned.

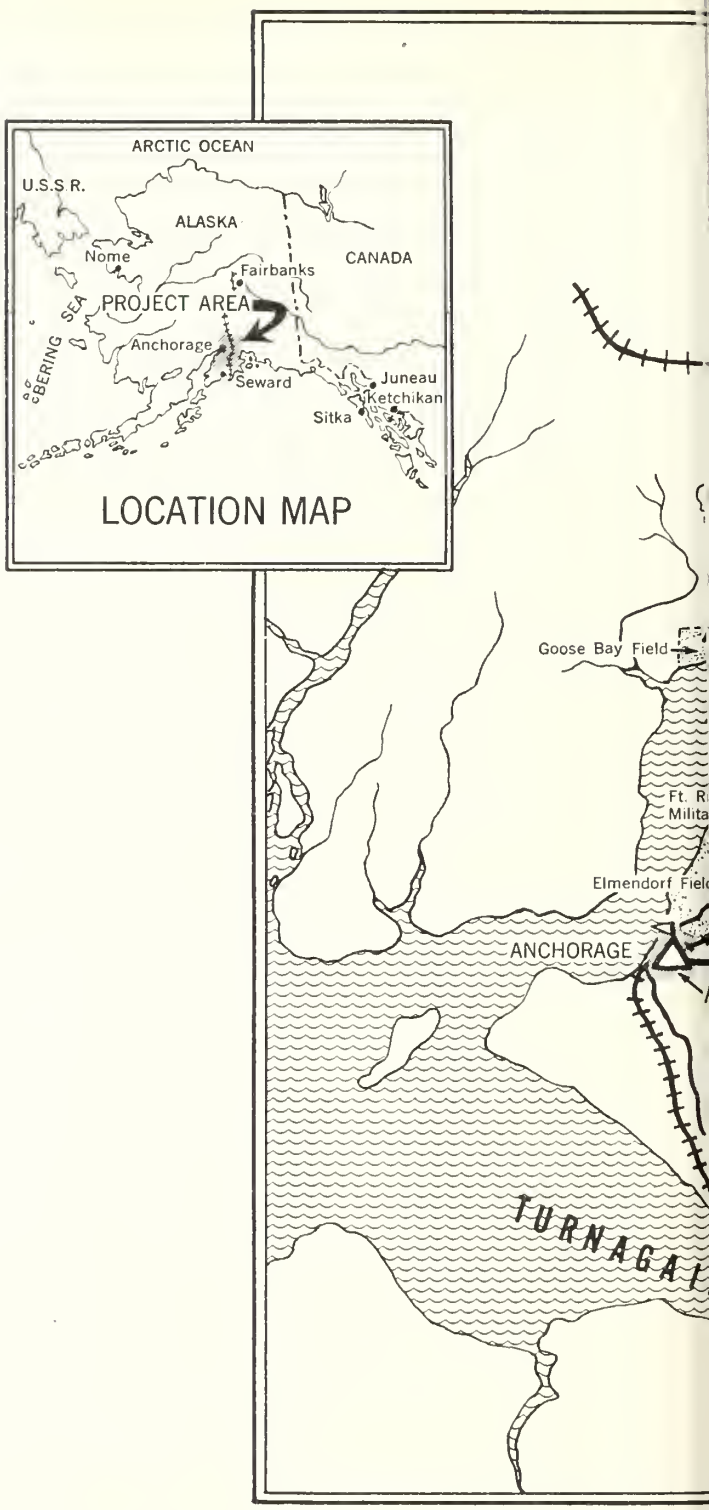
Power is the touchstone to progress in Alaska. For example, the city of Anchorage, gateway to Alaska, and the largest and fastest growing city of the Territory, has an electrical distribution system designed to serve a population of 3,500 people. These same facilities are trying to take care of 20,000 people, according to the best estimates available.

The city of Anchorage doles out its limited power facilities as fairly as possible, rations them so everyone gets a square deal—but in spite of it all, many interruptions and blackouts have occurred.

About 50 miles northeast of Anchorage is the Matanuska Valley, site of the 1935 Rural Rehabilitation Corporation settlement, now Alaska's most productive agricultural region. Headquarters and business center for the valley's farmers is the city of Palmer. About halfway between splitting-at-the-seams Anchorage, and raring-to-go Matanuska Valley, Eklutna Lake nestles high up in the Chugach Mountains. The lake is named for the Indian village of Eklutna nearby, and its depths hold the key for unlocking the door to opportunity for this region.

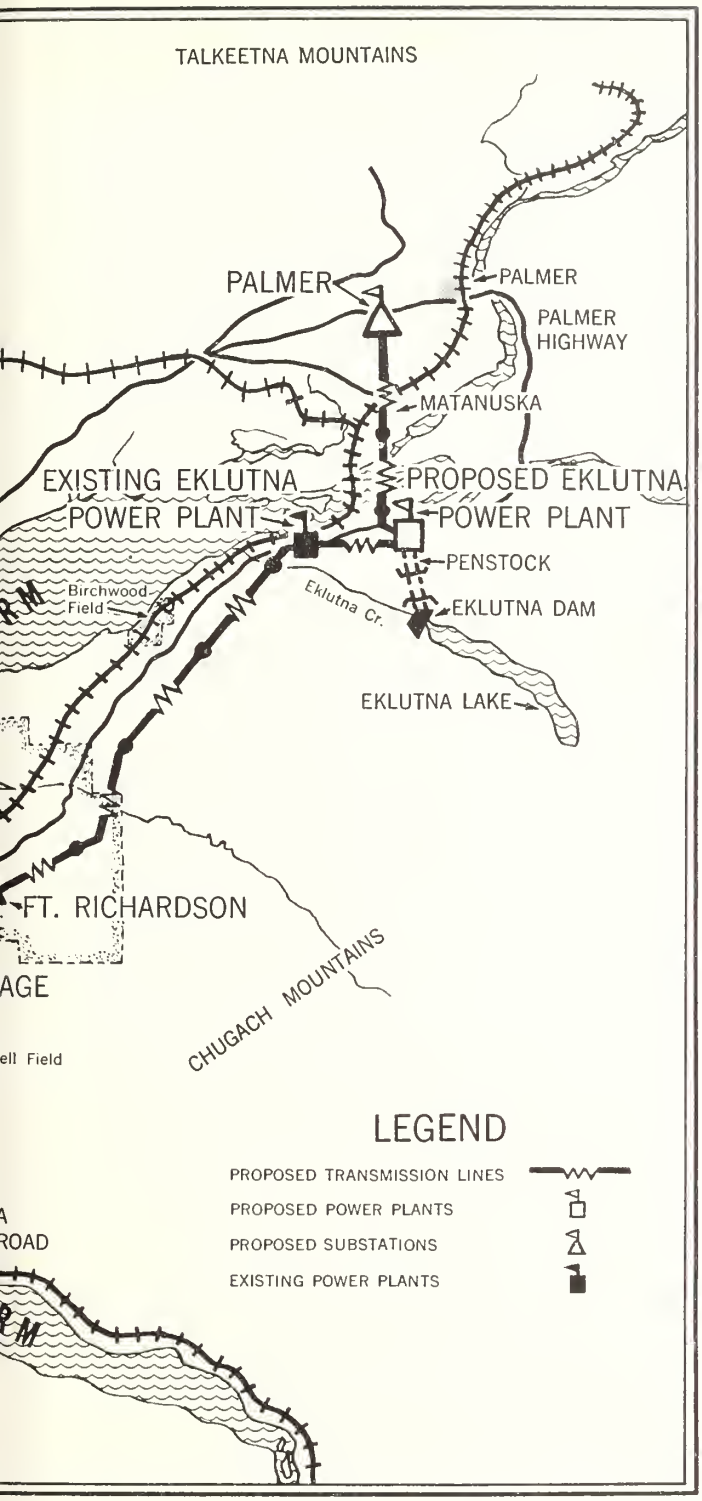
Eklutna Lake, remnant of a glacier which nudges it at the northeast, cupped more than 800 feet above sea level, is about 7 miles long by 1 mile wide, with a maximum depth of 200 feet. It is a natural reservoir. A glacier retreating up Eklutna Valley left behind its own dam across the creek, and created the lake. Power can be produced by the simple expedient of boring a tunnel through the mountain, slipping a penstock with a surge tank down the mountain side, and building a power plant at "tidewater level."

The Eklutna project area (see map) is usually referred to as Westward Alaska. From north to south it includes the



Willow Creek mining district, the Matanuska Valley, the lands bordering Knik Arm (you pronounce both "k's") or inlet between Palmer and Anchorage, and the Anchorage area south to Turnagain Arm (aptly named by Captain James Cook, the Englishman, about the late 1700's when he had to give up his search for an elusive passage to the sea).

The Eklutna project is bounded on the north and west by the sea and the Alaska Range of mountains and on the east by the Chugach and Talkeetna Mountains. In the northeastern sector of the Matanuska Valley are the Matanuska coal fields, while to the northwest is the Willow Creek mining district.



Fort Richardson, command headquarters for all armed forces in Alaska, and Elmendorf Field lie to the northeast of Anchorage. The Eklutna area is expanding rapidly and is one of the strategic outposts in our military defense structure.

In the Eklutna project area, the climate is very much like that of many of the North Central States. Anchorage is warmer in winter than Butte, Mont., St. Paul, Minn., or Lake Placid, N. Y., for example, and the hottest summer day seldom sends the thermometer above 90°.

When it comes to rainfall, Anchorage experiences about as much as Salt Lake City, averaging between 14 and 16 inches a year, most of it during the late summer months. The Eklutna area is considered semiarid, with light winds from the southeast. The high mountains south and east of the area get the heavy rains, so there is very little humidity—and no permafrost (permanently frozen ground) except high in the surrounding mountains.

There is no denying the fact that Alaska lies in a northern latitude, with short days in winter, and long ones in summer, but this arrangement means that crops really grow, and grow fast, during the warm summer months. Farmers in the Matanuska Valley (estimated at over 400 farms with 9,000 cleared acres) make the most of the growing season, which is a little less, for the most part, than three months long. Killing frosts sometimes occur as late as May 30 and as early as late August. In spite of this short growing season, potatoes, cabbage, cauliflower, parsnips, celery, rutabagas, turnips, carrots, beets, chard, peas, radishes, lettuce, string beans, rhubarb, onions, and spinach have been grown successfully, and enterprising farmers have raised many hot-weather crops such as corn, squash, cucumbers, tomatoes and melons in greenhouses.

Hogs, beef cattle, and sheep as well as goats, poultry, and rabbits all do well in the Valley, although winter feeding is expensive. Dairying is becoming more and more popular. Milk, butter, cheese, cream, and ice cream (this item seems surprising only to those who have not lived in the area) command high prices.

Although the harbor of Anchorage is ice-bound during some of the winter months, people in the Eklutna area are far from being isolated. Alaskans are among the most air-minded people in the world, but this area is blessed by all five modes of transportation: land, air, sea, rail, and dogteam. Ocean-going boats come into Anchorage during the ice-free months, the Alaska Railroad travels through Seward, Anchorage, and the Matanuska Valley on the way to Fairbanks, in the interior, a distance of 384 miles. There is a highway from Anchorage through the Matanuska Valley on to the interior road system,

Inset shows Anchorage in 1934 while foreground shows the town today.

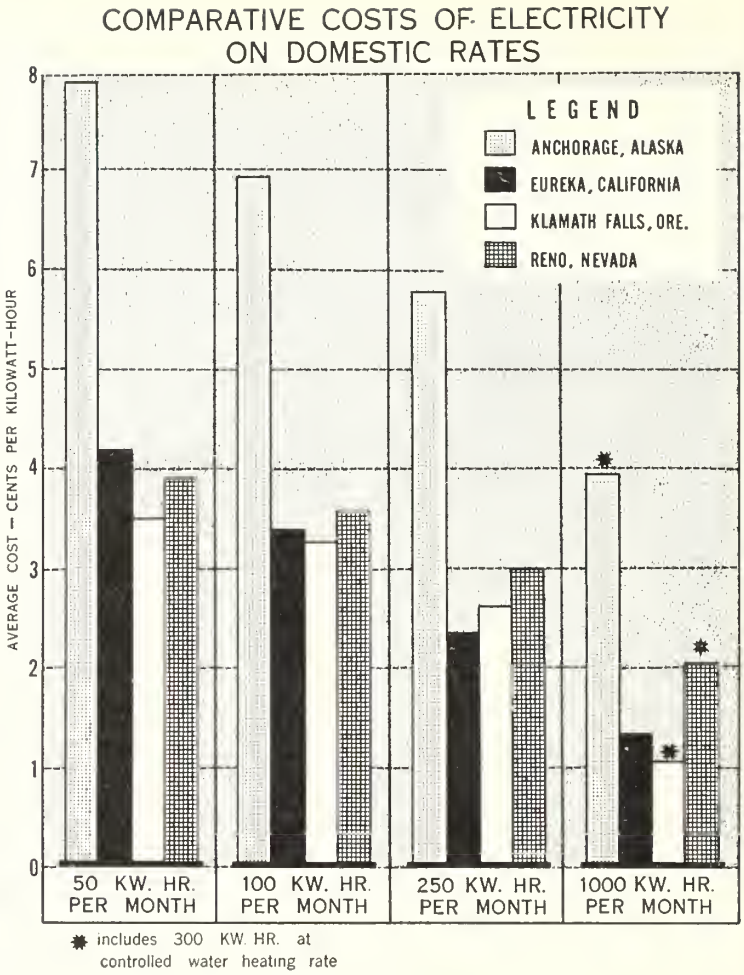
connecting with the Alaska Highway through Canada to the United States, and bus service is available within the towns and over the highway system. Both Anchorage and Palmer have airports, and air transportation is available to various points in the United States, the Orient, and throughout the Territory. Engineering has been started on the new International Airport, scheduled for completion in 1950 or 1951, and a new highway to the Kenai Peninsula should be ready for use by next fall.

Although the Eklutna project area was first visited by traders and trappers in the late 1700's and slight settlement commenced following the purchase of Alaska in 1867, it wasn't until the United States Government started construction of the Alaska Railroad in 1915 that settlement advanced to any degree. It has been said, and rightfully so, that the railroad "fathered" the town of Anchorage, for in that year the townsite of Anchorage was laid out and the city has since grown rapidly as headquarters for the railroad and many other Government agencies as well as the supply and trading center for large outlying areas. The establishment of the military base at Fort Richardson, near Anchorage, has had a tremendous influence upon the community in recent years.

Settlement in the Matanuska Valley began also in the early days of the development of Alaska, but not until the Government's resettlement program in 1935, under the Rural Rehabilitation Corporation of the United States Department of Agriculture, did large-scale development take place.

Industry in the area includes agriculture, livestock raising, gold mining in the Willow Creek district, coal mining in the Matanuska district, several small lumber mills, fishing in Cook Inlet south of Anchorage, with canneries located both along the inlet and at Anchorage, trapping and fur farming. Anchorage thrives as the trading, supply and recreational center for the area, with all the trades, services, stores and comforts to be found in a city of similar size in the United States. The tourist business is of growing importance, as is the guiding and outfitting of hunting and fishing parties. The air transportation business is often referred to as the city's leading industry.

The Eklutna project area, along with the rest of Alaska, is growing rapidly and on a firm basis but its needs are still



great if it is to become the substantially populated land it could be. In brief, the problem is this: at present, Alaska must import from the United States nearly everything it consumes, in fact 95 percent of all imports come from the United States. Because of the relatively small and scattered centers of population and the absence of backhaul, steamship companies charge freight rates which are among the highest in the world. These transportation costs make for high prices in Alaska, the resulting high cost of living discourages local industry, and the two combined discourage further settlement.

Alaska badly needs anything which will lower the cost of local production, and thus stimulate home industry and further settlement. Tied in with this is the need for industries providing year-round employment. At present, nearly all the large Alaskan industries, being of an "out-of-doors" nature, are seasonal. Construction, fishing and canning, mining, lumbering, agriculture, and the tourist business all flourish only during the summer months. Trapping takes place only during the winter, but does not give employment to many.

Adequate low-cost power is high on the list of necessities. Under present conditions no large consumer of electrical power could possibly locate in the area and hope to have his finished goods compete in either the Alaskan or United States markets. Farmers could better supply local markets with

(Continued on page 46)

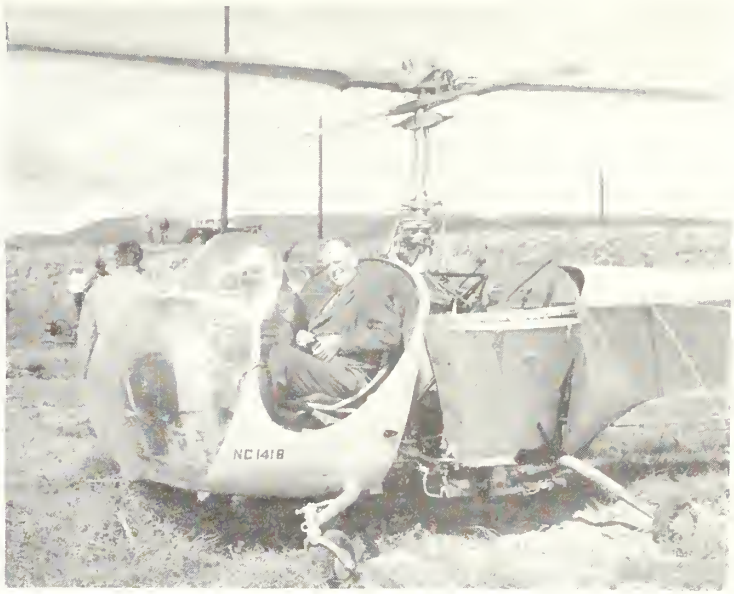
Agricultural scene in the Matanuska Valley. ***Photo used through the courtesy of Robinson Studio, Anchorage, Alaska.***

Windmill Weed-Killer

or

Aerial War on Weeds

by W. H. FARMER
Yakima Project, Washington, Region I, Boise, Idaho



WEED-KILLING HELICOPTER. This maneuverable machine flew at a speed of about 25 miles an hour except in difficult areas where it slowed down to 5 miles an hour or less. Yakima project superintendent, O. W. Lindgren (above), flew along to inspect the ditchbanks on some of the trips.

With the same crushing effect of Uncle Sam's Air Forces on enemy strongholds during the last war, the Bureau of Reclamation last summer wiped weeds from the map on the Yakima project by means of an aerial attack.

A helicopter, using 2-4,D, sprayed both banks of approximately 80 miles of the Roza main canal in eastern Washington with such success that other divisions of the 450,000-acre project are now planning to use this highly mechanized method to destroy weeds in 1949.

The Bureau experimented last May with both a conventional type airplane and a helicopter along the Roza main canal and certain laterals. Weed crew personnel quickly determined that the latter plane is more effective for weed spraying along the canal banks. The result obtained with the helicopter was quick, economical, and an effective solution to a serious problem.

Strips 15 to 20 feet wide along both banks of the 80-mile stretch and one lateral were sprayed in 8 hours of flying and servicing time.

The helicopter was equipped with a spray bar to effectively spray a 40-foot swath but only 18 feet of this bar width was used on each bank. Most of the canal had a water surface width of over 50 feet so both banks could not be sprayed in one operation. Two 25-gallon tanks were installed on the helicopter to carry the chemical mix, which was spread by whirljet nozzles at 2-inch spacings front and back on the spray bar. The spray mechanism permitted almost immediate turning on and off of the spray.

Except at obstructions, the spray bar was seldom more than 3 to 5 feet above the weeds to be sprayed. The helicopter flew at a speed of about 25 miles per hour except around sharp canal curves and over bridges and brace wires for telephone poles. Difficult areas were flown at 5 miles per hour or less. There were no hazards along the canal which the helicopter operator could not overcome to place the chemical as required. The pilot stated that flying the Roza main canal was no more difficult than flying orchards and small fields in the Yakima Valley.

Use of the helicopter permitted the Bureau to treat the weeds quickly at the stage of their growth when they were most susceptible to 2-4,D. In contrast, previous ground spraying methods took several weeks to do the same job, which resulted in many weeds becoming increasingly hard to kill as the season progressed and the weeds matured.

The amount of chemical used varied with the type and density of vegetation. Best results were obtained where between 1 and 2 pounds of 2-4,D acid equivalent were used in 5 gallons of water per acre.

Two crews of two men each with pick-up trucks were used to fill the helicopter tanks with chemical. The helicopter set down almost anywhere along the canal for refills after spraying a distance of about 4 miles. The crews, by alternating, were able to keep up with the helicopter for necessary refilling and servicing. The spraying was done early in the morning when there was no wind to cause drifting of the spray material.

The ditchbank weeds sprayed were located at least 75 feet from growing crops which might be damaged by the spray chemical. No crop damage was reported from the helicopter spraying operations. Earlier studies showed that it would be impossible to build up a killing concentration of chemical in the canal water with the quantity being used.

Uniformity of weed kill along the entire canal system was outstanding. In flying over the water, there were fewer obstructions to work around. When working from the ground, as every weed man knows, overdoses or underdoses of chemical are apt to be applied while ground spray equipment is passing by obstructions.

Good kills were obtained on willows, sweet clover, water hemlock, and various annual weeds. Return growth on the perennial noxious weeds, such as Canada thistle, Russian knap weed and white top, required a second spot spraying in 1948 to control them.

The cost for helicopter rental, chemical and labor was about $5 per acre. The End

Central Arizona Project (Part Two)

(Continued from page 30)

the needs of the upstream irrigated areas. Numerous plans of development have been proposed for these upper lands. In general, there appear to be four areas in need of additional development, namely, the Safford Valley; the Duncan-Virden Valley; the Red Rock Valley; and the Cliff Valley.

THE SAFFORD VALLEY IMPROVEMENTS would be built to conserve and utilize the existing water supply to best advantage. A permanent diversion structure at the upper end of the Safford Valley to supply a high-line canal would be included as a part of this development. A high-line canal would extend along the south side of the valley, and a branch canal would cross the Gila River near Safford to serve the north side. Pumps for the development of groundwater, to supplement available surface water, would be installed as part of this development.

Construction of a dam at the Hooker site, on the upper Gila River, about 7 miles northeast of Cliff, N. Mex., is considered as a potential development to serve requirements upstream from the Safford Valley. Such a structure would provide flood control and silt retention and eliminate serious problems for downstream irrigators. It would also regulate the flood flows of the river, for use at a time when the normal flow of the river would be insufficient to meet irrigation requirements. Lands in the Cliff Valley, the Red Rock Valley, and the Duncan-Virden Valley would all be benefited by this regulation.

IRRIGATION DISTRIBUTION SYSTEM.—Some of the districts included under the Central Arizona project maintain their own distribution systems. However, many of these areas which are irrigated by pump water do not. In addition, some areas irrigated by surface water have inadequate distribution facilities. Under the Central Arizona project, an irrigation distribution system would be designed to deliver water as required.

IRRIGATION DRAINAGE SYSTEM.—Despite water shortages throughout the major part of the Central Arizona project, some of the lower lying lands are faced with the problem of water-logging. The Central Arizona project would include an irrigation drainage system to prevent water-logging, and to remove excess dissolved salts from the area. Open gravity drains would be used where possible. Additional drainage as required would be accomplished by pumping from wells.

POWER TRANSMISSION SYSTEM.—Under this project a power transmission system would be needed to convey power from Bridge Canyon power plant to the Havasu pumping plants, and from the various power plants throughout the project to the power market areas.

In discussing these various features, the primary purposes of each have been outlined. In addition to those enumerated, each of the features would have secondary purposes, or incidental benefits, which are of considerable importance.

RECREATION FACILITIES.—In an arid country, such as that in which the Central Arizona project is located, the importance of lakes for recreational uses is of far greater significance than commonly realized by residents of more humid climates.

FISH AND WILDLIFE PROPAGATION would be another important purpose served by all the reservoirs to be created under the Central Arizona project.

The Central Arizona project is an enormous development. On the basis of costs prevailing in April 1947 it would cost approximately $738,400,000 to construct the features which we have just discussed.

In recommending that this vast project be authorized, Secretary Krug has concurred in the recommendation of E. A. Moritz, Regional Director of Region III, under whose direction the report was prepared. This recommendation is not, however, unqualified. Mr. Moritz has pointed out in his recommendation that there is a controversy between Arizona and California over the amount of water legally available to Arizona from the Colorado River. If Arizona's contentions in this controversy are correct, it will be legally possible for Arizona to divert 1,200,000 acre-feet of water each year. However, it is California's contention that there is no water available for such purpose. Mr. Moritz points out that the Bureau is not authorized to resolve this difference, but takes this opportunity to point it out and assumes that Congress will give due consideration to the matter of water rights.

The report points out that the project cannot repay the reimbursable costs which would be charged against it under the Secretarial authorization provisions of Reclamation Law. However, the report sets forth certain repayment provisions which, if applied to the Central Arizona project, would make it possible for the development to repay its obligations. In general these provisions would require repayment of reimbursable costs, within 78 years, from revenues derived through the disposition of irrigation water, municipal water and electrical energy. Funds spent for constructing power features would be repaid at 2.5 percent interest on the unpaid balance. Costs allocated to irrigation would be interest free. Project costs allocated to flood control, silt control, recreation, fish and wildlife propagation, and salinity control, would be nonreimbursable.

The report states that project revenues are based on a charge of $4.50 an acre-foot at the farm headgates for irrigation water developed by the project; 15 cents a thousand gallons for municipal water at the city storage reservoir; and 4.8 mills a kilowatt hour for electric energy delivered at the load centers. The total revenue from those three sources would be sufficient to repay the reimbursable construction costs.

The report further recommends that the State of Arizona enact an adequate ground-water code to limit the pumping from the ground-water in the project area to the safe annual yield; and establish an organization in form and with powers to tax properties within the project boundaries and to contract with the Government for payment of costs allocated to irrigation and municipal water supplies.

These are but recommendations dependent upon the will of the people and the final authorization of the Congress of the United States. Should they become realities, the Bureau of Reclamation may soon undertake what may be the final stage in development of the irrigation potentialities in central Arizona. THE END

Pioneer Women at Tucumcari

by CAROL ROBBINS

a former feature writer for The Amarillo, Tex., *News-Globe*. She is now completing her journalism studies at the University of Oklahoma. That Miss Robbins should choose to write about the women's contribution to western reclamation is not surprising. From her first recollection she had listened politely to discussions of man's contribution to the science of soil, water, and engineering. Her father is H. E. Robbins, Director of the Bureau's Region V at Amarillo, Tex.

It takes determination and fortitude to whack the dust out of a wilderness and shape it into a civilized land. And farm wives on the Tucumcari, N. Mex., irrigation project have an ample supply of both qualities.

These gals who cook the meals and tidy the cramped cabins didn't come to Tucumcari in a covered wagon. And they don't spend part of the day behind a team of oxen.

But they are breaking a frontier just as surely as their forebears before them. And despite all that men can do—plow the land, chop the cotton, and reap the wheat—it still takes a woman to rip the cussedness from a raw land.

One of the youngest of the forelooper (*according to Webster, a forerunner, or boy who goes before the oxen guiding them by a thong fixed to the horns.*—Ed.) wives, Mrs. W. B. Morton, arrived with her family 2 years ago in June. The Mortons had nothing with which to start a home except their land, material, four pairs of strong arms, and a minimum of time.

One month later they were living in a part of a house they had built themselves. Mrs. Morton mixed concrete, sawed boards, and hammered enough nails to make a "has-been" of the city contractor and his sigh of "impossible."

Attractive Mrs. Morton is the mother of two equally attractive children, La Dean, 12, and Howard, 11.

"We had decided before coming on the Tucumcari venture," she said, "that farm life was the only kind of life for children. The youngsters didn't relish the idea at first; now they wouldn't change back."

Mr. Morton had previously operated a garage and repair shop in Big Spring, Tex., although both of the parents were reared on farms.

One often hears fabulous tales about the kitchen in a farm home—the beauty, cleanliness—but it is hard to conceive a small part of the truth until you see one.

Mrs. Morton's kitchen would be a good model for any of the ultraperfect department store plans. The stove and refrigerator are sparkling latest models. The latest addition, a deep-freeze unit, is one she said has "already paid for itself."

It provides storage space for beef, pork, and chicken, all of which are grown by the Mortons. The average city housewife would be green with envy if she could see the roasts,

At left: That's meat Mrs. W. B. Morton is placing in her deep-freeze unit. Along with vegetables grown on her irrigated farm, it should help solve her shopping problems for a while. Below: Mrs. J. A. Carr does the honors as her husband comes in from the fields for his mid-morning java. *Photo by Fred Finch, Region V.*

steaks, and fried chicken dinners that need nothing but the stove.

Another forelooper wife, Mrs. J. A. Carr, is not a newcomer to the farming business. Before they moved to Tucumcari in December 1947, she and her husband had lived around El Paso for over a quarter century.

Mrs. Carr also has a positive reaction to the new country. Not long before the move they had finished a new home in El Paso complete with gardens and trees—things dear to any woman's heart. Unfortunately, the water situation grew steadily worse until it became necessary to find a better place to settle.

The Tucumcari project was just opening up, so the Carr family lent a willing ear and moved the following December.

One of Mrs. Carr's biggest jobs is being a mother to six children. The two eldest sons are married. Leslie, 25, farms with a neighbor, and J. A., Jr., with his father.

Betty Ann, 19, was a student at Texas Tech last year and will continue her education this year at the University of New Mexico. Next oldest are Phyllis, 12, Tommy, 9, and the baby, 4-year-old Ginger.

"I am rather aggravated at the luck with my vegetable garden," she said early in the summer. "The first time I planted, it was frozen out and the second time it was destroyed by hail. I'm getting ready to plant a third time, and I hope it produces something worth planting." Her hopes were realized in abundant measure.

"In spite of some disappointments," she continued, "I still like the country better than I thought I might. A feeling of adventure helps overcome some of the harder problems. First and foremost I like the climate. You can sleep at night during the summer here."

Mrs. Carr does all of her own baking, churning, and canning and, like Mrs. Morton, has a deep-freeze unit for storage of meat. Everything on the table at a meal, except perhaps the sugar and coffee, is the product of the Carr land.

Still another pioneer housewife, Mrs. Henry Batterman, has an interesting story behind the undertaking at Tucumcari. (See "The People," p. 73, April 1947 Reclamation Era—Ed.)

When she was a year and a half old, her family left Germany to settle on farm land in Nebraska. In the old country Mrs. Batterman's parents had lived across the street from those of Henry.

When Henry Batterman was 18 he finished a trade school in Germany and decided he wanted to come to the United States. His brother was already here, so after all entrance papers were signed, he sailed and arrived in 1928.

He spent some time in Colorado and then went to Nebraska where his brother was living. Six years later he married the girl whom he met when he looked up his former neighbors from the "old country."

They remained in Nebraska until 1946, at which time Mr. Batterman heard about the land being opened for irrigation and of its potentialities.

Now thoroughly settled in Tucumcari and liking it better all the time, Mrs. Batterman says, "It would be hard to think of leaving."

The two Batterman children, Ella Mae, 11, in the sixth grade, and Dean, 8, in the third grade, are intelligent youngsters. "The school system," said Mrs. Batterman, "is good and the children bring home grades we can be proud of."

"The winter climate," she went on, "is a relief after the winters spent in Nebraska. The wind may blow a little, but we don't have the endless snow here."

The Battermans have plans for building a more comfortable house this year. Their present home is far from uncomfortable, but they did not build it for permanent quarters.

As Mrs. Batterman said, her husband "likes to work with the ground. He has no one to take orders from but himself."

The newly developed land is all part of the ill-famed Dust Bowl of the thirties. Irrigation offered the challenge. The bushwhacking farmers put together the opportunity allied with a tremendous amount of foresight. The result, Tucumcari, is on its way to becoming another highspot for the American farmer.

One of the first newcomers was D. C. Atwood. A one-time cotton farmer in Oklahoma, the combination of hail and drought made him decide to hunt for another area. After a swing through the entire West, he stopped at Tucumcari and eyed the land for possibilities. To the unexperienced eye, the flat, rocky land was good for nothing but prairie dogs and rattlesnakes.

Nevertheless, Mr. Atwood saw definite possibilities. After returning to Oklahoma for the last time, he came back to Tucumcari and bought land in an area as yet not supplied with water. He planted his first patch of cotton in 1945 against all advice.

The hardheaded agriculturist had been warned against latitude, seasons, and insects but with the inherent gambling instinct every farmer must have, he figured a try was worth the effort. Fat, popping bolls told him cards had fallen his way.

The following year he planted again—irrigation waters were coming through by this time from far-away Conchas Dam.

"I knew I could do it," he said. "The season is just a mite short, but with water you can do anything, and I had the water."

In 1947, Mr. Atwood planted 25 acres of cotton. He averaged one and one half bales per acre and on one 2-acre plot, he made four bales. "Some of the prettiest cotton I have ever seen," he declared.

The project was in high cotton last fall. Two cotton gins, the first in the area, have been constructed and are in full operation.

Other leading cash crops in the project area include wheat, grain sorghums, alfalfa, and cantaloups. The project's experience with cantaloup production this year has left farmers mumbling in their beards.

Considerable acreage was planted to cantaloups, mostly on the urgings of potential buyers and shippers. As the vines began spreading across the rows and baby melons appeared on the landscape, hail, an unusual demon in the area, destroyed some of the planting. The would-be buyers eloped with the storm clouds. Growers were left with little encouragement that they would be able to market their product. Then, one day in the late summer, the first golden-tinged

Death of H. H. Johnson

H. H. "Ole" (pronounced Olee) Johnson

The Reclamation Era regrets to announce the death of one of its most faithful contributors, Harold H. Johnson, who will be remembered for his very fine article entitled "Forty-Three Years on the Shoshone Project," which appeared in the June 1947 issue.

He had been ill for several months and passed away in a Billings, Mont., hospital on December 17 last. His loss will be mourned by his friends, who were legion both within the ranks of the Bureau as well as among water-user groups and other Western interests. His untiring efforts and willingness to always help the other fellow endeared "Ole" Johnson, as he was popularly known, to every Reclamation farmer, businessman, and worker, who had the good fortune of making his acquaintance. His vast knowledge of the various reclamation problems, both small and large, established him as an authority on the subject.

Mr. Johnson was born October 20, 1887, at Brodhead, Wis., the son of Mr. and Mrs. Willard D. Johnson. He attended high school in Belvidere, Ill., and was graduated from the University of Wisconsin in 1910, with a degree in civil engineering.

His determination to always do a better job in each undertaking over his long years of Bureau service was frequently rewarded with promotions to positions of greater responsibility. He was a true Reclamation "pioneer" and has carved for himself a niche in Reclamation history which will inspire many of his numerous younger coworkers to try, like "Ole," to do a better job on each new assignment.

He first became associated with the Reclamation Service in July 1908, when he was engaged as a rodman and recorder on the Grand Valley project at Grand Junction, Colo. Upon graduation from the University of Wisconsin, Mr. Johnson was employed as instrumentman on canal location and land surveys for private firms in Washington. He reentered the Reclamation Service in July 1911 and was assigned to the Shoshone project in northwestern Wyoming as surveyman and assistant engineer. In 1919, he was made assistant superintendent of irrigation in charge of operation of the Garland Division of the Shoshone project.

From June 1924 until February 1925, he made surveys on the Kittatas division of the Yakima project in Washington. Early in 1925, he became engaged in economic surveys and land classification work on the Yakima, Umatilla, and Okanogan projects in Washington and Oregon and served as United States representative on appraisal of 100,000 acres of land and improvements on the Kittatas project.

In June 1926, Mr. Johnson was selected to serve as superintendent of the Milk River project near Malta, Mont. He continued in this capacity until June 1935, when he was made field supervisor of the operation and maintenance branch, with headquarters at Malta. In addition to the supervisory position, Mr. Johnson continued as supervisor for the Milk River project until June 1941, when he went to Great Falls, Mont., as field supervisor in charge of all operation and maintenance administrative activities on Bureau of Reclamation projects in Montana. From June 1944 until November 1947, Mr. Johnson was supervisor of the branch of operation and maintenance for Region VI of the Bureau of Reclamation. He was supervisor of irrigation operations for the region at the time of his death.

Mr. Johnson was active in Masonic work and was a past master of the Masonic lodges at Powell, Wyo., and Malta, Mont., and a past worthy patron of the Order of Eastern Star at Malta. He was a member of the Scottish Rite bodies at Great Falls and organized the DeMolay chapter at Powell. Mr. Johnson was a member of the Congregational Church.

Mr. Johnson is survived by his widow, Mary Ethel Reece, a daughter, Mrs. Edith G. Carlson, and three sons, H. H. Johnson, Jr., Donald E. Johnson, and Willard D. Johnson. In addition to these, he is also survived by his mother, Mrs. Lillian Johnson; a brother, F. D. Johnson; a sister, Mrs. E. Dixon, and three grandchildren. •

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fruit found its way into Tucumcari's luncheon clubs. The song-and-talk boys were amazed at the quality and taste of the free-will offering. They alone knew that Tucumari project farmers had struck a bonzer crop. They immediately carted a load of melons to the Rotary Club in Amarillo, Tex., 110 miles to the east, and left a pack of the goodies in the editorial offices of the Amarillo News-Globe. Within hours, the Texans were asking for more. Truckers began swinging west from Texas and beseeching the melon growers for supplies. Over a vast area, people were asking, "Have you tasted any of those Tucumcari irrigation project cantaloups?"

The cantaloup future on the Tucumari project appears to be very good, indeed! The melons have got what it takes to make them popular with the people who are willing to fork over extra pennies for a superior product.

Meanwhile, as the cantaloup season wanes, as the cotton pickers drag their full sacks toward the scales, as machinery moves across the landscape at harvest-time, other immigrants continue to leave family land in Texas, Oklahoma, Kansas, and elsewhere to build a new empire in the New Mexican oasis.

The call of the West does not have to be very loud to be convincing and the farmers who respond to the lure, always will be followed by their wives, for it is the womenfolk who plant family ties on solid ground. The End

Control Laboratory for Friant-Kern

(Continued from page 34)

of a vertical pipe was measured. This pipe was embedded in the soil to be tested and a can of water was inverted over the pipe, much like an old-fashioned chicken waterer.

Tests were conducted on undisturbed samples to determine percolation rates under laboratory conditions. Samples sealed in sheet metal containers in the field were trimmed to size and coated with paraffin, so they could be stored like canned fruit until they could be placed in the laboratory percolation apparatus. Other tests included screen analysis, optimum moisture and density determinations, Atterburg constants and colloids content.

Years of research by Reclamation laboratories and others have demonstrated the natural laws which govern the action and qualities of earth as an engineering material. For instance, each soil has an optimum percentage of moisture at which it compacts to the greatest weight per cubic foot, under a fixed amount of compaction. Again, the rate at which particles settle out of water depends upon their size, the smaller ones, of course, remaining in suspension longer. These laws and many others are constantly made use of in the laboratory, not only in investigations of materials, but also as a part of control during construction.

Control may be divided into two general categories: concrete control and earthwork control. Sometimes they overlap, and some tests, such as screen analysis, are used for both purposes.

Control of concrete commences with control of the raw materials—cement, aggregates, water and special admixtures for various purposes. Cement for Reclamation structures is purchased under Federal specifications and testing is done at the manufacturing plant by the Bureau of Standards. Testing of cement is unusual at any of the project laboratories. However, at Friant, a program to determine the relation, if any, between strengths of small mortar specimens made in the laboratory and specimens of concrete made at the mixer during placement of concrete in the structure are currently in progress. Cement for the laboratory specimens was obtained from the batcher at the time weighing was done for the batch of concrete from which the field cylinders were made.

Water, like cement, has required virtually no testing at Friant. Most of the water has come from wells on clear streams. Unsuitable water can usually be identified by color, odor or taste—if it's fit to drink it's suitable for concrete.

At the processing plant inspections are made of the production of aggregates from approved sources. Screen analysis to determine oversize and undersize particles in the rock and the grading of sand; determination of deleterious substances such as clay lumps, soft particles and roots; and specific gravity tests, are all a part of aggregate-control tests.

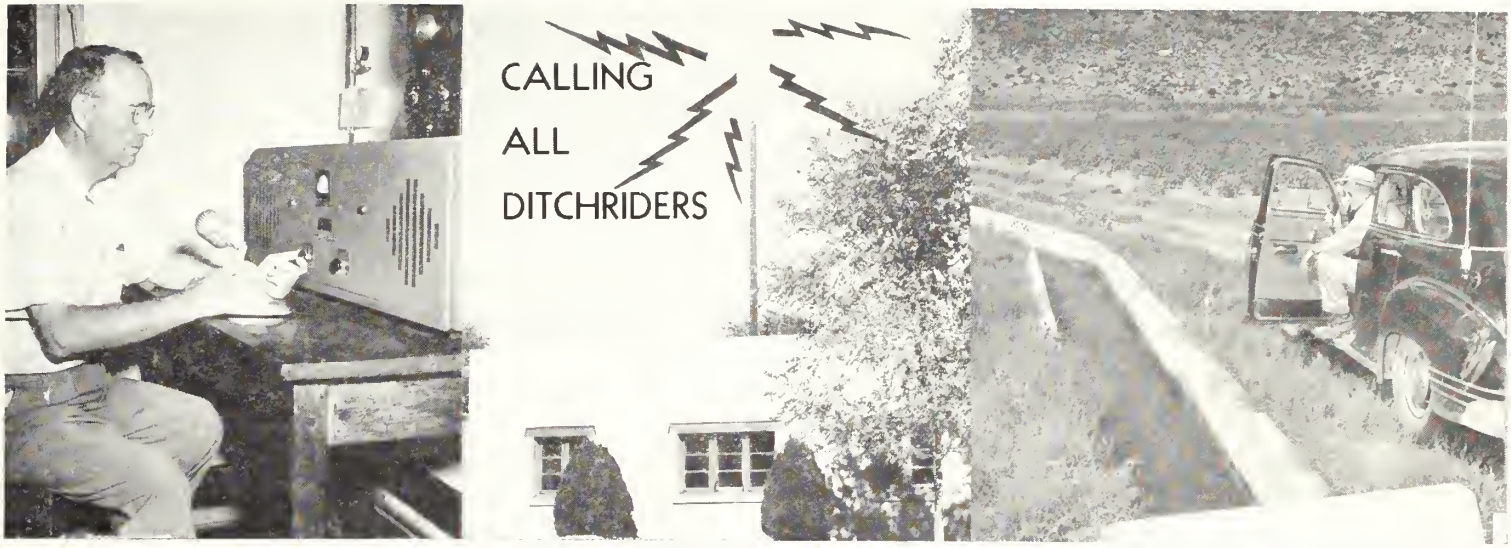
The final control is at the batcher and mixer. Concrete, after it leaves the mixers, passes into the hands of the field engineering organization which is responsible for its placing and subsequent care. Laboratory technicians, however, observe the batching and mixing operations, performing further tests on the sand and gravel as well as sampling and testing the fresh concrete as it leaves the mixer.

To many people, concrete is just concrete. To the construction man, it is a sensitive construction material. Take for instance, concrete for placement in a canal lining by means of a "traveling slip-form" which automatically spreads and smooths the concrete on the bottom and sides of the canal excavation. Concrete must be uniform in all respects; consistency and workability are especially important. Nonuniform batches; some wet, some dry, some harsh and some sticky, would be a never-ending source of difficulty, with a nicely laid side sluffing down into the bottom of the canal. It is the function of the laboratory to design mixes that are capable of producing good, uniform concrete, and to control production operations to the end that such concrete is consistently produced. From the first investigations of materials to the final breaking of test specimens to determine the strength of concrete, the object is to produce good, uniform concrete for placement in the forms, to ensure that durable and structurally safe concrete work results.

Testing the Earth

In the same way that concrete is merely concrete, so earth is just so much dirt to the layman. But earth, as a construction material assumes great importance and follows certain natural laws which enable the technician to take advantage of its abundance and versatility. We have already seen what steps were taken to investigate earth as a canal-lining material. Characteristics of the soils as determined in this investigation now become tools of the technician as he makes his control tests during placement of the embankment. Measurement of the effort required to force a needle of known cross-sectional area into the embankment gives an indication of the relative density or moisture content of the soil. Actual density of earth in the embankment is determined, as well as the moisture content at the time of placement. Undisturbed samples of the completed earth lining are removed to the Friant laboratory where further density and permeability tests are made. The permeability of the earth lining is determined by means of field "permeameters" set into the completed lining. Data from these tests are transmitted immediately to the inspectors in order that they may know if any areas are in need of additional work. A statistical analysis is made of all these test results, from which it is possible to gain a picture of the quality of the lining.

Naturally, all this laboratory work leaves in its wake a voluminous mass of technical data. During the construction period this information is of great value in assisting the inspectors and engineers in controlling the various operations involved. In addition, monthly reports are prepared for the information of the project, regional and Denver offices. These reports form a part of the permanent records of the construction of the Friant-Kern Canal. Finally, engineering knowledge is enriched to the extent that the record of our successes and failures will be of value in assisting someone else to solve problems which may be similar to the ones we encountered. Engineering is a progressive science, which means that new problems are constantly presenting themselves, and these problems make necessary new methods and new equipment for their solution. THE END



RAY LYMAN, left, superintendent of the Bureau's Tucumcari, N. Mex., Reclamation project, issues an order over the newly-installed two-way radio-telephone communications system on the project. Headquarters are maintained in the Bureau's project office in Tucumcari. Ed Cerny, right, project watermaster, makes a report many miles from the office on the water level of an irrigation lateral. *(Photographs through the courtesy of the Amarillo (Tex.) News-Globe.)*

By GARFORD L. WILKINSON,
Region V, Amarillo, Tex.

In those long ago days before the advent of radio, automobiles, and good roads, rural folk often spent long winter evenings entertaining themselves on the party line. Musicians poured forth into the wall telephones for the pleasure of all listeners and not infrequently an Edison phonograph would give forth with "Down in the Old Cherry Orchard" or "There'll Be a Hot Time in the Old Town Tonight."

Bureau of Reclamation employees on the Tucumcari, N. Mex., irrigation project have a new kind of party line buzzing across the broad expanse of cultivated fields and coyote-infested native pasture lands.

This party line on the Tucumcari project is a streamlined radio-telephone network, but though it is the product of up-to-the-moment radio research, this new system still works with the chatty cheerfulness of the old-time party line that functioned on a crank-handle impulse.

Ray Lyman, project superintendent, reports the new radio-telephone already has saved the Bureau its original installation cost. It is, he says, of immeasurable benefit to farmers on the irrigation project and to bureau workers in the field. The 45,000-acre project area is not completely served by telephones (the use of carrier pigeons for communications was not even considered) hence the use of the radio-telephone set-up.

The network is centralized in the Bureau's project office in Tucumcari. Six field cars are equipped with receivers and transmitters. More will be added when available. Most important of the six field installations are four sets in cars driven by the irrigation district's ditchriders—the fellows who control the flow of water over the hundreds of miles of main canals and subsidiary laterals. Two other sets are in Bureau cars operated by Mr. Lyman and Ed Cerny, watermaster for the entire project.

"We are exceedingly thankful for this service," Mr. Lyman declared recently. "It has enabled us to keep in continuous touch with the men in the field and also the farm operators.

"With this radio-telephone facility," Mr. Lyman continued, "if a farmer sees his crop is burning and decides he needs water immediately, he can check the Bureau office, obtain authority for his water, and have it on the way to his farm in a matter of hours. Formerly, days sometimes elapsed before the water could be sent on its way in some parts of the project."

Of prime importance is the ability of the Bureau's operation and maintenance crews to coordinate more effectively the flow of water through the network of canals, laterals, and ditches. If a sudden demand comes for water on the lower end of the project, the ditchrider merely calls up the project office which coordinates the flow for the entire project. The upper end of the irrigation district is the location of numerous water outlets from the main canals originating at Conchas Dam, many miles from the farmlands and almost inaccessible directly by automobile.

The ditchriders may be 10 or more miles apart. Formerly, it was necessary for one ditchrider to leave his other duties and travel cross country to secure a change in the flow of water. This resulted in a ditchrider traveling 60 to 90 miles a day, often over tortuous, winding roads. Two additional units in the irrigation project, now under construction by the Bureau, will create about 150 more miles of channels and laterals for the ditchriders to service and police. Then, the radiotelephone will be a much more handy gadget as the distances are extended.

The real pay-off of the radiotelephone service will come if and when breaks occur in walls of the irrigation system. A ditchrider, spotting a break, can sound the alarm and have a repair crew on the job quicker than the little Dutch boy stopped the leak in the dyke.

Another pay-off may come at the end of any long workday. It probably never will be reported officially, but it could happen. The weary ditchrider may pick up his sending gadget and send forth this message:

"Ray, please telephone my wife to put the biscuits in the oven—I'm headin' home." The End.

Eklutna—Number One Project

(Continued from page 38)

lower-cost produce in larger quantities through the benefits of a developed irrigation program as soon as power is available in sufficient quantities at lower rates than those in effect. The benefits to be derived from more and lower-cost power, both to individual and industrial consumers, are inestimable.

Present power facilities in the project area are insufficient to supply everyday needs. More than 3,000 people just outside the city limits of Anchorage are without electric service for their newly constructed homes. In the city, the demand is so great that circuit breakers are alternately opened on various sections of the city's power system, thereby plunging entire large areas into darkness. When there are no lights, no hot water, no way to prepare hot meals, and electrically operated heating systems fail, there is human suffering in Alaska.

The first electricity was produced by and for the Alaska Railroad during the early days. The 900-kilowatt steam-driven generating plant next to the railroad shops is still in existence, but is so obsolete and expensive to operate that it has only been used during peak-load periods in 1945 and 1946.

In 1927 the Anchorage Light & Power Co. constructed the present Eklutna hydroelectric plant, which started out in 1929 with a single 1,000 kilowatt generator, and added a second 1,000 kilowatter in 1935. This power is being transmitted to Anchorage over a single-circuit, wood-pole 33,000-volt line. With increases in population and electrical load, the Anchorage Light & Power Co., after installing a 700 kilowatt diesel-driven generating unit, failed to raise enough money to build more facilities. The city of Anchorage took it over in 1943 and is operating its properties under the name of the Anchorage Public Utilities, as an agency of the municipal government.

Diesel and steam units have been installed from time to time in a race against increasing demand and need. One of the most picturesque of these stop-gap measures is "Sackett's Harbor"—the stern half of a wrecked ocean-going tanker which was first leased in 1947, then purchased by Anchorage Public Utilities which has been utilizing its boilers and generating equipment as a power plant. It is dependable—has a capacity of about 3,000 kilowatts now and by improving its cooling-water system might be upped to 3,500 kilowatts, with a capacity for short-time daily peak loads of about 4,000 kilowatts.

In August 1948, the power supply situation in Anchorage became so critical that the voters floated a bond issue to buy another 1,000 kilowatt Diesel-driven generator to fight the power shortage.

Many people have been interested in the possibilities of Eklutna Lake as a source of hydroelectric power. Individuals, consulting engineering firms and the City of Anchorage have investigated the site, and in January 1947 the Geological Survey under the direction of Dr. John Reed began the collection of basic data. In February 1948 three reports were issued; namely, Preliminary Report on Water Power Resources of Eklutna Creek, Alaska; Reconnaissance Report on Geology of Eklutna Lake Dam Site and Conduit Route Near Anchorage, Alaska; and Preliminary Report on the Geology Along the Route of a Proposed Tunnel to Develop Power From Eklutna Lake, Alaska. We have used these basic data collected by Geological Survey extensively. As a result of these investigations, our reconnaissance and studies, we have submitted a plan for spark-plugging the development of Alaska through the construction of the Eklutna project.

Building on the site of the one and only hydroelectric development in the area—the existing low earth dike, concrete outlet works and spillway constructed by the Anchorage Public Utilities—we would raise a dam to an elevation of 879.5 feet. The spillway would be 329 feet with concrete wing-walls extending out 48 feet on the left, and 50 feet on the right, making a total structural length of 427 feet. This would protect the dam against any flood that might overtop, cut, or scour its embankments. But floods don't happen very often. When they do, they are caused by abnormally high temperatures which cause snow melt, or the rare occurrence of warm rains on the snow. The spillway we planned would be designed to pass 7,500 cubic feet per second. According to the records, a peak of 4,000 second-feet might be expected about once in a hundred years.

Water entering Eklutna Lake would be diverted through a 4½-mile tunnel, 9 feet in diameter, which would enter Goat Mountain and extend to the other (Knik Arm) side of the mountain range. Nearing the tunnel outlet a concrete surge tank, acting as a gigantic (96 foot high) escape valve, would nose up through the mountain. At the mouth of the tunnel a steel penstock 7½ feet in diameter and 1,250 feet long would rush the water down the mountainside to the power plant.

The power plant would provide for installing 30,000 kilowatts of capacity, which would produce a firm output of 100 million kilowatt-hours per year and about 40 million secondary power.

Transmission lines would be strung on wood poles to the city of Anchorage and to within 4 miles of Palmer. The plan provides for a substation to be constructed for the use of Fort Richardson and Elmendorf Airfield, and a 2,000 kilovolt-ampere substation for the Alaskan Railroad which has its $50,000,000 rehabilitation program well under way.

One important item in favor of the project is the fact that there are ample quantities of most of the construction materials needed for the Eklutna project within easy hauling distance.

A minimum of 4 years and appropriations totaling $20,000,000 would be required for the construction of this project. The rate of construction would depend upon the rate at which appropriations of funds were made by Congress, and upon the conditions in the labor and materials markets at the time of construction. If the members of the Alaskan investigations staff have made something of a record in swift reconnaissance, project planning, and design, we want to make it plain that this was not only in the nature of a rescue mission, but it was also one in which every organization, military, municipal, agricultural, commercial, territorial, and Federal cooperated, and gave 100 percent service. The task would have been impossible to accomplish in the short period of time allotted except for this cooperation on the part of all. Of

especial value were data supplied by Geological Survey, the city of Anchorage, Alaska Railroad, Alaska Road Commission, Office of Indian Affairs, Bureau of Land Management, Bureau of Mines, Fish and Wildlife Service, all of the Department of the Interior: Alaska agricultural experiment stations and Rural Electrification Administration of the Department of Agriculture; Civil Aeronautics Administration of the Department of Commerce; Alaskan Command of the Department of National Defense, the territorial government, and the Federal Power Commission.

There is a great deal of work yet to be done. At present the Bureau's Alaskan survey crews are mapping and running profiles over hazardous mountain terrain, making investigations, estimates and designs for the construction of the Dorothy Lake project. According to the latest word from the engineers, the Dorothy Lake development will be the highest head power development ever constructed by the Bureau of Reclamation. Its total static operating head will approximate 2,400 feet.

Similar investigations and reports for proposed water power developments at Sitka and Ketchikan are also contemplated for this fiscal year.

Those permanently assigned to the Alaska office are: Richmond C. Johnson, assistant chief; William W. Reedy, hydraulic engineer; Ade E. Jasker, geologist; Daryl L. Roberts, civil engineer; Aksel T. Jesperson, engineer-draftsman; Doran L. Ellery, chief of survey; Edward E. Dietz, chief clerk; William P. Farmer, administrative assistant and Ethel M. Finlayson, clerk-stenographer.

We shall be working on many problems connected with preliminary investigations for some time. For example, irrigation has a definite place in the Eklutna project plan. But the actual extent of potential irrigation benefits cannot be determined until studies now under way by several Government agencies are concluded. The present plan calls for the use of Eklutna project secondary energy to pump irrigation water each spring during the usual dry season and to continue pumping throughout the growing season in those years when summer rains fail to materialize.

Development of the Eklutna project is only a steppingstone toward realization of a full-grown regional economy. The project is the first stage of a much larger plan for development of water resources in the fast-growing and promising railbelt, extending from Seward on the Kenai Peninsula through Anchorage and the Matanuska Valley over the Alaska range and on to Fairbanks in the interior. The capacity of the Eklutna project would be fully utilized in the second year following completion. Studies are now under way to augment the proposed Eklutna system with development of the water resources of Kenai Peninsula, Matanuska, Susitna, and Nenana Rivers. This is the purpose of including in the Eklutna project a transmission line constructed for ultimate operation at 161,000 volts, whereas initial operation only requires 57,000-volt operation. The Eklutna project is definitely an integrated part of a coordinated and comprehensive plan for conservation and development of the abundant natural resources of the railbelt area.

Alaskan personnel has reconnoitered more than 200 potential water-power site over an area totaling more than 400,000 square miles. Its broad objectives are now being geared to make available to the Territory multiple-purpose benefits. A shortage of electric power exists in most communities. There is a need for irrigation, expansion, and improvement of existing municipal water supplies. Certain agricultural lands cannot be developed until drainage works are provided, which will reduce the mosquito menace. Coordinated development of water resources with mutliple-purpose features will encourage settlement, stimulate industrial expansion and give impetus to agricultural growth.

Alaska is the bastion of defense for the north Pacific. Billy Mitchell once said, "He who holds Alaska holds the world." The development of a self-sustaining economy and the natural resources of the Territory will implement an adequate defense at a minimum cost of money, men, and materials.

THE END

ABOUT THE AUTHOR.—Joseph M. Morgan, chief of the Alaska investigations office at Juneau, Alaska, member of the American Institute of Engineers, former major in the Corps of Engineers, statistical engineer for the Brooklyn Rapid Transit Co., field engineer for the Westinghouse Electric & Manufacturing Co., chief engineer for the South Carolina Power & Light Co., consultant to the General Management Corporation, electrical engineer for the State of South Carolina, rate and power engineer for the Federal Power Commission, senior electrical engineer to the national defense power staff, and instructor in electric utility engineering for the Graduate School of the United States Department of Agriculture, has only been with the Bureau of Reclamation for a little over 2 years, but in that time he has proven himself to be a man who gets things done.

No stranger to Alaska, he has visited that area and other territories during his career, and for over a year and a half was stationed at Whitehorse, Yukon Territory, assigned to the Northwest Service Command. His duties, as he says, were "broad and varied" consisting "in part" of design and preparation of specifications for constructing instrument landing approach systems for the Air Transport Command, supervising installation of lighting systems for runways, flight strips, etc., and scheduling and maintaining electrical inspections on all air bases of the Alaskan Division paralleling the Alaska Highway. His work in private industry has also been broad and varied, but centered around design, construction and operation of fuel and hydroelectric facilities.

In this article he presents the first report on the Bureau of Reclamation's plans for development of the hydroelectric resources of Alaska.

It DID Happen Here

A foreign visitor had listened intently to "Bill" Ballard, reservoir superintendent at Arrowrock (Boise project, Idaho), explain the many features of this structure. As he talked, the guest became more and more impressed. Finally he said, "You American engineers do amazing things. Everywhere I have gone I am seeing remarkable engineering achievements. This, likewise, is a most impressive structure."

Ballard agreed, and went on to explain how the Arrowrock dam had been refaced and "raised" 5 feet, an American engineer's way of saying that 5 feet had been added to the crest.

The visitor looked at him in amazement. Finally he smiled and said, "Oh, come now."

Review of Reclamation Homesteading

In 1948 thousands of veterans competed for 132 homesteads opened up on two Reclamation projects, the Tule Lake division of the Klamath project, California-Oregon, and the Gooding division of the Minidoka project, Idaho. Others sought to buy 1 of the 10 newly irrigated farms on the Pasco part of the vast Columbia Basin Reclamation project in the State of Washington, or to find an irrigated farm in California, Arizona, or another 1 of 17 Reclamation-served States.

Since the first post-war opening on public lands in August 1946, 50,938 acres of irrigated land served by the Bureau of Reclamation have been opened to homestead with veterans of World War II given preference. Over 100,000 requests for applications have been received. Of that number, 12,230 submitted applications and a total of 8,816 qualified for the 587 available farm units.

The Bureau of Reclamation is most appreciative of the work of local examining boards who screened these applicants before making the final awards. The examining boards are composed of farmers and businessmen in the vicinity of the project land. They must examine all applications and divide them into two groups—veterans and nonveterans. A drawing is then held of the veterans' applications to establish the order in which they will be reviewed in detail to determine whether the applicants fully meet the qualifications of farm experience, capital, character, industry and physical fitness. Qualified applicants are given an opportunity to select farm units in the order established in the drawing. If there is an insufficient number of qualified veterans to take all the farms, a similar drawing and examination is made of applications from nonveterans.

During 1949 irrigation water will be made available for the first time on more than 100,000 acres of privately owned land on five Reclamation projects. These are the Boise, Idaho; Deschutes, Oreg.; Yakima, Wash.; Tucumcari, N. Mex.; and W. C. Austin, Oklahoma. These lands, being privately owned, are not available to homesteading but it is probable that some of the land will be available for sale by the present owners to new settlers.

The following table shows postwar public land openings on Bureau of Reclamation projects for the years 1946–49.

Public Land Openings on Reclamation Projects 1946–49

Project	Acres	Farm units	Dates of—		Applications	
			Opening	Closing	Requested	Received
			1946	*1946*		
Klamath (Tule Lake division), Calif.-Oreg.	7,527	86	Aug. 1	Sept. 15	14,000	2,028
Shoshone (Heart Mountain division), Wyo.	7,720	83	Oct. 3	Nov. 25	4,900	532
			1947	*1947*		
Yakima (Roza division), Wash.	1,722	28	Feb. 1	Apr. 1	14,366	1,501
Sun River (Greenfields division), Mont.	74	1	Feb. 21	Apr. 8	450	46
Minidoka (Gooding division), Idaho.	3,226	43	Mar. 11	Apr. 25	5,935	1,172
Owyhee (Owyhee and Gem irrigation districts), Oreg.-Idaho.	138	3	Apr. 8	June 2	1,568	63
Vale (Vale irrigation district), Oreg.	55	1	do	do	[1](1,568)	56
Riverton, Wyo.	5,568	55	July 10	Oct. 8	1,878	512
Shoshone (Heart Mountain division), Wyo.	3,215	31	July 24	Oct. 22	9,818	632
Yuma (valley and reservation division), Calif-Ariz.	1,330	26	Sept. 9	Dec. 8	11,313	753
Klamath (Tule Lake division), Calif.-Oreg.	3,522	44	Oct. 22	(1948) Jan. 20	22,959	4,023
Gila (Yuma Mesa division), Ariz.	4,940	54	Dec. 30	(1948) Mar. 30	17,158	912
			1948	*1948*		
Columbia Basin (Pasco pump unit), Wash.[2]	846	10	July 20	Sept. 3	3,442	157
Klamath (Tule Lake division), Calif.-Oreg.	8,283	86	Sept. 21	Dec. 20		
Minidoka (Gooding division), Idaho.	3,618	46	Oct. 1	Dec. 30		
			1949			
Riverton (North Pavillion division), Wyo.[3]	5,727	49	February			
Shoshone (Heart Mountain division), Wyo.[3]	11,621	104	do			
Boise (Payette division), Idaho.[3]	4,320	48	September			
Yakima (Roza division), Wash.[3]	523	8	do			

[1] Vale and Owyhee notices issued simultaneously; copies provided to applicants requesting either notice.
[2] No public lands opened to homesteading on Columbia Basin project; lands sold by Government.
[3] Opening dates—tentative.

Pasco Unit Preview

You can talk about prize-winning couples on radio quiz programs, but there was no greater joy in anyone's heart when Mr. and Mrs. John M. Mullen of Grandview, Wash., heard Mullen's name announced as No. 7 among the veterans of World War II who will have priority in purchasing one of about 10 Government-owned family size farms in the Pasco unit of the Bureau of Reclamation's Columbia Basin project in eastern Washington.

Mullen, a technical sergeant in the Air Force during the war, was the only veteran present among the first 15 names called when the numbers were taken from a glass bowl at a public drawing in the Pasco (Wash.) Recreation Center in November.

"It's the first time we've ever been lucky like this," Mrs. Mullen said. "We came here hoping. You know how it is."

An examining board, holding the first drawing of its kind for project land, directed that all 139 numbers be drawn from the bowl. These represent the 139 veterans from 30 States who had petitioned for consideration in the sale of the units. The farms vary from 52 to 142 acres of irrigable land and will be sold at prices ranging from $455 to $2,169.

In determining who will be able to purchase the small number of farms, the examining board will start with No. 1 in the Pasco drawing and proceed down the line until sufficient qualified veterans are selected. These veterans in order of their numerical rating determined in the drawing, will be given their choice in purchasing the farms.

The board must decide whether the higher-ranking applicants have necessary capital requirements ($3,700 net worth) and whether the people listed as references can attest to their ability to establish and operate irrigated farms on the new land.

Members of the examining board have a wide background of farming experience. They are Loen Bailie of Mesa, Wash., president of the project's South Irrigation District, in which the Pasco unit lies; Melvin McInturf of Ringold, Wash., also in the project, a veteran of World War II; and Buford Kuhns of Ephrata, Wash., chief of the project's land-development section. ●

U. S. GOVERNMENT PRINTING OFFICE: 1949

NOTES FOR CONTRACTORS

CONTRACTS AWARDED DURING DECEMBER 1948

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2379	Hungry Horse, Mont	Dec. 14	Two 37,500-kilovolt-ampere outdoor transformers and 3 station type lightning arrestors for Hungry Horse power plant.	Westinghouse Electric Corp., Denver, Colo	$214,952
2380	Colorado-Big Thompson, Colo	Dec. 31	Two 21- by 20-foot radial gates for Granby Dam, item 1.	Pacific Coast Engineering Co., Alameda, Calif	10,400
2411	Columbia Basin, Wash	Dec. 7	Construction of Soap Lake Siphon, West Canal	Utah Construction Co., San Francisco, Calif., and Winston Bros. Co., Azusa, Calif.	7,614,728
2413	Missouri River Basin, N. Dak	Dec. 15	Construction of Dickinson Dam, Heart River unit	Adler Construction Co., Madras, Oreg	1,034,071
2421	Missouri River Basin, S. Dak	Dec. 31	Construction of Shadehill Dam	S. J. Groves & Sons Co., and J. L. McLaughlin, Minneapolis, Minn.	5,116,796
2422	Klamath, Oreg.-Calif	Dec. 15	Construction of addition to pumping plant D, Modoc unit, Tule Lake Division.	L. W. Jensen and A. E. Mangs, Palo Alto, Calif	112,198
2423	Missouri River Basin, Wyo.-Nebr	Dec. 29	Construction of Casper-Gering 115-kilovolt transmission line.	Smith Hi-Line Co., Nashville, Tenn	1,024,996
2426	Central Valley, Calif	Dec. 2	3 Reactors for Tracy switchyard, schedule 2	General Electric Co., Denver, Colo	13,563
2428	Colorado-Big Thompson, Colo Kendrick, Wyo. Missouri River Basin, Nebr.	Dec. 20	Coupling capacitors, potential devices, and carrier-current line traps.	do.	41,858
2431	Davis Dam, Ariz.-Nev	Dec. 2	Structural steel bracing and deck framing for Davis power plant.	Virginia Bridge Co., Denver, Colo	199,700
2432	Central Valley, Calif	Dec. 21	Construction of 27.1 miles of Friant-Kern canal	Peter Kiewit Sons' Co., Omaha, Nebr	7,494,372
2433	do Davis Dam, Ariz.-Nev. Hungry Horse, Mont.	Dec. 8	Cranes, rails, and accessories for Tracy pumping plant, Davis power plant, and Hungry Horse power plant.	Midwest Steel & Iron Works Co., Denver, Colo	29,000
2435	Missouri River Basin, Nebr	Dec. 13	2 high-pressure gates, hydraulic hoists, and equipment for Medicine Creek Dam.	U. S. Pipe & Manufacturing Co., San Francisco, Calif	18,475
2444	Central Valley, Calif	Dec. 9	Steel structures for switchyards, Keswick and Shasta power plants.	International Derrick & Equipment Co., Torrance, Calif	27,945
2450	Hungry Horse, Mont	Dec. 10	96-inch diameter welded-plate-steel outlet pipe and appurtenances for Hungry Horse Dam.	Pacific Coast Engineering Co., Alameda, Calif	73,700
2454	Central Valley, Calif	Dec. 16	Painting penstocks at Shasta power plant	Klaas Brothers, Los Angeles, Calif	58,710
2455	Davis Dam, Ariz.-Nev	Dec. 29	Distribution transformers and step-voltage regulator for Prescott substation, schedules 1 and 2.	Moloney Electric Co., St. Louis, Mo	15,045
2456	do	Dec. 14	Rails, accessories, hatch covers, and miscellaneous structural steel for Davis power plant.	National Iron Works, San Diego, Calif	18,297
2461	Columbia Basin, Wash	Dec. 27	Metal-clad switchgear units for Grand Coulee Left power plant.	Allis-Chalmers Mfg. Co., Denver, Colo	74,982
2462	Hungry Horse, Mont	Dec. 23	Construction of telephone system for Hungry Horse Government Camp.	McCann Construction Co., Missoula, Mont	37,710
2463	Boulder Canyon, Ariz.-Calif.-Nev	Dec. 9	Two 115,000-horsepower hydraulic turbines for units A-3 and A-4, Hoover power plant.	Allis-Chalmers Mfg. Co., Denver, Colo	2,080,100
2464	Columbia Basin, Wash	Dec. 8	Miscellaneous structural steel railing, grating, and floor plates for Units R-4, R-5, and R-6 Grand Coulee power plant.	Union Iron Works, Spokane, Wash	12,514
2468	Hungry Horse, Mont	Dec. 28	One 96-inch hollow-jet valve for Hungry Horse Dam	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala	99,950
2472	Missouri River Basin, Wyo	Dec. 21	Structural steel roof framing for Kortes power plant	American Bridge Co., Denver, Colo	35,501
2493	All-American Canal, Calif	Dec. 29	37,500 barrels of bulk portland cement for Coachella Valley distribution system, unit 1.	Monolith Portland Cement Co., Los Angeles, Calif	135,750
R1-33	Deschutes, Oreg	Dec. 8	Furnishing and erecting 5 residences and 4 garages in Bend, Oreg.	R. P. Syverson, Bend, Oreg	43,699
R7-25	Colorado-Big Thompson, Colo	Dec. 7	Steel structures for Sterling and Holyoke substations	Daco Metal Products, Oakland, Calif	17,120

Construction and Supplies for Which Bids Will Be Requested by April 1949

Project	Description of work or material
Boise, Idaho	Construction of a log boom for Cascade Dam near Cascade, Idaho.
Boulder Canyon, Nev	Construction of 15 permanent houses at Boulder City, Nev.
Do	Processing of sand and gravel for concrete aggregate.
Central Valley, Calif	Eleven 20- by 17-foot radial gates for Delta-Mendota Canal.
Colorado-Big Thompson, Colo	Excavation and stabilization of about 1 mile of Granby pump canal ending at Shadow Mountain Reservoir, near Granby, Colo.
Do	Construction of 51 miles of 69-kilovolt wood-pole transmission line between Brush and Yuma, Colo.
Do	Construction of 27 miles of 115-kilovolt wood-pole transmission line from Flatiron substation west of Loveland to Greeley, Colo.
Colorado River Front Work and Levee System, Calif.-Ariz.	Dredging of the Colorado River between Needles, Calif., and Topock, Ariz.
Columbia Basin, Wash	Construction of earthwork and structures for the 15-mile Winchester wasteway near Winchester, Wash.
Do	Spare motor-generator exciter set for Grand Coulee power plant.
Do	Control cubicle for station-service generator LS3, Grand Coulee power plant.
Do	Panels for station-service control board and associated terminal board and equipment for panels 5 and 7, Grand Coulee power plant.
Deschutes, Oreg	Rehabilitation of Ochoco dam, spillway, and outlet works near Prineville, Oreg. The dam is an earthfill structure about 125 feet high and 970 feet long.
Davis Dam, Ariz.-Nev	Transformers and switching equipment for Coolidge substation.
Davis Dam, Ariz.-Nev	Main control board for Mesa substation.
Do	Main control board for Prescott substation.
Hungry Horse, Mont	One 10.33-foot by 10.33-foot bulkhead gate for Hungry Horse Dam.
Missouri River Basin, Mont	Construction of Tiber Dam, an earthfill structure 185 feet high above river bed and 2,880 feet long, on the Marias River, 18 miles southwest of Chester, Mont.
Missouri River Basin, Nebr	Construction of earthwork and structures for about 16 miles of Courtland canal, near Superior, Nebr.
Missouri River Basin, S. Dak	Construction of the 42-mile long Bismarck-De Vaul 69-kilovolt single-pole, single-circuit, 3-phase transmission line.
Missouri River Basin, Wyo	One 48-inch hollow-jet valve for Boysen dam.
Do	One 77-inch regulating gate and 77-inch conduit liners for Canyon Ferry Dam.
Ogden River, Utah	Construction of earthwork and structures for a 10-acre-foot capacity equalizing reservoir for the south Ogden lateral distribution system near Ogden, Utah.
Palisades, Idaho	Furnishing and installing 1 package or unit substation, 5,000-kilovolt-ampere capacity, from 44 kilovolts to 12.5 kilovolts, about 56 miles southeast of Idaho Falls, Idaho.
Do	Construction of electrical distribution system for Palisades Government camp, 56 miles southeast of Idaho Falls, Idaho.
Provo River, Utah	Construction of 32 miles of 44-kilovolt transmission line for Duchesne tunnel, 30 miles northeast of Provo, Utah.
San Luis Valley, Colo	Construction of Platoro Dam, an earthfill structure 150 feet high above river bed and 1,500 feet long, on the Conejos River about 40 miles west of Alamosa, Colo.
Do	One 4- by 5-foot high-pressure gate valve for Platoro Dam.

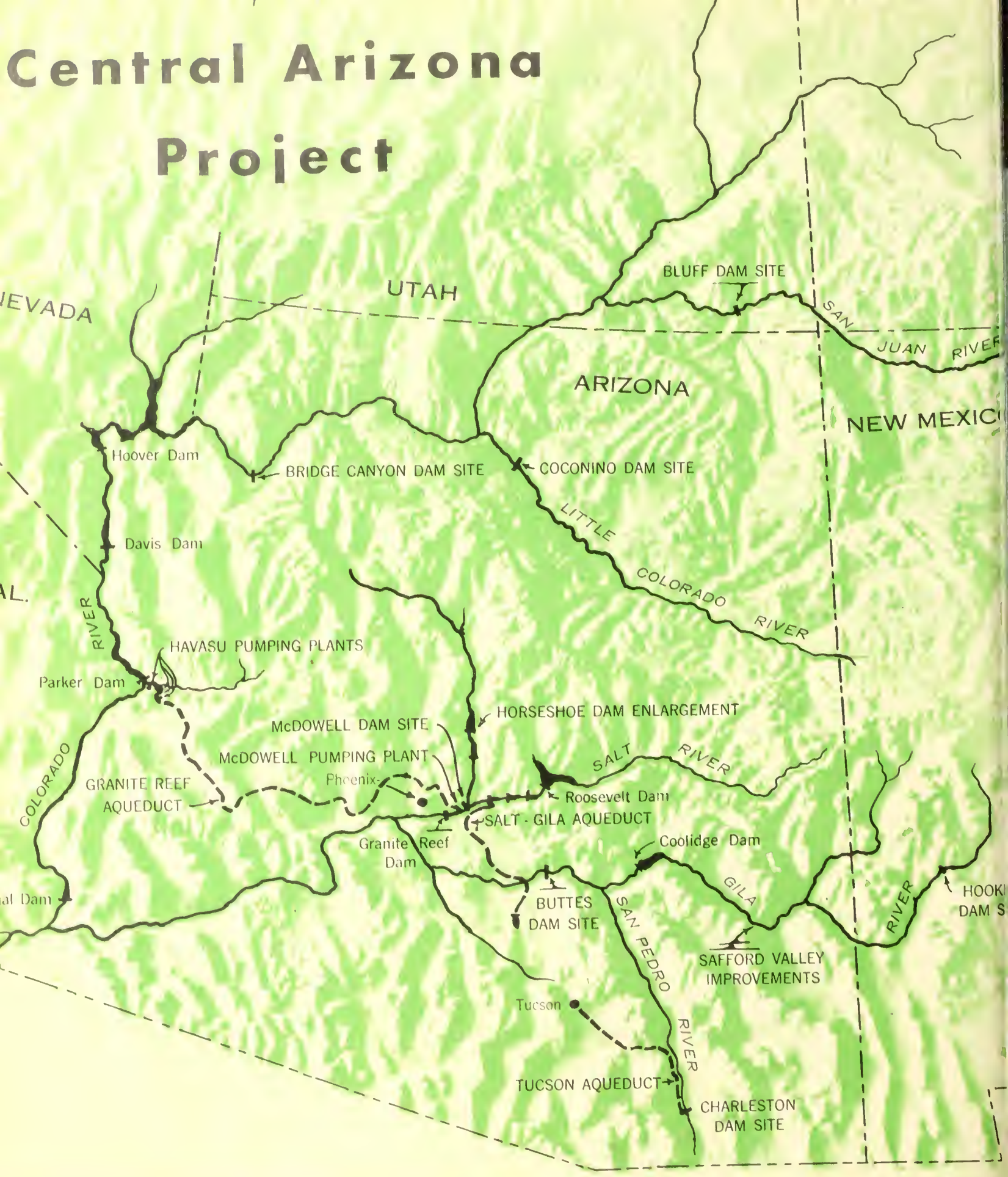
Our Front Cover

Leonard Crisafulli is continuously making careful bacteriological and enzyme tests in the small laboratory adjacent to the Crisafulli plant. This photo was taken by Photographer Charles A. Knell, Sr., Region VI, Billings, Mont.

Our Back Cover

This map of the Central Arizona project is based on a photograph of the relief model of the United States, prepared by Raisz and Brown, reproduced with the permission of the copyright owners Kittredge and Coolidge. We are most grateful to Messrs. Raisz, Brown, Kittredge, and Coolidge for their courtesy.

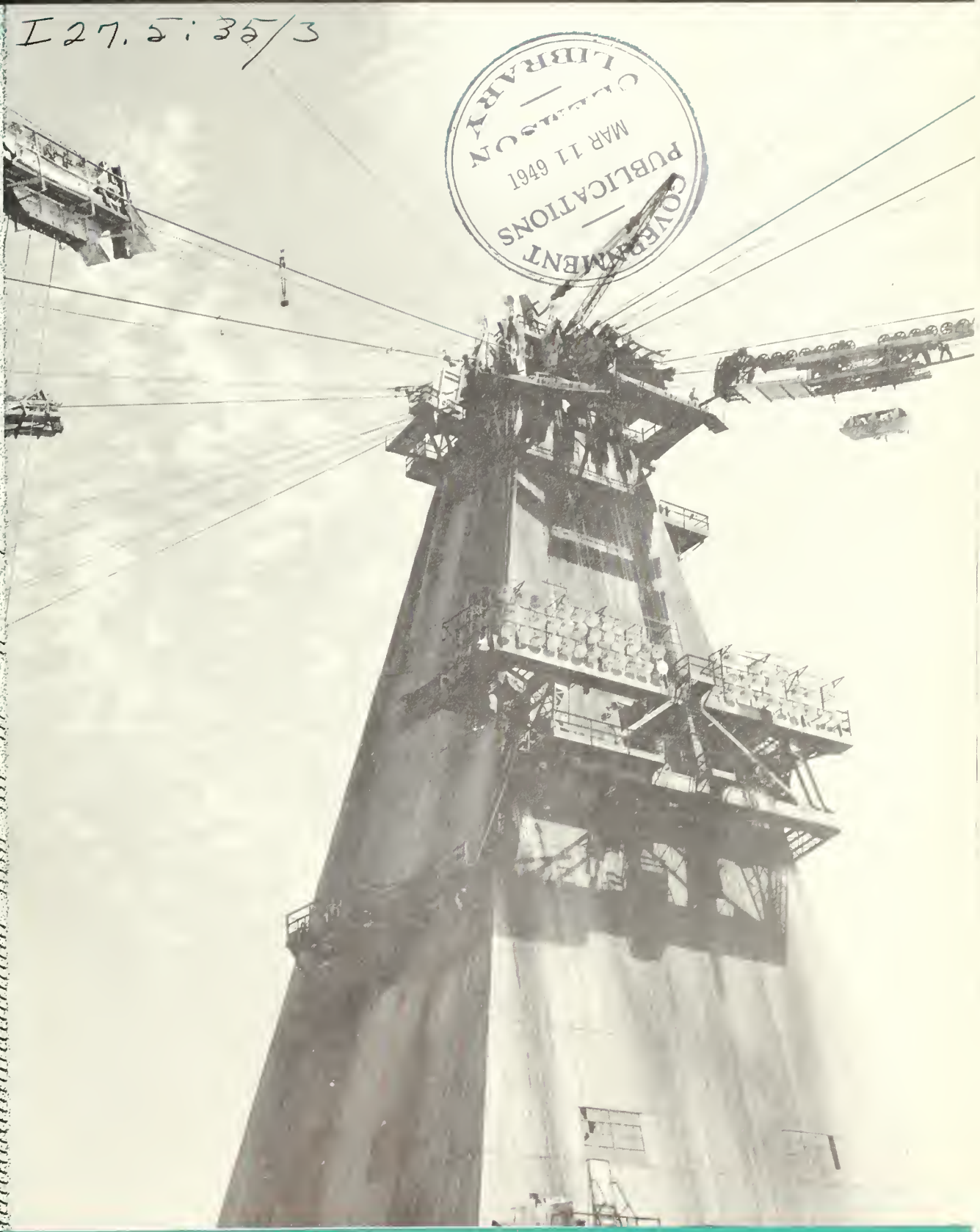
Central Arizona Project



The Reclamation ERA

March

1949



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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' association.

Permission is freely granted to reproduce articles and photographs (with the exception of those from outside sources) which appear in the RECLAMATION ERA.

Our best wishes and lots of luck to Carol Robbins, author of "Pioneer Women at Tucumcari," which appeared in the February 1949 ERA. Miss Robbins recently became Mrs. Jack L. Hitt but the information reached us too late to change her byline. Let's hope we see the Mrs. Hitt byline in the ERA soon.

OUR FRONT COVER

This scene shows the headtower at the height of its activity. This photo was taken from the top of Shasta Dam at crest elevation by Dale A. Hovey, formerly of Regions V and II. See story on page 50.

DO YOU KNOW . . .

- the Grand Coulee Dam power plant now produces almost two percent of the Nation's output of electricity?
- if the Grand Coulee Dam were divided up into souvenir pieces of concrete, there would be a 300-pound piece available for every man, woman, and child in the United States?
- the Hungry Horse Dam got its name from two horses who were lost and were almost starved to death during winter of 1900–1901?
- the concrete in Hungry Horse Dam (2,900,000 cubic yards) is sufficient to build a 20-foot highway from Seattle to San Francisco and back?
- the waterfall plunging over the Grand Coulee Dam spillway at the peak of the year's flow is the second largest waterfall in the world, when compared on the basis of horsepower?
- the Hungry Horse Dam will be the world's fifth highest and fourth largest concrete dam?
- the gate tender at Dead Wood reservoir of the Boise project is snow-bound five months out of the year, his only contact with the outside world being via short-wave radio?

RECLAMATION PLACE NAMES IN THIS ISSUE

In the July 1948 issue of the RECLAMATION ERA we carried an account of the congressional action on the Interior Appropriation Act which contained specific language which, subsequent to January 31, 1949, would require the Commissioner of Reclamation, Assistant Commissioners, and all Regional Directors to have at least 5 years of engineering and administrative experience. This provision as it now stands (January 31, 1949) will prohibit Commissioner Michael W. Straus and Regional Director Richard L. Boke from drawing further salary in their official capacities. The following communication in their behalf was submitted to the Congress of the United States by President Harry S. Truman on January 6, 1949:

THE WHITE HOUSE,
Washington, January 6, 1949.

The Speaker of the House of Representatives:

SIR: I have the honor to transmit herewith for the consideration of the Congress a repeal of a proviso contained in the Interior Department Appropriation Act for 1949 which is referred to in the attached letter of the Director of the Bureau of the Budget.

I have previously indicated my opposition to this proviso which has the effect of legislating out of office the Commissioner of the Bureau of Reclamation and one of his principal assistants. This arbitrary action is diametrically opposed to the principles on which this Government is founded. Furthermore, these positions are primarily administrative in character and do not necessarily require a professional engineering background.

I strongly urge the repeal of this restrictive provision.

Respectfully yours,

Harry Truman

823026—49——2

The PASSING

Dismantling head tower. *Photo by Paul E. Norine, now at Region IV.*

Any day now, the once famous trade-mark of Shasta Dam will become nothing but a passing ripple over the face of California's renowned man-made lake. For the 460-foot cableway headtower which, faded, red and weatherbeaten, has jutted incongruously from the surface of Shasta Lake for several years has now been relegated to the scrap pile. A contract has been awarded to remove it down to the lowest water level which will be reached during the operation of Central Valley project's key reservoir, Shasta Lake.

This once mighty steel giant served as the nerve center for the world's most unique and elaborate cableway system—the last job in the career of the late Frank Crowe, internationally reputed originator and pioneer of this method of large dam construction.

From the high structural steel headtower radiated seven cableways which served as aerial transportation for material and equipment necessary for the construction of the dam and power plant. Each cableway, a complicated pulley, block and tackle assembly line, was attached to a movable tailtower on double sets of railroad tracks across the Sacramento river canyon. Controlled from the headtower, each cableway was used to shuttle, lower and dump loads back and forth across the canyon.

It took 3-inch diameter track cable weighing 22 pounds per lineal foot, a system of lines to move the carriages to and fro on the track cable, slack carriers to keep lines from fouling and lines to raise and lower loads and place concrete

Above: General view of head tower, and right abutment with reservoir at elevation 838.2 as seen from old road to base of head tower. At right: Scene from right abutment waste dump showing construction of cableway headtower with left abutment excavation in the background. *Top photo by Paul E. Norine, now at Region IV. Right photo by B. D. Gloho of Region II.*

of the SHASTA SKYWAY

By ROBERT MIDTHUN, Chief Guide, Shasta Dam, Region II, Sacramento, California

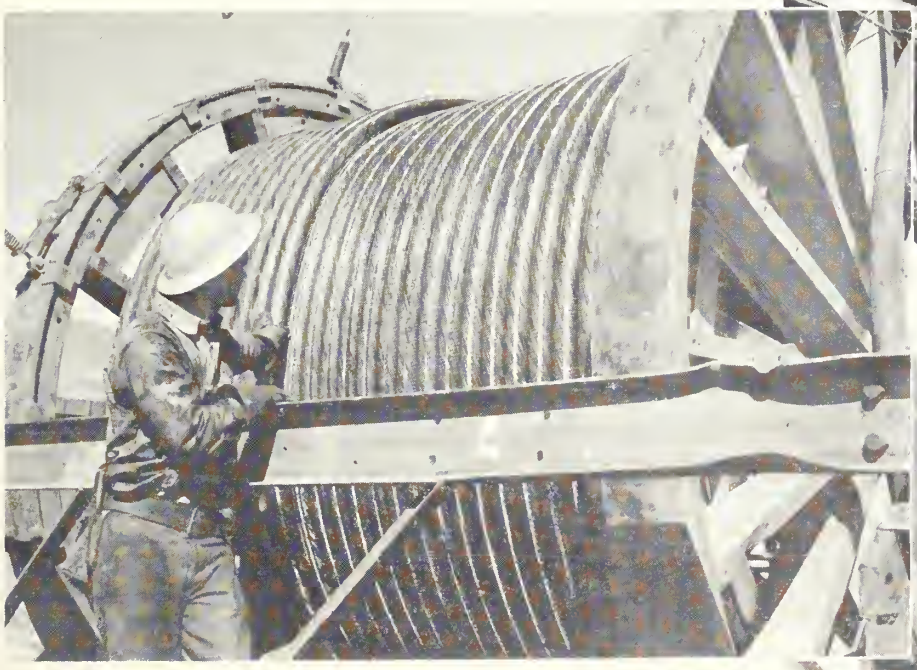
buckets. All told there were more than 25 miles of cables in the seven cableways across the canyon at Shasta Dam.

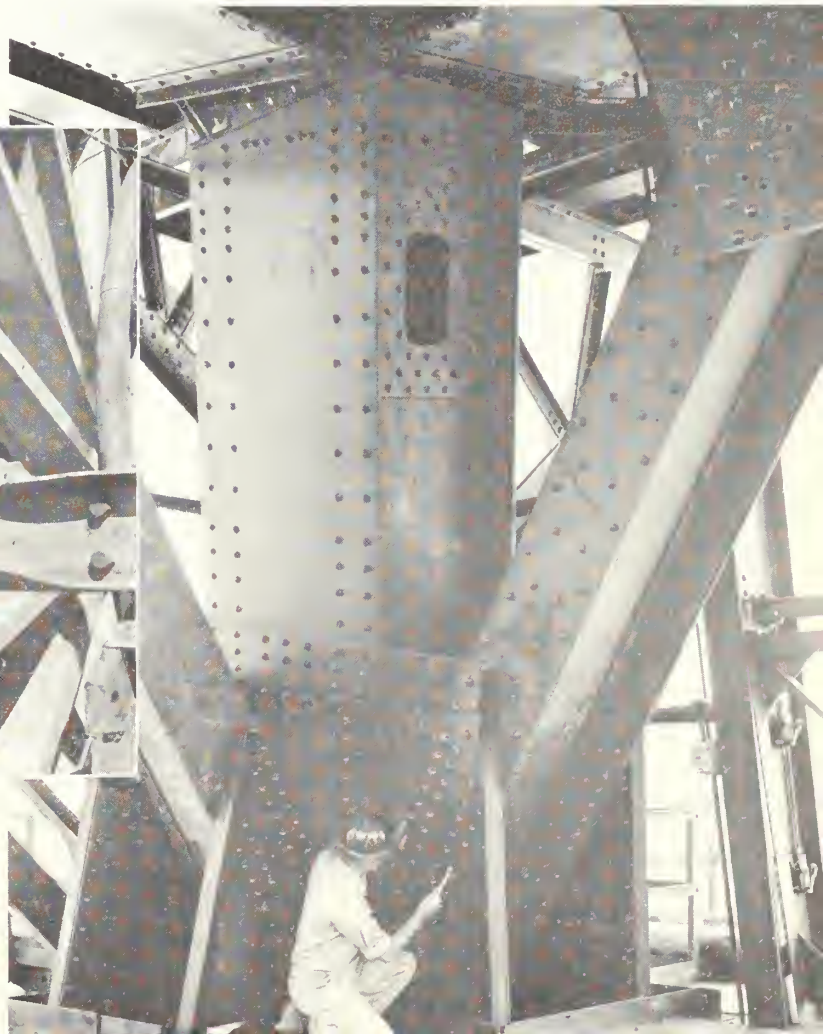
Those who may have forgotten or never saw or heard of the cableway at the height of its activity may wonder why such a complicated operation was necessary. The answer lies in the wartime need for hydroelectric power. The Shasta job had to be rushed to completion, at least to the point where water could be stored behind Shasta Dam to provide sufficient storage and head for emergency hydropower operation. That meant the contractor had to remove his concrete mixing plant from the base of the cableway headtower in order to continue construction operations and yet permit water to be stored behind the dam.

For more than 4 years from July 1940 to December 1944 the big tower served as the focal point of construction activity. The last bucket of concrete for Shasta Dam was lowered and placed from cableway No. 3 on December 22, 1944, a bleak gray day in northern California during World War II. Only a small group of workmen looked on as, slowly and silently, except for cables whispering through the sheaves (pulleys) the final load was placed. As the last whine of the concrete vibrators died away, the big job of placing 6,500,000 cubic yards of concrete for Shasta Dam and power plant was completed—without fanfare and almost without notice by the outside world so involved in wartime strife.

Construction Engineer Ralph Lowry of the Bureau of Reclamation and Mr. Crowe, superintendent of Pacific Constructors, Inc., exchanged congratulations with a deep sense of mutual pride. These men and their highly skilled organizations had completed a big step toward winning the war. Already water was accumulating and rising rapidly behind the not yet completed dam and for almost five months Shasta had been generating 150,000 kilowatts of critically needed power.

Thousands of visitors flocked to Shasta to watch the 16-ton loads of concrete shuttle back and forth across the mosaic-like form pattern as the world's second largest concrete structure took form. These "sidewalk superintendents" were provided





Above: Stringing cableway No. 1 from left abutment to the 460-foot head tower. The 3-inch locked coil cable can be seen in detail. Weight—22 pounds per linear foot. Length—More than ½ mile. At right: Inspector tests field rivets in cableway head tower on deck immediately below top sheave deck. *Top photo by R. A. Midthun; right photo by B. D. Glaha, both of Region II.*

Above: Operator at controls for cableway No. 2 in the cableway head tower at Shasta Dam. At right: View of control panel for No. 1 hoist. Below: The 460-foot cableway head tower as seen from beneath trestle for tail tower No. 6. *Two top photos by R. A. Midthun. Bottom photo by T. B. Gibson, both of Region II.*

with a vista house and grandstand on the brink of the excavation where they could safely see the spectacular construction job as loads of steel, skip-loads of muck and huge forms made the aerial circuit across the dam site from the headtower. The "biggest show on earth" had nothing on the Shasta cableway. Trapeze artists and high-wire experts could never strive to emulate the rapid transit of these inanimate performers. In one way it outstripped many aerial shows as there were seven, rather than the usual three or five, "high wires" working simultaneously.

During its working days, the cableway broke the world's record for placing mass concrete from a single mixing plant, when on August 9, 1941, Shasta Dam forces placed 11,790 cubic yards of concrete in 24 hours.

Many workmen casually rode up to the top of the mammoth steel headtower in their daily chores. The ride up the side of the 4,000-ton tower was, in itself, a most awe-inspiring trip. The elevator ascended a set of guide rails on the outside of the tower. On calm days the steel roller curtains on the cage were raised, giving unrestricted visibility. From the elevator it was difficult to realize that the giant tower enclosed almost an acre of ground at its base, and that the tiny objects shuttling around below were mammoth, specially built, excavation trucks carrying loads amounting to 25-cubic yards, or more than 40 tons.

It was a silent ride, except for the wind rushing through the steel framework, until you reached the 250-foot level. Here the quiet suddenly changed to a bustle of activity. At this point, high above the ground, seven motors and high-speed hoists provided plenty of action. Here was a room 95 feet square and 130 feet high. Overhead, the entire space was criss-crossed by cables running from the high-speed hoist drums to the sheaves which guided the lines safely to the cable sheaves on the top of the tower, 200 feet above.

But the only visible human beings would be two or three oilers casually wiping and oiling machinery, or perhaps a rigger handling cable. You could not help wondering what controlled this intricate layout. On this floor was located all of the controls for the entire cableway system, including the operation and moving of the seven tailtowers on the opposite side of the river.

The actual operators were in booths placed 18 feet above the hoist floor along the outer face of the huge tower. Each of the seven operators was responsible for one cableway, and their booths were located so they could see the hoists and machinery as well as the field of operation.

Three Men on a Team

Each highline or cableway required a team of three men on each shift—an operator, a signalman down on the site of the work and a hook-tender to attach and remove cable slings from loads. The hook-tender was a bonafide aerialist for he rode with his loads in order to handle rigging and slings. No one was required to ride with the 8-foot-high, 6-foot-square concrete buckets. They were designed so they could be dumped by the operator high up in the central headtower. The signalman directed the placement of the concrete buckets by remote control, using telephone and bell signals. Many times the loads were placed when they were out of the operator's sight. Only when landing the huge buckets at the loading docks at the base of the big tower did the operator rely upon his own judgment. At all other times he relied on the signals and instructions of the signalman.

The "Trade Mark" of Shasta Dam

The cableway headtower became a "trade-mark" of Shasta Dam. The entire system was designed, developed and tailor-made for the dam by the "Old Man," as Mr. Crowe was affectionately known to his men. The headtower was designed to withstand a force of 1,000 tons attempting to pull it over and not a single sway brace or guy was employed. The huge compression and tension legs were about 40 inches square and extended 102 feet below the ground surface to solid bedrock. The excavation was backfilled with concrete and it was impossible for the structure to yield under any loads to which it would be subjected. Manways inside and outside the legs provided access for checking the condition of the structure.

As the construction work progressed, the water began to creep up around the base of the cableway headtower, finally flooding its base. After its usefulness was completed and the contract reached final settlement, the Bureau of Reclamation accepted title to the giant structure and a sum of money with which to remove it at a more opportune time than during the war. The terms of the contract for the removal of the headtower call for its disappearance by April 10, 1949.

With the headtower's passing, the guide staff at Shasta Dam will probably never again be asked, "Is that tower out there an artesian well to keep the lake full?" THE END

Top photo: Cableway No. 1 crew at tail tower position, changing buttonline cable. Immediately above: Riggers putting the finishing touches on carriage for cableway No. 2. ***Both photos by the author.***

823026—49——3

McKay Dam and Reservoir

Photo by Phil Merritt, Region I.

by NOLAN SKIFF, Associate Editor, *East Oregonian*

One of the chief assets to irrigation and flood control in Umatilla County, the McKay Dam and Reservoir next door to Pendleton, Oreg., also provides one of the chief recreation areas near the Round-Up City.

Probably thousands of visits are made to this area annually—from the opening of the bass and crappie fishing season in early spring to the time in late fall when goose hunters edge cautiously near the deadline—and also in the wintry period when silver frosts turn portions of the area into fairylands of beauty.

The reservoir, just half a dozen miles from Pendleton via U. S. Highway 395 (The Three Flags Highway), and an even shorter distance by the Tutnilla road, is an asset of many facets. From a recreation standpoint, its appeal ranges from picnicking to setting off of fireworks the Fourth of July, from fishing to photography, from boating to oil painting, and from suntanning to swimming.

At no time of the year is the area more spectacular than the nights of July 3 and 4, when Pendleton people—barred from shooting off Roman candles and fireworks inside the city limits—flock to the shores of the usually placid lake and give way to Independence Day spirit in all its glory.

Campfires may be built along the sandy or gravel shores, and wieners and buns roasted, or perhaps freshly caught perch or crappies cooked, in a sizzling frying pan.

Boating and fishing top the sports. Many Pendleton and Umatilla County people own outboard motorboats which they take to the dam and spend hours or perhaps all day trolling for fish or basking in the sun while angling for catfish—an excellent pan fish!

Bass at certain seasons, trout—often of large size, perch, crappies, catfish, blue gills all yield to the proper angling lures, and many fine catches are made there annually. There is no closed season on the spiny-rayed fish so the more rugged fishermen get in many days of sport before the trout season opens in the spring or after it closes in the fall.

Upper right: McKay Dam area is converted into a Silver Setting by Jack Frost. Upper left: Lakeside Beauty—Upper end of reservoir, with border line of trees and grassy shores is both a beauty spot and excellent fishing site in early season. At right: They prove that they had a "good day." *Upper right and immediate right photos by Bus Howdyshell, of Pendleton, Oreg. Upper left photo by the author.*

Best of all, the recreation afforded by McKay Dam is without charge—except for the usual cost of fishing licenses, picnic lunches, gasoline to take the car to and from the lake, and perhaps some soft drinks. There is no drinking water along the banks, so some provisions must be made to quench thirsts when the visit is to be more than of short duration.

Cars can be driven along most of the many miles of shores and in safety, provided the driver follows tracks of others who went before him. It isn't particularly wise for a driver to move into damp ground below high water level unless it has been tried by others.

McKay Dam was started in 1923 by the Federal Government and completed in the fall of 1926. It is a rolled earth fill dam 167 feet high with a reinforced concrete face. When full it makes a lake 3½ miles long, and three-quarters of a mile wide at the widest point.

The surface area is 1,260 acres and the capacity is 73,800 acre feet. Cost of construction was $2,110,000—but no telling what it would have been under present-day prices.

The length across the top of the dam is 2,700 feet and the dam is 650 feet thick at the base and contains 2,313,000 cubic yards of material.

The spillway, which is used to bypass excess water when the dam is full, is controlled by six radial gates 10 feet high and 20 feet long, and a two-barrel siphon. The gates can be operated either by hand power, or by electricity, and can be automatically controlled by floats near each end of the spillway.

Release of water for irrigation purposes is by means of two balanced valves, each of which will release a stream of water 4 feet in diameter. Either valve has a discharge capacity of about 800 second-feet. A second-foot, by the way, is the quantity of water which will cover 2 acres 1 foot deep in 24 hours.

While McKay Creek is only a creek, and with a catchment area of 186 square miles, it does go on a rampage sometimes.

April 1, 1931, there was a pickup of 6,084 acre feet in 24 hours. The peak of the high water, which lasted 3 hours, was about 4,700 second feet.

March 16, 1932, the creek rose to 3,600 second-feet, and continued at that height for 2 days. This was during a flood in the Umatilla River which overflowed some of the Pendleton streets and filled some basements. The entire inflow of McKay Creek was held back until the Umatilla River dropped to a safe level, and made the flood damage quite a bit less than it would have been otherwise.

There have been numerous times when the inflow to the reservoir has been more than the creek below the dam could conveniently carry, but last year was the first time there was not enough space to hold it. Prospects elicited from the annual snow surveys indicated 10,000 to 15,000 acre-feet in the hills, and lots of space for it. However, 8 inches of wet snow and a blizzard at Kamela, changed the picture on May 8. The reservoir filled to the top of the gates, then to a point three inches above, and the highest water release since the dam was built occurred, about 1,240 second-feet.

The primary purpose of the dam is to furnish supplementary water for the irrigation of lands in the Westland and Stanfield irrigation districts, totaling approximately 11,000 irrigable acres. It also stores water for lands along the Umatilla River which do not have water rights permitting late irrigation. The drainage and return flow from those

lands provide the full irrigation supply for the West Extension irrigation district of about 4,850 acres.

While irrigation formerly largely ceased along the Umatilla River by the last of June, the stored water permits irrigation until the middle of September or later. In but one year, 1935, was there insufficient water for late irrigation and since 1942 the reservoir has filled each year. Last year occurred the greatest runoff since the dam was built. With a full reservoir, a total of 70,537 acre feet was bypassed down McKay Creek, almost enough to refill the entire reservoir.

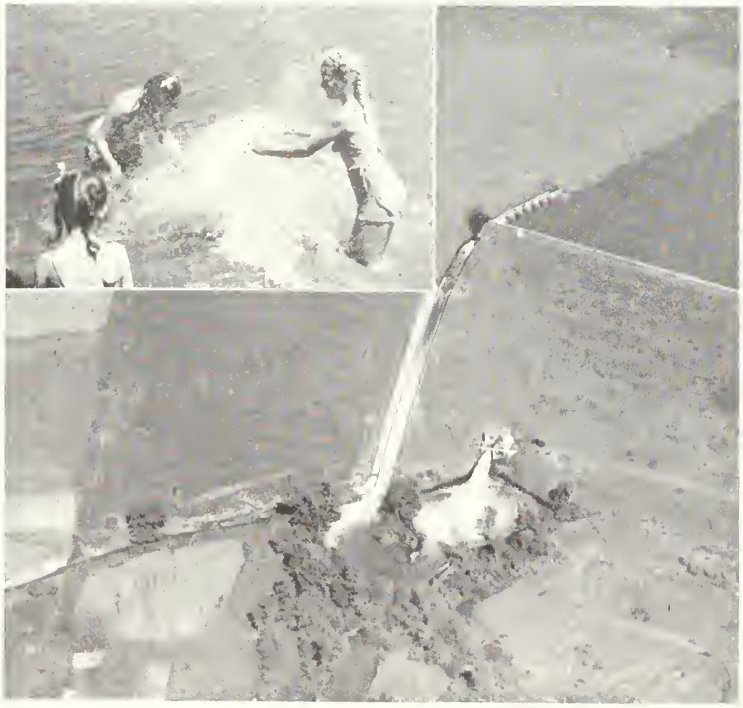
Another interesting point is that the Pendleton Country Club, the State game commission, and the eastern Oregon State hospital all buy water from McKay Dam. The water is taken directly from the Umatilla River by the three purchasers, and McKay Reservoir puts an eqivalent amount back in the river at a lower point.

In its earlier years outboard motorboat regattas were sponsored by the Pendeton Legionnaires for 3 years. Entries came from as far away as Spokane, Payette Lake, Astoria, and even Sacramento. The roar of the outboard motors as it echoed from the face of the dam was almost deafening. With the coming of the depression, this sport gradually almost died out, since big outboard motors use a lot of gas.

Since then motorboats appear on the lake frequently, but usually the smaller types used by anglers, with fewer of the larger boats in evidence, and no efforts are made to stage regattas or other similar events.

Chances are good, however, if you are looking for a nearby, outdoor spot for recreation, you will find some of McKay Dam's varied offerings very much to your liking. If you haven't tried it, now is a good time to make its acquaintance—and maybe make plans to visit it frequently during the years ahead.

THE END



Aerial view of spillway, discharge valves, and radial gates. Note stream of water spurting from valve in right center, and strong flow of water down spillway from gates. Inset: Sharon Pound and Donna Sutton engage in water battle. *Photograph by Bus Howdyshell, Inset by Stanley Rasmussen, Region 1.*

Water From Reservoirs Could Cover Half the Eastern States

Bureau of Reclamation dams have impounded enough water to cover more than half of the Eastern Seaboard States. Its 14 reservoirs have a capacity of 58,758,780 acre-feet of water for irrigation and other purposes. If spread over the States of New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Delaware, Maryland, and the District of Columbia, it would cover the entire land area 1 foot deep, with enough left to cover Rhode Island again.

Rainfall west of the Ninety-seventh meridian, where these reservoirs are located, averages 10 to 20 inches per year. Western farmers, therefore, think of water as "liquid gold." It is estimated that more than 14 million tons of food will be grown and approximately 15,000,000,000 kwh. of power will be generated on Reclamation projects this year with the aid of this water.

Andrew Weiss Honored by ASCE

Andrew Weiss, one of the foremost living Reclamation alumni, was recently made an honorary member of the American Society of Civil Engineers. This is the highest honor conferred by the society and Mr. Weiss now shares the distinction with such engineering luminaries as Ex-President Herbert Hoover, former Reclamation Chief Designing Engineer John L. Savage, and an exclusive number of other world renowned engineers.

Mr. Weiss obtained his technical training in the Colorado School of Mines, where he was graduated with the degree of engineer in 1899. He joined the U. S. Reclamation Service (now the Bureau of Reclamation) as assistant engineer in 1903 and conducted surveys on the North Platte project in Wyoming until the beginning of 1904 when he began reconnaissance surveys on the Salt River project in Arizona. He then returned to the North Platte project to direct the location and the construction of the first division of the Interstate Canal. He was subsequently promoted to the position of project manager on the North Platte in which capacity he supervised the construction and development of the Interstate Unit, which was later enlarged by the addition of the Fort Laramie Unit, comprising a total irrigable area of one quarter million acres.

In 1924 he became Assistant Director of Reclamation Economics and as a member of the Board of Surveys and Adjustments outlined the benefits of the Fact Finders Act to the various irrigation systems then in operation.

In 1926, following the passage by the Mexican Congress of a Reclamation law modeled after the United States Reclamation Act of June 1902, Mr. Weiss joined the J. G. White Engineering Corp. of New York which was employed to locate, plan, and construct irrigation projects in Mexico. Mr. Weiss took charge of the engineering and building of the Don Martin irrigation system, including a storage dam on the Salado River. He has been engaged in supervising reclamation construction activities in Mexico ever since, serving in many important consulting capacities throughout the ensuing years. ●

The coordinated plan for developing the resources of the Missouri Basin embraces an area more than 12 times the size of the Tennessee Valley Authority and 10 States will receive direct benefits from its features which comprise irrigation, flood control, power development, navigation, preservation of fish and wildlife and recreation.

REJUVENATING LEVELED LAND

After this large tractor and 12-cubic-yard "carry-all" have scraped the rich top soil from this Payette Division farm the big problem is restoring the productivity of the exposed subsoil. The magic of leveling and proper rejuvenation can be seen in the photograph at right. The land of C. W. Holmes on the Payette division of the Boise project was formerly a hilly terrain. Now, thanks to leveling, it has been transformed into uniform grades and length of rows suitable for irrigation. *Photos by Stanley Rasmussen, Region I.*

by C. D. BECHTOLT, County Agent, Canyon County, Idaho

For the farmer who is not just satisfied to "scrape along" on his farm, there is more to leveling irrigated land than just taking earth from a high point and dumping it in a low spot.

The most important step perhaps in the procedure of smoothing out the topography is to restore production in the area where the rich top soil has been removed by the scrapers.

Farmers on the Payette division of the Bosie project in southwestern Idaho have been doing an excellent job of quickly restoring the productivity of the land laid bare by the big earth-moving machines. The subsoil of several acres per farm has been exposed to depths of more than 2 feet in this new irrigated area. What the settlers have learned may be of real value to farmers on other projects who face the same leveling problems.

Let's start at the beginning.

The use of heavy earth-moving equipment in wartime construction emphasized the possibilities of using such machinery in leveling land on the Payette division. With the slackening of war construction late in 1944, some of the equipment became available and during the succeeding 3 years, approximately 6,000 acres, embracing 250 farms, were leveled. As assistant county agent in the area, the author prepared plans and assisted in establishing grades for this development work.

Farmers on the Payette wanted the land leveled for three principal reasons. First, the new grades improved irrigation by saving water and reducing soil washing, and saved manpower at a time when laborers experienced in irrigation were scarce. Secondly, the leveling provided field lay-outs for the farm. And third, the leveled land improved the appearance of the farm and enhanced its value.

From the outset it was apparent that farmers would have to face the problem of restoring or building up the fertility of the scraped areas. The extension service of the University of Idaho contributed materially toward the solution of the problem. We sent them soil samples from several farms on the division on which leveling operations had been completed. Samples were taken at various depths from areas which had been scraped and also of the virgin soil in the undisturbed areas on the same farm. The exposed subsoil samples were obtained from the scraped areas at various levels up to 8 feet in depth.

The university's analysis showed that the subsoil samples were quite similar regardless of the depth from which they were taken. This meant that regardless of the amount of earth removed, one recommended remedy could restore the soil's weakened fertility.

It was learned, as was expected, that the subsoils were without organic matter and carried little more than a trace of nitrogen. They showed a deficiency of available phosphate. Potash was found to be adequate. The calcium content was quite high. On one or two farms sodium was present in quantities sufficient to warrant consideration.

From the information obtained, restorative practices were determined. It may seem that the recommended restorative practices adopted are too simple, but proof of the pudding is in the eating—they have brought about highly desirable results.

In the exposed subsoil, the humus content must first be built up through the addition of organic matter. Barnyard manure is preferable for this purpose, and the desired rate is 15 or more tons per acre. Unfortunately, it is often not available on new land in sufficient quantities. However, organic matter can be added by applying clover chaff, pea, bean, or grain straw at the rate of 1 or 2 tons per acre, supplemented with 40 to 80 pounds of available nitrogen from either ammonium sulphate or nitrate fertilizer. The nitrogen is added to insure the break-down of the chaff or straw and to provide an adequate supply of nitrogen for the succeeding crop.

The phosphate deficiency of the exposed soil is easily remedied by the application of enough superphosphate to supply a minimum of 80 pounds of available phosphoric acid.

The cropping procedure may be varied. A common practice has been to plant grain as a nurse crop for alfalfa and then turn it over as a green manure the year following the seeding. Huban annual sweet clover has also proven satisfactory when seeded in grain and turned under in the early blossom stage. The green manure adds the much-needed humus and also builds up the supply of available nitrogen.

Attempts to crop scraped areas without following the above procedure were made on the Payette division but these proved futile. Without treatment the sterile subsoil will not produce sufficient growth in even a green manure legume crop to be of value.

Another practice that has come into use and has proven effective is to follow the leveling operation by deep subsoiling to a depth of 24 to 30 inches. This practice developed as the result of a difficulty in the leveling operations. Much of the subsoil of the division is so hard that it is impossible to load a carry-all scraper regardless of its size or the power used. When the operator first encountered this condition, he had to resort to the use of a "ripper" to break the hard layer in order to load his machine.

A farmer named E. M. Carter watched this operation and felt it had possibilities beyond the immediate task of loading a scraper. He had the entire scraped area on his farm "ripped." This thoroughly broke the hard layer, permitting aeration, water infiltration, and root penetration so necessary for good plant growth. It is a good practice for a hard impervious subsoil near the surface.

In preparing this article for the Era, the author visited several farms where heavy leveling had been done in 1945. He got a first-hand reaction of the owner-operators toward leveling and restoring land to production. All were enthusiastic.

One of those visited was Roy Miller, who has a farm 3 miles east of Parma, Idaho. In March 1945, he hired heavy equipment to level a small area that his farm equipment was unable to handle. A maximum cut of 4 feet was made. Following the leveling operation the cut and scraped area was "ripped." Barnyard manure was applied at the rate of 20 loads per acre, and worked into the surface. The entire field, including both the scraped and virgin soil, was spring seeded to alfalfa with wheat as a nurse crop. The wheat yielded 38 bushels—a good yield for new land. The alfalfa stand was considered to be excellent, with two cuttings made for hay in 1946. The third crop of alfalfa was plowed under early in September 1946 when it had reached a height of over 30 inches.

Succeeding crops on the scraped area could not be distinguished in productivity from those on the adjoining soil that had not been scraped. Since the initial leveling, other fields on the Miller farm have been leveled with heavy equipment. The work eliminated a deep native gully and provided uniform grades and length of runs for irrigation water. There was no apparent injury to production after the second year.

Frank Schlegel, who is Miller's neighbor, also has had considerable leveling work done. He reports that he can see no difference between the production of his leveled land and crops grown on the land that was not leveled. The leveling reduced the number of corrugations necessary for irrigation by two-thirds. Soil washing was eliminated by converting three steep slopes into one uniform gradient through leveling off a long narrow ridge. This also eliminated a field ditch and its waste area. Schlegel says that the cost of the operation and restoring the fertility has already been more than offset by the saving of labor, water, and soil. The gains from the leveling from now on are net profit, he figures.

Many other satisfied settlers similar to Miller and Schlegel can be found in the new land area. The End

Artist's conception of Heart Butte Dam, N. Dak., by M. H. Willson.

Heart Butte

Irrigation Pilot Plant for North Dakota

by Bruce Johnson, Acting District Manager, Missouri-Souris District, Region VI, Bureau of Reclamation

THE HEART DIVISION of the Missouri River Basin project is a small package containing full-strength samples of nearly all the problems and all the high hopes of water resource development along this northeast frontier of Reclamation activities.

Here in southwestern North Dakota, Heart River, an unruly minor western tributary of the Missouri River, is today being harnessed and put to work—to the general benefit of the country and to serve as a trail-blazer for a huge program of river development in North Dakota. Heart Butte Dam—an earth-fill structure 125 feet high—located midway between Mandan and Dickinson will be the key structure of the division. Construction of Heart Butte Dam began in March 1948 and conservation of water should begin with the storage of spring floods in 1950. This dam will substantially remove the annual flood threat from the lower Heart River and will provide a regulated water supply for irrigation. The 13,180 acres of irrigable land, in 49 separate tracts, lie along the 65 miles of meandering river between the dam and the Missouri River at Mandan.

Construction of Heart Butte Dam comes as a climax to over 40 years of sporadic investigation. The green light came in the Flood Control Act of 1944 which authorized construction of initial units of the Missouri River Basin project—among them the Heart division.

The Missouri Basin plan was born of drought and flood. The experience of the Heart River Valley with these destructive partners was typical of the violent climatic history of

the entire Missouri Basin. Dry years had followed wet years unpredictably here since earliest recorded times. A precarious dry-farm economy had taken root and reached its greatest growth in the early 1920's. Dust storm and searing wind, and years of watching an unrelenting sky for rain during the decade of the 30's left this economy bankrupt. Cattle were slaughtered as the native grasses disappeared, people migrated and farms were abandoned, while cities and towns stagnated. Huge sums of Federal money were poured into this new desert in a holding action against catastrophe. In 1941 and 1942, the rains returned, grass reappeared on the prairie, and the survivors of the drought began to rebuild.

The summer of 1943 supplied emphatic evidence that a wet cycle had arrived. The Missouri lowlands were devastated by three major floods that summer. A February blizzard piled 15 inches of soft snow on the icy uplands of the Heart River Basin and a week of warm weather in March sent this stream out of its banks. Cropland was flooded and covered with sand. Mandan, a city of 6,000 people near the mouth of the Heart, gave up a futile fight to hold the river behind its levees and evacuated a large part of the town. Mandan suffered a million dollar loss and east-west transcontinental rail and highway traffic was blocked for nearly two weeks. Spring floods have swept down the Heart River each year since 1943. Each year, also, the sandy soils of the Heart River flood plain need additional water for full crop production—even during a wet cycle.

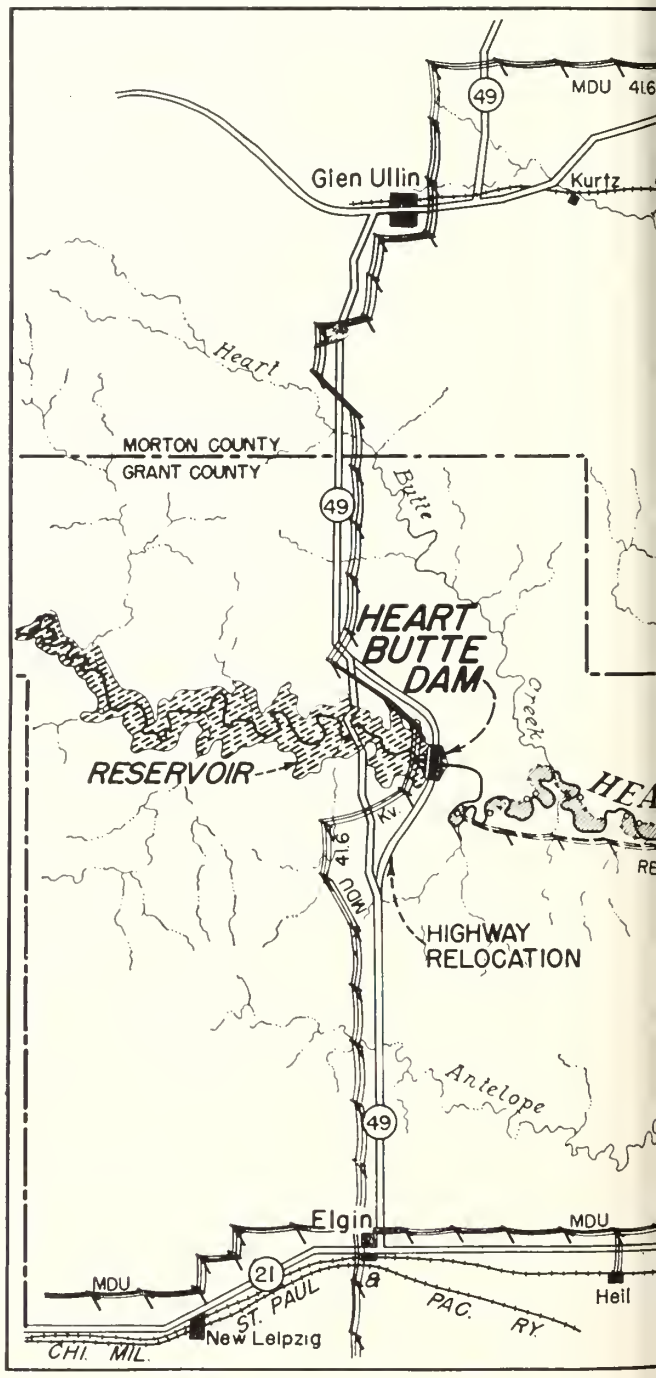
In 1944, upon authorization of the Missouri River Basin project, a committee of local residents began the organization of an irrigation district on the lower Heart River. Farmers were unfamiliar with irrigation and several excursions were made by farm groups to the lower Yellowstone Reclamation project, the closest comparable area where irrigated farming could be observed. An election was held in the fall of 1946 and the Heart River irrigation district was formed with a favorable vote of 144 to 46. Negotiation of a repayment contract is now practically complete after 2 years of painstaking discussion.

The construction schedule for Heart Butte Dam calls for storage of water in the spring of 1950 and it is planned that a few of the pumping plants will be completed so that water can be utilized as soon as power is available. The Heart River Channel will function as a main canal for irrigation, and pumps will be located along its banks to serve as turnouts to irrigated land. Each pumping tract is separated from neighboring tracts by steep bluffs which rise nearly 200 feet to the rolling uplands of western North Dakota. Tracts range in size from 35 acres to 2,500 acres.

Power for irrigation pumping and for lighting farm homes in the valley will come from Fork Peck initially and later from a large hydroelectric plant soon to be constructed at Garrison Dam on the Missouri River about 50 miles north of Mandan. Low-cost power for pumping was the key which solved the riddle of Heart River irrigaton. Early studies had indicated, in every case, that it was too costly to operate a long string of small pumping plants while paying for power at commercial rates. Present estimates are that pumping power will cost the irrigators about one-fourth of a cent per kilowatt-hour. On the Heart River, this amounts to something less than 1 cent per acre per foot of lift, or—on the average—about 20 cents per acre per year.

The main construction contract for Heart Butte Dam was awarded to Lytle & Green Construction Co. of Des Moines, Iowa, in December 1947. Work at the site commenced in March of 1948. The past construction season has been used in preparing the site, excavating and backfilling the cut-off trench, and constructing the "glory-hole" type spillway and outlet works. During 1949, it is planned that the dam will be raised to full height and work under the contract will be substantially completed.

Heart Butte Reservoir will provide 70,000 acre-feet of storage at full conservation pool, with 358,000 acre-feet of flood control storage in reserve. The spillway will consist of a concrete tube, 14 feet in diameter, with a riser or "glory-

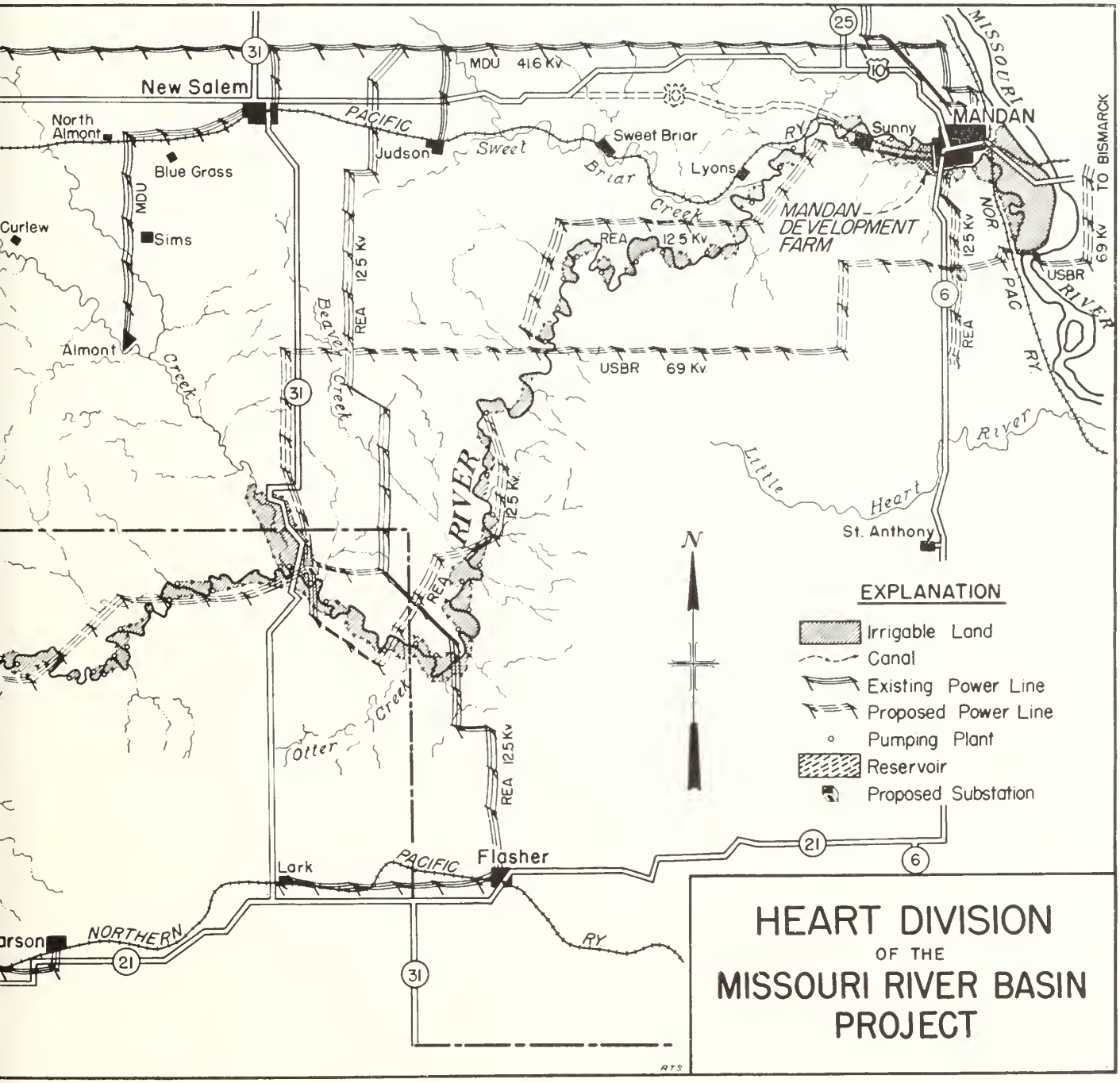


hole" intake on the upstream slope of the dam. No gates are provided for the spillway but the discharge will be limited to about 5,500 cubic feet per second. This spillway would have reduced flows past the damsite in the flood of 1943 to about 25 percent of their natural peak. In addition, such flows as passed the structure would have been delayed while runoff from the lower reaches of the Heart River was passing the critical area around Mandan.

Releases for irrigation will be made through two 3½- by 3½-foot slide gates, and a tube 5¼ feet in diameter, built so that it is tied in with the spillway conduit. These releases will pass directly into the Heart River to be recovered by pumping plants as required.

The Heart division will be rounded out by a smaller water control development at Dickinson, N. Dak. Here a dam, 69 feet above the lowest foundation, will store 7,000 acre-feet of water for municipal and irrigation use. Dickinson Dam will remedy a dangerous water-supply shortage for the 6,000 residents of Dickinson and will serve 1,000 acres of pump irrigation lying in 7 tracts around and immediately below the reservoir. Dickinson Reservoir is also an important part of recreational-development plans now being formulated by the city and the National Park Service. Construction of this dam is scheduled to begin next spring.

Construction Engineer W. W. Brenner is in charge of all Heart River construction activity. His office and the construction camp for Heart Butte Dam are located at Glen Ullin, 15 miles north of Heart Butte Damsite. Construction Engineer Charles Whipple, located at Dickinson, is resident engineer for Dickinson Dam. THE END.



Budget Recommendations for Fiscal Year 1950

President Harry S. Truman submitted to the Congress of the United States on January 3, 1949, a budget totaling $379,593,500 for the Bureau of Reclamation covering fiscal year of 1950 (July 1, 1949, through June 30, 1950). This is almost 100 million more than his recommendation for last year ($283,932,650). A detailed account of the recommended 1950 fiscal year budget appears below.

The language changes requested in the 1949 Appropriation Act were as follows: (1) to remove the limitation which stipulated that not more than $48,000,000 could be spent for personal services, (2) remove the clause limiting to 8 percent the amount of money which can be spent for force account or hired labor except for projects or items costing $200,000 or less, and this exception would apply only if the Bureau finds the lowest bid to be excessive, (3) remove the language which stipulates that not more than $7,800,000 may be transferred to the 1949 appropriation from other appropriations, and (4) to remove the limitation which held that not more than 3,500 persons could be employed by the Bureau in Grades CAF–9, P–3, and above.

BUREAU OF RECLAMATION

Supplemental Estimates of Appropriation, Fiscal Year 1949

(Submitted to Congress by the President on January 25, 1949)

Item	*Amount*
Reclamation fund, special fund:	
Salaries and expenses	$260,000
Operation and maintenance:	
Power revenues:	
Colorado-Big Thompson project, Colorado	52,000
North Platte project, Nebraska	17,500
Kendrick project, Wyoming	131,000
Construction:	
Boise project, Idaho, Payette division	275,000
Lewiston Orchards project, Idaho	350,000
Provo River project, Utah (including $215,000 to fund contract authorization included in Interior Department Appropriation Act in 1948)	500,000
Emergency fund	1,000,000
Total, Reclamation fund, special fund	2,585,500
General Fund, Construction:	
Davis Dam project, Arizona-Nevada	5,000,000
Colorado-Big Thompson project, Colorado	2,000,000
Columbia Basin project, Washington	5,000,000
Missouri River Basin	5,100,000
Total, general fund, construction	17,100,000
Grand total	19,685,500

BUREAU OF RECLAMATION

Appropriation Requests—Regular Annual Appropriation Act, 1950 (Exclusive of Trust Funds)

State	Project	Recommended by the President
Reclamation fund, special fund:		
Salaries and expenses		$5,000,000
General investigations		3,600,000
Advance planning: Washington.	Yakima—Kennewick division	50,000
Construction:		
California	Santa Barbara—Cachuma unit	6,100,000
Idaho	Boise—Anderson ranch	1,932,000
	Boise—Payette	2,725,000
	Lewiston Orchards	270,000
	Palisades	205,000
Montana	Milk River—Fresno Dam	71,500
New Mexico	Tucumcari	685,000
New Mexico-Texas	Rio Grande	20,000
Oklahoma	W. C. Austin	300,000
Oregon	Deschutes	180,000
	Deschutes—Arnold irrigation district	38,000
	Deschutes—Ochoco Dam	1,150,000
Oregon-California	Klamath	1,000,000
Utah	Ogden River	285,000
	Provo River	4,000,000
Washington	Yakima—Roza division	449,955
Wyoming	Kendrick	1,680,000
	Riverton	2,731,000
	Shoshone	140,000
Subtotal, reclamation fund, construction.		23,962,455
Operation and maintenance:		
Arizona-California	Parker Dam Power—power revenues	3,369,200
	Yuma—Direct Appropriation	150,000
	Yuma—power revenues	35,000
California	Central Valley—direct appropriation	392,200
	Central Valley—power revenues	1,108,400
Colorado	Colorado-Big Thompson—power revenues	437,150
Idaho	Boise—direct appropriation	350,000
	Minidoka—direct appropriation	45,000
	Minidoka—power revenues	445,000
Nebraska	Mirage Flats—direct appropriation	24,000
Nebraska-Wyoming	North Platte—power revenues	330,500
New Mexico-Texas	Rio Grande—power revenues	419,700
Oregon	Deschutes—direct appropriation	172,000
Oregon-California	Klamath—direct appropriation	303,000
Oregon-Idaho	Owyhee—direct appropriation	370,000
Washington	Columbia Basin—power revenues	2,190,000
	Yakima—direct appropriation	441,000
	Yakima—power revenues	25,000
Wyoming	Kendrick—power revenues	640,500
	Riverton—direct appropriation	185,000
	Riverton—power revenue	112,000
	Shoshone—direct appropriation	101,100
	Shoshone—power revenues	211,295
Subtotal, operation and maintenance, direct appropriation (irrigation).		2,533,300
Reclamation fund, special fund—Continued		
Operation and maintenance—Continued		
Subtotal, operation and maintenance, power revenues.		$9,323,745
Total, operation and maintenance.		11,857,045
Total, Reclamation funds, special fund (includes appropriations from power revenues).		44,469,500
General fund:		
Alaskan investigations		250,000
Construction:		
Arizona	Gila	5,000,000
Arizona-Nevada	Davis Dam	38,739,000
Arizona-California	Parker Dam power	138,000
	All-American Canal	6,000,000
Arizona-Nevada	Boulder Canyon	7,500,000
California	Central Valley	63,000,000
Colorado	Colorado-Big Thompson	21,500,000
Montana	Fort Peck	3,000,000
	Hungry Horse	24,000,000
Washington	Columbia Basin	69,500,000
Arizona-Nevada-California.	Colorado River front work and levee system	970,000
Various	Missouri River Basin	87,150,000
Subtotal, general fund, construction.		326,497,000
Total, general fund		326,747,000
Colorado River Dam Fund:		
Arizona-Nevada	Boulder Canyon project (operation and maintenance).	1,612,000
Various	Colorado River development fund (expenditure account).	500,000
Total, general and special funds (includes appropriation from power revenues).		373,328,500
Permanent appropriations		6,265,000
Grand total, all accounts (includes appropriation from power revenues).		379,593,500

DESERT CAVALCADE

by OLE J. NORDLAND, Managing Editor, *The Date Palm*, Indio, California

Aerial view of All-American Canal desilting works. *Photo by Harry Myers, Region III.*

Amazing as the chapters of California's 100-year-old history have been, one of its first bright stars is the adventure story of Imperial Valley and its reclamation.

The Tenth Annual International Desert Cavalcade, March 17, 18, and 19, at Calexico presents the saga of 175 years in vivid pageantry and historical fact.

This year the border city's pageant achieves new heights in historic importance, narrating and portraying it as it does, not only early California history but the story of modern reclamation of the great Southwest.

Interesting in the light of California's State Centennial celebration, is the fact that 1949 is the centennial, also, of the first conception of California irrigation from the turgid Colorado as practiced today.

The International Desert Cavalcade of Imperial Valley is a home-developed fastival, directed and conducted by the citizens themselves with no flamboyant Hollywood stagings.

Through gorgeous pageantry and equipage it has revived and dramatized the struggle of courageous men and women, reaching back through the pages of history to Capt. Juan Bautista de Anza, the Spanish explorer who opened a new overland route to the mission of Monterey. There is Dr. Oliver Meredith Wozencraft, who crossed the "Great American Desert" in 1849 and became imbued with the belief that the desert could be irrigated from the untapped Colorado River. The pageant recalls the time the first Imperial Canal through Mexico brought the water to the fertile but thirsty soil. Passing in review are the pioneers who leveled the acres and wrested the land from the desert. Also chronicled are the efforts to conquer the river which in 1905 broke the dikes and traveled the earthen canal to spill into the Salton Sink, over 200 feet below sea level, and form the huge, inland Salton Sea. The building of Hoover Dam, the All-American Canal and the system of river dams—all of these events and more are relived in the moving pageant presented two nights during the cavalcade at Calexico.

The cavalcade also presents on the closing day a glittering parade of early day surreys, stage coaches and other vehicles, farming equipment, Indians, Spanish conquistadores, dancing señoritas, singing Mariachis (troubadors), the resplendent Marine Corps band, fezzed and famous Shrine band, high-stepping majorettes from Imperial Valley high schools, a modern sheriff's posse, all led by the border citizen portraying Captain de Anza mounted on his caparisoned white horse.

In 1948 nearly 10,000 people lined the streets of Calexico in California and Mexicali in Mexico to view the array that moved across the border and through the streets of the twin cities.

Here each year at cavalcade time is a display of international amity and good will that might well serve example to people and governments in restless Europe. They could learn much by seating themselves at the annual Governor's banquet at which Governor Alfonse Garcia Gonzales of the Northern Territory of Baja California (Mexico) is seated with Gov. Earl Warren of California (U. S. A.), flanked by emissaries and dignitaries of the States of Arizona and Sonora and the sovereign Nations of the United States and Mexico.

But this formal dinner is not the only demonstration that marks this pageant as an outstanding event. The 3-day program is launched by another hands-across-the-border display when more than 3,000 school children of the two cities join to parade in gay, brilliant costumes. Chuck wagon breakfast, Mexican cenas, a grand costume ball and western dances complete the program.

The pageant itself is fittingly presented in a barranca which has its setting on the international boundary line. In the barranca, full use of the natural terrain and landscape has been employed to present a moving drama of the history of this area which has Signal Mountain as its backdrop.

Flood and spot lights bring the amateur actors, citizens of both sides of the border, and the events of history into focus while a narrator tells the story of the desert, its first conqueror in Captain de Anza, and closes with the promise of a boundless future because of the reclamation of the arid wastes to a cultivated, agricultural empire producing nearly 100 billion dollars in crops and produce.

While de Anza's expedition of 1774 was exploratory, seeking to locate and open the first overland route in history into California, colonists on the East coast were rising in rebellion against the tyranny of the English king.

De Anza crossed the desert on a forced march from Tubac, a few miles north of the present Arizona-Sonora border, to Monterey, Calif., in the area of Signal Mountain and his trail from Yuma might well have been across the very spot where the colorful pageant narrates and records his ventures.

The second Anza trek, in 1775–76, was for the purpose of colonizing Yerba Buena, later San Francisco.

Back of de Anza's explorations were two causes: King Carlos III of Spain feared Russia intended to extend southward from Alaska and he wanted a route from New Spain for colonization. Father Junipero Serra's missions at San Diego and Monterey, theretofore supplied entirely by sea routes, were in danger of extinction and also needed this route.

The desert became a highway frequented by trappers and prospectors. Gen. S. W. Kearny's Army of the West, marched across it in November 1846 to establish a garrison at San Diego. The pages of California and Imperial Valley history next remark the crossing by the famed and dogged Mormon Battalion led by Col. Philip St. George Cooke, with the first wheeled vehicles to bite into the wasteland, to make a historic trek from Council Bluffs, Iowa, to Santa Fe, N. Mex., and thence to San Diego, Calif.

The discovery of gold in 1848 brought a tide of adventurers estimated at 10,000 crossing the Colorado River at Yuma. In July 1857 the San Antonio and San Diego mail line, the "Jackass Mail," spun its wheels across the still terrifying and death-claiming wastes. Then came the Butterfield Stages operating from San Francisco to St. Louis, twice weekly. Finally, in 1879, the back of the desert's terrors was broken when the Southern Pacific Railroad connected Yuma with the Pacific coast.

Meanwhile a new chapter, the important chapter of reclamation also was being written.

Dr. Wozencraft, a New Orleans physician and an adventurer who joined the California gold rush, crossed the Colorado and the burning desert in 1849. He played an important part in the founding of the State of California as a member of the constitutional committee which drew up the State constitution. But he did not forget the desert and he devoted his life to the idea that it could be irrigated from the Colorado. California, in 1859, granted him lands to which he could bring water but his legislative battles, carried on in Congress until 1887, failed and he died in the Nation's capital that year.

New names entered the flicking pages of history—Charles Robinson Rockwood, an engineer; Dr. W. T. Hefferman, physician who poured his personal resources into the dream; A. H. Heber, L. M. Holt, George Chaffey, and others.

In 1901 the dream became a reality. In May the first water was turned into the canal near Pilot Knob, to wind its way through northern Baja California, and to re-enter the United States with its life giving flow. The valley began filling with settlers.

Because drought years depleted the river's flow; because at flood stages the river inundated the valley; because the canal was built south of the international boundary and the farmers were dependent on Mexico, citizens appealed to Congress and the Bureau of Reclamation for aid in remedying these problems. The apparent solution was a series of dams on the Colorado River to control floods and store them for year-round irrigation downstream. In addition, a canal built entirely within the United States was needed to deliver the precious water to Imperial Valley.

The Bureau spent approximately $400,000 between 1919 and 1928 to investigate river dam sites and controls as well

Below: Captain Juan Bautista de Anza is portrayed by a Calexico citizen during the Cavalcade. Immediate right: Surrey With a Fringe on Top is removed from the mothballs to lend color to the gala affair. Bottom right: This Mexican carreta, featured annually in the parade, played its part in winning over the wastes to fertile agricultural production. ***All photos courtesy of P. Padilla Photographers, Calexico, Calif.***

as the location of a canal on the American side of the boundary line.

In 1928 the fight for the Boulder Canyon Project Act and the All-American Canal was won in Congress. In June 1929, after all States involved in the project, except Arizona, had ratified the Colorado River Compact, the act was made effective by President Herbert Hoover's proclamation.

The building of Hoover Dam, 1931–36, will go down in history as one of the world's engineering feats. Hoover Dam, located in Black Canyon, some 300 miles north of the Mexican border, furnishes the major control of the river for downstream irrigation and power developments. Parker Dam, 147 miles downstream; Imperial Dam, about 125 miles below Parker Dam, and the All-American Canal were started around the middle 1930's and substantially completed by 1940. Parker Dam adds further refinement to the river's flow, generates power, and furnishes a reservoir from which water is pumped through the 242-mile Colorado River Aqueduct to the southern California coastal region. Imperial Dam diverts water to Imperial Valley in California via the All-American Canal and to the Gila project in Arizona via the Gila Main Canal. Davis Dam, now under construction 67 miles below Hoover Dam, will further re-regulate the river's flow and generate power.

The All-American Canal, extending 80 miles from the Colorado to Imperial Valley, and the 124-mile branch to Coachella Valley, was begun in 1934. It was completed in October 1940 to Imperial Valley and to Coachella Valley last summer.

The International Desert Cavalcade depicts in one of its closing tableaus the joyous street scene on the border when the first water trickled over the headgate in 1901. A church congregation sings "Praise God From Whom All Blessings Flow," and a stirring promise of the desert's future is left with those who attend the pageant.

And the dream and its promise are exemplified by the actual irrigation of more than 400,000 acres. Imperial Valley produced nearly $90,000,000 in crops and livestock products in 1947 while Coachella Valley's 19,000 acres produced $13,000,000 using pump irrigation. Coachella Valley faces a bright future when an additional 70,000 acres are given supplemental water from the river.

The cavalcade of history that changed a sea bed and river's delta to a winter garden is indeed an amazing story of reclamation's magic.

The International Desert Cavalcade with its authenticity in immortalizing the pioneer courage and vision of those who brought water and civilization to the desert is one of the real community projects of rich human drama in the Southwest today. Certainly it tells a moving story of reclamation that fiction would never duplicate. THE END.

Early Irrigation in Salinas Valley, California

The following item is reprinted from the California Farm Reporter for the benefit of readers interested in the history of irrigation. Our appreciation goes to Editor Grace McDonald of the Reporter for this addition to research on the subject.

It was during the year 1898, one of the worst dry years known in the Salinas Valley, Calif., that irrigation was started. Portable steam pumps (centrifugal type) were set up on the river bed, water pumped up on to the banks and ditched to where needed. Alfalfa was then planted, providing practically a year-round forage crop.

At about the same time, irrigation was further expanded with the building of a canal, taking its water from the river opposite Camphora, and extending northward about nine miles to the southern boundary of the Jacks ranch with laterals serving adjoining areas.

The ever increasing drain upon the water resources of the river by use of power pumps, however, eventually brought the water level down until there was no longer sufficient volume to supply the canal and it had to be abandoned. By 1912, the total cost of constructing and maintaining this project was said to have been way out of proportion to the benefits received. However, irrigation by use of pumps continued to expand with corresponding increases in alfalfa production and dairy herds.

The peak of the dairy industry was reached about 1925 when there were about 60 dairies and about 6,000 cows in the Gonzales district. The Soledad, Mission, and Greenfield area combined had about the same number.

In 1925 the first experiments were made in lettuce production which proved successful as a field crop. In 1926 the acreage started to expand and other vegetable crops were planted, all proving successful. With two crops annually under favorable marketing conditions the returns seemed almost fabulous, sometimes producing as much as $500 per acre for a single crop which matured in from 90 to 120 days.

With these unprecedented returns from irrigated land under mass production and modern scientific farming methods the rental value of irrigated land began to soar. Where dairymen had been paying from $25 to $30 per acre annually, vegetable growers boosted the rental rate to $60 per acre, some even higher. The dairymen could not compete with these prices; in fact, many of them turned to vegetable producing, others quit dairying, rented their land to the vegetable producers, retired and moved to town to live, building their homes there.

¶ The Bureau has always recognized Brigham Young's and his Mormon followers' claim to be the "first" large scale Anglo-Saxon irrigationists in this country as a result of their having broken desert land in the Salt Lake Valley of Utah in 1847.

Previously the prehistoric Indians of the Southwest practiced irrigation and within the boundaries of the Casa Grande National Monument can be seen traces of their early irrigation ditches.

The early Spanish missionaries who came over the Mexican deserts into what is now the Western United States brought from their homes in the Mediterranean a knowledge of irrigation which they practiced in California, Arizona, New Mexico, and Texas.—Ed.

Harvesting carrots in Imperial Valley—Former desert waste is now land of plenty.
Photo by Harry W. Myers, Region III.

Congress Quizzes Reclamation

Nearly half a hundred United States Senators and Representatives from 17 Western States attended a series of conferences on the Reclamation program for fiscal year 1950 in the Secretary's Conference Room, Interior Building, during January. An additional 15 members of the Congress were represented at the conferences by members of their staffs.

The occasion for the conferences, arranged by Commissioner Michael W. Straus, who personally invited all members of Congress from the Western States to attend, was to invite them to ask questions on the Reclamation budget estimates for fiscal year 1950 approved by the President, or any other phases of the Reclamation program that might be brought up.

No holds were barred in questions, and favorable as well as unfavorable phases of the program were brought to light and analyzed. The difficulties confronting Reclamation during the fiscal year 1949 as a result of a personal services limitation of $48,000,000 inserted in the Interior Appropriation Act and other factors were aired. Particular concern was expressed at the inclusion in the limitation of "trust" funds advanced by water users for operation and maintenance of Reclamation projects and especially the maintenance of facilities.

Prospective legislative proposals having to do with liberalization of the repayment features of the Reclamation Law were brought out, and the importance of amendatory repayment contracts to be presented to the Congress at the current session was a lively subject. Proposals looking to additional nonreimbursable allocations in connection with the construction costs of Reclamation projects which will also be the subject of legislative proposals were mentioned.

The conferences were held as follows:

January 17—California delegation.

January 18—Washington, Oregon, Idaho, and western Montana delegations.

January 21—Missouri Basin, including delegations of Montana, North and South Dakota, Wyoming, Nebraska and Kansas, and eastern Colorado.

January 28—Colorado River and southwestern area, including delegations from Utah, Arizona, New Mexico, Nevada, Oklahoma, and Texas.

The Senators and Representatives present or represented are as follows:

Arizona: Senator Ernest W. McFarland; Representatives John R. Murdock and Harold A. Patten.

California: Senators Sheridan Downey—represented by Edwin W. Bates—and William F. Knowland—represented by George F. Wilson; Representatives John J. Allen, Jr., (7th District); Clyde Doyle (18th District); Chet Holifield (19th District); Leroy Johnson (3d District); George P. Miller (6th District); Clinton D. McKinnon (23d District); Norris Poulson (13th District); Hubert R. Scudder (1st District) and Cecil F. White (9th District).

Colorado: Senators Edwin C. Johnson—represented by Earl R. Howsam—and Eugene D. Millikin—represented by R. J. McNair; Representatives Wayne N. Aspinall (4th District); William S. Hill (2d District); John H. Marsalis (3d District), and John F. McCabe of this staff.

Idaho: Senators Glen H. Taylor and Bert H. Miller—represented by James Hawley; Representative John Sanborn.

Kansas: Senator Andrew F. Schoeppel and Representative Wint Smith (6th District).

Montana: Senators Zales H. Ecton and R. E. Bodley of his staff, and James E. Murray—represented by William H. Coburn; Representatives Wesley A. D'Ewart and Mike Mansfield.

Nebraska: Senator Hugh Butler—represented by Kirkley L. Coulter; Representatives Carl T. Curtis (1st District) and Dr. A. L. Miller (4th District).

Nevada: Senator George W. Malone—represented by John B. Crane.

New Mexico: Senators Clinton P. Anderson, and Claude E. Wood of his staff, as well as Dennis Chavez—represented by Frank Burnett; Representative Antonio M. Fernandez.

North Dakota: Senator Milton R. Young and Glen Martz of his staff; Representative Usher L. Burdick and Donnell Haugen of his staff.

Oklahoma: Representatives Tobey Morris (6th District); Victor Wickersham (7th District) and George Howard Wilson—represented by Russell Chapin (8th District).

Oregon: Senator Guy Cordon; Representatives Homer D. Angell (3d District); Harris Ellsworth (4th District), and Lowell Stockman (2d District).

South Dakota: Senators Karl E. Mundt, with W. O. O'Brien and R. L. McCaughey of his staff, and Chan Gurney represented by Bob Delany; Representatives Francis Case (2d District) and Harold O. Lovre (1st District).

Texas: Representatives Ken Regan (16th District) and Lloyd M. Bentsen, Jr. (15th District).

Utah: Senator Elbert D. Thomas—represented by Paul L. Badger; Representatives Mrs. Reva Beck Bosone—represented by Virginia Rishel; Walter K. Granger and Elva W. Bell of his staff.

Washington: Senators Warren G. Magnuson, with Irvin A. Hoff and Bill J. Golden of his staff, and Harry P. Cain—represented by Art Burgess; Representatives Hal Holmes (4th District); Walt Horan (5th District; Russell V. Mack (3d District), and Thor C. Tollefson (6th District).

Wyoming: Senators Lester C. Hunt and Joseph C. O'Mahoney—represented by Pat Flannery and Donald Luttrell; Representative Frank A. Barrett.

Elmer K. Nelson of the Staff of Senate Committee on Interior and Insular Affairs. ●

_____
(Date)

The Commissioner,
Bureau of Reclamation, United States Department of the Interior,
Washington 25, D. C.

Sir: Enclosed is a check, or money order (no stamps) made out to THE TREASURER OF THE UNITED STATES in the amount of _____ for a _____ year subscription to the Reclamation Era.

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MY FIRST VIEW OF RECLAMATION

or

Four Days With Our Natural Heritage in the Niobrara River Basin

by VERN P. LINDHOLM, Secretary-Treasurer, Niobrara River Basin Association

At top: Two of the "tourists" inspect the Dunlap Diversion Dam. The center photo shows the interest displayed by the party in the numerous stream gages along the Niobrara, and pictured at the bottom is the place where the river "turned over on its side for about 50 feet." Photos taken by Dr. Wendell L. Johnson, Aquatic Biologist in Charge, Fish and Wildlife Service, Grand Island, Nebr.

JOHN FORSYTH OF NIOBRARA, NEBR., STARTED IT ALL.

He is one of the unsung heroes of the present Missouri River Basin development and the Fort Randall Dam, and during the latter part of 1945 he started a chain of events by urging the people of the Niobrara area to investigate the possibilities for irrigation hereabouts.

Accordingly, Nebraska people met in Valentine, Nebr., January 16, 1946, with representatives of the Bureau of Reclamation and the Corps of Engineers. The Niobrara River Basin Development Association was then organized in May 1946 for the purpose of (quoting from its bylaws) "bringing about flood control, irrigation, soil conservation, hydroelectric power, greater recreation and preservation of game and wildlife, and making the valley a better place in which to work and live."

Three men from each of the 11 counties within the basin were appointed as directors and from this body Dr. R. R. Brady of Ainsworth was elected president, Col. Joe Leedom of Gordon as vice president, and Mr. Paul Schneider of Ainsworth as secretary-treasurer.

At the annual meeting of the directors in July of 1947, Mr. E. A. House of Ainsworth (who had been in on the plans from the beginning) was elected president, Joe Leedom was reelected as vice president, and I was made secretary-treasurer.

Since the initiation of this association many a long step has been taken toward the development of a multiple purpose project in the Niobrara Basin. The association has worked "on a shoestring" and mostly on the time and at the expense of its officers and directors. The Basin has been surveyed and studied by the Bureau of Reclamation, the Army Engineers, Geological Survey, Weather Bureau, and others.

Last spring we took a tour of the area.

Ernie (E. A.) House and I were picked up Monday afternoon, May 10, 1948, by the man who is the hub around which this entire project revolves—Mr. Clyde Burdick, Area Engineer of the Bureau of Reclamation who has his headquarters at Ainsworth. We stayed at Chadron Monday night so we could get an early start and meet the rest of the men the next morning at the Box Butte Reservoir—on the Mirage Flats project in Nebraska—about a 35-mile drive from Chadron. The reservoir is about 12 miles east of Marsland, Nebr., on the Niobrara River.

The party met at 9 a. m. From the Bureau of Reclamation's Region VII office in Denver, Colo., were John T. Maletic, Reclamation economist and Ted R. Swem, administrative assistant of the Branch of Operation and Maintenance. The Nebraska Game Commission was represented by Lloyd P. Vance, supervisor of game, from Lincoln, Nebr. Missouri Basin interests were taken care of by the presence of Dr. Leo T. Murray, leader of project investigation, Missouri River Basin Studies, of Billings, Mont. The United States Fish and Wildlife Service sent quite a delegation, consisting of Francis Gillette, regional supervisor of Minneapolis, Minn.; Dr. Wendell L. Johnson, aquatic biologist in charge, and Biologist Goodman K. Larson of Grand Island, Nebr.; Louis Hatch, refuge manager, Oshkosh, Nebr.; and Edmund L. Dolling, hydraulic engineer from Billings, Mont.

Among men of this caliber, I felt rather reluctant to ask any questions, but despite my fear of appearing stupid, I asked questions anyway and received very courteous answers in words which I could understand.

We were standing at the downstream face of the dam looking west and saw a large earth dam stretched out before us about a mile long and 87 feet high. A small concrete structure stands on top of the dam a little less than a quarter-mile from the north end. This houses the controls for the outlet works which were seen as a concrete ditch at the foot of the dam. Finally we noticed the vegetation on the banks of the dam. It looked like a field where strip cropping is practiced. I was told that the Bureau of Reclamation was experimenting with different methods of "facing" material and found that wheat grass proved most successful on this particular dam. They even had a strip of blacktop such as we have on

many miles of our Nebraska roads. However, just like the roads, it cracked.

We drove up on the north side of the dam and as we reached the top, I couldn't believe my eyes. Water! About 1,700 acres of it—using technical terms, about 32,000 acre-feet, which means enough water to cover 32,000 acres 1 foot deep. The reservoir extended back about 4 or 5 miles with a shoreline as crooked as a corkscrew, due to the fact that this body of water was poured right in the middle of the sandhills. A two-lane, lime-rock road has been built on top stretching across the full length of the dam. The upstream face of the dam is lined with what they call "rip-rap." Right down in front of us was the overflow—so smooth and steady that it seemed a part of the structure.

To the right of us was the emergency spillway. This structure is so simple but so clever that it warrants a little explanation. There were about 10 concrete walls approximately 15 feet long parallel to each other across the spillway. They were about 25 feet apart with earth structure between. The earth bank between the concrete walls was graduated in height. In other words, it looked like a low angle stairway. In case of high waters the lowest section would go out first, then the next section, and so on, until the entire dyke would be worn away if the water got high enough. However, if a relatively small amount of high water occurred, only one section, or possibly two, would have to be replaced. That is only a minute example of the engineering efficiency of the Bureau of Reclamation and was obvious even to me!

To the left and below was the concrete spillway ditch forking with the overflow ditch and pouring out into the natural river bed, carrying the water that would end up on the fertile fields of Mirage Flats some 18 or 20 miles downstream (northeast) of the dam. During a normal season the Mirage Flats would use about 25,000 acre-feet of water, so with 32,000 acre-feet in the reservoir those farmers don't have to worry about water when they need it.

We drove to where the Niobrara emptied into the reservoir and it surprised me when I suddenly realized that a stream approximately 10 feet wide could fill a 32,000-acre-foot reservoir within one season. Clyde Burdick said the river had 45 second-foot flow at this point which means 45 cubic feet of water every second. This made it easier for me to understand how the reservoir could fill up so fast. Stream gages were placed at the point of inflow and outflow of the reservoir so that an accurate record could be kept of information such as seepage in the dam, evaporation, etc.

The fellows got in a huddle and discussed some of the problems resulting from the construction of such a project and how the different agencies could attempt to overcome these problems in a cooperative and coordinated manner. Ted Swem explained that one of the Bureau of Reclamation's outstanding problems was that of controlling the areas surrounding such reservoirs so that they would be suitable for wildlife and recreation. It was very noticeable throughout the entire trip that the agencies which these men represented were determined to see that the public received the maximum benefits from these projects not only from the standpoint of irrigation, but recreatiton and wildlife. After all, they reasoned, the tax payers paid for the project and should receive all the benefits possible from it.

John Maletic also explained the problem of silt infiltration from blowouts. For those of you who are not familiar with the sand hills, a blowout is where the grass has been killed by cattle trails, over-grazing, wind erosion, or other causes, and the wind blows the sand until eventually there is a large hole. The sand blowing from these holes adjacent to the reservoir adds to the silt problem. It is surprising how much silt is carried by a stream, and I had no difficulty in realizing the fact that thousands of acres of our land flows into the Pacific and Atlantic every day.

From the Box Butte Reservoir we drove downstream (east) about 6 or 7 miles to what they call the Dunlap Diversion Dam. This is a small dam where they divert the water from the river into the main canal for the Mirage Flats area.

Down the canal about 200 feet from the Dunlap Diversion Dam is a large Parshall flume—a concrete structure through which the water flows and is measured in second-feet.

A few rods down the canal I saw something hard to believe—the canal ran under a creek bed and came up the other bank! My matter-of-fact friends called this engineering feat a siphon. When the Bureau of Reclamation made this canal, which runs about 12 or 14 miles through the sand hills from the Dunlap diversion dam to Mirage Flats, a road was constructed on the one bank to be used in "riding the ditch" (inspecting). As we drove along the ditch I knew it was only an illusion that the water was running uphill. But in the heart of the sand hills we came to a large canyon about 1, 600 feet across, at the bank of which the ditch disappeared into a siphon 8 feet in diameter. It seemed as though the canal vanished and the water was being miraculously and invisibly transferred to the other side of this canyon. There was a small "blow off' in the bottom of the canyon so the siphon could be drained if desired. We had to speed up the cars to make the steep grade on the other side—and there was the canal and the water. It was hard to believe, but I saw it with my own eyes. It completely eradicated my preconceived idea that water does not flow up-hill. We crossed about four more of those canyons before reaching the flats.

When we reached the Mirage Flats it was like stepping from one room to another. All of a sudden we were torn loose from the sand hills and placed in the center of a flat fertile farming area. The first thing that attracted our attention was the obvious economic stability existing in this area as reflected in the neat and comfortable farm buildings.

We visited Mr. Fred C. Krauss, Bureau superintendent of the Mirage Flats project, who told us this project was started in 1940 under the Water Conservation and Utilization Act of 1939. The agencies involved in this project were the Bureau of Reclamation, WPA, CCC, and Farm Security Administration. Work ceased in 1942 and was again started in 1944. The first water reached the project in 1946 and 2,000 acres were irrigated that year. Eight thousand acres were irrigated in 1947 and 10,000 in 1948. The entire project, to amount to 12,000 acres, was divided into units averaging 91 acres each. To date about 55 percent of the units have been sold. Excellent records have been kept by all of the farmers and the average gross profit of all operating units in 1947 was $44 per acre. We continued to inspect the entire flat with Fred as a guide.

On Wednesday morning as we left Hay Springs (about 5 miles north of Mirage Flats) it was impossible to overlook the progress that little city was making as a result of irrigation. It was buzzing with activity. New business houses had been or were being erected. Even the merchants were sponsoring a daily broadcast over the Rapid City station to advertise their places of business—and this was all a result of a comparatively small irrigated area of 10,000 acres.

We then proceeded to Lavaca Flats, about 10 miles southeast of Gordon where Antelope Creek empties into the Niobrara. Lavaca Flats consists of an approximately 6,000-acre tract which is still under survey and study by the Bureau of Reclamation to determine its feasibility for reclamation. We then drove to Boiling Springs Flats about 7 miles south of Cody where Bear Creek empties into the Niobrara. Boiling Springs Flats consists of about 6,000 acres, split in half by the river. As we drove south from Cody, I wondered if Clyde hadn't become a little mixed up. I could not visualize any irrigable land in this area. Just as I was about to mention that fact we dropped down to the river, passing through a beautiful little valley. The river at this point was about 60 feet wide. Then as we reached the top

(Continued on Page 72)

Water Users and Bureau Officials Meet

Programs for full utilization of project land-water resources and problems of operation and maintenance were reviewed by representatives of nine federally constructed reclamation projects in Montana, North Dakota, and Wyoming at a meeting with Bureau of Reclamation staff members January 18 and 19 in Billings, Mont. This conference of officials of operating Reclamation projects is part of a continuing program for more effective relations with the Bureau.

Reclamation projects represented at the conference included Milk River and Sun River in northern Montana; Huntley, Buffalo Rapids First and Second Division and Lower Yellowstone in eastern Montana; Buford-Trenton in western North Dakota, and Shoshone and Riverton projects in northwestern and central Wyoming. Representatives of the Belle Fourche project in western South Dakota were not able to attend because of heavy snow on the highways. All the reclamation projects are in the Bureau's Region VI.

In his summation, E. F. Landerholm of Billings, supervisor of the Bureau's regional branch of operation and maintenance and chairman of the meeting, explained that although all the problems discussed had not been solved, they had been brought to the attention of the assembly and considered by the water users and the Bureau of Reclamation. "It is realized," Mr. Landerholm said, "that the Bureau can succeed in its work only to the same degree that the water users are successful on their projects."

C. L. Bailey of Fairfield, Mont., superintendent of the Sun River project, reported that one of the most important qualifications of a project superintendent or manager is an inquisitive nature that will lead him to keep abreast with the many problems, major and minor, that exist on any irrigation project.

He further explained that because of the many regulations governing the actions of the Federal government, operating reclamation projects can best be administered by the irrigation districts.

Mr. Bailey and other water users declared that drainage was an important problem on irrigation projects. "With the best irrigation practices," he said, "there will be some waste of water and some means must be provided to dispose of the waste water without injury to other project land."

Axel Persson of Sidney, Mont., manager of the Lower Yellowstone project, in reviewing the adequacy of irrigation features as originally constructed, pointed out that experience gained during many years of operating irrigation projects should be included in plans for new projects and units of the Missouri River Basin project.

Bruce E. Garlinghouse of Malta, Mont., acting superintendent of the Glasgow and Malta irrigation districts of the Milk River project, stated that one means of reducing the cost of operation and maintenance of the irrigation projects would be the provision of adequate roads along the ditches. The roads would also serve in carrying out an economical weed and willow control program. Mr. Persson urged a program of seeding grass on ditch banks at the time of construction to reduce weed and willow growth and to prevent erosion.

Discussions on other phases of operation and maintenance were participated in by all irrigation project representatives in attendance, who requested that similar meetings be arranged for annually to further the working relationships between the Government and the operating projects.

K. F. Vernon of Billings, Region VI Director, said in the opening address that the Bureau of Reclamation is dedicated not only to the construction of irrigation projects, but to the proper operation and efficient maintenance of the completed projects.

B. J. Schwab of Deaver, Wyo., a member of the Deaver irrigation district, Frannie division of the Shoshone project, discusses operation and maintenance problems at an assembly of irrigation district representatives and Bureau staff members at Billings, Mont.

"Operating projects have major attention in Reclamation. The delivery of irrigation water is the Bureau's main business, and the establishment of stable farms through irrigation is the principal result of our work," according to E. D. Eaton of Washington, D. C., Assistant Director of the Bureau's Branch of Operation and Maintenance, who was in attendance.

Representatives of the irrigation projects in attendance were:

Malta Irrigation District, Milk River Project: Bruce E. Garlinghouse, Acting Superintendent, Malta, Mont.; Norman Storbeck, Secretary, Malta, Mont., and W. F. McPhee, Watermaster, Malta, Mont.

Glasgow Irrigation District, Milk River Project: C. E. Wilson, Watermaster, Glasgow, Mont.

Greenfields Irrigation District, Sun River Project: C. L. Bailey, Superintendent, Fairfield, Mont., and C. B. Turnbull, Member of Board, Fairfield, Mont.

Buford-Trenton Mutual Aid Corporation: Thomas J. Kelly, Manager and Watermaster, Williston, N. Dak.

Lower Yellowstone Project: Axel Persson, Manager, Sidney, Mont.; Emmett M. Gardner, Watermaster, Savage, Mont., and Albert Grohinsky, Chairman, District 1, Board of Control, Sidney, Mont.

Buffalo Rapids Farms Association, Division 1: Ford E. Martin, Manager, Glendive, Mont., and Jerome E. Webster, Watermaster, Glendrive, Mont.

Buffalo Rapids Farms Association, Division 2: Barney N. Nelson, Watermaster, Terry, Mont.

Huntley Project Irrigation District: A. J. Bowman, Manager, Ballantine, Mont.

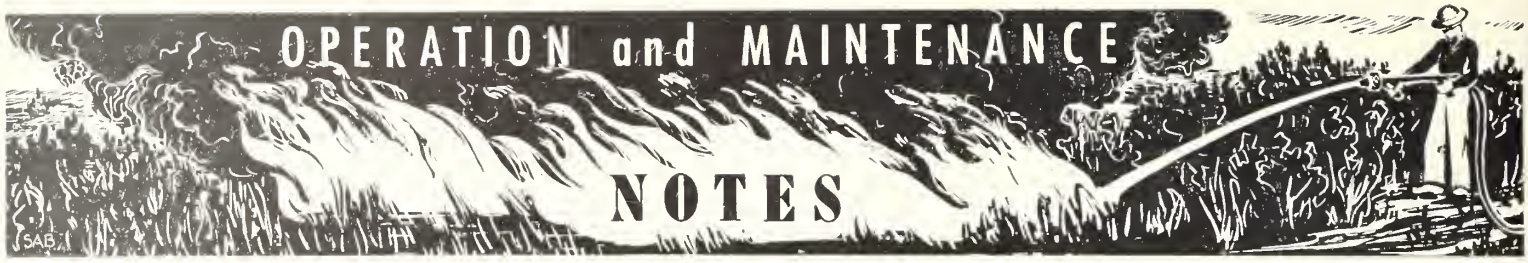
Deaver Irrigation District, Shoshone Project—Frannie Division: R. W. Fifield, Manager, Deaver, Wyo.; B. J. Schwab, Member of Board, Deaver, Wyo.; Triphon Wambeke, Member of Board, Deaver, Wyo.; Harvey Scott, Member of Board, Deaver, Wyo., and Virginia Henry, Secretary, Frannie, Wyo.

Willwood Irrigation District, Shoshone Project—Willwood Division: C. C. Stanwaity, Manager, Powell, Wyo.; Homer J. Mann, Attorney, Powell, Wyo., and Merle Barnhart, Member of Board, Powell, Wyo.

Midvale Irrigation District, Riverton Project, Wyo.: David G. Anderson, Member of Board, Riverton, Wyo.

Among employees representing the Bureau of Reclamation were K. F. Vernon, Director, Region VI, E. F. Landerholm, Supervisor, Branch of Operatiton and Maintenance,

(Continued on page 72)



Efficient Use of Irrigation Water

EDITOR'S NOTE: Dr. W. L. Powers, soil scientist in charge of Oregon State College's School of Agriculture, Experiment Station Extension Service at Corvallis, wrote us recently stating that "the RECLAMATION ERA is a very attractive journal that the reclamationists can understand," and also included with his letter a copy of an article on irrigation application efficiency which is abstracted below. You will note that Dr. Powers' findings apply only to conditions in the Willamette Valley.

Efficient use of natural precipitation lessens the irrigation requirement. In other words, you can save irrigation water by making the most of the rain that falls on your fields. For example, we studied the weather data for the Willamette Valley of Oregon and found there is a 6-month growing season, but that plant growth is limited by droughtiness during the last half of this season.

At Corvallis, for example, the rainfall for the three dry summer months is 1.93 inches, which is less than 5 percent of the yearly total. For the 5 months including May through September the mean precipitation is 13 percent of the yearly total. Two months of warm summer without effective rainfall causes droughtiness here.

Irrigation water is most economically used when you determine the amount of moisture in the soil before irrigation, and then apply only that quantity of water which will be retained in the root zone for plant use. The desired quantity, or "usable water," is the difference between the excess point (the water retained against gravity drainage) and the wilting point (that retained against the extracting power of roots). The excess point is approximately twice the wilting point. Silty clay loam will store approximately 2 inches of rain or irrigation water in each foot depth of soil; sandy loam, 1½ inches; and fine sand, 1 inch.

Crops such as green beans and ladino clover pasture extract or use moisture mainly from the first 2 feet of soil. These crops respond to light irrigations when the soil moisture content of the first 2 feet of soil is still above the wilting point and when the rather "raw" or less fertile subsoil is still fairly moist. The bulk of the feeding roots and most of the nitrifiable organic matter are in the surface soil or "A" horizon. Successful growers irrigate before the soil moisture reaches the wilting point—applying 1 to 2 inches of water to beans each week or less, or 2 to 3 inches to ladino each 10 to 15 days in mid-summer. The soil water storage capacity and seasonal rains are not sufficient to meet crop requirements, yet only supplemental irrigation is needed in the Willamette Valley. The net economic irrigation requirement in long-continued experiments here has ranged from 5 inches for potatoes to 24 for ladino pasture.

The crops giving best response to supplemental irrigation in western Oregon are those with a long growing season like sugar-beet seed, mint, ladino pasture, sweet corn, and the intensive horticultural crops. The soils best suited for supplemental irrigation are permeable in texture and fertile.

Sprinkler irrigation is well suited to light supplemental irrigation, to undulating or sandy land of moderate depth and water capacity where the annual returns from crops exceed $100 per acre.

APPLICATION EFFICIENCY in irrigation refers to the percentage of an irrigation application that can be accounted for as usable soil moisture by thorough pre-irrigation and after-irrigation soil moisture tests of each 6-inch layer of soil down to the bottom of the root zone. Example: If a 4-inch irrigation is applied to a small field and 2 inches can be found stored as increased soil moisture, the application efficiency is 50 percent.

SPRINKLER IRRIGATION in a dozen fair comparisons gave 74 percent application efficiency as compared to 58 percent for surface irrigation. Sprinkler application efficiency is higher at night. Six hours of night irrigation gave as much depth in rain cans as 7 hours in sunny afternoons.

In a survey of 181 sprinkler systems in the Wenatchee-Yakima area at Washington the farmers reported an average use of 24 percent less water after sprinklers were installed.

OTHER ADVANTAGES OF SPRINKLER IRRIGATION:

1. Saves leveling, labor and water costs.
2. Saves soil fertility by avoiding heavy grading, leaching, erosion, and waste water drainage.
3. Permits light frequent irrigation of the "A" horizon of the soil profile.
4. Permits freshening pastures after summer dressings with the liquid manure tank.
5. Provides fairly even irrigation by beginners.
6. Permits successful use of small irrigation streams and of steep slopes.
7. Portability, making it possible to avoid ditch maintenance, weed control and lost land in ditchways.
8. May serve for distribution of soluble fertilizers.
9. Avoids need of keeping an irrigator in constant attendance.
10. May aid in frost prevention.

SOME DISADVANTAGES:

1. Cost of power to provide required pressure.
2. Heavy initial cost especially for crops of moderate value per acre.
3. Labor of moving pipes.
4. Interference by, and loss due to, wind.
5. Spray removal.
6. Moistening foliage where this favors growth of fungus.

Low labor cost with sprinkler irrigation may be more important than the whole power bill. Where there is a choice of methods on medium textured soil of good topography, the choice between surface or sprinkler irrigation may be determined by the total annual cost over a long period, say 20 years. Low gross crop value per acre may not support the cost of sprinklers, while high cost of water for use in small amounts for supplemental irrigation may justify the relatively high cost per acre-inch with sprinkler irrigation of intensive crops. Each farm must be considered and the choice made according to the particular conditions.—W. L. POWERS.

DO YOU KNOW . . . .

• The first issue of the publication entitled "The Monthly Program" (now the RECLAMATION ERA) appeared in 1905? Appearing on the Reclamation roster at that time were a few names which later were to make Reclamation history: F. H. Newell, A. P. Davis, L. C. Hill, D. W. Ross, J. H. Quinton, and W. H. Code.

Inventions by Bureau Employees Benefit the United States

Bureau of Reclamation employees have invented a large needle valve for installation at the Hoover Dam outlet works, labor-saving office devices, more efficient and accurate apparatus for determining the flow of water through hydraulic turbines, and weed killers, to name a few.

In so doing they save many thousands of dollars in the installation of heavy equipment, improvement in construction and design methods, and in the speed-up of every-day operations. But even more important, they are contributing to the economy and welfare of the people of the United States, as their inventions, when properly filed, become the property of the Federal Government.

Because of the exacting requirements of the United States Patent Laws, the Interior Department, which encourages its employees to develop inventions, has established regulations for the handling of patent matters within the Department. These regulations are designed to insure adequate protection to the Government and its employees. However, many patents have been lost because employees have not been familiar with some of its laws. For example, a patent cannot be issued on a device if it has been in public use for more than a year before a patent application is filed. To assist employees and supervisors, the Bureau has taken steps to bring to the attention of all employees these various aspects of Patent Law.

The Interior Department Patent Regulations require that an invention report be submitted promptly by an employee whenever he develops what is considered a patentable device, whether developed in the line of official duty or whether it is developed on his own time without Government assistance. If developed within the scope of an employee's official duties or through the use of Government facilities, it is required that the invention be assigned to the Government and a patent application is prosecuted for the Government by the Department of Justice. However, if an invention has been developed by an employee outside his official duties and without Government assistance a determination of the respective rights of the Government and the employee is made by the Solicitor of the Department of Interior on the basis of the facts presented. The employee may, if he wishes to do so, request that an application for a patent be filed and prosecuted at Government expense under provisions of an act passed in 1883. Under these circumstances the invention may be manufactured and used, by or for the Government, for governmental purposes, without the payment of any royalty.

Master Chart Coordinates Bid Opening Dates

One day last autumn, a contractor was in a quandary. That day the Bureau of Reclamation was opening bids for a large structure in the State of Washington, a million-dollar bid was being opened by the Corps of Engineers for a flood control project in North Carolina, the Federal Works Agency had an interesting looking bid opening in Ohio, and to make matters worse the Navy had a job opening up in Maine on which the contractor would like to bid. What to do? He wanted to submit bids on all these contracts, and also be present at the meetings when the bids were opened, but he obviously could not be in more than one place at one time. So he submitted only one bid. He didn't get the job and the Government lost his potential services for the other jobs.

This is a purely hypothetical case, but according to the Associated General Contractors of America, contractors have faced similar situations all too frequently in the past. Bid openings on two or more important construction jobs were sometimes scheduled the same day, or nearly the same day, at widely separated locations because of the lack of any exchange of information as to scheduled openings between different agencies. Contractors planning to bid on more than one job were therefore unable, in some cases, to submit bids in person. The bidder naturally wants to be present at the meetings when the bids are opened. He then has full information and an opportunity to study the various bid prices for units of work submitted by all bidders. Being present at the bid opening is also important to a bidder because it affords a convenient opportunity to contact suppliers of materials who make a practice of attending as a means of getting orders from the apparently successful bidder.

To remedy the situation, officials of the Bureau of Reclamation, the Bureau of Yards and Docks of the Department of the Navy, the Corps of Engineers of the Department of the Army, the Federal Works Agency and the Veterans' Administration talked the matter over with each other and representatives of the Associated General Contractors. These five Federal agencies which conduct major construction programs agreed to establish a system to stagger bid opening dates on similar types of construction involving $1,000,000 or more.

The new system is now in successful operation. A master chart of bid opening dates on large construction projects of the participating agencies is maintained in the office of the Chief of Engineers, Department of the Army. This information is supplied to the other agencies, and they are able to avoid conflicts in scheduled dates.

It is believed that the improved bidding conditions are beneficial not only to contractors, but to the awarding agencies and the public as well, because of wider competition, improved relations with bidders, and resulting lower bids.

Teamwork on Aerial Photography and Topographic Mapping

Robinson Standard Aerial Surveys, Inc., of Newark, N. J., recently completed a contract with the Bureau of Reclamation for aerial photographs of the Oahe Unit, South Dakota. Behind this accomplishment lies a story of cooperation between the Bureau of Reclamation and the Geological Survey from the planning of the job to the filing of the negatives. This is another example of Government agencies working together which will result in an ultimate saving to the Government in its National Mapping Program. Since the Geological Survey is the primary mapping agency of the Department of the Interior it is logical that these two agencies should cooperate very closely in the interests of obtaining maximum efficiency and economy in mapping activities.

There has been in effect for the past several years a memorandum of understanding and agreement between the Bureau of Reclamation and the Geological Survey which sets forth

the procedure for these two agencies to develop positive means whereby the special facilities and capabilities of each organization will be made readily available to the other. So far as is possible, all mapping is to be done so that it will fit in with and contribute to the standard quadrangle mapping of the United States. It is by this means that the repeated preparation of special-purpose maps which do not contribute to the general mapping program can be eliminated or held to a minimum. On projects involving aerial photography, the Geological Survey reviews specifications submitted to them, looking toward the later use of the photographs in the production of standard quadrangle maps. Their topographic organization also supervises, inspects, and tests, as an agent of the Bureau of Reclamation, the work of aerial survey contractors, and they certify to the Bureau that the work has been performed according to specifications prior to payment to the contractor for the work done.

Recently an additional memorandum of agreement has been consummated with the Geological Survey on the storage and printing of aerial photographic negatives. In years past, negatives for aerial photography have been stored in various Bureau offices, and in a few cases they were left in the possession of the contractors who performed the work for the Bureau for lack of more suitable storage facilities. Arrangements are now being worked out whereby all Bureau aerial negatives are to be stored with the Geological Survey in their District Office at Denver, Colo. Upon request the Geological Survey will provide prints and enlargements on a standard cost basis. This arrangement will avoid duplication of storage and printing facilities in various Bureau offices and will result in better service to those requiring aerial photographs.

My First View of Reclamation

(Continued from Page 68)

of the valley on the south of the river, there was another table of fertile farm land peacefully stretched out in the heart of the sand hills.

By this time I had become almost immune to such surprises.

I saw a place where the Niobrara River turned over on its side and was only 18 inches wide for about 50 feet. After leaving this narrow passage of rock shale formation the river spread out into its usual 60-foot width.

But it was hard to believe when driving over sandhill trails, that one could come upon such scenic splendor as the Snake River falls—20 feet high, nestled in a 100-foot canyon. I began accepting as a matter of course, the stream gaging units which are strategically located over the entire basin.

When we came to the proposed diversion dam site it was easy for me to visualize Clyde's picture of the completed dam and reservoir which will hold about 35,000 acre-feet of water for supplying Ainsworth's irrigation needs.

On the way back past the dam site Clyde showed us the proposed canal line along which I noticed many small capped pipes. We were told they were test wells to determine the average ground water level, which had to be accurately measured the entire length of the canal line so that the canal water line will not be lower or higher than the ground water level. If the water level in the canal should be lower, it would tend to drain the adjacent lands, and if higher it would probably flood them. This is just one of the many problems to be worked out before construction can be started.

At Hackberry Lake, Dewey Lake, and the State Fish Hatchery at Valentine, we saw at first hand the concentration of fish and wildlife in this area—pelicans by the dozen, all kinds of ducks, night Herons, pheasants, prairie chickens, grouse, muskrat, mink, beaver, and raccoon! We discussed how the proposed Niobrara project could help preserve this wealth of natural resources.

At the Federal Refuge, 2 miles north of Valentine, we met John Connors, the manager, who showed us his interesting museum which contains, among other things, some fossils. As we drove along he explained the function and plans of this refuge. We saw a small herd of Elk, among which was a small four- or five-day-old calf, which already had the instinct to hide in the grass and swim across a small creek. We found the buffalo in one large herd, over a hundred, including about 50 small calves, and just before leaving the refuge we saw a herd of original Texas longhorn cattle and calves. One huge steer attracted our notice and we were told he weighed nearly one ton. The preservation of these almost extinct cattle is one of the many projects of the refuge.

Next we saw the proposed Carpenter Reservoir site, 7 miles southwest of Johnstown, which will be filled from the Diversion Dam on the Snake River and store water for the Ainsworth area. We ended our trip by inspecting the proposed White Cliffs and Winfield Reservoir sites on Plum and Pine Creeks. These two reservoirs are to store the run-off waters of the Ainsworth area, supplemented by diversion waters from the Niobrara and in turn supply the necessary water for the O'Neill area. I began to understand the meaning of "coordinated development" when I saw how all these projects fit together and depend upon each other. I also could not help realizing their advantages for recreational purposes.

Whether many of us realize it or not, the fact remains that these sites and many others within the Niobrara Basin could easily become the beauty spots of the Midwest. If they are not developed as such, along with the proposed irrigation project, we certainly are missing the boat. We have so many scenic and historic interests right here in our back yards, so close to our noses, that we can't see them.

If I had been given a choice of a 2-week paid vacation, or this 4-day tour, without hesitation I would choose the tour, Any indication of enthusiasm and/or hope in this poorly written story is purely intentional. THE END.

"As I think what the full use of the waters of Nebraska could bring to the people of this valley in the way of security and prosperity, I feel more fully convinced that our country's greatness depends on the development of little things—whether it be a little river which joined with other water makes a large river or whether it be an individual who through his irrigated farm or his small business contributes his share toward making a mighty Nation."—HARRY W. BASHORE, FORMER COMMISSIONER OF RECLAMATION, SPEAKING BEFORE THE MEMBERS OF THE REPUBLICAN VALLEY CONSERVATION ASSOCIATION, AUGUST 16, 1944, AT McCOOK, NEBRASKA.

Water Users and Bureau Officials Meet

(Continued from page 69)

and E. D. Eaton, Assistant Director, Branch of Operation and Maintenance, Washington, D. C.

The Conference adopted a Memorial to the late H. H. Johnson as follows:

WHEREAS, Mr. H. H. Johnson, whose death occurred on December 17, 1948, had worked ceaselessly and untiringly in the attainment of the objectives for which the Bureau of Reclamation is founded, and

WHEREAS, such men as "Ole" Johnson contributed immeasurably to the welfare, growth and prosperity of a score of communities.

BE IT HEREBY RESOLVED that this assembly herewith voices its deep and sincere regret at the death of a fellow worker and pays lasting and affectionate tribute to the qualities of leadership, friendliness, loyalty, and sincerity that endeared "Ole" Johnson to all those with whom he was associated.

AND, BE IT FURTHER RESOLVED That a copy of this memorial tribute be sent to the bereaved widow in expression of our heartfelt sympathy. THE END

U. S. GOVERNMENT PRINTING OFFICE 1949

NOTES FOR CONTRACTORS

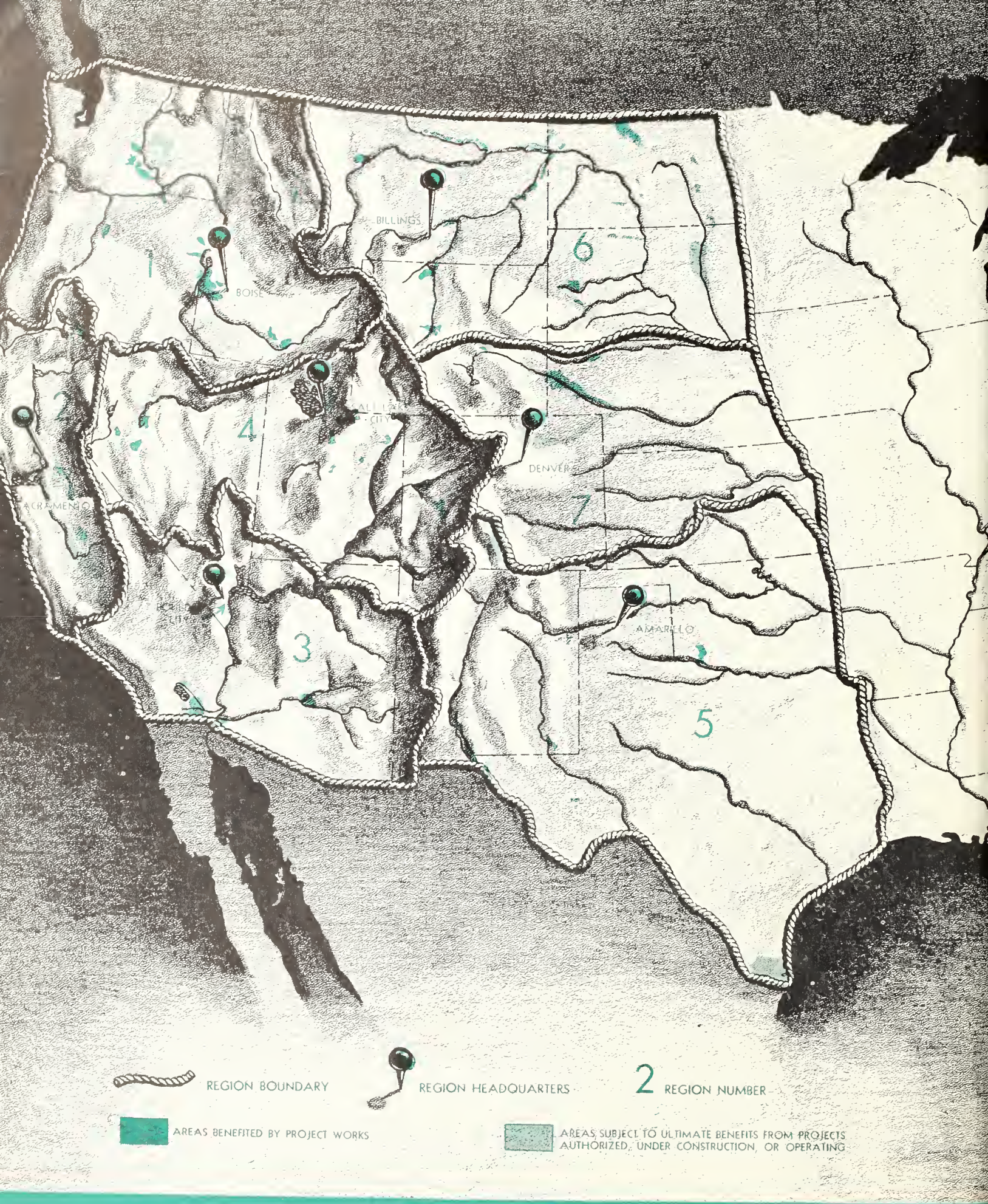
Contracts Awarded During January 1949

Spec. No.	Project	Award date	Description of work or mtaerial	Contractor's name and address	Contract amount
2424	Missouri River Basin, N. Dak	Jan. 13	Furnishing equipment and constructing one 1,500-kilovolt-ampere substation at Watford City, N. Dak.	Killoren Electric Co., Appleton, Wis	$108,800
2428	Colorado-Big Thompson, Kendrick, and Missouri River Basin, Colo.-Wyo.-Nebr.	Jan. 17	Carrier-current telephone apparatus, schedule 1	Control Corp., Minneapolis, Minn	32,896
2460	Central Valley, Calif	Jan. 3	Construction of earthwork, concrete lining, and structures for Delta-Mendota Canal, station 1,366+50 to 2,149+80, and timber operating bridge at station 1,229+28.0.	Hubert H. Everist, Sr., Westly, Calif.	3,679,107
2471	Missouri River Basin, Wyo	Jan. 25	Furnishing and installing 1 electrically operated elevator for Kortes Dam.	Gust. Lagerquist & Sons, Minneapolis, Minn	32,330
2474	Minidoka, Idaho	Jan. 27	Three 3,333-kilovolt-ampere transformers, and 1 138,000-volt and 1 34,500-volt circuit breakers for interconnecting substation at Minidoka power plant.	Westinghouse Electric Corp., Denver, Colo	111,655
2475	Columbia Basin, Wash	Jan. 14	Construction of river improvements and repair of spillway face and spillway bucket at Grand Coulee Dam.	Pacific Bridge Co., San Francisco, Calif	1,804,840
2480	Boise, Idaho	Jan. 25	Three 10,000-kilovolt-ampere autotransformers, and 3 current and 3 potential transformers for Anderson Ranch switchyard, schedules 1 and 4.	Westinghouse Electric Corp., Denver, Colo	110,837
2497	Central Valley, Calif	Jan. 31	Bulkhead gate metalwork for Tracy pumping plant	Schmitt Steel Co., Portland, Oreg	12,845
2504	Hungry Horse, Mont	Jan. 28	Structural steel roof framing for Hungry Horse power plant	Mississippi Valley Structural Steel Co., St. Louis, Mo.	76,502
2523	do	Jan. 24	Miscellaneous structural steel for cable trays in control gallery at Grand Coulee Dam.	Gilmore Fabricators, Inc., Oakland, Calif	26,266
R2-42	Central Valley, Calif	Jan. 20	Construction of 6 residences at Gustine Government Camp	Tornell Construction Co., Tracy, Calif	33,400
R4-11	Provo River, Utah	Jan. 6	Construction of earthwork, and canal lining, station 101+35.9 to 129+50 and station 466+00 to 496+50 and station 1,046+00 to 1,069+00, Provo Reservoir Canal enlargement, Deer Creek division.	Young & Smith Construction Co., Salt Lake City, Utah.	150,651
R4-12	do	Jan. 13	Construction of earthwork canal lining, tunnel lining, and structures, station 5+55 to 28+10, Provo Reservoir Canal enlargement, Deer Creek division. Schedules 1 and 3.	do	55,160
R5-8	Tucumcari, N. Mex	Jan. 14	Riprap for structures and stockpiles, lateral units 1, 2, 3, 4, and 5.	J. A. Terteling & Sons, Inc., Tucumcari, N. Mex.	41,250

Construction and Supplies for Which Bids Will Be Requested by May 1949

Project	Description of work or material
Boulder Canyon, Ariz.-Nev	Processing of sand and gravel for concrete aggregate.
Central Valley, Calif	Construction of earthwork and structures for about 17 miles of Delta-Mendota Canal near Los Banos, Calif.
Do	Construction of earthwork and structures for about 17 miles of Friant-Kern Canal near Delano, Calif.
Do	Stringing about 57 miles of single-circuit conductor for the Oroville to Elverta, Calif., transmission line.
Colorado-Big Thompson, Colo	Construction of the Estes Park-Marys Lake and Estes Park-Granby pumping plant transmission lines. Alternate schedules are to call for either 34 miles of wood pole and 6.5 miles of steel tower, 115-kilovolt line; or 14 miles of wood pole and 1 mile of steel tower 115-kilovolt line and 13 miles of 69-kilovolt cable through Adams tunnel.
Columbia Basin, Wash	Generator cooling water jet pumps for Grand Coulee right power plant.
Davis Dam, Ariz.-Nev	Furnishing equipment for and constructing a tap to Gila-Drop No. 4 transmission line from the second Parker-Gila line; and a tap to the Basic Magnesium south 230-kilovolt line from the Davis-Hoover line.
Do	15-kilovolt oil circuit breaker, switches, current transformers, and potential transformers for Mesa substation.
Do	Construction of the 75-mile long Tucson-Cochise 115-kilovolt, wood pole, H-frame, single-circuit, 3-phase transmission line.
Deschutes, Oreg	44-inch diameter outlet pipes for Ochoco Dam.
Fort Peck, N. Dak	Construction of the 5-mile long Cartwright 13.2-kilovolt transmission line near Williston, N. Dak.
Gila, Ariz	Construction of the 18-mile long Wellton-Mohawk Canal about 20 miles east of Yuma, Ariz.
Do	Construction of pumping plants Nos. 1, 2, and 3, on the Wellton-Mohawk Canal about 20 miles east of Yuma, Ariz.
Do	Four 1,000-horsepower, three 3,000-horsepower, and three 2,000-horsepower motors for Wellton-Mohawk pumping plants.
Hungry Horse, Mont	Domestic water pumps and oil pumps for Hungry Horse power plant.
Do	Relocation of Forest Service road between Riverside Creek and Elk Park ranger station, about 30 miles northeast of Kalispell, Mont.
Missouri River Basin, Mont	115-kilovolt outdoor power circuit-breakers, 34.5-kilovolt circuit-breakers, and 115-kilovolt and 34.5 kilovolt disconnecting switches for Canyon Ferry switchyard.
Missouri River Basin, Nebr	Construction of earthwork and structures for 6.5 miles of Cambridge Canal near Arapahoe, Nebr.
Missouri River Basin, N. Dak	Construction of the 16 cubic feet per second Cartwright pumping plant and discharge line on the lower Yellowstone River about 4 miles southwest of Cartwright, N. Dak.
Do	Construction of the 41-mile long Bismarck-DeVaul 69-kilovolt transmission line.
Missouri River Basin, S. Dak	Construction of the N-Bar-N pumping plant, discharge line, distribution box, and switchyard; and installing pumps, motors, and electrical equipment, 4 miles south of Frazer, Mont.
Do	Construction of a permanent residence, shop and generator building, pump house, and sewer and water lines; and furnishing and installing deep well pump and pressure tanks for Shadehill Government camp, about 13 miles south of Lemmon, S. Dak.
Missouri River Basin, Wyo	Construction of 1 permanent residence, 6 temporary residences, 1 office and laboratory building, garage, and sewer and water systems; and moving and remodeling 12 trailer houses, for Anchor Dam Government camp about 45 miles west of Thermopolis, Wyo.
Do	Pipe fittings and valves for Kortes power plant.
North Platte, Wyo	Construction of a Parshall flume on Fort Laramie Canal near Torrington, Wyo.
Ogden River, Utah	Construction of an equalizing reservoir for the south Ogden lateral distribution system near Ogden, Utah.
Do	Furnishing and installing a venturi meterin Ogden Canyon conduit.
Palisades, Idaho	Construction of the 52-mile long Goshen to Palisades 115-kilovolt transmission line.
San Luis Valley, Colo	Erection of 8 quonset huts, including utilities, for temporary construction camp at Platoro dam site on the Conejos River, about 40 miles southwest of Alamosa, Colo.
Do	Construction of 10 housing units, erection of 1 quonset hut for office, and construction of utilities and roads for temporary housing camp at Antonito, Colo.
Do	Construction of a permanent caretaker's residence and utilities at Platoro dam site about 40 miles southwest of Alamosa, Colo.

We sincerely regret to announce the death of Mr. James O'Sullivan on February 15 at Spokane, Wash., after a three-month illness. Mr. O'Sullivan's untiring fight saw Grand Coulee Dam and the Columbia Basin project become a reality. (See "Grand Old Man of Grand Coulee Dam" November 1946 RECLAMATION ERA.) The O'Sullivan Dam in the Columbia Basin project was named and dedicated in his honor by Secretary J. A. Krug in September 1948.



The Reclamation Area

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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' associations.

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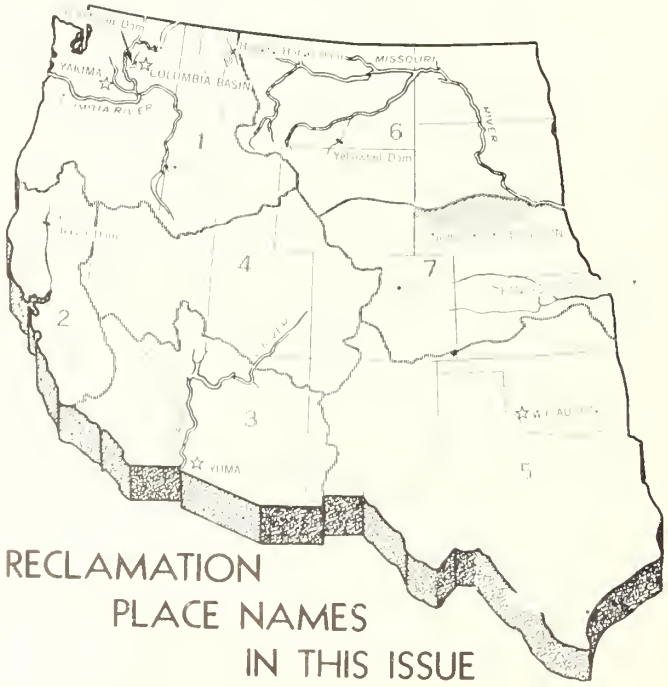
DO YOU KNOW . . .

- Parker Dam, with 235 feet of its structure below the Colorado River bed, is the deepest dam in the world?
- The present hydroelectric power output on the Colorado River could be quadrupled if all of the power resources of that stream were developed?
- Last year about 7 million acre-feet of Colorado River water (roughly 40 percent of the stream's average annual flow) was wasted into the Gulf of California?
- Davis Dam is named in honor of the late Arthur Powell Davis, one of the early Directors of the Reclamation Service (now Bureau of Reclamation), and father of the Reclamation development of the Colorado River?
- The 1,400-mile-long Colorado River drains an area one-twelfth the size of the United States?
- More than a million persons crossed the top of Hoover Dam in 1948 and nearly half of them took the Bureau of Reclamation guided tour through the dam and powerplant?



RECLAMATION PLACE NAMES IN THIS ISSUE

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J. A. Krug, Secretary

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REGION IV: E. O. Larson, Regional Director, 32 Exchange Place, P. O. Box 360, Salt Lake City 8, Utah.
REGION V: H. E. Robbins, Regional Director, P. O. Box 1609, Old Post Office Building, 7th and Taylor, Amarillo, Tex.
REGION VI: K. F. Vernon, Regional Director, P. O. Box 2130, Billings, Mont.
REGION VII: Avery A. Batson, Regional Director, 318 New Customhouse, Denver, Colo.

A Fighting Heart Is Stilled

By GENE NICOLAI, Coulee Dam, Wash.

The recent passing of James O'Sullivan, "The Grand Old Man of Grand Coulee Dam," marked the loss of one of the truest friends of reclamation, for although Mr. O'Sullivan's principal efforts throughout the years were directed toward building man's greatest concrete dam and completing the Columbia Basin project of eastern Washington, his influence in these fields helped bring Nation-wide attention to similar developments in other States.

In his 40 years of work in behalf of reclamation, Mr. O'Sullivan appeared often before congressional committees to plead his cause. The November 1946 RECLAMATION ERA, which first described Mr. O'Sullivan as "The Grand Old Man of Grand Coulee Dam," emphasized that his untiring struggle for reclamation developments stemmed solely from the fact that he was a disciple of a single axiom—that power and reclamation projects are not for the good of the few, but for the benefit of the multitude.

Publisher Rufus Woods of the Wenatchee World fought side by side with Mr. O'Sullivan down the years. He shared in his disappointments and triumphs. Of Mr. O'Sullivan's death, The World said:

"In the passing of Jim O'Sullivan, the fighting heart of a human dynamo is stilled. Jim lived a life dedicated to the little folks who admired his unselfish efforts in their behalf. The 'grass roots' people believed in Jim as he sought no personal gain or property in his fight for irrigation and cheap power."

Secretary of the Interior J. A. Krug, who officiated at ceremonies on the Columbia Basin project last September when the 3½-mile Potholes Dam was renamed O'Sullivan Dam, said:

"He was a man of great vision, great fortitude and great stature. . . . The development to which he gave his heart and strength to achieve is his monument—a monument more lasting than bronze."

"The whole Columbia Basin project is the fulfillment of his dream and is a timeless testament to the faith and vision of a truly great American," commented Reclamation Commissioner Michael W. Straus. "His wise counsel and unswerving devotion to the development of the Columbia Basin project was an inspiration for everyone associated with him."

District Manager Frank A. Banks of the Columbia Basin project recalled how Mr. O'Sullivan kept a faithful watch over construction progress on 22,000,000-ton Grand Coulee Dam, how he served the Columbia Basin Commission of the State of Washington, and how he kept urging speedy completion of irrigation works to provide thousands of farms for veterans of World War II.

Arising from his sick bed, James O'Sullivan insisted on attending ceremonies September 28, 1948, when O'Sullivan Dam, of the Columbia Basin Project, was renamed in his honor. This picture, taken that day, captured him in a typical pose as he admonished his listeners to continue the fight for reclamation. ***Photo by Harold Foss, Region I.***

"The Columbia Basin and the whole Nation have lost a great champion and friend, but his spirit has been captured for all time in the fulfillment of his great dream—the Columbia Basin project," Mr. Banks remarked. "Jim O'Sullivan had the greatest fighting heart of any man I've known."

Few of the people who attended the O'Sullivan Dam ceremonies last September realized that Mr. O'Sullivan was an extremely ill man when he appeared at the rites in his honor and gave one of his typical fighting speeches. He had been stricken following a banquet in his honor the night before. He was rushed to a hospital early the morning of September 28, but a few hours later he arose from his sick bed and went to the ceremonies at the dam. There he told an applauding audience of the heartbreaks, the disappointments, the failures and successes he and other project supporters had experienced through the years. And he counseled his listeners:

"We're going to go on and finish this great project. We're going to protect that great heritage, the Grand Coulee Dam."

Then he addressed the wide-eyed school children standing below him:

"You young fellows, you're going to get in and fight, aren't you? You bet. So I want to say God bless all of you. It's been worth living—to have been with you, to have worked with you in this great battle for the greatest project on earth."

Thus a beloved fighting man gave his last fighting speech.

CHEMURGY

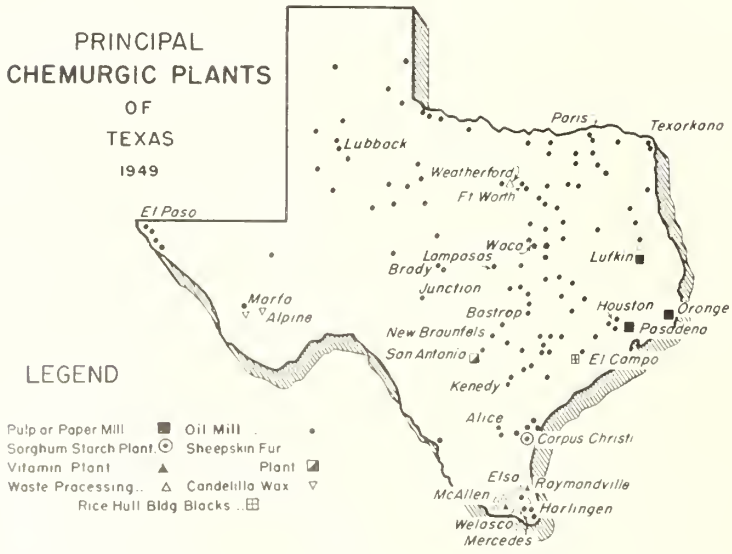
by W. BION MOORE

Chief, Economics and Resources Division, Branch of Project Planning, Region V, Amarillo, Tex.

YOUR GIRL FRIEND MAY WEAR NYLON HOSE made from such waste products as corncobs or cotton burrs. Or that expensive-looking fur coat she wears may be made of sheepskin. Or the life of someone you know may be saved by nitrofurazone, the latest, most powerful bacterial agent, which is made from cottonseed hulls. Many other developments based on chemurgic research are equally startling.

Nearly every day some new or more profitable industrial use is found for farm crops and related waste materials. For example, one of the chemicals used to make nylon (itself a spectacular chemurgic product recently developed) is furfural. Furfural is made from such waste products as oat or rice hulls, corncobs, or even cotton burrs. Modish furs resembling beaver or seal are made from sheep and lamb skins by a plastic process. Molasses is made from sawdust or other wood wastes; it could be made from such low value wood as mesquite. A prized vegetable wax used for phonograph records, polishes, and varnishes is extracted from the desert candelilla plant of west Texas. These are only a few of the many spectacular contributions to our economy that have been made by Chemurgy.

According to the National Farm Chemurgic Council, chemurgy is essentially the application of science for the development of new uses for farm-grown raw materials. Primarily the concept is that new uses can be found for the products of agriculture, that new crops can be added in many localities, and that profitable utilization can be discovered for the vast tonnages of wastes and residues produced incident to the food output. Unlike mineral or sea deposits (the other two sources of material wealth) the wealth from the soil can regularly be renewed and produced at man's will. The hope of abundance rests on extending, as far as human knowledge can be pushed, the fullest utilization of earth's plant resources. Reclamation and chemurgy are both essential to realize this hope of abundance. Reclamation can increase the crop production from our limited land resources. Chemurgy can increase the varieties and quantities of useful products that can be made from these crops; it can also point the way to new crops and new methods of land use.



Chemurgic developments in Region V of the Bureau of Reclamation are concentrated largely in Texas, where pioneer research in this field started many years ago. Chemurgic activities in recent years have been encouraged and publicized by the Texas Chemurgic Council with the support of industry and the endorsement of State officials. At its third annual conference, held in Corpus Christi in April 1948, the program of the council spotlighted developments in the coastal bend area (of which Corpus Christi is the trade center), with authoritative reports by technicians of the industrial concerns actually engaged in the activities described. The papers presented at this conference, together with articles from the Texas Chemurgic News, the monthly publication of the council, are the principal sources of data on specific industries included in this article.

Existing Chemurgic Plants

The approximate geographic distribution and major products of the principal chemurgic plants are shown on the map "Principal Chemurgic Plants of Texas—1949." Most important among Texas chemurgic industries are pulp and paper. There are three large plants, at Lufkin, Pasadena (near Houston), and Orange. The former, which produces newsprint from slash pine, was the first newsprint mill in the South. Since this industry utilizes forest resources it is only indirectly related to our irrigation or drainage planning.

The principal chemurgic industry significant in Reclamation planning involves production of starch from sorghum grain at the new Bluebonnet plant of Corn Products Refining Co. in Corpus Christi. Initially this plant will process 20,000 bushels of milo daily, to produce starches, dextrose sugar, stock feeds, and crude grain oil. A variety of other products, similar to those made from corn at other plants of this company, can be produced if desired.

In the Lower Rio Grande Valley are roughly a dozen chemurgic plants producing a variety of products from citrus or vegetable wastes. Orange and grapefruit pulp are used to produce citrus molasses for use in stock feed. Waste

New Uses for Farm Products

grapefruit peels are dehydrated for stock feed, with experiments under way to obtain oils and aromatics as byproducts. Pectin, metallic pectinates, tomato paste, and fruit powder are made from citrus and tomato cannery waste. These products are used to make tomectin, a product eagerly sought by manufacturers of pharmaceutics for use in medicines to control and cure dysentery. Stock feed also is produced from vegetable cannery wastes. Two plants produce vitamins, principally carotine or chlorophyll, from alfalfa or cereal grasses; stock feed is obtained as a byproduct.

There are numerous cottonseed oil mills in Texas. This crushing process, which produces primarily cottonseed oil and cake, is so long established that it may not be generally recognized as chemurgic. Cottonseed oil has many food and nonfood uses, including utilization in oleomargarine. Cottonseed oil cake is a valuable supplemental stock feed, widely used as the principal source of protein in balanced rations. At Kenedy is a new plant utilizing a similar process on flaxseed to produce linseed oil, which is the preferred oil base for most paints, and an oil cake used as stock feed.

Waste pecan shells are treated at Lufkin and Weatherford. High grade cooking and perfume oils, together with tannin for the leather industry, are extracted. A flour usable in plastics is made from the residue.

Perhaps the most unusual chemurgic plant in Texas is at San Antonio, where sheep and lambskins are transformed into modish furs that can scarcely be distinguished from beaver or seal.

Future Prospects for Specific Crops

New irrigation projects in semiarid portions of Region V would involve expanding production primarily of such crops as cotton, alfalfa, grain and forage sorghums, citrus and vegetables. Drainage and irrigation on the Coastal Plains of Texas would involve expanding production of primarily such crops as rice, cotton, and forage. Of these crops, cotton and rice are discussed briefly in subsequent paragraphs, because of their importance in Texas in relation to chemurgic developments that expand their utilization. Grain sorghum is discussed more fully because recent chemurgic developments

Through the magic of Chemurgy this Plainsman variety of combine maize is transformed into starch, dextrose sugar, and many other products in daily use throughout the world. *Photo by R. M. Reynolds, Region V.*

and expanding irrigation of this crop may magnify its importance several fold in future years.

Cotton and Cottonseed.—Although the long-range outlook for the cotton-lint market is not encouraging, there is a rising trend in the irrigated cotton acreage, presumably because of more efficient and high quality production under irrigation. According to the January 1, 1949, issue of the Texas Chemurgic News, "It is not unlikely that under an efficient system of irrigation in Texas and other parts of the Southwest, cotton will be grown much more cheaply than at present." Lower cotton lint production costs will permit profitable operations at lower prices that, in turn, will tend to stimulate the use of lint in chemurgy.

Another means of improving the status of cotton is through industrial use of cottonseed hulls. They can be used to make furfural (a chemical used to make nylon and in petroleum refining), wallboard, roofing, insulation, and, perhaps most important of all, the new germicide nitrofurazone, previously mentioned, which kills germs that escape penicillin.

Unlike the lint, there is an expanding market for cottonseed because chemurgic processing not only produces a vegetable oil in great demand for food and nonfood use but also a number of useful byproducts. With no major new development in lint utilization the big news in the cotton industry is the solvent extraction process for treating cottonseed. Although the economics of operation are not known outside the producing plants, the process reportedly has several advantages. The oil recovery is increased slightly; several

undesirable constituents normally left in the residual meal can be recovered in concentrated fractions, then sold as such after purification; and the meal will be a source of flour for human consumption or a source of commercial protein for fiber and plastic manufacturing.

Rice.—Texas became the leading rice-producing State in 1947 and now has over 470,000 acres of irrigated rice annually, much of it in premium priced long-grain varieties. An integrated irrigation and drainage program on the Coastal Plain of Texas probably could double its present production.

Chemurgic developments promise to improve the competitive position of United States rice growers and millers by adding new revenue from new byproducts. This revenue could permit lower prices for the portion sold as human food. Like cottonseed, rice bran can be used as a source of vegetable oils, import items in prewar years, with a residual meal desirable as a protein stock feed. Bran and rice polish find ready markets for this purpose. Distilleries use low-grade rice not salable as food to make alcohol.

In the past rice hulls either have been wasted, used for fuel, or spread on fields as fertilizer. Some mills pay trucking companies as much as $2 per ton to haul hulls to nearby burners or public dumps. Numerous chemurgic processes are now available to utilize hulls. Like oat hulls, formerly wasted in a similar manner, rice hulls can be used to produce furfural. This important intermediate chemical is used in petroleum refining and to make nylon. One plant in Texas uses rice hulls as a principal ingredient in light weight building blocks. On the west coast, experiments have developed a wallboard made from rice hulls. This board has a distinctive pattern, comprising successive series of rosettes, that is restful to the eyes. Acetone (an intermediate chemical), glue spreaders, abrasives, and insulation: all can be made from rice wastes.

Grain Sorghum.—Grain sorghum has been used in the manufacture of beer malt in Europe for many years. Wartime needs stimulated its use in the United States for industrial as well as beverage alcohols, including some alcohol used to make butadiene for the synthetic rubber program. Grain sorghum is much like corn for these purposes and for starch production; it has a slightly higher starch content than corn and a much higher protein content, but is lower in oil, fiber, pentosans, and sucrose. The endosperm, which is almost pure starch, comprises the bulk of the sorghum kernel; the germ, comprising the other and minor part of the kernel, contains mostly oil and protein. Texas grain sorghums having a waxy endosperm yield a starch that is especially desirable for adhesives, paper and textile sizing, stamp and envelope glue, and food products similar to tapioca. Both corn and grain sorghum were utilized for production of such starch during the war as a substitute for tapioca or other imported root starches, of which about 350 million pounds formerly were imported annually from the Dutch East Indies.

Only in recent years has grain sorghum been used to make starch and related products. Heretofore it has been processed at long-established plants of the wet-milling industry located near sources of corn. Consequently sorghum from Texas has been at a disadvantage in competing with corn as a source of supply. The situation recently has changed with construction of a new starch plant in a Texas sorghum-producing area. This plant, the new Bluebonnet plant of Corn Products Refining Co., is located on Nueces Bay in Corpus Christi. Since this company is investing several million dollars for that purpose, it is clear that its executives are convinced that processing of starch from local sources of milo, hegari, or other grain sorghums will be profitable at this location. Primary products will be starches and dextrose sugars. There will be many valuable byproducts, including protein cattle and poultry feeds that will be readily salable in this feed-deficient area. The annual grain consumption, primarily of milo, would amount to about 6 million bushels. An unusually high grain storage capacity, equal to 100 days requirements, has been provided. However, considerable grain will be purchased during the winter and spring after stored grain purchased locally at harvest time has been processed. Storage of sorghum is more expensive in the coastal bend area than in the South Plains counties near Lubbock because of humidity. Consequently grain from the South Plains, or in new irrigated areas in west Texas, may have an advantage over coastal bend sorghum in supplying late-season needs of the Bluebonnet plant.

In the coastal bend area relatively high yields for nonirrigated sorghums are obtained; with average rainfall, yields of about 25 to 35 bushels per acre prevail. Much larger yields are possible with irrigation, even in arid areas, using a total water application of as little as 6 to 9 inches. Careful experiments at Lubbock by the Texas Agricultural Experiment Station showed an average in the years 1937–40 of 17.7 bushels per acre without irrigation; 52.1 bushels by using 6 inches of irrigation water, and 58.8 bushels with 9 inches of irrigation water. Yields as low as 8 bushels per acre were obtained without irrigation in dry seasons; yet even in such years 60-bushel yields probably could have been obtained with 12 inches of irrigation water. Rainfall at Lubbock normally is about three-fifths that of the coastal bend area. It appears likely that lower cost grain would result with the high yields obtained under irrigation. Expansion of the irrigated grain sorghum acreage could provide a supply for other wet-milling capacity in west Texas that might prove as profitable as the plant at Corpus Christi. Investigation of the economic feasibility of such operations, and the availability of water for processing, are an essential part of our Reclamation planning program.

Chemurgy in Planning Investigations

The preceding discussion indicates how chemurgy is expanding the market for cotton, rice, and grain sorghum. It also is expanding the market for other irrigated crops of region V. Chemurgy is a factor of growing importance in increasing the demand for such crops and it is expected to be an influence in maintaining favorable farm prices. This factor may often be of major importance in project feasibility studies. Employment potentialities arising from new chemurgic plants may also be significant in many project areas. Consequently, progress in chemurgy will be watched closely in region V as part of our regular planning investigations.

The End

ACCOUNTING FOR RECLAMATION

by **ALFRED R. GOLZÉ**, *Director, Office of Programs and Finance, Washington, D. C.*

ANY FEDERAL AGENCY HAS A GRAVE RESPONSIBILITY to the taxpayers of the Nation to account for every penny spent, saved, and earned. When an agency grows from a $9,000,000 a year outfit, building small, single irrigation projects, to a flourishing organization creating multiple-purpose, basin-wide developments costing $250,000,000 or more annually, its responsibility to the taxpayers increases in proportion to that growth.

Every farmer and businessman knows that higher costs and increased expenditures, the result of expanded activities, call for close supervision of funds; and that an adequate and sensitive accounting system is the best supervisor.

During World War I, when the Bureau of Reclamation's average program cost $9,000,000 a year, a system of estimates and authorities to control the work, with a set of general ledger accounts and cost reports for record purposes, were adequate to meet the accounting needs. Since then, the Bureau's program has grown in size and scope of operations, and other Government agencies have established many new regulations which affect the operations of the Bureau and complicate its accounting.

In 1943, in anticipation of the end of the war and full resumption of work, the administrative activities of the Bureau of Reclamation were decentralized from Washington and Denver. Regional offices were set up to direct the field work of the Bureau, and to prepare for an enlarged program of construction.

Following the 1943 reorganization, the procedures of the Bureau were revised and employees added to carry out the expanded program. One of the branches to be revitalized was the Office of Programs and Finance.

Gone are the days of 1919 and the $9,000,000 budget. In 1949, appropriations for the Bureau for all purposes amounted to $246,058,942, three and one-half times (or 330 percent) greater than the appropriation of $74,547,114 for all purposes in fiscal year 1941, the last full fiscal year before the war. The amount recommended by the President for fiscal year 1950 for all purposes is $373,328,500, five times as large as (or 500 percent over) the 1941 figure.

By the end of World War II, when substantial appropriations for reviving the Bureau's program were made, the accounting system of 1919 bogged down.

As a result of this, and other circumstances, the Bureau found itself in the unenviable position of approaching the limit of available funds on the Central Valley project in California, a situation which helped lead to an exhaustive inquiry by a committee of the Eightieth Congress as to the Bureau's accounting policies and procedures. After a thorough investigation of the facts, the committee emphasized the importance of an early revision of the Bureau's accounting and related procedures.

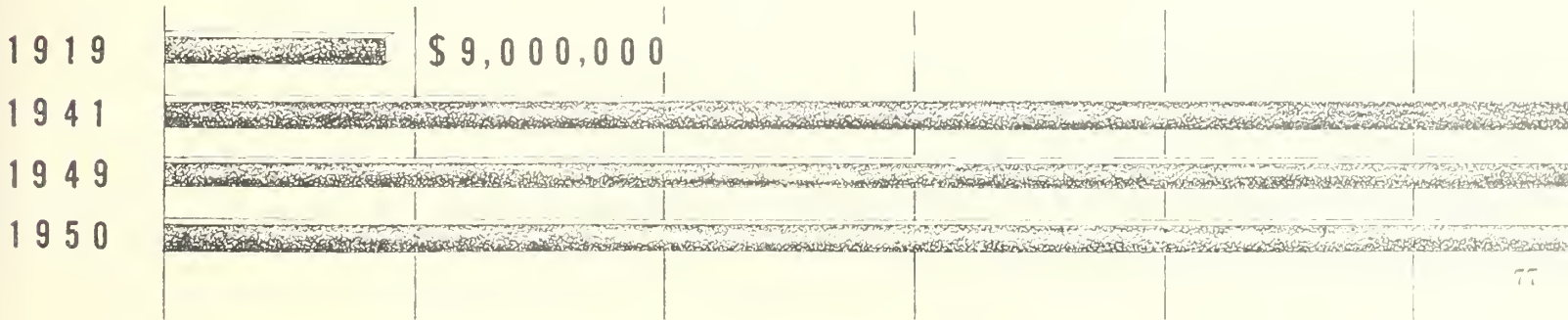
Accordingly, Congress instructed the Comptroller General, in charge of the General Accounting Office, to work out with the Secretary of the Interior an improvement of the accounting work system of the Bureau or Reclamation. This was done by means of an inter-agency committee, a group composed of representatives of the General Accounting Office, Bureau of the Budget, Treasury, Office of the Secretary of the Interior, and the Bureau of Reclamation, which held several meetings in Washington, D. C., and Denver, Colo., where they discussed the problems involved, developed the general procedure and method of approach and drew up a set of recommendations, which were approved by the Commissioner of Reclamation.

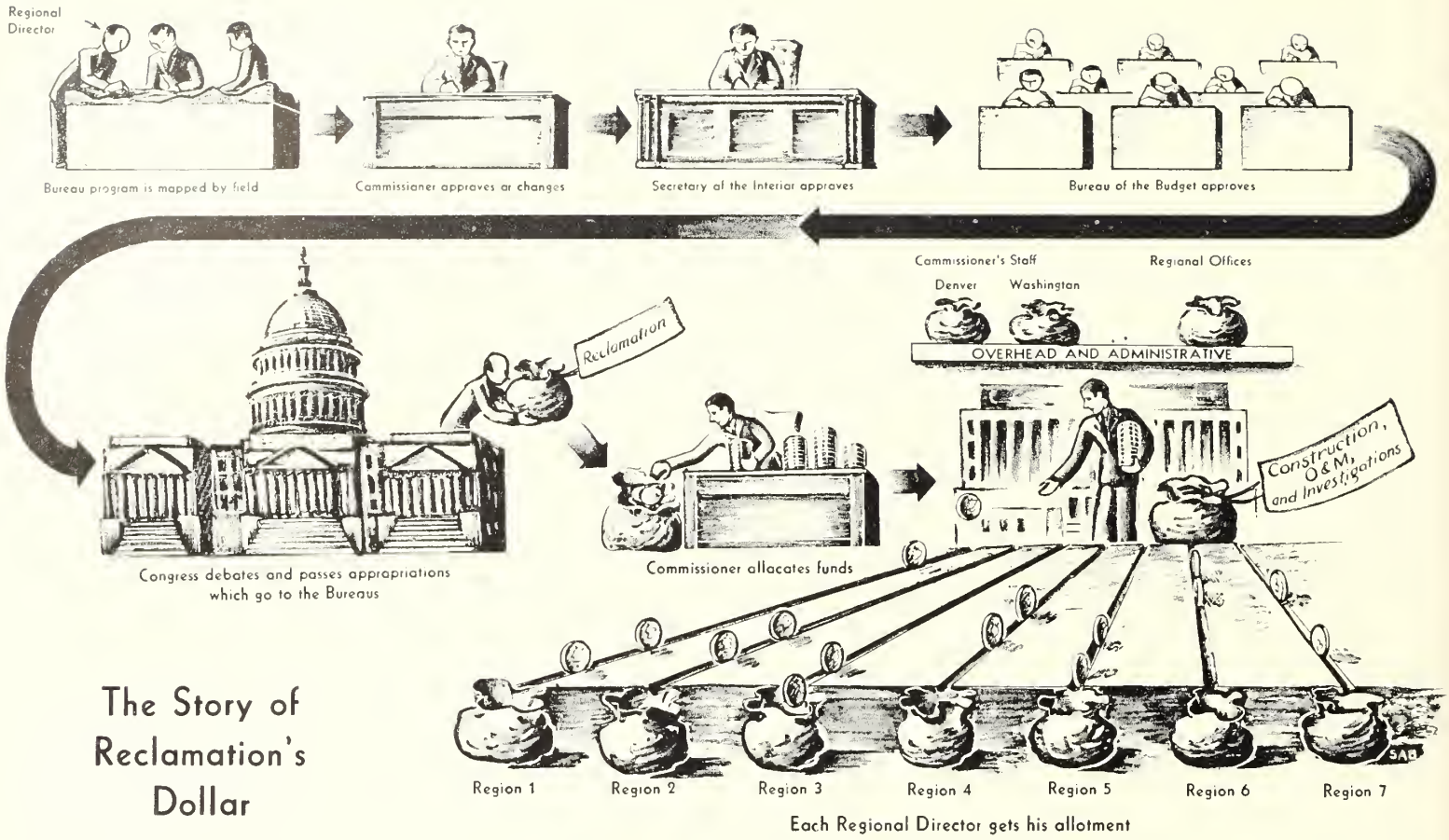
The more important of the approved recommendations, establishing the basic principles of the new system, are as follows:

(*a*) The project would be considered the "accounting entity" or the level of Bureau operation for maintenance of the books of accounts. The project would be considered as the basic unit, the center of its own operations and all accounting material would feed in and out of the project office, giving on-the-spot checks and balances.

(*b*) The modified Federal Power Commission classification of accounts was adopted as the basis for the general ledger accounts. This brought the Bureau's method of accounting in line with standard regulations and systems of accounting which are followed by the Federal Power Commission, the

RECLAMATION APPROPRIATIONS





The Story of Reclamation's Dollar

Interstate Commerce Commission, and private and public utilities.

(*c*) A "Common denominator system" of plant accounts was adopted to apply also to programs and budgets. This would make it possible to match up the various classifications of work done on the projects with the general ledger accounts. For example, after a certain sum of money has been spent for completion of an irrigation system, the sum would be classified into the "Irrigation" (one of the common denominators) plant account. Therefore, in addition to making it possible to determine how much money had been spent project by project, the new system enables the accountants to determine how much money has been spent on such "plant accounts" as Irrigation, Power, Flood Control, and Fish and Wildlife.

(*d*) A procedure for allotment of funds was put into effect so that expenditures could be controlled through a system following principles established by the General Accounting Office. Funds would first be divided up (allotted) to the regions, the Denver and Washington staff offices, and then broken down further and earmarked for certain projects.

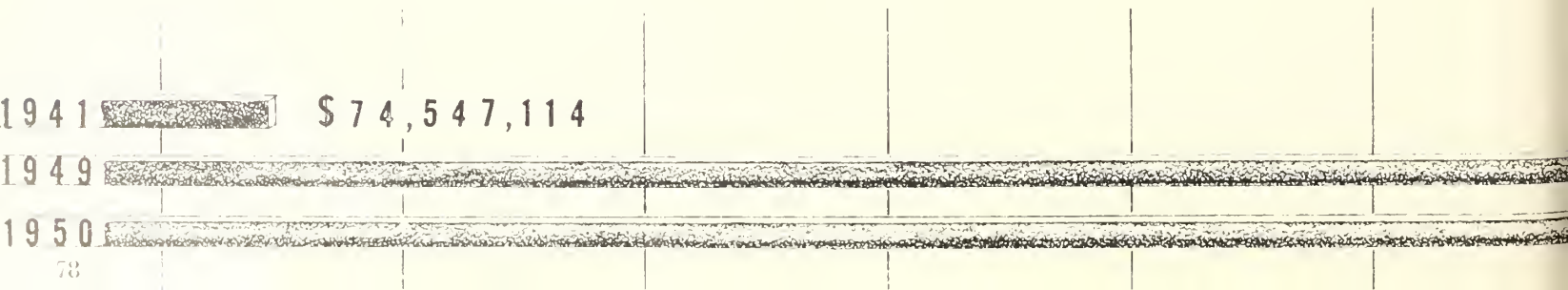
(*e*) Except for Bureau-wide appropriations (allotted by the Commissioner) the regional directors would control the allotment of funds within their respective regions.

(*f*) All reports, including deadlines, for submission of data, would be reviewed, and all unnecessary reports eliminated, to streamline operations.

(*g*) The Washington staff would be responsible for installing the new system and getting it under way, following trial runs in a selected region.

Committee representatives of the other agencies then visited a number of reclamation projects to get first-hand glimpses of what was actually involved in these paper transactions and the reactions of the project personnel to the proposals. After this eye-opener, other meetings were held, changes made in the original recommendations and then began that trial run with the proposed new system in Region 1, with field headquarters at Boise, Idaho.

As members of the Washington office of Programs and Finance, representatives of the General Accounting Office and a picked crew of accountants from Region 1 worked at the actual site of operations, the new principles and procedures were developed and tested. When the clean-up squad had finished, the new system was stripped down to



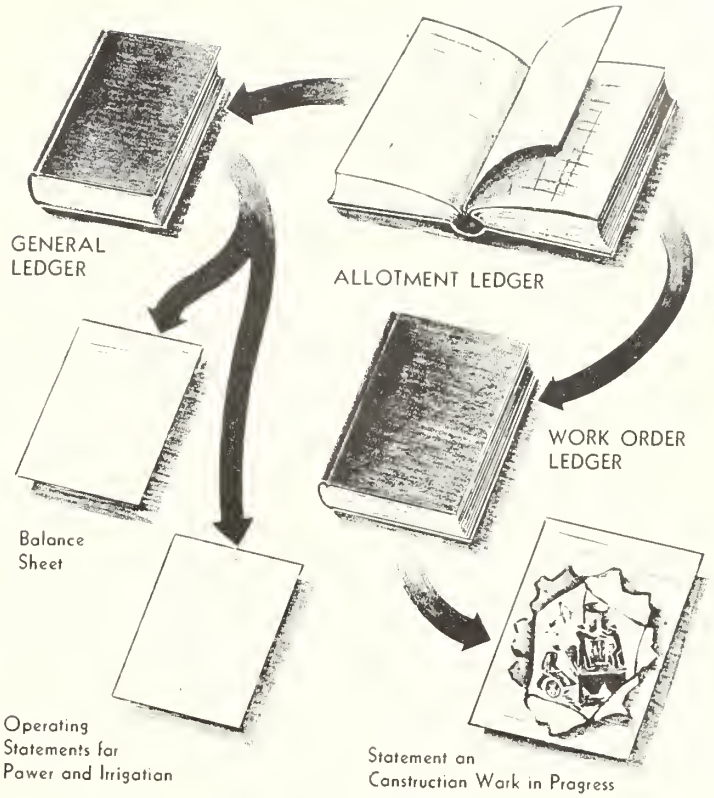
three major elements. First is the general ledger system of accounts; second the allotment ledger system of accounts and third, the work-order system. These three, with related procedures and flow of documents (assembly line charting of papers involved in all transactions) make up the Bureau's new accounting system.

THE GENERAL LEDGER is a standard device for accumulating a record of the money that is spent, in accordance with approved accounting practice, and controlling all related transactions. This means keeping track of accounts, making an orderly record of money that is collected, earmarked or spent, and finally listing the expenditures in the proper plant accounts. The GENERAL LEDGER SYSTEM is so designed that it can handle any type of appropriation, whether the money is spent for construction, general investigations, or operation and maintenance. Its operation makes it possible to prepare a monthly balance sheet or financial statement for each project, including operating statements for power and irrigation. The balance sheet shows how Uncle Sam's investment is coming along—on a credit and debit basis (how much money remains in the project's appropriation, and how much money it has spent, or owes). This balance sheet follows the same form prescribed by the Federal Power Commission for private utilities. The operating statements show income (how much money is coming in from power revenues, payments for irrigation water, operation and maintenance, etc.) and expenses.

THE ALLOTMENT LEDGER is a device developed by the General Accounting Office for Government use to make certain that Federal departments conform with the antideficiency law. This law prohibits any department from spending more money than has been appropriated for certain purposes. In the case of specific appropriations, or limitations set on certain funds, Federal departments cannot juggle from one item to another—if they find themselves short on funds for constructing a project which costs more than they anticipated, for example, they cannot use funds which might be left over in another category. In the allotment ledger, project transactions are listed on a day-to-day basis as they occur—broken down into three categories; encumbrances, obligations, and accrued expenditures, and the difference between these three groups is worth clarifying.

ENCUMBRANCE.—An encumbrance is the amount of money involved in a proposed transaction, which it is known will occur, but which has not reached the status of a legal obligation. In other words, it is money which the project has earmarked for a certain purpose, has made no commitment upon, but will have to pay eventually.

OBLIGATION.—An obligation is an encumbrance which has reached the status of a firm or legal commitment. For example, a contract has been awarded, or an agreement has been reached with a group of water users. In ordinary daily



Reclamation's New Books

business, an obligation could be likened to a sales slip, before the merchandise has been delivered or a bill submitted to the purchaser.

ACCRUED EXPENDITURE.—The accrued expenditure is an innovation in the Bureau of Reclamation allotment ledger. This accrued expenditure is the record of work or service performed or materials delivered, irrespective of whether the vouchers for such items have or have not been paid. The primary purpose is to insure that the accounts are sensitive at all times to accomplished actions, so that project administrators and other officials concerned know exactly the status of funds available to them, unimpaired by the red tape of making payments and other actions often occurring as much as 6 weeks after the work or service was performed or materials delivered. As soon as an allotment ledger is set up and functioning, the Commissioner requires that all reports of earnings of contractors be placed on an accrual basis to the end of each calendar month.

Each day the project accountant subtracts the amounts for the different types of expenditures, encumbered, obligated, or accrued, from the total funds available and thus can determine how much money is left in each category. In this way the manager of a project knows how the funds stand at all times, how much has been used and how much is available for future work. Properly kept and used, the allotment

ENCUMBERED—These simplified pictures of transactions at the Hungry Horse Dam in Montana shows status of funds in the various stages of one operation. Here funds are encumbered for clearing the reservoir site.

OBLIGATED—The contract has been awarded and work is being started. As has been usual in these days of rising construction costs, the lowest bid was yet higher than was originally estimated.

ACCRUED—The contractor and his forces have completed a portion of their work and present a bill for payment. A fourth picture might show $21,000 remaining obligated.

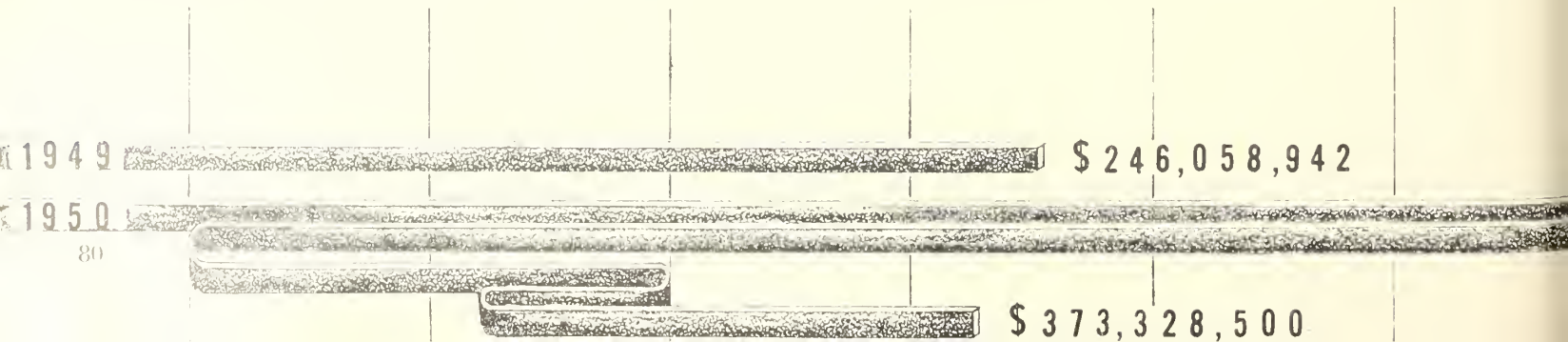
ledger provides a source of fund control preventing any project from overspending the amount available to it.

The third element in the new Bureau system is the Work Order System. This is a combination of work orders and reports on what the work costs. One or more work orders are issued for each item on the Bureau's official program by the project manager. Programs are first approved by the Commissioner, and then are made to conform to the budget and appropriation for the project or activity as passed by Congress. After each region receives its allotment of funds, and the regional director makes an allotment to the projects, the project manager authorizes the work by means of a work order. No work can be performed on the project without this authorization. Thus, throughout the entire Bureau, when the system has finally gone into effect, every penny spent will conform to the Commissioner's approved program, congressional authorization, regional policy, and project authority. The accountants maintain records of cost for each work order on a work-order ledger. The data that goes on this ledger comes from the accrued expenditure column on the allotment ledger so that the work-order ledgers are on a current basis and are kept up to date with field actions. Each month the work-order ledgers are consolidated on a statement showing construction work in progress, which also gives in dollars and cents how much has been spent for each item listed. The accountant then turns this information over to the project engineer in charge of the program so he can determine the progress made on each item and how much money he has available to complete his part of the program. The work-order system replaces the former estimate and authority system used by the Bureau and the ledger replaces the old type cost reports.

These three elements of the new system—the general ledger, the allotment ledger, and the work order—were tested by trial runs in Region I on the Boise-Payette, Minidoka, and Hungry Horse projects. The results of these tests were submitted to the General Accounting Office and the Bureau of the Budget for approval. The Comptroller General approved the Bureau of Reclamation's new system, and authorized it to go ahead with its installation in all Bureau offices, subject to further review by the Comptroller General and any changes which might be deemed advisable in the light of experience.

Following the Comptroller's approval, all regions were asked to submit a schedule of dates for putting into effect the new system in all projects within their respective regions. These schedules were reviewed in Washington and approved by the Director of Programs and Finance so that the trained, and highly experienced, team of accountants who had tested the systems in Region I could have all projects converted to the new system by July 1, 1949. As now scheduled, with Regions I, II, VI, and VII already well under way, the new system of accounting will be in full swing by that time, except for some of the operation and maintenance projects which have been or will be turned over to the water users this year.

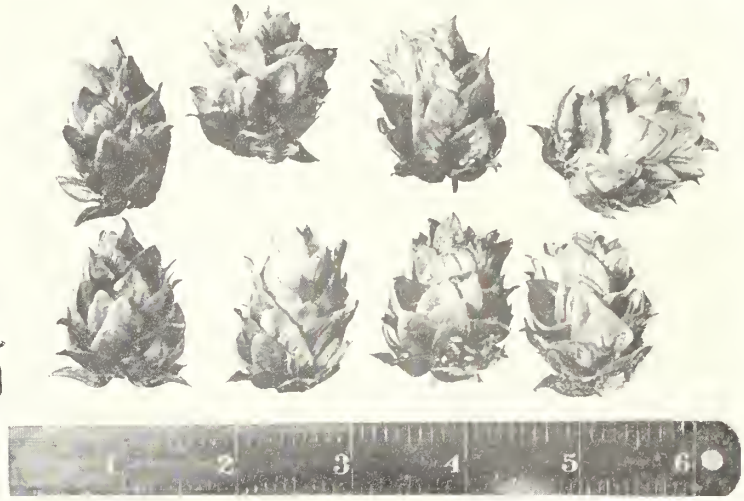
Beginning with the fiscal year 1950 (July 1, 1949) the new accounting system of the Bureau is expected to be functioning normally in all Bureau offices. The End



HOPS

by HU BLONK

Regional Information Officer
Region I, Boise, Idaho



Drawing by Shirley Briggs, close up of hop strobiles made available through the courtesy of the Bureau of Plant Industry, United States Department of Agriculture.

This is the story of the "Hanging Gardens of Yakima." And what they contribute to the prosperity of a lot of irrigation farmers, and, incidentally, to a certain malt beverage frequently consumed in a "garden" designated by its name.

It's worth telling, for 46 percent of the Nation's production of hops comes from the trellis network suspended high over about 13,000 acres of fertile farm land on the Yakima Federal Reclamation project in eastern Washington. The small green leafy cone contributes the flavor to the malt refreshment. Some say it adds "stability" too, whatever that means.

The Yakima Valley in 1948 produced nearly 23,000,000 pounds of the 50,000,000 pounds of hops grown in the United States. Some 11,300,000 pounds came from the irrigated lands of California and a small quantity from Idaho. Thus, if you want to speak with pride about irrigation's contribution to this special crop, it's correct to say that about 69 percent of all the hops grown in this country comes from irrigated land. Almost all of the remaining yield is produced in Oregon, which in 1948 grew nearly 16,000,000 pounds, almost entirely on nonirrigated land in the Willamette Valley. A limited amount came from New York.

The importance of irrigation to hop production is clearly evident from crop figures. The yield per acre on the 13,100 irrigated acres in Washington was about 1,770 pounds and that of the 9,200 acres in California, 1,482 pounds, as compared to 926 pounds per acre for Oregon's nonirrigated hop area of 17,700 acres.

The reason for the greater production on irrigated land is easily explained. With irrigation, which provides an ample water supply, always available when needed, you can grow twice as many hop hills per acre. In irrigated areas, hills are 4 feet apart in the row, in nonirrigated regions, they are normally spaced every 8 feet. The rows in both cases are about 8 feet apart.

Because of the increased production possible, irrigated land in the Northwest is becoming more and more popular as a hop-growing area. Expansion has been particularly noteworthy on the Owyhee project in eastern Oregon, and the Boise project in southwestern Idaho. An additional reason for the shift to irrigated areas is to get away from areas where soils are contaminated with diseases which attack the hop plants. Altogether 2,000 additional acres of hops were planted in 1948, all on irrigated land.

Hop growers have done well in recent years, with foreign imports reduced by war and postwar conditions. At 58 cents per pound, the average per-acre return in the Yakima area in 1948 exceeded $1,000 per acre. But that isn't all profit by any means.

The initial capital investment in a hop farm, including land, poles, wire, labor, preliminary field work, and machinery totals nearly $1,000 per acre. If drying facilities and mechanical pickers are included, the investment might run as high as $2,000 an acre. Portable pickers cost about $10,000 and stationary models as much as $40,000. In Washington, 85 to 90 percent of the crop is picked by machines. With high returns during and after the war years, it took about 4 years to liquidate the original investment in an average Yakima hop farm. Using average returns over a longer period of years, it took about 10 years to liquidate the original investment. Therefore, out of the gross return figured at over $1,000 per acre in the Yakima Valley since 1942, the hop farmer has to take out his payments on his initial investment, and his operating costs, which include annual royalties to be paid on all portable and some stationary picking machines. At that, Yakima hop farmers have been grossing between $250 and $400 per acre above annual operating costs. Hops have shown the highest per acre gross return of all extensively grown crops in the Yakima Valley since 1942. During 1948 about 100,000 bales, weighing 200 pounds each, were grown on 13,000 acres in the valley.

The hop plant is a hardy, long-lived perennial belonging to the nettle family. The vine grows from 6 to 20 feet in height by winding itself around a vertical support, in most cases hop twine. It is one of the temperate zone's fastest

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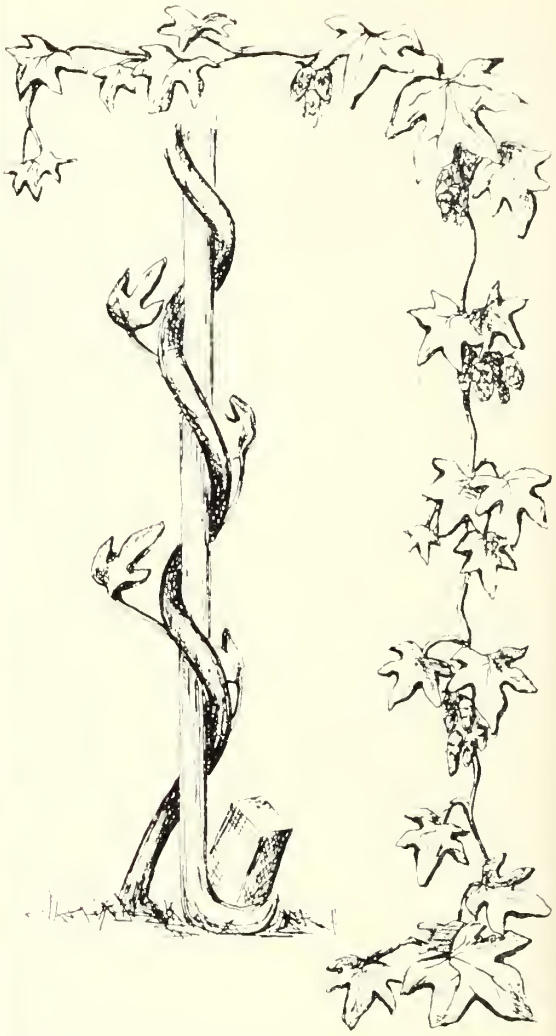


Farmers have a huge investment in producing hops. This is a first-year hop field in the Wilder district of the Boise Project. *Photo by Ben Glaha.* The drawing by Shirley Briggs shows the hop plants twisting around to "follow the sun" in their usual clockwise manner.

growing plants. Twelve inches of growth in 24 hours is not unusual. Many varieties are grown.

Male and female flowers are produced on different individual hop plants, one of the few cultivated plant species to have this feature. Fertilized flowers frequently produce larger, heavier, and earlier maturing hops than those which are not fertilized. It is customary in this country to grow about 1 male plant to each 100 female plants.

The hop plant sends out numerous runners just below the surface of the ground. These are removed by pruning in the spring, cut into pieces bearing two or more sets of buds, and used to establish new hills.

Planting hops is a labor-consuming operation. In the Yakima Valley two pieces of root are usually planted in each hill. From a stake driven into the center of a hill a string or wire is run to an overhead trellis, about 18 feet above the ground. When the vines are about 2 feet long, one to four vines are allowed to attach themselves or are trained to grow upward along this string. When the vines reach the horizontal strings or wires in the overhead trellis further training is necessary.

Inexperienced farmers have had some trouble training the vines as the hops have a freak habit of twisting from left to right, or clockwise. Most plants climb in the opposite direction. These men gave the young vines a few hasty counterclockwise twists around the training string. Shortly afterward they'd find it necessary to do the job over again, as the young hops had unwound themselves. The answer is, "hops follow the sun."

One of the costly steps of hop production is pruning. Excess roots from central rootstock in each hill must be removed. Each side of the hill is cut down, by a hoe or spade, on a slant from top to bottom after the ground between the rows has been plowed in both directions. The remaining hill is about 4 inches square at the top and 12 to 16 inches square at the bottom. Sometimes an inch or two at the top of the root crown may also be removed.

When the hops are ripe they are picked, by hand or mechanically, with all leaves, stems, and other foreign matter being removed. Then comes drying in kilns—a most difficult and important procedure. This is done by spreading the hops loosely on the drying floor of the kiln to a depth of from 1

to 4 feet and by passing heated air through them for 9 to 24 hours. If hops are dried excessively the weight is reduced and the quality of the hops is impaired. If not dried sufficiently, they will be injured in storage and the quality reduced.

Freshly picked hops are about 65 to 75 percent water. When dried they should contain 10 to 14 percent moisture. The technique of drying, involving temperature control, volume and depth of hops in the kiln, ventilation, use of sulfur, and other factors, is usually passed on from generation to generation.

When dried, the hops are pressed into bales, weighing 200 pounds, each by a mechanically operated press. The bales are generally 20 to 24 by 52 inches in size and covered with burlap for shipment to the brewers.

Heavy fertilization is essential in maintaining heavy yields in hops. Barnyard fertilizer is very popular in the Yakima area, where many growers feed beef cattle as a sideline to obtain this essential. Some farmers chop up hop vines and mix it in with the manure. Others plant a cover crop, such as Austrian peas, in the fall and disk it under in the late spring when it is about waist high. Commercial fertilizers are also used.

One grower, Amos Brulotte, who farms 365 acres of hops near Grandview in the Yakima Valley, increased his average hop yield by 400 pounds per acre by putting 15 tons of manure on each acre. Incidentally, Yakima Valley hop farms vary in size from about 10 acres to the 845-acre Yakima Chief Ranch. Many of the owners are of French descent, having learned many of the tricks of the trade from their European ancestors.

Diseases and insects are a distinct problem in raising hops. Spiders and aphids are the principal insects requiring control. Downey mildew is a particularly bothersome disease and experiments to find varieties resistant to it are being conducted. Nicotine sprays and HETP are used to control the insects, with yard (or field), sanitation, crown treatment and dusting, and spraying with copper fungicide constituting control measures against mildew.

Ninety-eight percent of all hops grown in the United States are used in the manufacture of ale and beer. From one half to four-fifths of a pound of dry hops are used in each 31-gallon barrel of beer. In addition to imparting a characteristic flavor to beer, ale, and other malt beverages, through a substance in them known as lupulin, consisting of resins and essential oil, the hops serve as a medium for bacterial development. Also certain materials occuring in the hops aid in clearing the brew after boiling. No satisfactory substitute for hops has ever been found for this purpose.

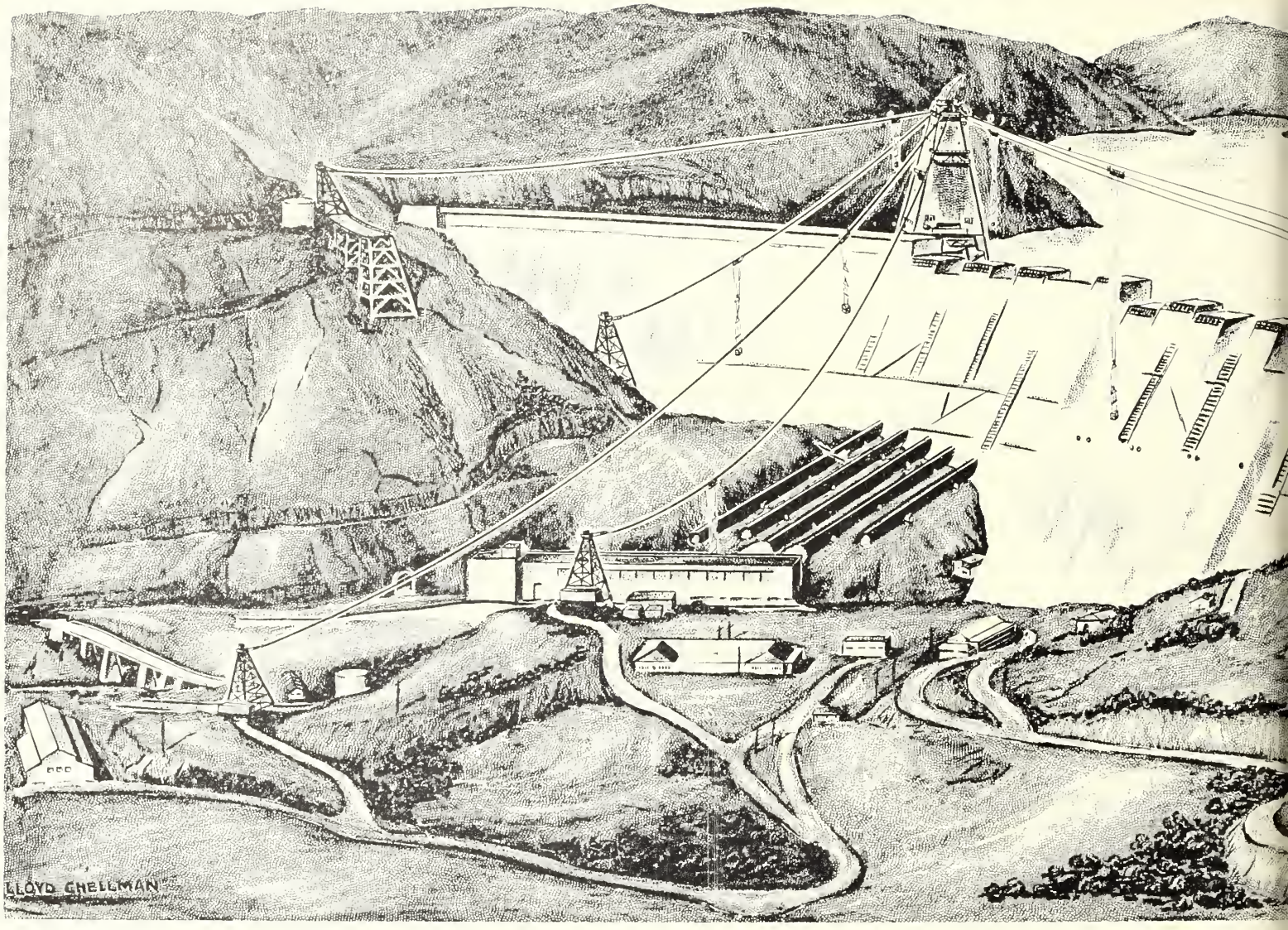
Hops were originally used by the Greeks as a salad. They were initially used for brewing in Germany or Russia, probably as early as A. D. 768. First hops were grown in this country in 1629, some plants having been brought over on the *Mayflower*. The Pacific coast saw its first plants in 1859. Several yards in the Yakima Valley are over 35 years old.

Competition in hop raising is apt to be a lot keener in the next few years, with surpluses in prospect, than it was during the war. While beer consumption in the United States has increased more than 100 percent between 1935 and 1948 the consumption of hops in the manufacture of beer increased only 33 percent, mainly because of a consumer preference for beer with a low hop content. The upper limit of beer manufacture, at the most likely hops-beer ratio, would require considerably fewer hops than were produced in 1948.

Furthermore, increased quantities of European hops are being imported. Foreign hops are produced more cheaply than domestic hops primarily because of lower wages in Europe. Then, too, brewers feel that foreign hops are more desirable—a feeling which local growers "pooh-pooh"—and therefore they command a premium in price.

To overcome the surplus, growers are planning to work out a marketing agreement under the Federal Marketing Act, similar to the one they operated under in 1938. A board would be set up, consisting of growers, dealers, and possibly brewers, which would determine control measures year by year. Lower prices for hops is not the solution to the surplus problem as the brewers are the only potential purchasers and they can only use a limited amount. THE END

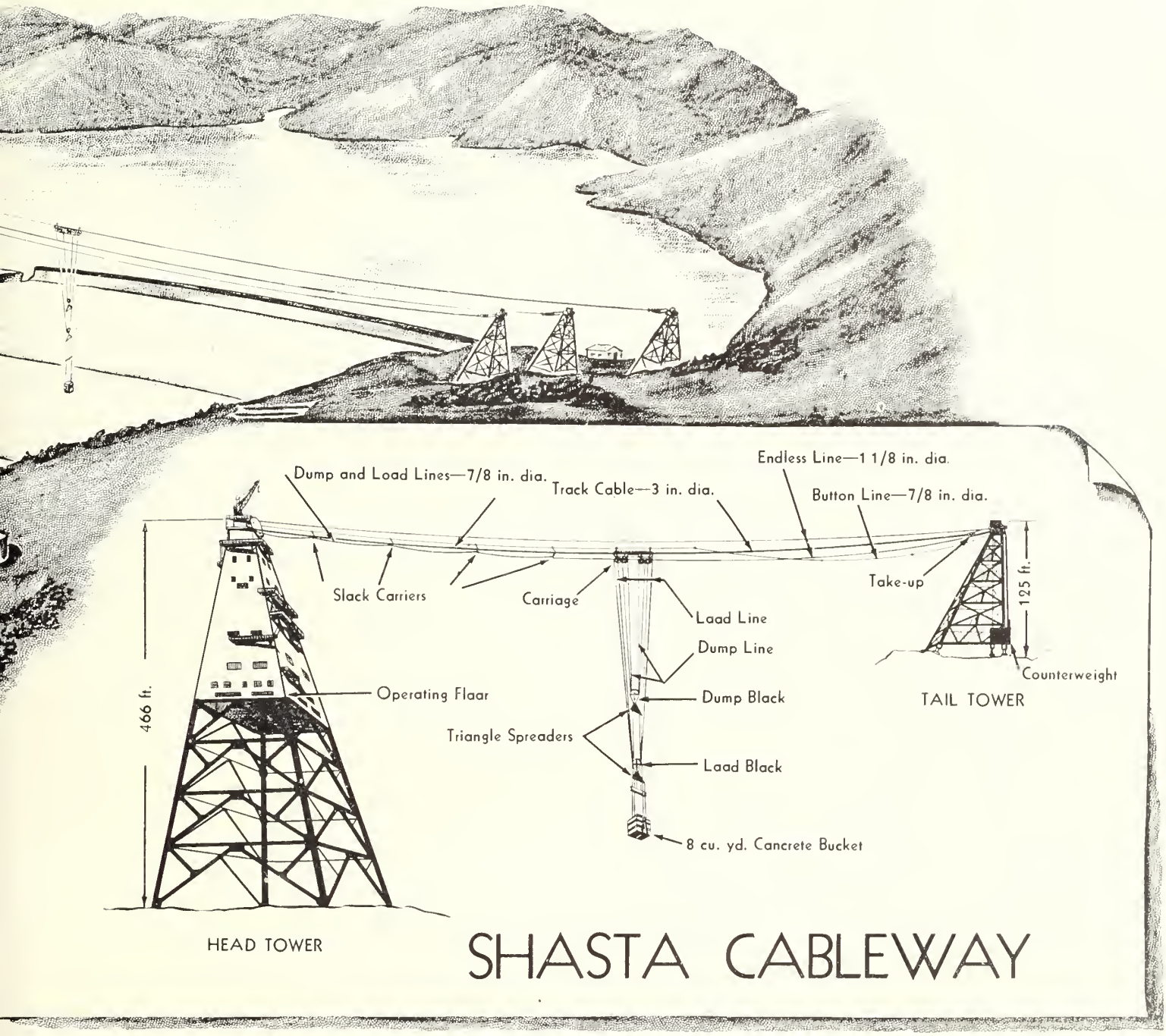
Directly below are portable pickers costing $10,000 which are used in the Moxee Bend country of the Yakima project, and the picture at lower right shows Yakima hops enclosed in huge bags, headed for the drying kilns. *Both photos by Stanley Rasmussen of Region 1.*



DUMPING CONCRETE by Remote Control

In our last issue we published an article entitled "The Passing of the Shasta Skyway" describing the operations of the aerial cableway used during the construction of Shasta Dam. In that article, Robert Midthun, the author, who is chief guide at Shasta Dam, stated that the concrete buckets could be dumped at the construction site by the control operator at the central head tower, even though the buckets were out of his range of vision. Because this statement aroused so much comment, we thought it worth while to do some additional research into the question. With the help of the Sacramento, Calif., office, and numerous technicians in the Bureau, we are able to present this detailed illustrated explanation as a matter of interest to our readers. Among other things, this demonstrates that, when it comes to reclamation engineering, practically anything is possible.

The cableways were rigged (cables arranged) in such a manner that the weight of the 8 by 6 by 6 feet concrete buckets could be carried by either of two 7/8-inch cables referred to as the dump line and load line. These cables were raised and lowered by hoist and load drums located on the operating floor of the head tower. These drums could be operated separately or synchronized to move at the same rate. The hoisting drums were controlled by a cableway operator who was stationed on the same floor facing the construction area. The cableway operator received his instructions by telephone and bell signal from the signal man (bell boy) who was stationed within a few feet of where the concrete was being placed. Much of the concrete was dumped out of sight of



the operator and as far as one-half mile distant from the head tower. All dumps were on signal from the bell boy who in turn took his cue from the pour foreman. At no time did the cableway operator dump concrete of his own volition, though the placing operation was plainly within his view.

With a full bucket of concrete in transit, from head tower to point of placement, the load blocks were carried high relative to the dump blocks which resulted in the weight being carried directly by the bottom of the bucket—something in the manner of a person placing his hands under a box of fruit to prevent the bottom from dropping out. This was an important safety feature in the design of the bottom dump bucket in that, barring a cable failure, there is no chance for the concrete to be released unintentionally over the heads of the workmen.

After the bucket had been lowered to the point of placement, the safety dogs were released by a man in the pour, the bell boy (by bells or verbally by phone) then instructed the operator in the head tower to dump the bucket. The operator dumped the bucket by simply transferring the load from the cables holding up the bottom of the bucket to the cables attached to the top edges of the bucket, thus allowing the bottom to "fall out" of the bucket. The transfer of load could be done either by holding the load block and hoisting the dump block or by holding the dump block and lowering the load block. Both methods, with variations, were used, depending on the circumstances under which the dump was being made.

The End.

Shasta Dam Builder Retires

by C. T. DOUGLASS

Materials Engineer, Branch of Design and Construction, Denver, Colorado

One of the men chiefly responsible for the Shasta cableway (see "The Passing of the Shasta Skyway" in the February 1949 issue) chief Construction Engineer Ralph Lowry, whose long and colorful career included the assignments as construction engineer at Shasta and Hoover Dams, retired last December after having served the Bureau for 35 years.

Recognized as one of the leading administrators in the heavy construction field, Mr. Lowry was appointed to administer the Bureau's vastly expanding construction activities from the Chief Engineer's office in 1945.

Mr. Lowry began his engineering career with the Bureau as an instrument-man on the Yakima project shortly after graduation from Washington State College with a B. S. in civil engineering and from which college he earned his master's degree in 1917. It was to this project, at Sunnyside, Wash., that Mrs. Lowry (the former Gladys Waller, daughter of the late Vice President O. L. Waller of Washington State College) came as a bride June 7, 1917.

From Sunnyside, Mr. Lowry was transferred to the Denver office in May 1918 where he was assigned to design duties in the mechanical, electrical, and dams sections, an assignment that assisted in preparing him for future achievements.

The first assignment of construction responsibility came when he was assigned to the McKay Dam, Umatilla project, Oreg., as resident engineer in 1923. At the completion of McKay, July 1926, there came a period of uncertainty and the inducement of other offers which resulted in his employment for just 1 month with the Aluminum Co. of America at Pittsburgh, Pa. Mr. Lowry describes this separation as "an event which made me realize that the wide open spaces and the tighter handclasps did not extend that far east." He returned to the Bureau as construction engineer at Gibson Dam, Sun River, Mont., August 30, 1926. After this assignment was completed in July 1929, he was engaged for a year on the design and preliminary investigations of Cle Elum Dam, Wash. He was appointed field engineer at Hoover Dam in 1930 and in 1935 he succeeded Walker R. Young as construction engineer when Mr. Young was appointed supervising engineer of the Central Valley project. Under Mr. Lowry's direction, the dam was completed and the powerplant put in operation.

In 1938 with the plans for the vast construction operation on the Central Valley project well under way, he was appointed constuction engineer to direct the building of Shasta Dam, the second largest and second highest concrete dam in the world, and a key feature in the great project. Upon virtual completion of Shasta Dam in 1945, he returned to the Denver office as assistant chief engineer, construction, and following the reorganization of the branch of design and construction in August 1948, he was designated chief construction engineer.

Construction Engineer Ralph Lowry

Mr. Lowry relates that he has made no future plans, but there is a good reason to believe that his 35 years of outstanding public service will not permit him to vacation long.

As for hobbies, Mr. Lowry states that "I like all sports, but participate only in golf, poker, and a friendly joke or two. I have always had a lot of fun with my work and have enjoyed the association with people who do see the humorous side of life." Just how much trouble or worry he experienced over his assignments, no one was able to observe.

Although firm in his convictions, he has the ability to deal fairly and impartially with his coworkers which he has used to good advantage both in maintaining high morale in the Bureau and cementing relations with contractors and other agencies.

Although Mr. Lowry has been rigorous in his demands for construction in accordance with Bureau specifications, contractors have found him to be fair and understanding with a keen appreciation of their problems. He has steadfastly stressed the importance of emphasizing standardization and decreasing costs of construction.

The Lowrys have two children, Robert and Ralph, Jr. Robert, a graduate of the University of Michigan with a degree in marine architecture, is employed by the Maritime Commission in Washington, D. C. Ralph, Jr., or "Ted," is attending the University of California and will graduate in civil engineering in June.

Mr. Lowry is a member of the American Society of Civil Engineers and the Sigma Nu Fraternity. •

'Bonifica' in Italy

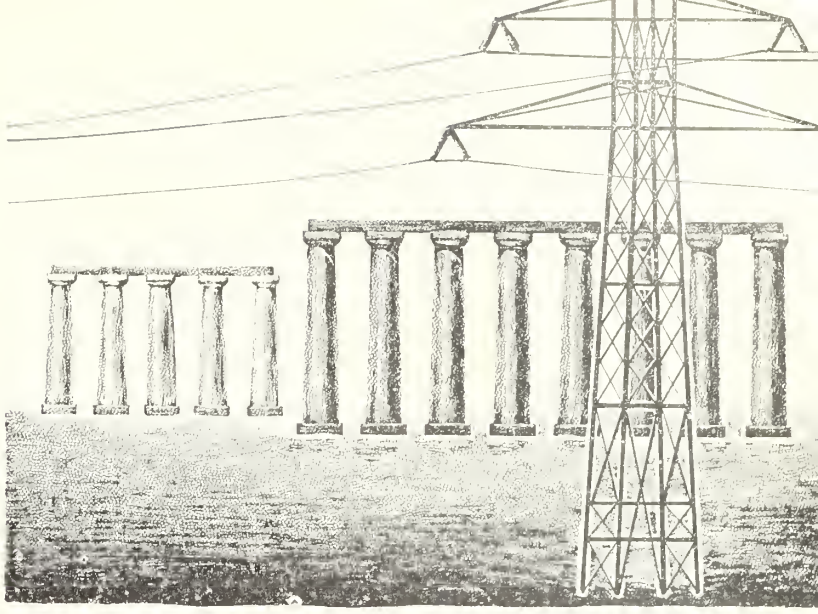
(Part Two)

[*The Italian equivalent of our word "reclamation." Loosely translated it means "for the good of the land."]

by GEORGE E. TOMLINSON

Assistant Director, Branch of Project Planning
Bureau of Reclamation

EDITOR'S NOTE.—The August 1948 issue of the RECLAMATION ERA carried a brief account of Mr. Tomlinson's observations and impressions during his recent 6 weeks' tour of Italy. At the request of the editor, a number of additional items, selected at random from the many notes he accumulated during the mission to Italy, are given here. Space does not permit the inclusion of more than a few, and consequently those selected were chosen because of their probable reader interest, and are not intended to give a complete cross-section of Italian life and customs.



Symbols of Civilization: Though 2,500 years apart, the modern transmission line which spans the Temple of Apollo, could not have been strung without the knowledge of mathematics once taught here. *Drawing by Shirley Briggs, based on a photograph taken by the author.*

Italy is more a country of extremes than I had imagined. The rich people are very rich and the poor people are very poor. Numerous beggars congregate on the principal downtown streets such as Via Vittorio Veneto in Rome, and it is difficult to reconcile the appearance of these destitute looking beggars in front of the swanky shops where roses sell for 200 lire (35 cents) each.

A meal in one of the better Rome restaurants costs about as much as 2 days' wages when measured in terms of a peasant's earnings—when he can find work. It is not unsual to observe a wealthy family of 2 or 3 persons living in a 20-room house and within a very short distance to see 20 or more peasants living in 2 or 3 one-room shacks.

As we traveled through the various cities, towns, and countryside, it was not unusual to see extremely modern buildings standing between others dating before Christ. I was particularly impressed by the sight of the ruins of a 25-century-old temple in which Pythagoras used to teach mathematics (and where he presumably developed the classic Pythagorian rule relative to the right triangle) pictorially framed by a newly erected transmission line. (See drawing above.)

One evening I mentioned to an Italian engineer the difficulty that I was having in mastering Italian phrases. He smiled and told me some of the difficulties he had when he was learning English. After a few lessons he was asked to spell "fish" in English. He thought a while and answered, "g-h-o-t-i." His surprised interrogator asked him how he arrived at such an answer. He replied that in English, "gh" had an "f" sound as in "enough"; "o" had an "i" sound as in "women" and "ti" an "sh" sound as in "nation." We both laughed, and I became somewhat more resigned to the difficulties attendant to meeting my privately established goal of learning one new Italian phrase each day.

Language difficulties were largely overcome, however, by our expert interpreter, and in the 6 weeks' visit I was able

Italy has a weed-control problem, too. This small "sternwheeler" launch travels up and down the canal slicing away at the weeds and grasses. The photo at the left is a close-up of the weed cutter.

to get a clear picture of the Italian form of "bonifica," or reclamation.

The Italian Government is keenly interested in developing the national resources of the country, realizing that the future of Italy lies not in her glorious past but in the optimum utilization of her potential for dams, hydroelectric plants, improved agriculture, and industry.

It has been the custom of the Italian Government to furnish grants-in-aid for the construction of works to develop water, land, and power resources. Each project so aided was made the subject of special legislation by the Italian Parliament—following a procedure not wholly dissimilar to the way many American reclamation projects are authorized by Congress. However, the Italian reclamation law provides larger subsidies than does the American reclamation law. A large portion of the Italian irrigation development, and practically all of the power development, has been done by large corporations—usually with financial aid from the Government. In the field of land reclamation, the Government has administered projects only in special cases, mainly the program of resettlement of war veterans. However, the Government has been indirectly responsible for much of the development of "bonifica" by extensive financial contributions, and in cases where subsidies are granted, by insisting that the landowners form a "consortium," or reclamation district, to carry out the prescribed works. (EDITORIAL NOTE.—Consortium is a very broad term, and "Reclamation district" is only one of its specific meanings.)

Reclamation legislation enacted during recent years provides five general categories of national assistance in southern and insular Italy:

(1) Reservoirs for general conservation purposes, reforestation projects, and works of a similar nature may be paid for by the Government in full:

(2) Major irrigation and drainage works, including diversion dams, canals, land leveling operations and local farm roads receive varying subsidies up to 87½ percent;

(3) Rural water supply aqueducts receive financial assistance up to 75 percent;

(4) Transmission lines and substations for power distribution receive subsidies up to 45 percent;

(5) Rural buildings, including farmhouses, farm structures, and similar items receive 38 percent aid. This percentage may be higher in areas such as mountain and hill country where work is more difficult and land is poorer.

Power installations are insufficient to meet present requirements, much less future loads. Only on the island of Sardinia is there coal for power generation. The total supply of natural gas and oil is inconsequential. Italy has taken great strides in developing power from its volcanic steam from hot springs by means of geothermal power plants. However, they have not been any more successful in using aerogenerators to harness the strong winds which are ever present in much of their south and southeastern windy areas than we have been in our windswept Western plains. Consequently, the required expansion of power supply for farm, industrial and municipal use calls for the development of every available hydroelectric resource.

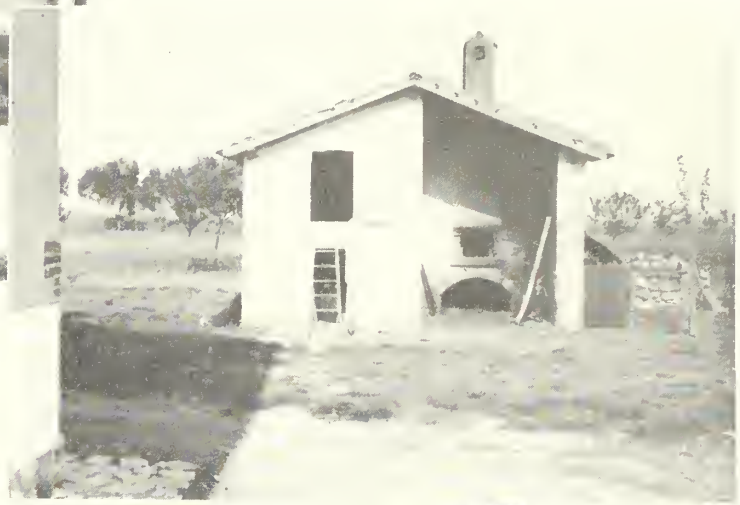
A large increase in hydroelectric power is possible. Based on the assistance expected to be received from the ECA program, the total potential electric power capacity and production for all Italy is about as follows:

	Installed capacity (million kilowatts)	*Energy (billion kilowatt-hours)*
1948	6.165	22.100
1949	6.522	23.400
1950	7.097	25.000
1951	7.811	27.650
1952	8.556	30.430
1953	9.136	32.800
United States total production in 1948 for comparison	69.486	336.335

Of the amounts, the distribution throughout Italy is approximately as follows:

	Percent
Northern Italy	66
Central Italy	20
Southern Italy	9
Sardinia and Sicily	5

Familiar Roadside Scenes in Italy: At right, inch-thick campaign posters; below, heavily pruned trees at Calabria; and lower right, a storage pile of crushed rock, marked to prevent pilfering.



Veteran Settlement: Here is one of the farms provided veterans of World War I, in the 1930's. Each family received about 50 acres of land reclaimed from the once mosquito-infested and malaria-breeding Pontine Marshes. *All photos taken by the author.*

Even before the war, Italian engineers began building underground hydroelectric plants with powerhouses excavated in the deep rock. Long tunnels are frequently used for intake and tail race features. A number of such plants are in operation and others are under construction. We inspected two of these plants under construction—one in Sardinia and one in northern Italy near the Austrian border. The plentiful supply of labor, which is inexpensive and especially skillful in quarry operations, improves the economic feasibility of such work. With the advent of the atomic age such underground facilities may become even more common in the future.

The interconnection of the many local power systems in Italy has been handicapped in the past by the variation in the frequencies used in the different systems. Until recently, each company was at liberty to adopt any convenient frequency with the result that frequencies ranged from 16 to 50 cycles per second, making any general interchange of power between systems impracticable. The present law requires standardization of all new electric power installations at 50 cycles, the common European frequency. This law also requires that all existing systems be converted to this new standard by 1952. Although several officials of private utilities told me that it probably would not be possible to meet this deadline except in a few cases because of critical shortages, the law is evidence of a step in the right direction. Equipment now on order or being installed in systems not yet operating on 50-cycle frequency is often designed for two frequencies—one, the frequency now in use in the local system and the other, the adopted 50-cycle national standard frequency.

Improvised Fuel Conservation Measures

Italy is perhaps as nearly devoid of fuel resources as any major country in the world. She has practically no coal, natural gas, or petroleum reserves. Because of this she must improvise to the maximum extent, even though it is possible now to import large quantities of fuels.

I was especially interested to observe the degree to which the people in the rural sections prune their vineyards and trees, and the care with which they save the amputated trunks and branches for firing their bake ovens. The picture on page 88 shows how the ever present plane trees along a roadside in Calabria had been pruned so they resembled telephone poles. Fortunately the climate is such that these trees "come back" quite satisfactorily despite the heavy and continued pruning.

Another good example of how Italy employs good husbandry can be seen in the neatly arranged piles of crushed rock, stacked along the roadsides and ready to be used for filling holes and for other maintenance work. This material acquires a rather high value because of the cost of crushing. Mechanical rock crushers are seldom used and "the big ones are made into little ones" by hand labor. Italy has a large number of unemployed, estimated at about 2 million in 1948, although Italy's employment program is so complex that the actual number has never been accurately computed. This available labor is used to the fullest practicable extent on roads and other public work programs. In order to prevent the peasants from pilfering rock for use in paths around

their cottages the storage piles are usually painted with a series of straight-lined black stripes so that the motorcycle police, motorized "carabinieri," can determine in a passing glance whether the pile has been molested. The photo on page 88 shows such a pile on the highway west of Menfi, Sicily, but this picture could well have been taken in any of a dozen Provinces.

Veteran Settlement in Pontine Marshes

The land reclamation in the former Pontine marshes is an interesting development. This area, only an hour's ride from Rome, has been the object of various drainage and reclamation schemes since the days of the early Caesars. After the fall of Ancient Rome, the general abandonment of the area allowed tremendous swamps to form in which mosquitoes bred, creating a virulent malaria zone. The present project was initiated by Mussolini in the 1930's as a resettlement scheme for the Italian veterans of World War I. Because it is convenient to Rome, the Fascists attempted to make an elaborate exhibit out of it to show the Italian people and the many foreign visitors what the Government was doing for its war veterans. Each family was provided with a stone house, stable, bake house, tool shed, hayloft and other small structures (as shown in the photograph on p. 89) together with approximately 50 acres of land. He was required to repay the Government a portion of the cost of this project over a period of years. The average peasant on this heavily subsidized project is not having any difficulty in meeting his payments because the lira today is worth only about one-fiftieth of what it was when the project was begun and the original repayment contracts drawn, and because the repayment contracts have not been readjusted proportionately.

Weed Control in Italy

The fact that weeds grow in some canals at the rate of about 2 inches a week presented a serious problem which was finally solved by employing a small "sternwheeler" launch, shown in the photo on page 87, which travels up and down the canal dragging a heavy iron V. The outer edges of this iron are sharpened, and the V is dragged point first in a series of jerks (by utilizing a cam arrangement on the launch) in such a manner that it does an effective job of keeping the weeds and grass under reasonable control.

No report on Italy in the spring of 1948 would be complete without some mention of the political scene, for the Italians took their recent elections seriously. Each of the 37 political parties made the most of every possible opportunity to sell its cause to the entire population. Loudspeaker trucks were omnipresent, intermittently dispensing canned music and political speeches. Sidewalks and streets were painted with the symbols of the various parties. The victorious Christian-Democrats developed a method for stenciling the streets and highways in a rapid and efficient manner. This method consisted of towing a drum resembling a small road roller which was so perforated that it continually printed a cross-inscribed shield, the symbol of their party. Although it was illegal, many of the parties painted their symbols and election appeals on the sides of the buildings, bridges, and other structures. Apparently it was perfectly legal to put up posters wherever one pleased, and in some of the better downtown locations the walls contained layer upon layer of election posters until they were sometimes more than an inch thick. As soon as some new poster would appear at one of these choice locations, loyal workers of another party would rush up to superimpose their own. Inasmuch as paper was one of the more critical items, it was difficult to learn where or how the necessary newsprint was obtained, but I imagine the various parties had been hoarding this material for quite a while. The photo on page 88, taken in the picturesque town of Ravello, shows a typical, but not extreme, example of the use of campaign posters.

The United States is making good its promise of assistance. Italy, in consultation with ECA, is developing plans for the use of local currency counterpart of approximately 70 billion lire (about 122 million dollars) and has tentatively allotted this amount for its bonifica program in the year 1948–49. Of this amount, ECA to date has actually approved requests from the Italian Government totaling approximately 3 billion lire.

It is understood from unofficial sources that the Italian Government is considering the following types of projects for its 1948-49 bonifica program:

	$ Equivalent of Lira Counterpart
Land reclamation and irrigation:	
New public work projects	$68,000,000
Repair to public works damaged by war	4,850,000
Land improvement:	
Subsidies for private works	25,000,000
Contributions to private concerns (other than cooperatives and colonization agencies) for installation and equipment of processing plants	2,600,000
Contributions to expenses for labor and instrumental goods in favor of direct cultivators	6,800,000
Improvement of salt lagoon fishing activities	350,000
Agrarian credit for improvements	1,750,000
Establishment of small landed property:	
Integration of Government share to form the Fund for the Establishment of Small Landed Property	1,750,000
Contributions to expenses for instrumental goods in favor of direct cultivators	1,750,000
Contributions to fund for S. L. P. for purchase and apportioning of holdings	6,600,000
Miscellaneous:	
Professional education of farmers	850,000
Pest and parasite control	350,000
Research and experimentation	400,000
Hybrid corn project	510,000
General expenses of the ministry of agriculture for implementing the above programs	240,000
Total	122,000,000

I am confident that continued progress will be made. As a Reclamation engineer, deeply concerned with resources development throughout the whole world, I sincerely hope that "bonifica" succeeds in Italy. Any depressed area is a potential focus for future world trouble. Italy's future welfare and ours are mutually dependent on a broad spread of contented and prosperous citizens without regard to national boundaries.

THE END.

OPERATION AMERICA

Based on an article by J. CLARK GOLLEHAN, Gila project, Ariz., news items and information from the Branch of Operation and Maintenance, Boulder City, Nev., Region III

Last November, the RECLAMATION ERA published a story entitled "Remaking a Farm in a Day" telling of a well-planned, superbly organized, rehabilitation program on the Tucumcari project in New Mexico, which required the cooperation of local, State, and Federal agencies as part of a Nation-wide program of soil conservation and utilization.

Here is a story of a similar demonstration. But no lengthy conferences were held, no long-range plans were drawn up, no written memoranda of agreements were signed. It was a spontaneous, unrehearsed performance—democracy in action.

Now that it's all over, nobody will come forward and claim the whole credit for the original idea and starting the ball rolling. That's because everybody pitched in and helped. If each one hadn't voluntarily carried his or her own share of the load, there wouldn't have been any credit for anyone.

Some say John Snyder was ready to quit. But there are others who would bet their bottom dollar that John wasn't the quitting kind. But here in the Southwest, we don't wait until a man is completely licked before we give him a helping hand, and as for credit, well, just say we wanted to keep a good neighbor. Or you might even chalk it up to the Christmas spirit, if you wanted to.

It all happened during the week between Christmas and New Year's Day. Word got around somehow that homesteader John Snyder was running into a lot of hard luck. He was the young veteran whose name was called first at the public drawing for 26 Yuma project homesteads at Yuma, Ariz., on March 10, 1948. He was farming with his father in Pennsylvania at the time, but as soon as he got word from the Bureau of Land Management that he had won a 70-acre homestead, he loaded his truck and drove out to see the first land he had ever owned. He had fallen in love with the Southwest when he was in the Army, stationed near El Centro, Calif., 55 miles west of Yuma and had lost no time in applying for a homestead when he saw Public Notice No. 59 announcing the opening. What he felt when he first saw his brush-covered farm is something we may never know. But we do know he didn't let the sight of a sagebrush waste discourage him. His Pennsylvania Dutch ancestry stood him in good stead. Irrigation farming was new to him, but he didn't have to worry about the actual irrigating of his land at first. Actually he had no land ready to receive the water. His first job was to clear the brush from his place. He did a lot of hard work hand grubbing, but that was too slow—besides he soon learned he had to keep an eye out for rattlesnakes. It wasn't too much like farming in Pennsyl-

At the top of the page is the happy Snyder family, including the two small daughters, Brenda Rae and Teresa Ann. Below, the volunteer army and some of its equipment which staged a successful maneuver against Snyder's former sage-covered acres. ***Photo at top of page taken by Samuel B. Watkins, Region III.***

vania. But he was determined to see the thing through and rented a D 8 Caterpillar tractor and dozer from the Bureau of Reclamation. He operated the machinery himself, and hired several Mexican laborers to pile and burn the brush. With his trained farmer's eye he picked out 20 acres of land that had been farmed many years ago, and concentrated on raising flax on that area as it promised the quickest return for his labor. By that time his savings, which he had accumulated since leaving school and during his service in the Army, were being gradually wiped out. But he stubbornly began leveling away on another block, which he hoped he might get planted to flax so he would have some cash income in 1949 to pay for preparing more land for production.

It was a couple of days after Christmas, Monday, December 27, 1948, when George Lott, a prominent farmer from the lower end of the valley, "just happened" to come along with a piece of heavy machinery, a tractor and scraper, and set to work helping John level the field. Perhaps he had heard of Snyder's difficulty, thought he'd take a look around, and during that day sized up the situation—the stubborn young man from the East, hacking away at the land, and trying against heavy odds to make his dream of a Western farm come true. Whatever happened that evening, next day 12 or 15 pieces of land leveling equipment and operators appeared on the scene and went to work. On Wednesday more than 20 pieces of leveling equipment were hard at work, including 13 crawler and 7 wheel tractors, making the Snyder ranch as level as a pancake. Pickups, Jeeps, and trailers, with ant-like activity, hauled away uprooted stumps which were loaded and carted off by a crew of Mexican laborers. Not to be outdone in this community movement, which grew as it gained momentum, the Future Farmers of America, supervised by C. D. Crawford, their advisor, went out on Thursday and hauled brush out of the way of the army of land levelers advancing across the field. The ladies were certainly not going to be left out of it. They cooked and served a noon barbecue each day. The merchants and business establishments furnished food for the one hundred or more hungry workers during the Snyder farm's facelifting. Yuma's lumber dealers furnished lumber for turn-outs; each day a different petroleum dealer or merchant furnished tractor fuel; and the hardware dealers handed over such necessary items as nails, bolts, and pipe for a well. Lester Barkley kept the surveying and leveling operators moving along smoothly; ex-sheriff J. C. Hunter took on himself the job of rustling up the grub each day, and Mr. E. M. Johannsen was kept busy procuring materials for turn-outs, gates, etc., as well as Diesel fuel and gasoline for the tractors. Within a few days the volunteer army had done a job which would have taken Snyder many months to accomplish alone—if he had been able to stretch his dwindling cash reserves that long. It was reminiscent of the "log-rolling" days back in Pennsylvania when Snyder's forefathers pooled their labor and other resources to erect each other's houses. When the job was done, Snyder found that he actually owned more irrigable farm land than the Bureau's surveys had indicated—the friendly neighbors had leveled land that was originally not considered feasible for development.

Writing in the Yuma Daily Sun, Chuck Maberey termed the incident on the Snyder ranch as "Operation America." The reporter declared, "Anyone who believes that the American way of life is not the best had better stay out of John Snyder's way. This whole undertaking was truly an American operation."

Snyder gratefully acknowledged the help of his friends in this letter published in the Sun:

> Dear Folks: I would like to thank each and every one of you who has donated his time, equipment, materials, and many hours of work put into making possible something that was near impossible for one person to accomplish.
>
> I came into your valley a stranger, yet no one anywhere received such a welcome as you people of Yuma and the Yuma Valley have shown me and my family.
>
> I thank you all so very much. No words seem to be enough to express what I feel for all everyone has done.
>
> Jack Snyder.

They Lent a Helping Hand

Commercial donations:
- Imperial Hardware Co. of Somerton—pipe for well.
- Gary brothers and Ray Quon—food for first day.
- Toland Williams—food for second day.
- Valley Commercial Co.—food for third day.
- Somerton Bank—food for fourth day.
- Sunland Dairy and Jersey Farms Creamery—ice cream.
- Roundup Buffet—after work treat.
- Al's Store—hardware.
- Texas Oil Co.—500 gallons Diesel fuel, 300 gallons gasoline.
- Richfield Oil Corp.—500 gallons Diesel fuel.
- C. H. Trigg—concrete.
- Yuma's five lumber yards—lumber for headgates.
- O'Malley-Smith—25 pounds of nails.
- Maharry brothers—carpenter labor on gates.

Cooks:
- Mrs. J. C. Hunter.
- Mrs. Thurman Hunter.

Others furnishing pastries and serving:
- Mrs. Perk Carvens.
- Mrs. Jim Barkley.
- Mary Martha Barkley.
- Mrs. Keifer Shipp.
- Mrs. Les Barkley.

Machinery, equipment, and labor donations:
- Vernon Robinson.
- Leroy Beck.
- George Pickering.
- Austin Franklin.
- Walt Kamman.
- Elwood Lee.
- James Lee.
- Marion Griffin.
- Hugh Beck.
- Henry Frauenfelder.
- Dudley Yowell.
- Lee Nunnaley.
- Ira Lee.
- Claude Price.
- Future Farmers of America.
- Don McCain.

Mexican labor gangs:
- Bill Hay Produce.
- Les Barkley.
- Yuma Producers Co-op Association.

Scraper rigs and tractors:
- Les Barkley.
- Arthur Daniel.
- Thurman Hunter.
- Jim Barkley.
- J. C. Hunter.
- Clyde Havins.
- "Geezer" Havins.
- Ernie Johannsen.
- Dave Lott.
- Sid Jeffries.
- B. C. Smith.
- William Smith.
- Edward Smith.
- John Smith, Jr.
- Elmon Sapp.
- Jim Greer.
- Hans Holling.
- L. C. Cravens.
- Betty Cuming.
- Henry Davis.
- George Lott.
- Bill Hay.
- Lloyd Jeffries.
- B. C. Smith, Jr.
- Henry Smith.
- John Smith.
- Hughes & Bilbrey.
- E. M. McDaniels & Sons.
- Pete Carstens, Jr.
- Jerry Nunnaley.
- Howard Salyer.

Yellowtail Dam and the Crow Country

by ROBERT F. HERDMAN, *Construction Engineer, Yellowtail Dam,* and CARL S. SLOAN, *Operations and Development, Hardin Unit, Mont., Region VI.*

Around the latter part of August last year an eastern tourist with his family stopped at Hardin, Mont., headquarters for the Hardin Unit, Missouri River Basin project, on their way through to the Pacific coast. During his stop he patronized one of the local barber shops and in the course of the conversation said, "It is too bad the way the Government is treating the Redmen—building those big dams all over their land and flooding the poor Indians out of their homes. I read where the Government is going to build a dam here on this reservation. It should be stopped."

The barber, originally from Illinois, but having lived in this community for over 20 years, said, "Stranger, you don't know what you are talking about. You have the wrong dope. As soon as I get through cutting your hair, you go next door to the Commercial Club and look over those pictures and maps of the Yellowtail dam site and the land to be flooded by the new lake. Have a talk with the secretary, who is familiar with the situation, then come back and tell me what you think."

Half an hour later the tourist returned, visibly impressed. He said, "You're right about this thing. There is no place in that canyon for anybody's home. After this I am going to get the right information on these things before I do any more talking. You know, many people where I live think the same way about it as I did."

The name of the dam, "Yellowtail," fascinated him and he asked many questions regarding the engineering features of the project; what the benefits would be, locally and nationally; and about the country—its history and people. The tourist seemed pleased with what he had seen and showed surprise when he was told that the Crow Indian Reservation, located in Big Horn County, southeastern Montana, comprised an area larger than the States of Delaware and Rhode Island combined, and he read with considerable interest the following geological description of the river to be harnessed and the lands to be flooded:

"The Big Horn River flows northward through a canyon which, near its northern end, becomes a deep, narrow, 27-mile-long gorge. The Big Horn Canyon has a total length of about 55 river miles and parallels the east flank of the Pryor Mountains while cutting across the northwest toe of the Big Horn Mountains. The Pryor Mountains range from 7,000 to more than 8,000 feet above sea level, while the more rugged Big Horn Mountains approach a general level of about 10,000 feet on the higher portion of the range, the highest point being Cloud Peak, 13,165 feet elevation. In the vicinity of the dam site the canyon has steep, rock slopes and vertical cliffs which, in less than a mile downstream, disappear onto a broad, fertile valley. Four and one-half miles above the proposed dam site, a deeper and narrower gorge named Black Canyon enters the Big Horn Canyon from the east. It is 1,200 to 1,500 feet deep, but contains only a small, crystal-clear stream called Canyon Creek, the waters of which are soon lost in the muddy Big Horn."

Since we are talking here of a development in the vast Missouri River Basin, an area which comprises one-sixth of the land mass of the United States, and particularly of development in the Redman's country, let us pause and quote (from Bonneville's "Adventures") old Chief Arapooish's description of the Crow country:

The Crow country, said he, *is a good country. The Great Spirit has put it in exactly the right place; while you are in it you fare well: whenever you go out of it, whichever way you travel, you fare worse. The Crow Country is exactly in the right place. It has snowy mountains and sunny plains, all kinds of climates and good things for every season. When the summer heat scorches the prairies, you can draw up under the mountains, where the air is sweet and cool, the grass fresh and the bright streams come tumbling out of the snow banks. There you can hunt the elk, the deer, and the antelope, with their skins fit for dressing; there you will find plenty of white bear and mountain sheep. In the autumn when your horses are fat and strong from the mountain pastures, you can go down into the plains and hunt the buffalo or trap beaver on the streams and when winter comes you can take shelter in the woody bottoms along the rivers. There you will find buffalo meat for yourselves and cottonwood bark for your horses, or you may winter in the Wind River Valley where there is salt wood in abundance.*

The Crow country is exactly in the right place. Everything good is to be found there. There is no country like the Crow country.

Reclamation engineers are planning a concrete dam 500 feet high and a hydroelectric plant to harness the principal river in the area described by the chief. From this dam and

The Grand Canyon of the Big Horn. ***Photo by Ed Kopac of Hardin, Mont.***

the power plant will come more than one-half billion kilowatt-hours of electrical energy per year—a boon to this power-starved area—and in place of the muddy Big Horn will be a clear lake of water covering about 17,200 acres in an uninhabited canyon. Of this area to be flooded, the descendants of the old chief own 1,200 acres and white men approximately 13,000 acres.

In addition to the power and flood control features, plans call for the irrigation of approximately 50,000 acres of new land, the application of the waters of the Big Horn River to the "scorched" prairies described by Arapooish. It is a fact that the Indian citizens own half of these new irrigated lands and will continue to own them after irrigation is developed.

When the old chief described the Crow country, he saw in his mind's eye the ideal home for the Indians of his day, but could not have foreseen the effect of modern development. Today the buffalo, the painted pony, and the tepee are not a part of their every-day living. Descendants of the old chief still hold the Crow country, but they ride in modern cars, wear Stetson hats, and use the tools of modern agriculture. It is impossible to tell whether the Indian has lost or gained, but we may appraise with him the degree of replacement and endeavor to fit the two civilizations together. Modern reclamation development, as proposed under the Missouri River Basin plan, is attempting to do just that.

The Yellowtail Dam irrigation and power project is but one development within the vast Missouri River Basin. Within its boundaries set by nature are located 14 Indian reservations, on the arid and semiarid lands of which is a potential arable area of about 488,000 acres, the development of which would unquestionably contribute greatly to the economic rehabilitation of these people. The Crow Indians claim title to their country by virtue of a "pre-Columbian and immemorial possession and occupancy" and by virtue of treaties with the United States Government. The dam site and part of the reservoir site is owned by the Crow Tribe and about half the proposed irrigable land is owned by the Crow Indians individually.

Since the muddy Big Horn River has left, as an heritage, an ideal site for a vast multipurpose development, would it not be a serious breach of faith with the Redman to withhold development of such a resource, principally because he owns the site or because he would be one of the beneficiaries? Is he not, by act and intent of Congress, a partner in the comprehensive Missouri River plan? Let us then reverse the expression of a famous movie magnate who, when asked if he were attending a certain function, said, "I have been included out." In this case, the Indian has been "included in." Such benefits cannot help but be desirable to both Indian and white man. The Indians have thus been "included in" in a project unique in having such important multipurpose functions while flooding so little usable land. Pretty On Top, past Chairman of the Crow Tribal Council, painted the picture in its proper light when he said in a telegram:

Project has many purposes and we will have droughts again and will be glad we have irrigation. Crow Tribe trying to take place in community and trying to do something worthwhile for tribe and community. Crows losing no homes or farms by flooding. Lake will be in a canyon, which is best use for this land. It's no good for farming, because there is no farm land in it.

The Congress of the United States has passed many acts in an effort to "promote the general welfare and provide for the national defense." In providing for the coordinated development of the water, land, and other resources of the Missouri River Basin, it is apparent that the Congress envisioned the many benefits of such development accruing to all the people within this vast area. It has been the policy of the Bureau of Reclamation to recognize the Crows' prehistoric possession and treaty rights, and to meet with the Black Eagles, Bear Claws, Yellowtails, Pretty on Tops, Medicine Crows, and others of the tribe in their tribal councils and discuss "just compensation" before undertaking construction. THE END.

Interior 100 Years Old

The Department of the Interior launched a year-long celebration of its centennial on March 3, its one hundredth birthday, by holding "open house" at Interior projects and installations throughout the United States.

In Washington, the day was marked by a public reception in the Interior Building preceded by a luncheon at which President Truman was guest of honor. Members of the congressional committees dealing with Interior programs and other Government officials were guests of honor.

Secretary Krug said every opportunity will be taken throughout the year to increase public understanding of the Nation's resources problem and the Interior Department's programs for conserving and developing them.

The Department will celebrate its centennial by dedicating its facilities to vigorous attainment of the resource goals necessary to keep this a land of freedom, prosperity, and expanding opportunity for the people. Those goals are:

"1. Full development of the potential land, water, hydroelectric power by the Bureau of Reclamation and the development of mineral and other basic resources by the various Interior agencies including the Bureau of Mines.

"2. Adoption of wise conservation measures to protect resources already available from premature exhaustion through waste and neglect.

"3. Preservation of those sound American ideals written into our resource laws to assure spreading the benefits of Federal Resource development as widely as possible among the people."

Secretary Krug pointed out that the past 100 years saw the Nation's industrial might, fed by seemingly boundless natural resources, rise to unprecedented heights and bring our people standards of living undreamed of in most of the world.

One of the Department's most important functions is the development of western river basin resources under the reclamation program, including great irrigation and hydroelectric projects; water and mineral investigations and mapmaking under the Geological Survey. Among other activities, the Department sells electric power through the Bonneville and Southwestern Power Administration, and even operates a railroad in Alaska.

"Though two world wars and generations of profligate waste have now brought us face to face with a natural resource crisis, we can still have ample raw resources to keep the United States a prosperous, growing Nation of steadily expanding economic opportunity if we take the bold, vigorous steps necessary to conserve and fully develop our resources.

"Contrary to the opinion of many people, conservation does not mean looking up our resources," he declared. "It means the full development of our resources for use by all the people, by the elimination of practices of exploitation that waste them."

Secretary Krug particularly urged the public to get acquainted with the Department and its resources programs at the open house and other activities which are scheduled to follow.

Secretary Krug said further that, "as custodian of the Nation's natural resources, the Department is anxious to report to the people on the first 100 years of its trusteeship but we also want to make certain the experience and knowledge gained during the first 100 years are geared into the job ahead."

It was on March 3, 1849, that President Franklin K. Polk signed the Vinton bill, creating the Department of the Interior and on March 8, he appointed Thomas Ewing as its first Secretary.

There long had been agitation for such a department and four Presidents—Madison, Monroe, John Quincy Adams, and Polk—had urged it. It was opposed as Federal invasion of State matters by Senators John C. Calhoun of South Carolina and Mason of Virginia. Among its stanchest supporters were Daniel Webster and a gangling young Representative from the pioneer Western State of Illinois, Abraham Lincoln.

But Senator Jefferson Davis of Mississippi probably sounded the most striking note in all the debate as to whether this new department should be set up to take internal "housekeeping" affairs out of the State, Treasury, and War Departments. At that time, it was the custom to sell the public lands through the Treasury Department to help finance the National Government.

"One of the strongest inducements to the support of this bill," Senator Davis urged, "is the provision to separate the disposal of the public lands from the office charged with providing the ways and means to support the Government. It is due those who tame the wilderness and open new sources of national prosperity and strength, that their interests should be regarded through a purer medium than pecuniary gain."

Thus, while most proponents were thinking of it as a "housekeeping" department, the noted southern leader was already, at that early date, planning for conservation and development of the national resources for the common good.

The new department, the seventh to be established, was the first Cabinet post created to care for internal affairs of the Nation. Later it became known as the "mother of departments," since it started the Government work now performed by Agriculture, Commerce, and Labor Departments and other Government agencies, such as the Veterans' Administration devoted to domestic interests. •

Reclamation on Ice

Photo through the courtesy of Smoke Thomas.

People who go to work for the Bureau of Reclamation have to be able to survive in any climate. Whether they work in the burning desert waste, or freezing snow-packed tundra, they learn to take it in their stride. Starting the New Year right, four members of the Bureau's Alaska Investigations office joined a United States Air Force group at Nome, Alaska, this January and learned how to live on an Arctic ice pack. The men, who later on will be heading into country where knowledge of how to live in extreme cold will be of the utmost importance, were sent to learn techniques of survival. They lived in snow houses and snow caves, using "survival rations" and all emergency equipment that is put aboard Air Force planes for use in case of crash landings in Arctic wastes. The Air Force group, which only figuratively took the Reclamation crew "under its wing" was out to test reactions of men in extreme cold and test efficiency of equipment. Smoke Thomas (and that is his given name), survey aid, an old hand at Arctic living after spending most of his life up there, considered the weather on the ice pack during the "indoctrination" week as pretty mild. By mild, he explained to a reporter from the Daily Alaska Empire of Juneau, it was only about 16° below zero with a 20-mile-an-hour wind. The temperature did get down to a minus 22, though, he added. For the other three men, Ade E. Jaskar, Bureau geologist; Doran L. Ellery, engineering aid, and Daryl Roberts, civil engineer, it was a new experience and they returned from their sojourn wiser for their training, having learned many new techniques which will help them prepare reclamation crews for winter field trips into interior Alaska. (See "Eklutna—Number One Job in Alaska" on p. 35, February 1949 RECLAMATION ERA, for details of the Bureau of Reclamation's Alaskan program.—Ed.) •

W. C. Austin Crops Reach New High

Income in 1948 from irrigated crops on the W. C. Austin project at Altus, Okla., now nearing completion by the Bureau of Reclamation, was more than double the income received from dry-land crops in the project area.

Average income last year on the 17,433 irrigated acres was $89.41. Average income on nonirrigated farms in the project area was $39.13.

Nonirrigated yields in 1948 were materially above average.

King Cotton retained his project area throne in total field crop acreage and field crop income. Average per acre income on the 7,638 irrigated acres was $145.78, including the value of seed. The average acre income from nonirrigated cotton was $73.72, including the value of seed. Maximum yield of irrigated cotton was 1.9 bales, and returned the grower $346.80 per acre.

Irrigated alfalfa averaged 2.75 tons, or $60.66 per acre. The maximum alfalfa yield was 7 tons per acre.

Thirty-nine acres of tame grass, irrigated and grown for seed, had an average cash value of $93 per acre.

One field of grain sorghum planted on land previously in alfalfa produced 100 bushels per acre. However, this yield was far above average.

An indication of irrigated yields in future years, after a majority of farmers become more familiar with irrigation practices, was noted in a study of 17 project farms. The average income on these farms, which had been prepared to receive water and whose operators were efficient in the use of irrigation water, was triple the average income of dry-land farms in the project area.

Past experience has shown that yields generally increase for several years after the change from dry land to irrigated farming. This is due to the experience gained by operators, acquirement of proper machinery, and the use of crops adapted to irrigation.

Last year marked the third year of partial irrigation of the W. C. Austin project. The Bureau's distribution system is nearing completion and water will be available to all of the project's 50,000 acres by planting time next spring. •

Contracts Awarded for Last Generators at Grand Coulee Dam

Contracts were recently awarded for the last 3 of 18 generating units which will make Grand Coulee Dam the greatest power producer in the world. The installation of these and other generators already on order is being rushed to help alleviate the critical power shortage in the Pacific Northwest.

When the last of these great generators goes on the line in 1952, the plant will have a rated capacity of 1,974,000 kilowatts. With emergency operation in excess of rated capacity, the ultimate continuous production, when water is available, may approximate 2,200,000 kilowatts. This would be enough power approximately to meet the combined needs of Philadelphia and Detroit.

The cost of adding these three units, including necessary switchyard and power plant changes, will be approximately 16 million dollars and will be entirely repaid from commercial power revenues.

The record-breaking population and industrial growth of the Pacific Northwest during and since the war, Commissioner Straus said, "has resulted in an unprecedented demand and resultant shortage of power which even Grand Coulee, which is now producing better than a million kilowatts of power from the left bank of generators already installed, could not overcome. The production from two small generators, each with 10,000-kilowatt capacity, and designed for station use, has gone into the commercial output."

The first big generator, with a nameplate capacity of 108,000 kilowatts, will go into production in the right powerhouse this spring. Three more of the big generators will go into production in each of the next two succeeding fiscal years and the final two generators in fiscal year 1952 if the Bureau is permitted to maintain its present schedule. Irrigation pumping beginning in 1952 on the project will also make heavy demands on the plant. One more smaller station service unit will also be generating power in 1950. •

OUR FRONT COVER

Practitioner of a fast-vanishing occupation—hand picking hops. Nowadays most of this work is done by machine, but here is one of the few remaining experts in the ancient art. For more details on hops (agricultural variety) see story on page 81 of this issue. The photograph was taken by M. L. Tillery of Region 1.

and on the BACK COVER

A worm's-eye view of some 1-day-old New Hampshire chicks. Stanley Rasmussen, of Region 1, took the picture from the underneath side of a glass-top table at the Thomas Hatchery, Strawberry Glenn, near Boise, Idaho.

_____ _____
(Date)

THE COMMISSIONER,
Bureau of Reclamation, United States Department of the Interior,
Washington 25, D. C.

SIR: Enclosed is a check, or money order (no stamps) made out to THE TREASURER OF THE UNITED STATES in the amount of _____ for a _____ year subscription to the RECLAMATION ERA.

Sincerely,

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U. S. GOVERNMENT PRINTING OFFICE: 1949

NOTES FOR CONTRACTORS

Contracts Awarded During February 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2363	Columbia Basin, Wash	Feb. 17	Nine 43,000-kilovolt-ampere transformers for units R7, R8, and R9, Grand Coulee right power plant.	General Electric Co., Denver, Colo	$906,819
2375	do	do	Fabrication and installation of three 108,000-kilovolt-ampere generators for units R7, R8, and R9, Grand Coulee right power plant.	Westinghouse Electric Corp., Denver, Colo.	5,250,034
2425	do	Feb. 21	Three 165,000-horsepower hydraulic turbines for units R7, R8, and R9, Grand Coulee right power plant, schedule 1.	Newport News Shipbuilding and Dry Dock Co., Newport News, Va.	2,497,950
2425	do	do	Three oil pressure governors for units R7, R8, and R9, Grand Coulee right power plant, schedule 2.	Woodward Governor Co., Rockford, Ill.	129,435
2467	Gila, Ariz	Feb. 8	Ten vertical-shaft centrifugal or mixed-flow pumps for pumping plants 1, 2, and 3. Welton-Mohawk division.	Worthington Pump & Machinery Corp., Harrison, N. J.	372,415
2478	Davis Dam, Ariz.-Nev	Feb. 10	Two 34,500-volt circuit breakers for addition to Gila substation, schedule 1.	General Electric Co., Denver, Colo	13,724
2479	Central Valley, Calif	Feb. 28	Completion of Keswick Dam and power plant	C. M. Elliott and John C. Gist, Sacramento, Calif.	1,239,409
2482	Boulder Canyon, Ariz.-Calif.-Nev	Feb. 4	One water-treating unit for Boulder City water supply	Dorr Co., Inc., Los Angeles, Calif	15,535
2487	Central Valley, Calif	Feb. 8	Furnishing and erecting one 100,000-gallon elevated tank for fire protection and domestic water system at Tracy pumping plant.	Darby Products of Steel Plate Corp., Kansas City, Kans.	57,384
2500	do	Feb. 21	One lot of 37 complete stairways for grouting and drainage galleries at Friant Dam.	Gihnore Fabricators, Inc., Oakland, Calif	12,858
2501	Columbia Basin, Wash	Feb. 17	One 4,000-kilovolt-ampere and one 1,500-kilovolt-ampere transformer for Grand Coulee switchyards, schedule 1.	Pennsylvania Transformer Co., Pittsburgh, Pa.	21,202
2508	W. C. Austin, Okla	Feb. 4	Construction of earthwork and structures for drains A1, C1, D, D1, and E; and construction of structures on Blair lateral, Blair 3.1 lateral, and Atlus 4.8 wasteway.	Stamey Construction Co., Hutchinson, Kans.	98,658
2509	Klamath-Tule Lake, Oreg.-Calif	Feb. 8	Construction of earthwork for Klamath Straits drain outlet enlargement.	George R. Stacy, Tulelake, Calif.	24,635
2513	Office of Chief Engineer, Denver	Feb. 25	Dismantling, moving, and erecting 1 compression testing machine at Denver Federal Center.	C. M. Hanes Construction Co., Denver, Colo.	13,738
2518	Paonia, Colo	Feb. 28	Construction of diversion works and earthwork and structures for enlargement of Fire Mountain canal, station 4+95 to 145+00.00.	Young & Smith Construction Co., Salt Lake City, Utah.	294,335
2521	Columbia Basin, Wash	Feb. 10	Miscellaneous structural steel, rails, rail accessories, and crane catwalk for Grand Coulee pumping plant.	Pacific Car & Foundry Co., Seattle, Wash	21,780
2525	Missouri River Basin-St. Francis, Colo.-Kans.	Feb. 21	One 56-inch, one 32-inch, and one 26-inch diameter outlet pipe for Bonny Dam outlet works.	Berkeley Steel Construction Co., Inc., Berkeley, Calif.	94,000
R2-46	Klamath, Oreg	Feb. 18	Construction of Miller Hill pumping plant and structures on the C-4-E lateral enlargement.	George R. Stacey, Tulelake, Calif	31,626
R3-B3	Boulder Canyon, Ariz.-Calif.-Nev	Feb. 7	Construction of Junior-Senior High School building	Lembke Construction Co., Las Vegas, Nev	635,324
R5-10	Tucumcari, N. Mex	Feb. 4	Construction of Hudson Lateral, station 889+00 to station 1711+90, Wilms, Ragdill, and McCarthy drains lateral unit 7 and Troutman, Out, and Heming north laterals.	D. D. Skousen, Albuquerque, N. Mex	634,722
R6-24	Missouri River Basin, Mont	Feb. 24	Construction of streets and sewerage, water and electrical distribution systems for Moorhead Government Camp. Schedule 1.	Blacktop Construction Co., Billings, Mont	36,748
R6-25	Fort Peck, Mont	Feb. 21	Relocation of 3½ miles of Fort Peck-Rainbow 154-kilovolt transmission line.	McCann Construction Co., Missoula, Mont	24,890

Construction and Supplies for Which Bids Will Be Requested by June 1949

Project	Description of work or material
Boise, Idaho	Relocation of domestic water supply pipe line for village of Cascade, Idaho.
Boulder Canyon, Ariz.-Nev	Construction of 15 permanent houses at Boulder City, Nev.
Central Valley, Calif	Construction of 18 miles of double-circuit and 54 miles of single-circuit, 230-kilovolt steel-tower transmission line from Elverta to Tracy, Calif.; and stringing 57 miles of single-circuit conductor for the Oroville to Elverta, Calif., transmission line.
Columbia Basin, Wash	Ten 12-inch 2,800-gpm jet pumps for generator air coolers at Grand Coulee power plant.
Do	Motor-driven centrifugal-type and propeller-type fans, air filters, electric space heaters, electric hot-water heating system, and air conditioning system with mechanical refrigerant condensing unit for Grand Coulee pumping plant.
Do	Three 24- by 25-foot radial gates and three 40,000-pound radial-gate hoists for Grand Coulee feeder canal.
Davis Dam, Ariz.-Nev	Three main control boards for Mesa, Prescott, and Coolidge substations.
Do	Galvanized fabricated structural steel transmission towers for 230-kilovolt Mesa-Coolidge transmission line.
Do	Power and instrument transformers for switchyards, Wellton-Mohawk pumping plants Nos. 1, 2, and 3.
Davis Dam, Ariz.-Nev.-Calif	Stringing conductor and overhead ground wire for 70 miles of 230-kilovolt, 3-phase, single-circuit transmission line between Davis Dam and Parker Dam, and for 64 miles of 230-kilovolt, 3-phase, single-circuit transmission line between Davis Dam and Hoover Dam.
Gila, Ariz	Construction of 18-mile Wellton-Mohawk canal, extending from mile 15 on the Gila gravity main canal to pumping plant No. 3, located about 20 miles east of Yuma, Ariz.
Do	Construction of pumping plants Nos. 1, 2, and 3, located at miles 8, 14, and 18, respectively, on Wellton-Mohawk canal.
Do	Four 1,000-horsepower, three 2,000-horsepower, and three 3,000-horsepower synchronous motors for pumping plants Nos. 1, 2, and 3.
Hungry Horse, Mont	Control switchboards, station-service distribution switchboards, and station-service transformers for Hungry Horse power plant.
Hungry Horse, Mont	Two 11- by 15-foot bulkhead gates, gate frames, guides, and latches for turbine draft tubes at Hungry Horse power plant.
Do	One 7½-ton draft tube bulkhead gate hoist for Hungry Horse power plant.
Do	One 64- by 12-foot ring gate for Hungry Horse Dam.
Do	Furnishing and installing 3 electrically operated elevators for Hungry Horse Dam.
Do	One 10.33- by 10.33-foot bulkhead gate, gate frame, guides, and anchorage for Hungry Horse Dam outlet works.
Missouri River Basin, Nebr.	Construction of earthwork and structures for about 16 miles of Courtland canal, near Superior, Nebr.
Do	One 6- by 5-foot and one 8- by 7-foot radial gates and two 3,000-pound radial-gate hoists for Superior canal.
Missouri River Basin, N. Dak	Constructing Williston substation and installing equipment including a 15,000-kilovolt-ampere capacity main transformer bank, from 115-kilovolt to 69-60-kilovolt, and a 1,000-kilovolt-ampere capacity bank, from 60-60-kilovolt to 12.5-kilovolt, at Williston, N. Dak.
Missouri River Basin, S. Dak	One 6- by 6-foot radial gate and one 10,000-pound radial-gate hoist for Shadehill Dam.
Do	One 6- by 6-foot slide gate and one 115,000-pound gate hoist, and control for Shadehill Dam.
Missouri River Basin, Wyo	Construction of Government camp for Anchor Dam, consisting of 1 permanent residence, 5 temporary residences, 1 office and laboratory building, 1 shop and garage building, sewer and water systems, and moving and remodeling 12 trailer houses, about 35 miles west of Thermopolis, Wyo.
Do	One 48-inch ring-follower gate, one 165,000-pound hoist, piping, and embedded metalwork for Boysen Dam outlet works.
Do	Two 100,000-pound radial-gate hoists for spillway at Boysen Dam.
Palisades, Idaho	Relocation of about 4 miles of State highway at Palisades Reservoir, 56 miles southeast of Idaho Falls, Idaho.
Rio Grande, N. Mex.-Tex	One package-type substation, 3,000/3,650-kilovolt-ampere capacity, from 115-kilovolt delta to 2.4-kilovolt delta or 4.16-kilovolt grounded Y, for Hot Springs, N. Mex.
Yakima, Wash	Construction of 5.8 miles of telephone line about 6 miles northeast of Prosser, Wash

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Ruth F. Sadler, *Editor*

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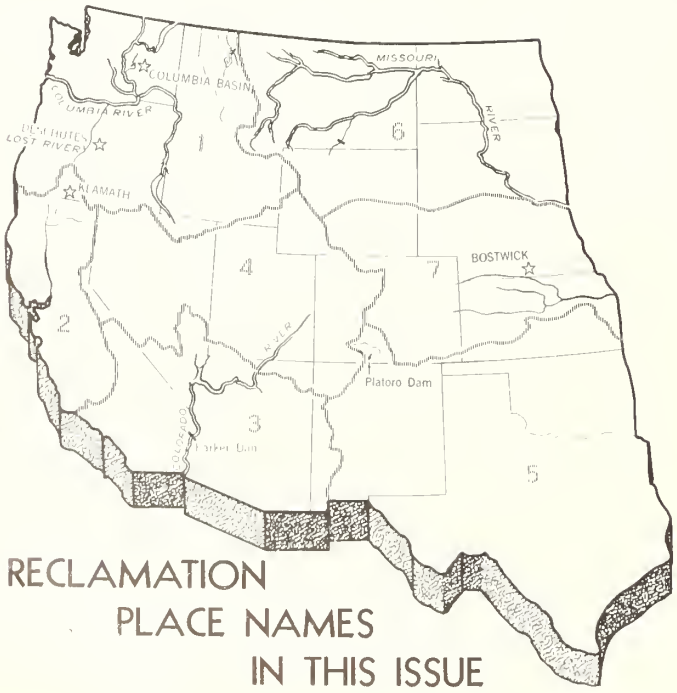
DO YOU KNOW . . .

- the 6.6 billion kilowatt-hours of energy generated annually at Hoover Dam and other Reclamation hydroelectric plants on the lower Colorado River, if developed by fuel oil, would require over 13 million barrels or over 60,000 carloads? The caboose of a train carrying this quantity of oil would be east of Salt Lake City, Utah, when the engine is entering Los Angeles, Calif.
- the potential Bridge Canyon Dam would be 13 feet higher than Hoover Dam, which is at present the highest dam in the world?
- enough dates are produced annually in the Coachella Valley, Calif., and on other irrigation projects in the southwest to feed 65 million people?
- enough lettuce is produced annually on Reclamation projects in the Southwest to feed over 36 million people?
- enough carrots are produced annually on Reclamation projects in the Southwest to feed over 20 million people?



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RAINDROP EROSION

by W. D. ELLISON*

The impact of an individual drop on the soil does surprising damage. Multiplied by the billions, it is one of the major problems of soil conservation.

MOST OF US HAVE OBSERVED the small but violent phenomenon of raindrops splashing on a pavement. On a dark, rainy night, in the beam of a car's headlights the splashes rise like miniature sparkling fountains. On bare earth we see no splashes, yet obviously raindrops must shatter and rebound there too; the difference is that the small splashes, charged with soil particles, are muddy, and more intensive lighting is needed to make them visible.

The displacement of soil by the splash of raindrops is of course a form of erosion, but there has seemed little reason to take it seriously, and until recently no one did. It is not until one makes experimental tests and finds that the impact of raindrops in a violent storm may blast more than 100 tons of soil per acre into the air, and then examines closely what becomes of the blasted soil, that raindrop erosion begins to look like something more than a trifling affair.

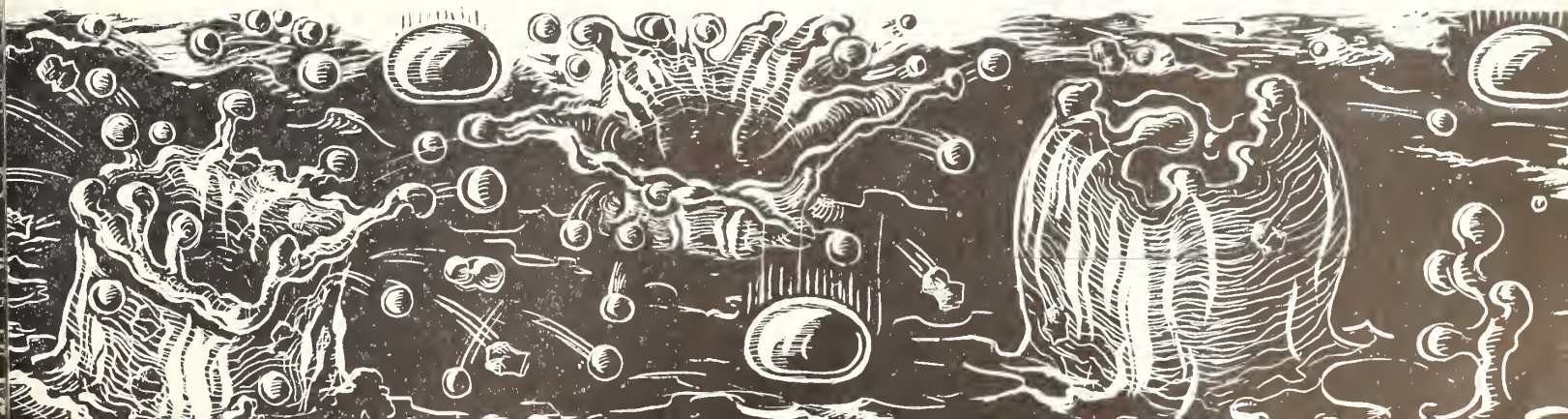
The old saying that what you don't know can't hurt you does not apply to splash erosion. We have not known much about this process, but we are learning that it has been hurting us a great deal. Water erosion has generally been thought of solely as the washing of soil by flowing water. We know now that on some soils and terrain, wash-off losses actually account for less than 10 percent of the erosional damage from a heavy rain; the other ninety-odd percent of loss is attributable primarily to raindrop splashes.

**Mr. Ellison is now a soil conservationist in the Department of the Navy, Bureau of Yards and Docks, and is the discoverer of raindrop erosion. He is a graduate of the School of Engineering, Montana State College, and has been engaged in hydrologic and soils research for more than 20 years, mostly with the United States Department of Agriculture.*

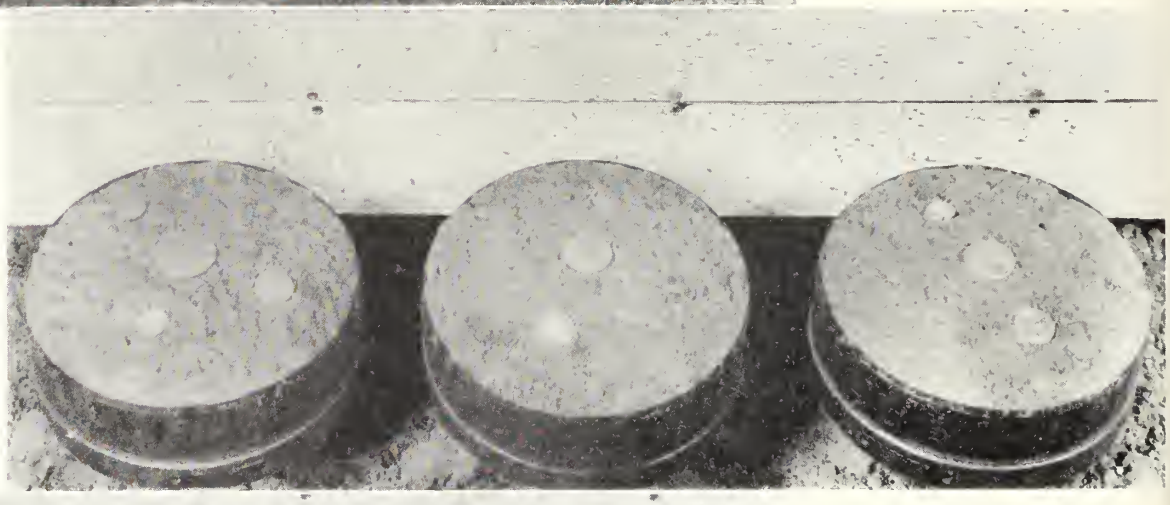
It was while examining an eroded area in my garden that I first noticed the effect of raindrops. I discovered many tiny columns of soil, each capped by a fragment of rock. Each of the odd-shaped columns or pedestals conformed in cross-section to the shape of the stone cap protecting it. It was evident that the cap-rock had protected the soil beneath it from raindrops, while the soil around the rock had been splashed away and transported downhill. This theory was consistent with a previous observation: that erosional damage to a field was usually in direct proportion to the intensity of the noise made by raindrops striking on the roof.

The first step in testing the splash theory was to determine whether raindrop splashes could carry significant amounts of soil. I held a small card about an inch from the ground while rain was falling. This soon became spattered with mud. Then I exposed pans of soil with metal disks on top. More than 1 inch of soil was splashed out during 75 minutes of heavy rainfall, and a soil pedestal was formed under each disk. The next step was to make these splashes visible so they could be photographed. This was accomplished with mirrors which directed light beams across the soil's surface. With a camera time-setting of one-twenty-fifth second, trajectories of the flying splashes were made to appear as short arcs of light in the printed photograph. The falling raindrops were visible as vertical shafts of light. Each splash described a parabolic curve, which indicated that its lateral movement was about four times its height of rise. Only a few stray splashes rise more than 2 feet; it appears that some 90 percent of them may be found within 1 foot of the surface.

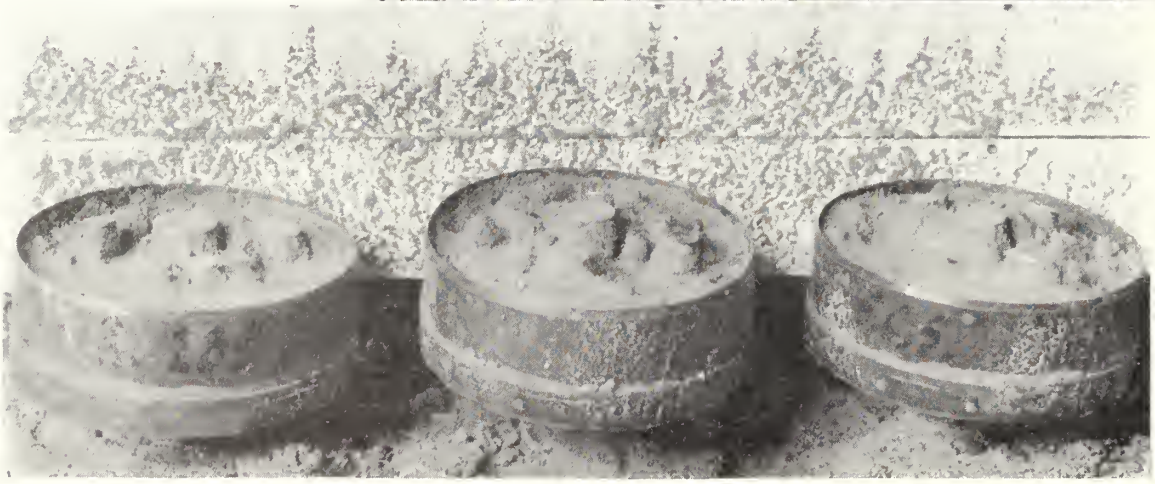
On level land the splashing particles of soil tend to bounce back and forth, so there is no net loss of soil from any point on the field. But on a slope the splashes move the soil down-



Exact measurement of the effect of raindrop is made by putting three pans of soil under a laboratory rain-making machine. Coins are placed on the soil to mark its original level.



In the above photo we see the soil samples before rainfall, while at the right the cavitations made by falling drops after 45 seconds of rainfall are clearly visible.



To the left we see the effect after 75 minutes of rainfall. Note splashes on white board, 6 inches from the soil samples. It's the same way in the field. Splashes carry soil into the air to be dropped into surface flow which carries it away.

hill. Part of this movement is caused by the drops striking glancing blows which kick most of the particles toward the bottom of the slope. Another part will be caused by the fact that soil splashed in the downgrade direction travels farther in the air than that splashed uphill. Many tests have shown that on a 10-percent slope the downhill movement is about three times the uphill.

Flowing water on sloping land produces erosion by forming gullies. Regardless of how smooth the surface may be, the washing process, known as scour erosion, always starts by grooving the soil. Scour erosion made the Grand Canyon and carved out our river systems. Gullies make the landscape rugged, so scour process is classed as a land-roughening process.

In contrast, splash erosion removes the sloping topsoil in sheets. It acts as a smoothing and leveling agent. These effects are demonstrated in miniature each time that beating raindrops flatten and level a small sand pile in the yard. It works in about the same way on a hill, bringing material down from the crest and depositing it low on the slope. After a great gully is carved by scour erosion, the splash process slopes the vertical side walls and converts the rough gully to a gently sloping valley. After a series of storms, topsoil scalped from the crest of a slope by raindrop splashes can be found piled lower on the hillside.

The splash process produces four different types of erosional damage:

1. Piling and burying of topsoil;

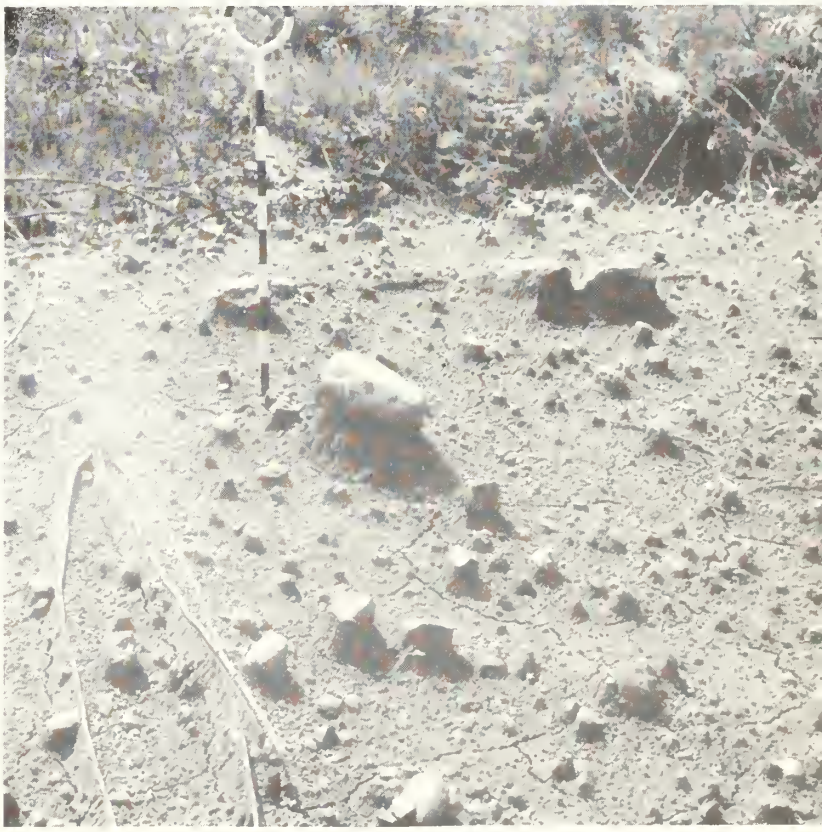
2. Surface sealing;
3. Deterioration of the structure of the soil; and
4. The loss of crop nutrients by the process called elutriation.

The piling and burying of topsoil is the result of the land-leveling process. Topsoil that is scalped from the crest of a slope slows in movement as it approaches the gentler slope near the bottom of the hill. This causes "telescoping" of the soil; that is, soil from high on the slope overtakes material in motion low on the hillside. The result is that the topsoil piles up in a bank near the bottom of the hill, and this is later covered with subsoil brought down from near the hilltop.

These changes do not come from a single storm. They are long-time developments. The first striking evidence of the splash process is the appearance of "bald" crests high on the slopes. Farmers have been heard to say that during the month of August they can see a rabbit in a neighbor's cornfield a mile away so long as it stays near the crest of the hill. They used to embarrass conservation experts by asking why all the erosional damage seemed to be at the crests of slopes where there was very little surface flow; the answer, although the experts did not know it, is splash erosion.

Damage caused by the piling and burying of topsoil is usually many times more important agriculturally than are the tonnage losses that go down the rivers. Data on the amount of soil carried down the Mississippi can be cited in support of this conclusion. The National Encyclopedia, 1935, states that approximately 400 million tons are carried down the great river annually. Expressed in terms of watershed units— and it must be expressed in those terms to deter-

Above: Soil and water splashing from raindrop impacts. Below: Typical result of raindrop erosion is the splashing away of an entire layer of unprotected soil. Where soil is shielded by stone, a small mound remains. ***All photos courtesy Soil Conservation Service, drawings by Shirley Briggs.***



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mine its significance—this loss amounts to only about 1 inch of soil removed from the surface of the entire watershed every 300 to 400 years. That amount is not too important agriculturally. Of course, we do not want to lose this soil if we can prevent it. But its loss does not represent the real erosion problem. A loss of 1 inch of soil every 300 years probably represents something less than 10 percent of the important damages to a soil by erosion.

Surface sealing, the second soil damage on our list, is caused by raindrop splashes puddling the soil and making it practically impervious to water. This point has been proved by experiments. For example, in a field where the soil splash was 1 ton per acre, the surface sealing was light; the water intake capacity of the soil was 8.5 inches of depth of water per hour. But in a field of the same soil type which had a splash of 33 tons per acre, there was considerable surface sealing and the infiltration capacity dropped from 8.5 inches to 0.96 inch of water per hour.

We have not been accustomed to thinking of surface sealing as an erosional damage. It does not occur where surface soils are made stable against the action of water. But where it does occur there is a host of ill effects associated with it. For one thing, it makes the soil droughty. Droughtiness and the high temperatures associated with it destroy worm life in the soil and curtail a field's productive capacity. For another thing, surface sealing tends to increase flash run-off, and this increases flood hazards. Surface sealing also interferes with aeration of the soil and with the emergence of seedling plants from the seedbed. Effective control of splash erosion could reduce the surface sealing caused by rainstorms by 70 to 90 percent.

Plugging the Plow Sole

Over a period of years, after surface sealing has been repeated many times, the structure of the soil declines. This occurs when tiny aggregates of soil on the surface are broken up, and when the pores in the soil of the plow sole (the compacted layer of earth at the bottom of the furrow) are plugged. The plugging can be caused by the intake of water that is charged with colloidal and other fine clay fractions. As this material filters through the soil layers it is deposited in the pores. Deposits near the surface may have only a temporary effect, but those in the plow sole produce more lasting results. By retarding the percolation of water into the deeper layers of soil they increase the run-off during wet seasons.

The structure of a soil changes with each change in the tiny soil aggregates. It seems probable that our failure to understand splash erosion has caused us to develop misconceptions about problems of soil aggregation and structure. Organically bound soil aggregates are developed through natural processes as organic matter is decomposed in mineral soils. They are destroyed in many ways. Principal among these seem to be the depletion of organic matter and the direct break-down of the aggregates by physical forces. The splash erosion process is one of the chief agents affecting both of these. The raindrop impacts break down many aggregates and this releases organic matter that was bound in the aggregates, permitting the organic material to be floated from the field.

It is through aggregate break-down that many field soils are made highly transportable. Consider, for example, a single aggregate made up of many thousand clay particles, several hundred silt fractions and a half dozen sand grains. In addition there may be some humus and some fragments of plant residues. So long as these materials remain bound together in a stable aggregate they are not easily washed away. But as soon as the splash process breaks up the aggregate, the clay and the organic matter become highly transportable and may be floated away in continuous suspension. The silt fractions, which are less transportable, may be dragged and rolled along by intermittent stages, with their movements being speeded each time a raindrop agitates the water that is in contact with them. The sand grains are the least transportable, and if the field slopes are gentle there may be no appreciable net loss of sand. Over a period of years everything but the sand will be carried away.

This process, called elutriation, can be very destructive in sandy soils, though it is of less importance on loams and clays. Uncontrolled elutriation on gently sloping, sandy land, besides rendering the soil deficient in crop nutrients, organic matter and clay, also destroys its waterholding capacity.

What can be done about it? There is only one way to control splash erosion, and that is by protecting the soil against the impact of raindrops. For example, stubble mulching, the method of tillage which leaves crop residues on top of the soil, is an excellent means of protecting the surface against splashing. The development of faster-growing plants also would provide more effective canopies for our cropped fields.

How much cover does it take to protect the soil against raindrops? The answer depends on the type and condition of soil. Here are the results from a piece of range land. On a section covered with 650 pounds of forage and litter per acre, the soil splash was 28 tons per acre. On the same soil, but with 4,300 pounds of forage and litter per acre, the soil splash was only 1 ton per acre. The amount of cover needed depends on the extent of each type of damage that may be caused by rain splashes on the particular soil involved.

The differences in erosion caused by splashing raindrops and by flowing surface water have not been well understood. A full knowledge of these differences is fundamental to an understanding of erosion problems. Studies made since the discovery of splash erosion have indicated that soil splash launches a chain of damaging processes, and that these can be prevented only by checking the falling raindrops before they strike the soil. THE END

The foregoing article was reprinted from the November 1948 issue of Scientific American with the kind permission of the publishers and the cooperation of the author, W. D. Ellison.

NEXT MONTH Mr. Ellison will present a special story written for the RECLAMATION ERA, telling reclamation farmers how to measure the detachability of their soil, and how to protect it against raindrop erosion.

The STORY of "DUSTY" RHOADES

How would you like to have $1,000,000 lopped off the cost of those projects the Bureau of Reclamation is building in the West?

And, furthermore, does it make you feel bad to know that the Bureau is going to save about $10,000,000 in dam building over the years ahead?

Well, that's what "Dusty" Rhoades, a 6-foot diamond driller from Coulee Dam, Wash., has done. He hit the jackpot with his device for inserting multiple packers in a single diamond drill hole, which enables engineers to measure the depths and the flows of up to eight underground streams through a single drill hole. Formerly a new hole was required for each two water tables, at $1,500 and up per hole. Rhoades received the Interior Department $1,000 Suggestions Committee award for his multiple packer. Water users will receive many times that amount in reduced preliminary construction costs alone for the Bureau's projects; and it is very likely that Rhoades' invention may be adapted for use by other agencies engaged in ground water studies.

Before a dam can be built, engineers must know whether underground streams would cause the reservoir to leak, and whether the rock will hold up the dam. To discover these secrets buried in the depths of the earth, engineers employ a method called core drilling. (See "Black Diamonds" in the July 1947 issue of the Reclamation Era for more data on this procedure.)

A diamond-toothed bit, attached to long steel pipes, with power supplied by a special rig, eats its way through the hardest rock. A long cylindrical "core" made up of a cross-section of the ground into which the bit has drilled, is lifted from the hole, giving geologists the clues to what lies beneath the surface.

These holes must be sunk at dozens and sometimes scores of places over a site. Underground water tables are frequently found at various levels at a given location, and characteristics of their fluctuating depths must be determined. Usually separate holes are drilled for this purpose and sounding devices connected to these holes. Before "Dusty" Rhoades developed his multiple packer, existing equipment would measure a maximum of two levels through one hole. When more than two water tables were encountered in one hole, only the first could be effectively sealed off and sounded. This, then required additional holes to study the other water strata. Now, with the Rhoades' multiple packer, up to six

Below left: Mr. Rhoades explaining his "multiple packer" device to Assistant Secretary of the Interior William E. Warne and Reclamation Commissioner Michael W. Straus, while Mrs. Rhoades smiles approvingly.

At right: Mr. Rhoades accepts his award in the form of a check and certificate of merit which Secretary Warne is about to hand to him. ***Photographs by Glen Peart, Interior Dept.***

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and eight water tables can be completely isolated and measured through one drill hole.

Using his wealth of practical experience in drilling holes, which adds up to more than 100 miles in total depth over the past 30 years, "Dusty" Rhoades found a way to eliminate the necessity of drilling a separate hole to test each strata. With steel, rubber, and lengths of copper tubing, and the ingenuity born of his craft, he fashioned a device that seals off each separate stream in a single test hole, and permits the depth and flow to be measured through a long copper tube running up to the surface.

Although diamonds commonly point the drills that sink these test holes and carve out sample columns of the rock, cheaper synthetic substitutes for the industrial diamond (carbonado, or bortz) are now growing in popularity, but many drillers, particularly the old timers, still prefer actual diamonds.

Rhoades has handled diamonds for years. He began his colorful career in the Alaska gold fields 30 years ago, and is famed throughout the Northwest for his skills as a driller, his jeweler's precision in setting diamonds into drill bits, and his canny eye in choosing the diamonds which will best cut the long cores out of the bedrock. He probably knows more about what is underneath Reclamation's Columbia Basin dams and reservoirs than any other one man.

After working in the Alaska gold fields around Juneau in 1916, he worked for the Lynch Bros., a Seattle drilling firm, until 1936. He went to Alaska to do exploratory drilling for gold five times in his career. Also he worked for the company in drilling on several dam sites in Washington and in mineral areas of the Pacific Northwest, including British Columbia. In 1933, the Lynch company contracted with the State of Washington for exploratory drilling on the site of Grand Coulee Dam. He thus participated in the first preconstruction work at man's largest concrete structure. He did other drilling in the Coulee Dam area for the company until 1936, and went to Michigan for a year's service on a drilling job. He then joined the Bureau of Reclamation at Coulee Dam and has been with the Bureau ever since.

Rhoades' formal schooling ended with Washington's Snohomish High, where, it is said, he earned the nickname "Dusty" by his prowess on the football field, although most any kid in the West who happens to have a last name sounding like "Rhoades" is pretty sure to be called "Dusty" at one time or another.

Mr. Rhoades flew to Washington for what he thought would be a quiet ceremony in which he would receive his $1,000 suggestions award, and promptly return home. Instead, he found himself toiling away under the hot lights of the television studios, hurrying to press conferences and radio stations, explaining his multiple packer to a Senate committee, and otherwise enmeshed in a dizzy week of events seldom experienced by a diamond driller. But—like any

(Continued on page 104)

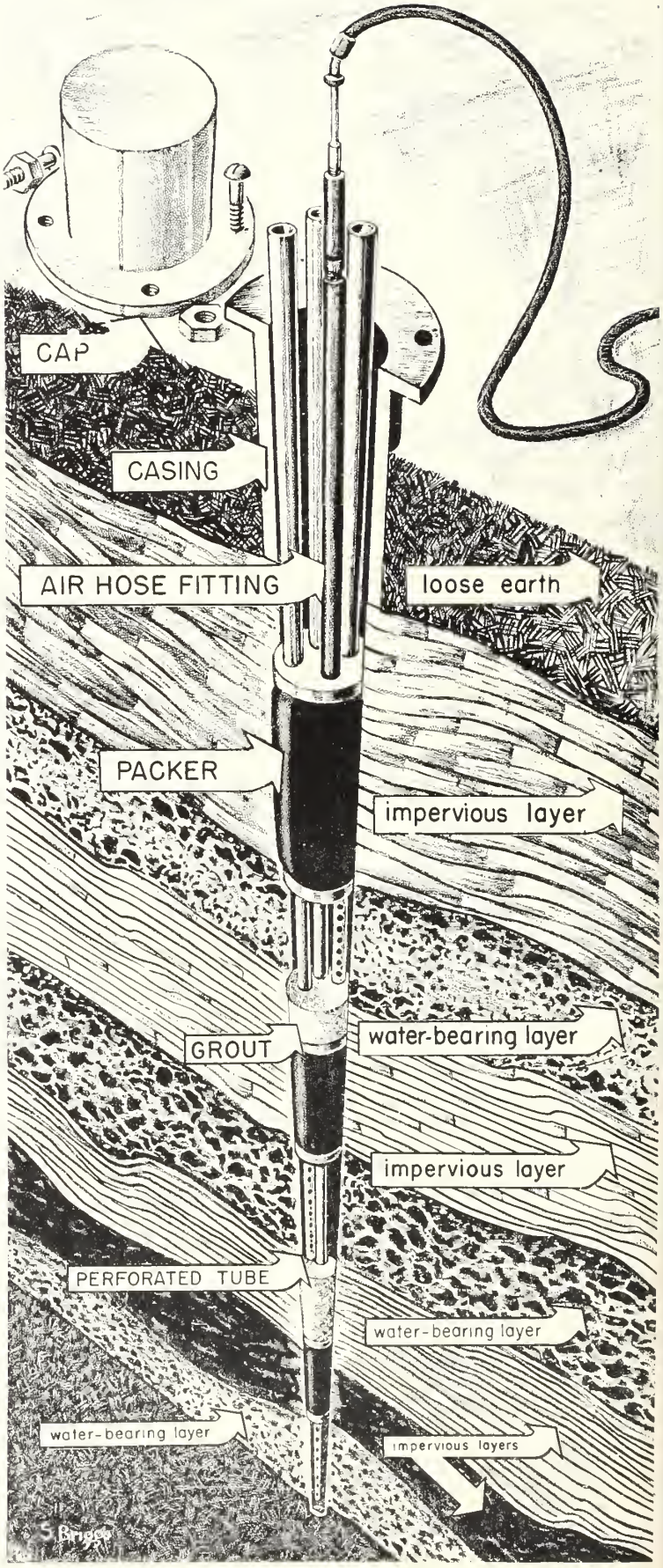

Diagram showing "multiple packer" device for which "Dusty" Rhoades received $1,000 Suggestions Committee award. The device is expanded after being lowered to the proper level to make the drill hole watertight. This permits a study of several subterranean water courses from a single hole. *Drawing by Shirley Briggs.*

Platoro Dam—the "Little Giant"

by A. N. THOMPSON, Assistant Regional Director
Region V, Amarillo, Tex.

Cradled among the crags of the Conejos River Canyon high on the eastern slope of the Continental Divide in south-central Colorado, will rise the "Little Giant"—Platoro Dam—to be constructed by the Bureau of Reclamation.

Here in the 8,000-foot high San Luis Valley, a lake will come into being behind Platoro Dam, higher than any other man-made body of water of equal proportion on the American continent.

Although only a mite compared with the vastness of the Rio Grande Basin, of which the Conejos River is a tributary, and only 135 feet of earth and rock in height above the streambed, Platoro Dam will raise the surface of the river to 10,042 feet above sea level.

The dam, estimated to cost $4,200,000, will regulate and impound the clean waters from the 10 feet or more of annual snowfall on the "Roof of the Nation." The impounding capacity of 67,000 acre-feet will supply supplemental water to 91,000 acres of fertile pasture and farm lands. It will effectively control torrential rain floods and floods from late spring snow melt which, for many years, have resulted in severe damage to farmsteads, fields, and other improved property. In addition, fish and wildlife conservation will be improved, although even now the Conejos River is classed as one of the finest fishing streams in the country.

Platoro, meaning silver and gold, derived from the Spanish *plata* (silver) *y* (and) *oro* (gold), is truly a fitting name for the new structure. Here in this general area, exploring Spaniards had sought gold and fought Indians; here hairy-faced miners from all over the globe once sweated in search of wealth and frequently assembled in Creede, a few miles north of Platoro dam site, to gamble and fight in the hurly-burly heyday of the mining era.

Here also, though less spectacularly, have the farmers and ranchers of the San Luis Valley struggled for years to capture control of the precious waters so necessary for abundant production of food and fiber. Today the goal is within sight. By the spring of 1952, Platoro Dam will begin impounding irrigation water for the valley's lands.

The Bureau's recent advertisement for bids for construction of the dam marked the end of extensive surveys, core drillings, mapping and related work by private, State, and Federal engineers, in cooperation with the local people, to determine the most economical project plan and location for the dam. Despite high, postwar construction costs, the people of the San Luis Valley are united and determined to forge ahead with the assistance of the Bureau of Reclamation. They expect to reap the golden harvest from their land in the years to come in proportions two times greater than the average produced to date.

But this is not all. There will be great joy among those of us on the Plains of Texas and Oklahoma who pack our duffel bags every year to indulge in the piscatorial art, for this will be an added attraction—this "Little Giant," which can do so much. THE END

The Story of Dusty Rhoades

(Continued from page 102)

other working man—he handed his check over to his wife, who—like any other woman—looked wistful when she figured out the tax deductions on the $1,000 check.

Wednesday, March 16, began Mr. and Mrs. Rhoades' week in the Nation's Capitol, where they were surprised to see the great interest in the West's development on the part of Congressmen, and members of the press, radio, movie, and television industries. The next time Dusty invents something that will save the Government a lot of money, he will probably try to shun the fame that goes with such an honor. Brass bands, cheering crowds, receptions, banquets, interviews with top Government men, the press, photographers, are all very well, but he was glad to get back to his job—it might be tough work—but not as tough as those cross-examinations with the press, radio, television, and motion-picture cameras all looking his way.

Rhoades has bossed the drilling on the sites of four earth-fill dams in the Columbia Basin project, and three dams are now being built where a few years ago he and his crews were probing the foundation rock. These are O'Sullivan, Long Lake, and South Dams. Their safety, as with Grand Coulee Dam, depends on the condition of the bedrock which he and his crews explored. North Dam, the fourth in the area for which Rhoades made foundation explorations, will be started later this year.

The big diamond driller estimates that he has drilled or bossed the drilling of more than 500,000 feet of holes. In connection with his work on the Columbia Basin project, he selects black diamonds and bortz which the Bureau purchases from dealers and importers in all parts of the United States for setting in the diamond drills. He is an expert at selecting the best diamonds, but has never worn a diamond ring and has no particular fondness for the stones as jewelry. He estimates he has selected several hundred thousand dollars worth of drilling diamonds for the Bureau. The diamond-setting calls for expert "know how" which he has passed along to his crews so that all of the project's diamond setting is done by Rhoades and his men.

Rhoades' family consists of Mrs. Rhoades and four daughters. He has two grandchildren, both girls, and likes to joke about the fact that the diamond-drilling tradition apparently isn't going to be carried on by the family.

His hobby is hunting and he has quite a collection of rifles. He heads for the forests each year in quest of deer and elk and frequents the lakes of Washington State each fall for ducks and geese.

But when a dam is to be built, Rhoades is found with his diamonds and drill rigs, searching the bedrock for information that will tell the engineers where they can safely raise Reclamation's great structures. THE END

Reclamation Engineers' Diamond Deal

Bureau of Reclamation engineers went heavily into the diamond market recently. After minutely examining over $300,000 worth of diamonds, they selected about $10,000 worth, and returned the balance to the firms that sent them.

These were industrial diamonds, and will be used on drills for drilling test holes at the Bureau's Hungry Horse Dam, near Kalispell, Mont., and at Salem, Oreg.

_____ _____
(Date)

THE COMMISSIONER,
Bureau of Reclamation, United States Department of the Interior,
Washington 25, D. C.

SIR: Enclosed is a check, or money order (no stamps) made out to THE TREASURER OF THE UNITED STATES in the amount of _____ for a _____ year subscription to the RECLAMATION ERA.

Sincerely,

Check (√) if member of water users association ☐

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(Name)

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The Bostwick, Nebraska, Contract

Signing of the Bostwick Repayment Contract, Superior, Nebr., February 21, 1949. Board President Oswin Keifer signs contract as H. E. Thomas, board member, and Secretary of the Board Ben Harrington, Avery A. Batson, Bureau's Regional Director of Denver, and Paul Spence, attorney for the Board, look on. *Photo by Demarest, Region VII.*

"In history, I suppose, signing of charters, declarations, and things like that, are among the important dates that we remember. I am sure that the contracts that will be signed today will make one of the biggest changes in the Republican Valley that will take place in quite some time and over many years."

Thus Mr. Jack A. Linn, president of the Superior, Nebr., Chamber of Commerce, sounded the keynote of the ceremonies which ushered in the signing of the repayment contract between the Bostwick Irrigation District of Nebraska and the people of the United States, as represented by the Bureau of Reclamation, United States Department of the Interior, at Superior, Nebr., February 21, 1949.

The signing of the Bostwick contract culminated over 20 years of planning and working toward an irrigation development, but as Paul Spence, an attorney from Franklin, Nebr., stated at the meeting, it not only marked the end of one phase, but the beginning of another.

Oswin Keifer, president of the Bostwick irrigation district, said, "We have tried to have this development start in most any way we could, and now we are fortunate that the Bureau will take it. We tried the PWA, the WPA and to same extent private financing, and now I believe we have an even better development through the Bureau. We have two agencies coordinated heer. The Army Engineers are going to store the water; the Bureau is going to build the works so that we can use it."

The Bostwick project lands were first settled and cultivated in the early 1870's. Population increased rapidly, reaching a peak of 66,838 for the 6 project counties in 1900, but has gradually declined since that time. During the droughts of 1931–40, over 7,000 people left the area, creating a population drop from 58,930 to 51,492.

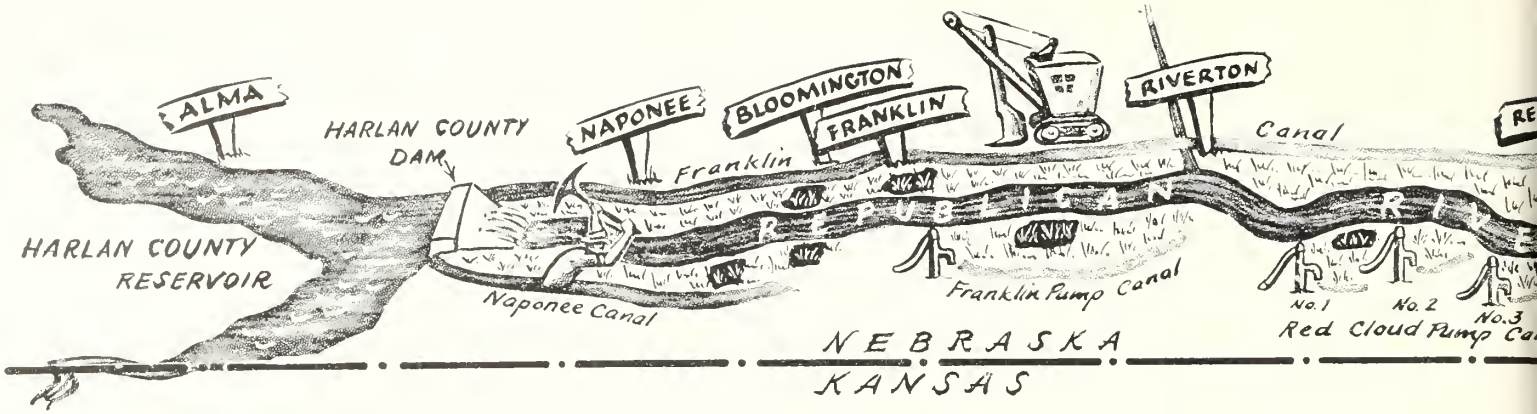
The area is well served with cities and towns, 24 municipalities having a population of 22,257 in 1940, or nearly half the total population of the 6 counties. Largest project towns are Concordia, Kans. (population 6,255) and Superior, Nebr. (population 2,650).

Commercial enterprises are largely limited to processing and marketing farm products, repairing farm implements, merchandizing, and transportation. Four railroads afford excellent transportation facilities, two of them being main lines. Railroads and State or Federal highways connect most of the cities and towns serving the area. Livestock products are largely shipped to Kansas City and Omaha, by truck or railroad.

Only a small portion of the area has access to electric transmission lines. Two Rural Electrification Administration cooperatives have 7,200-volt lines serving parts of the project area in Kansas, and principal project towns in Kansas are connected by public utility company 33,000-volt lines from a steam plant at Concordia. In Nebraska, a 33,000-volt public utility line extends from Hastings to Superior. Average prevailing power rates range from $0.042 per kilowatt-hour for small power service, to $0.064 for residential, and $0.07 for rural service.

Although there has been no major development of irrigation in the area, this does not signify lack of interest in irrigation. During the frequent periods of drought, farmers who could do so have attempted to develop water resources by pumping from wells or streams. However, the record flood on the Republican River in 1935 destroyed most of the stream pump installations. Well irrigation has not developed extensively because water bearing deposits of coarse gravel are not readily found in much of the project area. Yields obtained from even the limited acreage of irrigated crops compare very favorably with those obtained under more extensive irrigation near McCook and Holdrege, Nebr.

Widespread interest in the storage and diversion of water from the Republican River for irrigation has encouraged various governmental and private agencies to study the possibilities of irrigation in this area. Interest in irrigation and flood control increased during the 1930's when the agricultural economy of the valley was jeopardized by prolonged drought in addition to the severe flood of 1935. The Republican River Public Power and Irrigation District was organized in 1938 and the members applied for a loan and grant of Federal funds to construct an irrigation system for 35,000 acres in the river valley below Furnas County, Nebr. In the same year, irrigation district No. 1 of Republic, Cloud, and Jewell Counties, Kans., applied for a PWA loan and grant to construct an irrigation and power project, known locally as the White Rock project, for irrigating 75,000 acres,



mostly table land, lying west of the Republican River and south of White Rock Creek. Water diverted from the Republican River near Superior, Nebr., was to be stored in White Rock Reservoir. Both of these plans were abandoned.

Local interests then invited the Bureau of Reclamation to come into the picture, and the Bureau began an intensive study of the Republican River Valley in 1939. The Bostwick project was authorized as one of the units of the Missouri River Basin Plan under the Flood Control Act of 1944 (Public Law 534) Seventy-eighth Congress, second session. Petitions were prepared for the organization of irrigation districts in Kansas and Nebraska, and last year the Nebraska people organized the Nebraska Bostwick irrigation district which negotiated the contract with the United States Government. A Kansas Bostwick irrigation district No. 2 of Belleville, Kans., has also been formed and on February 25, 1949, the district board passed a resolution expressing a desire to contract with the United States in the same manner as the Nebraska Bostwick irrigation district, so that the Government can further cooperate with the district with regard to construction of irrigation works on the Kansas side of the Bostwick project.

Speaking of the Harlan County Dam which is now under construction by the Department of the Army's Corps of Engineers, Mr. Keifer said: "It is a good thing to have that dam there because a good many times we need flood control and irrigation in the same week, as you well know. So we are getting both and getting them at the right time."

Mr. Keifer introduced the board of directors of the Kansas Irrigation District who attended the ceremonies and said: "I want to speak a little more about this Kansas-Nebraska line. While that is a State line, and we operate under different laws, it is really not going to make any difference in our irrigation district." After Mr. Frank H. Garwin, president of the Kansas Bostwick irrigation district No. 2, expressed his appreciation of the invitation to attend the ceremonies, Mr. Keifer continued, "we intend to work together from here on out just the same as we have in the past."

Mr. Keifer introduced the "man with the Bureau whom we actually expect to build this project—Mr. Paul E. Strouse, chief engineer of the Bostwick project." Mr. Stronse thanked the chamber of commerce, the citizens of Superior, Franklin, Red Cloud, up and down the valley and down in Kansas for "the wonderful help that you have given the Bureau of Reclamation in the 3 years we have been here."

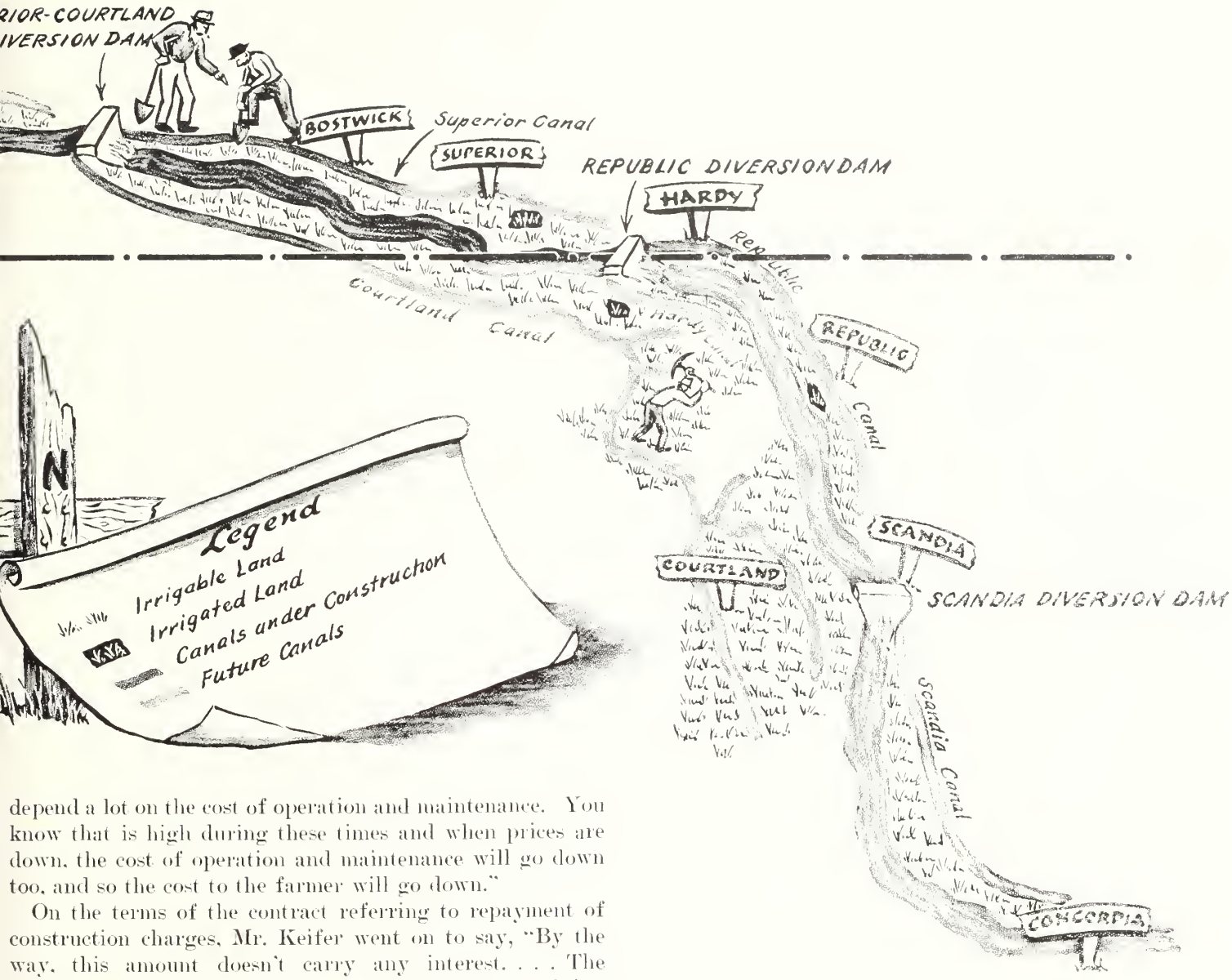
As the celebration approached its climax—the actual signing of the contract, President Keifer introduced the other two members of the board, H. E. Tomas of Red Cloud, vice president, and Ben Harrington of Franklin, secretary-treasurer, and also introduced as "one of the best attorneys for our board that there is in the State" Paul Spence of Franklin, who urged all those present to remember the men who had worked for over 20 years toward "the successful and happy conclusion to which we now arrive."

He then introduced representatives of the Bureau of Reclamation: Mr. Gibbs in charge of administration at the Bostwick project office, Mr. Pampel, the office engineer; Mr. Church, field engineer from the office in Superior, and H. E. (Hub) Robinson, district manager of the Kansas river district.

In explaining the terms of the contract, which provides for releasing water during a 5-year development period, Mr. Keifer said, "Fortunately the plan of the Bureau is such that we can work into our irrigation rather slowly—more or less at our own pace . . . the men can get water when available for the amount of land that they want to irrigate. We can experiment with it, the farmers can use a little or a lot as they please and they will only pay for what they use. . . . we will be expected to expand the irrigation as we go along during that 5 years. After this development period, then the contract period starts which runs for 40 years. In that contract period, of course, the men will have time to develop the land, and water will be available for the land that is deemed irrigable." Touching on the benefits to be derived from the project, Mr. Keifer said that the area had just started coming up. "There aren't any vacant houses in any of these towns along the line. I think we've already started development, but it will now come much faster. I think it will bring new industry, I think it will bring new men, larger population, I think it is just a start of building as fine a valley as there is any place in the world."

In explaining the 40-year term of the contract period, he said, "at the end of that time, the contract will have to be renegotiated by the board and by the Bureau, and there is no reason to think that it can't run on in about the same way it did at the start, because the Bureau will have the ditches, the men will have the land. The ditches would be no good without the land, and the men need the water."

About the cost of water and operation and maintenance, Mr. Keifer explained, "the farmers can only pay for water what they think is a fair price, what the Bureau figures out is a fair price, and I think they are fair in that . . . It will



depend a lot on the cost of operation and maintenance. You know that is high during these times and when prices are down, the cost of operation and maintenance will go down too, and so the cost to the farmer will go down."

On the terms of the contract referring to repayment of construction charges, Mr. Keifer went on to say, "By the way, this amount doesn't carry any interest. . . . The Bureau has been very good to us . . . they have been helping to get us a very fair contract. I think it is one of the best. It is the best one that I have heard of. There is no question about it. If it isn't fair to the district, it won't be fair to the Bureau."

Commenting on the history of the area, Mr. Keifer said: "We've seen a lot of things down here. I've heard them say that the pioneers went through a lot of hardships and low prices. But we've seen 8–10¢ corn here and we don't have to go back very far. We've seen grasshoppers, seen them stacked up there that deep. We've seen dust storms. We want to get away from that now."

The president of the Bostwick irrigation district took a look at the future and said: "Even though the land on each side should be dried out, and we have a lot more dry years than we have wet ones, we'll have this reserve in the valley to carry along on the hills. It is going to build up the whole country. It is going to be as good for the men on the hills as for the men in the valley. It isn't going to be a one-man proposition. . . . It is going to be good for everyone all along both sides whether they are getting water or not. . . . It may change our way of farming, it may bring in more people. It may break up the land into smaller areas, smaller farms for one man, but that's all to the good. He can make a better living off of a smaller piece and not only a better living, but he will have a more sure income every year."

With the four official copies of the contract before him, Mr. Keifer stated: "Anything we can do to make life more liveable in this country is an advance, and I think that is what the signing of this contract is going to start."

Avery Batson, Regional Director of Region VII of the Bureau of Reclamation, signed the contract for the Secretary of the Interior, J. A. Krug.

Signing the contract, Mr. Keifer said: "The board of directors of the Bostwick district have been kind enough to select me president, and I sign this contract in all humility as president of the district."

Mr. Harrington, the secretary of the district, testified to the president's signature, and after the applause died down, President Keifer said, "It is now up to the Bureau."

The End

Third Tule Lake Land Opening

A war veteran, resident of Tulelake, picks the name of a hopeful homesteader.

Proceedings are now under way to determine which 86 of 258 names drawn on February 23 for Tule Lake farms will be the lucky ones.

This third postwar opening and the last scheduled to date on the Tule Lake Division of the Klamath project in California and Oregon got under way September 21, 1948, when the public notices were issued to those wishing to file for 1 of the 86 available farms. The final date for filing was December 20, 1948.

On February 23 names were drawn (see photo above) on a ratio of 3 to 1 to assure enough "eligible" prospective settlers for the 86 farm units. On March 15 the local examining board at Tule Lake began examination of all applications to make certain that they met all the requirements for homesteading irrigated public lands. This examination had not been completed at the time this issue went to press. To be qualified to receive a farm, a person must have at least 2 years of full-time farm experience or its equivalent, gained since his fifteenth birthday. Also necessary is $2,000 net in cash, assets readily convertible into cash, or the equivalent in such assets as livestock, farm machinery and equipment which would be useful in developing and operating a new irrigated farm.

Both men and women were eligible to apply. Successful applicants must establish residence on the land within 6 months after their homesteading entry is approved and must cultivate at least half the farm for 2 years before full title to the land can be acquired. •

Reclamation Engineer Attends International Engineering Congress

T. W. Mermel, engineering assistant to the commissioner of the Bureau of Reclamation recently returned from Cairo Egypt, where he attended the Second International Technical Congress of the World Engineering Conference as an unofficial United States observer.

Mr. Mermel, who was on loan to the State Department for the trip, also represented the Engineers Joint Council, composed of societies representing some 125,000 professional engineers in the United States. He is a member of the American Society of Civil Engineers and the American Institute of Electrical Engineers.

Regarding Mermel's attendance at the conference, Reclamation Commissioner Michael W. Straus said: "This was a very effective means of transferring American technical engineering knowledge and training to regions most urgently in need of resource development, an objective proposed by the President. One of the major sections of the Congress was devoted to the problem of water in the Middle East where it is the lifeblood of existence as it is in our Western States."

Mermel's attendance meant that the experience and knowledge the Bureau gained in nearly half a century of reclamation of our own arid lands was available to engineers who were directly concerned with the reclaiming of the arid areas of the Middle East by maximum utilization of available water resources.

Mr. Mermel had an opportunity to look into the long-time stream run-off records, which were available through the facilities of the World Engineering Congress. A study of the great droughts of Biblical times going back as far as 600 A. D. may well prove helpful in making provisions for droughts in this country—where the records are comparatively short and fragmentary.

In addition to participating in the conference, Mr. Mermel consulted with Government representatives of the area as to the best means of extending the United States' technical information on irrigation, power and basin development to solve their reclamation problems.

Mr. Mermel heads the Washington engineering office of the bureau, serving as liaison between the Commissioner and the Chief Engineer, who is head of the branch of design and construction at Denver. •

Reclamation Reports

Commissioner Michael W. Straus in his 1948 annual Report to Secretary of the Interior J. A. Krug reveals the economic effect of western construction work on national employment.

Reclamation let 1,400 contracts totaling nearly $160,000,000 during the fiscal year of 1948. Every State in the Union, with the exception of one, furnished materials and supplies for Reclamation work. About 60 percent of the purchases went to manufacturers in the East.

Farmers receiving irrigation water from Bureau constructed facilities grew crops valued at $555,000,000, averaging $122 per acre. More than $26,000,000 in revenue resulted from the sale of 15 billion kilowatt-hours of electricity produced by Reclamation constructed and operated power facilities.

At the end of the year, construction was under way on 25 dams, 11 power plants, 26 pumping plants, including the major installations at Coulee Dam, Wash., and Tracy, Calif. (Central Valley project), 249 miles of main canals and approximately 1,600 miles of transmission lines. •

WATER REPORT

WEST-WIDE FORECASTS OF 1949 WATER SUPPLIES BASED ON WORK OF THE WESTERN SNOW SURVEYS

by **PAUL A. EWING, Senior Irrigation Economist, and R. A. WORK, Senior Irrigation Engineer, both of the Soil Conservation Service, United States Department of Agriculture**

A Good Year For Water

A good water year throughout the West is promised by the generally heavy snowfall of the 1948–49 winter. Analysis of April snow surveys, by the Division of Irrigation and Water Conservation, United States Soil Conservation Service,* shows only a few areas where deficient supplies may be expected; damaging peak flows are possible in the Northwest if weather conditions during the melting period are warmer than normal; elsewhere the run-off will be equal to or better than average. The notoriously severe winter will therefore pay off with widespread benefits in most Western States.

The winter was undeniably "unusual." It started early and, although high-mountain precipitation was not unusually heavy, owing to prolonged cold temperatures, most of it was snow accompanied by high winds. These storms covered the Western Plains and the Intermountain Valleys with an unusually heavy cover of snow relatively heavier, however, in the mountain valleys than at the higher elevations. The extremely high elevations had a cover of only about 120–160 percent of normal whereas in some mountain valleys it got as high as 200 percent.

The water content of the snow, as it fell, was not unusually high. In fact, due to very cold temperature, the snow was quite dry and powdery, but the accumulation of water in the snow cover built up to a considerable total. In Cache Valley of Utah, for example, the snow cover on the level got to be about 3 feet deep with water content of nearly 25 percent, which meant that there was between 8 and 9 inches of water in the snow cover on the valley floor. Conditions were similar over the Nevada desert, eastern Oregon and Washington, and northern Idaho, particularly the wheat-producing areas.

The snow cover over the plains and lower mountain valleys is now gone. In these areas the melting proceeded rather slowly with warm days but cold nights. Daytime melting was fairly fast, but during the night it would cease, thus giving an opportunity for the water to infiltrate into the soil. Except for eastern Nebraska, where the ground was covered with ice, the snow cover fell on open, dry soil. In fact, there was a major deficiency of moisture on the valley floors and on the areas of the Western Plains when the snows began. This permitted the water draining from the snow cover to filter into the soil with a very small surface run-off. This characteristic continued throughout the melting period in most of the areas. In a few cases where the soil mantle was thin, or where the temperature became unusually warm, some run-off occurred and there was some minor flooding in limited areas. However, for the most part the snow cover disappeared into the ground with a minimum loss.

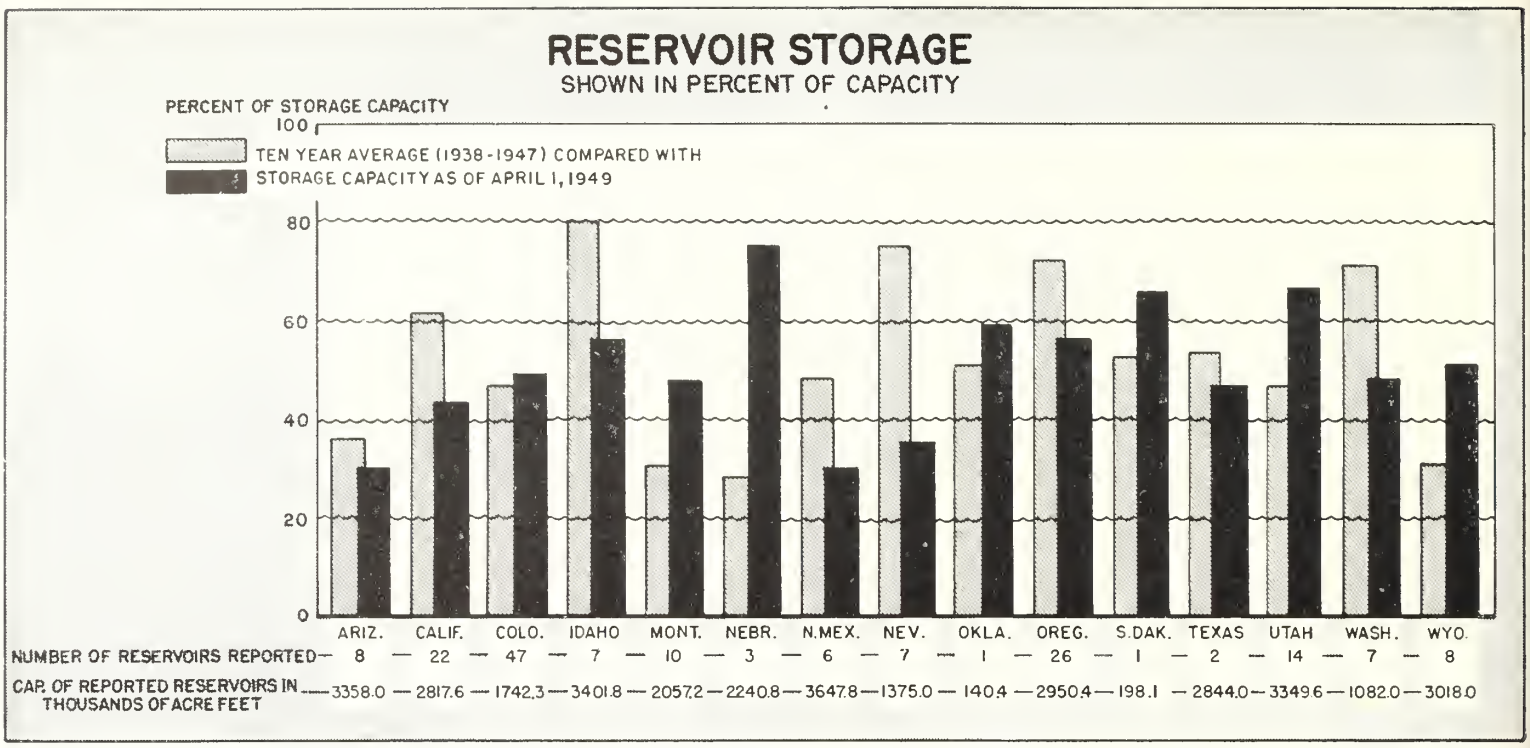
Melting was somewhat different in the Palouse areas of eastern Washington and northern Idaho. In these areas the water went into the ground until the earth mantle underneath the snow became saturated and the surplus above that required to saturate the earth mantle caused serious erosion.

The snow has now receded to the higher elevations. There is a relatively heavy cover between elevations of 6,000 and 8,000 feet. In fact, in most areas it is unusually heavy; in some areas the greatest since snow surveys began. From 8,000 to 10,000 feet and higher, the snow cover is above normal in most areas.

On these watersheds there has been some melting. The soil, for the most part, is primed and it is expected that the surface run-off when the water starts to leave the snow, will be unusually high. Ordinarily on the first of April, the high mountain valleys (from 5,000 to 7,000 feet) are quite bare. This April, between Denver and Salt Lake City, all the high mountain valleys still had an unbroken snow cover with a relatively high water content.

The run-off during April, if melting proceeds normally, is expected to be high, but a well-sustained late-season flow is looked for.

* The Division of Irrigation and Water Conservation is the Federal coordinating agency of snow surveys conducted by its staff and many cooperators, including the Forest Service, Bureau of Reclamation, National Park Service, Geological Survey, various departments of the several Western States, irrigation districts, power companies, and others. The California State Division of Water Resources conducts and coordinates snow surveys in that State, while the British Columbia Department of Lands and Forests, Water Rights Branch has charge of the snow surveys in that province.



Not all reservoirs in all States are reported, but enough are reported to give a reliable index of each State's storage supply. Most State averages for reported reservoirs are for a full 10-year period, but in a few cases reservoirs having shorter records are included.

CALIFORNIA—does not include Friant or Shasta Reservoirs. April 1 storage in those two reservoirs is 3,548,800 acre-feet, which is 84 percent of their capacity.

COLORADO—does not include John Martin Reservoir (capacity 655,000 acre-feet—April 1 storage 142,900 acre-feet).

MONTANA—does not include Fort Peck Reservoir (capacity 19,000,000 acre-feet—April 1 storage 13,140,000 acre-feet). Average used is 1940–49 rather than 1938–47.

NEVADA—does not include Lake Mead (usable capacity 27,935,000 acre-feet—April 1 usable storage 17,735,000 acre-feet, which is 63 percent of usable capacity).

Forecast Summary By States

In the following paragraphs the prospects are described, State by State, as they were viewed on April 1. The two charts illustrate the situation graphically.

Arizona.—The past 6 years of continuous drought in Arizona came to an end during the past snow season and the outlook for the irrigated areas of the State is very good. As of April 1 the water held in the eight important reservoirs was 30 percent of capacity, or three times the amount of water stored on April 1, 1948. San Carlos Reservoir, which last year was practically empty, now contains about 25 percent of capacity.

The extremely heavy storms of January and February combined with low temperatures resulted in a record snow pack at the higher elevations throughout the winter. The water content of the snow remaining on the principal watersheds is over 200 percent of normal, indicating that with normal precipitation run-off will continue good.

California.—The Sierra snow pack is satisfactory. Over-all run-off will average 90 percent of normal, which should provide a water supply sufficient for all reasonable uses of agriculture and industry. In Sacramento and San Joaquin valleys there should be enough water to fill all reservoirs except Shasta, with water spilling at the peak of the snow-melt run-off. At the southern end of San Joaquin Valley, which lacks storage, some water will probably reach Tulare Lake Basin. Lake Tahoe is expected to reach the 6,225.9-foot level, the lowest summer peak since 1937.

Total April 1 storage in 27 reservoirs serving Sacramento and San Joaquin Valleys was 4,796,000 acre-feet, which is 67 percent of capacity. Excluding Shasta Reservoir, Millerton Lake, and 3 smaller storages, water in the remaining 22 reservoirs is 42 percent of capacity, which is 69 percent of their normal April total.

Expected run-off of the principal rivers, in proportions of the recent 10-year averages, is as follows: Sacramento at Shasta Dam, 90 percent; Feather at Oroville, 92; Yuba at Smartsville, 107; American at Fairoaks, 110; Mokelumne at Mokelumne Hill, 102; Stanislaus at Melones, 103; Tuolumne at LaGrange, 97; Merced at Exchequer, 87; San Joaquin at Friant, 88; Kings at Piedra, 89; Kaweah at Three Rivers, 65; Kern at Bakersfield, 58.

Colorado.—Except for the Arkansas and Upper South Platte, snow cover on the mountain watersheds of Colorado was well above normal on April 1. Unusually heavy snow exists on the headwaters of the North Platte, Yampa, White, San Juan, Dolores, and Rio Grande. The 1949 summer flow should equal or exceed any of the past 10 years. In the South Platte drainage 125 percent of normal flow is expected in the Poudre, Big Thompson, and St. Vrain tributaries and normal to slightly below in Boulder Creek, Clear Creek, and Upper South Platte River. The flow of the North Platte should be very high with peak flows around 12,000 feet at the gaging station at Saratoga, Wyo. Unless April snow accumulation is above normal, the total and peak flows of Rio Grande and its main tributaries in Colorado should about equal those of 1941.

The summer flow of the Arkansas is expected to be slightly less than normal and about 70 percent of each of the past 2 years.

Seasonal precipitation over the State has been about average. Western Colorado has received somewhat more than normal. On the eastern slope precipitation has ranged from slightly below normal for the South Platte to very light in the Arkansas Valley.

Idaho.—Snow cover throughout Columbia River Basin was high during the entire winter. Snow surveys on April 1 showed a water content generally ranging well above normal. In the basin as a whole the snow cover is heavier this year than for any previous year of record.

Stream flow during March was below normal for most of the basin. Any snow that may have melted presumably was held in the watershed

soil mantle. However, extremely heavy run-off will occur down the main stem of the Columbia River during the next 6 months, and if the various tributaries peak more or less simultaneously, damaging peaks will occur. Under normal weather and run-off conditions the southern tributaries peak and pass down the Columbia before the northern streams rise. Abnormally cool weather over the southern part of the basin during April, with normal or above-normal precipitation, would greatly increase the prospects of high-water damage.

Valley precipitation accumulated since last October is now normal to slightly less than normal in Columbia Basin. Precipitation was slightly less than normal during March.

Reservoir storage in Idaho was below normal for April 1, but reservoirs will be filled readily when the spring run-off begins.

MONTANA.—Snow surveys throughout the upper Missouri Basin promise excellent irrigation supplies for the tributaries of Missouri River above Fort Benton. Water content is approximately 40 percent above the 12-year average. Valley precipitation was generally below normal during the winter months. Jefferson River and its western tributaries are likely to produce extremely high peak flows. In upper Columbia River Basin the snow pack ranges from 125 percent of normal in Canada and 150 percent of normal on the Flathead to 160 percent of normal on the upper Clarks Fork. The threat of extremely high peak flows lies in the unusually high percentage of water content at low elevation courses. High courses show more water content than in 1948 and the low courses double the threat of damaging peak flows, especially in the event of warm weather accompanied by rains.

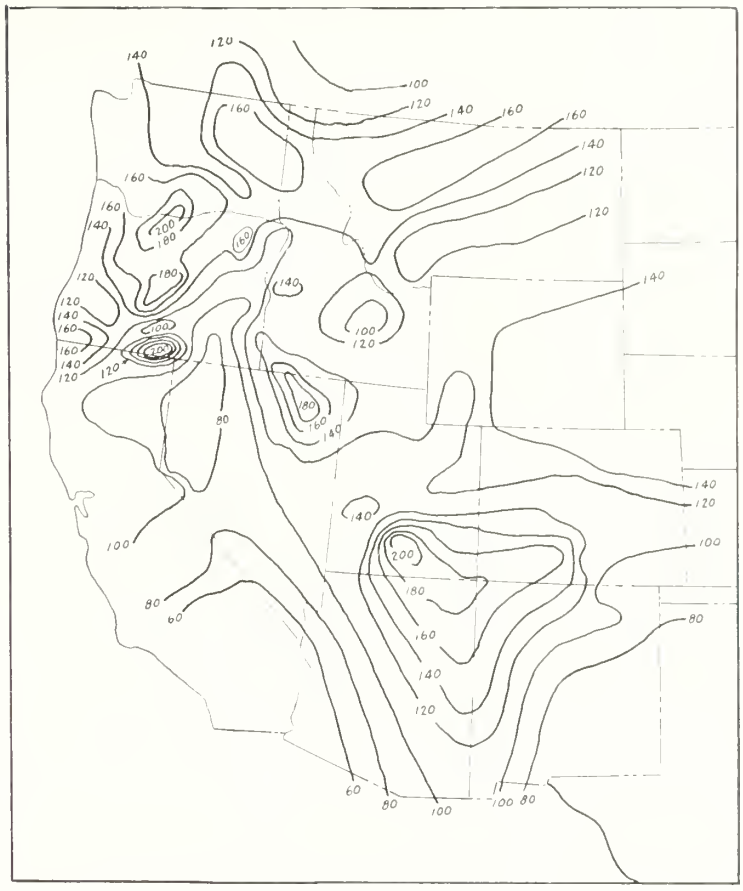
NEVADA.—Irrigation water supplies will range from fair in western Nevada to excellent in the eastern portions of the State. Snow-water run-off of eastern Sierra streams will vary from 70 to 100 percent of normal, while Humboldt Basin streams will flow from 100 to 200 percent. Groundwater levels continue low and subnormal temperatures have retarded early season streamflow. Reservoir storage is low with total storage on April 1 about 80 percent of last year, 45 percent of the 1938–47 average, and 35 percent of the usable capacity, but under normal weather conditions during the summer all reservoirs except Tahoe should fill. Lake Mead holds about 95 percent of last year's April 1 storage.

NEW MEXICO.—In northern New Mexico between the Rio Grande and the Continental Divide the snow accumulation is very heavy. East of the Rio Grande and on the Canadian River tributaries, the snow cover is normal to slightly below. Soil-moisture conditions are reported good throughout the irrigated areas of the State. Storage in Elephant Butte Reservoir is rather low but should increase substantially. El Vado Reservoir on the Chama has been drained in anticipation of high inflow during the 1949 season.

OREGON.—The 1949 water supply outlook is good throughout the State, deficiencies not being expected anywhere provided snow-melt and run-off conditions are normal. In fact, unusually high flows are likely to be recorded on most streams, especially the Walla Walla, Crooked, Upper Deschutes, White, Clackamas, North and South Santiam, Sandy, Applegate, Hood, and Umatilla Rivers. Watershed soils are believed to be wetter than usual, a condition favoring increased run-off from the snow pack. Soil moisture in valley soils is also reported as favorable, although recent drying winds have caused a demand for irrigation in some places. Reservoir supplies are rated as generally good to excellent. While total storage in all reservoirs is only slightly more than at this period in 1948, 17 percent less than in 1947, and 20 percent less than the 10-year average, further substantial inflows are expected. Many small reservoirs are already full.

SOUTH DAKOTA.—Snow cover in the Black Hills is 50 percent above normal and the highest for the past 6 years.

UTAH.—At the opening of the snow-accumulation period the watershed soils were very dry, but an abnormally high accumulation of snow and water was finally attained. While the dry soil cover has the effect of lessening somewhat the threat of excessively high water, there is still danger that considerable damage may result from peak flows of various streams. All watersheds will yield nearly 120 percent of average water supplies, with the East Fork of the Sevier expected to yield at least 200 percent of its average.



Prospective stream flow April—September 1949. Figures are percent of 1938—47 average.

All reservoirs are expected to fill even though the smaller ones have been drawn down to provide flood protection. The reservoirs as a whole show storage totaling 67 percent of capacity.

WASHINGTON.—Washington shares the generally favorable outlook of other Columbia Basin States, the heavy snow pack in the Cascades having been increased during March. While storage was lower than normal on April 1, the reservoirs are expected to be filled rapidly by spring run-off.

WYOMING.—Snow cover is well above normal and is especially heavy on the North Platte watershed. Although fall rains and winter snow brought the total precipitation just above average, soil moisture conditions are good throughout the State. Summer flow of all Bighorn River tributaries should be well above normal. There is a slight deficiency of snow cover on Powder River tributaries. Reservoir storage is about 25 percent less than last year's total.

BRITISH COLUMBIA.—The water supply prospects for southern British Columbia are very good. The Coastal, Lower Fraser, Skagit, Similkameen, and Okanogan areas should have high run-off with possibilities of flooding unless cool weather ends and more melting begins very soon.

The main Columbia and West Kootenai are expected to have more than normal run-off, while the East Kootenai and Upper Columbia should experience a run-off with proportions less than a 10-year normal. The latter is based, to some extent, on less than normal soil moistures on the western slope of the Rocky Mountains and in the Lardeau and Duncan River basins.

Snow-water content is more than normal throughout the entire southern part of the Province.

General flooding is not expected, although local floods will probably result from the reduced capacity of channels brought about by the flood of last year. Okanogan Lake, a difficult reservoir to regulate, will probably experience high water again, with attendant flooding.

THE END

Water Stored in Reclamation Reservoirs

Location	Project	Reservoir	Storage (in acre feet)		
			Active capacity[1]	Mar. 31, 1948	Mar. 31, 1949
Region 1	Baker	Thief Valley	17, 400	17, 400	6, 900
	Bitterroot	Lake Como	34, 700	17, 400	8, 200
	Boise	Anderson Ranch	464, 200	76, 200	12, 500
		Arrowrock	286, 600	171, 300	113, 100
		Deadwood	161, 900	85, 100	94, 000
		Lake Lowell	169, 000	162, 400	149, 800
	Burnt River	Unity	24, 600	12, 100	13, 100
	Columbia Basin	F. D. Roosevelt	5, 220, 000	4, 660, 000	4, 875, 000
	Deschutes	Crane Prairie	50, 000	29, 900	37, 500
		Wickiup	187, 000	148, 200	188, 800
	Minidoka	American Falls	1, 700, 000	1, 670, 900	1, 075, 400
		Jackson Lake	847, 000	629, 000	370, 300
		Lake Walcott	95, 200	97, 000	74, 300
		Grassy Lake	15, 200	14, 000	13, 000
		Island Park	127, 300	136, 600	102, 700
	Okanogan	Conconnully	13, 000	4, 700	10, 700
		Salmon Lake	10, 500	4, 500	8, 200
	Owyhee	Owyhee	715, 000	397, 900	354, 400
	Umatilla	Cold Springs	50, 000	50, 000	45, 700
		McKay	73, 800	71, 000	59, 900
	Vale	Agency Valley	60, 000	45, 500	53, 500
		Warm Springs	170, 000	40, 800	63, 900
	Yakima	Bumping Lake	33, 800	13, 300	7, 400
		Clear Creek	5, 300	5, 300	5, 300
		Cle Elum	435, 700	295, 800	177, 400
		Kachess	239, 000	197, 000	175, 000
		Keechelus	153, 000	105, 300	63, 600
		Tieton	197, 000	140, 100	78, 800
Region 2	Central Valley	Millerton Lake	503, 100	112, 700	209, 300
		Shasta	4, 389, 100	3, 030, 200	3, 192, 000
	Klamath	Clear Lake	437, 500	152, 400	172, 300
		Gerber	94, 300	29, 000	32, 800
		Upper Klamath Lake	524, 800	330, 200	376, 000
	Orland	East Park	47, 900	18, 900	48, 200
		Stony Gorge	50, 000	25, 100	45, 100
Region 3	Boulder Canyon	Lake Mead	27, 935, 000	18, 620, 000	17, 735, 000
	Parker	Havasu	688, 000	607, 500	605, 300
	Salt River	Bartlett	179, 500	19, 600	117, 600
		Horse Mesa	245, 100	157, 600	140, 700
		Horseshoe	67, 000	10, 800	62, 700
		Mormon Flat	57, 850	23, 000	35, 100
		Roosevelt	1, 398, 400	54, 700	331, 300
		Stewart Mountain	69, 800	36, 500	37, 200
Region 4	Fruit Growers	Fruit Growers	4, 500	4, 600	4, 100
	Humbolt	Rye Patch	179, 000	120, 300	65, 400
	Hyrum	Hyrum	15, 300	10, 700	10, 800
	Moon Lake	Moon Lake	35, 800	13, 000	10, 200
	Newlands	Lahontan	273, 600	184, 900	192, 400
		Lake Tahoe	732, 000	261, 600	180, 000
	Newton	Newton	5, 300	4, 900	3, 500
	Ogden River	Pine View	44, 200	1, 100	4, 200
	Pine River	Vallecito	126, 300	57, 100	33, 500
	Provo River	Deer Creek	146, 800	127, 800	102, 300
	Scofield	Scofield	65, 800	15, 400	6, 500
	Strawberry Valley	Strawberry	270, 000	115, 200	100, 200
	Truckee River Storage	Boca	40, 900	4, 300	400
	Uncompahgre	Taylor Park	106, 200	87, 400	65, 000
	Weber River	Echo	73, 900	38, 600	14, 000
Region 5	W. C. Austin	Altus	140, 000	72, 200	85, 300
	Carlsbad	Alamogordo	128, 300	37, 000	32, 700
		Avalon	6, 000	5, 300	5, 400
	Colorado River	Marshall Ford	810, 500	187, 600	219, 300
	Rio Grande	Caballo	345, 900	173, 300	162, 300
		Elephant Butte	1, 817, 000	395, 900	530, 700
	Tucumcari	Conchas	300, 000	271, 000	206, 500
Region 6	Belle Fourche	Belle Fourche	177, 500	161, 100	132, 000
	Milk River	Fresno	127, 200	77, 400	74, 500
		Nelson	66, 800	32, 200	33, 500
		Sherburne Lakes	66, 100	35, 800	13, 200
	Riverton	Bull Lake	152, 000	79, 400	40, 000
		Pilot Butte	31, 500	18, 100	13, 200
	Shoshone	Buffalo Bill	456, 600	307, 400	172, 900
	Sun River	Gibson	105, 000	64, 400	76, 100
		Pishkun	32, 050	20, 800	15, 500
		Willow Creek	32, 400	17, 200	19, 400
Region 7	Colorado-Big Thompson	Green Mountain	146, 900	47, 300	53, 800
	Kendrick	Alcova	190, 500	109, 900	129, 300
		Seminoe	970, 000	535, 800	467, 400
	North Platte	Guernsey	41, 050	37, 800	42, 900
		Lake Alice	11, 000	0	0
		Lake Minatare	57, 000	18, 000	15, 100
		Pathfinder	1, 040, 500	667, 800	538, 600

[1] Available for irrigation.

At left: Each irrigation season 40,000 to 50,000 acre-feet of water is lost from the Deschutes River, just above the City of Bend, Oreg., through the porous unweathered lava in the background. But the author has found a detective able to trace the lost water through the use of fluorescent dye. Note the streak of light in the bottle due to fluorescence of the sample which contained the dye. *Top photo by Harold Sexton, bottom photo by Randolph A. Baker, both of Region I.*

TRACING LOST RIVER

by HAROLD W. SEXTON
Civil Engineer, Bend, Oreg., Region I.

For many years, people have been wondering where the water went. It was important to know as it was disappearing from many individual areas in a 15-mile section of river channel above Bend, Oreg., and as usual in the West there was more land available for irrigation than there was water with which to irrigate it. Stream gaging stations had been used for many years to help locate the general areas of the loss. Evidence pointed to the fact that part of the visible river channel losses do return to the river above Bend and thus can be used for irrigation. But stream gaging couldn't determine where the water returned to the river and where it didn't. Hence other steps had to be taken—and a new detective was put to work—fluorescent dye.

Sanitary engineers and hydrologists have long used fluorescein in establishing the source of water in wells and springs and in tracing seepage from canals, reservoirs, and streams. The name fluorescein applies to a compound containing carbon, hydrogen, and oxygen. The particular material used for this investigation was uranine concentrate, an alkali (sodium) salt of fluorescein, manufactured by the national aniline division of a chemical and dye corporation.

Uranine is a red powder which, unlike true fluorescein, is easily dissolved in water. It was found that solutions of this fluorescein salt diluted as much as 1 part in 300 million by weight could be detected with the help of very simple equipment. If 1 pound were dissolved in 36 million gallons of water, you could see it. It is reported that fluorescein can be identified in dilutions of 1 part in 10 billion. However, this was not possible by the method used in this Bureau of Reclamation study.

These are the problems we faced. The Deschutes River rises in the high Cascade Mountains of central Oregon, a range of volcanic origin. Each winter heavy moisture-laden air from the Pacific Ocean drops rain and snow on the Cascades. A large part of the moisture falling on the upper basin is absorbed by the very porous volcanic soil of this

area. An appreciable portion of it then percolates into subterranean channels that supply the many bountiful springs which give the Deschutes River its notably cool, clear, steady flowing water.

In recent times, geologically speaking, part of the channel which the Deschutes has cut into the eastern slope of the high Cascades has been filled by lava from the Lava Butte Flow which came from the east and caused the river to seek a new and higher channel in several places. The new lava now forms the east bank of the river above Bend at intervals for several miles. It is into this porous Lava Butte Flow that the large visible losses of water occur.

In order to supply water for 50,000 acres of heretofore unirrigated land around Madras, Oreg., known as the "North Unit" of the Deschutes project, the Bureau of Reclamation built the 180,000 acre-foot Wickiup Reservoir on the upper river for the Jefferson water conservancy district, making a 35-year hope a reality. Above Wickiup Reservoir, the Bureau of Reclamation in 1940 completed the new 55,000 acre-foot Crane Prairie Reservoir for older non-Bureau-sponsored irrigation districts centering around Bend and Redmond, Oreg. These districts wanted midsummer peaking flows in order to supplement their direct flow diversion rights.

Beginning with the 1949 irrigation season, water will be delivered for the first time to the last section of the North Unit, embracing 27,000 acres, to bring the total acreage irrigated by diversion at or near Bend to approximately 100,000 acres. The releases during the irrigation season from the Wickiup and Crane Prairie Reservoirs, plus that of a third reservoir with a relatively small annual yield, will increase the flow through the mysterious section where the water is lost by around 30 percent above any previous average monthly flow, at least so far as suitable records for analysis of the channel losses show. The additional flow will cause increased flooding of the river against the porous Lava Butte Flow. Should the percentage of loss increase it would drastically reduce the amount of water estimated as available for diversion.

During the latter part of the 1948 irrigation season it was necessary to draw down Wickiup Reservoir for construction purposes and the flow in the section where losses occur was about the same as the anticipated flow for future years. Here was an opportunity for studying this flow and it was decided to begin using fluorescent dye to help ferret out the loss areas. A representative area, locally known as "Lost River" was chosen. It runs from the Deschutes River and shortly disappears into several distributaries which terminate into the porous Lava Butte lava flow. Prior to 1948, Lost River itself at times had run upwards of 16,800,000 gallons, or roughly 52 acre-feet, of water per day.

Before the decision to use the dye was made, we had to make certain that it would not harm the water supply of those dependent upon river water for domestic and livestock use nor would it be injurious to the fish. The University of Colorado School of Medicine and the Oregon State Board of Health assured us that the use of the dye in the concentrations proposed would be entirely safe and that fluorescein and uranine in small quantities was nontoxic to humans. The chemical was used with the approval of the Oregon State engineer, and the State Game Commission made no objections.

In preparing plans for the introduction of the dye into Lost River, several factors were carefully considered. The principal ones were:

- the amount of water flowing in the Deschutes River in which the presence of the dye would have to be detected should the flow of Lost River be returning to the river proper above Bend;
- the type of material through which the solution must pass;
- the distance it must travel;
- the rate of movement;
- the estimated lapse of time between introduction and arrival at the anticipated point of detection;
- the chemical or mineral analysis of the water;
- time interval between taking samples;
- the method of detection to be used; and
- the strength of the individual material used.

Experience showed that weighing and mixing the dye should not be done at points where samples were to be taken or examined. Persons working with the powder or the in-

The Deschutes River elevation near Bend, Oreg., never fluctuates because the run-off from the watershed reaches the stream through porous pumice and substrata formation. This requires a much longer period for it to reach the stream than if a large part of it flowed atop the ground to the river.

troduction of the dye solutions into the area being studied must exercise care that they not contaminate sample-taking or testing points. Clothing and shoes worn during the mixing or introduction of the fluorescein should not be worn while taking or testing samples until after laundering or dry cleaning.

Apparently clothing is not harmed by the dye, although my wife was bewildered when a pair of cotton trousers caused the water in the washer to fluoresce a bright green. It was found that the hands and faces of the men who worked with the dye, even after countless scrubbings, glowed with a pronounced fluorescence when exposed to ultraviolet light in a darkened room. The powder itself is very light and easily carried by the air.

In introducing the dye into the water course being studied it is preferable to have it in solution. The dye was taken from its original 25-pound container and put into paper cartons in 1-pound lots, an amount which could be satisfactorily mixed into about 2½ gallons of water. Although the mixing was done in an open container, a churn, such as a wooden-paddle butter churn, would have made mixing easier and minimized contact by the persons doing the work. The dye was introduced into Lost River at a rate of 1 pound to each 30 million pounds of water flowing in the Deschutes River proper. Twenty-five pounds were released over a 100-minute period.

Samples were taken in plastic-capped, 16-ounce glass bottles originally intended for use as prescription bottles. Before choosing these as sampling containers, several were tested under different ultraviolet lights to determine that no fluorescence was present which might affect the detection of the dye. The bottles were inexpensive, easy to fill and came in easy-to-carry cartons.

Basically, the samples were taken at hourly intervals. Sampling was done at three main points:

(1) One and one-half miles downstream from the Lost River area, a point which was 100 feet lower in elevation and just below the lowest point the Lava Butte Flow reached in the older river channel;

(2) Approximately half way to Bend; and

(3) at Bend.

Sampling was discontinued after 3 days as we believed it would be impossible to detect any further return of the dye after this period of time because of the probable extreme dilution.

The fluorescent properties of solutions of uranine makes possible its detection even in very dilute solutions. Fluorescence or "cold light" is the property of a material to give off a visible light when the material is exposed to invisible light or radiations of shorter wave length than the visible light color. Ultraviolet light which occupies the part of the spectrum between visible light and X-rays is the commonly used exciting agent for fluorescent materials. Sunlight and ordinary incandescent light contain ultraviolet light although the amount in the latter is small.

In our study we used an incandescent 35-millimeter slide projector, shielded to a thin beam, as the light source for examining the samples. Several ultraviolet lights were tried, but all were found unsatisfactory for detection of dilute samples. The characteristic deep violet color of these lights caused an objectionable reflection from the glass of the sample bottles. Dilute uranine solutions gave a green color within the thin beam of incandescent light, stronger solutions yellow or green in ultraviolet light and in sunlight.

In order to provide contrast, a sample bottle containing only river water was set beside the sample being examined with only a piece of black cloth between the two. Simultaneously passing a thin beam of light through both provided a ready method of detection.

We examined the samples in a darkened room and those containing fluorescein were compared with known concentrations to determine the approximate dilution. By referring to the time and place each sample containing fluorescein was taken and the approximate concentration, it was estimated that around 80 percent of the water leaving the Deschutes River via Lost River at the time of the test, 22 cubic feet per second, was not returning to the river above Bend and therefore not available for diversion.

One night in the Bend project office, a few drops of water, accidentally spilled on the concrete floor, were exposed to a powerful ultraviolet light. As a result a distinct yellow fluorescence appeared which was very similar to that of the stronger dye solutions. The mystery was solved when it was found that the engineers' shoes had picked up small quantities of the resurfacing materials from the street behind the office. The wet asphalt gave off a yellow fluorescence under ultraviolet light.

Handle Dyeing With Care

In tracing water with this fluorescent material, there are many factors not mentioned here which can influence the over-all results. Water which is slightly acid has a tendency to destroy the color of uranine but it may be brought back by the addition of ammonia which in turn may cause turbidity due to other impurities in the water, hindering detection. In large underground caverns filled with water, such as might be found in lava or limestone areas, fluorescein has a tendency to become diluted and settle, the dye solutions being slightly heavier than water. It is reported that carbonic acid and peat beds do not destroy the color of the solutions. Apparently the dye cannot be filtered out by passing through beds of sand, lime, or ammoniacal organic matter. However, the slower the movement and the longer the distance the dye must move, the greater the chance for the coloring matter to be taken up by various substances in the ground itself. Proper estimates of the quantities of dye to be used, the time and place of sampling and the length of sampling are important factors to consider if good results are desired.

As development of further irrigation from the Deschutes River continues, additional study of other loss areas will be necessary. The work will probably be continued for many years to come.

This work with fluorescent dye was performed by the writer, under the general supervision of J. W. Taylor, construction engineer, Deschutes project. The End

The Weatherman Helps Plan Reclamation Projects

How much rain does it take to make a flood?

What is your project's weather record for the past 50 years?

How big a spillway is needed to pass floodwaters safely through or around a dam?

Settlers on irrigation projects can rest assured that everything possible is being done to forecast what might seem to be unpredictable weather of the future. For this purpose the full resources of science are being utilized to make sure that the numerous flood spillways of Reclamation projects are not only big enough to do their protective job properly, but at the same time are as small in size and as inexpensive as the best scientific thought will allow.

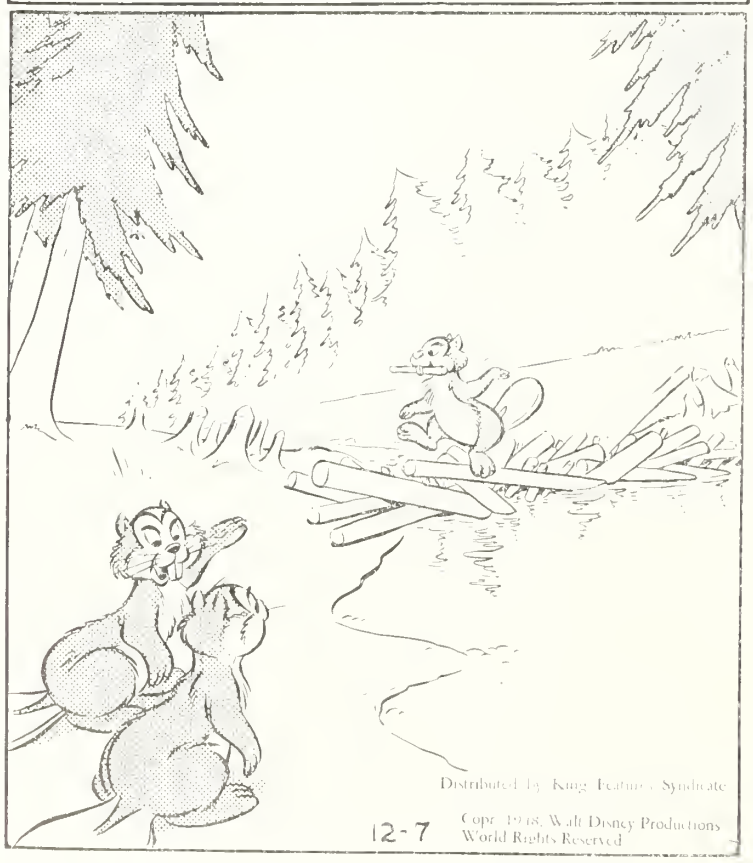
For 3 years the Bureau of Reclamation and the Weather Bureau have been jointly maintaining a group of meteorologists, located at the Weather Bureau's office in Washington, D. C., for the sole purpose of studying the problem of possible extreme storms upon the watersheds above the Bureau's irrigation projects. The cooperative studies bearing on the spillway capacity and flood-storage requirements for the numerous irrigation projects being planned by the Bureau are proving to be increasingly valuable adjuncts to the Hydrology Division of the Bureau's Branch of Project Planning. A staff of 10 to 15 meteorologists is employed by the Weather Bureau through funds allocated by the Bureau of Reclamation, plus two more employed with Weather Bureau funds, for the purpose of conducting studies of storm problems, under the supervision of the top experts of the Weather Bureau. New problems may be solved by the development of special techniques, where necessary, due to the fact that the scientists of the entire United States Weather Bureau are available for consultation, when their advice is needed.

The group studies not only the maximum rainfall which given irrigation projects and the surrounding areas have e perienced in the past, but likewise estimates or assists the Bureau in estimating the maximum rainfall, snow-melt, or combination of both which might occur and cause disastrous floods. Hydrologists from the Bureau's staff, as need arises, assist the meteorologists by providing detailed knowledge needed to help solve particular problems. By this intimate tie with the work of the Weather Bureau, full advantage is being taken of the enormous advances in meteorology which have occurred during and since the recent war, as well as of the most experienced personnel available in the field of meteorology.

Bureau Provides Earthquake Data

Through arrangements made during the past year, records of long-distance earthquakes, which are picked up by any of the five seismograph stations installed by the Bureau of Reclamation at its major dams, are teletyped immediately to the Washington office where the information is given to the Coast and Geodetic Survey, to assist them in locating the origin of the quake and to use in their general seismographical program studies. The data recorded by Bureau instruments are compiled and analyzed by Coast and Geodetic Survey under a Memorandum of Agreement between the two agencies, and the results obtained are furnished the Bureau for use in design studies. The most recent installation took place in October 1947 at the Hungry Horse dam site. Other instruments are installed at Shasta Dam, Hoover Dam, Boulder City, and Pierce Ferry, Ariz., near the site of the proposed Bridge Canyon Dam. In addition to these stations instruments are now being installed to reactivate the station at Overton, Nev.

Merry Menagerie—By Walt Disney



"I'LL SAY SHE'S PRUDISH. SHE CALLS IT A DARN!"

Reproduced by permission of Walt Disney Productions and King Features Syndicate, Inc., due to the similarity of busy beavers' activities and the Bureau's.

The crest of Hoover Dam is 45 feet thick, wide enough to accommodate a four-lane highway, and it is 1,244 feet long—nearly a quarter of a mile. The concrete used in Hoover Dam would have been adequate for building a standard paved highway 16 feet wide from Seattle, Wash., to Miami, Fla.

The Friant-Kern canal, one of the main features of the Central Valley project in California, when completed will be 156 miles long—the longest irrigation canal in the world.

There is enough concrete in Hoover Dam to build a monument 100 feet square and 2¼ miles high. If the concrete used in this dam were placed on an ordinary city block it would rise to a height greater than that of the Empire State Building in New York City, which is 1,248 feet high.

OUR FRONT COVER

Stanley Rasmussen's photo of a row of cherry trees on a highway 3 miles south of Melba, Idaho, portrays the essence of spring—water flowing free in the ditches on its way to productive fields, and blossoming trees, giving promise of a fruitful season.

OUR BACK COVER

George O. Bonawit's photographic study of one of the steel structure of the Parker-Gene transmission line, which links the Parker power plant with the metropolitan water district's Hoover-Gene line, presents another symbol of Reclamation's benefits—hydroelectric power.

NOTES FOR CONTRACTORS

Contracts Awarded During March 1949

Spec. No.	Project	Award Date	Description of work or material	Contractor's name and address	Contract amount
2437	Davis Dam, Ariz.-Nev	Mar. 15	Carrier-current telephone apparatus for Davis Dam and Parker Dam power systems, schedule 1.	Control Corp., Minneapolis, Minn	$48,510
2477	Central Valley, Calif	Mar. 14	Construction of earthwork, structures, track, and telephone line for Shasta dam branch line railroad relocation, Middle Creek to Matheson; and earthwork, structures, and surfacing for Shasta County road relocations, Keswick reservoir.	R. A. Heintz Construction Co., Portland, Oreg	1,714,619
2483	Missouri River Basin, Kans	Mar. 4	Construction of Cedar Bluff Dam and relocation of county road	C. F. Lytle Co., Amis Construction Co., and San Ore Construction Co., Sioux City, Iowa.	11,350,735
2488	Boulder Canyon-All-American Canal Ariz.-Calif.-Nev.	Mar. 3	Construction of earthwork, pipe lines, and structures for laterals 119.64 to 123.4 and sublaterals, unit 6, Coachella Valley distribution system.	American Pipe & Construction Co., Los Angeles, Calif	2,049,922
2495	Missouri River Basin, Nebr	Mar. 2	Construction of Superior-Courtland diversion dam and earthwork and structures for superior canal.	Knisely-Moore Co., Douglas, Wyo	866,263
2496	Central Valley, Calif	Mar. 22	Five 11- by 18-foot and three 18- by 18-foot radial gates for Friant-Kern Canal, items 3 and 4.	Somers, O'Rear, and Stephan, San Jose, Calif	18,891
2499	Columbia Basin, Wash	Mar. 1	Four 230,000/196,000-volt circuit breakers and fifteen 230,000-volt lightning arresters for Grand Coulee 230-kilovolt right switchyard.	General Electric Co., Denver, Colo	310,500
2503	Missouri River Basin, Wyo	Mar. 17	Two 30- by 25-foot radial gates for Boysen Dam	Union Steel Co., Los Angeles, Calif	51,856
2505	Colorado-Big Thompson, Colorado	Mar. 4	Furnishing and installing equipment and constructing one 1,500-kilovolt-ampere substation at Fleming, Colo.	E. A. Koeneman Electric Co., St. Louis, Mo	49,889
2506	Davis Dam, Ariz.-Nev	Mar. 16	Furnishing and erecting structural steel for highway bridge across forebay channel at Davis Dam.	American Bridge Co., Denver, Colo	229,876
2507	do	Mar. 18	One 20,000-kilovolt-ampere synchronous condenser and control equipment for Tucson substation.	Elliott Co., Jeannette, Pa	203,773
2511	Hungry Horse, Montana	Mar. 11	Fabricated wrought-iron pipe and appurtenances for Hungry Horse Dam, item 1.	Associated Piping & Engineering Co., Inc., Compton, Calif.	29,600
2515	Missouri River Basin, Kans	Mar. 4	Two 4- by 5-foot high-pressure gates with two 110,000-pound hydraulic hoists and appurtenances for Cedar Bluff Dam outlet works.	Albina Engine & Machine Works, Inc., Portland, Oreg.	33,917
2516	Office of Chief Engineer, Denver, Colo	Mar. 8	Construction of foundations for Universal testing machine and alterations to building 1-B at Denver Federal Center.	Martinson Construction Co., Denver, Colo	211,432
2519	Minidoka, Idaho	Mar. 9	Four 34,500-volt circuit breakers for switchyard at Minidoka power plant.	General Electric Co., Denver, Colo	25,800
2528	Davis Dam, Ariz.-Nev	Mar. 23	Five 2,000-amp bus structures with current and potential transformers, disconnecting and grounding switches, capacitors, and lightning arresters for units 1 to 5, Davis power plant, schedule 1.	I-T-E Circuit Breaker Co., Philadelphia, Pa	90,807
2533	Boulder Canyon, Ariz.-Nev	Mar. 17	Four 230,000/196,000-volt circuit breakers and nine 230,000-volt lighting arresters for Arizona-Nevada 230-kilovolt switchyard.	Westinghouse Electric Corp., Denver, Colo	309,250
2539	Kendrick, Wyo	Mar. 21	Installing equipment and constructing Medicine Bow substation.	Flora Construction Corp., Denver, Colo	16,770
2540	Columbia Basin, Wash	Mar. 8	26 stop logs for Grand Coulee Dam, item 1	Pacific Car & Foundry Co., Seattle, Wash	98,100
2541	do	Mar. 16	Construction of earthwork, concrete lining, and structures for west canal.	Morrison-Knudsen Co., Inc., Seattle, Wash	6,136,234
2557	do	Mar. 9	Fabricated structural steel for 230-kilovolt switchyard and 230-kilovolt tie circuits, Grand Coulee power plant.	Union Steel Co., Los Angeles, Calif	17,913
2569	Hungry Horse, Montana	Mar. 31	Two bulkhead gate frame assemblies for river outlets at Hungry Horse Dam.	Jumbo Steel Products Co., Azusa, Calif	18,541
R1-49	Palisades, Idaho	Mar. 8	Drilling test holes for highway relocation	Boyle Bros. Drilling Co., Salt Lake City, Utah	11,776
R2-51	Central Valley, Calif	Mar. 14	Erection of security fence station 2238+35 to station 2412+63, Friant-Kern Canal.	California Wire Cloth Corp., Oakland, Calif	19,604
R2-39	Klamath, Oreg.-Calif	Mar. 14	Construction of Adams pumping plant	George R. Stacey, Tulelake, Calif	47,902
R2-52	do	Mar. 23	Construction of the C-4-e lateral enlargement and parallel drain and earthwork and culverts, station 15+150 to station 101+20.8.	do	10,369
R6-24	Missouri River Basin, Mont	Mar. 8	Construction of electrical distribution system for Moorhead Dam Government Camp, schedule 2.	Hi-Line Construction Co., Wolf Point, Mont	11,699
R6-26	do	Mar. 31	Construction of pumping plant, canal, and laterals for Savage Unit.	Long Construction Co., Billings, Mont	255,963

Construction and Supplies for Which Bids Will be Requested by July 1949

Project	Description of work or material
All-American Canal, Calif	Construction of about 70 miles of concrete pipe lines and structures for lateral unit No. 7 of the Coachella Valley distribution system, near Thermal, Calif.
Boise, Idaho	Relocation of the remaining 13.6 miles of county road, including construction of 2 bridges, about 16 miles northwest of Cascade, Idaho.
Boulder Canyon, Ariz.-Nev	Processing of sand and gravel for concrete aggregate.
Central Valley, Calif	Furnishing and erecting temporary construction warehouse at Tracy switchyard.
Do	Construction of 18 miles of double-circuit and 74 miles of single-circuit, 230-kilovolt, steel-tower transmission line from Elverta to Tracy, Calif.; and stringing 57 miles of single-circuit conductor for the Oroville to Elverta, Calif., transmission line.
Colorado-Big Thompson, Colo	Construction of 68 miles of 115-kilovolt transmission line between Oak Creek and Green Mountain, Colo.
Davis Dam, Ariz.-Nev	69- and 15-kilovolt oil circuit breakers, disconnecting switches, and instrument transformers for Mesa substation.
Do	Construction of reinforced concrete dispatcher's building for power and communications system control, at Phoenix, Ariz.
Do	Construction of reinforced concrete condenser building, placing of transformer and steel tower foundations, and erection of steel structures at Tucson substation, Tucson, Ariz.
Do	Erection of steel structures for substation at Prescott, Ariz.
Do	Erection of steel towers for 42 miles of 230-kilovolt transmission line between Mesa and Coolidge, Ariz.
Davis Dam, Ariz.-Nev.-Calif	Erection of steel tap structure at junction of second Parker-Gila 161-kilovolt transmission line and Gila-Drop No. 4 line, near Pilot Knob, Calif.
Fort Peck, N. Dak.-Mont	Constructing Williston substation and installing equipment including a 15,000-kilovolt-ampere capacity main transformer bank, from 115- to 69-60-kilovolt, and a 1,000-kilovolt-ampere capacity bank, from 69-60- to 12.5-kilovolt, at Williston, N. Dak.
Hungry Horse, Mont	Furnishing and installing 1 freight and 2 passenger 10,000-pound capacity electric elevators at Hungry Horse Dam.
Missouri River Basin, Colo.-Nebr.	Construction of 88 miles of 115-kilovolt transmission line between Sterling, Colo., and Ogallala, Nebr.
Missouri River Basin, Nebr	Construction of earthwork and structures for 6.5 miles of Cambridge Canal near Arapahoe, Nebr.
Do	Installing equipment and constructing Sidney substation, 20,000-kilovolt-ampere capacity, from 115- to 34.5-kilovolt and 12.5-kilovolt, near Sidney, Nebr.
Missouri River Basin, N. Dak	1 transformer transfer car for Williston substation transformers.
Do	Construction of the 41-mile long Bismarck-DeYaul 69-kilovolt transmission line near Bismarck, N. Dak.
Missouri River Basin, Wyo	Two 100,000-pound radial-gate hoists for Boysen Dam spillway.
Ogden River, Utah	Furnishing and installing a venturi meter in Ogden Canyon conduit.
Palisades, Idaho	Relocation of about 2 miles of State highway at Palisades Reservoir 56 miles southeast of Idaho Falls, Idaho.
San Luis Valley, Colo	Clearing and disposing of timber covering about 69 acres in the Platoro Reservoir site area on the Conejos River about 1 mile upstream from Platoro, Colo.
Do	Construction of foundations for trailer camp, roads, and all utilities at Platoro dam site Government camp.
Do	Construction of one permanent-type caretaker's residence including necessary utilities at Platoro Dam site.
Yakima, Wash	Repairing Tieton Dam and spillway. The dam is an earthfill structure about 220 feet high and 920 feet long, 23 miles west of Yakima, Wash.
Do	Construction of channel improvements below Keechelus Dam about 65 miles northwest of Yakima, Wash.

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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' associations.

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The United States Department of the Interior
now celebrating
A CENTURY OF CONSERVATION
1849–1949

DO YOU KNOW . . .

- Tule Lake, located on the Klamath project northern California and southern Oregon, had a wa surface area of approximately 96,000 acres in 1910 today is confined to an area of about 13,200 acres, w another 18,600 acres of agricultural land reserved pond extreme floods?
- a total of 624 farm units, involving 43,558 rigable acres, have been opened to homestead en since 1922 in the area once covered by the waters Tule Lake?
- the first public land opening in the Uni States after World War II was the Tule Lake divis opening of August 1, 1946?
- the third public land opening on the Klama project following World War II was announc August 27, 1948? The 86 units involved will be awarc in time for the entrymen to farm the land in 1949.
- over 11,000 applications have been received the 216 farm units opened to entry on the Klamath pr ect in the three post-war openings?

RECLAMATION PLACE NAMES IN THIS ISSUE

NEW BLOOD for the Bureau

by HAROLD T. NELSON, Assistant Regional Director and Trainee Coordinator for Region I, Boise, Idaho, and GLENN D. THOMPSON, Chief Personnel Officer, Washington, D. C.

Instruction on the operation of concrete testing apparatus was given trainees on the Hungry Horse project. Top to bottom: Harold C. Margolis, Cooper Union School of Engineering, New York City; Fred P. Witte, Michigan State College; and Concrete Officer Harry P. McLean, Bureau of Reclamation. *Photo by A. E. McCloud, Region II.*

As college classrooms close their doors this month, engineering students from all over the country will pack their books, notebooks, and slide rules and converge upon the West, for Reclamation's three-way bargain—the engineer trainee program.

Taxpayers and water users will get more than their dollar's worth for each dollar of salary received by the trainees because (1) the Bureau will get sorely needed summer help on its construction jobs; (2) the young engineers will receive valuable on-the-job training coupled with a try-out period to determine the line of work for which they are best suited, and (3) the Bureau will eventually have a crew of live wire young engineers, hand-picked, job-trained, and job-suited.

For the Bureau of Reclamation does not want an organization wherein the "generals" outnumber the "buck privates," a state of affairs which threatened the Bureau's recruiting problem during the postwar years.

The "buck privates"—the backbone of the organization—are the young engineers in the lower classifications, starting with civil service grades of P–1 or junior engineers, who normally perform the bulk of Reclamation's engineering work, supervised by a relatively small group of older career engineers, many of whom are nationally known in their various fields. Enough of the recruits of former years stayed on for a career in Government service to staff the top-flight engineering jobs with competent, well-trained engineers.

At the end of the war, the P–1 engineer in Government service was as scarce as natural river flow in the desert in July. Both during and since the war years the old timers carried on to help take up the slack. But gray heads got grayer and the inexorable tide of retirements thinned the ranks.

Someone had to step forward to fill the shoes of men like John Page, Harry Bashore, J. L. Savage, S. O. Harper, "Brig" Young, Harold Comstock, E. B. Debler, Ralph Lowry, and other names that were bywords of Reclamation. In addition to recruiting to care for normal turn-over, the Bureau was called upon to carry on a postwar program five times as great as the prewar program. Contrary to all expectations, no returning tide of P–1 engineers greeted the Bureau recruiter. All he met was a disappointing trickle, although applicants in the high grades were reasonably plentiful.

Obviously ordinary recruiting techniques were not enough—an extraordinary program was required—and fast—to prevent the Bureau's organization from becoming top heavy with "generals" doing "buck private" work. As a consequence, an engineer trainee program was installed throughout the Bureau for the first time at the start of the 1948 construction season. Sophomore and junior engineering students from accredited colleges and universities were offered an opportunity, through a civil service examination, to qualify for summer employment in all Reclamation activities throughout 17 Western States. Registers were established in the branches of civil, electrical, mechanical, architectural, and general engineering and it was intended, so far as possible, to assign students to work in their options. Sophomore students were given probational employment at grade SP–4 with a salary rate of $2,498 per annum, and junior students were placed at grade SP–5 with a salary rate of $2,724 per annum. Engineer trainees were expected to "earn their keep" by working full-time on their assigned projects, in addition to paying all expenses, including travel to and from school. The program was of necessity rather hastily installed without benefit of prior precedent or trial. Supervisors at the various projects worked out training procedures and schedules, so that each trainee was given an opportunity to do the work for which he was best suited, and which would be of the most value to the Bureau. The engineer trainees

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H. J. Wolfstein (left), University of Washington, and H. D. Scott of Oregon State College, trainees on the Columbia Basin project, check the west powerhouse draft tube gates at Coulee Dam for damage incurred by Columbia River flood of 1948.

were rated on the basis of first-year-job performance and those found qualified were placed on educational leave without pay prior to returning to school. By this device the SP–4's are returning this summer without further examination at grade SP–5, and the SP–5's upon graduation may enter Bureau employment as professional engineers in the P–1 grade.

Time was when many of the engineers of the West bolstered an experience record by a "hitch" with the Bureau. Many of these former employees went on to fill a prominent place in the life of the West. Among the "trainees" of the past might be numbered Frank Crowe, that great builder of dams; and Harry Morrison, the head of a world-wide contracting firm that bears his name. City directories of most important irrigation communities of the West are similarly studded with names that once appeared on a Bureau pay roll. For instance, there is Judge N. K. Buck, one-time chief clerk of Tieton Dam, later Superior Court Judge, and still later Mayor of Yakima, Wash.

The engineer trainee program is designed not only to select and train future employees but also to sell the work of the Bureau as well as the position in the process. Under present economic conditions the entrance salary for Government service is lower than entrance salaries offered outside the Government, with the absence of bonuses, hospitalization and other added inducements frequently offered to graduating seniors by large corporations and industries. In order to remain in this competitive market and at the same time adhere to the Bureau tradition of sound engineering within reasonable cost limitations, the recruiter has emphasized experience opportunities rather than monetary return. An effective selling point is the opportunity to work with many pieces of fine equipment, processes, and through association with older engineers of world renown. The engineer trainee program can accomplish this far better than the best sales talk in the world in the few minutes available before a graduating class. The Bureau in effect is offering a select number of trainees a summer or two behind the scenes to see for themselves the value so many of their predecessors found in Bureau experience—value that may not now appear on the pay check, but value that may be money in the bank some day.

A total of 346 engineer trainees had finished their first assignment and returned to school, when the dust of the largest construction season in Bureau history had settled last fall. They had been recruited from 71 colleges and universities throughout the entire United States, 220 of them from Reclamation States and 126 from other States. What they may have lacked in experience they more than made up in enthusiasm as some of them set foot west of the Mississippi for the first time.

The engineer trainee program is not a magic formula for producing a qualified engineer. It was designed with the idea that certain education, training, experience and development should provide the qualifications necessary to win success as an engineer in the Bureau of Reclamation.

Trainees were told that, in order to climb the career ladder of the Bureau, they had to have stick-to-it-iveness, the ability to learn while on the job, the willingness to accept an assignment regardless of personal inconvenience, to transfer from one job to another, live in temporary housing facilities, and enough interest in their job to keep up with the profession and the economic changes involved in natural resource developments such as the Bureau undertakes.

Before entering on the job, these trainees were told that the Bureau is not offering them a summer vacation, a visitor's tour of Bureau operations, or an extension of their academic studies. Early in the game the principle was established that the academic type of training should be left to the colleges and universities. They are offered a real job—a challenge to do some work on an engineering project, to learn the "why's" and "wherefore's" of the project and the over-all objectives of the Bureau.

What jobs did they do?

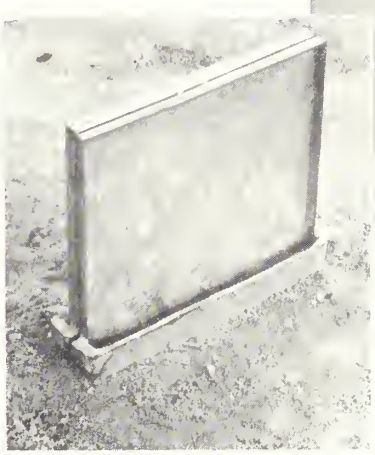
Last year they worked on the Platoro Dam and Reservoir (see p. 103, May 1949 Reclamation Era) on the San Luis Valley project in Colorado, making lay-out and measurements of base lines for the dam as set by paper location. They cross-sectioned the dam site; sampled borrow materials, and located timbered areas to be cleared. They were shifted to different positions and types of work to acquaint them with the multitude of operations which go into building a dam. Sometimes they were chainmen, rodmen, transitmen, levelmen, notekeepers, axe men, and calculators. Depending upon their attitude and initiative, they were given more and more responsible jobs to do.

Trainees assigned to the Klamath project in southern Oregon were given an unusual opportunity to work on a project which included all stages of development from pre-

(Continued on page 122)

how detachable is your soil?

by W. D. ELLISON, Soil Conservationist, Bureau of Yards and Docks, United States Department of the Navy



At left: Splashboard catches samples of splash erosion. Above: the author empties one into test tubes. Left tube: splash from unprotected soil. Middle tube: soil partially protected. Clear tube: from well protected soil.

EDITOR'S NOTE: Last month we had the privilege of publishing "Raindrop Erosion," extracted from Mr. Ellison's article, "Erosion by Raindrop," which appeared in the November 1948 issue of Scientific American. Here Mr. Ellison presents an article written especially for reclamation farmers, in the interest of soil and moisture conservation on reclamation projects, and also due to its helpfulness in studying sprinkler irrigation.

THE ACTUAL SPLASH EROSION PROCESS, so destructive to the productivity of our lands, is not visible to the naked eye. Yet, it is nonetheless real and potentially dangerous. Perhaps we should think of it as we do the microscopic germs which are forever endangering our health.

But you can see splash erosion in action for yourself without the aid of microscopes, and the average farmer can make some measurements that will enable him to know the most effective farming practices for controlling splash erosion in his own fields.

The rainfall applicator set up and ready for a test. The canvas "shower curtain" protects the falling drops from the wind.

As an experiment, some rainy night just direct the beams from a car's headlights across a bare field. Now get to one side and look at the ground surface where the lights are brightest. Then set a postcard on edge, something like a pencil stuck in the ground, and the splashing soil will soon splatter the card with mud.

How does splash erosion damage your soil? The answer will depend very much on the soil itself. Of course all soils will migrate down slope when splashed. On steep hillsides a violent rain may cause billions of tiny soil particles to literally "fly" down slope on each acre of a steep hillside. But then there are other damages that will vary with each different soil. For example, when sandy soil splashes, even though the land is relatively flat, the fine and light materials may be washed out and floated away, somewhat as cream is separated out of milk. When clayey soil splashes, the land is puddled and sealed against the intake of water. This is an important matter for the reclamation farmer to investigate; especially so if his soil is clayey, because it will affect the watering of his soil. When splash erosion occurs on most any soil it will destroy the small crumbs and the structure of the soil and thereby reduce the land's productivity.

Each of the above damages will tend to increase along with splash erosion and they will be curtailed by reducing the splash erosion process. Before the farmer can check splash erosion in his daily field operations, he must learn something about each of the three most important factors that control this splash: (1) the power of the falling raindrops, (2) the detachability of his soils, and (3) the value of cover in checking and curtailing splash erosion.

There is a wide variation in the power of the falling raindrops in different storms. Some raindrops fall with great energy and splash tremendous amounts of soil into

the air—more than 100 tons per acre on some bare fields during a single violent storm. In other storms the falling drops possess very little kinetic energy and may splash less than one ton of soil per acre into the air. The farmer will find that this energy factor will vary from one season to another, and that his need for soil protection will vary with these changes in the rainfall.

The second of the three most important factors—the detachability of the soil itself—indicates the amount of energy that is required to detach or tear loose small splashable particles from the surface. If a soil is easily splashed, such as a pure sand made up of small round grains, we say it is of high detachability. Others which splash at a very low rate, are said to be of low detachability.

The third and last of these important factors, that of a soil cover, can be influenced by plants and mulch materials that check the energy of the falling drops before they strike the soil. These represent a soil protection factor, and the amount of protection that is needed on any field will depend, first, on the energy of the raindrops, and second, on the detachability of the soil. During seasons of high raindrop impact, a heavy cover is needed on all soils. Also, soils that are highly detachable and easily splashed will require larger amounts of cover protection the year-round than do soils of lower detachability, for purposes of checking splash erosion.

It is an easy matter to measure each of these three factors, but some special types of equipment are needed to measure the first two: the energy of the falling drops, and the detachability of the soil. However, once this equipment is available there is nothing complicated about making the measurements and making use of the results. It can be done by the average first-year high school student.

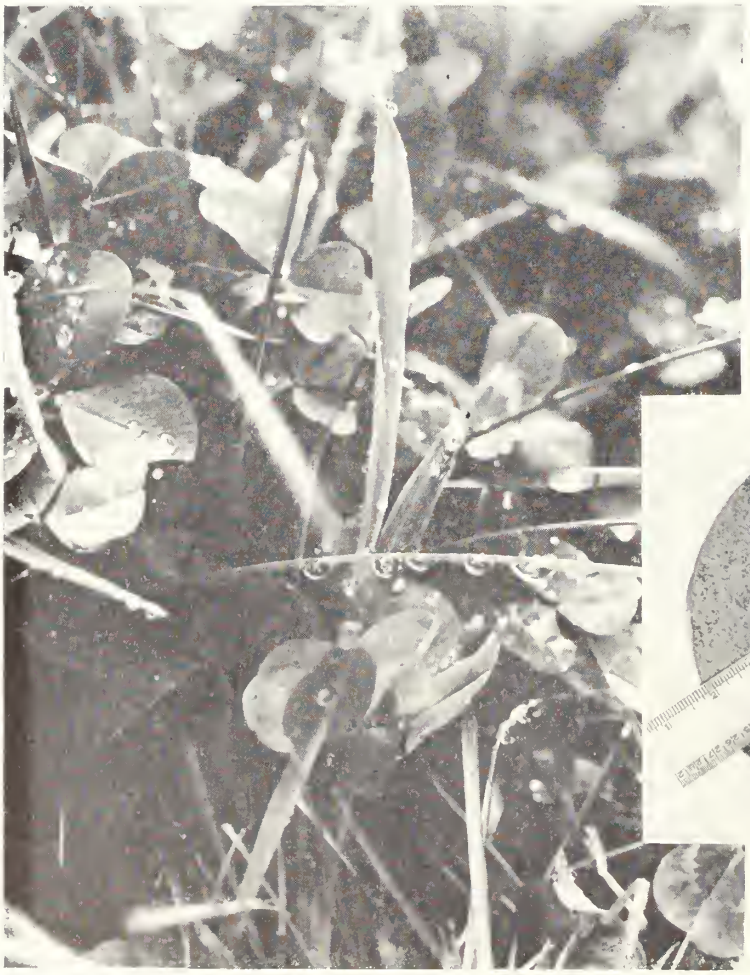
To measure the splash capacities (power to splash) of falling raindrops in different rainstorms, a small splash-dish (cup) of sand is set out in the rain. This dish is 3½ inches in diameter, filled level with a standard sand. As the raindrops strike, they splash the sand out of the dish. If they splash 100 grams of sand out, the rainfall is said to have a soil detaching capacity of 100; if they splash only 10 grams of sand out of the dish, the rainfall is said to have a soil detaching capacity of 10. Those are the amounts of sand they would detach on a field area of equal size.

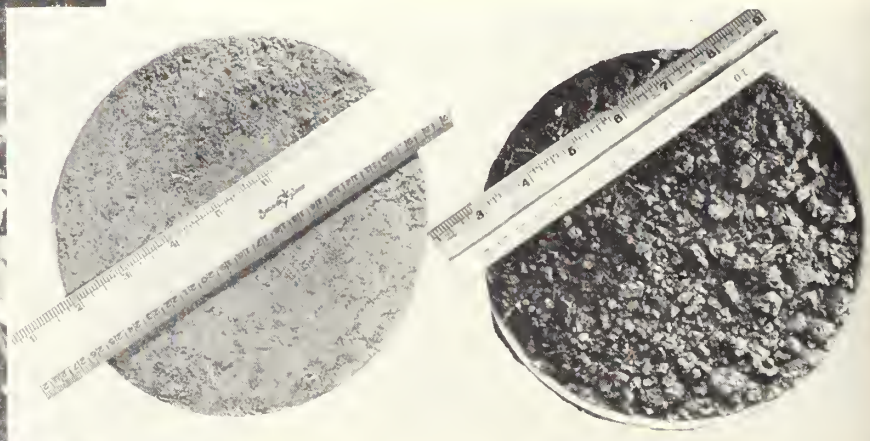
The sand that is used is a special laboratory material, round grained, that passes a 60-mesh sieve and is retained on a 70-mesh. Sand of this standard can be purchased from a commercial firm in Chicago which handles graded sand. To determine the amounts splashed out of the dish, it is oven dried for weighing both before and after the storm. A farmer might have difficulty in weighing the sand. He could dry it all right in an ordinary kitchen oven, but he does not ordinarily have a scale that will weigh to the nearest gram. Therefore, the best he can do is to guess how much is splashed out, and this procedure will enable him to differentiate between the most destructive storms and those that cause little or no splash damage to the land.

To measure the detachability of the soil, a farmer would place a splash dish filled with the soil to be tested beside a splash dish of the standard sand. If one-half as much soil is splashed as there is sand, the soil is said to have a detachability of one-half (0.50); if three-quarters as much soil as sand is splashed, that soil is said to have a detachability of three-quarters (0.75), etc. Detachabilities of different soils have been measured and found to vary from 0.20 to 0.90, during the length of one storm.

It would take about 651,960 of these small splash dishes to make 1 acre. Therefore, the amount of soil splashed from one of these dishes can be converted to grams per acre merely by multiplying by 651,960. There are about 907,200 grams

(Continued on page 133)





At left: Protection against raindrop erosion—about 70 percent vegetal cover. Above: What splash erosion did to the same soil on one field. Left: splash erosion active for many years. The soil on the right has been protected and is of high quality in all respects. *All photos accompanying this article made available through the courtesy of the author and the Soil Conservation Service, United States Department of Agriculture.*

The AGENCY PLAINS SPECIAL

or Streamlined, Convertible Housing in Oregon

by MERLE L. TILLERY, Acting Chief, Land Use and Settlement Division, Region I, Boise, Idaho

When they speak of the "Agency Plains Special" on the Deschutes project, they don't refer to a new express that thunders through the area in the middle of the night.

They're talking about a unique type of rural home being constructed by settlers on the new irrigated farms in central Oregon that reduces the investment in housing and outbuildings to a minimum during the difficult initial years of development after water is first delivered.

The housing is a cheap yet comfortable combination of living quarters and space for storage of equipment, machinery and supplies. Eventually, when the farmer can afford it, the living end of the building will become storage space for grain or other farm crops, added space for machinery or equipment, or living quarters for the hired help.

The "Agency Plains Special," so called because of its popularity in that section of the North Unit of the Deschutes project known as "Agency Plains," has been built at an average cost of approximately $2,400. In August 1948, when the photographs accompanying this article were taken, a dozen or more buildings of this type were inspected and found to cost about $2,000 each. Buildings constructed more recently have cost as much as $3,000, due to increases in the costs of labor and materials.

The average building is an 80 by 24 foot unit, with living quarters 24 feet square. The exteriors are covered with drop siding, or made of cinder blocks, with the roofs of corrugated aluminum.

The interiors of the homes have been made exceptionally attractive in many instances. Most have entirely modern kitchens, finished in knotty pine. Large windows and other modern features are to be found in many living rooms. It's a far throw from breaking in a new farm from a tent.

Some of the farmers have so constructed their buildings that when permanent homes are available, partitions can be taken out and the former living quarters used as a double garage, machine shop or added space for farm equipment. (See photo below.) Those who have built their houses of concrete or cinder blocks can quickly turn them into storage space for grain or other crops needing protection from the weather.

With considerable interest in the new type of rural housing having been aroused on projects other than the Deschutes, Oregon State College has begun preparation of a variety of floor plans and specifications for these buildings.

The one criticism that has been heard concerning the "specials" is that there may be a tendency on the part of the farmers to overfinish and overequip the living quarters to a point that the investment in the temporary home will retard the development of the farm and delay the building of a permanent home. The comment is considered justified by Bureau of Reclamation specialists and they urge that people who contemplate building such temporary living quarters should limit expenditures to the minimum and at the same time provide the necessary conveniences. The End

The interior of a rather permanent looking kitchen in the home of Mrs. Melvin Waldemar. This type home costing approximately $2,500 has an interior finished in second grade knotty pine. While it affords reasonable and comfortable living for now it will ultimately be converted into a machine shed when permanent living accommodations are constructed.

The John McDaniel residence, another Agency Plains Special, built at a cost of $2,000. It is an 80- by 24-foot building. The exterior has been covered with a 12-inch drop siding and the roof is of corrugated aluminum. After it serves its temporary duty it will also be converted to another use. *Both photos by Stanley Rasmussen, Region I.*

NEW BLOOD for the BUREAU

(Continued from page 118)

liminary reconnaissance to final construction. Rotation of assignments was a "natural" on this project. Trainees got a chance to see what goes into making an inspection of construction work, estimating contract payments, preparing mechanical engineering graphs, capacity curves, minor mechanical design changes, tabulating pump and motor data. They made field inspections of the installation of mechanical equipment such as pumps, float-control equipment, gates, hoists, and also were on hand for performance tests.

The young men who were specializing in electrical and mechanical engineering received an assignment right down their alley—working on the Davis Dam transmission system designs. When they returned to college they were proud to be able to report that they had had a hand in designing the steel tower transmission lines and plotting the profile sheets to select the proper sites where these structures would be built. They learned to use the sag and conductor height templates, side-swing charts, do detail and lay-out work and help make the drawings of various steel substation structures.

At Grand Coulee trainees had an opportunity to work in practically every phase of engineering on the world's largest concrete structure. At Hungry Horse in Montana, they got in on the ground floor of what will be the world's fifth highest and fourth largest concrete dam, and on irrigation projects, project planning offices and at the Denver, Colo., laboratories they performed valuable services and gained experience difficult to duplicate in any other organization. In some instances it was found most useful and valuable to the Bureau and the trainee to give the young engineer a single job to do during the summer, especially on operation and maintenance assignments.

Proving their interest in their work, during the summer, the trainees asked for copies of the Bureau manuals on concrete, design and construction, specifications, and surveying, so they could have reference data available for outside study. Supervisors checked up periodically on their work performance and production, and upon examining the first year's score cards, the results look good. Prior to return to school, each man was asked to file a written impression of his summer's work. In almost every instance the trainee was enthusiastic about his job opportunity and promised to return if invited back. It appears that the Bureau may have the jump on other agencies now installing similar trainee student programs. Those who return to the Bureau as P–1 engineers will have a better understanding of what is expected of them as professional engineers on the job.

Water users who exercise that inalienable Yankee trait of turning over the price tag before buying can be assured that summer training-in-service should inflate rather than dent Reclamation's well-worn pocketbook. Trainees displace a part of seasonal temporary labor at no appreciable increase in cost. Unlike seasonal labor that is here today and gone tomorrow, these trained young men should pay large dividends in increased competence and production.

This June the first of the trainees emerge with sheepskins and the Bureau will have received its first transfusion of new blood.

This year the Bureau has plans for putting 500 trainees to work, and in response to its announcement, 3,000 students from 80 of the leading universities in the country applied for an opportunity to join the ranks of the Bureau of Reclamation this summer. THE END

Indian Dam To Be Higher Than Hoover

The Kosi Dam project in India contemplates a dam 750 feet high—some 25 feet higher than Hoover Dam, at present the world's tallest. Spanning a narrow gorge in Nepal, the dam will store 11 million acre-feet of water for irrigation, and provide for the generation of 1.8 million kilowatts of low-cost electric power.

The Kosi River rises high in the Himalayas and a portion of its 24,000 square miles of watershed includes great glaciers and the highest mountain peaks in the world, among them renowned Mount Everest. The river is noted for its vagaries, having in the past 200 years changed its course so that in places its present channel is now some 70 miles from the original one. In its wanderings it has laid waste more than 3,000 square miles of rich agricultural lands. Its sudden flows often spread out across its valley inundating lands for 10 miles on either side of the river. The population density in this area is 900 persons to the square mile so loss of life and property damage from floods is tremendous.

Kosi Dam will tame the river much in the same manner as Hoover Dam has harnessed the Colorado. Floods will be minimized and large areas of swampy malaria-ridden lands can be drained and put under cultivation. Two diversion dams below the main dam will divert water into four canals which will carry water for the irrigation of more than 2 million acres of land in Bihar State and 1 million acres in Nepal territory. The total cost of the project, including canals and transmission lines is estimated at $300 million.

Foundation investigations are under way at the dam site with several exploratory tunnels being driven and diamond drill borings being made. Final design of the dam cannot be made until these explorations are completed but preliminary design studies are in progress. It is expected that the project can be completed in about 10 years once construction is begun.

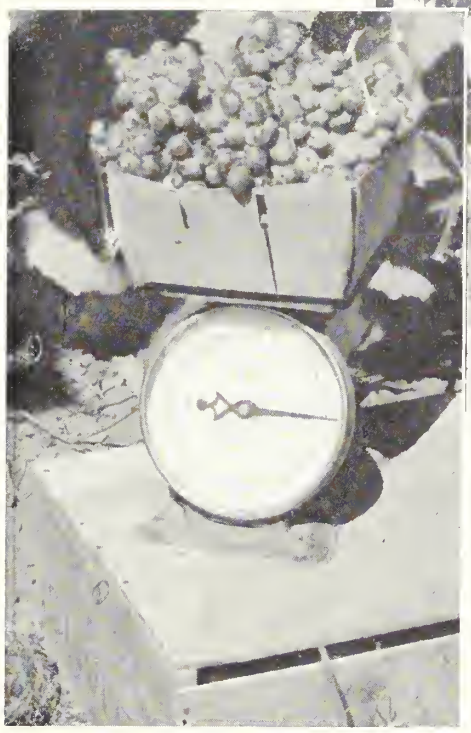
Mr. John L. Savage, world-famous dam expert and former Chief Designing Engineer for the Bureau, inspected the Kosi Dam site in 1947. He has been retained by the Government of India as a consultant on this and other important Indian projects. •

New Use for Old Broom

Even if a new broom does sweep clean, at J. B. Wyman's Napa county chicken ranch, old brooms are found to clean better when used as foot scrapers.

Located at all strategic points about the ranch, these foot scrapers are made by drilling a hole in a plank for the sawed-off handle of the broom, pushing the handle into the hole—and there you have a foot brusher and cleaner. This tip came from the February 12, 1949, *California Farmer*.

Below: The "Sanderson Special" is weighed in. At right, a close-up of the luscious-looking fruit. Judging from appearance it should make mighty fine eating. *Photos by the author.*



A NEW GRAPE IS BORN

by RALPH O. BAIRD, Office of Project Planning, Phoenix, Ariz., Region III

Mr. C. A. Sanderson, one of the early settlers in the Salt River project and now retired from the intensive agricultural pursuits characteristic of the valley, keeps active by maintaining a few acres of grapes, citrus, dates, and pecans, and is constantly budding, planting, and testing new varieties and otherwise pursuing his horticultural hobby.

His vineyard produces more than he and his family and friends can consume. Accordingly, many grapes fall from the vines; and their seeds, as is their custom, germinate.

Over the years Mr. Sanderson has become accustomed to the usual amount of growth made by the seedlings between germination and the time the cultivator begins its death march.

About 3 years ago the cultivator began ripping its way through the vineyard, with Mr. Sanderson at the handles observing the usual crop of grape seedlings, when he noticed one plant that had grown about three times more in height and diameter than any of the other seedlings. He stopped the cultivator, went to the shed for a spade, and transplanted this unusual vine to a place at the gate post.

Two years later this particular grapevine was nearly 300 feet long, and bore its first fruit.

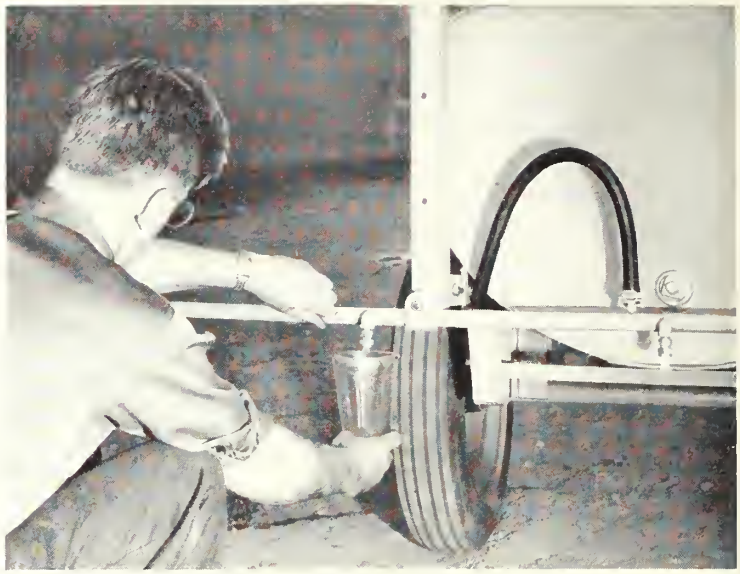
The size of the berry, flavor, and vigor of the vine was such that he decided to apply for patent on this new variety, which he named Sanderson's Special.

The grape is a blue slipskin of the Mediterranean type, with individual berries almost three-fourths of an inch in diameter. The vines bear profusely, as shown by the accompanying illustrations.

Plant Patent No. 782 was granted to Mr. Sanderson last year and plants of this new variety will become available to other vineyardists from commercial sources in the near future. Thus life and new products issue from irrigation projects, along with the abundant production of staple crops which continue to enrich the country's agriculture. The End

HOW MUCH 2,4-D for the SPRAYER

by T. E. LEIPER, Land Use Specialist, Yellowstone District, Region VI, headquarters at Billings, Mont.



Calibrating the spray rig begins with measuring the output of one nozzle during a 1-minute run. ***Photo by H. Wittman, Region VI.***

Since 2,4–D came into use a few years ago, managers and operators of spray rigs have been plagued with various tables, graphs, and formulas for determining how much of the herbicide to pour into the sprayer. Many of these early instructions were confusing to the operator. This article offers suggestions intended to simplify calculations for application of given amounts of herbicide, but makes no recommendations concerning rates, time or method of application.

Among other things, the successful operation of a spray rig requires the solution of two problems, namely:

(1) How much liquid spray will the rig apply per acre under average working conditions?

(2) What mixture of spray materials will make the proper solution for delivering the desired amount of acid equivalent per acre from the rig in question?

One of the most simple and accurate methods for solving the first problem is to measure the amount of solution delivered per minute by one of the nozzles, and then refer to accompanying table 1. The spray rig should be filled with 10 gallons or more of water. Start the engine and after establishing an operating pressure with all the nozzles open, catch the spray solution from one of the nozzles during a 1-minute period. Measure the volume of water in ounces—a glass kitchen measuring cup graduated in ounces may be used for this purpose. To assure reasonable accuracy, measure the volume from at least five runs, preferably from different nozzles which all should be of the same make and of the same size opening or orifice. An average of these 1-minute runs should give the amount of water in ounces per minute per nozzle. The number of gallons of spray per

Table I. For Determining Application Rate of Spray Rig

Gallons of spray applied per acre according to various nozzle spacings and individual nozzle delivery in ounces per minute with rig moving at 4 miles per hour.[1]

1	2	3	4	5
	Distance between nozzles			
Gallons per acre	15 inches	16 inches	18 inches	20 inches
	Ounces per minute delivered from each nozzle			
5	6. 40	6. 82	7. 68	8. 53
6	7. 68	8. 19	9. 16	10. 23
7	8. 96	9. 55	10. 75	11. 94
8	10. 24	10. 92	12. 28	13. 64
9	11. 52	12. 28	13. 82	15. 35
10	12. 80	13. 65	15. 36	17. 06
11	14. 08	15. 01	16. 89	18. 76
12	15. 36	16. 38	18. 43	20. 47
13	16. 64	17. 74	19. 96	22. 17
14	17. 92	19. 11	21. 50	23. 88
15	19. 20	20. 47	23. 04	25. 59

[1] Data obtained by using formula suggested by the U. S. Bureau of Plant Industry, Soils and Agricultural Engineering.

Table II. For Determining Proportions of Herbicide and Water

Amount of herbicide per 100 gallons of spray solution to apply 1 pound of 2,4–D acid equivalent per acre at various gallonages per acre

1	3			4			5			6			7		
Type	Butyl			Ethyl			Isopropyl						Amine		
Weight per gal.	8.26			8.10			8.90						10.01		
Lbs. acid per gal.[1]	2.64			3.00			3.34			3.48			4.00		4.20
Application rate in gallons spray per acre	Amount of herbicide per 100 gallons of spray														
	gal.	qt.	oz.	gal.	qt.	oz.	gal.	qt.	oz.	gal.	qt.	oz.	gal.	qt.	oz.	gal.	qt.	oz.
5	7	2	10	6	2	21	5	4	0	5	3	0	5	0	0	4	3	1
6	6	1	8	5	2	6	4	4	0	4	3	5	4	0	22	3	3	28
7	5	1	20	4	3	1	4	1	5	4	0	13	3	2	9	3	1	19
8	4	3	0	4	0	22	3	3	0	3	2	12	3	0	17	2	3	29
9	4	0	27	3	2	26	3	1	17	3	0	24	2	3	4	2	2	18
10	3	3	5	3	1	10	2	4	0	2	3	15	2	2	0	2	1	17
11	3	1	14	3	0	4	2	2	28	2	2	14	2	1	3	2	0	21
12	3	0	19	2	3	4	2	2	0	2	1	18	2	0	10	1	3	29
13	2	3	20	2	2	8	2	1	6	2	0	27	1	3	22	1	3	10
14	2	2	27	2	1	16	2	0	18	2	0	6	1	3	5	1	2	26
15	2	2	4	2	0	27	1	4	0	1	3	22	1	2	22	1	2	12

[1] Manufacturer's strength rating, taken from label on package of purchased solution.

Canyon Ferry Contract Let

The Bureau of Reclamation recently awarded a contract for $11,896,425 to Canyon Constructors for the construction of the Canyon Ferry Dam and power plant in Montana.

Canyon Ferry Dam will be located on the Missouri River approximately 17 miles east of Helena, Mont., and a little over a mile below the existing antiquated Canyon Ferry Dam. The new dam will create a reservoir of 2,050,000 acre-feet capacity. It will impound flood waters for the irrigation of more than 300,000 acres of new land and provide supplemental irrigation for almost 200,000 acres of presently inadequately watered lands. The development will also have a power plant with three generating units having a total capacity of 50,000 kilowatts. This power will be used for irrigation pumping and to meet other needs in the area. •

Exporting Reclamation "Know-How"

Another Region II expert, David S. Stoner, assistant supervisor of operation and maintenance, left Sacramento on March 28 enroute to Ankara, Turkey. While on a month's leave without pay, Mr. Stoner is being employed as consultant on ground water and irrigation by a private firm of engineers which is commissioned by the Turkish Government to investigate land and water conditions in that country to the end that the natives may become more self-sufficient agriculturally and economically.

Regional Geologist William I. Gardner returned April 1 from a month's assignment as consultant to the Government of the United Provinces of India. He had been selected by Engineer Jack Savage (also formerly of the Bureau of Reclamation) to inspect several damsites and make geologic tests as a part of investigations for irrigation development work that has been pioneered by Mr. Savage. •

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acre which the rig in question will apply can be found in table I.

Example.—With nozzles spaced at 18 inches and the measured rate of spray found to be 12 ounces per minute per nozzle, read down column 4 to the figure closest to 12, which is 12.28 ounces per minute. It then will be found on the same line under column 1, that the spray application rate will be 8 gallons per acre. This rate of application or a total of 8 gallons per acre will be delivered regardless of the number of nozzles on the boom. If greater accuracy is desired, the rig may be adjusted to deliver exactly 8 gallons per acre by turning down the operating pressure valve to increase the pressure until an average of 12.28 ounces per minute per nozzle is delivered. Since spray rigs are generally driven about 4 miles per hour, the table is based on this speed.

Using Table II

Having determined the number of gallons of spray per acre which the rig in question will disperse under working conditions, the amount of herbicide required to make up 100 gallons of spray solution can be readily found by referring to table II. If it is desired to apply 1 pound of 2,4–D acid equivalent per acre in 8 gallons of spray solution, read down under column 1 to 8 gallons of spray per acre, and across to the column which corresponds to the type and number of pounds of 2,4–D acid equivalent per gallon of manufacturer's solution, as indicated on the label of the package. Suppose the herbicide to be used is "Isopropyl" and labeled "3.34 pounds of acid equivalent per gallon," then column 4 indicates that 3 gallons and 3 quarts should be added to enough water to make up 100 gallons of spray solution. With this solution in the tank, the spray rig will apply 1 pound of 2,4–D acid equivalent per acre. If a stronger application of acid equivalent is desired, the quantity of herbicide can be increased proportionately. In our example, an acid equivalent rate of 2 pounds per acre would require 6 gallons and 6 quarts or 7½ gallons of manufacturer's solution. It is good practice to partly fill the spray or measuring tank before adding the herbicide and then add water to make the required spray solution. THE END

Want To See Raindrop Erosion in Action?

"RAINDROPS AND SOIL EROSION," a moving picture, colored, sound attached, 800 feet, 16 millimeter, by the author of the article on page 119 is available in the film library of the Soil Conservation Service, United States Department of Agriculture.

Circular Available on the Use of Aromatic Solvents for the Control of Waterweeds

A circular on the use of aromatic solvents for the control of waterweeds has been prepared in the Chief Engineer's office by J. M. Shaw, Chemical Engineer, Bureau of Reclamation, and F. L. Timmons, Senior Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, Department of Agriculture.

The mimeographed publication is based on an analysis of tests made on 84 canals and drains with the aromatic solvents. The discovery of the value of these compounds derived from petroleum or coal tar was made in the Denver weed control laboratory in 1947 by technicians of the two Bureaus which the authors represent.

It discusses recommendations on materials, concentrations, equipment, when to apply, and gives sources of materials and other information useful to prospective users.

The circular can be obtained from the Commissioner, Bureau of Reclamation, Washington, D. C., or Regional Directors, Bureau of Reclamation, at Boise, Idaho; Sacramento, Calif.; Boulder City, Nev.; Salt Lake City, Utah; Amarillo, Texas; Billings, Mont., or Denver, Colo., or from the Bureau of Plant Industry, Soils and Agricultural Engineering, at Beltsville, Md.; Logan, Utah; Phoenix, Ariz.; Meridian, Idaho, or Prosser, Wash.

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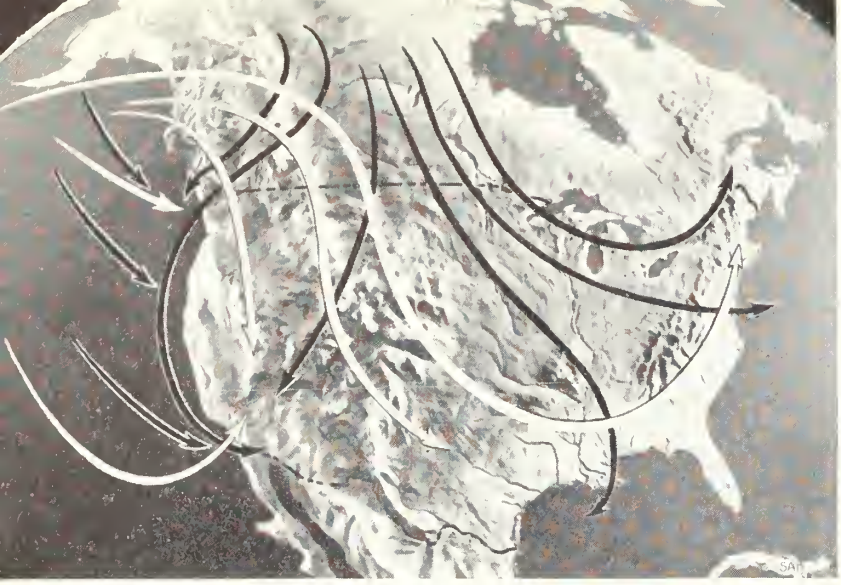


Normally, storms follow the course indicated by the black arrows. However, last winter the storms took a detour via the white arrow routes.

Why the Snow?

Newspapers have already headlined the blizzards and snowstorms throughout most of the West, especially in the plains of Wyoming, Nebraska, Colorado, and Kansas, and there has been considerable comment regarding the unusual snowfall in Nevada, Utah, southern California, Arizona, New Mexico, and in the coast ranges of the Columbia River Basin, coupled with the unseasonably high temperatures—with a deficiency of snowfall, in the middle Atlantic and Northeastern States.

Weathermen know that storms recognize no national boundaries, and it has been said that a traveller sneezing on the deserts of Mongolia and overtime work by the snow-disposal units in New York City may be the cause and result of one weather disturbance. This may or may not be far-fetched, but it is a fact that what happens in the atmosphere thousands of miles away can change your plans for cultivating or harvesting your crops.

Last winter, a mass of clear and cold air which hung over north central Canada, Alaska, and the Arctic Circle was under suspicion as the cause of our topsy-turvy, and extremely severe weather through the Northern Plains and Western States during the winter of 1948–49.

Ordinarily, the winter climate comes sweeping across the North American continent as shown on the map at left showing winter storm paths, based on reference 1 at the end of this article. The storms are the result of chiefly two air masses, interacting with each other. There is the cold and dry polar continental mass, which is formed over the sub-Arctic and Arctic continental snow fields of the North American continent and in Siberia. And then there is the polar maritime mass. This one comes into being as a result of the warm Japanese ocean current, which heats and humidifies the air as it flows into the Aleutian region.

Now an air mass is a huge chunk of atmosphere about 10,000 feet thick made up of layer upon layer of air having a characteristic distribution of temperature and water vapor, and often covering an area equal to that of the continental United States. Cold and dry air masses are heavy and are identified by high barometric pressures, with clear weather; whereas warm and wet air masses are lighter and are identified by low barometric pressures and are coupled with bad weather.

The polar air masses, with the *low* maritime mass containing warm and wet air, and the *high* continental mass, with its cold and dry air, meet each other, form storm centers, and normally enter the United States more or less at random anywhere along the Canadian border, except in the extreme northeast. They then sweep down and across the country over areas which are ordinarily expecting winter weather, and are prepared for it. Also, in traveling their normal paths, the storms usually spend themselves and be-

DECEMBER 5, 1948, early winter snow blanket just beginning to develop over Canadian Plains. Star in this and other maps indicates center of the "high" area according to the author's theory.

DECEMBER 22, 1948, unbroken snow field. Note average snow depth has now reached 12 inches as compared with December 5 coverage of 4 inches.

A possible explanation for the severity of the Winter of 1948–49 in the Western United States.

by WALTER U. GARSTKA, Hydrology Division, Branch of Project Planning, Denver, Colorado.

come less and less severe as they peter out.

But during this last winter, it seems these storm paths met an irresistable barrier, had to make a detour, and repeatedly centered the full fury of their wrath upon unsuspecting parts of the country, unprepared for such repetitious assaults.

The barrier we suspect was a *high* pressure area in central Canada. In the early winter there was an extensive snow cover in the Canadian Great Plains, specifically that vast, practically flat area west of Hudson Bay, north of our States of Minnesota, North Dakota, and Montana, and east of the Canadian Rockies. When this part of Canada is covered by an extensive, but not necessarily deep, snow cover in the early winter, and if conditions are such that the snow does not melt and break up into patches of snow separated by bare areas, a trend sets in which produces a stable and very cold *high* in central Canada. Snow reflects about 70 to 85 percent of the sunshine, while bare ground or vegetation may reflect only about 5 percent, more or less, of the radiation, absorbing most of the heat and warming the air. Over a snowfield, cold and dry air, formed by the constant reflection of the sun's rays from the solid snow cover, never had a chance to warm up, as the heat losses during the day and night were not even remotely replenished by the sunshine during the day, and the net result was a *high* pressure area, which became self-perpetuating. According to the best information available, the Canadian plains were covered by an unbroken snow field from early in December 1948 to early March 1949.

Storms originating in the Aleutians were probably no longer able to make their usual journeys across the Canadian plains in the general Northwest to Southeast direction. The intense cold air flowing out from this *high* pressure area is believed to have caused deflections in the storm paths. Thus, storms which might have gone to the Great Lakes region were deflected and instead were forced to go through Montana, Wyoming, Nebraska, and parts of Colorado and Kansas—which were subjected to a succession of blizzards all following the same path. The paths of the storms of January and February 1949 are also shown on the map at upper left.

The stubborn high pressure area on the Canadian Plains probably also caused a general displacement of air masses throughout the mountain and west coast States. The maps at the bottom of the page were based on 5:30 a. m. surface maps of the Weather Bureau, United States Department of Commerce. (See reference 7.) The December 5, 1948, map indicates the early winter snow blanket just beginning to develop over the Canadian Plains. The December 22, 1948, map shows an unbroken snow field. The February 1, 1949, map indicates practically the maximum spread of the snow blanket in the United States. Although not possible to show on the March 15, 1949, map, the snow has disappeared in a part of the Canadian plains. It is presumed that drifting and evaporation caused this break in the snow blanket.

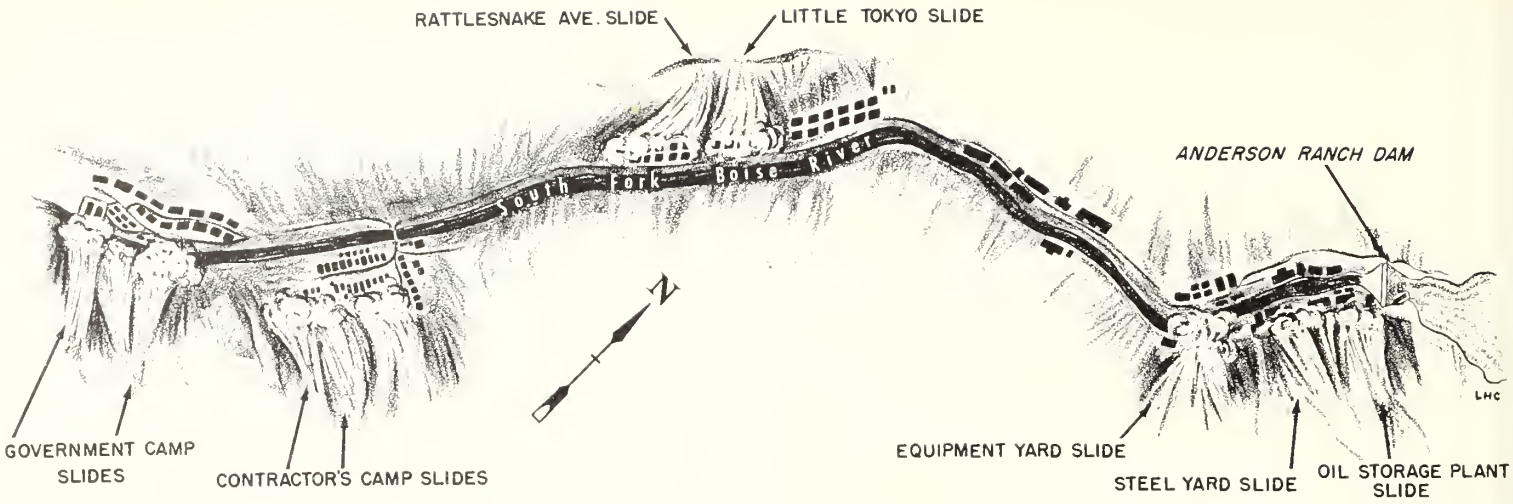
This break in the snow cover would indicate a return to more nearly normal conditions, as the days lengthen and the sun shines at more nearly vertical angles as spring approaches.

The above discussion has been based upon continental trends. A deflection of only a few degrees in the path of a storm as it travels from the Aleutians over Canada and into the United States may cause it to enter hundreds of miles to

(Continued on page 137)

FEBRUARY 1, 1949, practically the maximum spread of the snow blanket in the United States. The typical coverage has reached a depth of 33 inches.

MARCH 15, 1949, snow has disappeared in part of Canadian Plains. Maps based on information of United States Department of Commerce.



Avalanche at Anderson Ranch

by DONALD S. WALTER, Construction Engineer, Anderson Dam, Idaho, Region I

In the midst of the present hustle and bustle of this busy construction area at Anderson Dam, Idaho, it is difficult to realize that only a few short weeks ago all roads leading into the community were blocked by snow, and the 500 persons trapped in the deep narrow canyon were at the mercy of devastating avalanches.

Now that the snow has melted, only occasional piles of twisted lumber remain as grim evidence of many homes formerly occupied by construction workers. These homes were completely demolished by the snowslides which struck without warning, flowing down the steep canyon walls, with terrific force, destroying everything in their paths.

Residents who were unfortunate enough to be living in the area during these slides will remember for years to come how they were forced to leave their homes suddenly in the middle of the night to move into safer quarters. This experience and the anxiety during the days to follow of watching heavy masses of snow clinging to the high surrounding walls of the steep narrow canyon, and wondering where and when the next slide would appear, will linger forever in their memories.

The canyon of the South Fork of the Boise River at the site of Anderson Ranch Dam is extremely rugged and narrow. For this reason it was necessary to provide housing for the construction workmen and Bureau employees by building camps along each side of the river for a distance of about 2 miles downstream from the dam site. Although these camps have been in use for quite a number of years, the threat of snowslides has never been considered as being particularly hazardous. This is verified by "old-timers" in the vicinity who claim that slides similar to the ones experienced this winter were unheard of, at least during the past 50 years.

Severe winter weather started early at the dam and continued to grow worse. Beginning 2 weeks before Christmas, the 31-mile road between Anderson Dam and the nearest town, Mountain Home, Idaho, was closed for periods of from 1 to 3 days on an average of every two weeks. Abnormal snow conditions accompanied by high winds had isolated the community early in February. Starting late in the afternoon of February 8, chinook winds loosened the heavy masses of snow from the steep canyon walls and started the slides which continued intermittently during the following 48-hour period.

The first slide of any consequence occurred early Tuesday evening, February 8, when, without warning, a snowslide of major proportions developed in the left canyon wall opposite Government camp. It raced down the steep canyon face, crossed the dry riverbed, and proceeded up the right bank of the river channel where it smashed into the front of several houses occupied by Bureau of Reclamation employees. Luckily, the occupants of the house that received the full force of the impact were in California at the time,

SNOW BOMBARDMENT—arrows denote paths of four major slides affecting contractor's camp to the left and Government camp on the right. *Photo by L. R. Murphy, Region I.*

thereby escaping certain injury when the house was damaged and partially filled with snow. Two Bureau employees who were shoveling snow from the walks in front of their homes were nearly covered, and the son of one of these men was completely buried by the slide. The two men were able to extricate themselves and dig the boy out. Although many residents of the camp were in the vicinity at the time, fortunately no one was injured by the slide.

Earlier the same evening, a group of Bureau employees in an Army type ambulance had set out to rescue the Dulan family of Smith Prairie, who had been marooned for nearly a week at the Danskin Ranger Station located about 10 miles downstream from Anderson Dam. After clearing the road of several snowslides with a caterpillar tractor, the ambulance was finally able to bring the family to Anderson Dam where they arrived at 2 a. m., February 9, six days after they had left their home in Smith Prairie. The family was quartered in the guest apartment in the men's dormitory at Government camp, where Mrs. Dulan, an expectant mother, was placed under the care of a registered nurse.

At about 2:30 a. m., a half hour later on the same morning, a large slide occurred in the contractor's camp area which demolished five dwellings, all but one of which were unoccupied at the time. The J. M. Rush family, consisting of the parents and three small children, was trapped in one of the houses but miraculously escaped serious injury when the back of their house was caved in, and the bedroom where they were sleeping filled with snow.

Slides and heavy snowfall, added to the already approximate snow depth of 4 feet, immediately changed conditions from "very difficult" to "emergency." Patrols, consisting of Bureau employees, were maintained on a 24-hour schedule to assist in evacuating persons from the danger areas, and to aid in rescue and other emergency work. Persons forced to leave their homes were accommodated temporarily in the contractor's bunkhouses and in the dormitory and recreation building in the Government camp. In order to relieve the suffering and hardships of those persons who were forced to evacuate their homes in the canyon, the contractors, J. A. Terteling and Sons, Inc., graciously opened their mess hall to provide free meals. It is estimated that during the emergency period they dispensed about 1,800 such meals.

Early on Wednesday, February 9, it was apparent that the situation at the dam was critical and outside help was urgently needed. Knowing that it was only a question of time before slides would sever all lines of communication out of the canyon, the regional office in Boise was contacted by phone and apprised of the critical conditions existing in the area. Supplies of fuel oil and food were running low in the community, as the road into the canyon had been closed for nearly a week.

In the meantime, the State highway snow removal equipment started out from Mountain Home on Monday, February 7, but by the following morning it became apparent that this equipment was hopelessly bogged down. In fact, the three highway crew members were lost for several days before they could be located and supplied with food and sleeping bags by plane.

Prompt action by the regional director's staff in Boise, Idaho, resulted in arrangements being made with J. A. Terteling and Sons, Inc., to furnish sufficient snow removal equipment to open the road in the shortest time possible to relieve the emergency. Consequently four caterpillar tractors,

ROAD BLOCK—C. A. Jungquist and Jack Nichols take a look at snow bank before the road was opened to traffic. In the background the first mail for a week is being carried in. *Photo by Stanley Rasmussen, Region I.*

NARROW ESCAPE—Reclamation-owned automobile gets full impact of Rattlesnake Avenue slide a few seconds after the passengers had left the car. *Photo by L. R. Murphy, Region I.*

SLIDE SCARS—Rattlesnake Avenue slide as seen from access road on the rim of the 1,000-foot-deep gorge. At right: Floyd Landers holding mink he rescued from the slide. *Above photo by Stanley Rasmussen, right photo by L. R. Murphy, both of Region I.*

MINOR MIRACLE—J. M. Rush's home after February 9 slide. Door saved month-old Rush baby who was asleep in buggy. *Photo by L. R. Murphy, Region I.*

followed by a caravan of trucks and tankers loaded with supplies of fuel oil, diesel oil, food and other essential items, left Mountain Home early in the evening of February 9. Because of the heavy snow and slides encountered on the road, progress was slow and difficult. However, better progress was made the following day when, through the efforts of the Mountain Home Air Force Base, a rotary plow was placed in operation.

Although only one major slide occurred on February 9, warm rains the following morning started numerous slides from both sides of the canyon, some of which could be classed as avalanches. These slides apparently increased in frequency and size during the morning, and at 9:30 a. m. a large slide originating on the left canyon wall, approximately 300 feet downstream from the temporary access road timber bridge in the construction area, smashed across the canyon and up the right bank of the river where it caved in the side of an unoccupied bunkhouse. Broken pine trees, oil drums, tons of reinforcing steel, construction equipment, etc. were carried into, and in some instances across the river, blocking the only access road downstream to the camp areas.

About an hour later, two Bureau employees parked their car which they had been using for patrol duty, at a part of the contractor's camp known as Rattlesnake Avenue, and proceeded on foot to investigate several small slides that had occurred during the preceding night. A few minutes after leaving their car, a large slide originating from a ravine in the right canyon wall demolished five dwellings and a wash house. The roofs of the houses were deposited in the road which was completely blocked by the slide. The car that had been parked only a few minutes earlier was crushed and almost completely covered by a mixture of snow and broken lumber from the houses. It was this slide that severed all telephone and teletype lines in the canyon, completely cutting off the project from communication with the outside.

Mr. and Mrs. Floyd Landers were trapped in their house during the Rattlesnake Avenue slide, and miraculously escaped with their lives when the bedroom and other parts of their house were demolished. Otherwise, they were not so lucky, as mink pens, housing mink valued by the owner Floyd Landers at $7,500 were completely buried by the slide. Of the 110 mink in his pens, he later rescued about 25 alive from the 30-foot deep snowslide; however, many of these died of pneumonia soon after being rescued.

Shortly after the Rattlesnake Avenue slide a series of slides from the left canyon wall smashed down into the main oil storage plant, wrecking the facilities, which contained the only remaining supply of fuel oil for the community, and burying a tractor operator who was refueling his tractor. Fortunately there were several workmen in the vicinity who were able to uncover the operator after about 30 minutes of frantic work with shovels and other available tools. He apparently was uninjured but suffered shock.

It was somewhat colder the next day, February 11, following an overnight freeze which temporarily lifted the threat of new slides. Shortly before noon, a Civil Air Patrol twin-engined Beechcraft plane, piloted by Capt. K. W. Claybaugh, dropped two-way radio equipment to reestablish communications with the outside.

The minimum temperature on Saturday, February 12, was 9° below zero, but no complaints were heard. By this time everyone at Anderson Dam was willing to swap snowslides for chilblains, with no questions asked. By afternoon, the snow removal equipment working from Mountain Home had reached the canyon rim. Two tractors were working up the hill from the Anderson Dam end, but progress was slow due to the fact that the road was a continuous mass of slides from 8 to 35 feet in depth. A one-way road was finally opened early the next morning and the arrival of trucks bringing in essential supplies was welcomed by every one.

The miracle that no lives were lost or serious injuries incurred from the devastating slides experienced at Anderson Ranch Dam is brought out in the accompanying photographs taken by photographers Murphy and Rassmussen, under conditions which were anything but pleasant. THE END

Above: CATTLE FEED CARAVAN—This bulldozer is clearing the highway for the convoy of trucks loaded with cattle feed, west of Alcova, Wyo. At right: Rancher, one of the typical storm troopers 18 miles south of Alcova, rode out on horseback to seek Bureau aid for his cattle. Reclamation bulldozers in response to his call broke through at 2 a. m. after a terrible 14-hour attempt. ***Photos by Norton T. Novitt, Region VII.***

Winter Round-up

Old Man Winter went on a rampage last year and roared around the corner of 1948–49, in an exhibition of vindictiveness and versatility which outdid the records of decades.

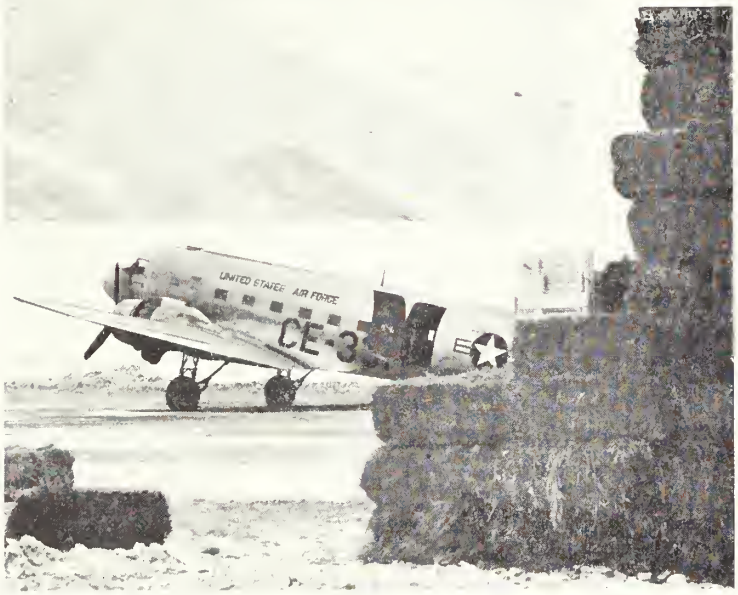
A seasoned campaigner, he softened up the areas chosen for attack, leaving them vulnerable and at his mercy, but as spring approached, he withdrew from the battlefield, leaving devastation as he retreated, and also as a token of reconciliation, priceless water from the melting snows, gurgling down from the mountains, to irrigate fields and pastures whose produce was desperately needed to make up for the ravages of the past winter.

Nebraska bore the brunt of a preliminary skirmish in November. A shrieking blitzkrieg of snow and wind swept over the entire eastern section. Roads were blocked, hay stacks covered, and many lives were lost. The defenders valiantly fought the storm, with the weapons at their disposal, but too often, as soon as a road was open after days of battle, the winds would close it up in 2 hours. Railroad service was interrupted and essential supplies began to run out. The enemy withdrew, but before the besieged inhabitants could recover, restore their lines of communication and build up supplies, the big battle began on all fronts. On January 3, 1949, Nebraska was subjected to a 3-day barrage of blizzard proportions. All roads and railroads were blocked, power and telephone lines were demolished. Due to the previous storm the situation was critical—livestock was without feed and many were lost. In some cases hay stacks one-half mile from starving cattle could not be reached because of the buffeting of the enemy. Even without the snow, the wind detachments swept down and eradicated the work of those attempting to keep the supply lines open.

Wyoming, another target for the attack, had been weakened by drought during the summer of 1948. By early fall the range grass was depleted and hay stored for the winter had to be used to feed thousands of sheep and cattle. Supplies were at their lowest ebb when the big push came on January 2.

Even where previous snowstorms or summer drought had not softened up the areas, modern living, mild winters, and new recruits unfamiliar with the methods of dealing with an inimical onslaught of wind and weather did their parts in breeding overconfidence and sabotaging a preparedness campaign.

As the storms grew in violence, the "old-timers" (among whom were seasoned campaigners from the winter of 1936–37) came into their own. Horses and sleds boomed in value



DRIFTING DISASTER—The scenes above were typical of the conditions near Rawlins, Wyo. Towering drifts nearly covered isolated homes. In many cases the Army came to the rescue. This plane distributed baled hay to stricken ranches in the area. *Photos by T. R. Broderick and Charles A. Knell of Region VI.*

as trucks, railroad trains, automobiles, bulldozers, tractors and snowplows bogged down in the drifts, fell through bridges, broke axles, wore out batteries and in general found themselves in difficulties as they attempted, with twentieth century techniques, to deal with an opponent which had had aeons of practice. And there wasn't enough equipment, mobilized in the right places. Rotary snow plows were at a premium. Despite the handicaps, or because of them, stories of heroism, dogged fortitude, and resourcefulness should furnish material for spinners of yarns for years to come.

No one in the snow area escaped the effects of the storm. The attacks varied in length and severity, the amount of defense equipment and supplies, the dispersion of livestock, the scattered population centers, and the individual conditions of the inhabitants combined to make an infinite variety of crises throughout the reclamation area.

Concern for human lives and livestock dominated the snow picture. Babies were born, doctors, nurses and medicine were rushed to the sick, one woman was snowmobiled to a Fort Collins, Colo., hospital, winning a race with the stork; children were inoculated against diphtheria; isolated families were rescued; marooned train passengers were either hauled to nearby towns or provisions convoyed to them; and food and fuel were delivered to families in desperate need.

Even the veteran winterers of the west found themselves in difficulties—those who had stored good old-fashioned fuel, and kept their wood-burning stoves or fireplaces, found themselves unable to make the trip to the woodpiles. One woman in Nebraska tearfully reported that her hoard of supplies, a large cave full of food, was buried under a 20-foot snowdrift. But even those with well-stocked smoke houses and cellars found their supplies dwindling after a 2-month siege.

Helpless livestock, beaten about the ranges, were in the sorriest plight. Operation Haylift did yeoman service in dropping feed to the thousands of cattle and sheep. The count

Thirsty cattle near Rock River, Wyo., anxiously await opening of water hole. Here again Reclamation equipment came through. The "cat" moved snow that had drifted 20 feet deep covering the animals' water supply for 5 days.

Near Rawlins, Wyo., an Interior Department plow leads caravan of hay-bearing trucks to aid farmers and ranchers, some of whom had been snow-bound for 6 weeks. *Photos by Charles A. Knell and T. R. Broderick, Region VI.*

of lost livestock has not yet been made, but in addition to those who starved to death, there were herds which were cornered in coulees, and froze in their tracks; sheep which smothered to death from frost on their nostrils, and many instances of livestock starving in the midst of plenty of feed because they had no water and were so cold and weakened by the battle with the elements, they had no desire to eat.

Reclamation's part in the program was as varied as the problems facing the snowbound western people. Clyde Burdick, area engineer of the Niobrara River area in Nebraska, helped the Ainsworth Chamber of Commerce in its relief plans. There was no heavy equipment available in the area, but he and his staff built some 9- by 16-foot sleds, loaded them with food, fuel and other necessities and hauled them by caterpillar tractor with dozers to isolated communities. They also worked night and day at small airports helping to load planes and move supplies.

During the storm period, Bureau construction work gradually came to standstill in the snowbound area, and bulldozers, caterpillar tractors, grease and repair trucks were freed for snow duty wherever they were needed. Transporting them from the construction sites to the localities where they could do the most good was a large scale maneuver of great proportions. The whole snow operation, called Operation Snowdrift, Snowball, Snowbound, Haylift and various other terms, was conducted under a coordinated organization as shifting as the snows, growing as the disaster area grew, and adapting its strategy as the enemy changed its tactics.

By January 10, all thought of keeping roads continually open was abandoned, and a convoy system was put into effect. Truckloads of vital supplies led by snowplows made periodic trips to isolated areas in need of help. Snowbound people were notified in advance of the arrival time of the convoys, and converged upon the appointed spot to get enough provisions to see them through the remainder of the emergency.

By January 24th the most critical situation in the eastern sector of the snowbound area was in Wyoming where snow drifts 14 to 20 feet high isolated large flocks of sheep. Rescue work went forward with all possible speed in Wyoming, Nebraska, Utah, Colorado, Idaho, and Nevada.

All over the West, men piloted large and small planes, worked around the clock, loaded supplies, took off on impossible improvised airstrips, flew against wind and snow, and landed in places that would make stunt flyers envious.

The men who operated the dozers and cats and snowplows also worked at great personal sacrifice night and day. In at least one case, a crew worked 36 hours without food or sleep, frozen to the controls, in a fight to rescue families who had been cut off from the outside world for weeks.

There were ornery people, too, like the man in a remote section of Montana who sent out desperate calls for help, saying he was critically ill. A rescue party fought miles of heavy snow drifts to come to his aid and found him calmly stacking hay. He then hopped in his car and sped to town over the road which had just been cleared, without a word to the anxious, weary men who had made up the rescue party.

Region VI, including North and South Dakota, most of

(Continued on page 137)

how detachable is your soil?

(Continued from page 120)

per ton; therefore, after multiplying the grams of splash from the dish by 651,960, the product is then divided by 907,200 and the answer is in tons of splash per acre. Since we multiply by 651,960, and divide by 907,200, that is about the equivalent of multiplying by 0.72. Therefore, we merely have to multiply the grams of splash from one of the small dishes by 0.72 in order to determine how many tons of sand the storm would splash on an acre of land. Then we multiply this figure by 0.50 in order to find how many tons of soil would be splashed on one acre where the detachability of the soil is one-half. Or, we multiply it by 0.75 to determine how many tons of soil per acre would splash on a soil of three-quarters detachability. To make a highly accurate measure of a soil's detachability will also require drying oven and scales. However, an estimate may be made by merely observing the differences in splash from the cups. For example, the soil having a detachability of 0.09 will lose 4½ times as much by the splash process as does the soil having a detachability of .02.

Another desirable piece of equipment for conducting highly accurate experiments is a turntable on which the samples are set to expose them to rainfall. This turntable makes a complete revolution about every 12 seconds, and it carries all samples through a common path so that each receives identical rainfall applications.

The detachability of a soil does not remain constant, but undergoes change in the field, as the soil is tilled and cropped. Soil will be most detachable when it is in a fine state of tilth, and it is least detachable when conditioned by natural processes of "field curing." It is important for the farmer to know maximum and minimum detachability factors applying to his soils. It is important that he know what each of his farming practices that affect this factor will do to increase or decrease the soil's detachability. Some of my various tests have shown that the way the soil is plowed and fitted with harrows, packers, etc., can have a tremendous effect on the soil's detachability. These effects, when known, will show us the way to protect seedbeds until vegetation develops a full protective cover for the field.

The third important factor that affects the splash erosion (the vegetal cover over the soil) offers a wide range of possibilities in the field management program. Even in seedbed preparation a mulch of crop residues may be kept on the surface instead of being wholly plowed under as has been done so often in the past. It is easy to see that the amount of mulch protection required will vary with the violence of the storms, and with the detachability of the soil. If the seed bed is prepared during a period of violent storms, more mulch protection will be required than if the preparation is during a period of gentle storms. Also, if the soil is of high detachability, more protection of the seedbed with mulch will be required than where soils are of low detachability.

Whether the protective cover on the soil be growing crops, or a mulch of residue materials, the useful function they perform is the same—they check the impact of the raindrops

and thereby reduce splash erosion. Therefore, their effectiveness can be measured in terms of how much splash erosion they prevent. In the previous discussion it was shown that THE SOIL DETACHED=THE SOIL'S DETACHABILITY×THE DETACHING CAPACITY OF THE RAINDROPS. If we denote the soil detached by the symbol D_1, the soils detachability by the symbol D_2, and the detaching capacity of the raindrops by the symbol D_3, then we can write the formula $D_1=D_2\times D_3$. It was previously pointed out that where D_3 is measured in terms of grams of sand splashed out of the dish, the results can be converted to tons per acre through multiplying D_1 by 0.72.

It is now apparent that where we know the detaching capacity of the raindrops (D_3) and the detachability of the soil (D_2) we can compute the amount of splash that will occur on a bare field. But on a field that has some vegetal cover, this splash will be reduced. If with this vegetal cover the splash is reduced to one-half, the protective value of the vegetal cover is equal to 2.0; if the splash is reduced to one-fiftieth, the protective value of the cover is 50.0; etc.

The farmer's approach to measuring the effects of the protective cover cannot be based on measures of the detaching capacity of the storm, and the detachability of the soil, because he is not able to measure these factors accurately. He can, however, make rough measures of the splash in a variety of crops, and in this way he can ultimately determine about how dense each different crop must be at each season of the year, to check the splash erosion and achieve soil and water conservation.

This measure of the splash can be made with splash boards that are set in the field. The sample of splash that he catches will be made up of soil and water. This he can pour off into any small pan and dry it in an ordinary kitchen oven. If there are no facilities for weighing the soil, the relative amounts from one sample to another can be estimated. For example, if the vegetation in one field permits only a thimbleful of soil to be splashed into the sampler, while that of another field permits a half cupful of soil to be splashed, these differences may be estimated without the assistance of scales. This will not be an exact study, but it will be a very useful one. The farmer who is able to make it will learn many facts about protecting his soils to conserve the productivity of his lands.

A soil's productivity depends on the preservation of two of its primary properties: its physical properties, and its nutrient properties. In clayey soils, and in many of the silts, the splash erosion process is a major destroyer of the physical properties. In sandy soils, the splash process washes away the nutrient materials. We must look to the growing crops for much of the surface protection that will control these splash damages throughout most of the year. In many instances some of the residues from the previous year's crop can be left on the surface to protect the soil against the impacts of raindrops. Tillage practices can also be effective in curtailing splash erosion. This is achieved through tilling the soil when it is in condition to leave some clods on the surface. Some preliminary experiments have shown that splash erosion may be curtailed by 90 percent through proper surface preparations. These tillage controls, however, must be recognized as temporary measures for protecting seedbeds during the time that the growing cover is being developed.

On ranges and pastures it will be important to control grazing so as to leave enough cover over the soil to control splash erosion at all times. This, in addition to preserving the soil's physical and nutrient properties, will insure full retention and use of rainfall. Where splash erosion is active, the surface materials will be puddled and the land will tend to be waterproofed. These damages by splash erosion are what marks overgrazing as an element of the "penny wise and pound foolish" economy. Through grazing off a few hundred pounds more than we should today, and making splash erosion too active, we may cause the decline of a soil's productive properties, and we may waste rainfall. Neither of these items can be bought and hauled in by the truckload; as could the feed that is represented by the overgrazing.

That splash erosion will tend to waterproof the soil and prevent water intake, while a vegetal cover will check splash erosion and maintain good water intake, are shown by some of my recent experiments that were made for the Soil Conservation Service. Where the soil was completely bare, during a 15-minute experiment, 70 tons of soil were eroded by the splash erosion process, and the water intake during this 15-minute period was 2,375 gallons per acre. Where the soil had 704 pounds of vegetal cover on the land, per acre, the splash erosion was reduced to 33 tons per acre, and the infiltration was increased to 6,500 gallons per acre during 15 minutes. On still a third piece of land having the same soil, but with an excellent cover amounting to 5,719 pounds per acre, the splash erosion was still further reduced to 0.5 ton per acre, and the water intake was increased to 63,750 gallons per acre.

When one can increase the water intake from rainfall, during a 15-minute period, from 2,375 gallons per acre to 63,750 gallons per acre, merely through keeping vegetative cover sufficient to control splash erosion effectively, it behooves all of us to learn something about this new science. Wastes from the land, whether they be soil or water, are only the results of other things that happen. One of the most important of these other things which cause soil and water waste is the splash erosion process. So long as we neglect to study it we cannot discover the broad principles that underlie this field of soil and water management which we call conservation.

The reclamation farmer is not only interested in saving soil and rain, but he is also deeply interested in all those processes of nature which have a bearing on the intake of irrigation water by fields. A field having considerable exposed bare soil may pose a widely different problem for irrigation during a period that follows damage by a violent rainstorm. Some soils tend to recover from this damage naturally, while others do not.

How detachable is your soil? What are the seasonal storm detaching capacities? What does soil detachment by splashing raindrops do to destroy the physical and nutrient properties of your soil? What does the splash erosion process do to the water-intake capacity of your soils? These matters represent basic facts that should be known to every farmer. The answers to these questions will contribute mightily to developing a program of good farming. THE END

Milestone at Belle Fourche

by S. T. LARSEN, Former Superintendent, Belle Fourche project,
now Head, Irrigation Operations Section, Missouri-Oahe District, Huron, South Dakota

The Belle Fourche project, located in west central South Dakota, and one of the oldest Reclamation projects in the country, has reached another milestone in its history.

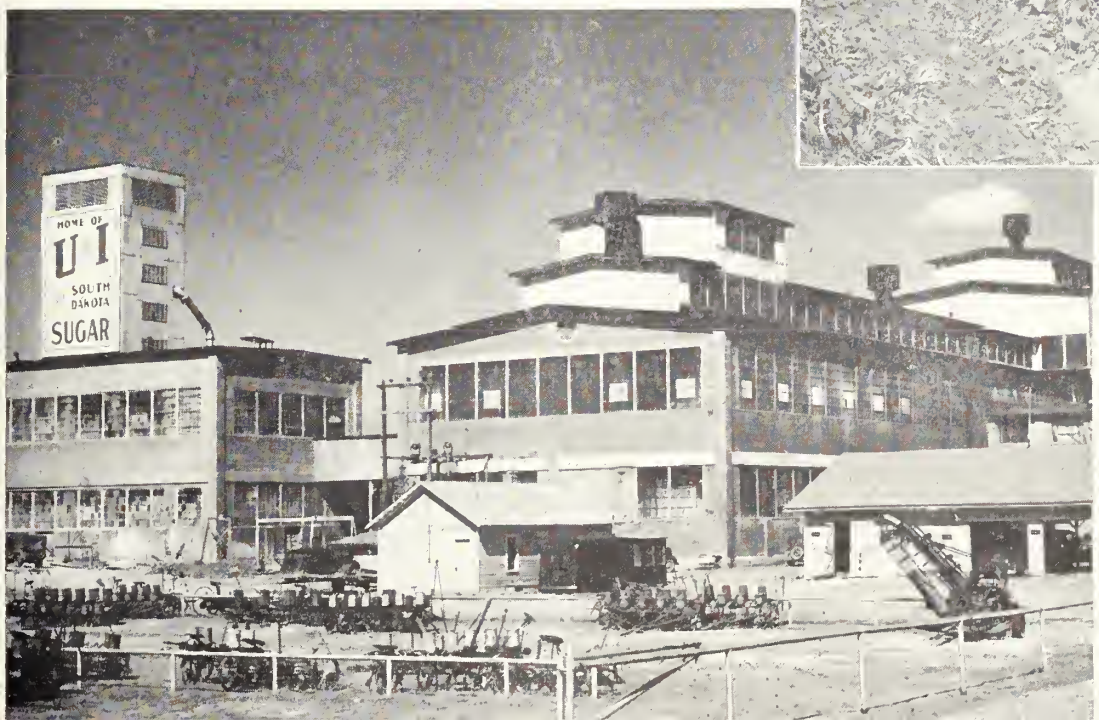
Construction of the project works was started in the year 1905 and the first irrigation water was delivered in 1909. This year the Bureau of Reclamation turned the project over to the water users.

Water for the project is diverted from the Belle Fourche River, at a point about 1½ miles downstream from the town of Belle Fourche, and is carried from there into the Inlet Canal, a distance of 6½ miles to the Belle Fourche Reservoir, which has a storage capacity of 177,510 acre feet. From the reservoir the water is distributed through about 500 miles of canals and laterals to serve the project lands lying to the east.

At the time the construction of the project was started there were a few cattle ranches along the creeks and river bottoms but there was very little farming being carried on, the bulk of the 56,000 acres, now being irrigated, being used as grazing lands at that time. The population of the area now embraced by the project is estimated to have been about 200 persons before the project was built; whereas at the present time there are over 3,000 people living within the project boundaries. Three towns, Newell, Nisland and Fruitdale, with a combined population of over 1,100 persons, owe their existence to the development of the Belle Fourche project.

It is impossible to estimate what might have been the value of the wealth produced annually by this area prior to the building of the irrigation works, but it is known that the total gross value of the crops produced on the project during the seasons of 1947 and 1948 is very nearly equal to the entire cost of constructing the project works. The gross value of crops produced in 1947 amounted to $41 per cultivated acre, making the total production for the project for that year in excess of $2,300,000. Due to lowered prices for farm produce, the 1948 gross crop value was about 12 percent below that of the year preceding.

In addition to the benefits from the project which are indicated by the increase in population of the area affected, there are many other very real contributions to the economy of the surrounding territory. For instance, in 1927 a $1,500,000 sugar factory was built at the nearby town of Belle Fourche to process the sugar beets raised on the project.



At left: Utah and Idaho sugar factory at Belle Fourche, S. Dak. Note farm implements in the foreground provided for the use of farmers growing sugar beets on the project. Above: Dallas Jordan harvesting beans on his Belle Fourche farm while Garry Jordan plays "skipper" on the Jordan tractor. *Left photo by T. R. Broderick, above photo by Charles A. Knell, both of Region VI.*

The fact that Belle Fourche has more than doubled its population in the last 20 years, expanding its trade and industrial facilities, is due in considerable measure to having the sugar factory located there and to the town's ability to draw trade from the project area. Also, a stabilizing influence is afforded by the production of project crops to the dry range lands surrounding the project.

The agricultural economy of the project is primarily one of integrating crop production from irrigated and dry land for raising fattened livestock, with a certain amount of cash cropping. Extensive dry range lands bordering the project on three sides are being utilized largely for sheep pasture either by project farmers who own large flocks of sheep, or by sheep ranchers living out on the range. The project provides a ready market for the range lambs produced by the sheep ranchers, and having the rancher's supply of lambs to draw upon is very important to the project farmers engaged in the lamb-feeding industry. The principal crops produced on the project are feed crops, namely, alfalfa and other hay, grains and corn, and sugar beets—a crop which produces both cash income and feed.

The Bureau of Reclamation has operated the Belle Fourche project for the water users for the past 40 years although the various contracts between the Government and the Belle Fourche irrigation district executed during the past 20 years stipulated that the irrigation district should assume the operation and maintenance of the project at specified dates. As these various dates were reached, the irrigation district invariably, for one reason or another, requested the Bureau to continue the operation of the project for another 5-year period, and the Bureau was willing to render this service to the project water users.

The latest contract covering the operation of the project by the Government stipulated that the project operations should be transferred to the irrigation district on December 31, 1948. During September preceding that date, the irrigation district's board of directors requested the Bureau to extend the time of transferring the project to them for another 5 years. Shortly after this request was made, the Comptroller's decision to the effect that personnel on Bureau projects, operating on funds advanced by water users organizations, were subject to the restrictions imposed by the Eightieth Congress, was received by the Commissioner of Reclamation. This decision necessitated the immediate transfer of several projects from operation by the Bureau to operation by the water users.

The Belle Fourche project was selected as one of the projects to be transferred because it was felt that the Belle Fourche irrigation district board was able to undertake the successful operation of the project at this time. The members of the irrigation district board would have preferred to postpone the transfer of the project until such time as certain rehabilitation work, now about to be started on the project, was completed. But, upon the insistence of the Bureau, they agreed to assume the operation and maintenance of the project on January 1, 1949, if a Bureau man could head up their organization until the Board could hire or train a man qualified to do the job. Mr. F. C. Winkler, who has held the position of project watermaster for many years and is eminently qualified to manage the project, was selected for the position. The district will advance the funds to pay Mr. Winkler's salary.

The transition from Bureau to district operation was accomplished with a minimum of complications. Civil service career employees, who so desired, were given a chance to apply for transfer to other Bureau projects. However, very few employees asked for transfers since most of them have homes established on the project, and they had been asked to stay in their present positions and work for the irrigation district under terms satisfactory to them. The irrigation district expects to effect some economies through the elimination of two or three positions in the project office, and it is believed that it can do so. The personnel required for the outdoor operations will be about the same as was used by the Bureau. The matter of transferring the project supplies and equipment to the irrigation district was simple and was effected without the exchange of funds, since the property purchased with appropriated funds had previously been depreciated into costs and the other property had been purchased with funds advanced by the water users and consequently belonged to them already. Accounting and other records along with 40 years' accumulation of correspondence and other files were moved to the office of the Missouri-Oahe District of the Bureau, at Huron, S. Dak.

And so another milestone in the hostory of the Belle Fourche project has been passed. THE END

_____ _____
(Date)

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Bureau of Reclamation, United States Department of the Interior.
Washington 25, D. C.

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ECA Sponsors Greek Engineers Visit to Reclamation Area

During the latter part of April 1949, two Greek engineers, T. N. Michalopoulos and Stavos Tiantafillidis, the first to be sponsored by the Economic Cooperation Administration, arrived in this country for the dual purpose of studying the Bureau of Reclamation's construction program, and checking up on their plans for construction of a reclamation dam in Greece.

ECA is providing funds to the Bureau for instructional assistance, and also paying the expenses of the visitors. While visiting the Washington, D. C., offices of the Department of the Interior, Mr. Michalopoulos and Mr. Tiantafillidis met with several reclamation officials as well as Paul G. Hoffman, ECA Administrator, Assistant Secretary of the Interior William E. Warne, and Commissioner of Reclamation Michael W. Straus.

The engineers plan a 2-month itinerary, the first month to be spent at the Denver, Colo., office of design and construction, followed by a month's field trip, including the inspection and study of the Central Valley project in California.

According to ECA, the trip was proposed by ECA field men in Greece, who have assisted in drawing up plans for construction of a reclamation dam in that country, for which it is probable some ECA funds will be used. The purpose of the trip is to give the visiting engineers, who expect to take part in the construction of this project, an opportunity to pick up some new American design and construction ideas, and also to consult with Bureau of Reclamation Engineers on the plans for the project in Greece. •

WHY the SNOW?

(Continued from page 127)

the right or left of the normally expected path. Only a continuing study of weather trends will disclose how the climate will make the transition from the abnormal winter of 1948–49 into the spring and summer of 1949.

REFERENCES:

The association of cold weather in the United States with high pressure areas hanging over northwest Canada, Alaska, and the Arctic Circle was noticed by J. M. Sherier, United States meteorologist at Denver, Colo., during the winter of 1928–29. (See reference No. 5.) A dissertation upon the cooling of the atmosphere and the structure of polar continental air was published by H. Wexler in the Monthly Weather Review in April 1936 (Ref. 8), and by H. C. Willett in his book, "Descriptive Meteorology," published in 1944 (Ref. 9). The association of clear and cold weather with an extensive snow cover was recognized by Charles F. Brooks, director of Harvard University's Blue Hill Observatory in 1940 (Refs. 2 and 3) and also by Landsberg, Cressman, and Saylor, of the University of Chicago, in 1941 (Ref. 6).

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THE END

WINTER ROUNDUP

(Continued from page 133)

Montana, and part of Wyoming and Colorado, made a noteworthy record. There was not a single case of a human death resulting from cold or lack of food in the area served by Bureau men and equipment in this region, and according to reliable estimates, animal losses from exposure and malnutrition were kept to less than one percent.

Perhaps the most graphic story of the horror of the storm came from Idaho in Region I (see "Avalanche at Anderson Ranch" on p. 128), but now that it is over our gratitude goes to the thousands of local and county organizations, sheriffs, State officials, Federal agencies, in particular the Army, Navy, and Civil Air Patrol, and the Red Cross for their front-line defense against the storm. Individuals who risked their lives to save other human beings, as well as livestock, on the ranches and farms, are too numerous to mention. But the West will not forget, and the photos taken by Bureau cameramen, whose frostbitten fingers coaxed freezing cameras and clouding lenses to record the disaster for posterity, tell the story.

THE END

NOT STALAGMITES—Icicles—500 feet inside Bacon Tunnel on the Columbia Basin project, formed by the moisture in the warmer air at the top of the tunnel condensing on the roof and freezing. This was just another of the freak effects of the 1949–50 winter. ***Photo by F. B. Pomeroy, Region I.***

Bureau and Army Engineers Dovetail Plans for Columbia Basin

Under the terms of a new agreement between the Department of the Interior and the Department of the Army's Corps of Engineers, the two plans for the development of the Columbia River Basin, popularly known as Interior Department's "Blue Book" and the Army Engineer's "308 Report," have been coordinated into one integrated program. On April 11 this agreement was submitted to the President. It sets forth the principles upon the basis of which the reports of both Departments are prepared, and the respective responsibilities of the agencies in the comprehensive plan of Columbia River Basin development. It provides an inventory of the jobs to be done and a specific initial program of construction. Both of these could be extremely valuable to the proposed Columbia Valley Administration recommended by the President on April 13.

The two Departments agreed as to which of them would be the more appropriate agency to build the projects recommended for construction and also agreed on areas of primary responsibility for future investigations and project planning.

Power Revenues to be Pooled

Agreement was also reached that the two Departments would recommend that power revenues should be pooled to extend financial assistance for irrigation development. In light of the 1948 floods, the Army Engineers and the Bureau of Reclamation reviewed their respective long-range basin development plans at the direction of the President, and coordinated them fully with other affected agencies of the Department of the Interior and, through the Columbia Basin Inter-Agency Committee and the Federal Inter-Agency River Basin Committee, with the Department of Agriculture and the Federal Power Commission. While the plans of these other agencies are not set forth in the agreement between the Departments of the Interior and the Army, the agreement will permit these two departments to go forward in submitting coordinated programs to the governors of the northwestern States for their views and comments. This coordination of plans also provides the basis for further Federal development of the region's water resources efficiently and in consonance with the views and needs of the people of the region.

The agreement carries the signatures of Secretary of the Interior Krug, the then Secretary of the Army Royall, Commissioner of Reclamation Straus, and Chief of Engineers, Major General Pick.

It is anticipated that eventually, as part of the coordinated program, appropriate agencies will develop and refine plans for forest management, land treatment, protection and propagation of fish and wildlife, recreation develoment, meeting the needs and rights of Indians, and interagency procedures for a coordinated operation of river control projects.

The comprehensive report of the Interior Department is to be the guide where irrigation and related power are concerned, and the Army 308 Review Report is to be the guide where flood control, navigation, and related power are involved.

The two agencies agreed upon the related plans for the lower Columbia River fisheries, for a hydrometeorological reporting network, and for necessary power transmission facilities as presented in the Army report, but postponed recommendation for a project or projects that will accomplish the purposes of the Glacier View project until after further study, which can be carried on while other elements of the main central plan are under construction.

Repayment According to Reclamation Law

Irrigation repayment contracts in connection with all Army Corps of Engineer dams would be negotiated by the Bureau of Reclamation in accordance with reclamation law.

The agreement contemplates no change in responsibilities for presently authorized projects, but proposes joint preparation of construction schedules in cooperation with the States and other Federal agencies, through such means as the Columbia Basin Inter-Agency Committee.

As set forth in the agreement, the Army Corps of Engineers will have primary responsibility for further investigations concerning the main stream of the Columbia River below Grand Coulee Dam; the main stream of the Snake River below the mouth of the Grand Ronde River; the Kooskia project; the Willamette River Basin; the Kootenai River Basin; the Spokane River Basin; and the Pend-Oreille River Basin below and including Pend-Oreille Lake.

The Bureau of Reclamation would be responsible for further investigation and operations in the Snake River Basin upstream from and including the mouth of the Grand Ronde River, which is approximately at the corner where the States of Oregon, Washington, and Idaho join; the basins of streams which are tributary to the Snake River below the mouth of the Grand Ronde River; the Clark Fork Basin above Pend-Oreille Lake; and the basins of streams flowing into the Columbia within the United States except the Willamette and Spokane Rivers.

"The coordinated plan," according to the joint statement of the agencies, "is comprehensive in scope and is designed not only to meet the most pressing current needs of the basin, but also to provide a basis for incorporation of future projects into the program as they become necessary." •

Bill Proposed To Adopt Comprehensive Plan

On April 14, 1949, Senator Harry P. Cain, of Washington, introduced Senate bill 1595, "A Bill—Approving plans for the development of the Columbia River Basin, and for other purposes." It provides for approval of the general comprehensive plans for the coordinated development of the Columbia River Basin as set forth above, authorization of the initial stages to be prosecuted by the Corps of Engineers and the Department of the Interior, and, in addition to previous authorizations, appropriations for the partial accomplishment of the plans of $500,000,000 for works to be undertaken by the Corps of Engineers and the sum of $500,000,000 for works to be undertaken by the Department of the Interior. •

Proposed Legislation for Columbia Valley Administration

On April 13, the President of the United States transmitted a message to Congress requesting the establishment of a Columbia Valley Administration. This was referred to the Committee on Public Works and ordered to be printed as House Document No. 158.

In this message President Truman recommended that legislation be enacted reorganizing certain Federal Activities in the region and consolidating them into a single agency, called the "Columbia Valley Administration."

In his message he stated "To that agency should be transferred the Federal programs of constructing and operating physical facilities on the Columbia River and its tributaries for the multiple-purpose conservation and use of the water, including the generation and transmission of power.

"These programs are now carried on by the Bureau of Reclamation and the Bonneville Power Administration in the Department of the Interior, and by the Corps of Engineers in the Department of the Army. This consolidation will provide not only for a balanced program of constructing dams, irrigation works, power-transmission lines and other facilities, but also for a workable operating plan for using these facilities simultaneously for flood control, navigation, power generation and transmission, fish protection, and other purposes. . . .

To Have Advantage of Present Plans

"The Columbia Valley Administration would have the advantages of a sound foundation of basic planning already done, and a large construction program already under way. The bulk of its staff would be secured from existing agencies. It would follow the practice of existing agencies in carrying on its construction work by contract so far as practicable. Under these circumstances the establishment of the Columbia Valley Administration would result in no hesitation or delay in the development program. . . .

"I do not recommend the consolidation of any other Federal activities in the Columbia Valley Administration. I do recommend, however, that the Administration be given direct responsibility for preparing definite plans and programs for soil and forest conservation, mineral exploration and development, fish and wildlife conservation, and the other aspects of Federal resource activities in the region, and the means to see that those plans and programs move ahead in step. Such plans and programs would be worked out in cooperation with all interested groups—local, State and Federal, private and public."

Following through on the President's message, on April 14, Representative Hugh B. Mitchell of the State of Washington introduced House bill 4286 and Representative Henry M. Jackson of Washington introduced House bill 4287, both of which were referred to the Committee on Public Works as bills to "Reorganize and consolidate certain Federal functions and thereby secure their more effective administration by establishing a Columbia Valley Administration to assist in the achievement of unified water control and resource conservation and development on the Columbia River, its tributaries, and the surrounding lands."

Senate bill 1645 under the same title was introduced on April 19 by Senator Magnuson of Washington, for himself and the following Senators: Senator Kefauver of Tennessee, Senator Humphrey of Minnesota, Senator Chavez of New Mexico, Senator Murray of Montana, Senator Langer of North Dakota, Senator Douglas of Illinois, Senators Sparkman and Hill of Alabama, Senator Wagner of New York, Senator Taylor of Idaho, Senator Gillette of Iowa, Senator Johnston of South Carolina, and Senator Johnson of Texas. On April 18 Senator Harry P. Cain also introduced a similar bill for a Columbia Valley Administration, Senate bill 1631. ●

Secretary Krug Endorses CVA

Secretary of the Interior J. A. Krug announced on April 14, 1949, that the Interior Department has endorsed and will testify before Congress in favor of legislation to create a Columbia Valley Administration in the Pacific Northwest. His announcement stated in part:

"The Columbia Valley Administration proposed by the President provides a great opportunity for intensified and more effective development of the great natural resources of the Pacific Northwest. The immense wealth of water power, irrigation farming land, minerals, fish and wildlife, timber, and recreation can be jointly developed under the leadership of a Columbia Valley Authority for the immediate and material benefit of the 4 million present residents of the Pacific Northwest and the hundreds of thousands of new residents who can be expected to move to that area in the coming years.

"With a century of experience at western development, the Interior Department is convinced that a Columbia Valley Administration is the best possible Government machinery for maximum development and wise use of Columbia Basin resources. The proposed legislation would absorb entirely one major Interior bureau—Bonneville Power Administration—and would take over the power, irrigation and other functions of the Bureau of Reclamation in the Columbia River Basin. I shall be glad to see these units of Interior transferred because I think they will do better work and be of more value to the people of the Columbia Basin States as part of an integrated, regional, at-home administration with its headquarters in the Pacific Northwest." ●

Columbia Interstate Commission Proposed

On April 19, Senator Harry P. Cain of the State of Washington introduced Senate bill 1632, "To establish a Columbia Interstate Commission and for other purposes." On that day he stated that this was the third and last of three proposals regarding development of the Columbia Basin, which, "would give the Senate the opportunity to study each and every plan fairly and on its merits." This bill is a companion bill to House bill 3636 introduced by Representative Walt Horan of the State of Washington on March 21, 1949. ●

Upper Colorado River Compact OK'd

When President Harry S. Truman signed the Upper Colorado Basin Compact in April 1949, he paved the way for the United States Government to proceed with the long-awaited over-all development of the upper Colorado River's water resources.

Utah, Colorado, Wyoming, New Mexico, and Arizona were the States signing the Compact, which is now a final document, in full force and effect. Its major purpose is to provide for the equitable division and apportionment of the use of the waters of the Colorado River system, the use of which was apportioned in perpetuity to the upper Basin by the Colorado River Basin Compact of 1922.

The Bureau of Reclamation has a tentative plan for the construction of the primary Upper Basin storage reservoirs and a small initial group of irrigation developments in Utah, Colorado, Wyoming, and New Mexico. The States affected are now informally considering Reclamation's proposals for development of this plan.

The initial group of irrigation projects would develop approximately 100,000 acres of new irrigated farm lands and provide supplemental water for more than 200,000 acres now inadequately supplied in Colorado, New Mexico, Utah, and Wyoming. The main dams would provide more than 1,780,000 kilowatts of installed hydroelectric capacity, and other benefits such as flood control, recreation, fish and wildlife, municipal water, etc.

The projects suggested in the initial plan discussed with the States are the central Utah and Gooseberry projects in Utah; the Collbran, Florida, and Paonia projects and Minnesota unit in Colorado; the Eden, Lyman, and Seedskadee projects in Wyoming; the Hammon project in New Mexico; the La Plata Units and the Pine River project in Colorado and New Mexico.

In addition to the 12 projects for which detailed information is now available, the Bureau of Reclamation is expediting investigations of other projects which under the tentative proposal could be brought under development as studies are completed.

Among the main storage reservoirs contemplated for river regulation are such dams as the Red Canyon, Rattlesnake and Split Mountain Dams in Utah; Echo Park, Cross Mountain and Cottonwood Dams in Colorado, and the Glen Canyon Dam in Arizona. •

Last Shasta Generator Goes on the Line

The fifth and final 75,000-kilowatt generator went into operation recently at the Bureau's Shasta power plant, Shasta Dam, Calif.

This brings California's largest hydroelectric power plant up to its name plate capacity, 375,000 kilowatts. The installation at this time with the present favorable water supply outlook will provide Northern California with needed additional power in this power-short year. The output of this new generator is adequate to fill the entire electrical requirements of a city the size of Sacramento.

Full operation of the Shasta power plant will supply hydroelectric energy equal to the labor of 4 million men working round the clock or an amount equivalent to that which could be developed by 875,000 gallons of oil or 130,000,000 cubic feet of gas daily. Besides conserving the State's diminishing supplies of oil and gas the addition of this generating capacity will make it possible for the Federal Government to realize a revenue of approximately $7,000,000 annually from the sale of the power, which in turn helps to make irrigation water available to the farmers of the Central Valley project at a reasonable price. Without this income from power the cost of the irrigation water would be almost prohibitive except in certain isolated cases. •

OUR FRONT COVER

Bureau Engineer A. A. Brownson (left) instructs a group of future dam builders in the use of field equipment at Hungry Horse Dam, Mont. The students are, left to right, John C. Naupauer, Newark College of Engineering, New Jersey; Bernard Fisher, Cooper Union School of Engineering, New York; and Joseph B. Eastman, Oregon State College. (See "New Blood for the Bureau," p. 117, this issue.) Photo by A. E. McCloud, Region II.

NOTES FOR CONTRACTORS

Contracts Awarded During April 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2526	Missouri River Basin, Wyo	Apr. 8	One 10,000-kilovolt-ampere autotransformer with three 69,000-volt lightning arresters, one 10,000-kilovolt-ampere transformer with three 34,500-volt lightning arresters, and six 115,000-volt lightuing arresters for Thermopolis substation, schedules 1 and 8.	Westinghouse Electric Corp., Denver, Colo	$104,23
2526	do	do	Three 69,000-volt and five 34,500-volt circuit breakers for Thermopolis substation, schedule 4.	Pacific Electric Maunfacturing Corp., San Francisco, Calif.	60,9
2526	do	do	One 115,000-volt selector-type switch; four 115,000-volt and three 69,000-volt horn-gap switches; and four 115,000-volt, eighteen 69,000-volt, and thirty-nine 34,500-volt disconuecting switches for Thermopolis substation, schedules 5 and 6.	Schwager-Wood Corp., Portland, Oreg	28,6
2527	do	Apr. 15	Three 115,000-volt and three 34,500-volt circuit breakers for Boysen switchyard, schedules 1 and 2.	Pacific Electric Manufacturing Corp., San Francisco, Calif.	71,6
2527	do	do	Two 115,000-volt selector-type switches, two 115,000-volt disconnecting switches, and one 115,000-volt horn-gap switch for Boysen switchyard, schedule 3.	Schwager-Wood Corp., Portland, Oreg	14,3
2531	Central Valley, Calif	Apr. 1	Three current and three potential transformers for Shasta substation, schedule 1.	Westinghouse Electric Corp., Denver, Colo	46,6
2535	Davis Dam, Ariz.-Nev	Apr. 7	One 50,000-kilovolt-ampere synchronous condenser and one autotransformer for Mesa substation.	General Electric Co., Denver, Colo	463,2

Notes for Contractors—Continued

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2536	Belle Fourche, S. Dak	Apr. 8	Six 2-foot-3-inch by 4-foot-3-inch high-pressure gates and 3 gate hoists for rehabilitation of north and south conduits of outlet control works at Belle Fourche Dam, item 1.	U. S. Pipe & Manufacturing Co., San Francisco, Calif.	24,488
2543	Columbia Basin, Wash	Apr. 14	Furnishing and installing 3 electric elevators for Grand Coulee pumping plant.	Westinghouse Electric Corp., Jersey City, N. J.	158,500
2545	Davis Dam, Ariz.-Nev.	Apr. 19	Construction of Coolidge electric district No. 5 115-kilovolt transmission line, using aluminum conductor, schedule 1	Vyne Bros. Electric Co., Inc., Prescott, Ariz	209,568
2548	Colorado-Big Thompson, Colo.	Apr. 21	Relocation of State Highway No. 280, Granby Reservoir	Horner and Switzer, Denver, Colo	303,912
2549	do	Apr. 1	Construction of 750-kilovolt-amperes substation at Haxtun, Colo.	E. A. Koeneman Electric Co., St. Louis, Mo	28,529
2563	do	Apr. 12	One 1,000-kilovolt-ampere transformer, one step-voltage regulator, and three 6,900-volt and three 2,400-volt lightning arresters for 6,900-volt Estes substation, schedules 1, 2, and 4	General Electric Co., Denver, Colo	18,980
2571	Builder Canyon, Ariz.-Calif.-Nev	Apr. 5	Two governors for regulating speed of 115,000-horsepower hydraulic turbines for units A3 and A4, Hoover power plant.	Woodward Governor Co., Rockford, Ill	94,880
2575	Columbia Basin, Wash	Apr. 18	3 generator unit control boards, 1 extension to main control board, and unmounted load and frequency control and recording equipment for units R7, R8, and R9, Grand Coulee right power plant, 230-kilovolt Spokane line No. 5, and Midway line No. 3.	Wolfe & Mann Manufacturing Co., Baltimore, Md.	63,699
2578	Klamath-Tule Lake, Oreg.-Calif	Apr. 19	Construction of earthwork and structures for channel improvements of Lost River and Miller Creek, Langell Valley.	Charles T. Hover, Burlingame, Calif	138,972
2580	Missouri River Basin, Mont	Apr. 7	Construction of earthwork and structures for relocation of county roads approaches to Canyon Ferry Dam.	Kiely Construction Co., Butte, Mont	107,032
2582	Klamath-Tule Lake, Oreg.-Calif.	Apr. 15	Construction of earthwork and structures for Lost River Diversion channel enlargement from Lost River to Klamath River.	George R. Stacy, Tulelake, Calif	537,292
2583	Davis Dam, Ariz.-Nev.	Apr. 8	1 bus structure, 8 selector-switch supports, 15 disconnecting-switch supports, 4 capacitor tie-down frames, and 1 take-off structure for 230-kilovolt Davis Dam Switchyard, schedule 1.	Gilmore Fabricators, Inc., Oakland, Calif	134,750
2583	do	do	5 transformer tie-down beams for Davis power plant; 1 tap structure, 2 disconnecting-switch supports, and 9 capacitor tie-down frames for Davis tap to Hoover-basic magnesium line, schedules 2 and 3.	Union Steel Co., Los Angeles, Calif	13,393
2584	Kendrick, Wyo.-Nebr	Apr. 1	Installing overhead ground wires on 94-mile Cheyenne-Gering 115-kilovolt transmission line.	Flora Construction Corp., Denver, Colo	61,201
2585	Missouri River Basin, Mont	Apr. 20	Construction of Canyon Ferry Dam and power plant	Canyon Constructors, Los Angeles, Calif	11,896,425
2586	Columbia Basin, Wash	Apr. 21	Construction of north Coulee Dam, feeder canal, relocation of United States construction railroad, and construction of access road to Electric City yard.	J. A. Terteling & Sons, Inc., Boise, Idaho	4,718,725
2588	Central Valley, Calif	Apr. 26	11 20- x 17-foot radial gates for Delta-Mendota Canal, item 1	California Steel Products Co., Richmond, Calif.	24,852
2588	do	do	11 15,000-pound radial-gate hoists for Delta-Mendota Canal, item 2.	Atlas-Pacific Engineering Co., Inc., Emeryville, Calif.	24,755
2591	do	Apr. 7	72,000 barrels of type V, low-alkali portland cement for construction of Soap Lake siphon.	Permanente Cement Co., Oakland, Calif	215,971
2597	Paonia, Colo.	Apr. 1	3,000 barrels of type II, low-alkali portland cement for construction of diversion works and Fire Mountain canal.	Ideal Cement Co., Denver, Colo	10,650
2599	North Platte, Wyo.-Nebr	Apr. 21	Grouting abutments and foundations for Pathfinder Dam	Continental Drilling Co., Los Angeles, Calif	29,392
2601	Fort Peck, Mont	Apr. 8	Construction of overhead ground wires for Glendive to Miles City 115-kilovolt transmission line.	Malcolm W. Larson, Denver, Colo	20,938
2602	Hungry Horse, Mont	Apr. 28	Relocation of forest service road, sec. 2, Hungry Horse Reservoir	McLaughlin, Inc., Great Falls, Mont	368,886
R3-B5	Boulder Canyon, Ariz.-Nev.-Calif.	Apr. 21	Alteration to 10 duplex cottages at Boulder City, Nev., schedule 1	Lembke Construction Co., Las Vegas, Nev	21,349
R4-15	Ogden River, Utah	Apr. 22	Construction of equalizing reservoir for laterals 25 and 25A	Wheelwright Construction Co., Ogden, Utah	63,223
R6-BIS-14	Missouri River Basin, N. Dak	Apr. 20	Clearing part of Heart Butte Reservoir site	Thompson-Kirkwood Co., Billings, Mont	31,800

Construction and Supplies for Which Bids Will Be Requested by August 1949

Project	Description of work or material
Boise, Idaho	Construction of 4 relift pumping plants with adjacent laterals and construction of the Willow Creek pumping plant on the C Line canal about 10 miles north of Caldwell, Idaho.
Boulder Canyon—All-American Canal, Calif.	Construction of about 70 miles of concrete pipe lines and structures for laterals, sublaterals, and wasteways of lateral unit No. 7 of the Coachella Valley distribution system, near Thermal, Calif.
Boulder Canyon, Ariz.-Nev	Construction of 15 permanent houses at Boulder City, Nev.
Do	Processing of sand and gravel for concrete aggregate at Boulder City, Nev.
Central Valley, Calif	Construction of earthwork, concrete lining, and structures for 18.5 miles of Delta-Mendota Canal, about 4 miles west of Newman, Calif.
Colorado-Big Thompson, Colorado.	Construction of 63 miles of 69-kilovolt transmission line from Yuma to Wray to Holyoke, Colo.
Do	Construction of 26 miles of 115-kilovolt wood-pole transmission line from Flatiron substation near Loveland, to Longmont and Lafayette, Colo.
Columbia Basin, Wash	Excavation of about 6.6 miles of Potholes east canal, about 16 miles west of Warden, Wash.
Do	Three 24- by 25-foot radial gates and three 40,000-pound radial-gate hoists for North Coulee Dam feeder canal.
Do	Galvanized fabricated structural steel for 11.95-kilovolt station service tie circuit towers and take-off structure.
Do	Motor-driven centrifugal-type and propeller-type fans, air filters, electric space heaters, electric hot water heating system, and air conditioning system with mechanical refrigerant condensing unit for Grand Coulee pumping plant.
Davis Dam, Ariz.-Nev.-Calif	Stringing conductor and overhead ground wire for 70 miles of 230-kilovolt, 3-phase, single-circuit transmission line between Davis Dam and Parker Dam, and for 64 miles of 230-kilovolt, 3-phase, single circuit transmission line between Davis Dam and Hoover Dam.
Davis Dam, Ariz.-Nev	Installation of electrical and hydraulic machinery and erection of steel structures for Davis Dam, power plant, and switchyard.
Do	Galvanized fabricated structural steel towers for 230-kilovolt Mesa-Coolidge transmission line.
Do	Two main control boards for Mesa and Prescott substations.
Do	No. 18 gage sheet steel, hot-galvanized after fabrication, for Davis-Hoover and Davis-Prescott-Mesa transmission lines. Alternate schedule for hot-galvanized after cutting and punching, but prior to breaking.
Gila, Ariz	Construction of pumping plants Nos. 1, 2, and 3, located at Miles 8, 14, and 18, respectively, on the Wellton-Mohawk Canal about 20 miles east of Yuma, Ariz.
Do	Control and supervisory equipment for the Wellton-Mohawk pumping plants.
Hungry Horse, Mont	Station-service distribution switchboards and station-service transformers for Hungry Horse power plant.
Kendrick, Wyo	Galvanized fabricated structural steel towers for 115-volt kilovolt Kortes tap lines, Seminoe-Casper transmission line.
Missouri River Basin, Nebr	Construction of earthwork and structures for about 17 miles of the Superior canal, near Superior, Nebr.
Do	Construction of earthwork and structures for 6.5 miles of Cambridge canal near Arapahoe, Nebr.
Do	Installing equipment and constructing 20,000-kilovolt-ampere Sidney, Nebraska, substation.
Do	One 8- by 7-foot and one 6- by 5-foot radial gate and one 3,000-pound and one 2,000-pound radial-gate hoist for Superior Canal.
Missouri River Basin, Colo.-Nebr.	Construction of 88 miles of 115-kilovolt wood-pole transmission line between Sterling, Colorado, and Ogallala, Nebraska.
Missouri River Basin, N. Dak	Construction of the 41-mile long Bismarck-DeVaul 69-kilovolt, wood-pole transmission line near Bismarck, N. Dak.
Missouri River Basin, S. Dak	One 6- by 6-foot high-head radial gate and one 10,000-pound radial-gate hoist for Shadehill Dam.
Do	One 6- by 6-foot slide gate with frame, one 115,000-pound gate hoist, semiautomatic gate hangar, and hydraulic control for Shadehill Dam.
Missouri River Basin, Wyo	Construction of the 18-mile long 115-kilovolt wood-pole transmission line between Boysen and Thermopolis, Wyo.
Do	One set of trashrack and metalwork for Boysen Dam and power plant.
Do	One set of spillway stoplogs for Boysen Dam and power plant.
Ogden River, Utah	Construction of 2 concrete-lined equalizing reservoirs of 12 and 14 acre-foot capacities; and construction of 1 mile of pipe laterals for the south Ogden distribution system, Ogden, Utah.
Paonia, Colo	Construction of three 6-foot diameter concrete siphons, combined length 1,000 feet, for the Fire Mountain canal enlargement, near Paonia, Colo.
Riverton, Wyo	Construction of earthwork and structures for about 12 miles of the Wyoming Canal, located about 20 miles north of Riverton, Wyo.

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The Reclamation Area

The Reclamation ERA

July

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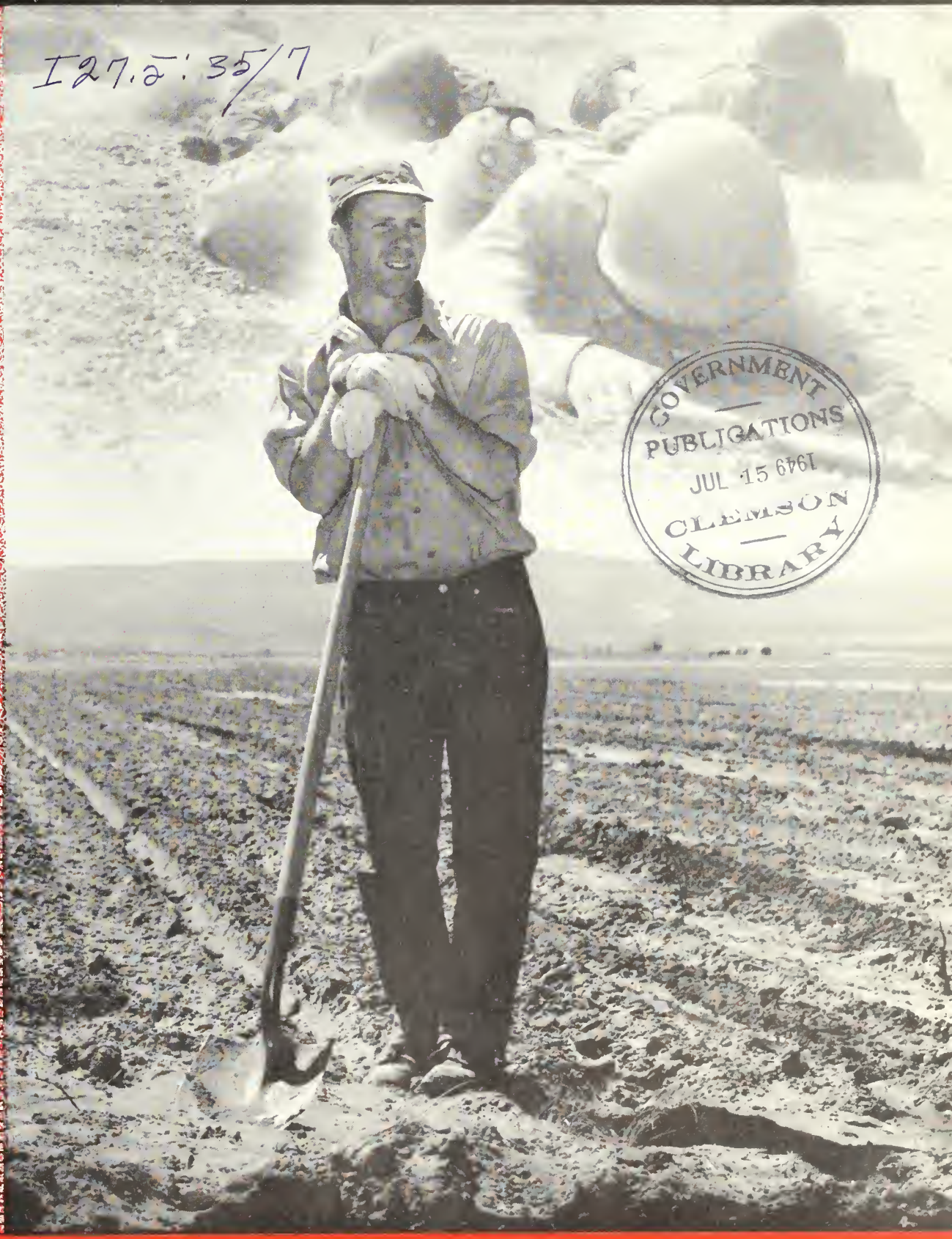

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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' association.

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RECLAMATION PLACE NAMES IN THIS ISSUE

"to produce the most, with the least"

The above words, lifted from Avery Batson's article next door, might well be adopted by irrigation farmers as their slogan of the new century of conservation.

Realistic, practical scientists, and practical, realistic men with scientific knowledge applied to their day-by-day work, are aware that conservation is the watchword of these times.

But the word "conservation" may be misinterpreted. When speaking of water, a renewable resource, the phrases, "saving water," "conserving water" may come to mean "be stingy," "be frugal," and even the word "economize" may develop a niggardly attitude toward water use. There's no sense to saving water for a rainy day.

Next month's issue will be devoted to topics which concern the proper use of water in the reclamation area.

Up to now, we have not found a suitable substitute for the phrase "water conservation," as applied to reclamation practices. What we need is a meaningful, hard-hitting combination of short words which will say, "make the most of water resources," "use water wisely," "maximum use with minimum waste equals the proper use of water."

Water has many jobs to do. To shut off or cut down on the water supply at the sacrifice of necessary crop, municipal, or power production is not true water conservation.

"To produce the most with the least" is a good slogan for anyone.

But we hereby invite our many readers to send in their suggestions for an even better, tailor-made, slogan for reclamationists in this century of conservation.

United States Department of the Interior

J. A. Krug, Secretary

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REGION VI: K. F. Vernon, Regional Director, P. O. Box 2130, Billings, Mont.
REGION VII: Avery A. Batson, Regional Director, 318 New Customhouse, Denver, Colo.

The "era of the good engineer," whose work brings life to the barren acres of the West. F. B. Pomeroy, Region I, graphically portrays realization of an engineer's dream—the main lateral of the Pasco Unit, Columbia River Basin, which irrigates land on both sides of the canal.

A NEW CENTURY of CONSERVATION

by AVERY A. BATSON, Regional Director, Region VII, Denver, Colorado

TWENTY-FIVE YEARS AGO my professor in Structures back at Nebraska told me that a good engineer was one who could build the best, to produce the most, with the least. He went on to say that most any nincompoop could build most anything if he had most everything to do it with.

During the last century—a century of progress beyond any century in history—engineers played a big part in using what we had lavishly to develop our resources—which seemed inexhaustible. It was a century of progress. The next century must be one of conservation and efficiency in use. It must be the era of the good engineer, the one who can build the best, to produce the most, with the least.

Three ways occur to me by which we can conserve our resources better, and increase our efficiency in use. The first is the substitution of plentiful resources for those in short supply. The second is by increasing the efficiency in our present use. The third is through the coordination of purposes in developing our resources.

Vast deposits of oil shale occur in northwestern Colorado, northeastern Utah, and southwestern Wyoming. Practical means have been devised to extract the oil from these shales. Large-scale operation of these processes would relieve, in a measure, the draft on our oil reserves. A number of oil companies have become interested in these possibilities. Many more should.

Processes for the hydrogenation of coal and the liquefication of gas are in the pilot plant stage. By far the greatest reserves of coal are found in the West. Where there's coal there's generally gas. That which cannot be transported for use directly, should be liquefied for its petroleum products.

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Water accumulating energy as it runs downhill is a renewable resource which does not wear out and can be used and reused until all its energy is extracted. It can be developed or allowed to run back to the sea, wasted and unused, damaging property and taking its toll in lives on the way.

Another possible source of energy may be the generation of electricity by wind turbines and the coordination of output with the hydroelectric power. Pilot wind turbines should be built to test the practicability of such installations.

These are only a few examples of the manner in which plentiful, and otherwise wasted, resources could be substituted for those exhaustible resources of short supply. Many other instances will occur to the good engineer.

We generally have been concerned with efficiency in use only to the extent of considering whether our production costs would drive us out of the market. Costs of extraction, processing, and marketing have been our only concern. The general economic value of the resource is seldom appraised.

How can we, as engineers, be satisfied with a low degree of efficiency in motors and prime movers, just because the public is willing to buy a few more gallons of gas or tons of coal to accomplish the same purpose that could be satisfied for less? The pressure top on the blast furnace should have been an obvious device. Why didn't we think of it sooner?

Reports indicate that the waste of flared gas today amounts to at least one-fifth of the annual well output. Must the States adopt stronger conservation laws and enforce them more effectively, or can the engineers, voluntarily, recognize the waste of resources, devise means of capturing its value and place it on the market?

Traditionally, we have taken pride in the ownership of flowing wells. We let the wells flow because that phenomena was unusual and spectacular. It has been only recently that we realized we were dissipating a valuable resource to no purpose which took nature thousands of years to provide. We are beginning to cap artesian wells. We should do that through common courtesy to the public. We should not insist on being forced to do it by law. We should tap ground water supplies, artesian or otherwise, only to the extent required for beneficial use.

Great improvements in the efficiency of irrigation systems are possible and necessary. This statement applies to systems built by the Federal Government, as well as by individuals and local agencies. The first pressure in the development of irrigation was to get the water from where it was to where it was needed to produce food for the people who settled this arid country. We used the best means at hand and were not concerned with canal and lateral losses because the seepage returned to the streams.

But there are losses to evaporation that are not recoverable and through raising the ground water table, the seepage carries salts to the surface and destroys the productivity of valuable lands.

The Bureau of Reclamation has undertaken a modest research project to discover materials and refine methods for canal linings. But we alone will not get very far, very fast. It will take the help of the laboratories and technical skills of the universities, the material companies, the contractors, and the engineers. When we consider that over 20 million acres of land are irrigated in the West and these lands are served by canals and laterals which should be operated at a greater degree of efficiency, we can recognize the breadth and the probable volume of the market for an efficient and practical product.

Our program for this year includes a start on the improvement of some of the canals where the losses are the greatest. The plans contemplate the use of conventional materials but I hope that the contractors who bid on the work will sharpen their pencils, scratch their heads, and devise methods of placement which will produce the most of the best for the least.

When we consider that there is much more highly productive land in the West than there is water to serve it, we must conclude that water must be used sparingly and to the best purpose. If the pressure for increased production accompanied by the need for changed crop pattern continues, and economists warn us that it will, it does not take a visionary to see the future day when water for irrigation will run in impervious, covered, and perhaps pressure, conduits. But unless the ratio of farm prices to material and placement prices changes violently, those conduits will not be of materials nor placed by methods known today. This need is a challenge to the engineers of the West.

The words "coordination" and "cooperation" have been overworked. They have come to imply a generous voluntary gesture which creates exclusive values to those with whom we cooperate or coordinate. Webster says that cooperation is collective action for mutual profit or common benefit. He says to coordinate is to bring into common action, condition, etc., harmonize. Now, I am not an incurable purist but for the purpose of this discussion, I insist on the definition and implication of those words as favored by Webster.

I firmly believe that Federal, State, and local governments, private industry, and individuals, properly disposed, can cooperate in a coordinated program for the development of resources to their mutual benefit and in the interests of the general public. I am convinced that conservation and wise use of our resources demands this cooperation. The alternative is government by directive and regimentation.

The part the public agencies play in resource development programs only forms the framework of the plans. The far greater part must be played by individuals and private enterprises—the application of the controlled water to the land to increase production; the processing of agricultural products through the use of the power produced, for marketing of those products throughout the basin and the Nation, the use of the power for the recovery and processing of mineral and petroleum resources; to cite but a few.

The activities of individuals and private enterprise in like fashion will affect the efficiency of the developments either favorably or unfavorably, to their own benefit or detriment.

Guernsey Reservoir, Wyoming, on the North Platte project, has lost 30 percent of its capacity through siltation in 20 years. A goodly portion of the silt was contributed through geologic erosion, a natural process for which we've found no effective methods of correction. But that process does

(Continued on page 146)

THE HISTORY of the SIPHON

by
EARL A. ALLEN, Engineer,
Branch of Design and Construction, Denver, Colo.

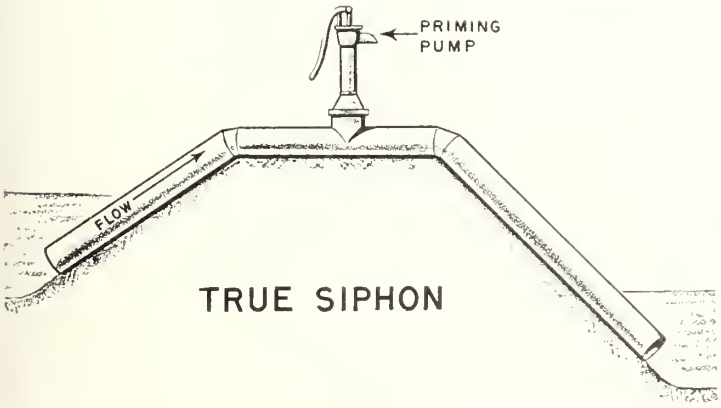
Typical of the many inverted siphons constructed by the Bureau of Reclamation, the Aspen Creek Siphon, pictured above during construction, is a reinforced concrete structure 10.75 feet in diameter and 1.32 miles long. The siphon, a feature of the Colorado-Big Thompson project, crosses Aspen Creek, a tributary of the Big Thompson River.

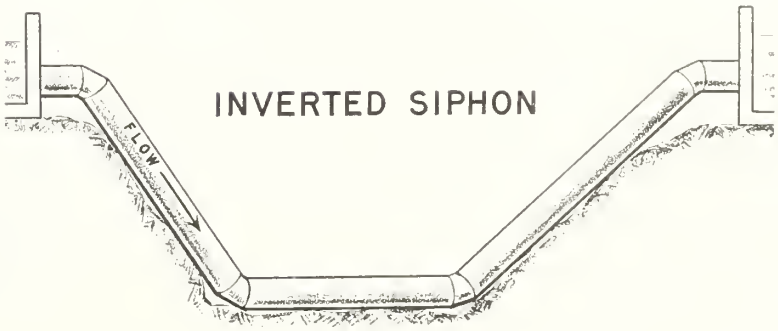
By way of introduction, the word "siphon" in this article refers to either one of two water conveying dedevices, a true siphon or an inverted siphon. A true siphon is a device in which a liquid can be transferred to a lower level over an intermediate higher elevation and consists of a pipe or tube bent in an inverted U-shape. The siphonic action or flow of water depends on the difference in pressure at the extremities of the conduit. An inverted siphon, the exact opposite of a true siphon, is a device in which a liquid can be transferred from one point to another under a lower intermediate point and consists of a pipe or tube bent in a regular U-shape. An inverted siphon carries water under hydrostatic pressure and operates on the principle that water, when conducted through a closed conduit, will rise to the level of its source.

The first true siphon was made at the school of the Ptolemies at Alexandria about the year 120 B. C., although Archimedes had established the fundamental hydrostatic law of equal pressure about 100 years earlier. There is practically no historic mention of the application of the true siphon in waterworks practice, and it has been within very recent times only that the siphonic principle has been applied to conduits of large size and capacity. One of the most important applications of the true siphon in current waterworks practice is its use as a device in discharging water at a dam or from a canal. Many siphon spillways which have been constructed in recent years to carry excess water away from a reservoir or canal, utilize also the principle of a true siphon.

The first application of the inverted siphon in waterworks practice preceded the use of the true siphon by more than a thousand years. Remains of remarkable water aqueducts constructed by the Phoenicians in Syria indicate that inverted siphons were constructed across valleys for the conveyance of water to the temples. Other records of aqueducts for irrigation in Babylonia, Syria, and Egypt extend back to very remote times, probably the earliest about 1400 B. C.

The Aqueduct of Patara in Syria was one of the earliest water conveyances constructed. It was formed by a canal covered with large stone slabs. Where the canal crossed a deep ravine, a conduit, consisting of a pipe forming an inverted siphon, was inserted. Originally, this siphon was made of earthen pipes but later these pipes were replaced by stone blocks which were bored through the center to a diameter of about 13 inches. Each stone block had an annular, or ring-shaped, projection at one end and a recess about 3 inches deep at the other, the blocks being connected





by a joint similar to the bell-and-spigot joint now in use on precast concrete pipes.

The Aqueduct of Laodicea in Asia Minor was similar to the Patara Aqueduct. Before the water reached the city, it was conveyed across a deep valley by a siphon of two lines of stone pipe about 8 and 10 inches in diameter, respectively. It is estimated that these pipes were subjected to a pressure of about 60 pounds per square inch.

The greatest aqueduct builders of ancient times were the Romans who, from about 300 B. C. to A. D. 97, constructed more than 350 miles of aqueducts. The aqueducts were supported across valleys on multiple-arch masonry bridges, or arcades. About 50 miles of these arch structures were built during the period of construction on the aqueducts. It is highly probable that the large size of the pipe siphons that would have been required to traverse these valleys, coupled with the great cost of lead pipe which was the only metal then used in pipe, led the Roman engineers to construct these extensive arcade structures to carry the open conduits. These engineers were certainly aware of the fact, however, that water in a closed conduit would rise to the level of its source, since lead pipes were used in distributing water to the houses in Rome. The Romans built, also, several important aqueducts at Paris and Lyons in France, and Segovia and Seville in Spain.

For more than a thousand years after the destruction of Rome in A. D. 475, no aqueducts of any importance were built in Europe. Construction of aqueducts on a large scale was resumed about 200 years ago. Several aqueducts to carry domestic water supplies were constructed early in the nineteenth century, both in Europe and America, and pipe siphons were utilized on all to great advantage. The production of cast iron and steel about the middle of the last century made possible the construction of large pipe siphons which could withstand the great pressure inherent in high head siphons. The extensive use of siphons in modern times can be attributed directly to the production of better and less expensive construction materials. Moreover, modern siphons built of cast iron, steel, concrete, or wooden pipe, obviate the necessity for construction of aqueduct arcades and bridges of ancient times as well as eliminate the circuitous routes necessary to avoid the construction of such bridges.

Until comparatively recent times, the use of aqueducts in conveying the water over great distances was confined principally to furnishing domestic water supplies. However, with the growth of irrigated agricultural developments during the last 50 years, the construction of conveyance structures for the delivery of water to irrigated lands has received much attention from hydraulic engineers. As a result, remarkable advancements have been made in the design and construction of siphons on irrigated projects.

The Bureau of Reclamation, in its work of providing irrigation facilities for the 17 Western States, has constructed thousands of canals and aqueducts which include innumerable siphons. The great majority of these siphons are precast concrete pipes or reinforced monolithic structures. Steel pipes have been used, also, where high hydrostatic heads were encountered.

As an example of recent Bureau construction, see page 143, photo of the Aspen Creek Siphon, a feature of the Colorado-Big Thompson project, during construction. Now completed, this siphon is a reinforced-concrete structure 10.75 feet in diameter and 1.32 miles in length. It is designed to carry a capacity flow of 550 cubic feet per second.

Thus, from the earliest days of recorded history to modern times, the inverted siphon or pressure pipe has proved to be an invaluable device in the development of water distribution and irrigation systems. THE END

This represents the first in a series of articles which will comprise a symposium on siphons as used in reclamation farming or construction. Each region of the Bureau of Reclamation has submitted articles for inclusion in this series and we welcome additional contributions from non-Bureau readers who could contribute interesting items on this topic for publication.

In irrigating, the man with the shovel, diking, breaching the dike, and damming the little stream again and again is replaced by the man with the siphons who can irrigate the same amount of land in a fraction of the time with fraction of the effort.

At left, soldered sheet-metal siphons, the first improvement over the shovel, are used to irrigate a tomato field near Knight's Landing, Calif. At right, the plastic siphon, an even more modern improvement, is used on the Klamath project. Left photo by Ben Glaha, right by J. E. Fluharty, both of Region II.

POWER at Heart Mountain

by CLAIR F. BOWMAN, Chief, Marketing and Sales, District Power Division, Big Horn District, Wyo., Region VI

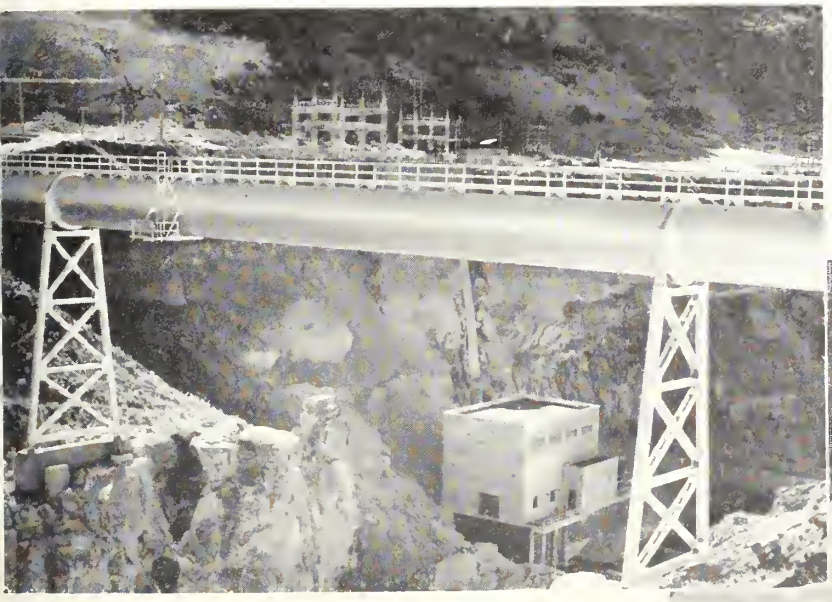
Lights are brighter in 15,000 homes, industry's proverbial wheels turn faster and farm life in the Big Horn Basin is more convenient and pleasant—all because of the Heart Mountain power plant, one of the Bureau's most recent accomplishments on the Shoshone project.

The 5,000-kilowatt plant was near enough to completion last December to be rushed into service, barely in the nick of time to meet a new record peak in electric power demand in the Big Horn Basin. Unfortunately, even with the new plant the demand for electric power continues to exceed the available supply. In the words of a Bureau power authority, the generation provided by the Heart Mountain plant "has been soaked up as though by a sponge."

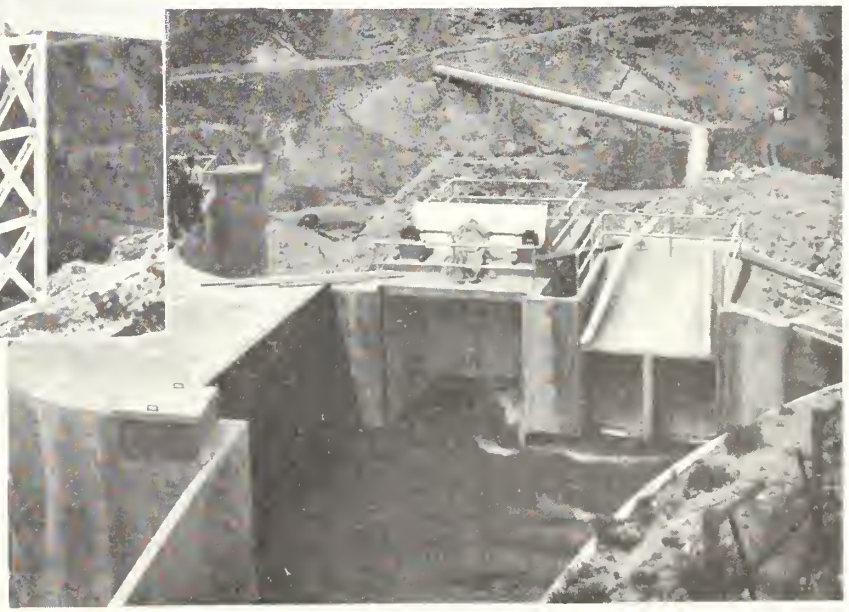
The legion of Reclamation partisans (99.44 percent of Wyoming's citizens) are proud, though, that the Bureau has again demonstrated its technical ability to provide for economic needs through plain, old-fashioned efficient water use. The Heart Mountain plant meets the most demanding criteria in its "push-button," semiautomatic operation, its invaluable kilowatts, and its ability to make full use of a water system without interfering with its utilization for irrigation purposes.

Water for the turbines travels 3 miles from famous Buffalo Bill Lake, which arose 40 years ago when the Bureau of Reclamation completed Buffalo Bill Dam (then known as Shoshone Dam). The 3-mile journey is via the Shoshone Canyon conduit which carries the water to an open flow division structure—the headworks for the Shoshone Canyon siphon. At this siphon (the longest self-supporting structure of its kind in the world) the water divides, to be used at the Heart Mountain power plant, or for irrigation purposes. The water for the power plant leaves the division structure and drops 265 feet through a 1,150-foot penstock to the power plant in the canyon below. Water for irrigation enters the siphon which crosses the river and is delivered to the Heart Mountain canal which will provide the water supply for the future Oregon Basin feeder canal, a feature of the Shoshone Extension Unit of the Missouri River Basin project.

The plant contains a single generator rated at 5,000 kilowatts, 6,000 kilovolt-amperes, 450 rotations per minute, 2,400 volts, 3-phase, 60 cycles. The generator is mounted on a vertical shaft Francis-type turbine, surmounted by the exciter unit. With incomplete installation of auxiliary and control equipment, the generator has carried a load of 6,000 kilowatts for a 1-hour period with an estimated water requirement of 300 second-feet. It is believed that when all installations are



At left: The Shoshone River Siphon with a capacity of 900 cubic feet of water a second is 150 feet higher than the stream bed, which can be seen near the front of the Heart Mountain power plant below. The switchyard with its interconnecting facilities can be seen above the siphon, the largest self-supporting structure of its kind in the world.



At right: The distribution pool, located near the tunnel, with its four openings. The structure at the left leads to the power plant, the next opening takes water to the siphon leading to the Heart Mountain Canal, the divided aperture next to it is the spillway for overflow, and the opening only partly visible at far right will provide for irrigation water in the proposed Oregon Basin.

completed, tests will show a dependable capability of 6,000 kilowatts. Since there is no storage at the head of the penstock, the plant will be required to carry an essentially constant load.

The Heart Mountain plant will be operated by remote control from Buffalo Bill Dam and the Shoshone power plant (constructed in 1922) 3 miles upstream. The higher plant added a third generator in 1931 bringing the total nameplate rating up to 5,600 kilowatts. With the installation this summer of the remote control cable, "push-buttons" at the Shoshone plant will start, synchronize and stop Heart Mountain power plant, and adjust the load as required. Automatic equipment at Heart Mountain will shut down the turbine and generator in emergencies such as overheating of vital parts, water failure, low oil pressures or levels, or electrical faults.

Investigations of the Heart Mountain plant were carried on in the office of Director H. F. McPhail of the Branch of Power Utilization during World War II. The report, including the finding of feasibility of the Secretary of the Interior, was printed in 1945 as House Document No. 281, Seventy-ninth Congress, First Session. Funds for construction of the plant were provided in the appropriation acts for fiscal years 1946, 1947, 1948, and 1949, and a budget request for funds to complete minor remaining work is included in the appropriation bill for the fiscal year 1950. Construction of the plant was under the direction of W. F. Kemp, project engineer, Shoshone project, and William P. Killmore, construction engineer, aided by Martin H. Soulé, Big Horn district power manager, and Frank Vollmer of the Chief Engineer's office, during the fiscal year of 1949 (July 1, 1948, through June 30, 1949).

The power plant building was constructed under contract by Samuels and Franklin and Gibbons and Reed Co. The turbine was purchased from S. Morgan Smith Co., the generator from Elliott Co. and the control equipment from the Control Corp. Installation was made by Government forces.

Construction was initiated in September 1946, and originally was scheduled for completion in 1947. Postwar labor and materials shortages accounted for the delays. The plant was placed in service December 12, 1948, with numerous improvisations, barely in time to meet the Big Horn Basin's new record peak that occurred on December 20. The improvisations added about $20,000 to the over-all cost of the plant currently expected to total $1,980,000 upon completion, but made it possible to place the plant in service about 3 months earlier than would otherwise have been the case. In addition to avoiding a likely "brown-out" through the winter months due to lack of power, the plant produced revenues of approximately $20,000 for each of the 3 months of operation thus gained, thereby crediting the improvisations with a gross profit of $40,000.

Mr. Earl Bower of Worland, State Senator and a director of the National Reclamation Association, Milward H. Simpson of Cody, president of the University of Wyoming board of trustees, and Regional Direction K. F. Vernon, participated in the dedication before several hundred spectators at the plant on December 12. The ceremonies were broadcast over Cody's radio station KODI, with the owner, William F. Garlow, a grandson of William F. "Buffalo Bill" Cody, serving as announcer for the occasion.

Completion of the Shoshone project will be marked this Fall by drawings for and the settlement of the last of the farm units to be developed on the Heart Mountain Division. Drawings for the 104 farm units are to be held in September 1949 with appropriate ceremonies at Powell, a flourishing trade center of about 5,000 population that came into existence with the start of construction of the project in 1904. Crops produced on the 61,309 acres of the project cultivated in 1948 had a value of $3,427,233.

Irrigation and power make up a paying team at Heart Mountain. THE END

A New Century of Conservation

(Continud from page 142)

not account for all of the silt. Some was contributed by erosion on overgrazed range.

The State Agricultural Colleges have found that the range can be managed in such a manner to reduce erosion and increase production of livestock on a sustained basis, a better use of a resource mutually beneficial to all interests. The Forest Service has found that timber can be harvested on a sustaining basis to reduce erosion and increase production of lumber and better quality water. Highway drainage structures can be designed to induce erosion or prevent it.

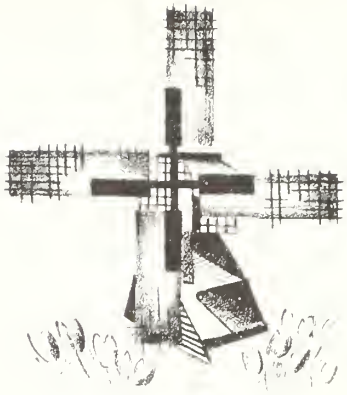
What the rancher does with his range, the lumberjack does with his ax and the highway designer does with his pencil and slide rule, affects not only their own interests but that of others. When a reservoir fills with silt, that means less water for less productive acres. Less water means less food for the Nation and less income for the irrigator. Less income to the irrigator means less business for the merchant, the doctor, the lawyer, the dentist, and the engineer. Less control of stream flow by the silted reservoir means more damages by floods and choked river channels to spread those damages farther. The losses pyramid; there is no end.

Conservation and efficient use of our resources will not come easy. Patterns have been established. Rights and interests have been vested. Some patterns must be adjusted. Vested rights and interests must be considered in that adjustment. This process will require knowledge, understanding, courage, forbearance, patience, and persistence in addition to technical skills.

Industry will come to the West. Industry needs raw materials, power, water, transportation, and people. Raw materials abound; power and water can be developed for economical use; transportation can be improved. People will demand a decent environment and food on which to subsist. We have the environment. The food can be produced through irrigation. In the interest of conservation and efficient use of our resources, the engineer of this new century can help provide a congenial place in which industry can abide. THE END

The above article was culled from an address by Avery A. Batson, before the Convention of the Wyoming Engineering Society, at Cheyenne, Wyo. on April 1, 1949.

The Dutch Reclamation Company



by GERARD LUTKE MEIJER,
Author and Publisher, Amsterdam

THE CORRECT USE OF THE NATIONAL TERRITORY has become an oppressing problem for the people of Holland. In the past 60 years, land reclamation has not been able to keep pace with the ever-growing Dutch population.

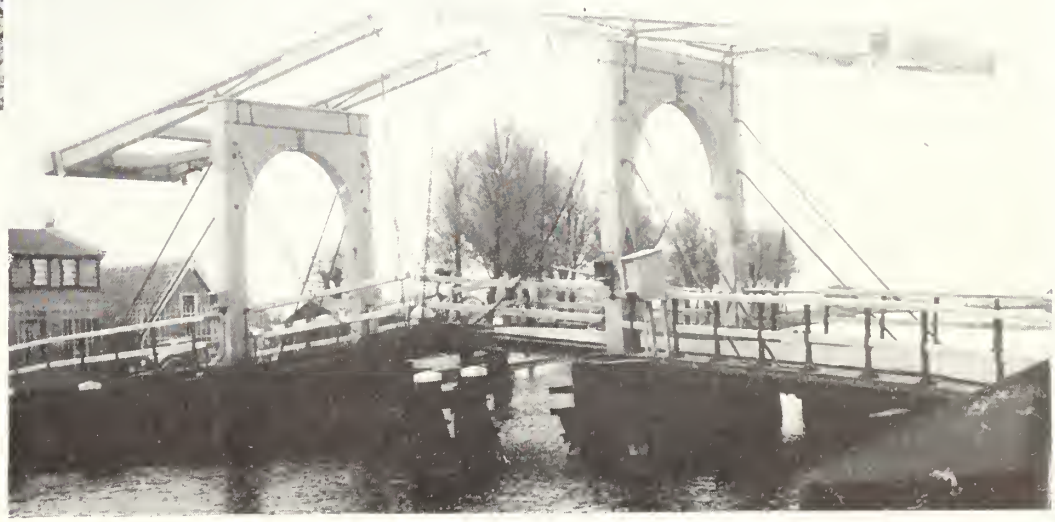
The country has now entered the era of district planning and social planning. These have become words which represent need and reality to the people of Holland.

The Dutch feel that this is an important task which can be entrusted to no other coordinating power than governmental authorities. The Nederlandse Heidemaatschappij (Dutch Reclamation Co.) has adopted a very careful policy in determining the use of the last open spaces.

This company employs about 2,000 officials and close to 50,000 employees at certain periods. When it was first established over 60 years ago, its task was chiefly the improvement and cultivation of rough and worthless areas for the fast growing population. But now the company must decide what part of the national territory will be used for agriculture, what part for living purposes, for recreation, for traffic, for air strips, or for health resorts to best serve the increasing population.

Since 1888 the Dutch population has doubled, and it is still growing at a tremendous rate. There are 280 people for every square kilometer, which is equal to about 25 acres. In the western part of the country this figure is as high as 730 people per kilometer. Reclaimable areas in the same length of time have been reduced to 500,000 hectares or 1,235,500 acres. The population has increased 55.4 percent in the years 1900–39, while the quantity of farm land has increased only 8½ percent.

Because of the ever-increasing number and size of cities and towns, Holland now faces a period in which planning is the most essential part of reclamation work. Mistakes made now in allotting the national space might well have a fatal influence on the economy of the country for many coming centuries. In such an overcrowded country, the



Above: From a "Walcheren"—an area reclaimed from the ocean floor—emerge productive fields, redivided by the Dutch Reclamation Co. for efficient agriculture. At right: From the former bottom of a lake arises a town, typical of Holland, with its water thoroughfares and its picturesque and practical drawbridge.

Netherlands has no choice but to plan carefully and conscientiously the future use of space.

The principles of economic land-reclamation were laid in the years about 1880–90 as the flow of cheap cereals from Canada and the United States convinced the Dutch of their agricultural shortcomings. Since 1890 they have nearly doubled their output per acre; they have changed an arid, sandy district into a fine, rich, producing province; they have regulated small rivers, drained inaccessible marshes, dried up a number of small lakes and a part of a sea, and made woods out of dusty dunes and shifting sands. The organization of the Forest Fire Brigade in the Netherlands can be rivalled but not surpassed. The 6,425 acres of fine forestland were in 1897 only shifting sands and waste land of no value whatever.

The growing importance of cultural factors in the final determination of the use of the Dutch territory is an outstanding feature of land reclamation in the Netherlands. The cultural life of the whole people demands a continually growing part of the available country. Thousands of acres have to be reserved for recreation. Miles of roads and bicycle paths have to be opened for the crowds of pleasure-seeking city people. Land and water sports claim grounds and lakes. But as the cities expand, the country must be protected. No disturbing advertising shields may spoil its garden-like loveliness.

The work of reclamation increased a thousandfold because of the havoc war played in Holland's lands. More than 531,265 acres were inundated, mined, and devastated by military occupation. In the Dutch territory as a whole, 9,500 farms were destroyed or abandoned. The tragic fate of Wieringermeer, our newest "polder," or tract of land reclaimed from the sea, is known throughout the world. It was one of our most prosperous isles where small villages flowered on the former bottom of the sea. Now, the re-emerging and still salt-impregnated fields must be replaced by new vegetation. There is much, much work to be done to regain our ground.

One of the unique features of reclamation in this country has been the necessary work of combining tracts of land. For centuries the land has been divided into many small parcels. By handing the land down from generation to generation and dividing it among the heirs, it was split in so many pieces that it became almost useless from an economic standpoint. Since 1943, the Dutch Reclamation Co. has been working to convert 1,235,500 acres of these land strips into new units of a more manageable size.

No doubt the Netherlands is one of the first countries to undertake planned reclamation with a clear understanding of its real meaning. National planning is a new task and includes the coordination of all existing district plans and urban-expansion projects. The country is making a realistic attempt to solve the immense problem of fitting large numbers of people into small areas. The Dutch are working to answer the question: How can we make it possible for over 10 million people to live and prosper in a space of 13,205 square miles without making an ugly, commercial farm-and-factory mixture out of the garden land of Holland?

THE END

John L. Savage To Serve Turkey

John L. Savage, retired chief designing engineer of the Bureau of Reclamation, has been engaged by the Turkish Government to make a study of the reorganization of hydraulic works and methods of financing them. He has also been requested to visit the new government of Israel to discuss reclamation.

Mr. Savage, known the world over as the "billion dollar engineer," directed the designing of the Grand Coulee, Hoover, and Shasta Dams during his career with the Bureau of Reclamation. Since his retirement in 1945, Mr. Savage has traveled widely, spreading the story of the development of reclamation in the United States. In June Mr. Savage was in India, and his passport shows visits to Australia, Afghanistan, Ceylon, China, Egypt, France, Greece, Italy, Mexico, Netherlands East Indies, Palestine, Pakistan, Philippines, Siam, Spain, Switzerland, and the United Kingdom. His trips have been devoted to showing other Nations of the world how to help themselves through the development of their natural resources. •

Reclamation Aid for Rhodesia

Construction engineer David R. May after completing the earth-fill Jackson Gulch Dam on the Mancos project, Colo., in record time, is now in Southern Rhodesia, British South Africa, for a 3-month assignment at the request of the Department of State and officials of the Union of South Africa.

Mr. May's salary and expenses will be paid by the Rhodesian Government which sent Mr. Robertson, former secretary of irrigation and agriculture for southern Rhodesia, and two engineers from the Union of South Africa, to the United States last year.

They visited the Denver, Colo., design and construction office of the Bureau of Reclamation, as well as several projects. After inspecting earth-fill dams, they expressed the opinion that such dams would work out at several sites in their areas. It is understood that May's principal assignment will be to check these sites and the availability of materials.

May has been a Bureau of Reclamation engineer for 17 years, his first job being in connection with investigations for Hoover Dam construction. He has spent 2½ years at the Mancos project, where he supervised construction of a dam requiring 2 million cubic yards of fill and costing approximately $3,500,000. •

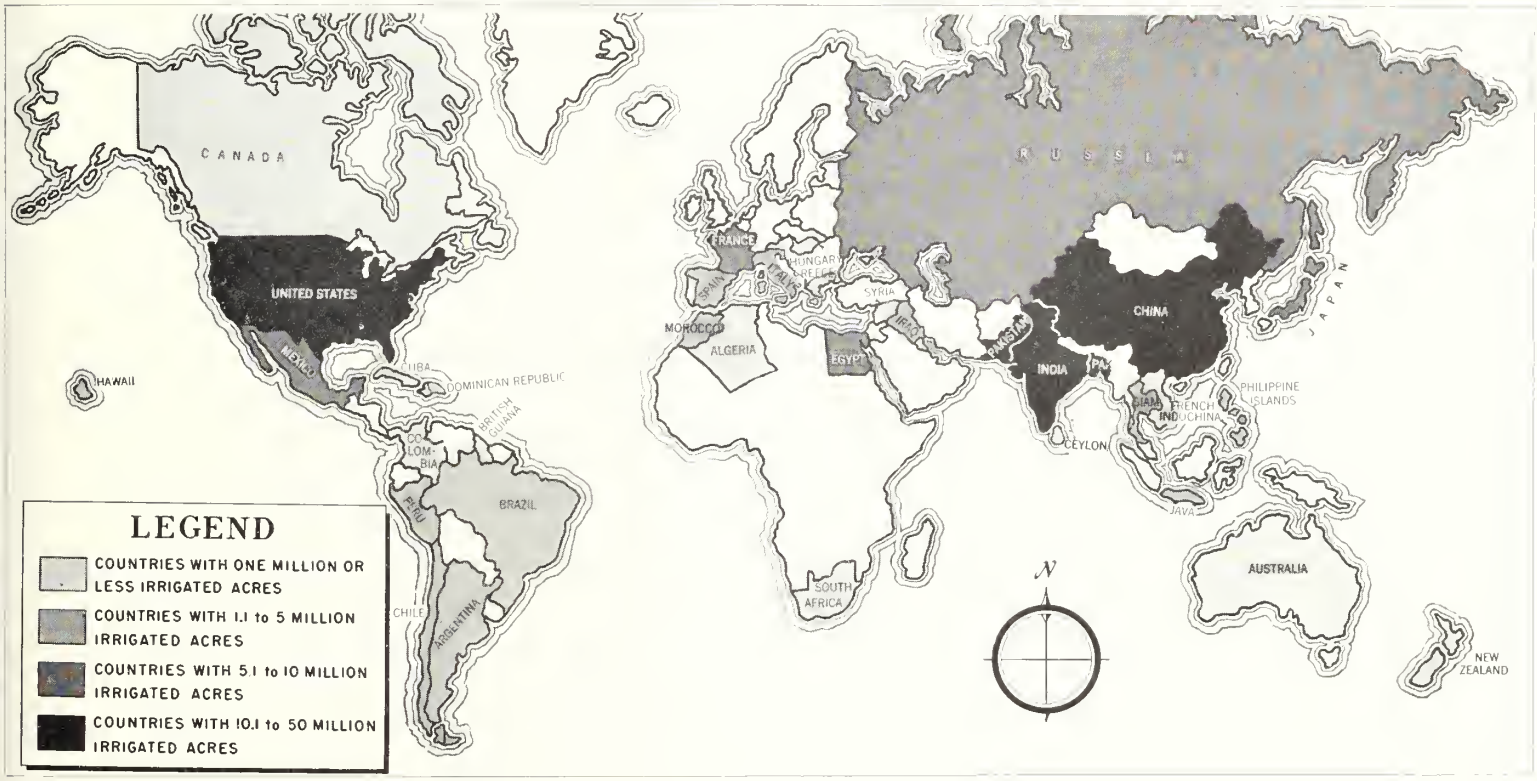
Douglas Reports on Japan

Assistant Regional Director L. R. Douglass of Boulder City, Nev., in reporting on his recent assignment to Japan stated, "The Bureau of Reclamation is properly taking its place in and making its contribution to the promotion of a better understanding of American philosophies and ideals throughout that part of the world which is now looking to the United States for leadership. The individual employee, who has the good fortune to receive a foreign assignment finds, as a result, that his own horizon is broadened and his experience enriched. We cannot overlook the basic law of life that we help ourselves by helping others."

Mr. Douglass went to Japan at the request of the Department of the Army and worked as a visiting expert on problems of agricultural water utilization in Japan. His work was in the Soils and Fertilizer Branch where he worked closely with Mr. Earl G. Johnson, Reclamation Specialist.

Japan, with a land area of 142,000 square miles, and an increasing population, which is presently estimated to be 80,000,000, is faced with the urgent requirement for increased food production. Moving toward a solution, the Japanese Government has initiated a large land development program. The phases of the program with which the assignment of Mr. Douglass were specifically concerned were: inspection of engineering works completed, under construction or proposed for construction, for the purpose of estimating their economic soundness and adequacy of design; suitability and completeness of plans and specifications; quality of construction methods and materials; and the technical ability and proficiency of the Japanese engineers and technicians responsible for the conception and actual execution of the work. •

World Irrigation Approaches 200 Million Acres



A paper on "Global Hydro-Economics" by the Commissioner of the Bureau of Reclamation was recently presented at the Third Congress on Large Dams, held at Stockholm, Sweden. This paper incorporated data on the areas of irrigated land throughout the world, obtained by the Bureau in a recent survey. The survey revealed that a total of almost 200 million acres of land throughout the world are now receiving the benefits of irrigation. Many acres are being added to this total every month. Every country on the globe is striving to increase its standard of nutrition and its prosperity—a goal which invariably calls for more irrigation. Two countries of the world, strange as it may seem to Americans, India and China, both greatly exceed the United States in the amount of land irrigated. By far the greater portion of their irrigated land, however, is devoted to the growing of basic crops such as rice, one of their principal foods, and a crop which at the same time requires exceedingly large amounts of water.

The following table gives the acreages of lands now being irrigated by the various countries of the world. The figures shown represent the best data currently available to the Bureau and are believed to be reasonably accurate.

Country	*Acres*
Algeria	400, 000
Argentina	2, 000, 000
Australia	1, 000, 000
Brazil	2, 200, 000
British Guiana	100, 000
Canada	1, 000, 000
Ceylon	400, 000
Chile	3, 000, 000
China	47, 500, 000
Colombia	30, 000
Cuba	50, 000
Dominican Republic	20, 000
Egypt	6, 500, 000
France	5, 700, 000
French Indo-China	1, 000, 000
Hawaii	200, 000
India	60, 100, 000
Iraq	4, 000, 000
Italy	4, 900, 000
Japan	7, 600, 000
Java	3, 000, 000
Mexico	5, 700, 000
Morocco	1, 500, 000
New Zealand	250, 000
Peru	2, 400, 000
Philippines	1, 100, 000
Russia	8, 000, 000
Siam	1, 800, 000
South Africa	800, 000
Spain	3, 500, 000
Syria	700, 000
United States (continental)	21, 000, 000

RECLAMATION ALMANAC

It's good news to western water users and others concerned with reclamation activities that in the year which marks a centennial of conservation for the Department of the Interior, the Bureau of Reclamation is going forward with the largest construction program in this agency's 47 years of existence.

When the Interior Department was established 100 years ago on March 3, 1849, only a few people dreamed that some day the West, a barren wilderness, would become an economic fortress for the Nation.

Commissioner of Reclamation Michael W. Straus in announcing the Reclamation program for 1950 said, "The enactment of this fiscal year's appropriation, by far the largest in the history of Reclamation, is not only a vote of confidence in the work of this agency; it is, furthermore, an endorsement of the zeal, courage, and cooperation of you western water users. You have proved your ability to make good on Uncle Sam's investment in western irrigation and hydroelectric power.

"The Reclamation record you have helped write in the past four decades and more is a proud one. The record you'll help make in the next half century is one which will guarantee the good things of life to you and your children."

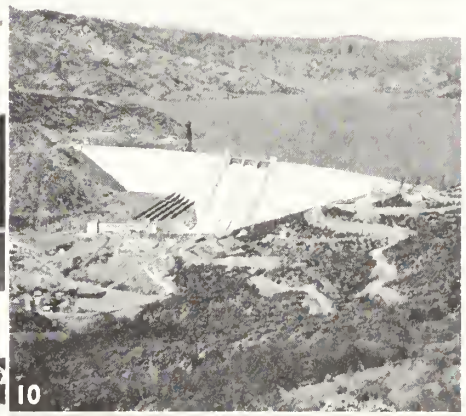
On the accompanying pages, you will find an illustrated conservation calendar depicting a few memorable days in Reclamation history. For those who are sticklers for accuracy, the Salt River project in Arizona was actually approved on March 12, and by March 14, the other four, comprising the "first five" projects had received official approval.

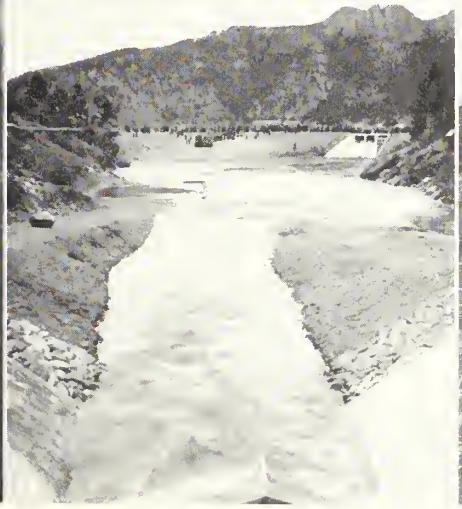
We regret space limitations which prevented us from pictorializing the following red-letter days, and would appreciate your writing in and suggesting additional Almanac Dates for this feature, which we may present from time to time.

April 16, 1906—Congress passes the first Reclamation Power Act, providing that whenever a power development is necessary for the irrigation of lands under a Reclamation project, or an opportunity afforded for a power development on a project, the Secretary of the Interior could lease for a period of not more than 10 years any surplus power or power privilege, with preference given to municipalities, provided the lease would not impair the efficiency of the irrigation project.

June 12, 1906—Texas is brought into the Reclamation program, completing the group of seventeen western States in which Reclamation now operates.

1. JUNE 17, 1902—President Theodore Roosevelt signs The Reclamation Act, inaugurating the reclamation program.
2. MARCH 14, 1903—Five Reclamation projects approved: Salt River, Newlands, Uncompahgre, North Platte, and Milk River.
3. AUGUST 24, 1903—First reclamation construction begins on the Salt River project in the State of Arizona.
4. APRIL 1, 1905—First water flows down a reclamation ditch on Newlands (formerly called Truckee-Carson) project.
5. OCTOBER 1909—First commercial power sale. Delivered from Roosevelt Dam to operate street railway in Phoenix, Ariz.





ARCH 18, 1911—First Reclamation dam, Roosevelt Dam on the Salt River dated by Theodore Roosevelt.

BRUARY 28, 1920—First veteran homestead opening on North Platte project Nebraska-Wyoming by World War I vets.

ECEMBER 13, 1933—Construction begins at Grand Coulee Dam, Wash., world's rgest man-made concrete structure.

SEPTEMBER 30, 1935—President Franklin D. Roosevelt dedicates Hoover (Boulder) an world's tallest dam.

JULY 14, 1944—Shasta Dam completed. Second highest dam in the world 0 feet high) with great power plant.

11. AUGUST 1, 1946—First post-World War II land opening on the Tule Lake Division of the Klamath project, Calif.-Oreg.

12. FEBRUARY 14, 1947—First pay-off party. Tieton Irrigation District, Wash., celebrates completion of repayment contract.

13. JUNE 23, 1947—First water crosses Continental Divide through the Alva B. Adams tunnel, world's longest (for irrigation).

14. SEPTEMBER 5, 1948—Reclamation's easternmost irrigation development, W. C. Austin project, Altus, Okla., is dedicated.

15. MAY 15, 1948—First irrigation water reaches Columbia Basin project at Pasco Unit in State of Washington.

March 9, 1907—Reclamation Service is separated from the United States Geological Survey and becomes an independent agency reporting directly to the Secretary of the Interior.

February 21, 1911—The Warren Act "providing for the disposition of surplus waters and cooperation in irrigation work" becomes law. This Act permits farmers with land outside the project area to purchase from the Bureau of Reclamation surplus water which will not interfere with the water required by the project.

November 24, 1922—The Colorado River Compact is signed by Representatives of the seven Basin States (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming), paving the way for the building of Hoover (Boulder) Dam as well as further development of the Colorado River Basin's resources.

December 5, 1924—The Fact Finders Act, designed to adjust repayment schedules on Reclamation projects so that settlers might be able to meet their indebtedness to the Government is signed.

December 21, 1928—The Boulder Canyon Project Act becomes law. Under this act, Hoover Dam, the world's tallest (726 feet high) dam was built to harness the unruly Colorado River, now producing hydroelectric power up to 1,034,800 kilowatt capacity. In addition the giant All-American canal was built in southern California, and the rich agricultural economy of the Imperial Valley established.

August 4, 1939—The Reclamation Project Act, now one of the basic laws of the reclamation program, is signed by President Franklin D. Roosevelt and becomes law.

December 22, 1944—The Missouri Basin program is authorized as President Franklin D. Roosevelt signs the Flood Control Act of 1944, designed to get the Missouri River Basin project under way—the largest peacetime construction program ever undertaken by the Federal Government and the first Reclamation project embodying the river basin-wide development concept.

May 17, 1946—First construction on Missouri River Basin by Bureau of Reclamation begins at Kortes Dam, Wyoming.

October 11, 1948—Upper Colorado River Basin Compact is signed. This interstate agreement opens the door to use of Colorado River waters for wide-scale development of the Upper Colorado River Basin. •

Don't Kill That Gourd!

IT MAY BE A POTENTIAL GOLD MINE.

This was one of the many findings of the Fourth Annual Texas Chemurgic Conference held at Houston, Tex., on March 4 and 5. (See "Chemurgy—New Uses for Farm Products," by W. Bion Moore in our April 1949 issue.)

Seeds of the cucurbits (gourds and squash) contain 45–55 percent fat and 35 percent protein. They can be roasted and salted like peanuts as a nut delicacy, or they can be processed to salad oils or solid fats that can be hydrogenated to make oleomargarine. By plant breeding, the yield of squash seed can be brought from 100 up to 1,500 pounds per acre. Gourds that farmers often spend time eradicating as a weed, and that grow in arid areas where the rainfall will not support a stand of grass, also contain seeds as high in fat as soybeans and as good in protein as cottonseed. The dried gourds can readily be threshed for seed. Dr. Lawrence C. Curtis of Dallas, Tex., agronomist with the National Cottonseed Products Association, concluded that these gourds deserve consideration as a cash crop although experiments have yet to establish economic justification.

Other findings of the Fourth Annual Texas Chemurgic Conference included these facts:

- Full utilization of pecan hulls is profitable.
- Sawdust and raimie make good livestock feed.
- Alfalfa is already used as a source of vitamins for human consumption. New processes make it possible to extract, in a stable form, the instable vitamin content of alfalfa that is largely lost even when fed to livestock.

The Bureau of Reclamation is watching closely these developments as they may affect the economic feasibility of irrigation projects. Reporting on the conference, Region V's W. Bion Moore stated:

"Whether the future holds shortages or surpluses of farm products, chemurgy will be important in creating a better balance between supply and demand. Whenever a surplus of a specific crop prevails, and it is one of the raw material sources for chemurgic processing, competitive price conditions channel that crop into processing with a higher net price than would prevail otherwise. However, the general impression given at the conference was that the main func-

(Continued on page 160)

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(Date)

THE COMMISSIONER,
Bureau of Reclamation, United States Department of the Interior.
Washington 25, D. C.

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Reclamation's Hall of Fame

Nomination No. 1

ROBERT J. NEWELL
Dean of Regional Directors

by J. LYLE CUNNINGHAM
Assistant Regional Director, Region I,
Boise, Idaho

EDITOR'S NOTE: With this article, we inaugurate a new feature, to be called "Reclamation's Hall of Fame" through which those men and women who have contributed toward the development of western water resources will receive the recognition that is their due. Several nominations have already been received, along with supporting data written in a style suitable for publication in the *Era*. As our number one nomination, it seems particularly fitting to start off with Robert J. Newell, who retired from official reclamation duty June 30, 1949. Send in your nomination. Articles should be no longer than 1,000 words, accompanied by illustrations, and tell the story of the nominee's claim to recognition in "Reclamation's Hall of Fame."

Newell took on an "Abraham Lincoln" type of personality in his later years, both in appearance and philosophy. This is a typical photograph of him, taken in 1946. Photo by Stanley Rasmussen, Region I.

MANY THOUSANDS OF WATER USERS, businessmen, private citizens, and Reclamation employees of the Pacific Northwest who have known and respected Robert J. Newell for most of the past half century enthusiastically combine to nominate this distinguished engineer and administrator for Reclamation's Hall of Fame. In doing so, they consider such an honor fully deserved and a token of the recognition which this outstanding Reclamation leader has truly earned. To them, "Bob" Newell is not only a close and sympathetic friend but also an outstanding public servant meriting maximum praise and everlasting gratitude for unselfish service.

It was back in 1903, only 1 year after President Theodore Roosevelt attached his signature to the Reclamation Act, that "Bob" Newell neatly packed his personal belongings in Iowa and journeyed to the then little publicized State of Idaho. Included in his satchel were a recently awarded diploma certifying to a well-earned degree in engineering from Highland Park College and a notice of appointment to the Reclamation Service. Arriving at what is now the Minidoka project in southern Idaho, "Bob" was assigned to a survey crew, on which served another young fellow named Jack Savage. "Bob" and Jack thus launched careers at modest salaries of $60 per month which were to lead them to well-earned fame and numerous significant accomplishments.

With the exception of the period between 1908 and 1923 during which Newell served on private engineering assignments in Idaho and in China and was engaged in the cattle business in his beloved Boise Valley, this man's full energies have been devoted to the development of the water resources of the Pacific Northwest. He walked the sagebrush lands of southwestern Idaho and eastern Oregon investigating the feasibility of the Owyhee, Vale, and Black Canyon projects; he administered the affairs of these three projects upon their completion; he served as Construction Engineer on the Deadwood Dam in Idaho, the Cle Elum Dam in Washington, and the Owyhee Dam in Oregon; he became Assistant Regional Director when the Bureau of Reclamation was reorganized into regions in 1943; and in 1945, he was named Regional Director, a position from which he chose to retire last June 30. No matter what the job, "Bob" Newell rendered a service which brought distinction to himself and to the organization which he so loyally served.

In order to appreciate fully this man's contributions to the government and to its people, it is necessary to describe some of his unique characteristics. Whether viewing him seated at his desk in the Regional Office in Boise, Idaho, or accompanying him upon an inspection trip of a canal system in Oregon, one is first impressed by the maneuverability of his long, slim legs. Walk into his office, and you see his feet occupying the forepart of the chair and his bushy head framed by the two thin, vertical legs. Go on an inspection trip with him, and his stride along canal banks has, to date, been unequaled by any mechanisms employed by ditchriders.

Perhaps the personal trait above all others for which "Bob" Newell has become endeared to the hearts of those who know him is his unusual method of expression. Known far and wide as a mild-mannered man, always willing to

listen patiently to others, his own remarks consist of a few well-selected words which are filled with meaning. His frequent use of the word "check," indicating his approval or disapproval of the request or proposition presented to him for decision—one is never sure which it is—is as much a part of the Newell personality as are his physical features.

While the comment "so be it" may have an entirely different meaning to many people, those who hear it from "Bob" Newell know that it means, "I'm tired of listening," or "I understand what you mean." But sometimes, words are not even required to convey the Newell reactions. When he looks over the top of his glasses with his eyes intently fixed upon the speaker, he means with no uncertainty, "You'd better check that again," or "You'd better give that some more thought."

As an administrator, "Bob" Newell consistently follows techniques which are not included in any book informing executives how best to manage an organization. Yet his techniques can compete favorably with all others prescribed for effectiveness. He never issues an order as such but has an indirect method of indicating what he wants done and whom he desires to do it. All who work under his supervision hold him in such high respect and are so anxious to carry out his wishes that all they require is an indication from him. This may be in the form of a question he raises or even by a mere nod of the head.

Much more could be told about this "Dean of Regional Directors," as Commissioner Straus often refers to him, all of which would demonstrate his qualifications for a prominent place in Reclamation's Hall of Fame. If there is a single water user with whom he has dealt, a single contractor with whom he has worked out difficult technical problems, a single Congressman who has heard him testify before Senate and House committees, a single resident in his area with whom he has had relationships, or a single employee of the Bureau of Reclamation who has worked with him or for him who is not personally fond of "Bob" Newell and who does not accord him the highest possible respect, he is not known by name.

"R. J." in the sagebrush on the Minidoka project in southern Idaho in 1904—a year after he joined the Reclamation Service.

A "right smart lookin'" young fellow was Bob Newell in his early years. The above photo was taken when "R. J." was 23 years old. Newell looked like the photo at right when he got ready to go to work for the Reclamation Service in Idaho in 1903.

After a period of 46 years since he first enlisted with his Government to provide greater opportunities for the people of the Western States, and with 32 years of active service to his credit, "Bob" Newell has elected to retire from the Bureau of Reclamation. His loss will be keenly felt, but he has justly earned his relaxation.

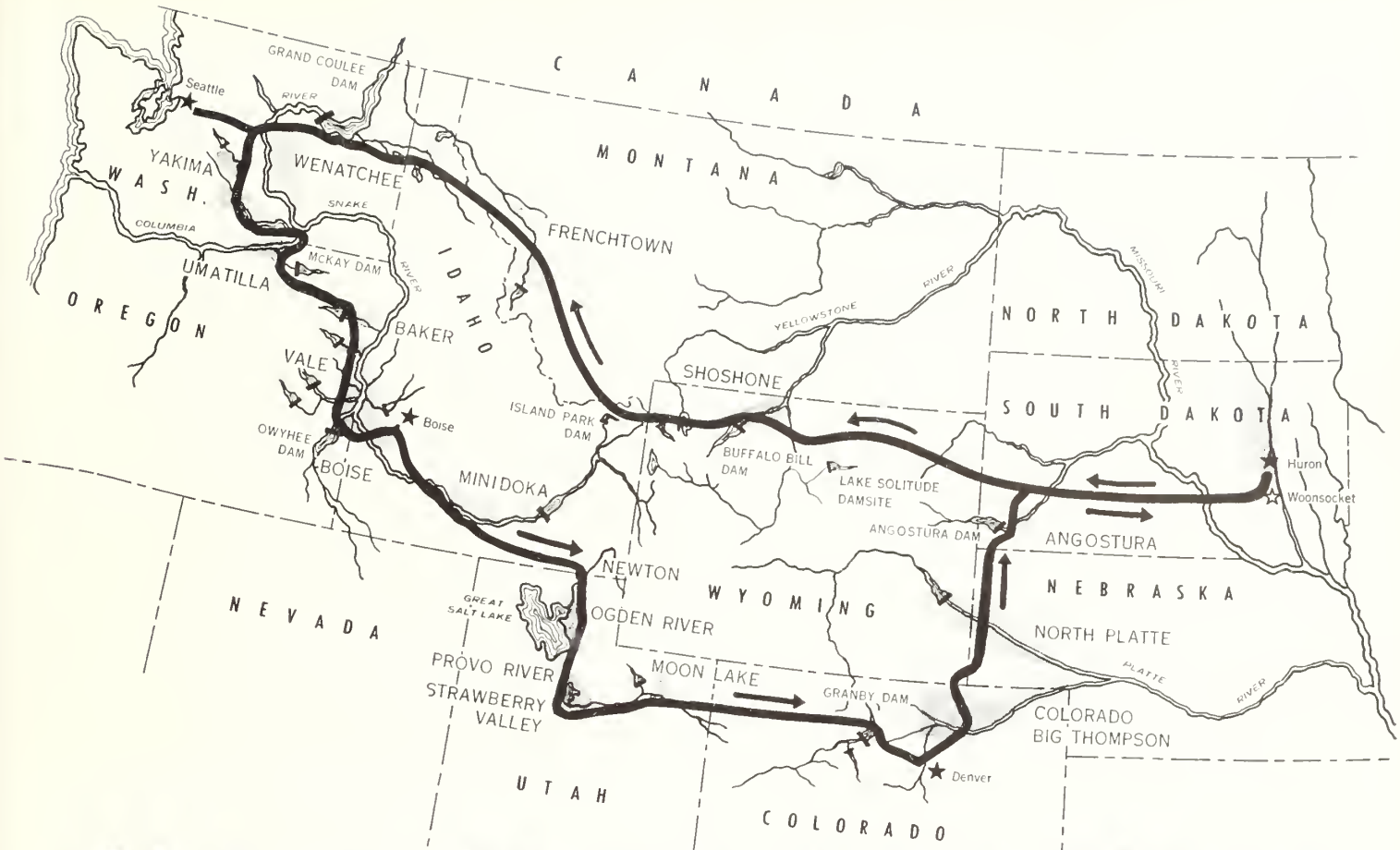
When recently asked the reason for his decision to retire before he had attained compulsory retirement age, he replied in the characteristic Newell manner:

"There are a lot of excellent men about 45 years old or so in the Bureau. They can't go up because there are a lot of us old fellows holding them back. We can either move out through death or retirement. I choose the latter course."

THE END

Culbertson Dam Renamed "Trenton"

Culbertson Dam on the Republican River in the State of Nebraska was renamed "Trenton Dam" by an Act of Congress approved May 12, 1949. In commemoration of the late Carl H. Swanson, attorney for the Frenchman Cambridge Division, the body of water arising behind the dam has been designated "Swanson Lake." Construction is soon to be started on the Frenchman-Cambridge Division of the Missouri River Basin Project. •



IRRIGATION - First Hand

by
FLOYD BEACH,
County Agent, State Agricultural Extension Service, Sanborn County, South Dakota

Far-reaching changes are in store for the James River Valley of South Dakota through the Missouri River Basin project. This plan of development will bring about the irrigation of approximately 750,000 acres of land in this area of the State, and also the production of vast amounts of low-cost power from hydroelectric plants at dams on the main stem of the Missouri River.

Sanborn County, where I am now serving as Agricultural Extension Agent since returning from 3 years of service as a navigator in the Army Air Corps, is located in the heart of this valley. After learning about the proposed irrigation development from Bureau of Reclamation personnel, I was eager to acquaint myself more fully with irrigation practices in order to advise the farmers of my county. My training at the University of Minnesota had not included any irrigation courses and my farm experience, 4-H Club activities, and dairy cattle breeding work did not afford any practical experience for me regarding farming under irrigation. I felt that I needed to familiarize myself with irrigation agriculture and its many opportunities and benefits. Consequently, I asked for a month's leave to visit 23 irrigation projects in 8 Northwestern States in order to prepare myself for the transition which was going to take place in the James River Valley.

During my trek through South Dakota, Wyoming, Montana, Idaho, Washington, Oregon, Utah, Colorado, and Ne-

braska, I observed at first-hand completed irrigation projects, as well as new projects under construction. The numerous farmers and businessmen who were interviewed during this trip seemed unanimous in their praise of the results of irrigation and the benefits of low-cost power.

I was amazed to learn that a farmer could grow 125 bushels of corn and 60 bushels of wheat per acre every year through the control of water by irrigation, while a 35-bushel corn average would be considered excellent production in Sanborn County of South Dakota. Alfalfa yields of 5 to 7 tons to the acre under irrigation speak for themselves as compared with 1 to 2½ tons per acre, such as we have on dry-land in my county. Irrigation farms nearly everywhere produced a bountiful supply of alfalfa hay which resulted in more extensive dairying and livestock feeding. These farming areas showed very substantial pasturage supplied by irrigation water. The thriving towns and cities in the irrigated areas make for a ready market for dairy products.

The irrigation farmer's gross farm crop income ranged from $100 to $300 per acre, and was even more for specialized crops such as sweetcorn, vegetables, clover seed, popcorn, sugar beets, and others. In Utah, the production of honey was a profitable sideline for many farmers and, at the same time, served a desirable purpose whereby the bees assisted the pollination of legumes, fruits, and seed crops. One of the most beautiful parts of this tour was in the Yakima Valley of Washington, during apple-picking time. Beautiful, Delicious apples hung on trees on either side of the highway for miles, and fruit stands selling peaches, pears, and plums were seen everywhere.

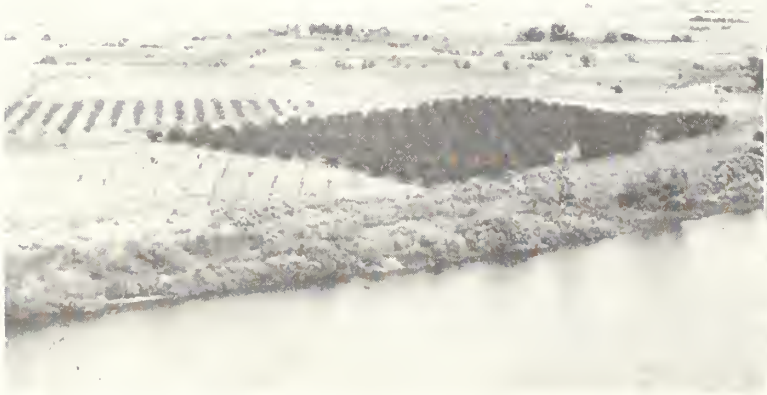
During the course of my trip, I stayed with Mr. Charley McClaskey for a few days on his 80-acre irrigated farm which is near Wilder, in the Boise Valley of Idaho. Mr. McClaskey grew some truck crops, cared for a 9-acre orchard, had 40 acres of alfalfa and red clover, and raised some wheat and corn. As we visited and asked questions one evening, I was amused when Mr. McClaskey doubted that his son-in-law, Gus Miller, could handle and farm an additional 40 acres along with the 80-acre farm he was already operating. This is quite a contrast to our dry-land operations in South Dakota where 400 acres comprise about the average size farm.

Former dry-land farmers who had moved into these irrigated areas expressed their enthusiasm about irrigation farming and would not go back to their former dry-land operations. While talking with a hardware store owner at Greybull, Wyo., I learned that each additional 40 acres under irrigation there meant another farm family to be served, and each new 160 acres under irrigation resulted in two more families in town to handle and process the farm produce brought in. This businessman also pointed out that low-cost power helped to attract many small industries to this area, which also meant more people and more business. It was interesting to note that on nearly all of these irrigation farms there was a plentiful supply of low-cost power. Farm women delighted to show their deep-freezers and other electrical equipment and conveniences, along with the hundreds of quarts of preserved fruits and vegetables which they had raised under irrigation.

"Go to the Dam" For Recreation

On a number of these irrigation projects, a most popular expression in the summertime would be: "Let's go to the dam!" Here the reservoirs were well-stocked with fish and the grounds were desirably set up for picnicking and made especially attractive to the tourist trade, as well as to local patrons and visitors.

After seeing these thriving irrigation projects and talking with both farmers and businessmen in the areas, I concluded that South Dakota, under the Missouri River Basin Development Plan, was definitely on the threshold of a "new golden age"—a promising future of greater farm income, more stabilized agriculture, expanded population, both rural and urban, widespread industrial development, and more attractive and comfortable living. THE END



An irrigated orchard near Yakima, Wash., is green and rich with water—photo at left. At right, sprinkler irrigation is being applied on seedbeds near Salt Lake City, Utah. Photos were taken by the author on his trip through the reclamation area. (Itinerary shown on preceding page.)

Red River Dilemma

by R. L. FRAZEE,

W. C. Austin Project, Okla.

Old-timers living today in the area of the W. C. Austin Reclamation project in southwestern Oklahoma still take sides in frequent and heated discussions of the "Battle of Greer County."

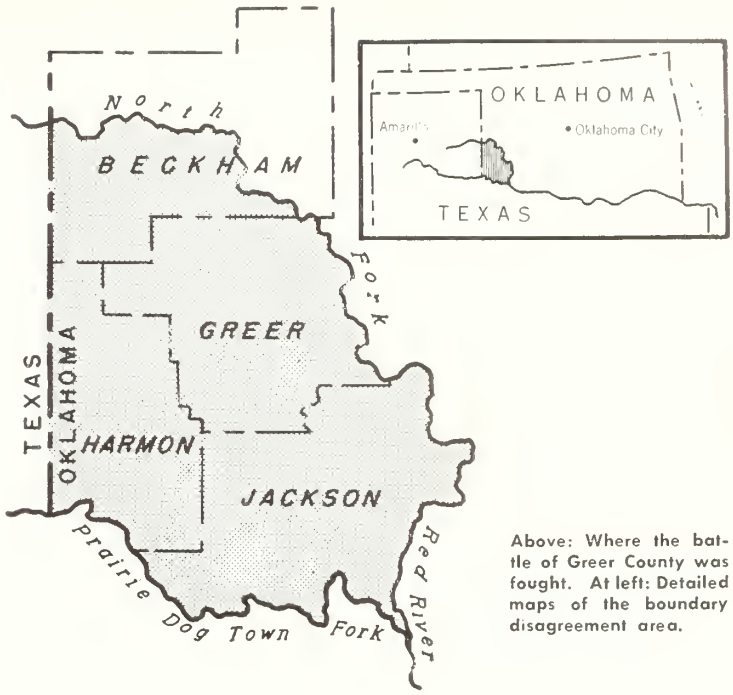
Since the Louisiana Purchase in 1803, the Austin area has belonged to the government of Spain, the Republic of Mexico, the Republic of Texas, the State of Texas, Oklahoma Territory, and the State of Oklahoma. Ownership of this region, twice the size of Rhode Island, was the subject of a long and turbulent dispute between the United States and the Republic of Texas, and later between the States of Oklahoma and Texas.

The fuss all began with the purchase from Spain, when the boundary between the Spanish territory and our newly acquired lands was vague. A treaty in 1819 between Spain and the United States attempted to define the boundary in that region. The north boundary of Spanish territory was defined as following the Red River northwestward to the degree of longitude of one hundred west from London, or 23 west from Washington, and thence north along the one hundredth meridian. This was laid down in Melish's map of the United States which was attached to, and became a part of, the treaty. The map showed the river running in a southeasterly direction, crossing the plains about the present site of Amarillo, Tex. The map did not show two forks in the river.

Later surveys, however, showed that there were two forks to the river, both crossed by the one hundredth meridian, and that the true location of the one hundredth meridian was many miles west of the place shown on the map.

In the meantime, Mexico won her independence from Spain and Texas cut loose from Mexico and became the Republic of Texas. The dispute carried on between the Republic and the United States, Texas claiming the north fork of the Red River as her north boundary and the United States asserting it was the south fork. The second point of argument was the proper location of the true one hundredth meridian. By the time Texas was admitted to the Union in 1845, the wrangle had reached the point of armed clashes.

Several years passed and Texas named the disputed region Greer County, Tex. At that time, however, the Civil War was being fought, and the boundary dispute was shelved for the time.



Above: Where the battle of Greer County was fought. At left: Detailed maps of the boundary disagreement area.

In 1883 when settlers from Texas moved into the area, a detachment of the Ninth Cavalry from Fort Sill was sent to remove them. President Arthur issued a proclamation warning all people against entering and occupying lands in the Indian Territory, of which the United States considered Greer County a part. The wrangling continued. A joint boundary commission was set up but could come to no agreement. Settlers set up a county seat at Mangum and requested and got post offices with Texas addresses. The Post Office Department later discovered the new offices were in disputed territory and changed the addresses to Indian Territory. President Cleveland issued a proclamation warning all people, including the Greer County officials, not to try to buy or sell land or exercise any authority in that area. And then in 1890, the Oklahoma Territory was organized.

That year, a long and bitterly fought court action known as the *Greer County case* ended the dispute when the United States Supreme Court ruled that the south fork of the Red River was the south boundary of Oklahoma. Greer County Texans now found themselves in Greer County, Okla., Territory, with the true one hundredth meridian still not officially located. When Oklahoma became a State in 1907, old Greer County was divided into the counties of Greer, Harmon, Jackson, and a part of Beckham. In 1930 the one hundredth meridian was finally definitely established, further complicating the lives of a few settlers who again found themselves back in Texas. Now, although the question is legally settled, people in the region still air their views on the long, drawn out dispute.

Greer County is a fertile valley, but the settlers were plagued for years by droughts which respected neither the sovereignty of Oklahoma nor Texas. In 1940, the Bureau of Reclamation began work on the W. C. Austin Reclamation project. A dam was built across the north fork of the much disputed Red River, and water is now provided for some 50,000 acres. THE END

Strawberry Valley

In addition to one of his regular monthly project reports, Robert E. Huber, secretary, Strawberry Water Users' Association, submitted this interesting and enjoyable report of progress at the Strawberry Valley project. It serves to inject a note of philosophy and humor into the serious business of reclamation work. See back cover for illustrations.

1. Operation and Maintenance of Irrigation System

And that ye may prolong your days in the land, which the Lord swear unto your fathers to give unto them and to their seed, a land that floweth with milk and honey.

For the land, whither thou goest in to possess it, is not as the land of Egypt, from whence ye came out, where thou sowedst thy seed, and wateredst it with thy foot, as a garden of herbs; but the land whither ye go to possess it is a land of hills and valleys, and drinketh water of the rain of heaven. Deu. 11: 9–11.

2. Crops, Livestock, and Marketing

Isreal then shall dwell in safety alone: the fountain of Jacob shall be upon a land of corn and wine; also his heavens shall drop down dew. Deu. 33: 28.

And Laban went to shear his sheep; and Rachel had stolen the images that were her father's. Gen. 31: 19.

3. Settlement of Farms; Community and Industrial Development

He that tilleth his land shall be satisfied with bread: but he that followeth vain persons is void of understanding. Wealth gotten by vanity shall be diminished: but he that gathereth by labour shall increase. Love not sleep, lest thou come to poverty; open thine eyes, and thou shalt be satisfied with bread. Prov. 12: 11; 13: 11; 20: 13.

4. Weather and Water Supply

And it shall come to pass, if ye shall hearken diligently unto my commandments which I command you this day, to love the Lord your God, and to serve him with all your heart and with all your soul, that I will give you the rain of your land in his due season, the first rain and the latter rain, that thou mayest gather in thy corn, and the wine, and thine oil. Deu. 11: 13–14.

5. Labor Conditions

A certain man planted a vineyard, and set an hedge about it, and digged a place for the winevat, and built a tower, and let it out to husbandmen, and went into a far country. And at the season he sent to the husbandmen a servant, that he might receive from the husbandmen of the fruit of the vineyard. And they caught him and beat him, and sent him away empty. St. Mark 12: 1–3.

6. Activities of Water Users Organizations

15. But now bring me a minsterel. And it came to pass when the minsterel played, that the hand of the Lord came upon him. 16. And he said, "Thus saith the Lord, Make this valley full of ditches." 17. For thus saith the Lord, "Ye shall not see wind, neither shall ye see rain; yet that valley shall be filled with water, that ye may eat and drink, both ye, and your cattle, and your beasts." II Kings 4: 15–17.

7. Personnel (including guards for structures) and Visitors

And he lift up his eyes and looked, and, Lo, three men stood by him; and when he saw them, he ran to meet them from the tent door, and bowed himself toward the ground and said, "My Lord, if now I have found favour in thy sight, pass not away, I pray thee, from thy servant." Gen. 18: 2–3.

8. Future Work and Miscellaneous Items of Interest

In the sweat of thy face shalt thou eat bread, till thou return unto the ground; for out of it wast thou taken; for dust thou art, and unto dust thou shalt return. Gen. 4: 19.

The Last Time Elliot Paul Saw Trembles

Old-timers, and those who like to collect early reclamation lore, might like to know that Elliot Paul, author of "The Last Time I Saw Paris," to mention only one of his literary efforts, was once an employee of the Bureau of Reclamation and has written about his experiences in his latest book, "Ghost Town on the Yellowstone."

The town of Trembles (named for the trembling aspens beside which it was founded) is the locale, close by Glendive and Mondak, not far from the spot where the Yellowstone and Missouri meet. The time is 1907–08. Among the notables mentioned are Frank Banks, as an automobile enthusiast, in an episode involving a cage of circus lions; Worthington T. Stackpole, then consulting engineer on the project, featuring in one of the last trips of the stern-wheeler *Expansion*, captained by Grant Marsh; Frank E. Weymouth, project engineer; Scotty McVeigh; and the author's brother, Charles Paul. Although this is in no way a Bureau of Reclamation publication, we believe it deserves mention as an account of construction days and attempts at early settlement in northeastern Montana, which may be of interest to reclamationists. •

Two-Way Radio Rescue at Gila

A two-way FM radio system, installed by the Bureau of Reclamation to assist in water control work, was instrumental recently in the rescue of two women from a mesa canal on the Gila project.

The two women apparently lost control of their car while approaching Yuma from the east. The car ran off the highway and plunged into the canal in about 9 feet of water. The automobile sank immediately, lodged against and jammed a control gate in the canal.

Two unidentified men helped remove the women from the car, while another Bureau of Reclamation employee radioed for assistance. In less than 30 minutes, a wrecker summoned by the radio had arrived and removed the car from the canal, restoring the canal gate to use. Neither of the women was injured in the mishap. •

Assistant Secretary William E. Warne Photographs Gila

On a recent inspection tour of the Department of the Interior's activities, Assistant Secretary W. E. Warne spent a day at the Gila project. The Assistant Secretary made a number of photographs of the project, which show more clearly than words the outstanding work that has been accomplished by some of the settlers on this project. The black and white pictures below were reproduced from kodachromes for publication.

At left: PROOF OF PRODUCTIVITY—the first spring cutting of alfalfa on one of the homesteads of the Gila project. The land produces about one ton to the acre with usually five or six cuttings per year.

At right: INDICATION OF INGENUITY—an attractive home built by one of the Gila homesteaders from the equivalent of two 20- by 100-foot barracks alloted each settler from the old Yuma Army Air Base 1½ miles away.

Advice to Homesteaders

From among the many letters we receive, we publish extracts from a heart-warming communication from John C. Goodrich, Santa Rosa, Calif., a long-time subscriber of the Reclamation Era:

Homesteading is tough business at times, but there's real satisfaction in it. And there's more of that satisfaction today than in the days when I homesteaded. You play on a team today, which pulls together to make a go of these frontier lands.

New homesteaders now will find the Bureau of Reclamation working right alongside them. Homesteaders have got to pay their share, but it's a satisfying reward we get. I say it's a privilege to develop and help pay for these new lands.

What a job the long range irrigation program of the Bureau of Reclamation is! The people in the Bureau are helping us to improve our homesteads and produce food. And it's not only their job—it's our job too. The homesteader has got to do his part, and I think he knows it. It's a wonderful opportunity for him and a challenge and an inspiration to take a plot of ground and make it grow into a home and productive farm. We need more homes and productive farms for our ex-servicemen.

Homesteading wasn't forced on me. It was something I wanted to do. I homesteaded in April 1929 at Tule Lake, Calif., where in the fall of 1938 oats were $3 a sack. In 1939 they were 70 cents a sack and it cost me 80 cents to harvest and deliver them at the mill. It was like that or worse for years. So failures were not always the result of cotton-string spines saturated with sardine oil.

The homesteads abandoned during those years were like a blight on the reclamation project. My first thought when seeing an abandoned homestead then was, "How unfortunate the settler is who attempts to homestead without first summarizing the cost." My thought is still that. But you won't see abandoned homesteads today as you did then because of the help the homesteader gets. I thank the Bureau of Reclamation people.

If a homesteader has a chance at all, he'll work till he not only has gray hair but till he's black and blue all over. I've gritted my teeth and said, "This is my homestead. I have a traditional moral mortgage (and I'm proud of those words) which as an American homesteader I can cancel only after my last effort."

Now, the program has grown, the frontiers have lengthened, and homesteaders today have much to be grateful for. As an old homesteader I wish I could tell those coming to homestead to make the most of their Government-sponsored opportunity. I wish I could say to them, "Know your costs, know how you will pay them, be happy to pay them, and give thanks for your home and fireside." •

Don't Kill That Gourd!

(Continued from page 152)

tion of chemurgy would be to relieve the deficiencies in food supplies that have prevailed in most countries of the world for many years.

"In future years chemurgy may be the principal means of increasing the net per acre production of food nutrients. One means appears to be synthetic production of protein from carbohydrates, a process now used in Jamaica, which will release considerable acreage now devoted to stock feed production and usable for other crops. Another is direct production of vitamin-bearing human food from alfalfa or other cereal grasses. The latter process involves a major irrigated crop and may be important to our Reclamation program in future years. The synthetic protein process requires carbohydrates as a raw material and it seems logical that maximum crop yields per acre would be attained under irrigation. Consequently it appears that both chemurgy and irrigation will be significant in progress made toward solution of the problem of providing a food supply for the people of the world.

"Chemurgy may create a new activity for the Bureau of Reclamation, namely irrigation projects in humid areas on the Gulf coast designed entirely for production of the algae chlorella. A recent magazine article told of the synthetic production of protein from carbohydrates (which was referred to in Mr. Houston's paper), in which it was pointed out that a possible source of maximum efficiency production of the carbohydrates would be by growing chlorella under water in tanks." •

Corrections and Additions

In the June issue of the Reclamation Era, E. A. McCloud was listed as a Region II photographer. He is now stationed at the Hungry Horse project as photographer in Region I.

We are happy to announce the correction on Merle L. Tillery, author of "The Agency Plains Special" in the June issue. At the time we received the article, his title was Acting Chief of the Land Use and Settlement Division, Region I. He is now Chief of the Division.

The artist's conception of Platoro Dam which accompanied the article "Platoro Dam—the Little Giant" in the May issue was drawn by W. H. Willson, Office of the Chief Engineer, Denver. •

OUR FRONT COVER

A World War II veteran leans on his irrigation shovel and looks proudly over his freshly leveled land as he rests for a moment on the Fourth of July holiday and realizes his dream of war days—to own his own farm— has come true. The soldier-returned-to-the-soil is represented by Jack Cline, formerly a torpedo officer on the submarine forces, who farmed on the Roza Division of the Yakima project in eastern Washington. Photo by Stanley Rasmussen, Region I.

Send-Off for Shasta Dam Special

The Shasta Dam Special of the Southern Pacific Railroad recently made its last passenger run over the tracks to Shasta Dam.

The tracks which now run through a slot in the Keswick Dam will soon be relocated as construction progresses. The roadbed between Keswick and Shasta Dams will be covered by the waters impounded by Keswick Dam. The present site of the railroad tracks will be flooded when Keswick Dam is completed.

Passengers on the last run of the special train were members of the California Legislature who made a 1-day inspection tour of Keswick and Shasta Dams, power houses and facilities. •

Gold Key Starts Coulee's Tenth Generator

The tenth main generator at Grand Coulee Dam was placed in commercial service recently when President Truman pressed a gold key at the White House. An electrical impulse from the key was telegraphed 3,000 miles to set the machinery in motion.

With the new generator on the line, Grand Coulee now has a rated power capacity of 1,100,000 kilowatts, the largest rated power-producing capacity of any plant in the world.

Installation of the tenth main generator places the power development aspect of the huge multiple-purpose Columbia Basin project past the halfway mark. The power plant is being equipped with 18 generators which will drive the world's biggest irrigation pumps. Twelve of these pumps will lift Columbia river water into a reservoir 280 feet above Lake Franklin D. Roosevelt so that it can flow by gravity across the project lands. Each pump will deliver 720,000 gallons of water per minute, enough to irrigate 100,000 acres of land. Eighty-seven thousand acres of land to be irrigated with Grand Coulee water is scheduled to become available in the spring of 1952. •

U. S. GOVERNMENT PRINTING OFFICE: 1949

NOTES FOR CONTRACTORS

Contracts Awarded During May 1949

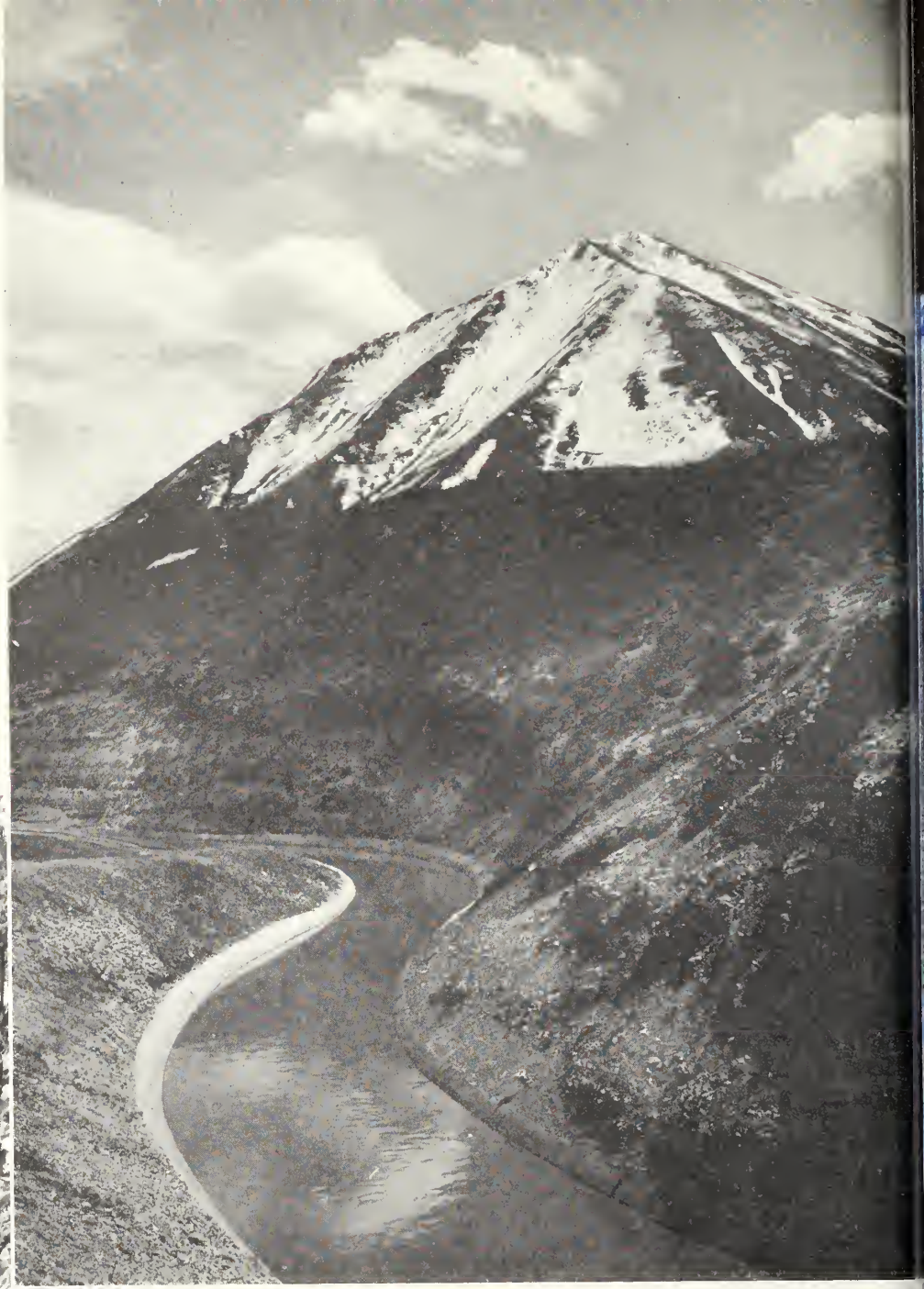
Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2537	Davis Dam, Ariz.-Nev	May 10	300 trash racks for intake structure at Davis power plant	Industrial Tubular Equipment Co., North Hollywood, Calif.	$76,770
2538	do	May 20	Furnishing and installing equipment and constructing 15,000-kilovolt-ampere Blythe substation.	Del Monte Electric Co., Oakland, Calif	209,563
2551	Colo.-Big Thompson, Colo	do	Construction of Flatiron-Greeley 115-kilovolt transmission line, schedule 1	J and J Construction Co., Oklahoma City, Okla.	233,942
2554	do	May 5	Completion of Granby pump canal	Granby Constructors, Colorado Springs, Colo	304,750
2560	Gila, Ariz	May 13	One 30-ton traveling crane for Wellton-Mohawk pumping plant 2, item 1	Crane Hoist Engineering Corp., Bell, Calif	14,870
2560	do	do	One 25-ton traveling crane for Wellton-Mohawk pumping plant 3, item 2	Craneveyor Corp., Los Angeles, Calif	13,843
2572	San Luis Valley, Colo	May 5	One 4- by 5-foot high-pressure gate and one 110,000-pound hydraulic hoist for Platoro Dam outlet works.	Albina Engine & Machine Works, Inc., Portland, Oreg.	14,224
2573	Davis Dam, Ariz.-Nev	May 10	Eight 15,000-volt circuit breakers and three 220,000-volt and six 13,800-volt lightning arresters for Coolidge substation, schedules 2 and 4.	General Electric Co., Denver, Colo	103,387
2575	do	May 18	Three 27,500-kilovolt-ampere autotransformers with lightning arresters, and 10 current transformers for Coolidge substation, schedules 1 and 5.	Westinghouse Electric Corporation, Denver, Colo.	391,533
2577	Missouri River Basin, Mont	May 13	Three 13-foot 6-inch diameter penstocks, one 13-foot diameter pumping intake for Canyon Ferry Dam, schedule 1.	Pacific Coast Engineering Co., Alameda, Calif.	108,590
2577	do	do	Four outlet conduit liners for Canyon Ferry Dam, schedule 2	Gunderson Bros. Engineering Corporation, Portland, Oreg.	15,168
2587	Central Valley, Calif	May 31	Construction of 230-kilovolt transmission lines, tap line from Shasta-Tracy line No. 1 to Pacific Gas & Electric Co. Shasta substation, and wood-pole section of Shasta-Tracy line No. 1.	Petersen Engineering Co., San Francisco, Calif.	68,862
2589	Hungry Horse, Mont	May 24	One lot of pipe, appurtenances, and stilling-well liner for Hungry Horse Dam, item 1.	Hydraulic Supply Manufacturing Co., Seattle, Wash.	24,978
2593	Central Valley, Calif	May 5	Materials for control cable duct and cable trays for Tracy pumping plant	Golden Gate Iron Works, Inc., San Francisco, Calif.	21,395
2594	San Luis Valley, Colo	do	Construction of Platoro Dam	Hinman Bros Construction Co., Fort Collins, Colo.	2,727,792
2595	Missouri River Basin, Bostwick Unit, Nebr.-Kans.	May 2	Two 20- by 12-foot radial gates and six 5,000-pound and two 10,000-pound radial-gate hoists for Superior-Courtland diversion dam, items 2, 3, and 4.	United Engineering Co., San Francisco, Calif	12,470
2596	Lewiston Orchards, Idaho	May 27	Construction of filter house, coagulation and sedimentation basin, influent and effluent pipe lines, sewage disposal facilities, and appurtenant work for Lewiston Orchards water treatment plant, schedule 2.	J. F. Konen Construction Co., Lewiston, Idaho.	176,362
2598	Missouri River Basin, Bostwick Unit, Nebr.-Kans.	May 26	Construction of earthwork, canal lining, and structures, for Superior canal, Pawnee Lake wasteway, channel changes, and intercepting drains.	Knisley-Moore Co., Douglas, Wyo	597,615
2603	Columbia Basin, Wash	May 20	Construction of earthwork, concrete lining, and structures for East low canal and Rocky Coulee wasteway.	J. A. Terteling & Sons, Inc., Boise, Idaho	8,029,762
2612	Missouri River Basin, Wyo	May 19	Fabricated structural steel for switchyard at Kortes power plant	International Derrick & Equipment Co., Torrance, Calif.	13,358
2613	Colo.-Big Thompson, Colo	May 20	Construction of earthwork, concrete lining, and structures for Horsetooth Feeder canal, and access road.	Western Paving Construction Co., Denver, Colo.	2,369,654
2614	Deschutes, Oreg	May 24	Repair of Ochoco Dam	Dragline Rentals Co., Long Beach, Calif.	573,545
2617	Gila, Ariz	May 3	Ten 72-inch diameter flap gates for pumping plants 1, 2, and 3, Wellton-Mohawk canal.	Columbia Machine Works, Berkeley, Calif.	33,955
2621	Missouri River Basin, Wyo	May 13	One penstock and outlet pipe assembly and one 66-inch diameter outlet pipe for Boysen power plant.	Pacific Coast Engineering Co., Alameda, Calif	176,680
2623	Columbia Basin, Wash	May 12	Ten 12-inch jet pumps for units R1 to R9, Grand Coulee power plant	do	15,200
2629	Missouri River Basin, Wyo	May 24	Pipe, fittings, and valves for Kortes power plant	R. L. Spitzley Heating Co., Detroit, Mich.	34,141
2639	Missouri River Basin, S. Dak	May 9	20,000 barrels of bulk portland cement for construction of Angostura Dam	Ideal Cement Co., Denver, Colo	53,000
R1-40	Palisades, Idaho	May 13	Construction of Goshen-Palisades 115- and 44-kilovolt transmission lines	Darnell Construction Co., and Askevold Construction Co., Missoula, Mont.	558,96
R2-53	Central Valley, Calif	May 26	300,000 gallon welded steel water tank, Shasta Dam	Pittsburgh-Des Moines Steel Co., Santa Clara, Calif.	15,330
R3-B6	Boulder Canyon, Ariz.-Calif.-Nev.	May 16	Automatic sprinkler system for park, Boulder City, Nev	Byron W. Taylor, Los Angeles, Calif	12,400
R3-P4	Parker Dam Power, Ariz	May 10	Sandblasting and enameling five 50-foot by 50-foot gates, Parker Dam Spillway.	Rust-Proofing, Inc., Phoenix, Ariz.	43,125
VII-55	Missouri River Basin, Colo.-Kans	May 3	Construction of residence, combination garage and testing laboratory, pump house, water supply system and utilities, Bonny Dam field office.	Northwest Realty Co., Alliance, Nebr	28,589

Construction and Supplies for Which Bids Will Be Requested by September 1949

Project	Description of work or material
Boise, Idaho	Relocation of the remaining 13.6 miles of county road at Cascade Reservoir including construction of 2 bridges, about 16 miles northwest of Cascade, Idaho
Boulder Canyon, Ariz.-Nev	Processing of sand and gravel for concrete aggregate at Boulder City, Nev.
Central Valley, Calif	Construction of a 26-mile long concrete pipe distribution system from the Friant-Kern Canal to supply the Southern San Joaquin municipal utility district near Delano, Calif.
Do	Construction of 18 miles of double-circuit and 54 miles of single-circuit, 230-kilovolt steel-tower transmission line between Elverta and Tracy, Calif.; and stringing single-circuit conductor and overhead ground wire on 57 miles of 230-kilovolt transmission line between Orville and Elverta, Calif.
Do	Erecting steel structures, placing concrete and installing electrical equipment for Tracy Switchyard at Tracy, Calif.
Do	Furnishing and erecting 30 residences, and constructing streets, walks, and utilities at Delano, Calif.
Colo.-Big Thompson, Colo	Construction of 68 miles of 115-kilovolt wood-pole transmission between Oak Creek and Green Mountain, Colo.
Colorado River Front Work and Levee System, Calif.-Nev.-Ariz.	Construction of steel warehouse building at Needles, Calif.
Do	Construction of four 3-bedroom houses at Needles, Calif.
Columbia Basin, Wash	Three 12-cylinder carbon-dioxide fire-extinguishing systems for protection of oil storage room and 65,000-horsepower motors at Grand Coulee pumping plant.
Do	Centrifugal-type and propeller-type fans, multiple-louver dampers, registers, grilles, air diffusers, and air filters for Grand Coulee power plant.
Do	Two 59.5 cubic feet per second and two 64 cubic feet per second vertical centrifugal pumps for Quincy pumping plant.
Columbia Basin, Wash	Motor-driven centrifugal-type and propeller-type fans, air filters, electric space heaters, electric hot water heating system, and air conditioning system with mechanical refrigerant condensing unit for Grand Coulee pumping plant.
Davis Dam, Ariz.-Nev	Construction of reinforced concrete condenser building, placing of transformer and steel tower foundations, and erection of steel structures at Tucson substation, Tucson, Ariz.
Do	Erection of steel structures for substation at Prescott, Ariz.
Hungry Horse, Mont	Fabricated structural steel for transformer circuit take-off structure at Hungry Horse power plant.
Do	Crane runway and conductor angles for Hungry Horse power plant.
Do	Four 13.5- by 18.93-foot penstock fixed-wheel gates for Hungry Horse Dam.
Do	Three 96-inch ring-follower gate-hoist controls for Hungry Horse Dam.
Missouri River Basin, Mont	Construction of Moorhead Dam, an earthfill structure 190 feet high and 3,250 feet long at the crest, located on the Powder River in Powder River County, Mont., 2.5 miles north of the Wyoming State line.
Missouri River Basin, S. Dak	Construction of a permanent residence, garage, pump and generator building; extension of access road and utilities; and erection of steel warehouse for Shadehill Dam Government Camp about 13 miles south of Lemmon, S. Dak.
Do	Erection of two 7-stall prefabricated steel garages and chain link fence enclosure for Shadehill Dam Government Camp at Lemmon, S. Dak.
Do	One 6- by 6-foot CI slide gate, one 100,000-pound hydraulically operated hoist, and one 10,000-pound semiautomatic gate hanger for Shadehill Dam.
Missouri River Basin, Wyo	Construction of Keyhole Dam, an earth-fill structure 100 feet high and 3,300 feet long at the crest, located on the Belle Fourche River in Crook County, Wyo.
Ogden River, Utah	Furnishing and installing a venturi meter in Ogden Canyon near Ogden, Utah.

Strawberry Valley

The Strawberry Valley is as picturesque and colorful as its name. At right, a view of the Spanish Peak & High Line canal, which well illustrates the "land that floweth with milk and honey." Below, a worker picks "the fruit of the vineyard" (?)—apples. Lower right corner, a steel mill at Provo, Utah, where "in the sweat of their faces," people of the Valley contribute to the industrial growth of their region. Photos by Ben Glaha, Region II. (See story on p. 158.)



The Reclamation ERA

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Water where it's needed

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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' association.

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WATER! Where It's Needed

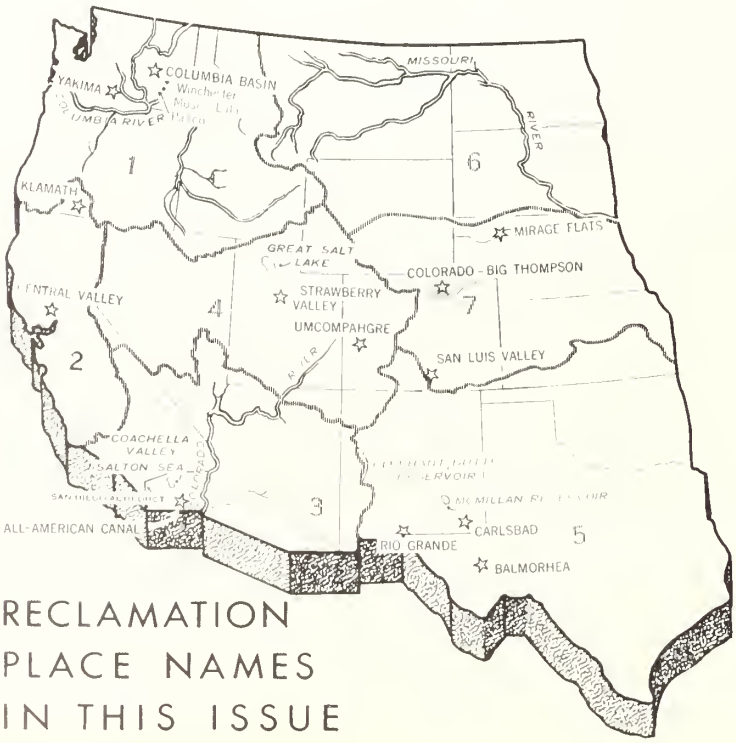
From cover to cover this issue of the RECLAMATION ER is devoted to topics directly concerned with the problem o western water conservation, which means saving and usin every drop of water in the Western States for the benefi of its people and the people of the United States.

This has been our objective ever since the Congress o the United States recognized the importance of wester water resource development and enacted the Reclamatio Act of June 17, 1902, into the law of the land.

We have built the dams, canals, and other structures whic made possible greater use of western waters, and in thes pages leading authorities tell what has been done and re mains to be done to use that water wisely—a matter of in creasingly vital importance to the agricultural and industria development of the West.

On the front cover we have Kenneth Hampton, Worl War II veteran and manager of the Bureau of Reclamation' Moses Lake development farm (see story on p. 185 personi fication of "water is life," as in the midst of his scientifi farming duties he pauses for a moment to quench his thirs at the pump discharge pipe on the irrigation canal. Phot by F. B. Pomeroy, Region I.

On the back cover is represented one of the end product of western water resource development—a thriving sugar beet industry with the productive Twin Falls, Idaho, irri gated area in the background. Photo by Stanley Rasmussen also of Region I.



RECLAMATION PLACE NAMES IN THIS ISSUE

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J. A. Krug, Secretary

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REGION VI: K. F. Vernon, Regional Director, P. O. Box 2130, Billings, Mont.
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CONSERVATION (Full Utilization) of Water

by MICHAEL W. STRAUS, Commissioner of Reclamation

For years, the Bureau of Reclamation has not only been aware of the need for, but has been intensively working toward, full utilization of water supplies throughout the West. As both land and water resources become more fully developed, it is necessary to examine more and more critically the planning, design, construction, and operation and maintenance of water storage and distribution systems.

Full utilization of land and water resources is no one-step enterprise. An adequate Bureau program must begin on the mountain watershed, where the rain falls and the winter snow collects, and follow through to the farms on the last irrigation ditch, far down the valley. Successive steps are:

(*a*) Soil and moisture conservation beginning on the watershed and continuing through project areas;
(*b*) Storage in multiple purpose reservoirs;
(*c*) Control of transmission losses;
(*d*) Sprinkler irrigation;
(*e*) Better irrigation practices on the farm;
(*f*) Control of weeds;
(*g*) Reuse of return flows;
(*h*) Transmountain diversions; and
(*i*) New sources of supply.

The following paragraphs illustrate the steps the Bureau of Reclamation is taking in these directions:

a. Soil and Moisture Conservation.—An important phase of complete and proper utilization of our water supply is covered by the soil and moisture conservation program. The Bureau program is now active in all its regions. Outstanding work is being done in preventing loss of water by the salt cedar growth at the head of the McMillan Reservoir of the Carlsbad project on the Pecos River in New Mexico.

b. Multiple-use Storage.—Storage has, of course, long been a major job. Now, however, we are designing our storage reservoirs to serve many uses, irrigation, power, flood control, recreation, fish and wildlife, sediment and salinity control, and navigation. We are also building regulating and re-regulating reservoirs where they will permit fuller use of water and minimize losses.

c. Control of Transmission Losses.—Seepage from unlined canals and laterals result both in serious loss of water and in waterlogging of adjacent crop land. The Bureau is making a threefold attack on this problem.

1. Rehabilitation and Betterment.—After a thorough survey of the conditions on existing projects, the Bureau asked for and received a moderate sum for use in fiscal year 1949 for the rehabilitation and betterment of several of the older projects. One of the major aims of this project is the conservation of water. Under the program, canals and laterals are being lined.
2. Lower-cost Canal Lining.—In June 1946, a program was initiated to develop and test various types, materials, and placement methods for lower-cost canal and lateral linings under actual field conditions. Both of these programs have been beset by fund difficulties, but are being revitalized for the fiscal year 1950.
3. Pipe Distribution.—Pipe distribution systems have been or are being installed on the Coachella

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THE BIGGEST THING ON EARTH—Grand Coulee Dam in the State of Washington—the key feature in a mightly multiple purpose project. Once the water has been caught and tamed, it must be put in harness, where it will work for the benefit of all our people.

SALT WATER DISTILLATION

by OSCAR L. CHAPMAN

Undersecretary of the Interior

"WATER, WATER, EVERYWHERE, NOR ANY DROP TO DRINK."

Those famous words from "The Rime of the Ancient Mariner" can be applied to all of the world's vast oceans, as well as to some of our large inland lakes, such as Great Salt Lake in Utah, and Salton Sea in southern California.

But those words were written by Samuel Coleridge 150 years ago, and the world has progressed immeasurably since that time. For a number of years, for example, some of our leading chemical companies have been extracting magnesium and other elements from sea water in huge plants built especially for that purpose on both the Atlantic and Gulf coasts.

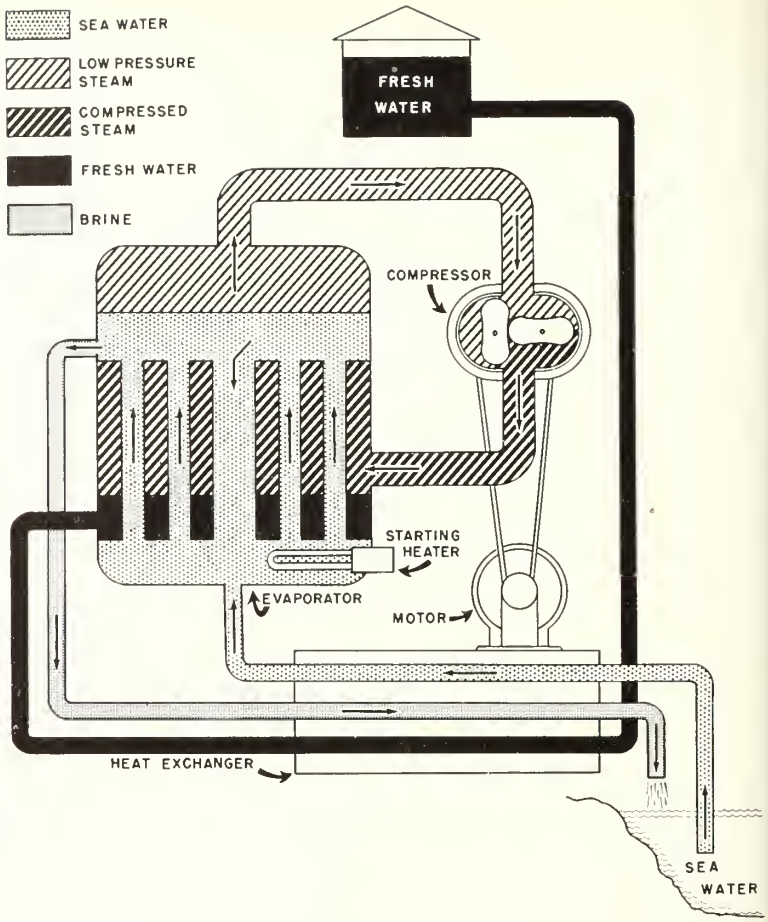
Will the next big development in connection with this great natural resource of the oceans lapping at our shores be through distillation or rectification of the oceans' unfit-to-drink waters to obtain fresh water supplies at costs low enough and in quantities large enough for domestic, industrial, and perhaps even irrigation use? A growing number of far-seeing persons believe that it is more than a possibility.

Water shortages are acute in many areas of the West today. Hundreds of thousands of acres of irrigated land are being kept in production only through serious overpumping of the existing ground water. Pumping for irrigation in some of the most highly productive areas in California, Arizona, and New Mexico during the past few years has been at rates more than double the safe yields as estimated by the Geological Survey. The same situation exists to a lesser degree in other of the Western States.

Between 1940 and 1947, the Los Angeles, San Diego, and San Francisco-Oakland metropolitan areas of California increased in population from 4,265,000 to 6,380,000. Estimates forecast a population of 8,250,000 for those three areas in 1960. In case of another national emergency, the need for additional domestic and industrial water supplies in those and other western cities would be immediate and pressing.

The present total annual use of water in California is approximately 15,000,000 acre-feet, of which 2,250,000 acre-feet are for domestic and industrial purposes. Requirements for the estimated 1975 population of that State will total 26,000,000 acre-feet, of which 4,000,000 acre-feet will be for domestic and industrial uses. This would mean complete use of California's water resources and would clap a ceiling on the State's growth of population, industry, and agriculture.

There are four ways in which additional supplies for consumptive use may be provided to water shortage areas. The first, and for many areas the most important, is through conservation of the presently available supplies. This includes more efficient use of water, reduction of losses, and greater re-use of irrigation, drainage, and industrial waste waters and sewage effluents. The second is through diversions from areas having an excess water supply, such as that involved in the transfer of water from west of the Continental Divide for use in eastern Colorado through construction of the Colorado-Big Thompson project.



FRESH WATER FROM SEA WATER. This diagram shows compression distillation of sea water. Raw water enters by way of heat exchanger which extracts heat from outgoing distillate and brine to heat the feed water coming in, which then goes to the evaporator. Steam at atmospheric pressure goes to the compressor, which raises steam pressure to about 3 pounds per square inch, thus raising its saturation temperature to about 222° F. Circulation in evaporator causes boiling and evaporation of brine and condensation of the compressed steam, which then passes to the heat exchanger where it is cooled and discharged from the system as fresh water. Diagram based on drawing appearing in Mechanical Engineering, March 1946. Permission to reproduce granted by the editors.

The Bureau of Reclamation, by congressional direction, is also now investigating the possibility of diverting and transporting to California a part of the 150 million acre feet of water of the Columbia River Basin that now pours into the Pacific Ocean each year. This may or may not prove to be feasible from engineering and economic standpoints.

The third, and a rather dubious, possibility is through induction of rainfall artificially.

The fourth is through distillation or other purification of salt water. One of the principal advantages of this fourth possibility is that of having an unlimited, inexhaustible

source of water supply. The Pacific Ocean has been envisioned by some writers as the West's "last water hole."

The distillation of fresh water from salt water in fairly large quantities (in comparison with laboratory operations) has long been a common practice aboard ship, both to obtain boiler feed water and water for personal use. At the beginning of World War II, the Navy Department took the lead in urging manufacturers to greater research activities, not only in connection with stills for shipboard use, but also for the development of distillation units that could be set up ashore. These units were intended particularly for use on South Pacific Islands where it was expected that there would be very short supplies of surface or underground water for use of United States troops.

The units that were most efficient at that time were capable of producing 250 gallons of fresh water per hour through fuel consumption of approximately 10 to 12 gallons of Diesel oil. Within the past 6 years, developmental research has been continued on a small scale and today several companies in the United States are manufacturing vapor compression distillation units varying in rated capacities from 60 to 4,000 gallons of distilled water per hour.

It is estimated by the manufacturers that the largest of these units have been improved to such an extent that their water to fuel ratio is approximately 200 to 1, and that the cost of distilled water produced, including depreciation, fuel, cleaning, and all other operating costs might be as low as 55 cents to $1.50 per 1,000 gallons. This is equal to approximately $180 to $490 per acre-foot.

It is evident that the cost of distilled water is still much too high for municipal use, except perhaps in a few isolated or emergency situations, and that distillation by today's known methods is entirely infeasible for providing water for irrigation use, both from the standpoint of cost and production quantities. It should be noted, however, that since the beginning of World War II, the efficiency of the largest distillation units has been increased eight times.

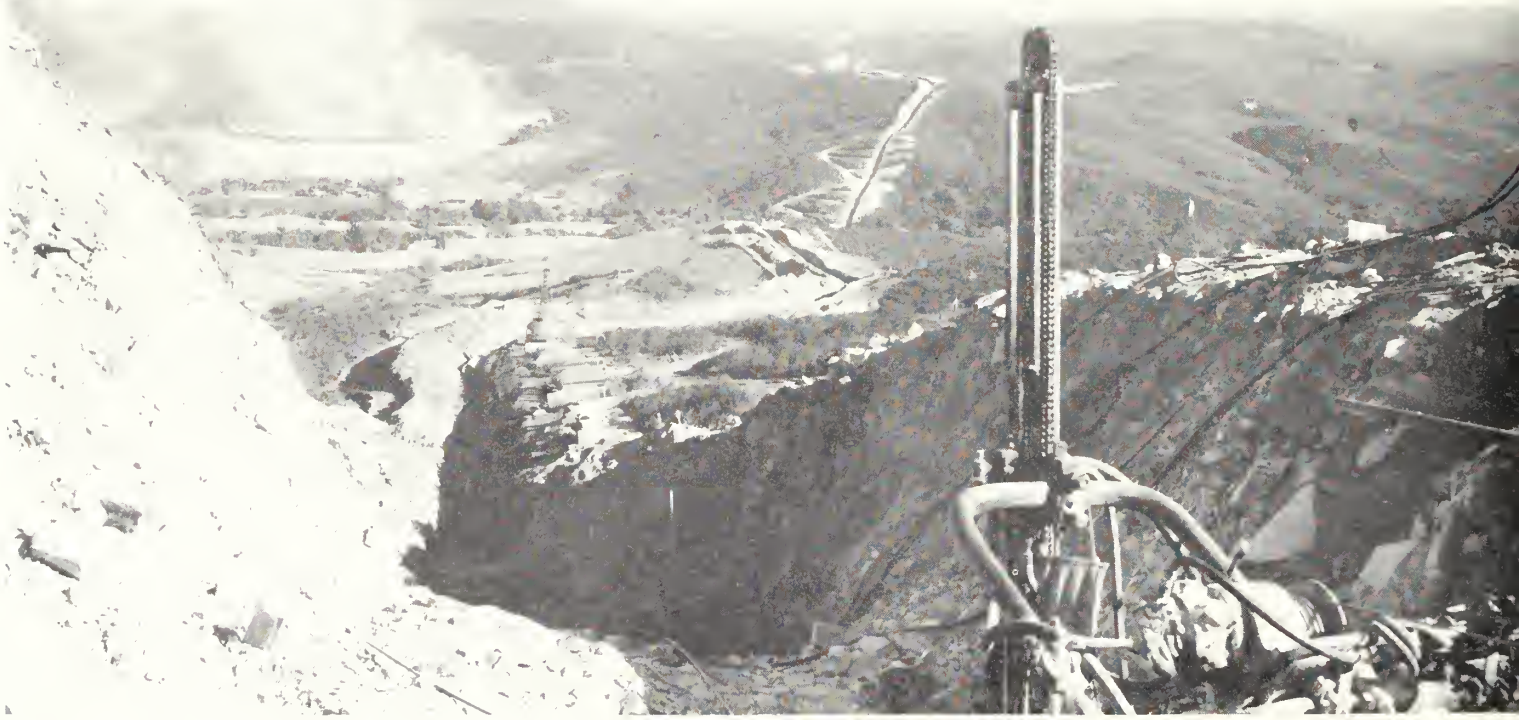
With this as encouragement, the Department of the Interior believes that additional developmental research on a large scale is warranted. The problem with which we are confronted is to develop, through extensive research and experimentation, distillation plants with 500 times the capacity and 50 times the efficiency of the largest units manufactured today.

A bill (S. 1300) "To conserve and increase the Nation's water resources, for promotion of irrigation in arid areas, by research and demonstration of practical means of producing, from sea or other saline waters, water suitable for

(Continued on page 166)

FROM THE MIGHTY OCEAN—may come the clear, fresh water to bring life to the West's arid but fertile lands. The Navy Seabees pictured below, are setting up portable compression distillation units on a tropical beach. Critical peacetime water shortages may be alleviated by similar improved methods.

WATER – Where It's Needed



THE SAN DIEGO AQUEDUCT—one of the more spectacular of the structures which the Bureau of Reclamation has helped plan and build for transferring and redistributing nature's water supply. This view was taken looking downstream along the aqueduct from a point near Keyes Creek crossing. The crane, at the time R. E. Burnett of Region II took the photo (July 9, 1947), was laying pipe. Red Mountain is the high ridge above the smoke at left.

by WILLIAM E. WARNE, Assistant Secretary of the Interior

MOTHER NATURE'S DISTRIBUTION OF WATER in the Western States does not always coincide with her children's desires. Clouds heavily laden with life-giving water sweep in an endless succession from the Pacific Ocean over our western coast line. As they cross the mountain ranges they are forced to give up some of their water as they rise above each successively higher mountain range. As a result, the western slopes receive moisture while a definite "rain shadow" forms on the eastern slopes. The majority of the water, therefore, falls on rough, high mountain lands and runs off to the sea, while enormous areas of potentially fertile lands nearer sea level are parched and useless in their virgin state.

Before the turn of the century, men started looking about for ways to overcome Mother Nature's shortsightedness in this respect. Water was rerouted by ditches and tunnels over or through divides to supply thirsty fields and homes. Water users of the Central Mountain States were especially active in such practices. The simpler diversions were soon accomplished and as the demand for water grew, more and more elaborate and costly structures became necessary. In time, maintenance of high living standards and hope for future economic expansion for large areas became completely dependent upon imported water supplies.

In 1904, just 2 years after the Reclamation Service was inaugurated, construction began on the Uncompahgre project, Colorado, where a 6-mile tunnel swapped water between the Gunnison and Uncompahgre Rivers. Later on, projects were built to transfer water from surplus water areas to areas in need of additional water, each project growing successively larger and more complicated. Descriptions and articles about the Colorado-Big Thompson project, the San Diego Aqueduct, the Central Valley project, and other examples of the feasibility of transferring water from one watershed to another have appeared on these pages and in other publications so often as to make any statements here unnecessary. But Reclamation is actively planning other projects of this type, which warrant discussion.

The great Missouri Basin project includes several daringly complex water transfers. Beginning at Fort Peck, Mont., the Missouri Souris unit will shift water from the Missouri River into the Souris River Basin in North Dakota, thence through the Sheyenne River Basin back to the Missouri by

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PROGRESS IN LAND AND WATER USE

by CARL S. SCOFIELD, Retired, Formerly Agriculturist in Charge, Division of Irrigation Agriculture, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture

IRRIGATION AGRICULTURE IN THE UNITED STATES was a new venture 100 years ago. Even now with the experience of a century, it is still in the stage of active growth with changes in thinking and in procedure much in evidence. This is a good time to review the trend of events in order to use the experience of the past in shaping action to meet current problems. It seems clear that we are going forward with irrigation agriculture and that our objective is the full use of our available supplies of water. In general we have more irrigable land than we have water to serve it. We should, therefore, aim to use the available water on the best of the available land.

Factors of Soil Deterioration

It is a fact of profound agricultural significance that the waters of many of our streams used for irrigation carry mineral salts in solution. Concentrations equivalent to a ton of salt in an acre-foot of water are characteristic of a number of important streams in the Southwest. Crop plants do not absorb the soil solution as it occurs in the root-zone reservoir of the soil. They absorb the water from that solution and, for the most part, leave the mineral salts in the residual solution. Replenishment of the root-zone reservoir by irrigation adds more salt and the concentration of the soil solution increases progressively. Salt concentrations in excess of 8 to 10 tons per acre-foot of water retard or inhibit the growth of crop plants. Thus the sustained productivity of irrigated land depends upon a system of drainage, either natural or artificial, to carry away the dissolved salts brought in by irrigation, or dissolved salts coming from deposits in the soil or underlying strata. When drainage conditions are such that for any area the drainage output of dissolved salts equals or exceeds the irrigation input, a favorable salt balance exists, provided there is no contribution of salt from local sources. Where the irrigation input exceeds the drainage output, the salt balance is adverse and the prospects for sustained productivity are not good.

In arid and semiarid areas, irrigated soils tend to deteriorate in productivity more rapidly than nonirrigated soils for two reasons:

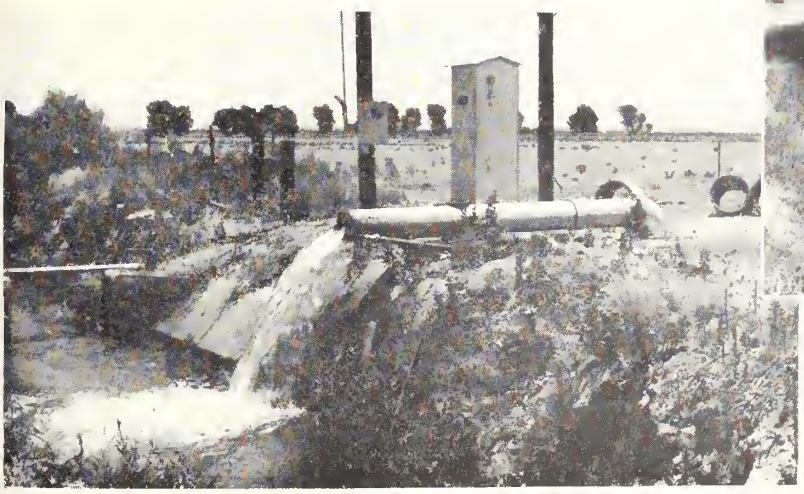
(1) With the hazard of drought reduced or eliminated, crops grow better and make larger yields. This tends to hasten the depletion of the native stock of essential nutrients. For this reason sustained productivity calls for wise soil management, including crop rotation and fertilization. The long continued productivity of semiarid dry-farm land has not been shown by similar soils under irrigation.

(2) The dissolved salts contained in irrigation water may have a profound effect on the productivity of irrigated soil. Some of the constituents of these dissolved salts are not harmful but others are decidedly so. These harmful effects operate in three ways:

(*a*) By increasing the concentration of the soil solution to the point at which it is difficult for the crop plants to obtain the water they need, or

(*b*) Because of the injurious effects on the physical condition of the soil of reactions with sodium (a common salt constituent) these reactions of base exchange impair the tilth and permeability of the soil.

(*c*) By increasing the concentration of specific elements to the point at which they are toxic to plants.



USE WATER WISELY—whether irrigation water comes from wells, such as the photo at left showing one of the 52 wells in operation in the Maricopa County municipal water conservation district No. 1, in Arizona, or is stored in a reservoir and distributed by canals like the one above in the Coachella Valley. Both photos by Harry W. Myers of Region III.

During the last half century our accumulated experience on some 20 million acres of irrigated land has contributed to marked improvements in the techniques of distributing irrigation water. This important operation involves not only conveying the water by canal or pipe line from the reservoir or diversion point to the individual farm but also its distribution on the farm to the cropland. It must be admitted that, despite the improvements currently in use, the operations are still laborious and wasteful. It is not unusual for the conveyance losses from a system of distributing canals to reach 20 percent or more of the net input of water. There is room for further progress here. There is room for improvement also in the distribution of water on the farm. There are many different expedients currently in use. Different crops and different topographic conditions require different methods. It is, unfortunately, true that the method actually used is generally determined by tradition, inheritance, or local custom rather than tby open-minded consideration of the major objective. This objective is to replenish the root-zone reservoir uniformly but not excessively before its supply of available water is exhausted.

Supplemental irrigation, as the phrase is here used, may be defined as the use of irrigation for a limited number of crops in a region where the rainfall is adequate to support an established agriculture. There is currently much expansion in this category of irrigation. The census of 1945 reported some irrigation in every State of the Union. It is probable that nearly 10 percent of the irrigated land in this country belongs in this category. Supplemental irrigation differs from arid land irrigation in that, in the case of arid land irrigation, the regimen of water distribution may be determined in advance and the farm operations may be adjusted to that regimen. In the case of supplemental irrigation, the time of need for water may not be predicted and because all the fields have been watered uniformly by rainfall, the need for irrigation (when drought occurs) is mandatory for nearly all fields at the same time. This poses an engineering problem essentially different from that of arid land irrigation and also very important problems of farm management and of the distribution of water on the farm.

POOR DRAINAGE DID IT—a typical example of a citrus tree dying because of poor drainage conditions, rapidly rising ground waters and high salt content of the soil. Photo taken by Dale A. Hovey, former Bureau photographer, of the Valley Gravity, Tex., region.

Allocation of Water to Specific Areas

In respect to the allocation of surface waters for irrigation use, it has long been a basic concept, both in legislation and in administration, that an appropriation of water be attached to a specific tract of land. In the light of experience of more than 50 years, this concept appears to be faulty. In the early years of irrigation it was natural that water be alloted to the land that was most easily accessible. Our people then had little experience from which to forecast the potential productivity of desert soil.

It has long since become obvious that desert soils differ greatly in potential productivity and particularly in respect to sustained productivity. In recent years, progress has been made in the techniques of estimating the response of land to irrigation and currently the criteria of potential productivity outweigh considerations of accessibility in the selection of land to be irrigated. There remains, however, the need for remedial legislative and administrative measures to the end that irrigation water may be reallocated from the less productive to the more productive land. The acuteness of this need becomes increasingly apparent as we approach the complete use of the available water supplies in some of our river basins. THE END

Salt Water Distillation

(Continued from page 163)

beneficial consumptive use, and for other purposes," has been introduced in the Eighty-first Congress by Senator O'Mahoney of Wyoming. A similar bill was introduced by Representative McKinnon of San Diego, Calif. Under either of these bills, if enacted into law, the Secretary of the Interior, through the Bureau of Reclamation and other agencies, would be authorized to conduct research and to construct, maintain, and operate one or more demonstration plants to produce fresh water suitable for municipal and irrigation uses from sea water. The plants and facilities for distribution would be of such capacities as to furnish all cost and engineering data necessary to determine the feasibility of such production and transportation on a large-scale basis.

Through the evolvement of economical methods for wholesale purification of ocean waters, new frontiers would be opened for development not only in the Western United States but throughout the world. We believe that an aggressive attack on the critical water supply problems of the West must be made in the same manner and in the same spirit that were employed in the war-time research and development programs. THE END

LININGS FOR IRRIGATION CANALS

by O. W. ISRAELSEN, Irrigation Engineer, Utah Agricultural Experiment Station, Logan, Utah, and C. W. LAURITZEN, Project Supervisor, Division of Irrigation Research, Soil Conservation Service

How would you like to decrease water losses, facilitate water deliveries, save labor, contribute to weed control, prevent soil erosion, retard soil waterlogging and add beauty to irrigated regions—in one operation? All these benefits may be gained by lining irrigation canals.

Because of the demand for more water to expand agricultural and industrial development, water must be conveyed and used efficiently in the West. The best means of increasing the efficiency of water conveyance is through properly lined canals. A canal such as the one pictured in figure 1, for example, is responsible for the loss of 2.2 acre-feet from each acre of the canal bed each day—a waste of vitally needed water for irrigation—and this is only one of many similar canals throughout the western area. State colleges and the Bureau of Reclamation are now engaged in a cooperative research program designed to reduce the cost of canal linings and at the same time improve present methods and materials. Better and lower cost canal linings will make possible great savings in water and money for the people of the West.

Materials for Lining Canals

Concrete is the most popular lining for irrigation canals in the United States. We are now studying the use of earth, soil-cement, oil, asphaltic membranes and fabrics which can be installed at lower initial costs, although it is not yet certain that the annual cost of these materials, including maintenance and replacement, will be less than the cost of concrete.

Concrete Linings

Thickness and Subgrade.—Concrete linings differ widely in thickness, type, and extent of reinforcing, mix, finish, cost, and durability. The thickness and the need for reinforcing steel is governed chiefly by the climate and the earth subgrade on which the lining is placed. The permissible minimum thickness of a lining is less in mild climates than in severe climates. A large percentage of slab breakage in concrete linings is caused by natural adverse subgrade conditions and to construction practices used in the excavation and preparation of the subgrade. For naturally unfavorable subgrades, a thicker slab with more reinforcing, underdrains, and other foundation protective devices, is needed to construct durable linings. More care in design, and in the preparation of subgrades, would do much to increase the durability of concrete linings.

Methods of Lining.—Linings may be poured in 10- or 12-foot panels as shown in figure 2. The alternate panels poured first serve as screed guides in the installation of the connecting panels and reduce cracking. This method of installing concrete linings is best for small jobs when special equipment is not available and site conditions are favorable.

"Slip-form pavers" is the name given to shaping screeds or templates with supporting structures, and compartments for the concrete mortar, which is fed under the leading edge of the screed as it is propelled forward. Two templates in tandem are used with an opening between for supplying the concrete mortar to the subgrade as the form is pulled forward.

Placing concrete mortar pneumatically, as shown in figure 3 to produce a lining commonly termed shotcrete or gunite, has some advantages over other methods, the chief advan-

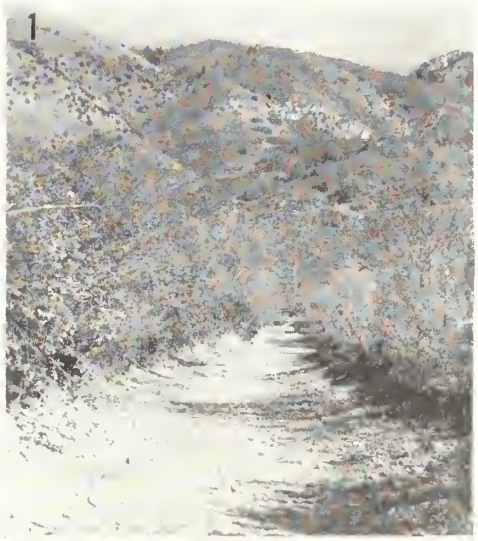
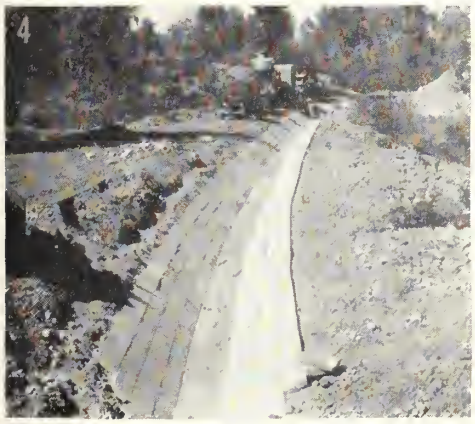


FIGURE 1: A canal in need of lining. Losses from this canal were 2.2 cubic feet per square foot per day. FIGURE 2: Alternate panels of concrete lining in place and intervening panels ready for pouring. FIGURE 3: Placing shotcrete. FIGURE 4: Precast concrete slab lining under construction.



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tage being the elimination of forms and the adaptability of this method to fitting the lining to irregular surfaces. (See "The Man Behind the Gun" on p. 214, October 1947, and "Shotcrete Canal Linings" October 1948, p. 189, Reclamation Era.)

Precast Concrete for Lining.—Lining with precast concrete slabs placed by hand, as shown in figure 4, has been limited to a few installations. (See "Try-outs for Precast Canal Linings," p. 734, November 1947, Reclamation Era.) The joints may be sealed with mastic or left open where the slabs are placed over a blanket of low-permeability material such as earth or soil-bentonite mixtures. Information on the durability of this type of lining is limited. It may be more durable under certain conditions than cast-in-place concrete linings because of its flexibility, a feature which should protect it from damage by expansion and contraction of the subgrade caused by large changes in temperature and by wetting and drying of materials. This lining may provide an acceptable type for field laterals to prevent excessive seepage losses or erosion. Slabs can be produced commercially, and installed without special equipment, removed and reused if desirable.

Stabilized Earth Linings

A number of types of lining such as compacted earth, soil-bentonite mixtures, soil-cement, and earth treated with light oils are called "stabilized earth linings." All reduce seepage losses at lower initial cost, although considerable maintenance may be necessary to keep linings of this type intact. Earth and earth-bentonite linings require a protective nonerosive cover such as rock riprap or a layer of gravel to prevent destruction by erosion. Canals lined with earth materials, because of lower stream flow velocities, require nearly double the cross-section area and a larger wetted canal surface in comparison with concrete, to provide the same flow. These factors all contribute to increasing the cost of lining with earth as compared to concrete or other nonerosive materials.

Generally, fine-textured earth material is less permeable (or more watertight) than coarse textured. Exceptions, however, are numerous. There is wide variation in permeability of materials of the same texture, and therefore, it is essential in selecting earth materials for lining, to make permeability measurements. Most earth materials of medium texture or finer can be made reasonably water tight by compaction at optimum moisture. Unless the material has a low permeability independent of its compaction, however, it will not be suitable for lining canals since frost action, wetting, and drying destroy the compaction.

Cracking which accompanied drying of a silt loam lining when the water in the channel was lowered is shown in figure 5. The permeability of this material is low, but the extensive cracking which accompanies drying makes it less satisfactory for lining than sandy loam bentonite mixtures (shown in fig. 6), which are nearly as water tight, and are less subject to cracking. Gravel coverings to protect earth linings from erosion will likewise minimize the drying and contribute to the effectiveness of the lining.

Rapid deterioration of soil-cement and oil treatments appears to be the chief objection to these types. Soil-cement, when mixed as a mortar, is normally referred to as plastic. The latter may be mixed and placed in the same manner as concrete, although a saving in cost can be effected by the use of a machine consisting of a loader and pugmill-type mixer which picks up the aggregate from material windrowed on the bank of the canal. Standard soil-cement is more durable, but since its installation necessitates compaction it presents a construction problem, since satisfactory equipment for compacting side slopes is seldom available.

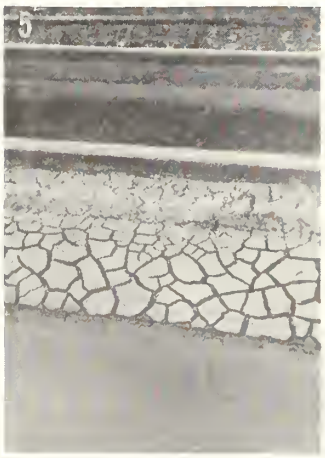
Field Laboratory Studies

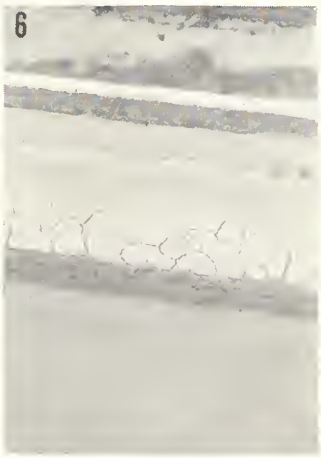
The Utah Agricultural Experiment Station, Soil Conservation Service, and the Bureau of Reclamation are making comprehensive studies of various kinds of lower cost linings at the Field Laboratory near Logan, and in Utah canals by means of field test installations.

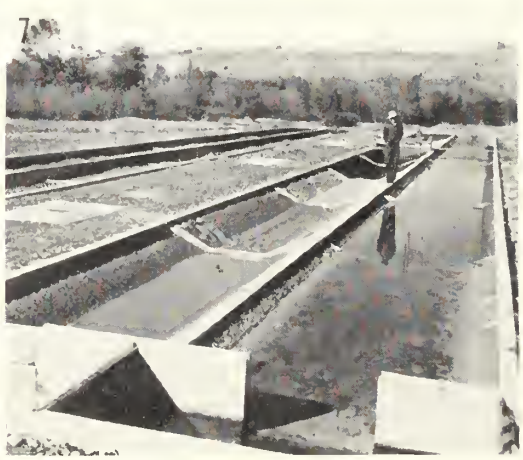
The laboratory has four channels simulating irrigation canals, with bed widths of 3 feet, side slopes of two horizontal to one vertical, top widths 9 feet, and lengths 160

(Continued on page 176)

FIGURE 5: Oasis silt loam lining showing pattern and degree of cracking associated with drying. FIGURE 6: Lining of Trenton sandy loam 10 percent bentonite mixture showing pattern and degree of cracking associated with drying. FIGURE 7: Experimental channels at River Laboratory. FIGURE 8: Butyl-coated fibreglass lining showing uncemented lap joint. All photos for this article submitted by the author.







FIND THE RIGHT COMBINATION—

and open the door to water wealth through better soil, crop, and irrigation practices

by

ROBERT M. SALTER, Chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture

ARE YOU GETTING YOUR MONEY'S WORTH out of the irrigation water used on your farm?

New-type experiments being conducted in irrigation areas by the United States Department of Agriculture, in cooperation with State agricultural experiment stations and the Bureau of Reclamation, indicate that there may be far higher crop yields and profits in an acre-foot of water than now are generally obtained.

In 1947, for example, 162 bushels of corn an acre were obtained in the Columbia River Basin in a section where irrigation farmers usually get about 40 bushels. In other tests since then, in various parts of the West, as much as 40 tons of sugar beets an acre, and 10 tons of alfalfa have been harvested. Oat yields went to 114 bushels, potato yields to almost 600 bushels, and grain sorghums to 174 bushels per acre.

The conditions under which the Department of Agriculture tests have been carried on can be duplicated on most irrigated farms. On similar soils under irrigation equally good results should be possible.

How were these yields obtained? By finding and applying the right combination of plant-growth factors or practices. So far, the process of finding such combinations has been something of a juggling act. It has required some fancy "footwork" or manipulation of different practices in experimental research to determine those that fit together or "click" well under a particular set of conditions. One fact, however, stands out in bold relief. Regardless of the other practices in the combination, favorable moisture conditions are essential. Such conditions can be provided without waste of water wherever irrigation is possible.

Water conservation long has been a matter of great concern to irrigation farmers for two reasons: First, because of cost; and second, because of its scarcity in parts of the West. Excessive run-off at the end of the field, seepage in canals and laterals, deep percolation during irrigation, and other losses have been attacked and in some cases solved, by many farmers. That is one form of water conservation—stretching out the supplies by preventing loss. Conservation use, however, begins on the crop land, and it does not mean saving water supplies so much as getting the most value out of the water that is used.

The irrigation farmer of the West has one advantage over most eastern farmers. He can control the water. This gives him perhaps the greatest opportunity in applying the new principles being developed by research scientists of the Department of Agriculture and State experiment stations. The scientists are finding a high degree of interdependence or "interaction" among the various factors that affect the growth of a crop. Among these factors are the amount of nutrients, how thick the crop is planted, time of planting, the amount of available water, genetic make-up of the crop variety, control of weeds and other cultural practices, control of insects and diseases, and others.

Research is under way to find the best practice combinations. In this research the approach has been different from the traditional one in developing a new variety of crop plant, or breeding in resistance to a particular disease. The usual experimental method is to hold all factors constant except one, and to vary this one over a wide range. In the research to find the "right combination," all or many factors are juggled back and forth in an effort to get the most effective combination.

Adequate fertilization is required before irrigation water can be used efficiently. In a corn experiment in the Colum-

Prize winning pototoes receive admiring glonce from Evelyn Kelly of Modros, Oreg., Deschutes project, who reigned os Queen of Irrigotion when water wos first delivered to the oreo. See front cover, July 1946 Ero. Photo by Phil Merritt, Region I.

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bia River Basin, increasing irrigation for the season from 3 to 5 acre-feet per acre gave no increase in yield—at low fertility. Increasing fertilizer use, with 3 feet of water, raised yields from 55 up to 90 bushels per acre. The same fertilizer increases, combined with the heavier irrigation rate, brought corn yields from 55 to over 130 bushels per acre. This is just one of many cases which show that efficient use of irrigation water and fertilizers requires optimum combinations of both factors.

Similarly, in potato experiments, increasing irrigation from 1.7 to 3.3 feet of water produced an increase of 138 bushels of potatoes per acre—when the fertility level was high. The same increased use of irrigation water caused a 46-bushel decrease in yields when used with low rates of fertilization. It is obvious that the proper combination of water and nitrogen was necessary to get the highest results. The difference of 138 bushels, at $1.65 a bushel, amounts to more than $225 an acre, but the cost of obtaining the higher yield versus the cost of obtaining the lower yield was comparatively low.

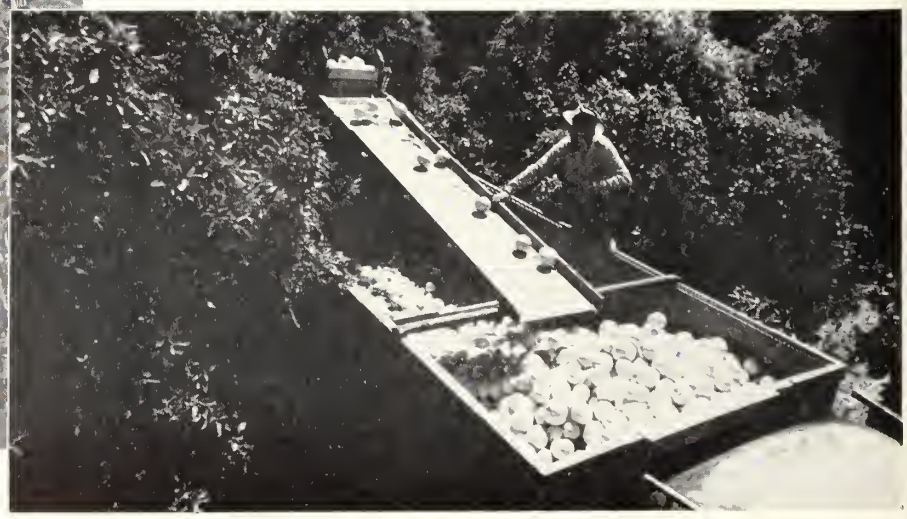
In Utah sugar-beet experiments at a high fertility level—with 160 pounds of nitrogen and 15 tons of manure added per acre—one treatment yielded 26 tons with six irrigations totaling 7 acre-feet of water, and another yielded 22 tons when only three irrigations were used with a total of 5 acre-feet of water. The difference in irrigation brought 4 tons more sugar beets. With beets at $15 a ton, the value of the extra yield is about $60 an acre—at a cost of 2 acre-feet of water.

The examples of how proper combination of all crop production factors produces efficient use of irrigation water can be multiplied many times, for the Department of Agriculture in cooperation with States and the Bureau of Reclamation is conducting as many experiments as funds permit, both on new lands awaiting irrigation development, and on developed areas. This program will help prevent many of the costly errors earlier irrigation settlers made. Developing a profitable farming enterprise on newly irrigated land is a costly job, and leaves little room for error. After paying the cost of water, the expense of fertilizer, and the burden of debt, efficient production is a must.

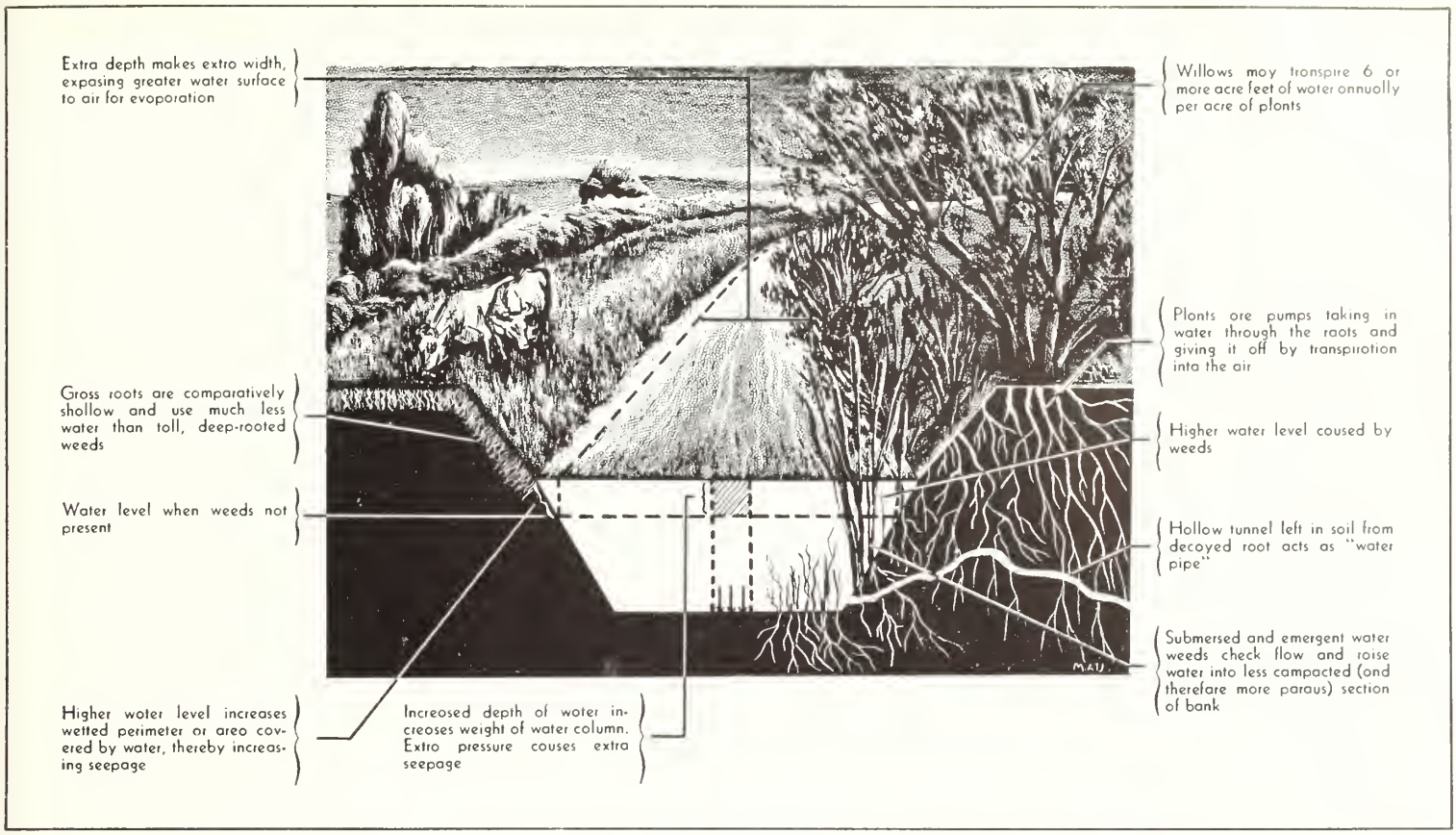
The soil, crop, and water investigations in the Columbia River Basin and the Lower Colorado Basin now under way are designed to discover the basic facts on water use, soil management, and crop production before new settlers are brought in. They will also point the way to new profits for established irrigation farmers through efficient use of water in proper combination with other improved cultural practices for the type of soil that they must use.

The soil studies are important, for what works on one type of soil may not be the correct combination on another type of soil. The combinations working on certain Columbia Basin soils, for example, would not do on the mesa soils in lower California and Arizona, but through research, systems of crop, soil, and water management can be developed that will permit profitable farming in both areas, even though the practice combinations may be different.

When farmers get the most value from irrigation water, conservation use of the water is a fact. And that is important when water supplies are limited and water costs are high. THE END



"*The irrigation farmer of the West has one advantage over most Eastern farmers, he can control the water.*" Typical crops grown on irrigation farms are shown here. Extreme left: Hybrid corn. Immediate left: Atlas sorghum. Below: Citrus fruit. Extreme left photo by Stanley Rasmussen, Region I, and photo below by Harry Myers, Region III. Name of other photographer unknown.



What Price WEEDS?

by ROBERT B. BALCOM, Chief Agronomist, Branch of Operation and Maintenance, Washington, D. C.

Weeds have been under suspicion for petty and grand larceny of water for many years, but their "take" in terms of actual money stolen from the farmer's cash box has been hard to prove.

However, the Bureau of Reclamation can now give an estimate in terms of dollars at least, of how much water is stolen by "old demon weeds" which grow along the canals and laterals.

It comes to a total of over $3,000,000 a year on Bureau of Reclamation projects alone and $25,500,000 for irrigation farmers in the 17 Western States. And this does not even include the water usurped by weeds growing with crop plants.

How did we arrive at these figures? As part of a survey made in 1947 and 1948, with the cooperation of several projects and the regional weed control specialists, we obtained among other weed data, figures on water losses sustained because of weeds.

Of course several other factors like seepage and evaporation cause water losses in distribution systems, but until recently, they alone were blamed for many of the losses which should have been attributed to ditch vegetation. Also it was not realized how much of the seepage and evaporation may have been caused by the weed growths. Even small quantity water losses should be a particularly important consideration on projects which do not have sufficient water to furnish their available irrigable acreage, and of course for all projects during years when water is short.

All living plants are miniature pumps, drawing up water through their roots and giving it off again into the air. This is known as transpiration and accounts for the greatest loss of water due to weeds on an irrigation system. While all plants utilize water in this manner, in general those species usually thought of as weeds use larger quantities in their growth processes than most cultivated plants. This is the reason why weeds have been given the name of "water robbers" when growing with crop plants. It has been proved that when weeds are allowed to grow in a crop much more irrigation water is required.

For example, the Yearbook of Agriculture for 1934 states that a heavy stand of lambsquarters was found to use about 40 percent more water than alfalfa, one of the heaviest water users among crop plants. It was determined that a thick stand of smartweed—a Polygonum—found not only in fields, but particularly abundant along irrigation ditches, may consume in a season's growth on 1 acre enough water for the year's irrigation of 3 acres of alfalfa. It was pointed out that emergent aquatic species like tules, cattails, and reeds were charged with using 9.63 acre-feet of water for each acre of these weed pests.

In other tests made to determine the consumptive use of tules and cattails it was found that 15 or more acre-feet may be used in a single year, particularly when the plants grow in narrow strips as often happens along irrigation ditches. They are thus more exposed to the sun and air currents and transpire relatively larger quantities of water than when growing in dense patches. It is known also that many weeds can adapt themselves to a small amount of water, but the more they have, the more they use. When they grow along canals and laterals where the water supply is abundant they take a good, long, drink.

In addition to the plants usually called weeds, willows and other woody plants are often prevalent on irrigation systems. They send their extensive roots down into the banks and draw heavily on water that may be seriously needed for a crop of sugar beets which some farmer is depending upon for his family's livelihood.

Temperature, humidity, and number of hours of sunshine affect the rate and amount of transpiration from plants. Therefore the water lost through transpiration in the Southwest is greater than in the more humid, cooler areas further north. An excellent summary of the principal research on the subject of transpiration is contained in the report "Use of Water by Native Vegetation" prepared by Arthur A. Young and Harry F. Blaney which was printed in 1942 as Bulletin No. 50 by the State of California Department of Public Works, Division of Water Resources.

The serious problems created by various kinds of weeds growing on ditchbanks and in irrigation channels in addition to water losses are well known to every employee of an irrigation district. The enormous volume of these growths choke the ditches and reduce their capacity until finally some method of elimination must be employed in order to deliver sufficient water to farmers' crops. Also costly dredging operations often are necessary to remove silt which these growths cause to be deposited in the canals. Many other adverse results of weeds growing on or in the ditches (which are discussed in the Bureau of Reclamation's publication Control of Weeds on Irrigation Systems) are in plain view of any observer. However, some of the effects of these growths are not so easily seen and therefore often go uncounted.

Besides the water losses caused by transpiration, the weeds and deposited silt raise the water to a higher level in the canal and still further water losses result from extra evaporation and seepage.

The additional evaporation resulting is of course in direct proportion to the additional water surface exposed. On an average ditch with a 1½ to 1 slope, each 1 foot rise in water level increases the total surface width by 3 feet. It is not unusual for a dense growth of submersed waterweeds to raise the level of the water in a canal 2 to 3 feet, thus increasing the surface width 6 to 9 feet. For every mile of ditch an 8¼-foot increase in width exposes an extra acre of water surface.

The raising of the water level causes additional seepage in three ways. First, the wetted perimeter or area occupied by the water in the channel is increased, thereby exposing a greater area of earth where seepage can take place. Second, the increased depth makes the water column heavier, adding more pressure to the water, and forcing more water into the soil on the sides and bottom of the channel. Third, the higher water level brings considerable water in contact with the upper portion of the banks which is less compacted and therefore more susceptible to seepage. Also there is more chance of rodents having worked in this section and leaving holes in the banks which will cause a loss of water, if not a more dreaded result—a ditchbreak.

Ditchbreaks are also caused by overflows which result when weeds check up the water to full capacity and additional water enters the ditch. This extra water may be from flash rains, waste water from fields, farmers completing their irrigating and shutting off their heads of water, or the ditchrider not being familiar with the "bank full" condition at some point and trying to force more water down the ditch. Ditchbreaks not only result in loss of water but also in costly ditchbank repairs and damage to flooded crops.

Large weeds like sweetclover cause additional seepage when their roots die and decay forming small tunnels in the soil through which the water easily flows.

While water losses caused by weed growth on and in ditches have been assumed to be considerable, there were no figures on which to base this assumption. But now, with the aid of the Bureau's survey it has been estimated that 148,773 acre-feet of water is lost each year due to a combination of all the causes discussed above in the Bureau of Reclamation's 14,075 miles of canals and laterals. This is almost enough to fill reservoirs like the Bartlett on the Salt River project, Arizona, the Deer Creek on the Provo River project, Utah, or the Green Mountain on the Colorado-Big Thompson project in Colorado. It is nearly three times more water than was delivered to the farms on the Orland project, California, in 1947; nearly twice as much as delivered to the Grand Valley project, Colorado; and more than the combined amount delivered to the Sun River and the Milk River projects in Montana—and these figures do not include the highway robbery of salt cedars from rivers where our water supplies are obtained, or from reservoir areas like McMillan where they filch about 60,000 acre-feet of water each year.

It is difficult to set a productive value on irrigation water because it varies considerably between localities. However, it is believed that it would not be unreasonable for the purpose of this discussion to assign to irrigation water an average gross productive value of $20 per acre-foot. At this value, plus the projected costs for ditchbreak repairs and damage to flooded crops attributed to weeds, the total loss on irrigation systems built by the Bureau of Reclamation would be nearly $3,000,000 annually.

To obtain a better idea of the gross productive value of the lost 148,773 acre-feet of water, let us compare it to actual project records. This is approximately the amount of water delivered in 1947 to the Sun River project, Montana, and the Carlsbad project, New Mexico, combined. These two average projects, one in the north and the other in the south, together produced, that same year, crops with a total gross value of nearly 5½ million dollars. In making the same comparison with one of the above average projects, that amount of water produced crops valued at almost 8 million dollars.

If we project these water losses to all irrigation in the 17 Western States, using the 1940 census figures of 120,386

(Continued on page 176)

Conservation of Water

(Continued from page 161)

Division of the All-American Canal project, California, and the South Ogden project, Utah, and planned for the Contra Costa unit of the Central Valley project, California. Similar systems are proposed for The Dalles and Canby projects, Oregon, and suburban areas of the Rio Grande project, Texas-New Mexico. Pipe distribution systems in addition to saving water, save extensive rights-of-way which otherwise are lost to farming.

d. Sprinkler Irrigation.—An important development in the irrigation field is sprinkler irrigation. This method will save considerable water under certain conditions adverse to surface irrigation. In addition, it will make possible irrigation of some lands otherwise almost or entirely nonirrigable. A preliminary report was prepared in 1947 and a more complete report is now in the hands of the printers. Much remains to be explored in the use of sprinklers and the equipment needs further development. Several types of sprinkler systems are being used on Bureau development farms. The results obtained under a wide variety of soils and climatic conditions will be very useful in determining the proper field and usefulness of the present systems. They will also serve as a reliable base for further development.

e. Better Farm Irrigation Practices.—Important losses of irrigation water occur on the irrigated farm. More efficient and less laborious means of water control are needed. Surface methods of applying water have not been given sufficient scientific study nor has the best information always been available to the men who are advising the farmers. Here, again, the Bureau has a threefold program.

1. Development Farms.—Development farms have been established by the Bureau in cooperation with the State colleges and Department of Agriculture agencies on the Columbia Basin project at Moses Lake, Pasco, and Winchester in Washington; on the Missouri River Basin project at Bowbells and Mandan in North Dakota, and at Huron and Redfields in South Dakota; on the Yuma project in Arizona; and on the Tucumcari project in New Mexico. These farms are conducted for the purpose, among others, of investigating and demonstrating to the settlers on the projects improved water saving irrigation practices including sprinkler irrigation.
2. Cooperation in Research.—In Washington, Oregon, Idaho, North Dakota, South Dakota, Arizona, and New Mexico, the Bureau is cooperating with the State experiment stations in research on irrigation farming. In several States the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Research Division of the Soil Conservation Service are also cooperating. This research includes sprinkling and other methods and rates of water application, kinds and amounts of fertilizers, kinds and varieties of crops and other farm practices.
3. Settler Assistance.—Settler assistance programs, through which new settlers are provided with technical assistance, are being conducted in cooperation with the State Agricultural Extension Services on all projects where postwar land openings have been held. This technical assistance includes the layout of the farm distribution and surface waste water disposal systems and instruction on methods, times, and rates of application of water. An Irrigation Advisers' Manual, prepared in Region 1 in 1947 has proved very helpful in this regard. This manual is now being revised and completed for Bureau-wide use.

f. Control of Weeds.—Direct transpiration from weeds and woody plants growing on canal banks and the additional seepage and evaporation resulting from aquatic vegetation result in an estimated loss of 150,000 acre-feet of water annually from 14,000 miles of Federal Reclamation canals and laterals. The Bureau has inaugurated a comprehensive weed-control program for its irrigation systems and cooperates with Federal, State, and county agencies in their educational weed-control programs on project farm lands. Congress has made a small appropriation to the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, for a weed-control-research program which is being conducted in coperation with the Bureau of Reclamation.

g. Reuse of Return Flows.—Attention is being given the recovery of water temporarily lost through seepage and farm percolation. On the Rio Grande project in New Mexico and Texas, for instance, even after rediversion of return flows from the upper valley at El Paso, 16,000 acres of land in the Hudspeth County conservation and reclamation district below the original project are irrigated by reuse of waste waters.

h. Transmountain Diversions.—Almost since the beginnings of modern irrigation in the United States, water has been carried in small quantities over minor divides from stream basins having an excess of water to those having deficiencies. Now, however, the Bureau is carrying on major work in this direction as on the Colorado-Big Thompson project in Colorado, and is studying the much larger scheme for transferring excess water from the Columbia River to the dry Southwest.

i. New Sources of Supply.—Another attack on the most urgent problems in water shortage areas is envisaged in the pending legislation authorizing extensive investigations for obtaining fresh water from sea or other salt waters.

The Bureau of Reclamation, definitely cognizant of the need for expanding water conservation in the West, is prepared to do its utmost in developing these resources for effective use.

The End

The above article is based upon a recent report made by Commissioner Straus to Secretary of the Interior Krug, outlining the progress which had been made, and the present plans for full productive use of water on Bureau of Reclamation projects.

CONSERVATION (full

ilization) OF WATER

AN ENDORSEMENT

The Bureau of Reclamation's program for conservation, or full utilization, of water for irrigation, hydroelectric power production and related purposes has my hearty endorsement—with one qualification. It is a good beginning—but only a beginning—in our renewed and redoubled drive to save our waters to put them to work.

Much more remains to be done.

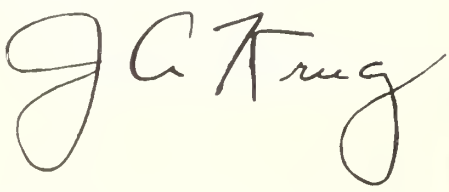
Our objectives require the wholehearted assistance and cooperation of the 100,000 water users on reclamation projects, plus all Federal, State, county, and local agencies concerned with the problem of western water resources.

Fortunately, many far-sighted men and women of the West have made great progress in the conservation and use of these all too limited water resources. We are particularly grateful for the cooperation of the Western State agricultural colleges, the United States Department of Agriculture, State water conservation boards, and other agencies which have long recognized the fact that water must be used effectively and economically if the people of the West are to continue on their way toward agricultural and industrial prosperity.

Water is wealth to the West. In recognition of that fact, the Federal Government, through the Bureau of Reclamation, has invested more than 1½ billion dollars in reclamation works to bring new life to desert areas, new homes to abandoned countrysides, new and thriving communities to "ghost town" areas, and booming industries to one-time wildernesses. In less than half a century of reclamation the Federal Government's investment has paid dividends in better living, better homes, better farming, and better business, not only throughout the West but throughout the Nation.

But an investment of greater time, thought and effort is needed to bring the Bureau of Reclamation's present program to completion, and even more will be required if we are to conserve and use every drop of water in the West to the greatest advantage, and for the benefit of the increasing population in an area that beckons to more and more people.

The full resources of the United States Department of the Interior are being mustered in this program to conserve and use the wealth of the West—its water resources. But the final results depend upon you, the people of the West and of the Nation, who are concerned with the continued prosperity of the country which in turn depends to a great extent upon our planning and working together during this new century of conservation.



Linings for Irrigation Canals

(Continued from page 168)

feet. Each channel is divided into eight sections, as shown in figure 7, and each section is provided with independent underdrainage facilities to collect and measure seepage losses. Streams are continuous, making it necessary to operate each channel as a unit.

The permeability of the linings studied at the River Laboratory varies widely, but when linings have an initially high permeability, it tends to remain high or increase, and those linings with an initially low permeability remain low or decrease. Several of the linings have permeabilities lower than 0.1 foot per year.

As an example of cooperative field tests, 1,829 linear feet of experimental lining was installed in the canal at Richmond, Utah. Included were 729 feet of concrete, 400 feet of shotcrete, 300 feet of precast concrete slabs, 100 feet of gravel-covered earth, and 300 feet of butyl-coated fibreglass (shown in fig. 8). Represented in the various sections of the concrete lining were individual panels reinforced and unreinforced, concrete with and without air entrainment, three finishes, two thicknesses, and all possible combinations of these. The shotcrete lining included two thicknesses each, with and without reinforcing. The precast slab linings included a section of slabs with mastic-filled joints, a section with open joints over a soil bentonite mixture, and a section with open joints over a lining of silt loam. THE END

WHAT PRICE WEEDS?

(Continued from page 172)

miles of unlined canals, we arrive at an estimated water loss of 1,272,480 acre-feet annually with a gross value of nearly $25,500,000 if the conservative value of $20 per acre is applied.

One of the most interesting points revealed in the whole survey of water losses was that projects which had a considerable area of their ditchbanks covered with grasses and pastured with livestock reported only a small fraction of the average transpiration loss estimated for all projects. This should be expected, as grasses are comparatively shallow rooted and some are particularly efficient in their use of moisture, therefore transpiring much less water than some of the deep and extensively rooted weeds. Experience also has shown that a grass covered, pastured ditchbank reduces weeds and erosion to a minimum and results in very low operation and maintenance costs. Of course pasturing ditches has a dual advantage—while it is doing such an effective and economical weed control job, it is making money for the project farmer who has the good fortune to be able to take advantage of the ditchbank pasture.

As anyone can see, a weed control program really pays dividends to the reclamation farmer. THE END

HOW MANY TIMES CAN YOU USE WATER?

by CHARLES C. FISK, Hydrologic Engineer, Hydrology Division, Branch of Project Planning, Denver, Colo.

In these days of widespread interest in the conservation of our western water resources, the reuse of water is a matter of real economic importance.

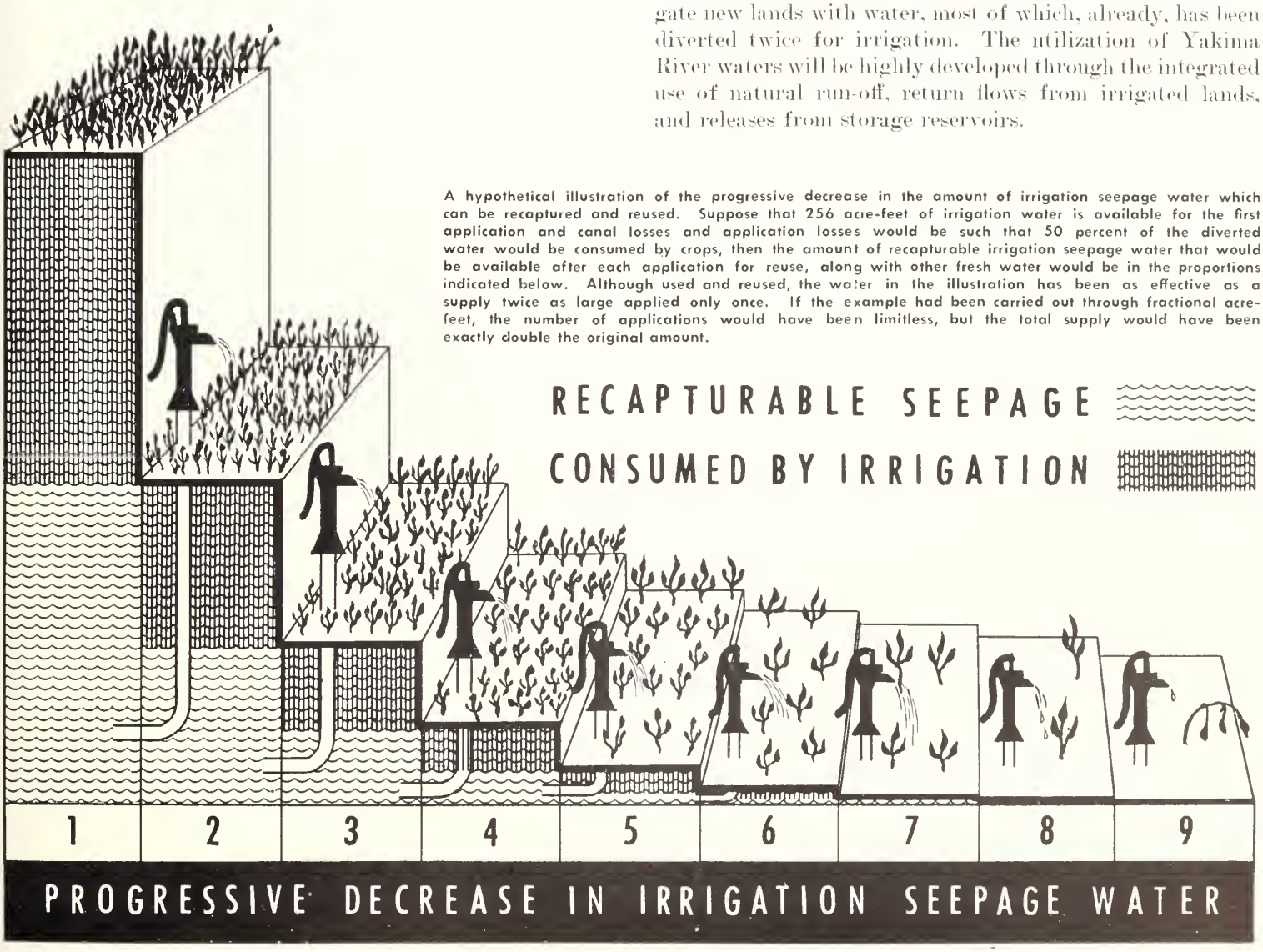
For hydroelectric power generation, of course, water can be used over and over again. On projects such as the Colorado-Big Thompson, water will be passed through power plant after power plant without loss or detriment.

Water for irrigation purposes can also be applied to the land, then recaptured, and used again to irrigate other agricultural lands. On many reclamation projects irrigation water is being used twice—three times—five times—as many times as the water is available and continued use is practicable. With each re-use there may be a substantial saving in costs to the irrigators.

There are several ways in which "used" irrigation water—irrigation seepage water—can be recaptured and made available for later use. The most common way involves interception of the "return flow", or the flow of underground irrigation seepage water into surface drainage features. When these waters are used again for irrigation the phenomenon of return flow may be repeated.

Return flow has great economic value as a source of water supply for irrigation. The volume of return flow is surprisingly large in some areas. For example, most of the 300,000 acre-foot annual flow of the South Platte River at the Colorado-Nebraska State line is made up of return flow which has been diverted several times for irrigation as the water passed down the river valley.

On the proposed Kennewick division of the Yakima project in Washington, prospective irrigation farmers will irrigate new lands with water, most of which, already, has been diverted twice for irrigation. The utilization of Yakima River waters will be highly developed through the integrated use of natural run-off, return flows from irrigated lands, and releases from storage reservoirs.



A hypothetical illustration of the progressive decrease in the amount of irrigation seepage water which can be recaptured and reused. Suppose that 256 acre-feet of irrigation water is available for the first application and canal losses and application losses would be such that 50 percent of the diverted water would be consumed by crops, then the amount of recapturable irrigation seepage water that would be available after each application for reuse, along with other fresh water would be in the proportions indicated below. Although used and reused, the water in the illustration has been as effective as a supply twice as large applied only once. If the example had been carried out through fractional acre-feet, the number of applications would have been limitless, but the total supply would have been exactly double the original amount.

The Tule Lake Division of the Klamath irrigation project in southern Oregon and northern California offers a most interesting example of the reuse of water for irrigation. A complicated system of storage reservoirs, diversion dams, drainage works, pumping plants and irrigation canals permits the use of irrigation water over and over again, at least five times in all.

Pumping from the groundwater reservoir presents another satisfactory method of intercepting return flow. In the Salt River Valley of Arizona, for example, water is applied to the land by gravity irrigation. The seepage water passes downward to the groundwater reservoir. The groundwater is then pumped to the surface and used again for irrigation. This pumping is necessary as a means of drainage, in order to keep the watertable from rising, saturating the land, and poisoning it from salt residues. But it also makes possible a cycle of use and re-use of irrigation water.

Factors such as the availability of the unconsumed and recapturable irrigation seepage water, even legal barriers, and the chemistry of the used water can individually or collectively limit the number of times irrigation water can be used.

The availability of the recaptured irrigation seepage water is an important consideration. You cannot reuse it if you have not got it or cannot afford to go after it. Each time that you reuse irrigation water there is a progressive decrease in the quantity of seepage water that can be recaptured and made available for later use. This progressive decrease is usually due to transpiration and evaporation losses. Also a part of the seepage is delayed and may reach the second point of diversion after the close of the irrigation season. Other fractions may appear below the limits of irrigable land and so escape to the ocean.

Local water law sometimes stipulates that the original water right does not entitle the user to recapture and reuse return flow, except through a new and separate right. In some States there are legal restrictions that limit the use of groundwater for irrigation.

The quality of a water may impose a chemical limit to the number of times you can use that water for irrigation. When we say that water has "quality," we are referring to its suitability for its particular purpose. If you want to use water for irrigation, its quality is directly related to its content of dissolved mineral substances. In general, the purer a water is, the better it is for irrigation.

Unfortunately for irrigators, water used for irrigation in arid and semiarid regions is usually far from pure. Repeated application of saline irrigation waters has impaired to some extent the productivity of nearly one-half of the irrigated land west of the Mississippi River. It has also led to the abandonment of many once fertile farms.

Little or no difficulty is encountered when slightly saline irrigation waters are used only once and in quantities great enough to wash the soluble salts down below the root zone of the plants. Difficulties are quite certain to be encountered, however, if a slightly saline irrigation water is reused many times. Various plants have different degrees of resistance to the effects of salts. Water that may be harmful to one type of crop may have a minor effect upon another. Thus it may frequently be practical, by planting special crops, to utilize water that otherwise would be unfit. Repeated use of any irrigation water in an arid or semiarid climate will inevitably cause a serious degeneration in the quality of that water. Eventually, water will become so saline that further use for irrigation will be impracticable.

The cause of this degeneration in the quality of irrigation water with repeated use is well established. When irrigation water is applied to arid or semiarid lands, the greater portion of this water is evaporated from the soil or transpired by plants and the dissolved salts are left behind in the soil solution. Consequently, the residual water in the soil becomes more concentrated with soluble salts than the original irrigation water. The surplus water seeps downward and reappears eventually as return flow. This return flow is usually several times more saline than the original irrigation water. Each time that this cycle of irrigation—seepage—return flow—irrigation is repeated, the soil solution becomes more saline. Finally, the salinity becomes great enough to inhibit plant growth and render irrigation impracticable.

The degeneration in quality of irrigation water with repeated use is illustrated by the increasing quantities of salt constituents reported at successive stations along the Rio Grande. The Rio Grande collects annually from its headwaters in the high mountains of southern Colorado approximately a half-million acre-feet of water of very low salinity. Some of this water is diverted for irrigation use in the San Luis Valley of Colorado. As the river leaves that valley, it carries, in addition to its residual channel flow, the discharge of drains from the irrigated lands of the San Luis Valley. The salinity of these return flows is sufficient to increase materially the salt concentration of the Rio Grande.

Below the San Luis Valley, in a canyon section, several tributaries increase its volume to somewhat less than a million acre-feet annually, without materially changing its salt concentration. Below this canyon, water is diverted to irrigate lands above and below Albuquerque, N. Mex. In this section the river is joined by several tributaries and it also regains drainage water from the irrigated areas. The net effect of these diversions and contributions is to increase about threefold the concentration of soluble salts.

Rio Grande waters leaving the Middle Valley are collected in Elephant Butte Reservoir. Water released from this reservoir, amounting to about 790,000 acre-feet annually, is practically all diverted from the stream channel for irrigation use. There are no important perennial tributary contributions between Elephant Butte Reservoir and the lower end of the El Paso Valley, but drainage waters from the upper divisions are returned to the stream channel and rediverted to the lower divisions. The flow leaving the Valley at Fort Quitman consists largely of drainage waters returned to the stream from the lower divisions. The mean annual volume at this point is about one-third of that released annually from Elephant Butte Reservoir, whereas the average concentration of dissolved solids is more than three times as great.

It is evident that there is no one answer to the question, "How many times can you use water? However, the reuse of water for irrigation, besides being a complex matter, is also a matter of real economic importance to the water users on reclamation projects. THE END

Rehabilitation and Betterment

by R. S. BRISTOL, Regional Supervisor,
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Rehabilitation has been defined as 'restoration to a former state;" obviously it can be applied to persons, structures, equipment or any of a thousand different things. In this instance, the term applies to existing Federal irrigation projects and districts in which the Bureau of Reclamation has an interest.

Irrigation projects and districts in the 17 Western States experienced severe financial difficulties in the depression of the 1930's and, like many private concerns, were forced to postpone all maintenance work except that absolutely necessary to keep water running. Following this came inflexible demands on manpower, equipment and supplies of World War II, which took up where the depression left off, further deferring accumulated maintenance of Reclamation and irrigation projects.

These conditions, coupled with the high postwar costs have continued almost up to the present time. Consequently, there is a backlog of delayed operation and maintenance work, which, in the best interests of reclamation projects, should not be longer delayed.

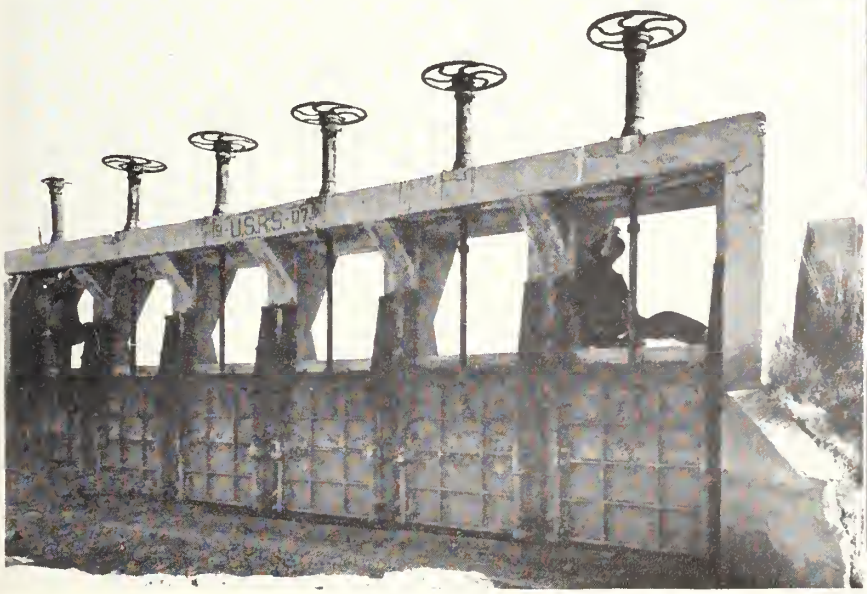
The cost of performing this backlog of delayed operation and maintenance work is in practically all cases beyond the ability of the districts to finance on a current basis, particularly when considered in connection with the relatively high and increasing annual operation and maintenace costs. However, the cost of this delayed work can be met by the water users if spread in installments over a sufficient number of years.

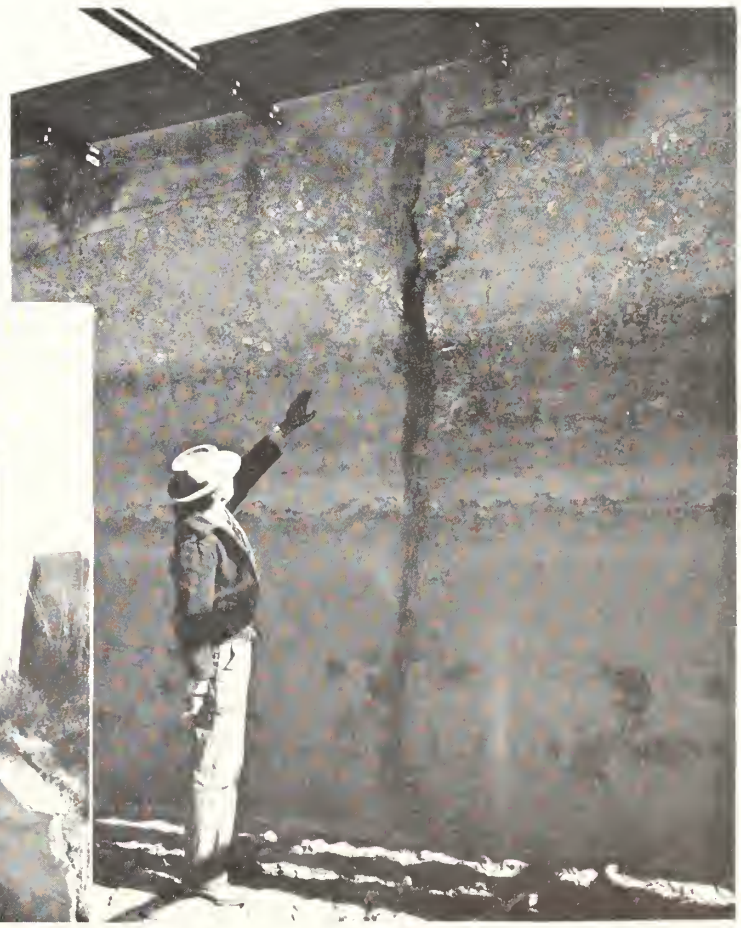
By placing these projects in good operating condition now, crop losses, which may occur through interruption in water service, can be avoided and precious irrigation water can be husbanded and conserved through the repair, replacement, improvement, and modernization of the many existing deteriorated and leaky, wooden structures, and other irrigation features that will bring project irrigation systems and works to an efficient operating condition. It should also result in lower future operation and maintenance costs and improved service.

An inventory of the rehabilitation and betterment needs of the existing projects was initiated following the war, and an improvement program was started on a limited scale in fiscal year 1949, when Congress appropriated one and a half million dollars for this purpose.

Obviously, only the less costly and more urgent needs of a few projects could be undertaken with these funds. In making the appropriation, Congress pointed out that work should be done first on those projects with smaller monetary requirements, and that any remaining funds be used to carry out rehabilitation and betterment on those projects where needs were most urgent.

The report of the conference committee, in approving the appropriation of one and a half million dollars for this pro-





IN NEED OF REPAIR—below, the upstream face of a gate structure on the Carlsbad project in New Mexico. Note the fallen separation blocks and also the broken wheel on the first gate from the left. At right, on the same project, a close-up view of the center abutment crack in the left wall of the Pecos River Flume—also cap slippage. Both photos by C. W. Kapus, Region V.

gram, called attention to the need for basic legislation authorizing the rehabilitation and betterment work to be undertaken in the future on a deferred repayment basis. In view of the need for spreading payments over a period of years, such authorizing legislation appeared to be particularly desirable so that rehabilitation and betterment could be performed with repayment spread over a period of years within the financial ability of each particular project.

A bill (H. R. 1694) to accomplish these objectives, is pending in Congress. If this bill is enacted into law it will represent a long step forward in a program that will make possible the performance of long delayed and urgently needed maintenance, improvement, and modernization work on many of the older irrigation projects.

Once a rehabilitation program including repairs, replacements, improvements, betterments, and modernization has been accomplished to place the irrigation system in an up-to-date condition, the annual charges to meet deferred repayment of the cost will be offset by decreased annual maintenance costs, increased economy in operation, more efficient service, and greater conservation of the water supply.

The Rio Grande project in New Mexico and Texas is one that has been operating successfully and economically over a long period of years, but in spite of this history of achievement there is a need for considerable rehabilitation and betterment work as a result of long delayed maintenance. Improvements and modernization of the irrigation system are required to meet present-day requirements of mechanized operation and maintenance, farming, and transportation; and to keep pace with the extensive developments and improvements which are being carried out on the farms in land leveling, farm irrigation facilities and practices, farming methods, crop programs, and general farm improvements; and to conserve the available water to the maximum possible extent, in order to meet the requirements of the project now reaching full development.

The Rio Grande project was constructed and is being operated by the Bureau of Reclamation for the multiple purposes of meeting stream flow requirements to Mexico as agreed upon in the treaty with that country, the irrigation of project lands consisting of 155,000 acres and the incidental development of hydroelectric power. Project lands are well developed and highly productive and the continued high level of production is not only essential to this section of the Rio Grande but to the Nation as a whole. The project comprises two irrigation districts, the Elephant Butte irrigation district in New Mexico and the El Paso water improvement district No. 1 in the Texas portion of the project.

Although the entire Rio Grande project has the problem of providing for delayed maintenance work, El Paso County water improvement district No. 1 provides a specific example of the type of service that can be performed under a rehabilitation, betterment, and modernization program. This district has shown an interest in the program and in this particular case it has been possible to complete the study and agree on a general plan. The proposed work can best be carried on over a period of from 4 to 5 years and will put the irrigation facilities of the district in first-class operating condition to meet present-day standards. It includes replacing wooden farm turnouts, checks, and bridges with more permanent type of construction, construction of a canal-regulating basin, measuring devices, office, shops, and storage buildings, ditchriders' houses, extension of drains and realinement of certain laterals, with some concrete lining in sections where seepage losses are raising the water table of adjoining land.

Practically all of the existing original bridges in the district are in need of replacement as a result of deterioration of the wooden structures and because of the greatly increased weight of farm and transport equipment now in use as compared to that in use when the bridges were originally built 25 to 35 years ago.

Timber checks installed between 1917 and 1921, now with 30 years' service, are so deteriorated they must be replaced faster than they could be paid for through regular annual advancements of funds for operation and maintenance. In many instances wooden farm turnouts have reached the end of their useful life, and a program has been under way since 1936 to replace these structures in cooperation with individual water users. However, this cooperative replacement program has not kept pace with the needs, and the number needing replacement now is beyond the scope of the cooperative program.

Laterals must be replaced to prevent waste of water and provide better service and further drainage, thus preventing seepage and waterlogging of project lands. Workshops need repair and enlargement. Ditchriders' houses must be constructed, additional mechanical equipment is needed for efficient operation and maintenance. Similarly, as the project reaches maximum development and the water supply is progressively being more intensively used, accurate water measuring devices—essential to an effective water conservation program—are needed for both laterals and farm turnouts.

The rehabilitation and betterment needs of the El Paso County water improvement district No. 1, described here, serve only as an illustration of the work required on most of the older projects in order to place them in first-class operating condition and prevent crop losses attendant to interruption of water service. The same needs exist in other older projects in Region V.

The Balmorhea project in southwestern Texas needs additional storage as well as improvement work on the distribution system. As yet it has been impossible to develop a satisfactory program to meet the needs as the water users do not feel able to finance the added cost.

Now is the time to inventory our needs and develop a program that will place our projects in sound, modern, up-to-date physical condition so that the greatest efficiency in operation, most economic maintenance, and maximum conservation of water may be attained, and continued high production of agricultural products may be assured in the future.

There is nothing mystical or novel in the term "Rehabilitation," particularly when it is used in connection with replacement needs of the older projects; in fact, "farm rehabilitation" has been extensive during the past 5 years on the Rio Grande project.

During the past 5-year period water users have undertaken major changes, and modernization of the farm irriga-

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SPRINKLER TESTS ON THE COLUMBIA BASIN PROJECT

by

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SPRINKLER IRRIGATION IS THE OLDEST METHOD of watering crops, because rainfall itself is sprinkler irrigation.

But this does not prove that sprinkler irrigation is the best method for applying moisture to all types of soils and crops.

Thus it is that on the Columbia Basin project of eastern Washington, the Bureau of Reclamation has launched a series of investigations which it hopes will answer some of the many questions asked about the future of sprinkler irrigation in the vast development. The project area never has had enough rainfall to assure success for anything but dry-land grains, and then only in years or cycles of relatively high precipitation.

Existing information, as far as the project itself is concerned, is inadequate. In a few scattered places, water from wells or lakes is used for sprinkler irrigation. But the soils represented and the types of crops grown do not provide a cross-section of conditions that will be encountered when extensive acreage is served by the great network of canals and other structures now shaping up in the project. By 1952, large-scale settlement will be underway. Farmers will have to decide what type of irrigation they want. By our pre-settlement research in sprinkler irrigation, we're going to try to have some of the answers ready for the farmers.

Sprinkler irrigation has one point definitely in its favor on the Columbia Basin project—cheap electrical power. But that factor alone isn't enough, because power costs, even at low rates, will run from $2 to $4 per acre per season. The farmer must consider, too, that the initial costs of sprinkler systems are, in most instances, higher than for gravity methods. He must consider, too, the type of soil he will work, kinds of crops he will grow, and the area he will attempt to cultivate.

On the Columbia Basin project, the Bureau is testing sprinkler irrigation at three different locations. The most extensive operations are at the Winchester Development Farm, where the light-textured soil varies from 18 to 36 inches. This soil seems more favorable for sprinkling than for regular surface irrigation because the soil has an extremely high infiltration rate and is subject to blowing.

A second test area is near the Pasco Pumping Plant of the project. This is class 3 ST land, the "3S" indicating the soil is shallow and the "T" meaning that the slope (topography) is between 10 and 15 percent.

The third area under sprinkler irrigation is on extremely porous soil near one of the Pasco unit canals. This sandy soil, which blows easily and collects in the canal, can be served most easily by sprinklers. Here the Bureau is developing a 20-acre plot on an experimental basis in response to the requests from residents of the Pasco area. We hope this will determine whether sprinkler irrigation will make it feasible to add areas of coarse sandy land to irrigable acreage of the project.

The Winchester farm presents an ideal arrangement for testing sprinkler methods because it will permit parallel observation with gravity irrigation. This farm, with about 75 acres under sprinkler and 5 acres under the traditional gravity system, is one of three already established on the project to test crops, fertilizers, and irrigation methods for the benefit of future settlers. The development-farm program is a joint venture of the State College of Washington, the Bureau of Reclamation and the United States Department of Agriculture.

We believe that the Winchester sprinkler tests will approximate conditions the farmer will encounter on perhaps 20 percent of the land in the project, with one basic difference—the Winchester Farm gets its water from a well, but water for sprinkler systems on privately operated farms will come from the main irrigation network now under construction.

INSTALLING TEST SECTION—six-inch invasion pipe for sprinkler irrigation on Winchester development farm. The man in the foreground is checking a riser pipe before installing a valve, which will be the outlet for a portable aluminum lateral line. Photo by Harold E. Foss, Region I photographer.

Advantages of Sprinkler Irrigation

1. Under most conditions should save water.
2. Under some conditions will save labor.
3. Reduces soil erosion.
4. Lessens drainage problems. Eliminates necessity for surface wasteways, when carefully supervised.
5. Land leveling, borders, and corrugations are unnecessary.
6. Permits watering steep slopes and rough land.
7. Porous soils are watered more efficiently.
8. Avoids creating uneven soil fertility, caused by removing topsoil from high areas as a result of leveling operations.
9. Requires less skill in applying water.
10. Under average conditions permits more regular hours by operator.

Disadvantages of Sprinkler Irrigation

1. Power costs, even when cheap electricity is available, will run from $2 to $4 per acre per season.
2. Purchase and installation call for large cash expenditures.
3. Labor required for moving pipe is high, even though it may be less than labor requirements for surface irrigation of uneven or steep land or land which is otherwise difficult to irrigate by conventional methods.
4. Depreciation of equipment constitutes a large item of expense.
5. Wind interferes with sprinkling, causing uneven distribution.
6. Desilting sumps with weed and trash screens are required to reduce wear of sprinklers and prevent them from plugging when water does not come directly from well.
7. Unless a sprinkler is so designed to meet emergencies arising from breakdown of sprinkler or canal system, difficulty may be experienced in catching up with the water requirements of the crops.

On the Winchester farm, the possible overall head is 370 feet, of which 100 feet is above ground level. The pressure at the most distant sprinkler in the system is 30 pounds.

Four different types of pipes are used in the 3,400 feet of underground mains. There are 700 feet of 6-inch asbestos-cement pipe, 700 feet of 6-inch bituminous-coated spiral-welded pipe, 1,400 feet of 6-inch and 8-inch treated invasion pipe, and 600 feet of 4-inch untreated invasion pipe.

The Bureau believes that the use of different pipes will yield valuable information for settlers regarding durability.

The invasion pipe selected for treatment was vat-dipped in an aluminum mixture with an asphaltic base containing a rust inhibitor. Best results were obtained when the temperature of the mixture was above 85° F. Risers were welded on the pipe before treatment.

In using the spiral-welded pipe, risers were welded within 18 inches of the pipe end, thus permitting recoating of any treated area damaged during welding. The pipe is connected with dresser-type couplings.

Since the Bureau had acquired about 800 feet of war-surplus asbestos-cement pipe, it was decided to convert this to sprinkler use to compare its durability with the metal pipes. The manufacturer's recommended procedure for making riser installations is expensive and probably would outlaw the use of this type of pipe on private farms if his custom-made risers were used.

The Bureau successfully cut installation costs by using mortar in attaching risers. Each riser was equipped with a flange at its lower end to provide additional protection against pressure. The mortar was a 1:2 mixture (1 part cement, 2 sand) with sufficient water to give a pliable mixture. A band of mortar, 6 inches thick, was formed around the entire circumference of the asbestos-cement pipe and special attention was given to tamping the mortar about the riser connection to insure a compact joint. The mortar was permitted to cure 7 days before pressure tests were made. Experiments showed that risers function satisfactorily under 45 pounds of pressure. In fact, a 123-pound pressure was used in one test without harm, thus indicating that a 3-to-1 safety factor is possible.

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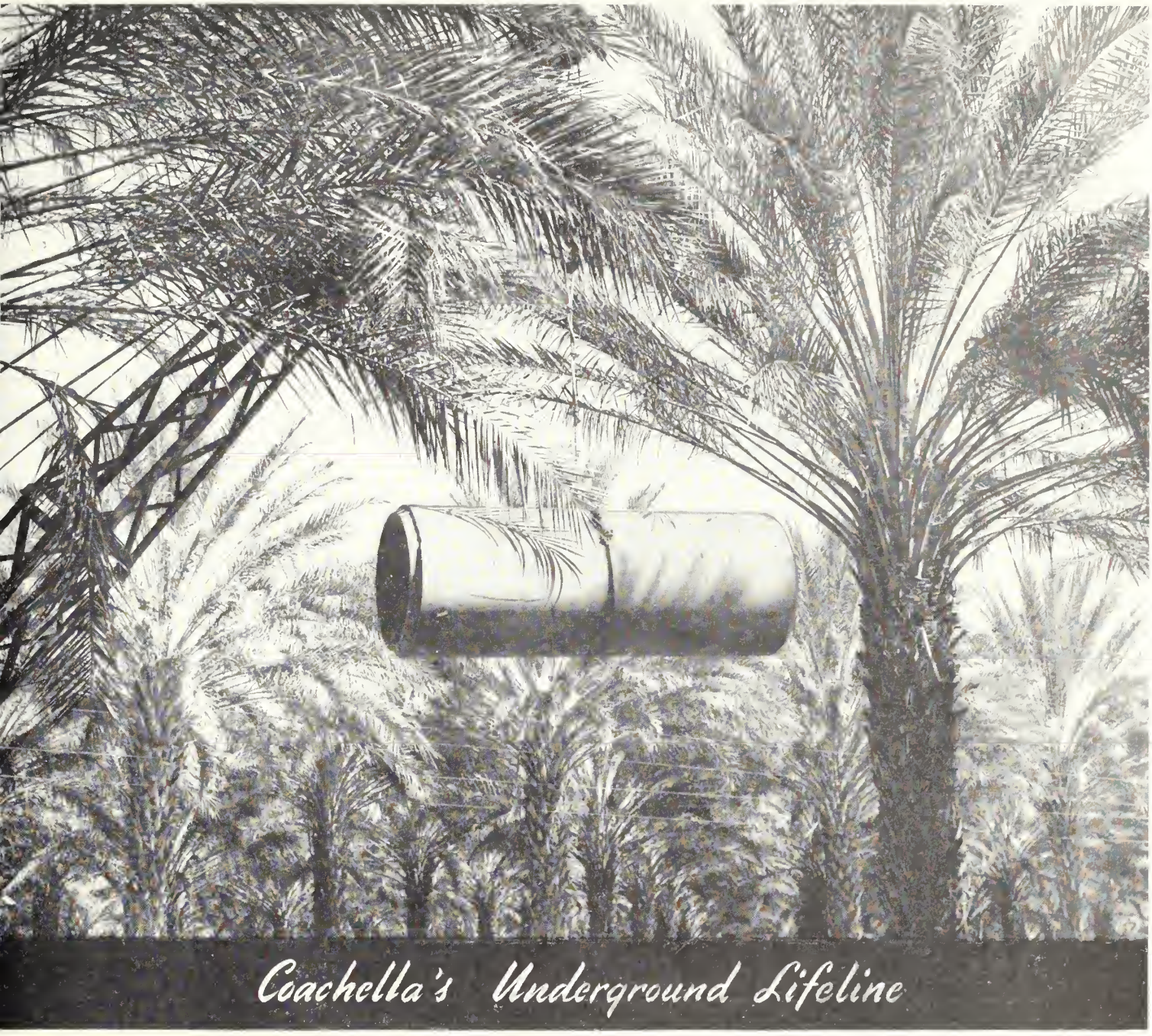
TEN YEARS AGO—operators of privately owned farms like that above experimented with sprinkler irrigation. After this photo of a field of lima beans was taken, the farm was reconverted to gravity irrigation because of difficulties encountered in handling the heavy steel pipe then used in surface lines. Since that time large-scale manufacturing of aluminum pipe has given a boost to sprinklers. Photographer unknown. Date of photo August 17, 1939.



Coachella's Underground Lifeline

These beautiful date palms shroud a large section of pipe being lowered into the ground. Many such pipe sections make up the valley's underground lateral system, which prevents evaporation by the sun's rays and assures continued crop production in the area, which ultimately will total 75,000 acres.

Thirsty fields of the Coachella Valley—producing as much as $4,000 on a single acre of ground in a year—are now drinking from underground lifelines through which Colorado River water flows via the Coachella Branch of the All-American Canal.

This southern California desert oasis, for the first time in its 55-year irrigation history, will have a dependable water supply this year for the acreage now under cultivation. Construction by the Bureau of Reclamation of underground pipe laterals to serve the valley's potential 77,000 acres of irrigable land is well along. By the end of June 1950 some 45,000 acres will be receiving water from the underground system. Only about 18,000 acres were irrigated by pumping from underground storage before the arrival of Colorado River water.

The Coachella Valley is a fabulous agricultural area. Land, sun, and water combine to produce dates, citrus, grapes, and truck crops in abundance for the specialty markets of the Nation. Grapes and truck crops, maturing in the off-seasons, command premium prices. Last year the valley produced nearly 16 million dollars from 22,677 cropped acres. Per acre crop values ran as high as $4,000 on some farms. However, the average for all land was around $700 per acre. This productivity emphasizes the necessity for a continued and adequate water supply without which the valley's lands would have but little value.

Exhaustive studies by competent engineers revealed that the present underground supply of water would maintain only 8,000 to 12,000 acres in continuous production. Without any other possible source of supply, Colorado River water

was the only answer, if the arable acres of the valley were to be irrigated, or even if the present level of agricultural production were to be maintained. Water from the Colorado River encircled the valley in 1948 upon completion of the 123-mile Coachella Main Canal, but a distribution system was necessary before that water could be used. Possible use of either an open ditch lateral system or an underground pipe system was given intensive study, and the pipe system was finally selected after the comparative advantages, both from an engineering and a farming standpoint, were considered.

Water, the most precious commodity aside from the fertile land of the valley, must be conserved if it is to turn raw desert into green fields. The underground pipe system materially reduces losses by seepage and evaporation and permits an accurate measurement of water which in turn minimizes wastage. The accurate measurement of water further allows the farmer to farm both intelligently and scientifically with resultant increases in crop production. Even land is conserved, as open laterals would require use of an estimated 2,000 acres of land (which is now destined for farming) for rights-of-way, and would also necessitate payment of severance damages. Embankment obstructions of open canals, which contribute greatly to traffic hazards, are eliminated in the underground pipe system.

Furthermore, the underground system is easily adapted to fit the farmers' present pipe distribution systems, while open laterals would not furnish sufficient head in most cases to operate through the farmers' pipelines. Valley topography allows the pipe system to use the trough-shaped valley contour to maximum advantage. Maintenance of the underground system will cost relatively little when compared to the expense of removing wind-blown sand and water weeds from open unlined ditches or moss and sand from open lined laterals. Uniform flows are possible at the deliveries as, in a continuously "wet" system, head variations are minimized.

On December 17, 1947, the land owners of the Coachella Valley gave graphic evidence of their approval of the proposed underground pipe distribution system and their confidence in their own ability to repay the construction costs by voting 1,133 to 19 in favor of construction of the system. The approved plan provides for construction of laterals to deliver water to 77,000 acres of arable land, including some 9,000 acres of Indian land for which turn-outs have not been constructed and to which in some cases laterals have not been extended, and 7,000 acres of land which are yet to be reclaimed through drainage or leveling. Except in isolated instances, the farmers of the valley have voluntarily cooperated to the fullest extent by donating permanent easements over their properties.

The system is primarily a low pressure gravity flow underground concrete pipe system, with pipe sizes ranging from 12-inch diameter to 84-inch diameter, providing in general a delivery of 3 cubic feet of water per second to each 40-acre unit. More than 475 miles of underground pipe will assure an adequate distribution of the 1,300 cubic feet of water per second which enters the Coachella Valley through the canal.

Features of the system include a 7.2-mile high pressure lateral consisting of 78- and 84-inch diameter reinforced concrete pipe and 78-inch diameter reinforced concrete steel cylinder pipe. In the case of lands which are at too high an elevation to be served by gravity flow, low lift pumping stations will be used to raise the water to the required level. Every effort has been made to effect lateral alignments which will least disturb existing improvements and will facilitate connection of the system to present distributaries of the farmers. The proficiency attained by the contractors' forces in laying the concrete pipe is amazing, the work progressing at a faster rate than was originally contemplated, and some of the first laterals are now in service.

The Bureau of Reclamation has taken a long step ahead in providing this underground pipe distribution system, the first of its kind ever attempted on such a large scale by the Bureau, and quite possibly in the whole world. The End

Freshly turned earth clearly indicates route of underground pressure pipe across Coachella Valley. The underground lateral system carries water down into the valley from the Coachella Main Canal built along the mountain slopes.

WASTE NOT, WANT NOT

by J. L. TOEVS, Chief, Land Development Section,
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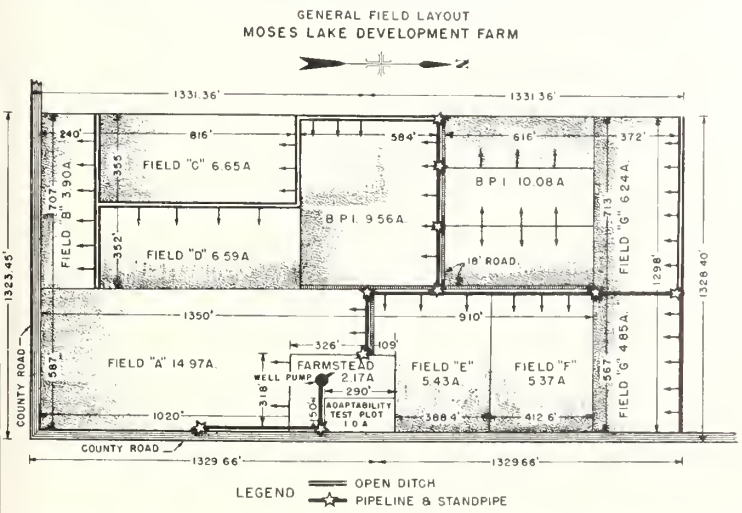
Pumping irrigation water from 150 to 300 feet is expensive. On the Columbia Basin project in eastern Washington, where virtually every drop of water used is pumped from the ground or from the Columbia River system, it is important that it be used economically and without waste.

Therefore, the Bureau of Reclamation established a development farm program on the project to determine the economic duty of water and to promote good irrigation practices. Two miles east of Moses Lake, Wash., is an 80-acre unit, chosen as the first place where the practical irrigation problems facing project settlers are being studied. Typical of certain areas of the irrigable land in the project, this farm has 24 to 26 inches of sandy loam soil overlaying sand and gravel.

As a case history, the Moses Lake farm presented a problem all too familiar to new settlers. The land at the farm was generally flat, although it had enough irregularities to require leveling. Before leveling could be started, an extremely careful job had to be done in laying out the fields because the limited soil depth made it impossible to establish a common grade for the entire farm. The resulting field pattern required a distribution system with irrigation runs in three directions.

On a new irrigation project, top priority must be given to the conservation of soil, particularly where its depth is limited. On this farm the first soil-conservation steps were taken in the leveling plan, while the prevention of soil losses through water erosion and leaching was provided for in the distribution system layout and in the plans for irrigation operations.

As shown in the farm layout sketch, irrigation runs on the farm vary in length from 240 to 1,350 feet. Under ordinary conditions the distance water travels in a continuous furrow greatly affects the amount of deep percolation losses. On the Moses Lake farm the variation in length of run from



ACCURATE CONTROL OF WATER—by means of the gated pipe used on the Moses Lake farm which carefully delivers the correct amount of water to each furrow. Photo by Harold Foss, Region I.

the shortest practical, to the longest (which was much more than the usually accepted maximum) was chosen deliberately to provide a length-of-run study under controlled field conditions.

During early season irrigation, the long field south of the farmstead is divided into shorter runs by using a portable gated pipe. (See photo above.) Because this pipe eliminates a cross ditch, no land is lost for ditch and turn rows. In 1948, after corn and potatoes were laid by (or had developed to the point where no further cultivation or field work was required) it was found that the infiltration rate slowed up enough so water could be run the full length of the long fields without overirrigating the upper end. It is likely that these extremely long continuous runs will not be advisable at any time during the irrigation season after the organic content of the new soil has been built up.

An exact record is kept of all water used on the farm. The discharge from the pump is metered to one-thousandth of an acre-foot. Meter readings are taken daily and only when two or more fields are irrigated at the same time is it necessary to estimate the division of water between fields. The total of these estimates must check against the meter.

All the cropland on the farm, except 3 acres left idle for experimental use in 1949, was cultivated in 1948. Crops included 17 acres of potatoes, 18 acres of barley used as a companion or nurse crop to alfalfa and red clover, 10½ acres of alfalfa, 8 acres of field corn, 7 acres of field beans, 5½ acres of mixed pasture, and approximately 5½ acres of assorted experimental crops.

During the season in which these crops were grown, 2.3 acre-feet of water per acre were used. This is 1.7 acre-feet less than the 4 acre-feet recommended in problem 4 of the Joint Investigations of the Columbia Basin Project as the probable requirement for this class of land. It is recognized, however, that conditions in 1948 were not normal. Rainfall for April, May, and June exceeded the average by 3.83 inches. Nevertheless, it appears on the basis of accumu-

lated operating experience that 4 acre-feet, if carefully managed, should be ample for a diversified cropping program on the Moses Lake farm and on similar project lands.

Deep percolation losses were not excessive on this farm. They were determined by deducting the amount of water required to replenish the soil moisture within the root zone, field waste, computed evaporation, and ditch losses from the measured quantity of water applied. The amount of water retained within the root zone was checked by making moisture determinations on soil samples taken before and after each irrigation.

The period of experience on the Moses Lake farm is too short to justify final conclusions about the length of runs, rate of water application, frequency of irrigation, and other factors comprising an irrigation program of maximum efficiency. For more accurate determinations of these and other factors pertaining to the economic use of water on Columbia Basin project farms, the work started on the Moses Lake unit and on similar farms on other parts of the project will be continued.

The development farms are leased to operators by the Bureau of Reclamation, with the Bureau reserving the right to offer suggestions regarding operation of the property. Its proposals, plus results of experimental work done by the United States Department of Agriculture's Bureau of Plant Industry and the Washington State Experiment Station on a portion of the farm unit reserved for their use, should lead to a basic pattern for the most efficient and economical use of project water. As this information becomes available it will be passed along to new settlers. THE END

WATER—Where It's Needed

(Continued from page 164)

way of James River in South Dakota. Large tracts of land will be watered and many cities supplied through this scheme. The Oahe unit will irrigate a large tract near the James River at Huron, S. Dak., by pumping water over the divide from the Missouri River. A complicated trade and transfer plan for the Lower Platte units in Nebraska would bring varied and valuable benefits to that area.

East of Denver and south of the South Platte River a large area of fertile irrigable lands could be served from the South Platte River if additional water can be obtained. Reclamation has a plant for diverting more than 400,000 acre-feet of water a year from tributaries of the Blue River and adjacent streams through the Continental Divide. This Blue-South Platte project would produce a large amount of hydroelectric power and would have incidental benefits through municipal water supply, flood control, fish and wildlife conservation, and recreation.

Then there is the proposed Gunnison-Arkansas project which would divert water from tributaries of the Gunnison River through Continental Divide tunnels to the upper Arkansas River. Ample irrigable land exists in the Arkansas River Basin which could use 655,000 acre-feet of water if it could be transferred by this project. Pueblo and other Arkansas Valley communities would also benefit.

Around Phoenix, Ariz.—our prize exhibit of the value of irrigation—large areas are in danger of going out of production due to an overdrawn "water account." To balance the supply of water and land, the Bureau of Reclamation proposes the Central Arizona project which would transfer 1,000,000 acre-feet of water a year from the Colorado River near Parker Dam through a long pump aqueduct and canal system to Phoenix.

West of the Wasatch Mountains in Utah the bed of prehistoric Lake Bonneville contains vast areas of irrigable lands, needing water to bring them into flourishing production. The potential Central Utah project, a major diversion and replacement water proposal, could supply water to that area from the Colorado River Basin. Water from the eastern slope of the Wasatch Mountains would be collected and conveyed through an aqueduct and tunnel to the western slope, and water from the Colorado River, through a second, lower-lying aqueduct, would take care of the lands now dependent upon the water to be exported.

The Central Valley of California is unique among western valleys not only for its size, but also for the distribution of precipitation within the valley. The project now under construction will transfer excess flows of the Sacramento River to the water-deficient San Joaquin Basin to the south. But even this major project will not be enough to completely solve the valley's water problems. The Bureau of Reclamation is now considering the possibility of importing water from the Trinity to the Sacramento River.

The metropolitan water district of southern California constructed and operates the Colorado River Aqueduct to serve southern California coastal areas near Los Angeles with water from the Colorado River. During the war an extension of this aqueduct was authorized and constructed to avert threatened water shortages in San Diego. Already, less than 2 years after completion of the San Diego Aqueduct, it appears that it may be inadequate to meet the demand during an extended dry period under growing population and irrigation use, and the local interests have requested the Bureau to investigate the feasibility of building a twin barrel to double the capacity.

These examples indicate that the Department of the Interior and the Bureau of Reclamation are helping the States and the water users to redistribute the water in the Western States so that water supply and land resources come more nearly into balance. But even after all these projects have been built, vast areas will still be in need of water, and tremendous discharges of our Pacific coast streams will still be wasted to the sea.

Is there some way to transfer the excess flows of the Columbia River or some of the other Northern Pacific streams to the parched areas to the south? We believe that it may some day be economically feasible and that the construction of such a project would involve no insurmountable engineering difficulties. Accordingly, the Bureau of Reclamation has begun a reconnaissance survey to estimate the potential source and quantity of surplus water, the location and water demands of the potential service areas, the value of such water in the various areas, and many more such factors. It will probably require years of study, but eventually we believe the demand for more and more water will make such an unprecedented project a necessity. The West is not yet staggering in thirst toward the last water hole. THE END

Rehabilitation and Betterment

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tion system, leveling, and releveling has been extensive. New farm irrigation plans involving changes in farm ditches, installation of farm ditch turnouts, and farm checks have been proceeding at a fast rate. Obviously, the farmers believe that farm irrigation system modernization is practical and economical.

Good business practice requires that the plant be kept in good condition. During years of economic stress or war periods, the plant cannot be replaced, as required by process of physical deterioration, by ordinary maintenance costs only. In attempting to do this, normal maintenance suffers, with the final end result of a huge backlog of accumulated heavy maintenance facing the plant at once. In such a case, rehabilitation accomplished by a different manner of financing is of utmost importance to the continued existence of a first-class plant, and certainly a first-class irrigation system.

THE END

Sprinkler Tests on Columbia Basin

(Continued from page 182)

On one part of the Winchester farm, the Bureau may increase the normal working pressure of 30 pounds to 60 to determine whether operating costs can be reduced.

The possibility of sprinkler irrigation at a lower cost by using a higher pressure seems favorable on the Columbia Basin project because of the reasonable power rates. It is hoped that even the increased costs for high-pressure pumping will be offset by the saving of labor due to the wider spacing of laterals.

Five portable lateral lines, totaling 3,300 feet, are used in the present set-up on the Winchester farm. All the lines are 4-inch aluminum tubing, virtually all in 20-foot lengths. However, 600 feet of 40-foot pipe was purchased so that comparisons on ease of handling can be made with the 20-foot sections. Each section has a male and female quick coupler.

All sprinkler heads have the same capacity and all pipes have the same diameter. This is highly desirable from the standpoint of efficient handling.

Sprinkler heads have a capacity of 7 gallons per minute, thus requiring the operator to move his laterals only in the mornings and evenings. This permits him to devote most of his day to performing other farming activities.

Thus far, some acreage on the farm has been planted to alfalfa and Ladino clover primarily for seed production. Other parts have been seeded to pasture and alfalfa to support a dairy herd that will be established on the farm.

As on other development farms in the project, careful records are maintained to provide authentic information for settlers who will begin moving into the northerly part of the project in 1951 in anticipation of the 1952 delivery date of water to many thousands of acres.

On the small acreage near the Pasco pumping plant, the sprinkler system is a model of simplicity. Pressure is obtained by tapping into the discharge pipe leading from the main pumping plant to the main lateral of the distribution system for the 5,400-acre Pasco unit. This is ample to overcome friction loss in the underground pipe and laterals and provide 30 pounds of pressure at the sprinkler heads. Underground pipe, with the riser mounts, was located in the direction of the slope, thus permitting lateral settings to be made in the direction of the least slope to hold the difference in pressures to a minimum.

In this system, sprinkler heads with a capacity of 8 gallons per minute are used to convey water to land planted to pasture.

Farther south in the Pasco unit, where the sandy soil is encountered, a system somewhat similar to that on the Winchester farm was installed. War-surplus invasion pipe was used in the underground system and joints were the common couplings furnished with the pipe. Angles were formed by welding, and welding also was used in placing the risers at 60-foot intervals. In all, 1,300 feet of 6-inch pipe and 460 feet of 4-inch pipe were used.

One thousand feet of the underground line is located along the canal bank to permit the stabilization of a particularly troublesome blow area by using sprinklers.

Laterals are 2-inch portable aluminum pipe, 20 feet long. Twenty-six sprinklers, with a capacity of 6 gallons per minute, are available. Although the soil has a high infiltration rate, low-capacity sprinklers are used so that the operator, who lives some distance away, can leave the laterals in one location for as long as 7 hours.

The centrifugal pump serving the system is operated by a 7½-horsepower electric motor. The unit provides 155 gallons per minute at a head equivalent to 108 feet. This is sufficient to develop 30 pounds of pressure at the most distant sprinkler.

To stabilize the area, it is being planted to grass-legume mixtures.

Present plans of our development program do not include additional sprinkler lay-outs. Results obtained on tests completed during the first few years will dictate whether our studies should be expanded. It may prove desirable to match sprinkler irrigation side by side with surface irrigation on land ideally suited to surface methods of distribution.

THE END

CAUTION: The sale of sprinkler irrigation systems has entered into a competitive market. Consequently, some systems are being designed to meet the purchaser's pocketbook rather than the water requirements of the land to be irrigated.

Look out for:

- undersize pumps which do not supply sufficient pressure or water at the sprinkler head to give a good water distribution pattern,
- undersize mains and laterals resulting in larger motors and higher power costs,
- too few laterals and sprinklers to enable sufficient irrigations to meet the consumptive water demand of growing crops.

This same word of caution also applies to surface method distribution systems with respect to undersize pipe lines, flumes, and too few drops in open ditches to prevent erosion.

Bashore Receives New Honors

Former Commissioner of Reclamation Harry W. Bashore (above) recently received the honorary Degree of Doctor of Laws from the University of Wyoming at Laramie on June 6.

At the ceremony presided over by Dr. G. D. Humphrey, president of the university, the following citation was read:

> Harry William Bashore, eminent civil engineer, successful builder of irrigation projects, and able administrator, has devoted his entire professional career of over 45 years to the development of reclamation in Wyoming and the West.
>
> He has had an outstanding engineering career, starting in 1906, when he first joined the United States Bureau of Reclamation as a junior engineer on the North Platte project located in eastern Wyoming and western Nebraska. For 21 years he served in an exceptional manner on the project, becoming superintendent of this very extensive irrigation development. The hundreds of thriving farms in eastern Wyoming and western Nebraska are a monumental testimony to his ability as one of the great reclamationists of his time.
>
> From 1927 to 1933 he served as construction engineer on several large irrigation projects in a number of Western States. In 1933 he returned to Wyoming as construction engineer for the Bureau of Reclamation on the Kendrick project.
>
> In 1939, because of his outstanding record and many achievements in the field of irrigation and reclamation, he was named Assistant Commissioner of the United States Bureau of Reclamation. He served in this capacity until 1943, when he was appointed Commissioner of Reclamation, a position which he held with distinction until 1946 when he retired at his own request.
>
> During his term of office as Commissioner of Reclamation and as a result of his vision and leadership, the present plans for the over-all development of the Colorado River and Missouri River Basins became a reality.
>
> Since his retirement as Commissioner of Reclamation he has served as consultant to the United States Department of the Interior. In 1946 he was appointed Federal representative on the Upper Colorado River Basin Compact Commission. While serving as chairman of this important commission he made many vital contributions to the development of a compact allocating the water of the Upper Colorado Basin among the five Western States in the Upper Basin.
>
> He has manifested a continuing interest in the people of Wyoming, in the progress of the university and in the development of the State's resources. His counsel has been extended willingly to many young engineering graduates of this university.
>
> Outstanding engineer, capable administrator, and distinguished public servant, he is indeed worthy of the highest honor which the University of Wyoming can bestow.

In addition to this honor Mr. Bashore has been recently designated United States representative of the Upper Colorado River Commission by President Harry S. Truman. The Commission created by the Upper Colorado River Basin Compact, which was consented to by the Congress in an act signed by the President on April 6, 1949, will include, in addition to Mr. Bashore, members representing the Upper Basin States of Colorado, New Mexico, Utah, and Wyoming.

The Upper Colorado River Commission will make cooperative studies, findings, and reports and carry out other functions under the compact, providing for the distribution and potential development of the water resources of the Colorado River and its tributaries. •

Mirage Flats Dedication

Last June 23 marked the dedication of the Mirage Flats project in Nebraska, one of the reclamation projects made possible under the Water Conservation and Utilization Act of 1939, which was coauthored by Representative Francis Case of South Dakota and former Senator Burton K. Wheeler of Montana.

The principal feature of the project is the Box Butte Dam, a rock-fill structure approximately 87 feet high and 5,500 feet long, designed to provide irrigation for 12,000 acres of land lying south of the town of Hay Springs, Nebr. The area is largely devoted to stock-raising and sustained agriculture has been hampered by inadequate rainfall.

The Honorable Carl S. Horn of Hay Springs, early sponsor of the project, served as host at the celebration. Director of Operation and Maintenance G. W. Lineweaver, representing Commissioner Michael W. Straus, was the principal speaker, and former Reclamation Commissioner Harry W. Bashore presided as master of ceremonies at the dedication. Congressmen present at the celebration were Representative Fred L. Crawford of Michigan, Dr. A. L. Miller, Representative from Nebraska, Representative Compton I. White of Idaho, Representative Francis Case (coauthor of the Case-Wheeler Act) of South Dakota, and Representative Norris Poulson of California. Other speakers included Harry Polk, president of the National Reclamation Association, Chris Petrow, secretary to Governor Val Peterson, Harry D. Strunk, president, Republican Valley Conservation Association of McCook, Nebr., A. E. McClymonds, regional conservator, Soil Conservation Service, Lincoln, Nebr., H. C. Gould, associate director, extension service, Agricultural College, University of Nebraska, Vern Lindholm, Niobrara River Development Association, John A. Goe, assistant chief of operations, Soil Conservation Service, Washington, D. C., Regional Director Avery A. Batson of Reclamation's Region VII at Denver, Colo., and Don Barnes of Denver, Colo., representing the Bureau of Reclamation's Chief Engineer L. N. McClellan.

The Soil Conservation Service has arranged for the sale and development of the farm units within the project. Only a small number of units remain unsold. Approximately 80 percent of the settlers now on the project are veterans of World War II. The Mirage Flats irrigation district has been formed and the Bureau expects the water users to take over the project in the near future. •

U. S. GOVERNMENT PRINTING OFFICE 1949

NOTES FOR CONTRACTORS

Contracts Awarded During June 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2555	Colorado-Big Thompson, Colo	June 2	Construction of Brush-Yuma 69-kilovolt transmission line using aluminum conductor, schedule 1.	R. N. Campsey Construction Co., Denver, Colo.	$273,293
2570	do	do	Construction of Wiggins-Hoyt 115-kilovolt transmission line using aluminum conductor, schedule 1.	do	88,394
2609	Minidoka, Idaho	June 10	One 3,333-kilovolt-ampere transformer for use as spare transformer for interconnection substation, Idaho Power Co.	Westinghouse Electric Corp., Denver, Colo	25,987
2618	Missouri River Basin, S. Dak.-Nebr	June 27	Construction of Fort Randall-O'Neill 115-kilovolt transmission line using aluminum conductor, schedule 1.	Elliott Construction Co., Omaha, Nebr	333,428
2649	Yakima, Wash	June 23	One 11,200/14,000-kilovolt-ampere, 8,000/10,000-kilovolt-ampere, and 9,600/12,000-kilovolt-ampere transformer with three 115,000-volt and three 34,500-volt lightning arresters for Roza switchyard, schedule 1.	General Electric Co., Denver, Colo	64,107
2619	do	June 24	One 115,000-volt and one 34,500-volt circuit breaker for Roza switchyard, schedules 2 and 3.	Pacific Electric Mfg. Corp., San Francisco, Calif.	24,630
2619	do	June 23	Two 115,000-volt disconnecting switches, one 115,000-volt horn-gap switch, and three current and three potential transformers for Roza switchyard, schedules 4 and 6.	Westinghouse Electric Corp., Denver, Colo	21,033
2624	Rio Grande, N. Mex.-Tex	June 2	One 3,000-kilovolt-ampere package-type substation for Hot Springs substation.	General Electric Co., Denver, Colo	50,131
2630	Central Valley, Calif	June 17	Eight 10,000-pound and seven 5,000-pound radial-gate hoists for Tule River and Deer Creek checks and wasteways, Friant-Kern Canal, items 5, 6, 7, and 8.	Northwest Marine Iron Works, Portland, Oreg.	18,900
2633	Columbia Basin, Wash	June 23	Nine 230,000-volt lightning arresters and 3 current transformers for Grand Coulee right power plant and switchyard, schedules 1 and 3.	do	27,452
2646	Colorado-Big Thompson, Colo	June 30	Construction of 69-kilovolt transmission circuit including cable, from Estes power plant to west portal of Adams tunnel and 115-kilovolt transmission line from Estes power plant to Marys Lake power plant.	Electrical Constructors, Inc., and C. M. Elliott, Chula Vista, Calif.	986,000
2649	Central Valley, Calif	June 22	Construction of earthwork, concrete lining, and structures for Delta-Mendota Canal.	Western Contracting Corp., Westley, Calif	4,165,764
2657	Columbia Basin, Wash	June 30	One 72-inch ring-seal gate and accessories for station-service penstock, Grand Coulee power plant.	Bethlehem Steel Co., San Francisco, Calif	31,505
2660	North Platte, Nebr.-Wyo	June 29	Construction of earthwork and buried asphaltic membrane lining for Fort Laramie Canal, using catalytically blown asphalt, schedule 2.	Inland Construction Co., Cheyenne, Wyo	62,199
2661	Colorado-Big Thompson, Colo	June 14	Installing embedded parts for hydraulic turbines and completing crane installations for Estes and Marys Lake power plants.	Eichleay Corp., San Francisco, Calif	54,800
2666	Hungry Horse, Mont	June 23	Two sets of 15- by 36-foot stop logs for diversion tunnel at Hungry Horse Dam.	Gunderson Bros. Engineering Corp., Portland, Oreg.	20,532
2667	Hungry Horse, Mont	June 27	Four 13.5 x 18.93-foot fixed-wheel gate frames for penstocks at Hungry Horse Dam, item 1.	Willamette Iron & Steel Co., Portland, Oreg	97,685
2685	Boise, Idaho	June 15	35,000 barrels of bulk portland cement for construction of Anderson Ranch Dam and power plant.	Oregon Portland Cement Co., Portland, Oreg	106,750
2701	Boulder Canyon-All-American Canal, Ariz.-Nev.-Calif.	June 30	12,500 barrels of portland cement for construction of Coachella Valley distribution system, units 2, 3, and 4.	California Portland Cement Co., Los Angeles, Calif.	35,000
R1-CB-22	Columbia Basin, Wash	June 20	Left powerhouse draft-tube and bridge-ramp extension at Grand Coulee Dam.	Morrison-Knudsen Co., Inc. Seattle, Wash	21,235
R3-PX-14	Parker Dam Power, Ariz.-Calif	June 8	Construction of eight 6-room permanent residences at Parker Dam Government Camp.	Mardian Construction Co., Phoenix, Ariz	97,560
R5-14	San Luis Valley, Colo	June 21	Construction of quonset huts and facilities for Government Camp at Platoro Dam.	Ward E. Mathias, Monte Vista, Colo	27,521
VII-61	North Platte, Nebr.-Wyo	June 24	Earthwork, lateral lining, and structures, station 130+18.6 to station 172+69.5. Existing lateral 90.4.	Starr Construction Co., Scottsbluff, Nebr	22,463

Construction of Supplies for Which Bids Will Be Requested by October 1949

Project	Description of work or material
Boulder Canyon, Nev	Construction of 15 permanent houses at Boulder City, Nev.
Do	Removing and replacing approximately 70,600 square feet of bituminous sidewalks with concrete sidewalks at Boulder City, Nev.
Boulder Canyon, Ariz.-Nev	One 70,000-horsepower vertical-shaft hydraulic turbine, including pressure regulator, for unit A9 at Hoover power plant.
Central Valley, Calif	Construction of earthwork, concrete lining, and structures for about 8.5 miles of Delta-Mendota Canal.
Do	Approximately 35,000 pounds of fabricated square tubular railing and sheet steel covers for Tracy pumping plant.
Colorado-Big Thompson, Colo	Construction of earthwork and structures for about 5 miles of Poudre supply canal, 1,500 cubic feet per second capacity, near Fort Collins, Colo.
Do	Construction of about 73 miles of 115-kilovolt, wood-pole, H-frame transmission line between Brush and Limon, Colo.
Do	Construction of about 42 miles of 115-kilovolt and about 13 miles of 46-kilovolt wood-pole, H-frame transmission lines between Kremmling and Oak Creek, Colo.
Do	Construction of about 31 miles of 115-kilovolt, wood-pole, H-frame transmission line between Estes power plant and Leyner switchyard, 6 miles south of Longmont, Colo.
Do	Reconstruction of about 2.7 miles of U. S. Highway No. 34 at Granby Reservoir, near Grand Lake, Colo.
Do	Installation of electric motors, pumps, and miscellaneous equipment, erection of tower and equipment in switchyard, and architectural finish work in Granby pumping plant.
Do	Two 15- by 18-foot top seal radial gates and two 10,000-pound radial-gate hoists for Horsetooth supply conduit.
Columbia Basin, Wash	Excavation of about 6.5 miles of Potholes east canal, ultimate capacity of 3,900 cubic feet per second, about 16 miles west of Warden, Wash.
Do	Approximately 65,000 pounds of galvanized fabricated structural steel for 11.95-kilovolt station-service tie circuit towers and take off structure, Grand Coulee power plant and switchyard.
Davis Dam, Ariz.-Nev	Stringing conductor and overhead ground wire for about 238 miles of 230-kilovolt steel-tower transmission line from Davis Dam to Prescott and Mesa, Ariz.
Do	Approximately 220,000 pounds of galvanized fabricated structural steel for switchyard structures at Coolidge substation.
Do	Approximately 190,000 pounds of No. 18 gage sheet steel for Davis-Hoover and Davis-Prescott-Mesa transmission lines.
Davis Dam, Ariz.-Nev., and Gila, Ariz.	Supervisory control and telemetering equipment for Wellton-Mohawk pumping plants and switchyards.
Hungry Horse, Mont	Approximately 170,000 pounds of fabricated structural steel for transformer circuit take-off structure at Hungry Horse power plant.
Do	Station-service distribution switchboards and transformers for Hungry Horse power plant.
Kendrick, Wyo	Installing overhead ground wires and rebuilding all structures at angle points and replacing or repairing all damaged structures between Cheyenne, Wyo., and Greeley, Colo.
Do	Repairing existing telephone line between Casper and Alcova, Wyo., and erecting new telephone line between Alcova and Seminoe power plant.
Missouri River Basin, Colo.-Nebr.	Construction of 88 miles of 115-kilovolt wood-pole transmission line between Sterling, Colo., and Ogallala, Nebr.
Missouri River Basin, Mont	Construction of Moorhead dam and dike. The dam is to be an earthfill structure about 190 feet high and 2,660 feet long at the crest; the earthfill dike is to be about 25 feet high and 540 feet long at the crest.
Missouri River Basin, Nebr	Relocation of about 6 miles of county road at Enders Reservoir.
Do	Construction of one 3-bedroom and one 2-bedroom residences, two 2-car garages, one 24 by 48-foot garage and laboratory building, and 2 sewage disposal, water supply and propane gas systems at Medicine Creek and Cain Bridge diversion damsites, near Cambridge, Nebr.
Do	Construction of one 3-bedroom residence, one 24 by 48-foot garage and laboratory building, and sewage disposal, water supply, and propane gas systems at Trenton damsite.
Do	Construction of one 2-bedroom residence, one 2-car garage, and sewage disposal, water supply, and propane gas systems at Superior-Courtland diversion damsite, near Guide Rock, Nebr.
Do	Furnishing all material and seeding 95 acres on Cambridge diversion dam and dike, and banks of Cambridge Canal, near Holbrook, Nebr.
Missouri River Basin, N. Dak	Construction of 41-mile Bismarck-DeVaul 69-kilovolt wood-pole transmission line, near Bismarck, N. Dak.
Missouri River Basin, Wyo	Installing equipment, constructing foundations, and erecting structural steel for switching equipment at Lusk substation, Wyo.
Do	Control and station-service auxiliary equipment for Boysen power plant.
Do	Control board for remote control and telemetering of Kortes power plant.
Paonia, Colo	Construction of 2 precast concrete pipe siphons, 135- and 100-cubic feet per second capacity, near Paonia, Colo.

The Reclamation ERA

September

1949

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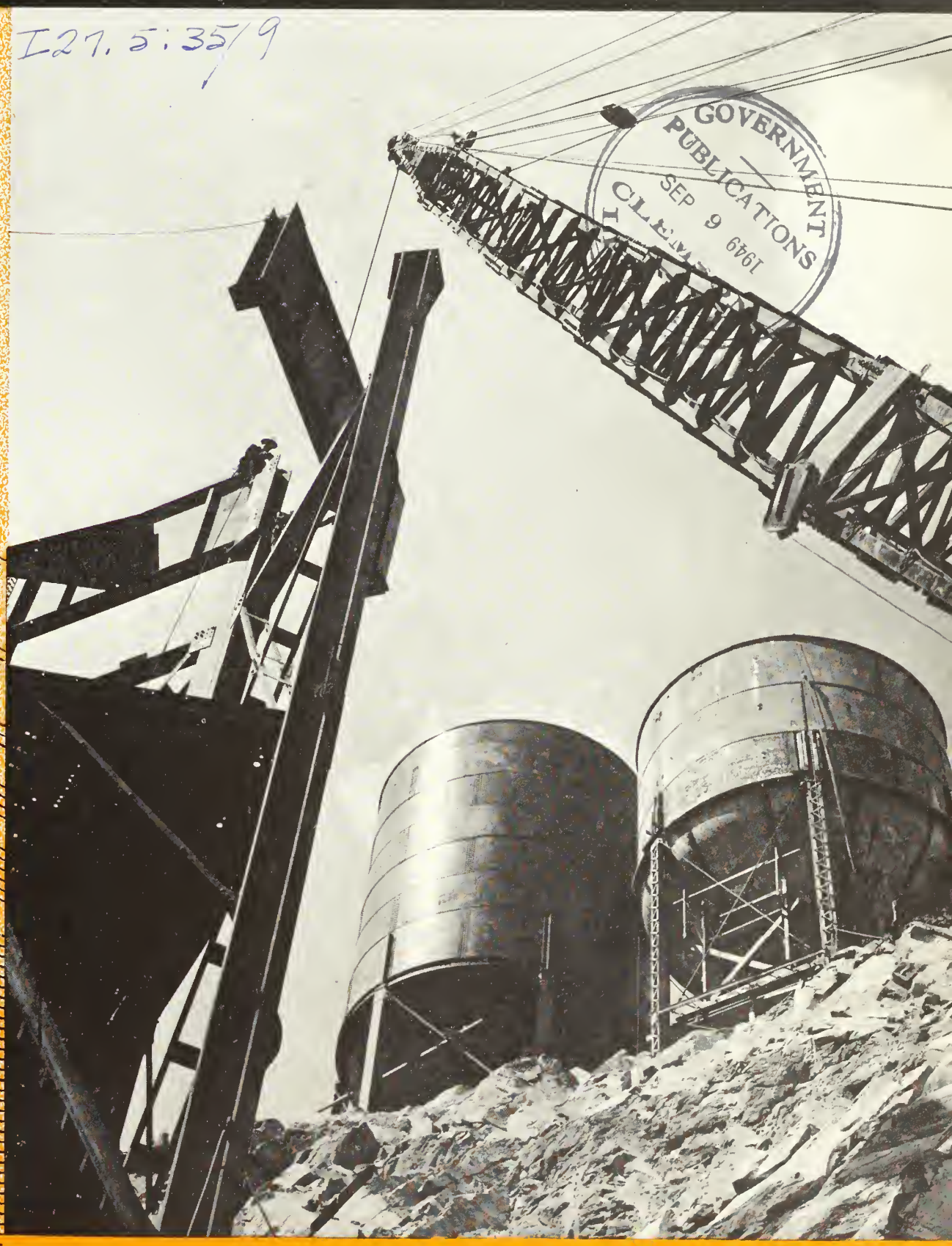

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Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' association.

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OUR FRONT COVER

Framed by steelwork of the concrete mixing plant and a huge crane boom are the two silos in which cement and pozzolan (see story on page 191) will be stored at the Hungry Horse project in Montana.

. . . and on the back cover

A telephoto view of Great Northern Mountain, prominent peak in the watershed above the Hungry Horse dam site. This view was taken from a point just below the headtower site on the left abutment of the dam. Both photos by A. E. McCloud of region I.

Saving Water for a Rainy Day

202 Colorado Building,
Fort Collins, Colo.

Dear Editor: "to produce the most, with the least" is not the story in my opinion as I view the situation. And the possibility for misinterpretation of the word "conservation" is real.

You made a more forceful point than you probably imagine in the July 1949 issue of the Reclamation Era when you stated, "There's no sense to saving water for a rainy day." We moved to Fort Collins which is in the heart of the Northern Colorado Water Conservancy District which will be served in time by the Colorado-Big Thompson project. In the summer of 1945 we saw vast crops left to dry up and burn while the available irrigation water was saved to mature other more valuable crops in the area, only to later experience adequate daily rains for the first 15 days in the month of August. No one is to blame nor could anyone foresee the subsequent situation, but it proved "There's no sense to saving water for a rainy day." The Colorado-Big Thompson project is designed to correct such situations.

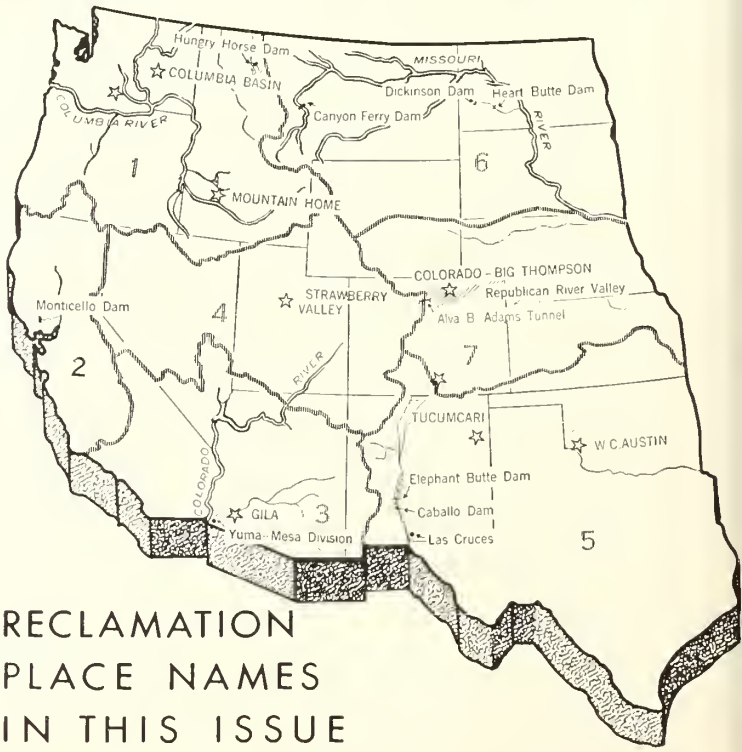
You requested slogans for reclamationists. I herewith submit the following:

Water for Health, Wealth, and Happiness

This slogan defeats the sacrificial connotations in the word "Conservation" and substitutes instead a sense of joy.

Very truly yours,

Stanley W. Vordenberg,
Attorney at Law.



RECLAMATION PLACE NAMES IN THIS ISSUE

RESOURCE DEVELOPMENT for the WORLD

Photo by J. E. Fluharty, Region II

Highlights of Secretary Krug's welcoming address at the United Nations Scientific Conference on the Conservation and Utilization of Resources, Lake Success, New York, August 17, 1949

by J. A. KRUG
Secretary of the Interior

When President Truman invited the Economic and Social Council to hold this meeting in this country he was aiming at the heart of the problem of world peace. Real conservation can remove economic pressures and fears of scarcity which have always played a large part in bringing on wars.

In the field of conservation, the administrator's task is to apply the utmost of scientific knowledge as effectively as the available human and financial resources permit.

Perhaps the problem can best be summarized in a mathematical form. Resources plus technical and scientific skill plus capital investment equals economic development. And it is such development which supports the good living that every child born on this globe is entitled to have.

Most of my experience has been in resource development and use, first in the TVA, then the War Production Board, and now in the United States Department of the Interior. As an administrator applying our current scientific knowledge to the solution of conservation problems, I have encountered certain general guides to sound programs of resource development and conservation.

First—Most natural resources are interrelated and must be developed and conserved together for maximum benefit. It is folly and waste to build flood control dams without at the same time doing soil and forest conservation to slow up the rainy season run-off and to prevent the reservoirs from filling with silt. It is not conservation or wise utilization to build such flood control dams without also developing the hydroelectric power, the irrigation, and the navigation which are possible. In water control developments, frequently the integrated whole shows much greater benefits than the sum of its parts.

It is not sound conservation to concentrate research and development on metals and materials in short supply when possibilities exist on every side to find and develop substitute materials which are available in abundance. It is not sound to extract a primary product without giving careful consideration to the development and use of byproducts which can be derived from the same basic raw materials.

Second—Faster economic progress and greater social values are obtained from the combined development of industry and resources during the same period than in the usual pattern where there is no such coordinated development.

This is a matter of proper timing. Roads, harbors, power plants, and other public improvements will not pay for themselves until industry is ready to utilize them. The opening up of a new area requires demonstration of the new opportunities and advantages of industry and agriculture so that businessmen and farmers will have their projects ready to go as soon as the basic developments are ready. Ten dollars of development in 1 year are frequently worth 20 scattered over 10 years.

Third—In a competitive society, the responsibility for careful resource development and use should bear equally on the individual owners of natural resources.

Natural resources are the basis for the strength, the growth, the very future of every nation and people. The private owners of them have many rights. But if free governments are to survive, individual citizens cannot have the right as private owners of essential resources to imperil the future of the nation by short-sighted practices in developing these resources.

No individual has the right to damage his fellow citizens irreparably by reckless and wasteful use of resources. For example, overgrazing the range and clear-cutting the forests can dump water and floods on people downstream, silt up vital control reservoirs, pollute the streams and endanger future supplies of food and fiber. Until we come to the place where we recognize the real damage of such acts to the property and lives of others and find a practical way to prevent them, it is useless to talk about full conservation in any competitive society.

Fourth—In regions where economic development is at a standstill or has never even started it takes a vigorous push, and frequently from the outside, to get any substantial development under way.

The Tennessee Valley in this country, for example, had seen fairly

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good times for many decades, but the time came when, after years of exporting its coal, lumber, and raw materials, its smart young men went elsewhere to find opportunities and the people of the valley could not get enough money from further exploitation of their depleted resources to purchase even the essentials of a decent standard of living. On its own, the region could not have raised the hundreds of millions of dollars that were needed to build dams to check the devastating floods, supply low-cost electric power, or produce fertilizers to revitalize the exhausted soil. The Federal Government had to do that. With this help, the people of the region made an all-out effort to reestablish their prosperity on a firm foundation and the successful results have been the focus of attention of thinking people the world over.

The underdeveloped regions of the world are not alone to blame for their predicament. Yes, they are poor because they have no industry and only primitive agriculture. And yes, they have no industry and only primitive agriculture because they are poor. We know all that. But nobody can ask them to lift themselves by their own bootstraps. They need help from outside; understanding, technology and investments. The vicious circle of no capital and no development must and can be broken.

FIFTH—There can be no major economic development without an institutional climate that aids it.

That climate includes many things. It includes a whole generation of young people who know how to repair and operate trucks, tractors, pumps and electrical appliances. There must be technicians who can make the learning of the industrial world available. There must also be, however, a corps of technically trained professional people who can adapt new techniques to local circumstances. There must be men trained in business management. There must be people trained in public responsibility, and able to put the general interest above immediate profit opportunities.

There must, however, also be a general understanding that wealth is created only by increasing production. There must be a similar understanding that no real economic progress can be achieved on a high-cost small-sales basis.

There must be investment, some of it in the form of risk capital. Those who use the capital must understand their responsibility toward the lenders, whether the investment be private or public. There must be an equal acceptance of responsibility on the part of those who lend. They must know that no great economic progress can be started with high interest rates and excessive profits. Low-cost credit is essential for all conservation work.

Perhaps most important of all in a favorable institutional climate is a feeling of confidence which must be shared by most of the people, that the country is on the right track, that progress is being made, and that revolutionary changes which greatly affect the rights and equities of the people are not in prospect. All worth-while resource improvements take considerable periods of time and no one can be expected to initiate them without a reasonable feeling of security for the future.

Without a favorable economic and political climate there can be little success in basic resource development. It will be a difficult task to help undeveloped nations create that climate.

SIXTH—It is essential to know the extent of our resources, and preliminary inventories must be subject to continuous revaluation to keep them up to date.

There is no inventory of world resources available. We will have to go ahead for some time blindly without knowing what materials are available in the world to see it safely into the future or what they may cost. I hope that the United Nations will give leadership to this project in its member countries as all of them will surely want to know more and more about what is on top of and under their soil, and what power potential can be developed in their rivers.

SEVENTH—Progress of the underdeveloped areas will inevitably bring them and all of us far more closely together. Interdependence follows industrialization.

We all have great confidence in our scientists. We will, in plain truth, have to rely on them heavily if the world's resources are to stretch over its populations.

In this country we have gone through many decades of waste of our natural wealth through selfish exploitation premised on the old time formula that a dollar in one's pocket today is worth an infinity of dollars in some one else's pocket a century from now or even a few years from now.

In recent years there has been a tremendous and effective movement in the direction of real conservation. This movement has been led for the most part by men and women who do not possess any particular technical or engineering competence, but who have spoken up courageously to halt the short-sighted policies of those interests which in past decades have had most of our scientists and engineers in their employ.

This movement has been spearheaded by Government leaders since the days of Theodore Roosevelt, for the most part regardless of political allegiance. These efforts, however, have been largely negative in the sense that they have dramatized the waste and damage which have resulted from exploitation. They have stressed the need for conserving our natural wealth without putting forth many constructive ideas as to how we should find the wherewithal to satisfy our ever-increasing needs for the fuels, energy, and materials which are the basis of a sound standard of living.

It is time that we start a new era in conservation, an era consecrated to the development and wise use of what is available to the people of the world.

Certainly the greatest problem facing the world today is that of raising the standard of living of the people, not just maintaining it. This necessary objective cannot be accomplished by "locking up" our natural wealth. It can be accomplished, and steady future progress can be assured, by the intensive concentration of the world's scientific and engineering know-how on the basic problem of making the most of what we have. You all know of dozens of examples of the opportunities for using this "know-how." To mention just a few, I would list:

1. The peacetime application of atomic energy.
2. More effective utilization of solar energy.
3. Development of synthetic fuels, particularly from oil shales.
4. Development of substitute materials for those in short supply. Aluminum, magnesium and glass can be produced in almost limitless quantities. With improved technology they can be substituted for many uses of steel, copper, and lead, which may at some future date be in short supply.
5. Improved agricultural methods, including the development of new plants which will require less water and less nutrition from the soil and absorb more energy from the sun and better ways of checking soil erosion and restoring soil productivity.
6. Increased use of sea water for the growth of food fishes and other food materials for extracting chemicals and minerals, and for conversion to fresh water for irrigation and industrial purposes.
7. Improved utilization of metals and other materials to eliminate the waste presently experienced, particularly in the construction of homes and office buildings and consumers' durable goods, such as automobiles.
8. Development of hydroelectric power to conserve oil, gas, and coal.
9. Development of improved use of foods and feeds for human and animal nutrition.
10. Further development of improved space heating in cold weather and cooling in warm weather.

These are just a few of the ideas for raising the world's living standards which deserve the attention of all of us.

It is perfectly possible that the destruction of the last war will be wiped out in the memory of men by scientific progress and service in these peaceful, constructive fields. When the historian of the year 2000 looks back over the twentieth century, he may well find it possible to say that the soil and plant and forest scientists, the fuel and power and mineral experts, and the resource economists, made up a team that helped save the world's resource base when it was in great danger. And he may say that these groups crowded 250 years of industrial progress into 50 years and raised the living standards of the whole underdeveloped world beyond anything known in history. He may say that the United Nations gained confidence, unity, and power in the process.

I hope so. With high ability, good will, good faith, and cooperation, it is possible.

THE END

POZZOLAN

HOW HUNGRY HORSE DAM AND OTHER MASSIVE STRUCTURES OF THE BUREAU BENEFIT THROUGH RESEARCH

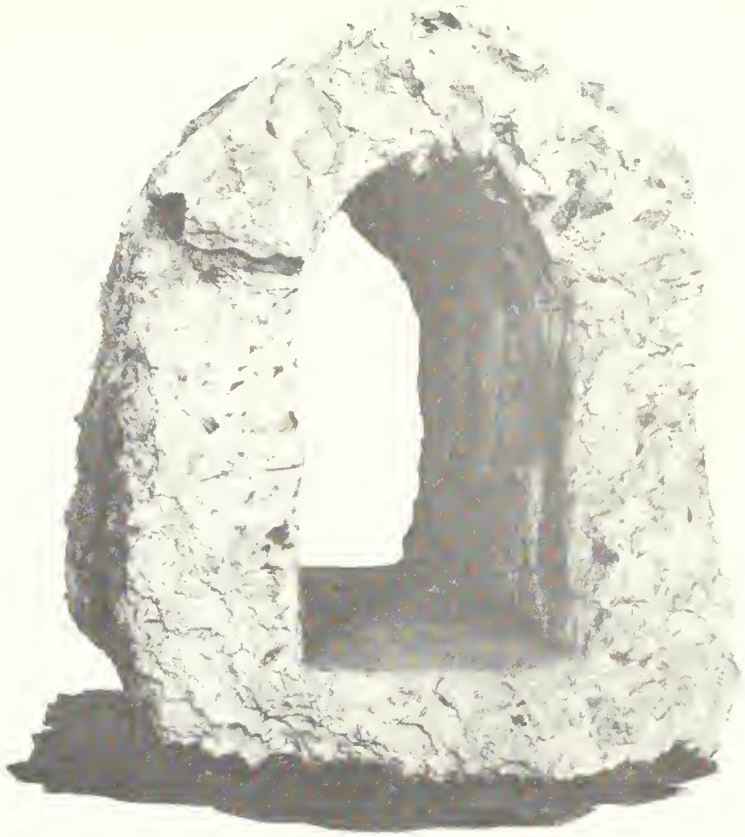
By HARMON S. MEISSNER, Reseach Engineer,
Branch of Design and Construction,
Denver, Colorado

Ancient history, modern construction, and world-wide conservation efforts have much in common. In commenting upon the Bureau of Reclamation's largest construction program in its history, Commissioner Michael W. Straus said, "While we have a tremendous construction program this year and in the years ahead, we take pleasure not so much in bigness for bigness' sake but in seeing just how far we can make the funds appropriated to us by the Congress go in developing the water resources of the West. The research laboratory which is a part of the design and construction office of the Bureau at Denver, has paid for itself many times over in technological economies which have been incorporated in the construction program. The research has also been extended into field construction and operation and maintenance activities with equally satisfactory results."

One of the most spectacular savings in work now in progress is on cement used in the Hungry Horse Dam on the Flathead River in western Montana. With a volume of 2,900,000 cubic yards, involving 2,500,000 barrels of cement, approximately $1,000,000 will be saved by using pozzolan in the concrete mix.

Cement has been so difficult to procure on some Bureau jobs that it has been found necessary to ship from Pennsylvania to South Dakota, and to get cement for work in Wyoming from the Pacific coast. The freight on such shipment is many times the value of the product.

STILL STANDING—The Aqua Claudia, built between 38 and 52 A. D., one of many aqueducts built with pozzolan for the purpose of supplying water to Rome.



AS GOOD AS NEW—after 2,000 years. This section of an old Roman aqueduct, built with pozzolan cement in which the ashes of destructive and erupting Mt. Vesuvius were put to constructive and stable use, demonstrates the permanency of pozzolanic materials. Photo courtesy of the Smithsonian Institute.

During the past 15 years the Bureau's laboratories in the chief engineer's office at Denver, Colo., have studied the characteristics of mass concrete made with a combination of portland cement and pozzolanic materials. These studies have shown that excellent concrete can be made for massive dams by replacing a considerable amount of the portland cement ordinarily used in a mix with fine powdered pozzolan.

Previous mention of pozzolanic materials has appeared in the Reclamation Era. (See "Expansive Cracking in Concrete," Reclamation Era, April 1948, p. 74.) The Greeks and Romans discovered that by adding fine, easily crumbled or powdered, materials to lime, they greatly improved its cementing qualities. The Romans used a fine volcanic ash, found near the town of Pozzuoli, in simple combination with lime to prepare their mortars. Hence, the name "pozzolan" which refers to active fine siliceous (similar to, or containing silica) material added to limes or to portland cement (containing abundant lime) in the preparation of pozzolanic cement.

The Greeks had a similar material called Santorin; in Gaul the early Romans used the gaize; along the Rhine River in Germany they found the material called Trass, which is still used today. The photo above shows a section of an old Roman aqueduct built along the Rhine River some 2,000 years ago, using Trass and lime. It will be observed that the Romans were actually making concrete, for the structure contains sand and broken rock, as well as the cement matrix. That such work is durable is attested by this exhibit as well

as the many Roman engineering structures found intact today.

Hydrated lime and active siliceous material will, in the presence of moisture, unite to form calcium silicates which are cementitious, that is to say, they have the property of cement. Active silicas, or silicates, are materials such as acid volcanic glass, pumicite, artificial glass, diatomaceous earth, opal and tridymite. These may be contrasted with the most common form of silica, quartz, which type will not combine with basic materials (lime) very readily.

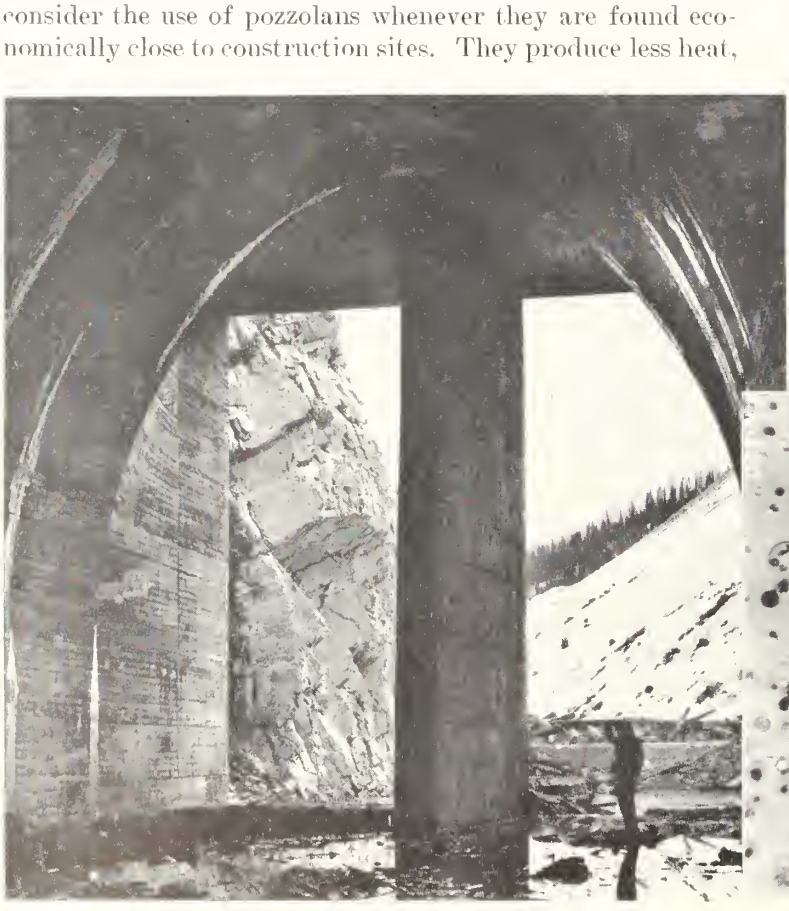
By adding such active siliceous materials to portland cement, there is produced what is called portland-pozzolan cement. When portland cement hydrates (combines with the water used in a concrete mix), a considerable amount of lime is set free. This is subject to leaching and dissolution by percolating waters, with the result that concrete may suffer from weathering and other disintegrating forces. When active silica is present, this freed lime may be fixed and retained within the concrete. The resulting pozzolanic action may thus concentrate or consolidate an otherwise deficient plain portland cement concrete.

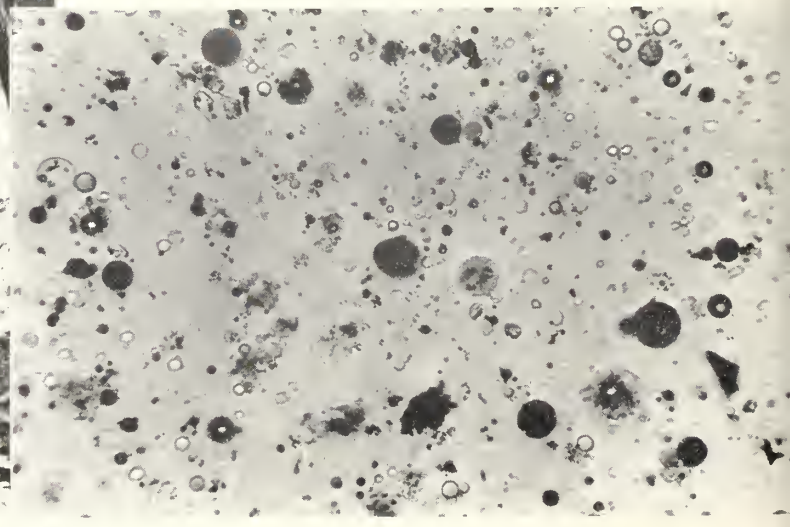
Portland-pozzolan cements have been somewhat popular on the European continent, but have not been used extensively in the United States. The Bureau has employed a pozzolanic addition (pumicite) in both Friant and Altus Dams, and is at present using a pulverized calcined siliceous shale in the concrete for Davis Dam. The War Department used portland-pozzolan cement in building Bonneville Dam, and this type of cement also was used on both the Golden Gate and the San Francisco-Oakland Bay Bridges. Laboratory tests have shown portland-pozzolan cements to possess excellent characteristics for mass concrete and the Bureau will consider the use of pozzolans whenever they are found economically close to construction sites. They produce less heat, when hydrating, than the usual portland cements and are similar in this respect to the low-heat portland cement which is generally used in massive dam construction. Concretes made with portland-pozzolan cement have demonstrated high resistance to cracking, a fact that also recommends such cement for massive work.

Fly ash is a pozzolan which has attracted recent attention. This material is fine flue dust collected at the base of smoke stacks at steam power plants burning pulverized coal. It is finer than portland cement and the particles are all tiny glassy spheres, as may be seen below. The picture is an enlargement of a sample of fly ash, as viewed under the microscope. This spherical shape is very important as the bits of ash, when incorporated in a concrete mix, act as minute ball bearings between the pieces of sand and gravel. Such a mix is so workable that much less water is required than ordinarily used to produce satisfactory consistency in the fresh concrete. As the quality of concrete is inversely proportional to the amount of water used (the less water you must use, the better the concrete), the strength of concrete containing fly ash will be improved for this reason alone. The pozzolanic action will add considerably more to strength; to an extent that, in some mixes, it is more effective (pound for pound) than the portland cement itself. Tests have shown that it is possible to replace 30 percent to 50 percent of the portland cement in a concrete mix with fly ash and still produce concrete of equal or improved quality.

Being a byproduct, fly ash is very cheap. All of these facts led the Bureau to consider it as an excellent material to use in Hungry Horse Dam. It will reduce construction costs, improve the concrete, and more cement will consequently be available to the farmer, the contractor, and the home builder.

THE END





LOOKING OUT through the intake structure of the Hungry Horse diversion tunnel, at left you can see modern use of pozzolanic materials which will last for centuries. LOOKING THROUGH a microscope you can see the small "ball bearings" in a typical fly ash. These spherical glass particles are the secret of success in the use of pozzolans for cement. Photo at left by A. E. McCloud, Region I. Photo below submitted by the author, H. S. Meissner.

THE IRRIGATION SERVICE COMBINE

REGION V DESIGNS A UNIFICATION PROGRAM IN WHICH EVERYONE SHARES RESPONSIBILITIES AND BENEFITS

by RALPH S. BRISTOL, Regional Supervisor, Branch of Operation and Maintenance, Region V, Amarillo, Tex.

A DREAM OF COMPLETE, UNIFIED ACTION by various agencies of government to work with and assist the public in attaining a common goal—a dream cherished in all echelons of government for many years—is being realized on one irrigation project and rapidly approaching materialization on a second one in the Bureau of Reclamation's Region V with headquarters at Amarillo, Tex.

The successful coordination of the interagency program on the W. C. Austin project in western Oklahoma, and the present establishment of a similar working relationship on the Tucumcari, N. Mex., irrigation project, is the result of intelligent approach by an enlightened people who have used their wisdom and skills and power to achieve results with respect to new irrigation development.

Officials of the several Federal and State agencies working in the project areas, joined with officials of the irrigation districts, are reminded of the time when the noted evangelist, Sam Jones, was asked the question: "How do you know that you have religion?" Sam Jones replied, "I was there when I got it."

These Government officials and the elected representatives of the water users on the W. C. Austin and Tucumcari irrigation projects were on hand when the problems associated with the development of these new ventures began cropping up. The people, with the help of the various governmental agencies designed to serve them, joined forces and went looking for problems to conquer before they could become serious.

The exemplary program began in Oklahoma in 1944 while the Bureau was constructing the 50,000 acre W. C. Austin project—the most eastward irrigation project ever undertaken by the Federal Government. On 95 acres owned by the Government in the project area, the Lugert-Altus irrigation district and the Oklahoma Planning and Resources Board assisted the Bureau in establishing a demonstration farm. Lands in the demonstration farm were among the first to receive water as project construction progressed. On these watered acres, project farmers who had tilled their dryland farms since before Statehood, learned some essentials of irrigation and the action of crops under the ditch.

Within four years, as many thousands of acres in the project began receiving irrigation, the demonstration farm had completed its function. By 1948 the paramount needs of the project farmers were far greater than could be served

COOPERATION PAYS OFF—As can be seen from this flourishing field of Combine Maize (Plainsman Variety) at the Altus Demonstration Farm in Oklahoma. Photo by R. M. Reynolds, Region V.

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by the initial institution, however successful. Meanwhile, the Soil Conservation Service of the United States Department of Agriculture, the State extension service, the agricultural experimental service of Oklahoma A. & M. College, the Production and Marketing Administration, the Farmers Home Administration, and other agencies had been working in the area within their official capacities to assist farm operators.

But even though there had been excellent working relations among the various agencies and the irrigation district, the lack of a master plan and a comprehensive, common goal was recognized by all concerned.

The problem was cited by officials of the Bureau of Reclamation. The project is unique in the Bureau's history, for it is the only Federal project that receives an average of 26 inches of rainfall annually. Information that is available from other Bureau projects has limited value. Among questions for which there are no answers insofar as this project is concerned are those relating to proper land preparation and water distribution, time and rate of water application, drainage, irrigation of field crops and pastures, irrigated horticultural crops, soils and fertility and the introduction of crops foreign to the historical dryland operations.

As knowledge of the need for charting a pioneering course in the project's development increased, representatives of the several interested agencies, in complete cooperation with irrigation district officials, began concerted action. On February 2, 1948, the demonstration farm, including all of the buildings and equipment, was transferred to the Oklahoma A. & M. College for an experiment station. Thenceforward the lands were to be used for irrigation experiments with horticultural crops, fruits, berries, and vegetables. On another State experiment station in the project area, experiments are being conducted with grains, legumes, grasses, and other feed crops as well as in basic soil changes and soil management practices.

Subsequent to this action, the State extension service, cooperating with the Bureau and the irrigation district, employed an associate county agent, experienced in irrigation farming, to work with project farmers on their irrigation and farm management problems.

The final step toward complete unification of work by all interested agencies was taken in the early part of this year at a planning conference in Altus, Okla., called by the Lugert-Altus irrigation district. At this conference the work of each agency in the project area, all closely entwined, was clearly defined.

The two experiment stations were to be operated by Oklahoma A. & M. College. The services of a full-time irrigation specialist were to be available to all project farmers under the direction of the State extension service. The Soil Conservation Service would provide technical assistance to project farmers with respect to land preparation and the design of on-the-farm irrigation distribution systems. The Farmers Home Administration would meet the credit needs of project farmers to the limit of funds available for authorized loans. The Production and Marketing Administration's conservation practices would be applied wherever possible in the project area. The State planning and resources board would continue to work with all agencies insofar as authorized funds were available. The Bureau would direct the project's operation and maintenance program and all other functions prescribed to it by Federal law.

In outlining the need for interagency planning and action, Bureau officials know that in areas with an established agriculture, such as prevails on the W. C. Austin project, the advent of irrigation does not create a rapid change in agricultural practices. In view of this, many farmers continue to use the same spaces for planting, the same varieties of crops, and the same rates of fertilizer application under irrigation that they formerly used for dry farming purposes.

If farmers on a project such as the one in Oklahoma are to obtain maximum results from their lands and labor, it is necessary for them to adopt as rapidly as possible those varieties and cultural practices that will create the greatest benefit from the application of irrigation water. We in the Bureau believe that leadership in this work should be provided by the State colleges, through their experiment stations, and the Bureau of Reclamation is pledged to assist the experiment stations in every way possible to develop facts that can be applied, in a practical manner, by every farm operator.

Progressive farmers might eventually, by trial and error, determine the correct amount of irrigation water to apply, and when to make the applications, but such methods obviously would be of great expense to the growers in loss of yields, time and resources.

The contract with the Lugert-Altus irrigation district provides that all operational expenses on the W. C. Austin project must be borne by direct charges against the project lands. This emphasizes the need for rapid development of data for dissemination to farmers on the project so that they can meet their obligations without financial hardship. Thus we need to develop a source of data concerning irrigation, not only for the direct benefit of farm operators in Oklahoma, but also in order that these facts may be used in the development of similar subhumid areas that may come under irrigation in the near future.

Although the Tucumcari, N. Mex., irrigation project, where the Bureau will soon complete a water distribution system to serve 45,000 acres of land, is not similar in any respect to the W. C. Austin project in Oklahoma, the solutions to many irrigation problems are eagerly sought. Lands in the Tucumcari project, with an average annual rainfall of about 16 inches, formerly were generally native pasture lands, infested with mesquite. Consequently, the proper time and amount of irrigation, cultivation, and seeding practices and crops and varieties are largely speculative. For this reason a completely coordinated interagency program has been organized to serve Tucumcari project farmers.

With the landowners on both the W. C. Austin and the Tucumcari irrigation prospects fully realizing the enormous value of proper land, water, crop, and cropping practices, with the spirit of willingness of the various agencies of government to cooperate for the maximum benefit of the people without jealousy or partisan identification, the interest and welfare of these and other reclamation projects are certain to be in good hands. THE END

Reclamation's Hall of Fame

Nomination No. 2

HARRY STRUNK—Republican River Valley

THE MAN WHO IS ALWAYS THERE—Harry D. Strunk checks up on Medicine Creek Dam—one of the projects for which he fought. Photo by L. C. Axtheim.

by N. BETH WOODIN, Kansas River District, Indianola, Nebr., Region VII (headquarters in Denver, Colorado)

MEET A MAN WHO LIVES BY THE AXIOM ENGRAVED over the door of his newspaper office building—"Service is the rent we pay for the space we occupy in this world"—Harry D. Strunk, founder and president of the Republican Valley Conservation Association since its organization in June 1940, owner and publisher of the McCook Daily Gazette, and the man above all others responsible for the present rate of progress of the Pick-Sloan plan of development in the Republican River Valley of Nebraska, Colorado, and Kansas.

Many of the readers of RECLAMATION ERA know Harry Strunk. They know him in Washington. The President may not know him personally, but he has heard of him. This tall (he is 6 feet 3), gaunt, slightly stoop-shouldered man, with his lined, swarthy face, his forceful personality, is not a man to be ignored. Delegates in Congress of the midwestern states know and call him "Harry"; the heads of Departments and agencies know him; Governors of States know him.

Perseverance is the keynote to Harry Strunk's character. Reclamation Commissioner Michael W. Straus once said, "if you want a man to haunt a house, call on Harry Strunk."

Born in Pawnee City, Nebr., in 1892, Harry Strunk moved to McCook in 1910 and started the newspaper now known as the McCook Daily Gazette in 1911. He first became interested in irrigation at about that time when E. B. Debler, then working for a Denver engineering firm, later director of Region VII, came to McCook to make a survey of the feasibility of diverting water from Frenchman Creek, a tributary of the Republican River, to irrigate land on the divide north of McCook. The project fell through, but Harry Strunk carried on, publishing column after column in his newspaper advocating irrigation and flood control in the Republican River Valley.

In 1928 Harry and a group of valley citizens organized the Twin Valleys (Republican and Frenchman) Association. A year later, the association sponsored in McCook one of the largest flood control congresses ever held, attended by the Governors and State officials of 14 States. After that meeting, laws were passed to make certain that human consumption should have first priority in the use of water and that irrigation and flood control should be placed ahead of power.

The Twin Valleys Association died in 1930 because of financial difficulties, but during the drought years of the 1930's, Harry continued to use his paper to advocate reclamation and conservation. Then came the 1935 flood in the Republican River Valley, with its enormous loss of life and property. Shortly thereafter the Bureau of Reclamation and Corps of Engineers began their investigations in the valley. When Congress approved construction by the Corps of Engineers of the Harlan County Dam on the Republican River near Republican City, Nebr., Harry really went into action. He organized the Republican Valley Conservation Association, with members from the same towns represented by the ill-fated Twin Valleys Association. The objectives of the association were to "control the waste waters of the upper Republican River Drainage Basin and utilize the water upon the land in the form of irrigation; to promote

subsurface irrigation, soil conservation, wildlife and recreational facilities."

One of Harry's first acts as president of the association was to go to Kansas City to ask the Corps of Engineers why something could not be done to control the upstream waters of the Republican, too. When he was told that preliminary investigations showed that the cost of flood control upstream would greatly exceed the benefits, he produced affidavits from hundreds of landowners testifying to the property damage they had sustained. As a result of this meeting, the district engineer promised a resurvey of flood damage upstream.

Concurrently with the investigations of the Corps of Engineers, the Bureau of Reclamation was making investigations of the feasibility of irrigation in the valley. Out of the surveys by both agencies came the Pick-Sloan plan of development for the Missouri River Basin, of which the Republican River Basin is a part.

But before work could be undertaken in the Republican River Basin, legislation had to be enacted. A tri-State compact between the States of Nebraska, Colorado, and Kansas was negotiated to provide, among other things, for an equitable division of the waters of the Republican River between the States. The plans of the Corps of Engineers and of the Bureau of Reclamation for the entire Missouri River Basin were coordinated, and Harry Strunk had a hand in all of these accomplishments. He kept the congressional delegation informed of the need for new laws and amendments to laws, and as director for Nebraska of the National Reclamation Association (an office which he held from 1940 to 1948) it was he and Harry Polk, now president of the National Reclamation Association, who suggested to Governor Hunt of Wyoming that the Governor call a meeting of the Governors of all the States in the Missouri River Basin and of the Federal agencies concerned, in an effort to work out a coordinated plan of development. This meeting was held in 1942.

Harry Strunk believes that fish and wildlife conservation and recreational facilities should be planned for and carried on concurrently with the construction of the dams and reservoirs. To that end, in May of this year he called a meeting in McCook of the heads of all the participating Federal agencies, officials of the three State governments, and of the congressional delegation from Nebraska. An outcome of the meeting is that legislation needed to expedite the work of the National Park Service and of the Fish and Wildlife Service is now being drafted.

Harry Strunk has a hobby—the collection of autographed photographs of men important in the fields of conservation and reclamation. On the walls of his office are hundreds of such pictures. Over the face of each picture is a personal note, paying a fitting tribute to a great man.

May 29, 1947, and August 10, 1948, were momentous days for Harry Strunk and the people of his valley. They dedicated Enders Dam on May 29, 1947, and Medicine Creek Dam and the Cambridge diversion dam on August 10, 1948. By popular request, Harry presided over the dedication ceremonies on both occasions.

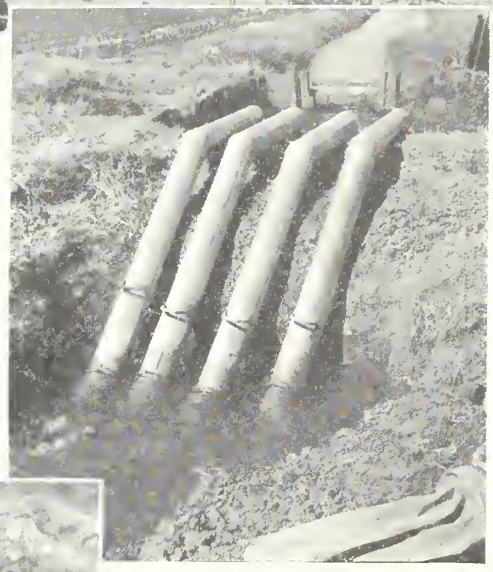
One of these days in the not too distant future, Harry's dream of a valley in which "every drop of water that falls will be conserved and utilized for the benefit of the greatest number of people" will have been realized. Speaking for himself and the other officers and directors of the Republican Valley Conservation Association, he says: "We will never quit until the entire basin is freed forever from the menace of flood, every farmstead is employing soil- and water-conserving practices, and every irrigable acre is receiving supplemental irrigation water, and this valley is one of the finest places in America in which to live." THE END

EVERYBODY KNOWS HARRY— Here he is in his office in the McCook Daily Gazette building, sitting in front of a few of his cherished (and autographed) photos of men prominent in the fields of reclamation and conservation. Photo by L. C. Axthelm.

Yuma Tests Portable Siphons

by P. R. KIERNAN, Operations Engineer, Gila Project, Region III (headquarters at Boulder City, Nevada)

All photographs by SAMUEL B. WATKINS, Lower Colorado River District, Region III



Above—A man carries a 12-inch outside diameter aluminum siphon, weighing about seventy pounds. At right—four 6-inch outside diameter siphons discharging water into a head ditch. Note handles on siphons and canvas priming sleeves in foreground.

TIP IT UP—A turned-up outlet on the discharge end of a 7-inch outside diameter siphon saves soil cutting.

At right—Lightweight priming pump and fittings attached to 7-inch outside diameter aluminum siphon. This siphon can be primed in less than 30 seconds with this arrangement.

New problems call for new techniques even in an enterprise as old as irrigation agriculture. Among the many problems that the Bureau of Reclamation found in its development work on the Yuma Mesa near Yuma, Ariz., is that of finding an efficient, economical means for conveyance of water from the farm ditch to the land. Conventional farm ditch headgates leave much to be desired. They are expensive to install, costing $50 per acre under Yuma Mesa conditions. They leak copiously under the pressure from irrigation streams of 12 to 15 c. f. s. (cubic feet per second), and they result in wasted productivity on expensively leveled land at the beginning of the border. The answer possibly lies in the use of large diameter, portable siphons.

This method of irrigation has been improved greatly during the past few years, mainly by the availability of lightweight materials for fabrication of the siphon tubes and by the development of means for priming them. During the past year the Bureau of Reclamation, under its soil and moisture conservation program in the Yuma area, has experimented with aluminum siphons from 4 to 12 inches outside diameter. Tests were carried out under field conditions and included various methods and devices for priming siphons, measurement of water discharged under various heads and conditions, and observation of their operation for flood and furrow irrigation.

Farmers in the Yuma area have found these advantages in using the siphons for delivery of water from the field ditch to the field:

1. They conserve water by elimination of leaky field turnouts.
2. They reduce cost of maintenance of ditches in that mechanical equipment can be used instead of hand labor.
3. They eliminate wet spots in the field during harvest time.

PRESSURE COOKER CAP—An 8-inch outside diameter galvanized steel siphon showing cap and attachment for priming cap.

NOT A BABY BOTTLE—The turned-up end of a 7-inch outside diameter siphon with rubber priming plug in place.

4. They reduce, in some cases, initial construction costs.

5. They make it easier to control water as the amount applied can be regulated from a large flooding stream to a small furrow stream by increasing or decreasing the number of siphons used, or increasing or decreasing the head under which the siphons operate.

Although siphon irrigation will not replace the field turnout in all instances there are many cases where it will prove greatly superior in initial installation and maintenance costs.

The siphons used are trapezoidal in shape to conform to the ditch bank and the length of the horizontal section varies according to the top width of the bank. The usual horizontal length is 3 to 4 feet. The sloping legs are usually on 1½ : 1 slope and 5 or 6 feet in length. If the siphons are too long they become cumbersome to handle. They weigh more and therefore cost more. An aluminum handle welded to the siphon at about 18 inches from the discharge end and at right angles to the direction of flow, is an aid in handling the tube during priming operations.

Siphons are primed by three principal methods—canvas priming sleeves, priming pumps (hand and mechanically operated), and a siphon tube with a venturi attachment inside the discharge end.

The canvas sleeve is slightly larger in diameter than the outside diameter of the tube and is about 18 inches long. It is attached to the discharge end of the tube by means of a wrap lock. The sleeve is slit open on the top except for a space of about 6 inches next to the tube so that it can be opened when the siphon is operating. The siphon is primed by submerging it in the ditch of water until the tube is completely filled. Then the sleeve is twisted to form a seal and the discharge end of the tube is slid over the top of the ditch to the field level. The sleeve is released, allowing the water to flow. Care should be taken to keep the ditch end of the tube submerged at all times. If it rises above the surface of the water the seal will be broken and the operation will have to be repeated.

A 6-inch siphon is the largest size that can be easily primed by one man. An 8-inch siphon can be primed by the sleeve method if a hook is placed on the top of the siphon adjacent to the bend. One man pulls on a rope attached to the hook and another man on the handle. In this manner the tube can be easily slid over the top of the ditch.

In the use of a pump as a priming device, both ends of the siphon must be submerged or a plug or cap must be fitted to the discharge end during the operation. A fitting and valve is installed on the top of the horizontal section to which the pump is connected so that the air can be exhausted from the siphon tube. When the air has been exhausted (priming pump is then pumping water) the valve is closed, the plug or cap is removed from the discharge end, and the water is allowed to flow. Tests by the Bureau show that an 8-inch outside diameter siphon of 14-foot over-all length can be primed by use of the pitcher pump in 1 to 3 minutes, depending on the condition of the pump. The priming time is less than 1 minute if the pump is in good condition. The pump has to be screwed on and off the priming stem if more than one siphon is to be primed. A double-acting pump was built by the operation and maintenance section of the Gila project by using parts of a discarded booster air brake assembly from a truck. The pump will prime a 7-inch siphon tube of 20-foot over-all length in less than 30 seconds and will prime a 12-inch diameter siphon in from 1 to 1½ minutes. It is attached to the priming stem by a quick-connecting air hose. A pump similar to a double-action pump, or a diaphragm pump, used for priming irrigation pumps, could be used.

Farmers in the Yuma area prefer the sleeve method in priming 6- and 8-inch siphons because it is less expensive than a pump, and the installation of the priming stem, and there is no hazard of an inoperative pump. Moreover, the sleeve reduces or eliminates soil erosion at the discharge end.

A local siphon manufacturer has experimented with a venturi tube from a small airplane fitted in the discharge end of a 6-inch siphon tube. The tube is primed with the sleeve and when the siphon is operating, a flexible rubber hose with a fitting that can be attached to the priming stem is hooked onto the stem of the venturi tube which projects through the side of the siphon. This makes it possible to prime a 7-inch outside diameter siphon 20 feet in over-all length in less than 1 minute instead of using a pump to exhaust the air. The manufacturer is now working to improve this method by means of a venturi tube built of aluminum and fitted in the end of a 6-inch siphon tube. If this arrangement works, it will eliminate the need of a pump for priming purposes and will be a simple priming device with no working parts to wear out or break.

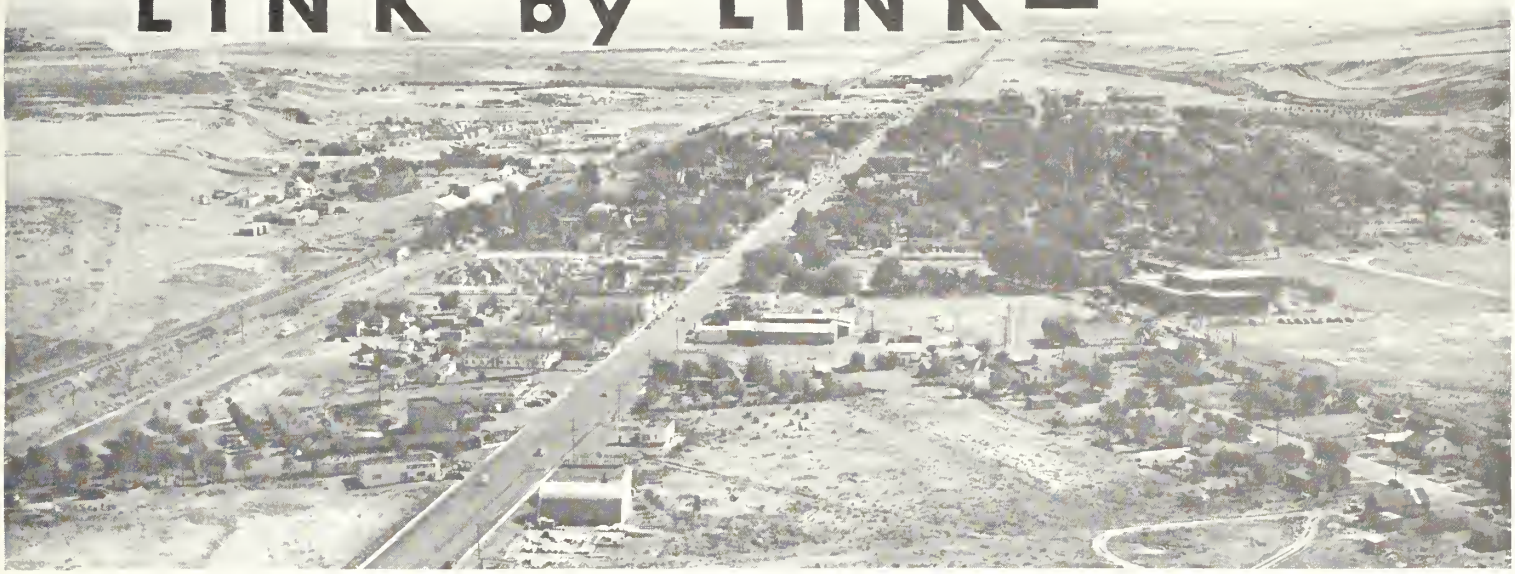
The rubber plunger part of a "plumber's friend," built up by vulcanizing on strips of rubber, is used to seal the end of a 7-inch outside diameter siphon. The plunger forms a neat fitting—is easy to put in place and remove from the end of the tube. It works quite satisfactorily.

A pressure cooker type of cap, consisting of a metal cap that fits over lugs attached to the end of the siphon tube, is also being used with success as a means of sealing the tube. A half turn secures or removes the cap.

A tube with a turned-up end largely eliminates soil cutting at the discharge end. A straight end tube discharges a larger quantity of water for a given head, but unless there is some protection on the field, such as a canvas tarp, a wooden box, or other arrangement, it will cut a hole 2 or 3 feet deep and about 8 feet in diameter when operating under a 1-foot head. THE END.

This is the third in our series of articles on siphons used in reclamation construction and farming. The second, although not so labeled, was "Coachella's Underground Lifeline" on page 183 of the August 1949 issue.

LINK by LINK—



Ephrata in the Columbia Basin project. Like other cities in the area, it has grown tremendously in recent years. Photo by Harold Foss, Ephrata, Wash.

—A COLOSSAL CHAIN WELDS PROSPERITY IN THE COLUMBIA BASIN

by GENE NICOLAI, Coulee Dam, Wash., Region I (headquarters at Boise, Idaho)

A few days ago, a former resident of Ephrata, in eastern Washington, drove through the city and continued westward toward Seattle. Then he suddenly applied his brakes and retraced his route, making careful survey of a highway sign that read:

"EPHRATA—POPULATION 3,269"

The traveler, a bewildered look on his face, stopped at the local newspaper in Ephrata and told the editor:

"Why, I lived in this very place many years ago and I just now passed through without recognizing it. The streets are new and wider, there are nice sidewalks, new stores, new homes. You have grown tremendously. What happened?"

The editor smiled understandingly and said, "The Columbia Basin project, that's what! Out here contractors for the Bureau of Reclamation are building the biggest irrigation system you ever saw—big canals, big dams, big siphons. They are going to turn this sagebrush into irrigated farms. Ephrata is just growing with the Basin."

And the same is true of other cities—Moses Lake, Warden, Othello, Pasco, Quincy—to mention a few. All are feeling the effects of the biggest construction job ever attempted in the Pacific Northwest. All are awaiting the delivery of the first water from an irrigation system being forged like links in a chain by 3,000 men and modern construction equipment.

In terms of money, the construction picture is imposing, but in terms of the structures themselves, the work proceeding during the centennial year of the Department of the Interior is so tremendous that visitors gasp in wonder. Even those who witnessed the building of the Grand Coulee Dam are amazed.

Out of the earth-shaking blasts of explosives, the chatter of wagon drills, and the roar of diesel-powered trucks and tractors have emerged three earth-fill dams, whose total bulk is greater than that of the Grand Coulee Dam, mother structure of the entire irrigation system; a 10,000-foot tunnel piercing a barrier of solid basalt; a feeder canal with a capacity exceeding the flow of many rivers; siphons big enough to carry triple-deck roadways; and many miles of main canals.

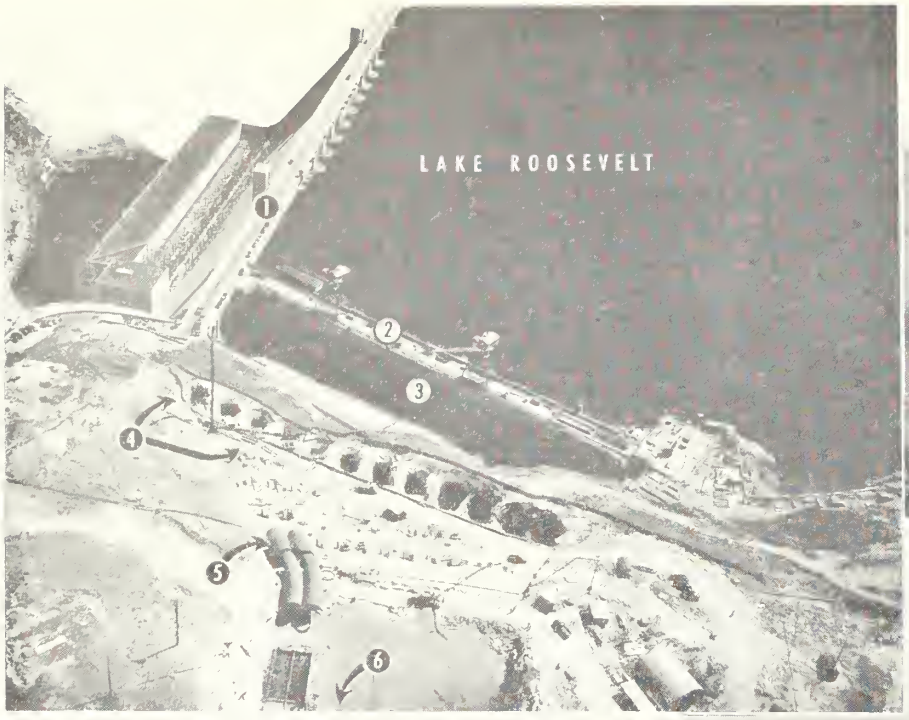
Since 1946 the job has been going on, day after day, month after month. With three large irrigation dams completed, a fourth and final barrier was started this year. In addition, work is progressing rapidly on the world's largest siphon, a $7,000,000 tube of steel and concrete to carry west canal water across a long and deep coulee north of Soap Lake.

And up at Coulee Dam, in the northernmost part of the project, another army of skilled men is working, carving out the world's biggest feeder canal originating near the world's biggest pumping plant, whose world's largest pumps will be powered by the mightiest electric motors ever designed. And these motors will receive their energy from the largest hydroelectric generators at the world's biggest power plant.

The list of superlatives seems endless.

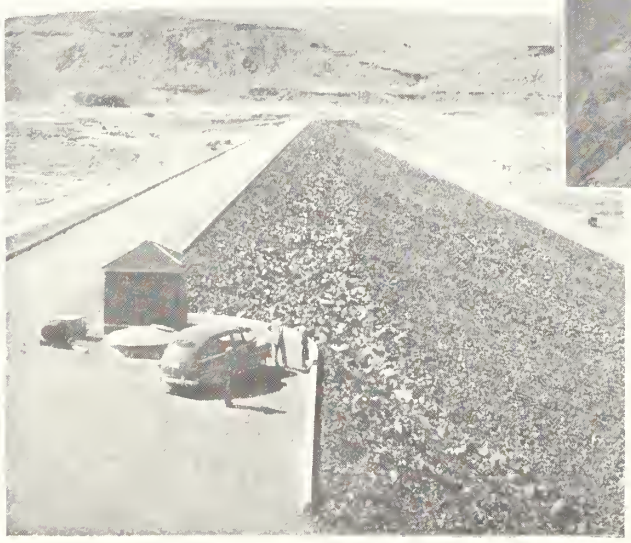
But even with construction in the Basin hitting its highest peak this year, the irrigation system is still less than 20 percent complete, while the power features at the Grand Coulee Dam are about 75 percent finished. This is because work on irrigation structures did not begin until after the war.

The same war that made the Grand Coulee Dam the foremost power producer on earth also created equipment and techniques that have helped speed construction of the irrigation system. Many contractors have completed their jobs



Here is where the irrigation water for the Columbia Basin project will start on its long journey toward thirsty farmlands. From Lake Franklin D. Roosevelt, created by the Grand Coulee Dam (1), the water will flow into the pumping plant (3), behind a wing dam (2) on which the two cranes are shown. Then it will be boosted approximately 280 feet through steel-lined tunnels (4), and out the discharge pipes (5) into the feeder canal (6). Photo by J. D. Roderick, Coulee Dam, Wash.

Here is why structures in the Columbia Basin project are described as links in a chain Soap Lake siphon, excavation for which is visible in the distance. After crossing the c above the far shore of the lake. A contract for this section of canal recently was a Harold Foss, Ephrata, Wash.



Long Lake Dam, first of four earth-fill dams to be completed in the Columbia Basin project, stands ready for operation of the irrigation system. It will permit the use of natural channels and has saved many miles of costly canal construction. Photo by F. B. Pomeroy, Coulee Dam, Wash.

months ahead of deadlines because of the new tools and methods.

Today, with about $95,000,000 outstanding in construction, supply, and equipment contracts for irrigation and power features; with approximately $76,000,000 in canals, siphons, dams, and other irrigation works completed; and with $36,000,000 in new irrigation structures and equipment contracts scheduled to begin this fiscal year, persons in other parts of the United States may wonder why large acreages in the Basin aren't already receiving water.

The answer lies in the extent and complexity of an irrigation system which ultimately will serve nearly 14,000 family-size farms. Water originating from the Columbia River at the Grand Coulee Dam must be carried nearly 60 miles before it reaches the first irrigable land in the Basin. Then it must be transported many more miles to reach other arable acreages. Thus far, most of the separate links in the

anal, right foreground, is awaiting completion of the $7,000,000 iphon, the irrigation water will follow an open canal to be built will be ready for use when the spihon is completed. Photo by

WEST CANAL (at top of page) typifies the massive splendor of some of the irrigation structures. The radial gates will operate in the slots. MAIN CANAL (directly above) dwarfs the men who helped create it. WEST CANAL SIPHON (at right) stretches its length for nearly a mile across one of the coulees. Top photo by F. B. Pomeroy, above and at right by Harold Foss.

vast chain have not been joined. In a few years, however, they will be coupled together and the first irrigation water from the main system will begin flowing on the land. In coming years, as additional links are formed and united, many thousands of farms will be receiving a stable supply of life-giving irrigation water.

Before the first water begins pouring onto the land from the main irrigation system in 1952, approximately $97,000,000 in irrigation structures will have been finished. Other irrigation works will be progressively nearing completion for service in subsequent years.

The primary irrigation works, of course, will serve not only the initial acreage to be brought in within a few years, but also lands to be brought under irrigation in later years. All are permanent structures, built to endure. And like the Grand Coulee Dam, they will be the servants of this and many future generations of Americans. THE END.

SOAP LAKE SIPHON will be the largest in the world. At right is only one section for the $7,000,000 structure which gives you an idea of the huge quantities of steel which are being used in the Columbia Basin project's construction program. Photo by Harold Foss, Ephrata, Wash.

More on Chemurgy

A company in McAllen, Tex., produces carotene and chlorophyll from alfalfa largely grown on their own land. Carotene is best known as a source of vitamin A; it goes largely into bakery products and coloring for butter and oleomargarine. Chlorophyll, the active plant catalyst, is the most important substance on earth. It gives the green color to plants; it is used in pharmaceuticals and as coloring for soap and cosmetics, but is best known to many in connection with an air purifier. Process details at the McAllen plant are given in an 8-page article in the February 1949 issue of the magazine, Industrial and Engineering Chemistry.

Dr. Boris Berkman, of Chicago, Ill., has developed a process for recovering the vitamins, proteins, carbohydrates, fats, and pigment from plants, instead of utilizing livestock as the processor. Apparently it has not reached the pilot plant stage. Significant points presented by Dr. Berkman include the following:

- Direct consumption of plants such as alfalfa and grasses as human food is infeasible because the undigestible cellulose lining will create an obstruction.
- Stored hay loses its vitamin A content because the enzyme content destroys carotene. This destruction is reduced by processing immediately after hay is cut and cutting before plant makes its first joint.
- The chlorophyl and carotene products are stable, whereas before removal of the enzymes both constituents of the hay are unstable and deteriorate rapidly.
- The high temperature of dehydration destroys the nutritive value of the products.
- The nutritive products can be utilized as human food only with each of group of sterols as catalysts. Natural vitamins contain these sterols, which have in the past been considered impurities.
- The principal product is chlorophyll units containing all fat soluble vitamins A, E, and K in concentrated form. This product should prove valuable for medical and nutritional purposes.
- As byproducts, without added cost, vegetable proteins usable directly or in hydrolyzed form can be made.
- Alfalfa processing plants would be most effective in areas where alfalfa grows all year, such as the Lower Rio Grande Valley.

Herman W. Hawker has been growing Ramie on his farm near Teague, Tex., for several years. In addition to its fiber value (reportedly it is the finest of all fibers) Ramie appears to have considerable value as a forage crop; it requires 40 inches of water annually and acid soils.

Research at the Southern Regional Research Laboratory at New Orleans, La., is developing cotton processing methods that improves its marketability for many uses. Wool dyes can be used on cotton, thereby getting richer colors, if cotton has nitrogen added by the ammonization process. Partial acetylization improves rot and heat resistance, which gives cotton longer life when used as water softener filters or ironing board covers. Its effectiveness for towelling is improved by the 20 percent increase in absorbancy that results from partial carboxy methylization. Adding of phosphorous to the basic cellulose unit gives a flame resistant cotton that has many uses. Cottonseed can now be treated so that deterioration while in storage will be greatly retarded. The solvent extraction process for cottonseed will create new chemicals not recovered by the old process that may prove most valuable.

Other technical papers covered chemurgic developments in timber and tree nut utilization. These crops are not at present grown on irrigated land. As yet we have no evidence that irrigation would provide enough yield increase to justify irrigation, although experiments at Brownwood may show irrigation of pecan trees to be worth the cost. Pecan waste, tung nuts, old longleaf pine stumps, and the Chinese tallow nut are processed to make valuable industrial products, principally vegetable oils or turpentine, which are essential for paint manufacture and many other uses. •

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Translated, Las Cruces means "The Crosses" and the town in New Mexico was so named in memory of three priests who were massacred by the Indians near the present town. Their markers stand as a reminder of their sacrifices and services to the people of the area, who learned from pioneers such as these priceless lessons in tilling the soil. More cheerful evidence of pioneers' progress in the Rio Grande Valley is provided at harvest time, when cotton is king and its excellent quality brings premium prices. Photos submitted by the author.

Las Cruces Celebrates—

TAMING A WILD RIVER

by CLINT G. SMITH
Manager, Mesilla Valley Chamber of Commerce

For countless centuries, the Rio Grande rolled through what are known now as the Mesilla Valley of New Mexico and the El Paso Valley of Texas—its waters of little use to man.

An erratic, unruly stream, given to floods and changes of course, the silt-bearing Rio Grande through the centuries piled up layers of rich alluvial soil, but there were no farmers in the valley who knew how to make the rich but arid soil produce properly, and no engineers to tame the river and use its power.

Although prehistoric Indians who lived elsewhere along the stream did some irrigated farming there is no clear evidence that the wandering tribes that inhabited the Mesilla and El Paso Valley were irrigators. They may have tilled a few patches of maize and squash along the river's edge, but the first Spaniards in the valley reported that the Indians lived chiefly on meats.

It was the Spaniards who first realized that the rich valley soil needed only water to make it grow crops. Padres who founded Juarez, Mexico (Paso del Norte), Mission in 1659 taught their Indian converts how to divert water by means of dams and how to convey it to the soil by means of acequias or community irrigation ditches.

Throughout the Spanish period, irrigated agriculture flourished in the valleys on a modest scale. By the close of the seventeenth century, the Spaniards had about 3,000 acres in cultivation, raising grain, vegetables, grapes, fruits, onions, and peppers; also cattle, sheep, and goats. The Mission grape produced wine that became celebrated, and thirsty travelers often likened it to the best that the vineyards of France and Italy could produce.

Until the middle of the nineteenth century almost all farming activity in the valleys was on the south or Mexican bank of the Rio Grande.

The first settler on the present site of El Paso did not arrive until 1827, and it was well after the close of the Mexican War that agriculture became extensive on the American side. By 1850, El Paso had only a handful of Anglo-Americans, and Las Cruces, N. Mex., some 40 miles above El Paso in the Mesilla Valley, had just been settled. However, earlier settlement is evident, since in 1805 Don Juan Antonio Garcia petitioned the Governor of the province of New Mexico for a grant of land, located about 10 miles south of Las Cruces.

The Americans followed the same practices as the Spaniards and Mexicans, irrigating their lands from a community irrigation ditch. Up until 1908, the diversion dam that served that part of the Mesilla Valley around Las Cruces, was only an obstruction built of poles, interwoven with twigs, with stones for ballast.

The Civil War was not a serious interruption to normal life

in the Southwest, and immediately afterwards the two valleys were enjoying a period of agricultural prosperity.

Travelers had called the valleys "a paradise on earth," but there were serpents even in this Southwest Eden. The Rio Grande was acting up; one season it would send down a raging flood and destroy valley crops, and another, it would dwindle away to a thin trickle or go dry altogether. Floods and droughts destroyed the Juarez Valley vinyards which have never regained their old prestige.

In the Mesilla Valley, especially, this was almost a calamity. In 1865, the Rio went on a rampage, and straightened out a section of its bed for about 10 miles south of Las Cruces, eliminating many bends in the stream and placing the town of Mesilla, N. Mex., on the east, instead of the west, bank of the river.

A drought of several years followed. In 1884, came another big flood, one of the largest in the memory of men. It destroyed large portions of the villages between Las Cruces and El Paso. The names of the villages destroyed are Picacho, Santo Tomas, La Union, La Mesa, Chamberino, and Nombre de Dios, the latter of which was never rebuilt.

In one season near Mesilla 13 diversion dikes for diverting irrigation water were built; and washed out every time. Again came the drought. Many valley settlers grew discouraged and moved to other places, some going to old Mexico, and others migrating to La Luz and Tularosa, N. Mex., to the eastward, and Colorado Village and Santa Barbara, N. Mex., in the Rincon Valley of the Rio Grande to the north.

These droughts inspired a nationally known humorist to describe the Rio Grande as "the only river with its bottom side up." But it was not funny to the valley farmers.

By 1888 the situation became alarming. In that year, the City and County of El Paso asked Anson Mills, the surveyor who had laid out El Paso streets, for advice and action. The then Colonel (later General) Mills proposed, in a report to the Secretary of State, that an international dam be built 3 miles up the river from El Paso.

This proposal set off an argument that lasted for 16 years.

Residents of the Mesilla Valley above El Paso could see no benefit deriving to them from a dam downstream, but only damage as a result of their lands being flooded by the reservoir. Mexico, protesting that increased use of irrigation water by Americans upstream had caused shortages of water in the Juarez Valley, asked the United States to indemnify Mexican farmers for loss of crops on the ground that the Rio Grande is an international stream.

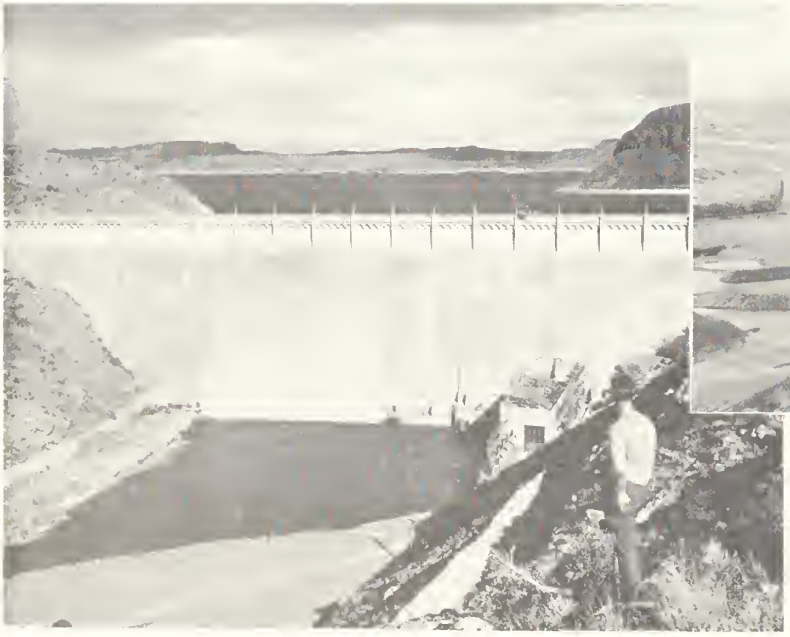
Then, New Mexico granted a charter to a private promoter to build a dam at Elephant Butte, 123 miles above El Paso. Mexico protested that the projected promotion ignored her claims and the United States State Department restrained the promoter; ensuing litigation lasted for years, with the Supreme Court finally ruling against the promoter. However, construction of a diversion dam and canal was initiated in December 1896 and about $35,000 was spent which was about equally divided between the dam and canal. This work was suspended during April 1897, probably due to a lack of funds and litigation involving water rights, right of way, and construction permits. For the concrete works approximately 2,000 barrels of cement were shipped direct from England and today about a mile below the Leasburg Diversion Dam the old unfinished diversion dam headworks and part of the canal are still standing.

An absurd question that arose during this litigation was the claim that the Rio Grande was a navigable stream, and such a dam would prevent its use for navigation.

After this, citizens of the valleys started a brand new campaign to construct some kind of a dam somewhere, to provide irrigation water for all. Their efforts were rewarded, when, on December 2, 1905, the Secretary of the Interior approved the Rio Grande reclamation project, and Texas was brought under the provisions of the Reclamation Act.

When the Elephant Butte Dam was constructed, consideration was given to possible use of water for hydroelectric power. Gates and six penstock openings were built into it. At first, demand was not great enough for such development, but as the valley prospered, such power was needed. How-

(Continued on page 206)



ELEPHANT BUTTE DAM AND POWER HOUSE (at left) where the Rio Grande was first tamed and controlled. Photo by D. B. Parker, Region V. CABALLO DAM (above) is another step in controlling the wild waters of the Rio Grande. It was named after the nearby Caballo Mountains, which means "horse." Photographer unknown.

FINE IN FEBRUARY—At upper left the pipeline from the spring to the dam site lies imbedded in the high snowbank at the left, but directly above, the tiny hot spring provides warm water for the winter drilling operations. Both photos taken in February 1949 by Howard Knighten of Region I.

WINTER CORE-DRILLING With Natural Hot Water

by CHARLES LeMOYNE, Jr., Civil Engineer, Central Snake River District, Boise, Idaho

PLAYING ONE ELEMENT OF NATURE AGAINST THE OTHER to keep a core-drilling operation in the southwestern Idaho area on schedule during the severe cold of last winter demonstrated the imagination and perseverance which Bureau of Reclamation engineers are often called upon to use in building structures to bring about transformation of desert into irrigated land.

The circumstance occurred in the narrow canyon of the South Fork of the Payette River, where the Bureau is proposing to build the second largest storage reservoir in Idaho, as part of the Mountain Home project. The development, which will bring irrigation water to 192,000 acres now covered only with sagebrush, is one of those proposed for early authorization in the Bureau of Reclamation's comprehensive plan for the development of land and water resources of the Columbia River Basin. As such it was important that the project planning work be kept on schedule.

Core-drilling to determine the geologic structure and the suitability of the foundation rock at the proposed dam site was started in June 1948 and was scheduled for completion early in 1949. The drilling operations proceeded in a normal fashion until late in November, when cold weather began to work its destructive forces on all operations using water.

Any winter in this area is severe, but no one realized the severity of the one then approaching. The wind often drove down the deep gorge of the South Fork at 20 to 30 miles per hour, with the mercury barely visible in the thermometer.

Handling a water supply for drilling the rock walls of the canyon would normally be impossible without heating equipment capable of maintaining the water temperature above freezing. Such an installation would be justified for only the most urgent jobs.

However, Howard Knighten, drill foreman, is a man with imagination and persuasive power. He recommended using water from a hot spring, located near the site, to supply the needed nonfreezing water and, incidentally, to furnish needed warmth for the drillers. Nature had provided the needed hot water (temperature 172° F.) and in sufficient quantity within eight-tenths of a mile of the site.

The problems to be met consisted of conveying the water to the site without excessive loss of heat and arranging an economical lay-out of pipes and pumps which would function without freezing and operate without costly attention.

The assortment of pipe that could be collected for the job consisted of a limited amount of Ax-size[1] drill casing, some 2-inch iron pipe, and about a half mile of 1½-inch canvas fire hose. The pipe and hose had to be laid on top of the ground as it was impracticable to excavate a trench through the solid rock floor of the canyon.

When laid, the pipe line required the full 100 feet of head between the hot spring and the dam site to deliver a mere

[1] About 2¼" in diameter.

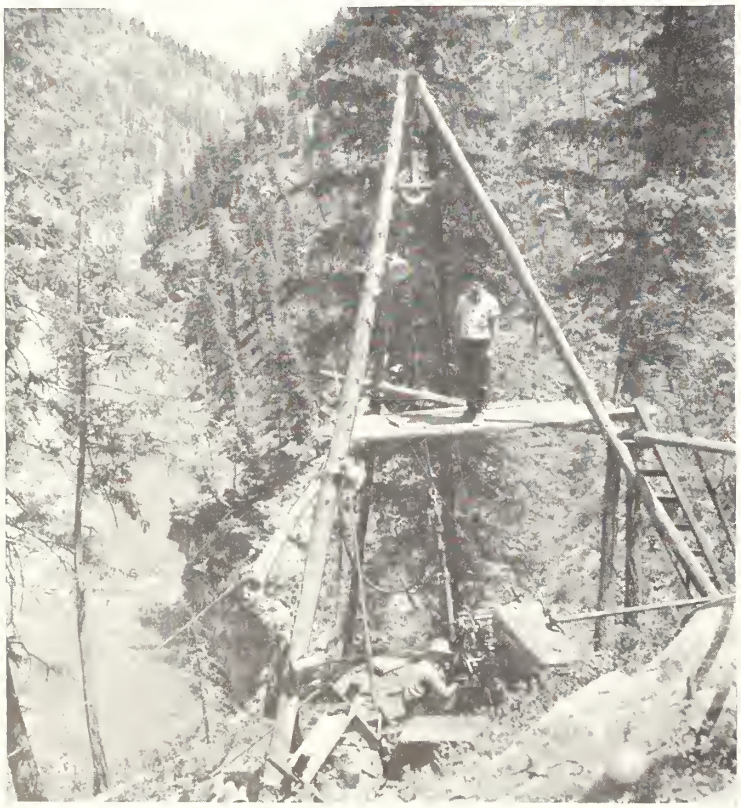
dribble of water. This was sufficient, however, to keep the line from freezing during the off shift or when drilling or testing operations were not in progress. To bring sufficient water from the hot spring to the dam site a booster pump was placed in the line near the spring and provided with a bypass to let the hot water pass through when the pump was shut down.

At the dam site the water line was connected to a triplex piston pump, with a waste bypass to the river to keep the line open when this pump was shut down. The triplex pump lifted the hot water as much as 350 feet up the canyon wall to the drilling operation, where it was used for the drilling, pressure testing for seepage rates in the drill holes, and last but not least, to help keep the drillers warm.

Temperatures during December, January, and part of February generally averaged below zero, at night dropping to nearly 40° below zero. During this period the drill was operated on a two-shift basis; thus it was necessary to shut all equipment down for at least 8 hours per day. The water line from the triplex pump to the drill was drained daily while the line from the hot spring remained open with the booster pump shut down. Both the booster and triplex pumps were housed in huts for protection from the snow and cold and therefore could be started with ease. After drillers turned on the pump, they would scale the canyon wall. By the time they reached the drill, warm water was available. Playing this warm water over the drilling equipment permitted immediate operation.

Production during this period was approximately equal to that of warm weather operations. Of course, it was more difficult to move equipment, but without warm water, it would have been impossible to continue drilling during much of the winter period. Mr. Knighten reports no frozen hands or toes at Garden Valley last winter.

HIGH ABOVE THE SOUTH FORK RIVER—Drilling operations were continued the year 'round because of the ingenuity of a Bureau engineer in overcoming the handicaps of severe winter weather. Photo by L. D. Jarrard, Region I.



The hot spring, in addition to supplying the drilling operations with warm water, also provided sufficient warm water to permit tunneling operations to continue on the two exploratory tunnels being driven into the abutements. The contractor stated his work would have been closed down for at least 2 months if the warm water had not been available.

Using this little spring of hot water to overcome the adversity of a severe Idaho winter during the planning stage of the Mountain Home project might well set the stage for its greater use when the Bureau undertakes to build another monument to Reclamation between the canyon walls and to force another river to do its full job. THE END

LAS CRUCES CELEBRATES

(Continued from page 204)

ever, since irrigation was seasonal, the power would have to be seasonal too, unless much valuable irrigation water was to be lost in the winter seasons. A secondary storage dam became the answer to that problem, and in 1938, the Caballo Dam, some 21 miles below Elephant Butte Dam, was completed. It is an earth fill embankment, 96 feet high and 4,590 feet long, including spillway. This dam not only saves winter run-off from Elephant Butte in the generating of electricity but also catches flood waters from the Black Range which were discovered to be a source of flood danger to the valleys.

In addition to the storage reservoirs, the project's irrigation and drainage system consists of 5 diversion dams, 610 miles of diversion and distribution canals and laterals, 490 miles of land drains and waste ditches; seven canal and drain structures across the river; and thousands of appurtenant miscellaneous structures. Total construction cost to January 31, 1946, was $21,555,973.82.

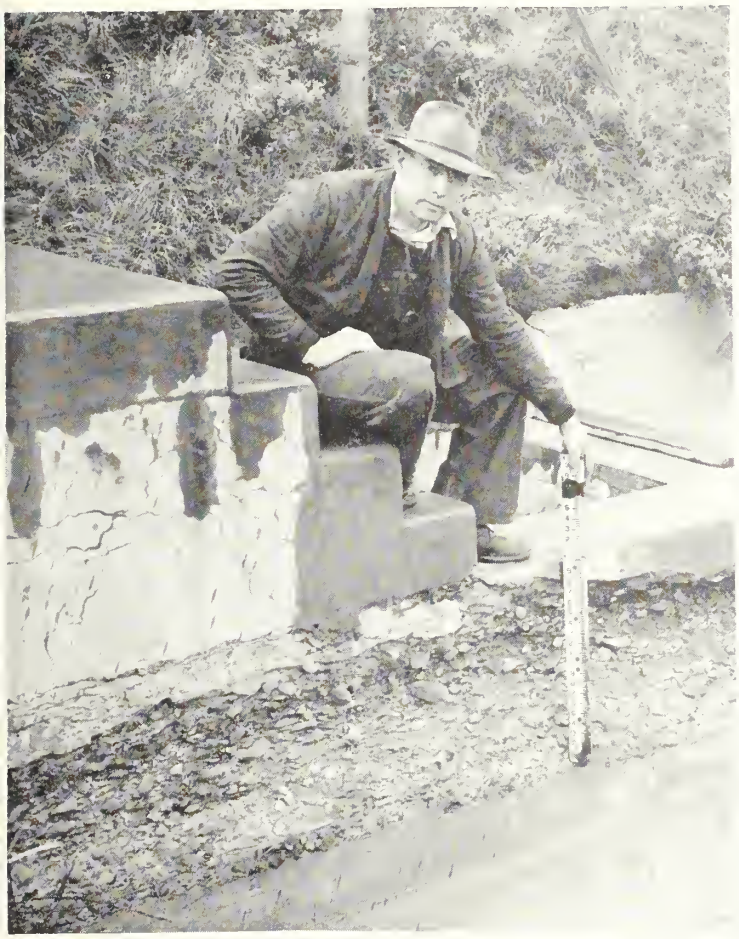
Despite the cost, despite long years of frustration, the project has justified the faith of the valley pioneers. Today, for nearly 200 miles below the dam, stretches a thriving and lovely garden strip where once was mostly desert. In 1948, 155,715 acres were irrigated in the El Paso, Mesilla, and Rincon Valleys.

The valleys are now dotted with flourishing towns and cities, modern farms and happy homes. With irrigation water on tap, like city water at a turn of the faucet, valley farming has become independent of local weather and as scientific as the manufacture of factory goods.

The Department of the Interior is not alone this year in celebrating its centennial anniversary, for it was one hundred years ago this fall that the little city of Las Cruces had its founding. The 7-day celebration—October 9 through 15, 1949—will include an historical pageant commemorating this important event. It should be easy to guess that the theme of that pageant will be—The River.

Today, the subject most heard on every Las Cruces street is—water—water—water. The whole life-blood of the Mesilla Valley depends on the river. Without its copious waters, this land would be only another bit of desert. And so each winter, we anxiously watch the snowfall reports of northern New Mexico and southern Colorado—for it is only down the river that our prosperity can come. THE END.

More on Strawberry Valley



Here is Robert E. Huber, secretary of the Strawberry Valley Water Users' Association, the man who was responsible for the feature entitled "Strawberry Valley" which appeared on page 158 of the July ERA. In addition to his many duties outlined in that article it is also part of his job to check up on the condition of the irrigation facilities. Thus, here we see him measuring erosion of concrete on one of the project canals.

As to the origin of the name of the project—Strawberry Valley—we have been informed that it was so named because of the abundance of wild strawberries growing in the valley and particularly along the Strawberry River in the reservoir basin. These berries are about the size of a gooseberry and can still be found along tributaries of the Strawberry River and along Diamond Fork of the Spanish Fork River, which conveys water tunneled from Strawberry Reservoir into Bonneville Basin. •

C. L. Killgore Receives New Assignment

C. L. Killgore, assistant to the Bureau's chief designing engineer in Denver, has been named advisor to Mr. Lloyd F. Hunt, the United States representative on the Conférence Internationale des Grande Réseaux Electriques, International Study Committee No. 3. This committee deals with high-tension switching and circuit breakers. •

Ground Broken for Canyon Ferry Dam

Past president of the Montana Reclamation Association O. S. Warden, newspaper publisher and proponent of Missouri River Basin development, broke the first ground during the ceremonies celebrating the start of construction on Canyon Ferry Dam on the Missouri River near Helena, Mont., on July 22, 1949, as a crowd of 6,000 cheered.

Commissioner of Reclamation Michael W. Straus called the event "a milestone in our progress and partnership," but warned that there was a long trail ahead. He stated, "Let us appraise the facts. This ground-breaking is but a turning point in the efforts of you and your Government for this area to achieve its destiny. The main contract alone calls for 1,500 days work before the dam alone is scheduled for completion, and a hundred other contracts still must be let."

Centering his remarks on the theme of the long trail ahead before construction would be completed, he said, "Canyon Ferry is one of the key structures of the whole Missouri Basin program—a program that in turn is the high point of man's advance planning to date to conserve and put his limited water resources to work."

Outlining the history and background of the Missouri Basin program, of which Canyon Ferry is a vital part, he described the Canyon Ferry unit, saying, "The dam and power plant will cost some $30,000,000 at today's prices. That money is being advanced you by taxpayers all over the country, and the beneficiaries (irrigators, and power users) under the reclamation law, will pay back Uncle Sam over the years. But this single structure at this point will make possible initial irrigation of some 310,000 acres of new lands, as well as providing supplemental water to 196,000 acres, a total of approximately half a million acres—all in that part of the upper Missouri Basin above Fort Benton. It will do that in many ways, not only by holding and conserving water for irrigation in the reservoir behind Canyon Ferry, but also providing power which, in turn, will not only pump irrigation water but will also provide power for industry and farms, and, in addition, bring back revenues which make possible the whole Canyon Ferry multiple-purpose project and aid the Missouri Basin program."

Commissioner Straus then went on to explain to the crowd the power program at Canyon Ferry, and said, "There are certain basic principles of the reclamation law that you have developed, particularly, that one of the greatest of your basic resources, water, should be developed for the greatest good of the greatest number of people. The power policy of the Department of the Interior is a result of the expression of the desires of the people through congressional enactments. You have requested it, and past Congresses have written into reclamation law that reclamation should generate public power, transmit and distribute it widely with preference to public bodies. Therefore, the Bureau of Reclamation's plans for the Canyon Ferry power plant provide for the Government's producing and transmitting a possible 300 million kilowatt-hours of electrical energy a year. That is low-cost energy that will pump irrigation water, light farm homes, milk cows, process food, and, through its sale, help pay for the project construction works." •

Power to Travel Via "Submarine" Cable Through Alva B. Adams Tunnel

An unprecedented, subterranean, "submarine" power cable will transmit 69 kilovolts of hydroelectric power through the world's longest irrigation tunnel (the Alva B. Adams, 13 miles long) piercing the Continental Divide.

This decision was announced on July 1, 1949, by Commissioner of Reclamation Michael W. Straus, upon authorizing an award of contract to Electrical Constructors, Inc., and C. M. Elliott, Chula Vista, Calif. Their low bid, amounting to $986,000, for running the transmission circuit through the tunnel, represents a saving of almost $500,000, as the low bid for building a mountain-climbing transmission line over the towering mountains of the Divide amounted to $1,483,782.

More than the cost was involved in reaching the decision as to whether the power line would be run over or under the Divide, often called the "backbone of the Nation." The Bureau's decision was based on studies of the tremendous maintenance problems posed by either route, as well as studies of bids received for the alternate proposals. The problem was to determine the best method for transporting Colorado-Big Thompson project power from the Estes Park power plant, on the east side of the Continental Divide, to the Granby pumping plant on the Divide's western side. On the west side, the power will be used to drive three huge electric pumps to deliver water to the mouth of the Alva B. Adams Tunnel, through which it will flow to produce electric power and irrigate farm lands on the eastern side of the Divide.

In awarding the contract for the tunnel cable, Commissioner Straus said, "This will eliminate the necessity of erecting and maintaining a tower transmission line across one of the highest and most rugged sections of the Rocky Mountains, including the scenic grandeur near Rocky Mountain National Park.

"There is a calculated risk involved in that any emergency maintenance of the cable might require stopping the flow of water through the tunnel, but technicians, after full study, report that this risk is no greater than that in maintaining a tower transmission line through the almost inaccessible area which is swept by bitter cold storms every winter with severe icing conditions."

The cable will be contained in a gas-filled pipe to keep out moisture and will be strung along the ceiling of the nine and three-quarter foot diameter, 13-mile-long tunnel. The tunnel cuts under the Continental Divide running more than 3,600 feet below some of the high peaks towering above it. It will present a unique situation when completed, with two-way traffic, as water from the west slope of the Rockies runs through the tunnel to plunge through hydroelectric plants on the east slope, and a portion of the power generated there returns through the tunnel via the transmission lines to pump more water to run eastward through the tunnel. •

History of the Bureau of Reclamation's Regular Annual Appropriation Act, 1950 (*Exclusive of Trust Funds*)

State	Project	Allowed by the Bureau of the Budget	As reported by committee (Report No. 324) and passed by House (H. R. 3838, March 31, 1949)	As reported by Senate committee (Report No. 661, H. R. 3838) July 13, 1949	As recommended by conference committee [1]	Appropriation Act 1950 [1]
Reclamation fund, special fund:						
Salaries and expenses		$5,000,000	$4,300,000	$4,300,000		
General investigations		3,900,000	3,500,000	3,700,000		
Investigations, upper Colorado River Basin		500,000		500,000		
Advance planning: Washington	Yakima—Kennewick division	50,000	50,000	50,000		
Construction:						
California	Santa Barbara—Cachuma unit	6,100,000	5,185,000			
	Solano County					
Colorado	Grand Valley					
	Paonia					
	San Luis Valley			250,000		
Idaho	Boise—Anderson Ranch	1,932,000	1,642,200	1,300,014		
	Boise—Payette	2,725,000	2,316,250	2,725,000		
	Lewiston Orchards	270,000	229,500	270,000		
	Palisades	205,000	174,250	205,000		
Montana	Milk River—Fresno Dam	71,500	60,775	64,240		
Nevada	Humboldt			500,000		
New Mexico	Tucumcari	685,000	582,250			
New Mexico-Texas	Rio Grande	20,000	17,000	14,450		
Oklahoma	W. C. Austin	300,000	255,000	255,000		
Oregon	Deschutes	180,000	153,000	176,700		
	Arnold irrigation district	38,000	32,300	38,000		
	Ochoco Dam	1,150,000	977,500	1,150,000		
	Grants Pass irrigation district			100,000		
Oregon-California	Klamath	1,000,000	850,000	803,460		
Utah	Ogden River	285,000	242,250	219,170		
	Provo River	4,800,000	3,400,000	4,542,600		
Washington	Yakima—Kennewick division					
	Roza division	449,955	382,462	413,205		
Wyoming	Kendrick	1,680,000	1,428,000	1,327,910		
	Riverton	2,731,000	2,321,350	2,632,750		
	Shoshone	140,000	119,000	107,400		
	Shoshone, Willwood division			60,000		
Subtotal, Reclamation fund, Construction		24,077,455	19,785,837	17,154,899		

[1] Data not available.

History of the Bureau of Reclamation's Regular Annual Appropriation Act (1950) (*Exclusive of Trust Funds*)—Continued

State	Project	Allowed by the Bureau of the Budget	As reported by committee (Report No. 324) and passed by House (H. R. 3838, March 31, 1949)	As reported by Senate committee (Report No. 661, H. R. 3838) July 13, 1949	As recommended by conference committee [1]	Appropriation Act 1950 [1]
Reclamation fund, special fund—Continued						
Operation and maintenance:						
Arizona-California	Parker Dam Power—power revenue	$3,369,200	$3,200,000	$3,369,200		
	Yuma—direct appropriation	150,000	150,000	150,000		
	power revenues	35,000	35,000	35,000		
California	Central Valley—direct appropriation	392,200	365,900	392,200		
	power revenues	1,108,400	1,034,100	1,108,400		
Colorado	Colorado-Big Thompson—power revenues	437,150	400,000	437,150		
Idaho	Boise—direct appropriation	350,000	300,000	350,000		
	Minidoka—direct appropriation	45,000	45,000	45,000		
	power revenues	445,000	445,000	445,000		
Nebraska	Mirage Flats—direct appropriation	24,000	24,000	24,000		
Nebraska-Wyoming	North Platte—power revenues	330,500	300,000	330,500		
New Mexico-Texas	Rio Grande—power revenues	419,700	375,000	529,700		
Oregon	Deschutes—direct appropriation	172,000	150,000	172,000		
Oregon-California	Klamath—direct appropriation	303,000	285,000	303,000		
Oregon-Idaho	Owyhee—direct appropriation	370,000	350,000	370,000		
Washington	Columbia Basin—power revenues	2,190,000	2,100,000	2,190,000		
	Yakima—direct appropriation	441,000	402,000	441,000		
	power revenues	25,000	23,000	25,000		
Wyoming	Kendrick—power revenues	640,500	640,500	640,500		
	Riverton—direct appropriation	185,000	161,950	185,000		
	power revenues	112,000	98,050	112,000		
	Shoshone—direct appropriation	101,100	89,000	101,100		
	power revenues	211,295	186,000	211,295		
Subtotal, operation and maintenance—direct appropriation (irrigation)		2,533,300	2,322,850	2,533,300		
Subtotal, operation and maintenance—power revenues		9,323,745	8,836,650	9,433,745		
Total, operation and maintenance		11,857,045	11,159,500	11,967,045		
Emergency fund						
Rehabilitation and betterments of existing projects:						
Arizona	Salt River					
	Yuma					
California	Orland					
Idaho	Boise					
Montana	Bitterroot					
	Milk River					
Nebraska	North Platte					
New Mexico-Texas	Rio Grande					
Oregon	Klamath					
South Dakota	Belle Fourche					
Washington	Yakima					
Wyoming	Riverton					
	Shoshone					
Subtotal, rehabilitation and betterments of existing projects						
Total, Reclamation funds, special fund (includes appropriations from power revenues)		45,384,500	38,795,337	37,671,944		
General fund:						
Alaskan investigations		250,000	150,000	250,000		
Construction:						
Arizona	Gila	5,000,000	4,250,000	4,833,750		
Arizona-Nevada	Davis Dam	38,739,000	32,928,150	37,504,860		
Arizona-California	Parker Dam Power	138,000	117,300	110,290		
	All-American Canal	6,000,000	5,100,000	5,100,000		
Arizona-Nevada	Boulder Canyon	7,500,000	6,375,000	6,761,650		
California	Central Valley	63,000,000	53,550,000	60,789,890		
Colorado	Colorado-Big Thompson	21,500,000	18,275,000	20,172,750		
Montana	Fort Peck	3,000,000	1,445,000	1,515,200		
	Hungry Horse	24,000,000	20,400,000	23,786,250		
New Mexico	Fort Sumner			750,000		
	Tucumcari	685,000	582,250	582,250		
Washington	Columbia Basin	71,500,000	59,075,000	70,034,390		
Arizona-Nevada-California	Colorado River front work and levee system	970,000	824,500	970,000		
Various	Missouri River Basin	87,150,000	73,822,500	81,668,560		
Subtotal, general fund, construction		329,182,000	276,744,700	314,579,840		
Columbia Basin project flood repair						
Total, general fund		329,432,000	276,894,700	314,829,840		
Colorado River Dam Fund:						
Arizona-Nevada	Boulder Canyon project (operation and maintenance)	1,612,000	1,600,000	1,600,000		
Various	Colorado River development fund (expenditure account)	500,000	500,000	500,000		
Total, general and special funds (includes appropriation from power revenues)		376,928,500	317,790,037	354,601,784		
Permanent appropriations:						
Payments to States of Arizona and Nevada		600,000	600,000	600,000		
Repayment of advances from the Treasury with interest (Boulder Canyon project)		5,000,000	5,000,000	5,000,000		
Repayment of advances from the Treasury (All-American Canal project)		300,000	300,000	300,000		
Transfer to Colorado River development fund (holding account)		(500,000)	(500,000)	(500,000)		
Continuing fund for emergency expenses, Fort Peck project, Montana		365,000	365,000	365,000		
Total, permanent appropriations		6,265,000	6,265,000	6,265,000		
Grand total, all accounts (includes appropriation from power revenues)		383,193,500	324,055,037	360,866,784		

[1] Data not available.

DICKINSON DAM UNDER CONSTRUCTION

By C. R. WHIPPLE, resident engineer, Missouri-Souris district, Bismarck, N. Dak., Region VI (headquarters at Billings, Mont.)

Dickinson Dam will be an earth-fill dam across the Heart River, in western North Dakota, with a combined spillway and outlet works at the right abutment. It will be about 2,275 feet long and 49 feet high. The upstream slope of the embankment will be covered with a sand and gravel filter and a layer of rock riprap. A 40-foot-wide cut-off trench will be excavated for approximately 2,000 feet of the length of the dam. The uncontrolled, open-channel spillway will be 200 feet wide with a stilling basin. The outlet works consists of a 24-inch conduit that discharges into the spillway.

On March 30 the Adler Construction Co. of Madras, Oreg., contractor for the construction of Dickinson Dam, began work on the excavation of the diversion channel, about 800 feet long and 20 feet wide. The river was diverted through the channel on April 13.

Excavation and backfill of the cut-off has been completed. The contractor encountered some difficulty in drying up the trench, and finally installed an upstream and downstream well-point curtain, with points on about 6-foot centers.

The construction of Dickinson Dam will provide water for irrigation and an adequate industrial and domestic water supply for the city of Dickinson, long harrassed by a serious water shortage. Recreation opportunities afforded by the creation of Dickinson Reservoir will fulfill a definite need in southwestern North Dakota. •

Wellton-Mohawk Canal Contract Awarded

On July 22, 1949, Commissioner of Reclamation Michael W. Straus authorized the award of contract for the construction of the first 8.5 miles of main canal on the Wellton-Mohawk division of the Gila project in Arizona.

Low bidder on the job, the first major construction contract on this division, is the Fisher Contracting Co. of Phoenix, Ariz., with a bid of $1,335,463.70. The work is to be completed within 525 calendar days after the notice to proceed is issued. The Yuma Mesa division of the project is now in operation and the new work is continuing its construction.

An equipment contract for ten pumps for the three pumping plants on the Wellton-Mohawk Canal was let last February to the Worthington Pump & Machinery Corp. of Harrison, N. J., on a bid of $372,415, and a contract is to be let soon for motors to drive the pumps. Power to operate the pumps will come from the Davis Dam, now under construction on the Colorado River.

The Wellton-Mohawk division consists of 75,000 acres of the Gila project located along the Gila River, beginning some 15 miles east of Yuma, Ariz., and extending 35 miles eastward. Wellton is the principal town of the area, being approximately at the center of the development. The presently irrigated area in the Wellton-Mohawk division is threatened by salt water intrusion on underground supplies, and construction is to be expedited to rescue this section, as well as provide new settlement opportunities on irrigated land.

First irrigation on the Wellton-Mohawk division is contemplated during the 1952 fiscal year. •

BARREN BUT BUSY—This view along the axis of Dickinson Dam from the left abutment shows the diversion channel in the foreground and the well-point system in center. Photo by Thomas R. Broderick, Region VI photographer.

Secretary Krug Approves Minidoka, Idaho, North Side Pumping Project

Secretary of the Interior J. A. Krug approved on July 14, 1949, a Bureau of Reclamation planning report calling for the irrigation of 77,650 acres of new land, most of which is public land to be opened to settlement by World War II veterans and others, on the North Side pumping division of the Minidoka project, near Rupert, Idaho. The report is now being sent to the States and interested Federal agencies for comment.

As recommended by Commissioner of Reclamation Michael W. Straus, the development would result in a monetary benefit to the Nation, nearly seven times the construction cost. Almost the entire Federal investment in the project—$11,395,000—would be repaid by water users. An allocation of $995,000 to fish and wildlife is nonreimbursable.

Under the proposal, 13,650 acres of the Division would be served with water from the existing American Falls Reservoir and the authorized Palisades Reservoir by pumping from the Snake River behind Milner Dam, and 64,000 acres would be supplied from some 300 wells to be drilled to tap the great groundwater body underlying the area.

Hydroelectric power for pumping would be obtained initially from the Minidoka and Anderson Ranch power plants. The proposed Palisades power plant will, when completed, be an additional source of power, and the report suggests that the completion of the American Falls power plant should also be considered for this purpose. An electrical power distribution system to service the pumps required to bring the water supply to the land is an integral part of the development plan.

The report is based on a settlement of the long-standing controversy between local groups over the final utilization of 433,593 acre-feet of reserve storage space in American Falls Reservoir. Recent negotiations with 22 irrigation organizations, which have leased this space annually since 1931, have resulted in a tentative agreement to sell to them 315,000 acre-feet of the reserve space and use of the remaining space (118,593 acre-feet) for new land development.

The tentative agreement calls for 47,593 acre-feet to be allotted to the North Side pumping division and 71,000 acre-feet of new lands in the Michaud Flats area of the Fort Hall Indian Reservation near Pocatello. In addition to storage space in American Falls Reservoir, the division will require 90,000 acre-feet of storage space in the proposed Palisades Reservoir, to be constructed on the Snake River on the border of Idaho and Wyoming.

All available evidence, including that obtained from nine wells in the area, three of which were test wells drilled by the Bureau of Reclamation in 1948, indicates that the groundwater supplies are adequate to supply the irrigable area of 64,000 acres to be served from that source. The total requirement will be only 5½ percent of the total annual flow of 4,000,000 acre-feet of groundwater underlying the Snake River Plain. The report recommends sinking 7 additional production-size test wells in the preconstruction period for test purposes and 21 observation and exploratory wells at a later date to secure additional groundwater information. ●

Straus Speaks at Lake Success

At the United Nations Scientific Conference on the Conservation and Utilization of Resources, being held at Lake Success, N. Y., from August 17 through September 6, Michael W. Straus, Commissioner of the Bureau of Reclamation spoke on "Recent Developments in Irrigation." An abstract of his remarks follows:

Around this shrinking world, mankind is struggling intensely to see if he can produce food as fast as he reproduces himself. In many countries, he is turning to irrigation of arid lands as his road to survival. The wedding of the land and water produces food. Irrigated acres provide food for perhaps 10 to 15 percent of the world's population.

Following the Second World War, the United States has inaugurated a program to extend to all free countries financial and technical assistance in their reconstruction and resources development program, a program in which the Bureau of Reclamation is cooperating.

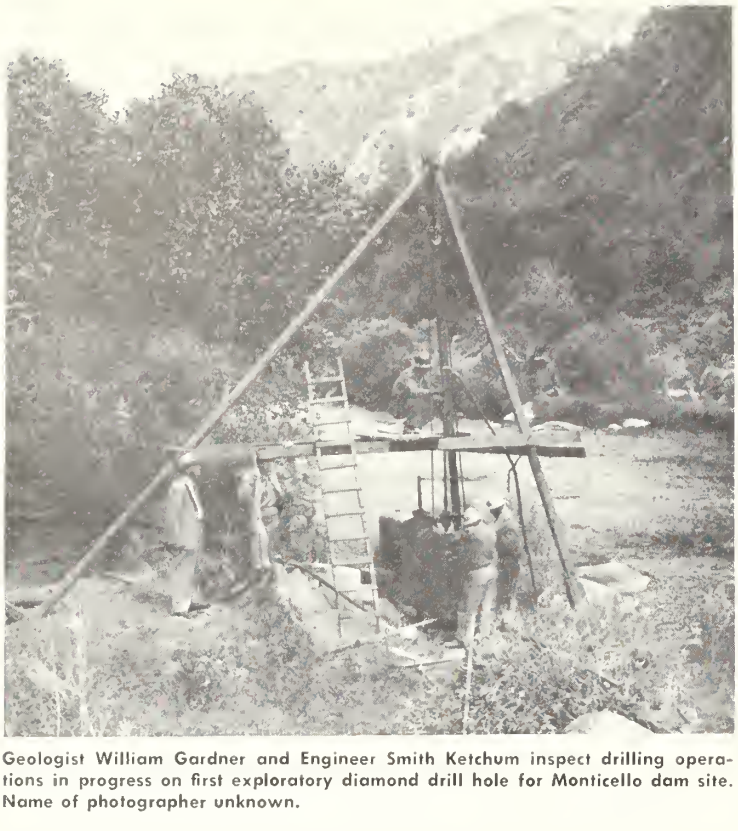
River control for irrigation is fundamentally a conservation activity. It conserves, in reservoirs, excess flood waters for use at a later, more profitable time. Also, storage dams frequently provide a source of hydroelectric power which not only helps to carry the load of financing the project but also makes an additional contribution to the national welfare in the form of low-cost power.

The extension of irrigation practices into subhumid and humid areas, the acceptance of national responsibility in irrigation development, the liberalization of repayment requirements, and international agreements for full utilization of international streams are, or could be, generally applicable throughout the world. In a great many instances they already have been applied. Guided by such precepts, the acreage under irrigation in the arid and semiarid sections of the United States—and perhaps in the rest of the world as well, can be increased approximately twofold.

It is logical, in the light of world-wide food deficiencies, that irrigation development will command more and more attention. And it is logical to predict that the countries of the world will set as their goals, full development of irrigation potentialities. Reclamationists in the United States look forward to reaching that goal by sharing technical knowledge for the benefit of everyone. ●

CORRECTION!

In the July 1949 issue, two errors occurred in the item entitled "Culbertson Dam renamed 'Trenton'." Carl W. Swanson was attorney for the Frenchman-Cambridge irrigation *district*, not the Frenchman-Cambridge division. The last sentence should have read, "Construction is soon to be started on the Trenton Dam. Bids for the foundation work were opened on June 29, 1949."



Geologist William Gardner and Engineer Smith Ketchum inspect drilling operations in progress on first exploratory diamond drill hole for Monticello dam site. Name of photographer unknown.

Drilling Started at Monticello Dam Site

The Solano County project in California was authorized on January 28, 1949, by the Secretary of the Interior. On May 18, foundation test drilling was initiated for Monticello Dam, the major construction feature of the project.

The immediate objective of the drill program is to supply foundation and geologic data which will enable the designers to select at an early date the proper type of dam, earth or concrete, to be built on the site. The next year will be utilized in carrying out advanced planning work and the preparation of final designs and specifications for the construction of project features.

Monticello dam will be located in a narrow sandstone canyon on Putah Creek, 30 miles west of Sacramento. This 300-foot high structure, when finished, will impound 1,600,000 acre-feet of water for irrigation and for municipal, industrial, and military use. Especially in urgent need of a supplemental water supply are the cities of Benecia, Fairfield, Suisun, and Vallejo, and the key military installations of the Fairfield-Suisun Air Force Base, Benecia Arsenal, and the naval shipyard at Vallejo.

Major features other than Monticello Dam of the Solano County project will be Winters Diversion Dam, and Putah South Canal, 43 miles in length, with an initial capacity of nearly 1,000 cubic feet per second. The canal will extend southwesterly from Winters to a terminal point near Cordelia.

The construction of Monticello Dam will necessitate the relocation of some 11 miles of California State Highway and miscellaneous county and farm roads. The town of Monticello, population 125, will be inundated as will 11,000 acres of Berryessa Valley lands within the reservoir area.

It is hoped that construction on the first section of the canal can be gotten under way during the fall of 1950, as completion of the canal is a critical link in making water available for the most pressing need, that of municipal supply. Construction of the canal will be coordinated with construction of Monticello Dam and the Winters Diversion Dam. Completion of the latter two features is scheduled for sometime in 1954. •

Two-Stage Diversion Speeds Work at Heart Butte Dam

Construction of Heart Butte Dam, located approximately 50 miles west of Mandan, N. Dak., on the Heart River, started in March 1948, with a time limit of 975 days or three working seasons allowed for completion. Contractors C. F. Lytle Co. and Green Construction Co. submitted a construction schedule based on completion of the dam in two construction seasons, or approximately 600 days.

To meet the accelerated schedule proposed by the contractors, it was necessary to excavate and backfill the cut-off trench across the bed of the river the first season. As originally contemplated, diversion was to be made through the spillway tube in August, 1948. Excavation and refill of the cut-off trench were to follow in the fall of 1948. It soon became apparent that diversion of the river through the spillway tube could not be made during the 1948 season. This meant delaying the completion date a full year, or making river diversion by some other method.

A two-stage diversion plan was decided on. The first stage consisted of shifting the river channel against the south abutment while excavating and backfilling the cut-off adjacent to the north abutment and then diverting the river across the completed north portion of the cut-off trench to the south abutment. This stage of the diversion was completed in the fall of 1948, with the river flowing in a channel across the completed cut-off trench until stage two of the diversion could be made.

Work in the spring of 1949 was concentrated on early diversion of the river through the spillway tube, which is stage two of the diversion. This work was completed and the river diverted through the spillway tube on June 1, 1949, permitting construction of the main embankment to proceed on schedule.—by Walter W. Brenner, construction engineer, Heart Butte Dam, Missouri Souris district, Bismarck, N. Dak., Region VI (headquarters at Billings, Mont.) •

Illustrated Folder on Hungry Horse Available

An informative and well illustrated (20 photographs and a map) folder entitled "Hungry Horse Dam" has recently been released by the Bureau. This bulletin contains statistics and data regarding the background, present status and a summary of the construction involved in Hungry Horse Dam in Montana. Copies may be obtained free of charge by writing to the Commissioner, Bureau of Reclamation, United States Department of the Interior, Washington 25, D. C., or one of the Regional Directors, Bureau of Reclamation. •

NOTES FOR CONTRACTORS

Contracts Awarded During July 1949

Spec. No.	Project	Award Date	Description of work or material	Contractor's name and address	Contract amount
2600	North Platte, Nebr.-Wyo	July 7	Grouting Fort Laramie canal	Jones Core Drilling Co., Dallas, Tex	$29,105
2634	Hungry Horse, Mont	July 8	12 lots of bulkhead gate frames, guides, and latches for turbine draft tubes, Hungry Horse power plant.	K & H Mfg. Co., San Francisco, Calif	12,846
2648	Columbia Basin, Wash	July 7	Construction of earthwork and structures for Winchester wasteway.	J. A. Terteling & Sons, Inc., Boise, Idaho	1,088,817
2650	Davis Dam, Ariz.-Nev	July 8	Five 100-kilovolt-ampere transformers and five 85-kilowatt resistors for units 1 to 5, Davis power plant.	Westinghouse Electric Corporation, Denver, Colo.	18,615
2652	do	July 13	Four 69,000-volt circuit breakers for Mesa substation, schedule 1	Pacific Electric Manufacturing Corporation, San Francisco, Calif.	39,480
2652	do	do	Five 15,000-volt circuit breakers for Mesa substation, schedule 2	Allis-Chalmers Manufacturing Co., Denver, Colo.	64,233
2652	do	do	One 230,000-volt selector type switch, and ten 69,000-volt and thirty-four 15,000-volt disconnecting switches for Mesa substation, schedules 3, 4, and 5.	Railway & Industrial Engineering Co., Greensburg, Pa.	26,035
2663	Hungry Horse, Mont	July 21	Twelve 11 by 15-foot bulkhead gates and one lifting beam for turbine draft tubes, Hungry Horse power plant.	Schmitt Steel Co., Portland, Oreg	17,600
2669	Missouri River Basin, Wyo	July 8	Two 126-inch ring-seal gates with hydraulic hoists, position indicators, throttle valves, seal valves, and handling equipment for Boysen power plant, item 1.	Hardie-Tynes Manufacturing Co., Birmingham, Ala.	114,549
2670	Davis Dam, Ariz.-Nev	July 20	Constructing foundations and erecting steel towers for Mesa-Coolidge 230-kilovolt transmission line.	Mark Cockrill Contracting Co., Phoenix, Ariz.	164,642
2675	Gila, Ariz	July 18	Three 3,000-horsepower synchronous motors for Wellton-Mohawk pumping plant No. 2, schedule 2.	Electric Machinery Manufacturing Co., Minneapolis, Minn.	138,245
2680	Davis Dam, Ariz	July 8	Pipe handrailing for spillway, outlets, gravity wall, and intake structures at Davis Dam and power plant.	Converto Co., Pittsburgh, Pa	12,000
2681	Missouri River Basin, Mont	July 11	Four 77-inch regulating gates for river outlets at Canyon Ferry Dam, item 1.	Willamette Iron & Steel Co., Portland, Oreg	73,777
2681	do	do	Four sets of conduit sections for river outlets at Canyon Ferry Dam, item 2.	Goslin-Birmingham Manufacturing Co., Inc., Birmingham, Ala.	15,990
2686	Columbia Basin, Wash	July 12	Steel structures for right transformer circuits and 230-kilovolt right switchyard, Grand Coulee power plant.	Muskogee Iron Works, Dallas, Tex	80,312
2688	Gila, Ariz	July 29	Construction of earthwork and structures for Wellton-Mohawk check and turn-out, Gila Gravity Main Canal; and earthwork, concrete canal lining, and structures for Wellton-Mohawk Canal.	Fisher Contracting Co., Phoenix, Ariz	1,335,463
2689	Missouri River Basin, Nebr	July 15	Construction of Trenton Dam foundation	Marshall, Haas, & Royce, Belmont, Calif	1,626,250
2691	Davis Dam, Ariz.-Nev	July 12	Hatch covers for Davis power plant	Missouri Valley Steel, Inc., Leavenworth, Kans.	31,226
2692	Central Valley, Calif	July 18	Hatch covers for Tracy pumping plant	Missouri Valley Steel, Inc., Leavenworth, Kans.	14,950
2700	Davis Dam, Ariz.-Nev	July 8	Miscellaneous structural steel for cable trays and walkway for Davis Dam and power plant.	Jumbo Steel Products Co., Azusa, Calif	19,870
2714	Columbia Basin, Wash	July 29	Rewinding 9 current transformers for Grand Coulee right switchyard.	General Electric Co., Denver, Colo	17,955
2727	Gila, Ariz	Jnly 21	10,000 barrels of portland cement for construction on Wellton-Mohawk division.	California Portland Cement Co., Los Angeles, Calif.	42,400

Construction and Supplies for Which Bids Will Be Requested by November 1949

Project	Description of work or material
Boulder Canyon, Nev	Installing equipment and performing alterations to water treatment plant at Boulder City, Nev.
Do	Installing water lines at Boulder City, Nev.
Do	Installing sprinkling system for Government lawns at Boulder City, Nev.
Central Valley, Calif	Construction of 26-mile concrete pipe distribution system from Friant-Kern canal to supply the Southern San Joaquin municipal utility district near Delano, Calif.
Colorado-Big Thompson, Colo	Construction of earthwork and structures for about 5 miles of Poudre supply canal, 1,500-cubic-feet-per-second capacity, near Fort Collins, Colo.
Do	Construction of about 73 miles of 115-kilovolt wood-pole H-frame transmission line between Brush and Limon, Colo.
Do	Installation of electric motors, pumps, and miscellaneous equipment, erection of towers and equipment in switchyard.
Do	Construction of about 31 miles of 115-kilovolt wood-pole H-frame transmission line between Estes power plant and Leyner switchyard, 6 miles south of Longmont, Colo.
Colorado River Front Work and Levee system, Calif.	Furnishing and erecting four houses at Needles, Calif.
Columbia Basin, Wash	Excavation of about 9.1 miles of Potholes East canal, ultimate capacity of 3,900 cubic feet per second, about 16 miles west of Warden, Wash.
Do	Relocation of 6.5 miles of county road including construction of one reinforced concrete and steel bridge near O'Sullivan Dam.
Do	Construction of earthwork, concrete lining, and structures for 19.7 miles of the 3,100 cubic feet per second capacity, West canal near Quincy, Wash.
Davis Dam, Ariz.-Nev	Installing equipment and constructing 132,000-kilovolt-ampere Coolidge substation.
Do	Constructing addition to Phoenix control house.
Do	Stringing conductor and overhead ground wire for about 238 miles of 230-kilovolt steel-tower transmission line from Davis Dam to Prescott and Mesa, Ariz.
Gila, Ariz	Construction of 9.5 miles of concrete lined Wellton-Mohawk Canal, 1,300 cubic feet per second capacity, and relocation of 4.5 miles of county road, about 12 miles east of Yuma, Ariz.
Kendrick, Wyo	Control board for remote control and telemetering of Kortes power plant.
Missouri River Basin, Mont	Construction of Moorhead Dam and dike. The dam is to be an earthfill structure about 190 feet high and 2,660 feet long at the crest; the earthfill dike is to be about 25 feet high and 540 feet long at the crest.
Missouri River Basin, N. Dak	Construction of 41-mile-long Bismarck-DeVanl 69-kilovolt wood-pole transmission line, near Bismarck, N. Dak.
Missouri River Basin, Nebr	Construction of 3,800-foot long, 4.5-foot diameter Superior siphon, a precast concrete structure in Superior, Nebr., on Superior canal.
Missouri River Basin, S. Dak	Construction of permanent residence, garage, generator and pump house, steel warehouse, and installation of utilities for Shadehill government camp, about 13 miles south of Lemmon, S. Dak.
Missouri River Basin, Wyo	Construction of Keyhole Dam, an earthfill structure 109 feet high and 3,300 feet long at the crest, located on Belle Fourche River 18 miles northeast of Moorcroft, Wyo.
Do	One 14-cylinder carbon-dioxide fire extinguishing system for the protection of an oil storage and oil purifier room, and one 6-cylinder carbon-dioxide fire extinguishing system for three 13,333-kilovolt-ampere generators at Kortes power plant.
North Platte, Wyo	Erection of a 250-foot long structural steel walkway on Pathfinder Dam near Alcova, Wyo.
Ogden River, Utah	Furnishing and installing a venturi meter in the 75-inch diameter Ogden Canyon conduit.
Paonia, Colo	Construction of earthwork and structures for the second section of Fire Mountain Canal on the North Fork of the Gunnison River near Somerset, Colo.
Parker Dam Power, Calif	Constructing 18 residences at Parker Dam, Calif.
Do	Constructing machine shop at Parker Dam, Calif.

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Ruth F. Sadler, *Editor*

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30 YEARS AGO

IN THE ERA

The high cost of living, which constitutes the chief subject of conversation in most circles in the East, is present with our farmers, but not in the same degree, because with their abundant crops and good prices, and with so much of their food produced right at hand, an inventory always indicates a balance on the right side of the ledger. The prosperity of the country, as usual, is reflected in the cities and towns. Their growth has been phenomenal.

(From the October 1919 issue of the Reclamation Record, predecessor of the Reclamation Era, page 450, "Current Comments Gathered From the Project Press and People," by C. J. Blanchard, Statistician.

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AT LONG LAST

WATER RUNS DOWN THE DITCH—The observers, members of the younger generation, appreciate the engineering perfection of the Friant-Kern Canal. It's the longest irrigation structure of its kind—156 miles. *All photos by the author.*

by BEN GLAHA, Chief Photographer, Region 2, Sacramento, Calif.

It was 109 degrees in the shade on that Saturday afternoon in California, on July 9, 1949, but the only bit of shade in all that hot, sun-broiled scene was under an awning stretched atop the massive concrete structure housing the huge needle valves which, later that day, were to jet the first flow of water into the Friant-Kern canal. At 1 o'clock all there were under the awning were several rows of funeral-parlor chairs, a rostrum with an empty water pitcher, a battery of microphones and a lone technician in a sweat-drenched T-shirt who fiddled with his transmitting equipment and flipped cables across the floor of the platform.

By 2 o'clock several thousand citizens of the San Joaquin Valley of California, farmers, businessmen, family picnic groups which had spent the morning on Millerton Lake, and just plain spectators, had lined the banks of the canal or arranged themselves in a sizzling row on the crest of Friant Dam, the better to view the proceedings.

The water coolers provided by Construction Engineer Dick Durant, the Bureau's local host, were doing a land office business (the water was free, of course). The news-reel cameramen and lesser photographic fry had their cameras set up and trained on the speakers' stand and the inactive but ex-

THERE WERE SPEECHES—Left to right: Governor Earl Warren of California, George Creel, one of the project pioneers, Bureau Chief Engineer L. N. McClellan, celebration chairman Irvin H. Althouse, and Regional Director Richard L. Boke of the Bureau of Reclamation's Sacramento, Calif., office.

pectant valves below. The microphones had been "tested" and were waiting. The radiomen adjusted their earphones and twiddled their dials. The photographers looked bewildered as they directed their light meters toward the blaze reflected from the dam. A large truck drove up to the platform and the Fresno brass band straggled to their places.

At this juncture the wail of a highway patrol siren heralded the approach of the official party and a parade of shiny cars drove onto the parking lot. A gaudy, flag-bedecked station-wagon convertible, representing the city of Bakersfield, was emblazoned with the slogan, "A Billion Dollars' Worth of Sunshine."

By this time those who had been invited to sit on the speakers' stand had filled the chairs, and as the official party, headed by Governor Earl Warren of California and Leslie N. McClellan, Chief Engineer of the Bureau of Reclamation, filed onto the platform, there was a bustle of greetings and handshaking. Then the speakers of the day took their places and the crowds out along the canal banks and atop the dam fell silent. A color guard of Boy Scouts raised Old Glory against the shimmering, massive backdrop of Friant Dam and the band struck up the "Star Spangled Banner."

A fervent invocation was spoken by Roland R. Meredith, D. D., First Methodist Church, Fresno, Calif., in which he prayed that the impressive man-made works about to be pressed into service be used for the greater glory of God and for the widest possible benefit to His children.

Mr. Irvin H. Althouse of Porterville, acting as general chairman of the celebration, delivered the address of welcome and introduced the day's master of ceremonies, George Creel of San Francisco. Mr. Creel, whose intercession with President Franklin D. Roosevelt was instrumental in securing the first allocation of Federal funds for the construction of the Central Valley project, briefly reviewed the history of the project. He cited the many and diverse difficulties which had marked the progress of the work and lauded those whose unselfish labors have brought about its present state of completion. In introducing Governor Warren, he praised the effective cooperation of the State and the Federal Government in the pursuit of a mutual endeavor, conceived by the State engineer's office and executed by the Bureau of Reclamation.

Governor Warren spoke of the occasion as "a glorious day in the life of the State * * * and a happy day for the San Joaquin Valley." He declared the completion of the Friant-Kern Canal "will go down in history as one of the outstanding accomplishments of the Nation in the last half century." In closing his brief address, the Governor urged his listeners to remember that "the most precious resource the State has is water and we do not have an over-abundance of it. We need every drop that falls on the mountains and the plains. We must see that every drop is conserved and put to use."

Representing the Department of the Interior, Chief Engineer McClellan described the engineering aspects of the Friant-Kern Canal and Friant Dam and cautioned the people of the valley that anything short of comprehensive development of their water resources would fail to meet present and future demands. In part, he said: "A few minutes from now you will see water stored by Friant Dam start on its long journey toward the farms of Tulare County through the Friant-Kern Canal, an artificial river that can carry 5,000 cubic feet of water a second. But this water delivery could not be accomplished without the help of many other works." This final reference was to the other features of the Central Valley project: Shasta and Keswick Dams, the Delta Cross Channel, Tracy pumping plant and the Delta-Mendota Canal which operate to effect the transfer of surplus water from the Sacramento River watershed into the water deficiency areas of the San Joaquin Valley, thereby permitting San Joaquin water to be diverted southward by the Friant-Kern Canal.

Several officials representing San Joaquin Valley irrigation and utility districts responded to the remarks of the Governor and the Chief Engineer.

And now the climax—not only of the present celebration but of years of planning, work, and waiting—had arrived. Seemingly unaware of the drama of their task, Mr. W. B. Kiggens of Lindsay, who was the first vice president of the San Joaquin Water Conservation and Development Association, and G. H. Hogue, a former engineer of the Bureau of Reclamation, now retired, stepped forward and pressed the switch buttons starting the motors which operate the gigantic 94-inch needle valves which slowly opened to release the first service water into the Friant-Kern Canal.

At first the jets of water curving downward into the stilling basin were beautifully symmetrical. As the volume increased, spray spouted to the top of the training walls and the turbulent flood broke and subsided into the canal section. Then an enveloping draft of cool air surged over the crowd like a benediction.

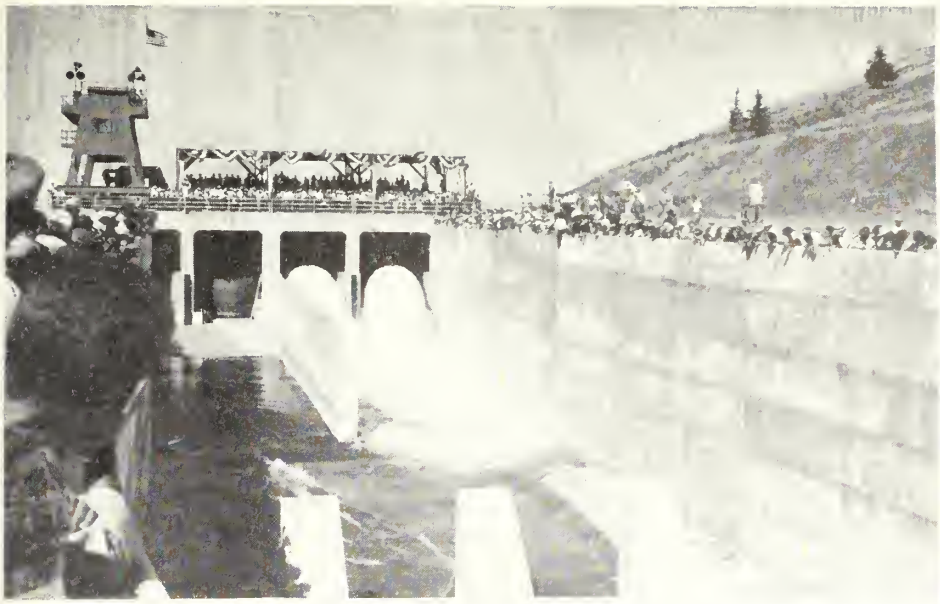
Far to the south the thirsty acres awaited the coming of this first refreshing stream and the people who farm the thirsty acres were in a carnival mood to receive it. In the irrigation community of Orange Cove, headquarters of a district which a few weeks earlier had signed a contract with the Department of the Interior for water and a distribution system, elaborate plans for a welcoming celebration had been made. Principal events had been scheduled for the afternoon of Sunday, July 10, by which time the water, traveling southward from Friant Dam at about 3 miles per hour, should have reached the town.

The streets were decorated with flags and bunting and a water festival queen to preside over the festivities had been crowned at a community dance Saturday evening.

During the morning and early afternoon of Sunday, an air show had kept the crowd entertained as hourly bulletins on the stage of the water in Friant-Kern Canal timed the beginning of the main events.

By 3 o'clock the water stood several feet deep in the canal along the eastern boundary of the town and the people had gathered around a pavilion on the bank. A welcoming address was delivered by M. N. Jensen, chairman of the Orange Cove irrigation district board of directors, and B. J. Foster, general chairman of the occasion, acted as master of ceremonies. Speeches were made by Chief Engineer McClellan; Thomas Waddell, of the California Water Resources Division; and Regional Director Richard L. Boke, of the Bureau of Reclamation.

At the conclusion of the formal program, E. M. Sheridan,



Above: A new group of "forty-niners" cheer enthusiastically as the first water pours down the Friant-Kern Canal en route to the thirsty lands of the San Joaquin Valley. Above right, Mr. and Mrs. J. O. Coffey of Reedley, waited 30 years for this day. Next: Orange Cove Lions Club members engage in some horseplay while decorative bathing beauties get their first feel of the water. Bottom left: Thomas Waddell of the California State Division of Water Resources; center: Leroy McCormick, attorney for the irrigation districts. Right: One of the floats which keynoted the carnival spirit of the Orange Cove event.

an old timer, started the pump which lifted a gushing flow of water over the canal bank and onto the land which for 30 years had waited for an adequate supply. As the stream touched the ground, members of the Orange Cove Lions Club in special costumes leaped under it in an exuberant demonstration which seemed to express the feeling of just about everyone present.

The next event was a street parade in which the floats carried out the water-use theme. The one which perhaps best exemplified the spirit of the community on that day carried a large banner inscribed simply "Orange Cove Is Grateful for Water." Later the celebrants gathered at a huge community picnic dinner and in the evening there was dancing in the streets.

And so after all the years of waiting, after all the work, after all the years of untiring and unselfish effort against heavy odds, after all the oratory and debates, after all the the parades, the San Joaquin Valley was getting water—and the people were grateful. THE END

THE COLORADO RIVER DELTA

Part 1 – *The Seven Citie*

by Engineer C. P. VETTER,

Chief, Office of River Control, Region 3, Boulder City, Nevada

MUCH HAS BEEN WRITTEN BUT LITTLE IS KNOWN about that great, partly desolate area, often referred to as the Colorado River Delta. It is perhaps natural that this paradox should exist. In the Colorado River Delta there are thriving irrigated fields and modern Diesel-powered pumping installations, furnishing water to those fields. But there are also endless swamps and jungles and salt flats stretching as far as the eye can see. Through it all winds the Colorado River—not as a single confined stream as we know it in this country, but in innumerable individual channels, now wide, now narrow, some deep, and some so shallow that even the lightest boat cannot penetrate them.

For centuries the flow of the river has changed from one group of channels to another, from east to west and back again, forming new channels and filling up those where before even moderate-sized ships could pass.

Not so many people have explored this delta, but everyone who has been there has written about this strange land and has prepared maps. It is when we try to reconcile the reports of those travelers and compare their maps that we realize that little is known about the Colorado River Delta—except that it is subject to change without notice.

The Colorado River Delta covers an area of approximately 1,800 square miles and lies entirely to the south of the Mexican border below the States of Arizona and California. On the east it is bordered by that great area of land, the Sonora Mesa; to the west by the Cocopah Mountain range; to the south by the Gulf of California. Westward of the Delta is another basin called Laguna Salada, which is perhaps still more desolate and unknown than the Delta itself. This depression separates the Cocopah Mountains from the great coastal range of mountains extending south down through the Lower California peninsula.

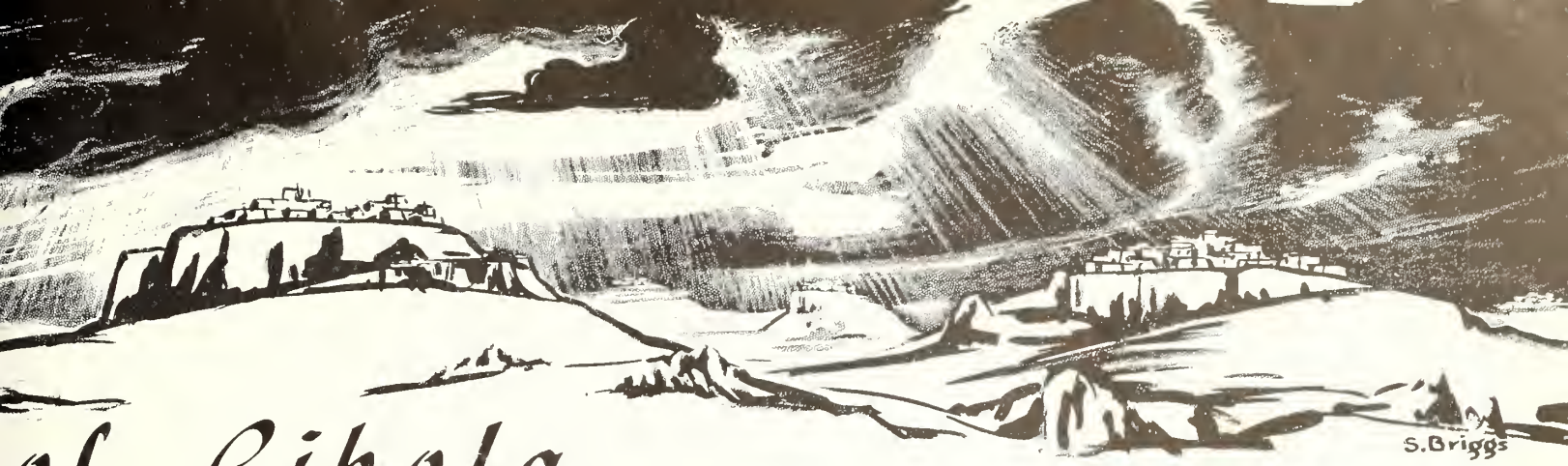
The Delta itself may be described as a very flat cone, with its apex near Yuma, at an elevation somewhat over 100 feet above sea level, and with its base reaching sea level at the head of the Gulf and slightly below sea level near the California border. Geographically speaking, the Imperial and Coachella Valleys are also part of the Delta and have again and again been the recipients of overflow from the river. The character of this part of the Delta, however, is now so changed (as is also the part located immediately south of the California border—the Mexicali Valley) that it actually forms an area distinct from the Delta proper now occupied by the river and its many arms.

The first white man to reach the mouth of the Colorado, which incidentally, he did not recognize as a river, was Francisco de Ulloa, who arrived at the head of the Gulf some time in the late summer of 1539. Ulloa's purpose was not primarily to explore or to get to know new and unknown lands. Mostly, his reason was the same as that which led to the discovery by white men of almost the entire area between the Colorado and the Mississippi—the lust and the search for gold by the Spanish conquerors of Mexico.

By 1539 Hernando Cortes, the Governor General of New Spain, or Mexico, was nearing the end of his rope. Having once escaped from the services of the Governor of Cuba, he had conquered an empire, drained its gold and treasure and heaped his plunder on his royal sovereign to make him forget the somewhat shady past of the conqueror. Now, the sources of gold and precious stones were running dry in Mexico and the Spanish king was getting restless and wondering whether he had better not get another representative in the new empire who would be more liberal with his gifts.

So Cortes sent Ulloa with three ships up the Gulf of California to determine whether Lower California was truly an island as it was rumored, or whether it was connected with land still farther north, and mainly to see whether he could find there any trace of the fabulous Seven Cities of Cibola, where it was rumored the streets were paved with gold and golden apples hung from the trees and that fabulous figure, El Dorado, the "Gilded One," was rubbed daily over his entire body with gold leaf.

Cortes had reason to believe that the Seven Cities of Cibola were located somewhere to the far north of Mexico and this reason is just as strange as anything that has ever happened in the dim history of our Southwest. It came to pass that in 1536 there arrived at the court of Cortes four strange men of which one was a Negro, perhaps a Moor, called Esteban. They were the survivors of an expedition which had originally landed on the coast of Florida, but of which the rest had perished. Only the three white men and Esteban managed the unbelievable feat of traveling by foot through the



# of Cibola

totally unknown and wild country around the head of the Gulf of Mexico until they reached the Spanish outposts. Somehow one cannot blame these weary travelers for wanting to receive all the attention that they could command. Their hardships, in themselves, would not command much interest. All the men in Mexico in those days had experienced considerable of the same. They knew, however, if they could bring tales of gold—unbelievable quantities of gold—they would be listened to and they would be taken seriously: so they swore they had seen the Seven Cities of Cibola, and Esteban insisted that he could find the Cities again. But Cortes did not have the money or the power at that time to outfit an overland expedition, however, he could scrape up enough cash to outfit the three ships for Ulloa. In the autumn of 1539, Ulloa reached the head of the Gulf and discovered that Lower California was truly a peninsula and thus he wrote—the first white man to write about the Colorado River Delta:

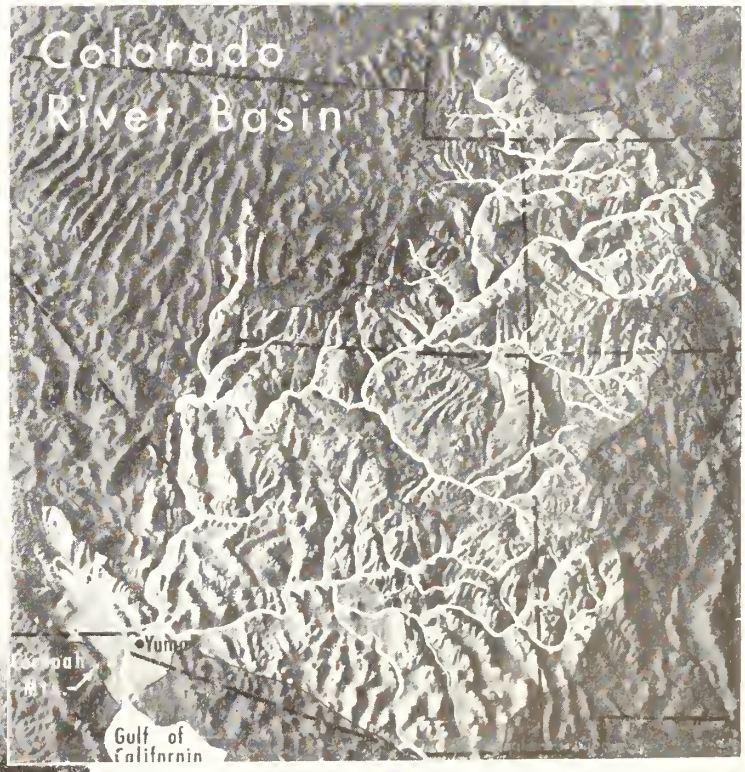
> . . . we always found more shallow water, and the sea thick, and very muddy . . . whereupon we rode all night in five fathoms of water, and we perceived the sea to run with so great a rage into the land that it was a thing much to be marvelled at; and with a like furry it returned back again with the ebb, during which time we found eleven fathoms of water and we went up to the ship's top and saw all the land full of sand around the compass and joining itself with the other shore; and it was so low that whereas we were a league from the same we could not discern it, and it seems there was an inlet of the mouths of certain lakes, whereby the sea went in and out. There were divers opinions amongst us, and some thought that the current entered into these lakes, and also that some great river might be the cause thereof.

Ulloa surmised that there might be a great river but he was sure that there was no gold, so he sent one of his ships back to Cortes to report. With the other two, he returned down the Gulf and around the cape to investigate the land around the west coast. He was never heard of again.

This was the end of Cortes. Within the year he left for Spain to plead with his king but was unsuccessful, and 7 years later he died, in distress and poverty. Thus passed from the scene of the new world the man who reportedly once said that he had given his king more provinces than Spain had cities.

This was not the end, however, of the dream of the Golden "Cities of Cibola." Cortes' successor, Mendoza, sent out

(Continued on page 220)



"Through it all winds the Colorado River"—Above, the entire Colorado River Basin, with the practically unexplored Colorado River Delta shown in the extreme lower left-hand corner, south of the Mexican border below the States of Arizona and California, bordered on the west by the Cocopah Mountains, on the south by the Gulf of California and on the east by the Sonora Mesa. At left is a newly opened connecting channel between the Colorado and Hardy Rivers. Photo submitted by the author. Map prepared by the Bureau's Drafting and Graphics staff.

WIDE OPEN SPACES—Shall they be desolate and deserted, or prosperous and fertile? The answer lies in wise use of soil and water. *Photo submitted by the author.*

by REED W. BAILEY, Director, Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden, Utah

People in the West are perhaps more conscious of the part land features play in their daily lives than people in the Middle West, the South, or the East. Mountain peaks and ranges are close at hand. They can be more readily conceived as watersheds from which comes the water so vital to crop production and daily human needs than in other, more humid parts of the country. But even westerners need a better understanding of what watersheds are, how they receive and deliver water, the extent to which man is capable of speeding up soil erosion and water run-off on them, and the limits of his capacity to control erosion and run-off through treatment of his watershed lands.

A watershed is a land area from which the run-off from rain and snow drains toward a single channel or body of water. It may cover less than an acre, or it may be a complex of many drainage areas. Our entire land surface is made up of watershed units from which water gathers into streams, and upon which we are dependent for our water supplies.

The Watershed Mantle

Each watershed has definite characteristics of stream flow and yields of sediment. These characteristics are the result not only of the present climate but also of past climates. They are also the result of features of the landscape, including the topography, the soil and the plant cover, all of which have been inherited from the past. Of these inherited watershed features, the soil mantle and plant cover are of major importance because they exert a dominant influence on stream flow regimen and sediment loads, and because they are the two components of the land which are used by man and can be greatly altered by that use.

The soil mantle on watersheds is a product of rock weathering and the activity of plants and animals. Disintegration and decomposition of rock of the earth's crust into soil-sized particles is a very slow process. The succession of plant and animal communities, and the incorporation of organic matter in the soil also is a long process. A soil mantle with its top layer of humus is truly a product of the ages.

The soil mantle in some places is formed from underlying rock; in others, from materials that have been transported by gravity, wind, glaciers, and water. Regardless of the mode of origin, the presence of soil on a site today means that the process of soil development and accumulation has proceeded at a rate greater than the rate of soil removal. The key to the development and maintenance of a soil mantle in the face of the forces of removal is the presence of a plant cover.

Any sloping land surface having a soil and plant cover is a product of all of the elements of the weather and of other natural influences such as fire, rodents, and game which have operated through the period of slope formation. Such slopes, by reason of protection afforded by vegetation, have existed in spite of cyclic changes of climate as well as extreme variation within cycles. All soil-covered slopes, in other words, exist because of an adjustment between constructive and destructive forces in which the plant cover is the key to stability.

How Watersheds Work

Every small parcel of land in a drainage area receives and disposes of precipitation, or as a hydrologist might say, functions hydrologically. It may yield the precipitation it receives either as seepage flow or as overland flow, or both. The former is water that reaches channels after infiltrating into and percolating through the soil mantle. Overland flow, as the name implies, is run-off that reaches channels by moving over the surface of the land.

Seepage flow can take place only after the soil mantle is wetted to beyond its field capacity, or in simpler terms, only after the soil can absorb and retain no more water. Tests have shown that mountain soils can hold from 2 to 3 inches of water per foot without yielding any to seepage. Thus, a dry mantle 4 feet deep must receive more than 8 to 12 inches of water before water will flow from it. Even after the mantle is thoroughly wet, the movement of additional precipitation as free water through the soil to lower levels, and on out to channels, proceeds slowly as compared to the movement of overland flow. Because seepage flow run-off is delayed in delivery to channels and is generally free of sediments, it is the most useful water yielded by watersheds.

Overland flow can occur whether the mantle is wet or dry: it starts whenever rain falls or snow melts at a rate that is faster than the water can get into the ground. Because it does flow over the land surface, it is capable of eroding the soil and of gathering quickly into channels—rills, gullies, or streams—often producing discharges of great violence.

Whether run-off occurs as seepage flow or as overland flow depends primarily on the infiltration capacity of each watershed site—on how well different sites absorb the water they receive as precipitation. Many tests have shown that there is much natural variation in the capacity of sites to infiltrate water due in part to the structure and porosity of soils, but to an even larger extent because of the kind and amount of plant and litter cover. This natural infiltration capacity of any site can be materially decreased by reducing the density of the plant and litter cover on the surface of the ground and by trampling and packing the soil.

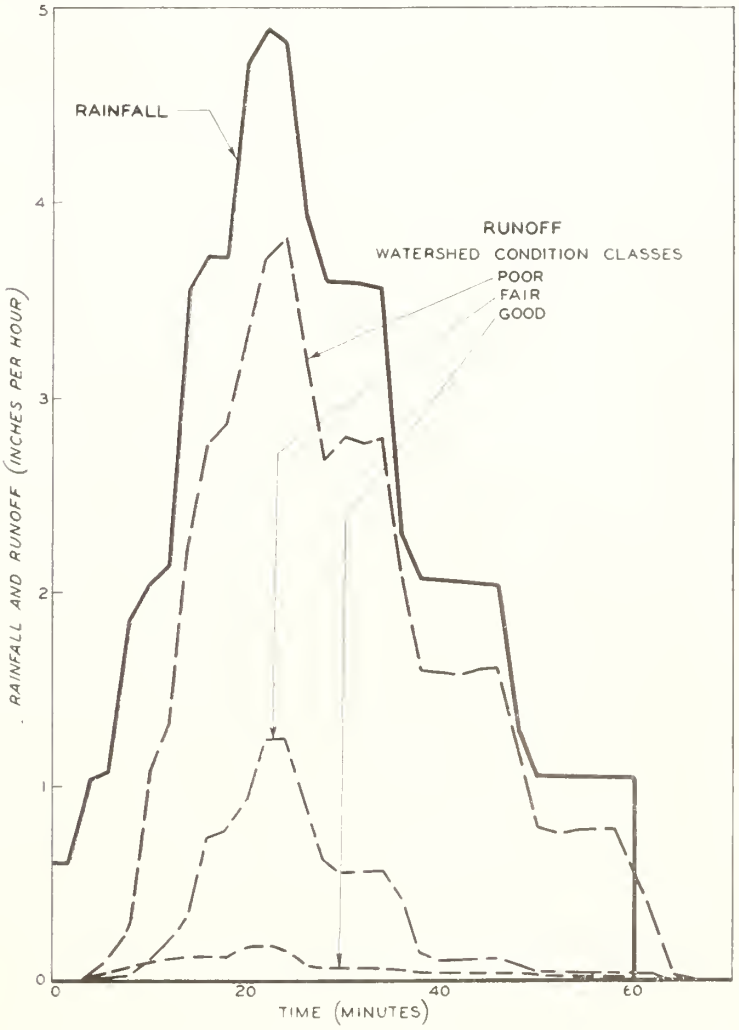
Watershed sites with an undisturbed soil and a natural cover of plants and litter can often absorb rainfall at rates in excess of 6 inches an hour. After the plant and litter cover has been removed or drastically reduced by fire, land clearing, overgrazing, or other harmful landuse practices, the same or similar sites may be able to absorb water at only 2 inches an hour or less. Such reductions of the plant cover can also change the rates of soil loss from negligible amounts to many tons per acre per storm. Where this happens, the normal hydrologic pattern of the watershed is altered: run-off and soil losses become accelerated.

Man as a Geologic Agent

Accelerated erosion and changed stream regimen are taking place in parts of many of the topographic and climatic regions in the world. The comparatively new erosion events we are now witnessing are highly selective, soil losses and abnormal discharges occurring wherever man has altered or destroyed the natural plant cover. This new rate of erosion constitutes a marked change from the geologic norm of run-off and sediment load of the immediate geologic past.

The new erosion has become manifest in many ways. The magnitude of flood discharges has mounted and the recessional stages of flow have weakened. Signs of this change are also discernible on the land itself, for the history of past degradation of a watershed is written not only in the channels and deposits made by streams, but also in the profile of the slopes and in the soil.

WHERE DOES THE RAIN GO? A few lines tell the graphic story of what happens to rainfall during a typical major summer storm under different watershed conditions. Under poor watershed conditions with only 17 percent of the ground covered by plants and litter, run-off occurred almost as fast as the rain fell. Under good conditions, with 65 percent ground cover, there was very little run-off. In these same tests, poor areas lost 100 times more soil than the areas in good condition. *Graph submitted by the author.*



Soil that has been ages in forming and that has been stable for centuries is now being removed at a rapid rate. Fresh gullies, sharply incised through black soil, exposing the roots of long-established plants, are clear-cut evidence of the newness of this process.

Abnormal deepening of stream beds is another expression of this recent change; it is occurring in many parts of the world. In Utah, as an example, at numerous places around the shorelines of the ancient Lake Bonneville, deltas have been cut by floods of historic times, to depths that are as deep or deeper than all of the cutting that occurred since the lake waters receded from the deltas many thousands of years ago. Here, again, this abnormal rate of channel cutting has been selective; it has occurred only at the mouths of drainage basins in which the plant cover in the headwater areas had been damaged in recent years by overgrazing and man-set fires.

Prior to settlement and extending back over long periods of time, many valleys of tributaries to the Colorado River were aggrading—that is, the valleys were being built up by sediments. In the last 100 years the process of sediment accumulation in these valleys has been reversed and the removal of these materials by channeling is occuring over extensive areas.

The building up of flood plains in river channels and the silting up of reservoirs in many areas provide further evidence of the newness of the current accelerated erosion. Tremendous effort has been required to cope with the loads of sediment that have been deposited in river channels and harbors since man started accelerated erosion by improvident use of watershed lands. The sediment load of the Rio Grande has greatly increased in modern times, raising the channel bed several feet above the main streets of Albuquerque, N. Mex.

This new change in gradation processes we are talking about is significant when compared with the results of the entire cycle of erosion in which, over periods of millions of years, canyons are cut, valleys are filled, and whole mountain ranges are reduced to peneplains (a condition of low relief—almost a plain). However, these new erosion events are of vital importance to present-day man because they are destroying productive soil that has been ages in the making, and because they are impairing the usefulness of water resources.

Watershed Control of Run-Off and Erosion

Can this new rate of erosion be checked on mountain watersheds? It can to a certain extent. Here again plant cover is the key—this time to restoration of balance. To accomplish restoration, a variety of watershed treatment methods, including mechanical and structural aids, is necessary.

On areas where there has been slight plant depletion and soil deterioration, measures that will aid in the natural establishment and growth of local plants can be used. These may include: protection from fire; the regulation of grazing and timber cutting; and the preservation of seed sources. To attain the goal of natural plant restoration in limited cases, all use may have to be curtailed or prohibited.

Where plants will not come in naturally because of extreme overuse or fire damage, or because of inadequacy of seed source, artificial revegetation may be required. Methods of reestablishing the protective plant cover will differ greatly for different regions. A primary need for the new cover is protection. Once well established, it needs continuing wise use and management.

Mechanical controls such as contour trenches, water spreaders, gully plugs, water drops, retaining walls, impounding dams, and debris basins constitute a third category of watershed restoration measures. These may be essential where erosion is severe in order to stabilize channels and soil on the slopes so that the plant cover can be reestablished.

Watershed treatment measures, of course, will not prevent all floods nor will they keep all sediment out of streams. Some degree of soil loss from slopes is normal, being rapid in some places and very slow in others; some degree of flooding and sedimentation is normal in all streams. What can be accomplished by watershed management practices is restoration of erosion and run-off characteristics to their geologic normal where the lands have been abused, and prevention of accelerated erosion and abnormal run-off where the hydrologic functions of the soil and plant cover have not yet been impaired. THE END

The above article was condensed and modified by the author from a paper "Geologic Understanding and Watershed Management," which he presented at the Inter-American Conference on Conservation of Renewable Natural Resources, Denver, Colo., September 1948.

The Colorado River Delta

(Continued from page 217)

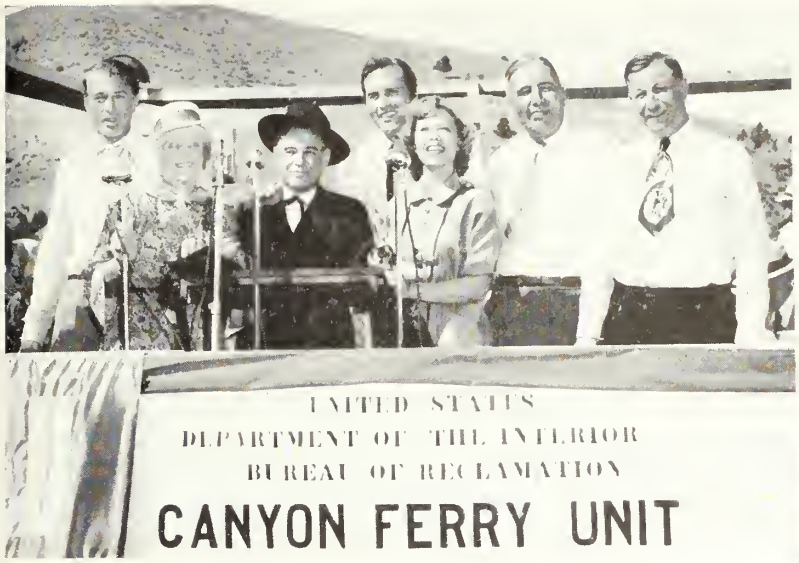
Esteban, in company with a monk, to see if they could find the way to the Cities overland. They traveled far and long and finally they sighted the Zuni villages in what is now southwestern New Mexico. There, said Esteban, were the golden cities, and he hurried ahead while the monk stayed behind. Esteban, too, was never heard of again. The monk waited and was afraid to follow, but he gazed at the villages on their hilltops as the setting sun shone on them, and they looked golden to him and he returned to Mendoza to tell him that indeed the "Seven Cities of Cibola" had been found.

Mendoza quickly organized two great expeditions—one under the command of Coronado, to proceed overland; the other under the command of de Alarcon, to proceed by ship up the Gulf and farther on, if possible. De Alarcon reached the head of the Gulf in August 1540, and, after battling the same tides that had almost wrecked Ulloa, he passed safely into the mouth of the river. He worked his way upstream to a point near where Blythe, Calif., now stands. There he was supposed to have met with messengers from Coronado's party, but failed to make connections and returned to Mexico.

Meanwhile, Coronado reached the Zuni villages, but of course found no gold or riches; whereupon, he killed the inhabitants to the last man and proceeded on his way to explore a huge territory extending possibly as far east as the Mississippi, and as far north as the Kansas-Nebraska line.

Thus ended a dream of mending riches lying at the feet ready to be picked up, and so began a new era of the southwest—the rule by the Spanish conquerors.

(To be concluded next month)



Unfortunately these photos missed the deadline for the September issue which carried on page 207 a résumé of the ceremonies on July 22 marking the beginning of construction on Canyon Ferry Dam, 172 feet high, 1,000 feet long, located 17 miles east of Helena, Mont.

At right you can see the smoke from the first blast, detonated by O. S. Warden of Great Falls, Mont., vice chairman of the Montana State Water Conservation Board and nationally known reclamationist. At upper right is an artist's drawing of what the Canyon Ferry Dam and power plant will look like when completed.

Surprise visitors on hand to witness the event which concluded with an historical pageant built around the theme of the Department of the Interior's Centennial, were Gary Cooper, Dinah Shore, and George Montgomery, film and radio stars. The picture above shows Mr. Cooper and his mother on the reviewing stand with Lester Noble, Helena attorney and master of ceremonies, George Montgomery, Dinah Shore, Commissioner of Reclamation Michael W. Straus, and Montana's Governor John W. Bonner. The artist's drawing is by M. H. Willson, and the photos by C. A. Knell, Regional Photographer for Region 6.

Estes Park Construction Contract Awarded

Commissioner of Reclamation Michael W. Straus awarded a contract to the Wunderlich Contracting Co. of Omaha on August 10 which will start construction of the Estes Park-Foothills aqueduct and power system, a unit of the Colorado-Big Thompson project in Colorado. The contract calls for boring the Olympus (1.8 mile-long) and Pole Hills (5.4 mile-long) tunnels through the foothills of the east side of the Rockies. These tunnels are designed to carry water from the Estes Park Reservoir, at approximately 7,500 feet elevation, for the purpose of providing power generation for the eastern slope of the Continental Divide.

Power revenues will carry a large share of the repayment costs of the Colorado-Big Thompson project.

A relatively small amount of water is now flowing from the western to the eastern slope of the Rocky Mountains through the Alva B. Adams, a principal feature of the Colorado-Big Thompson project, and is being used for irrigation purposes but there is as yet no power being generated on the eastern slope. Construction of the Marys Lake and Estes Park power plants has been under way since May 1947, and the production of power in these plants is expected to start by the end of the present fiscal year.

First power production from the Estes Park-Foothills aqueduct unit, according to the Bureau's construction program, is scheduled for fiscal year 1953 although this schedule is contingent upon the rate of appropriations and other factors not now ascertainable. When completed, the system of power plants on the Colorado-Big Thompson project will have a total installed capacity of 175,000 kilowatts. ●

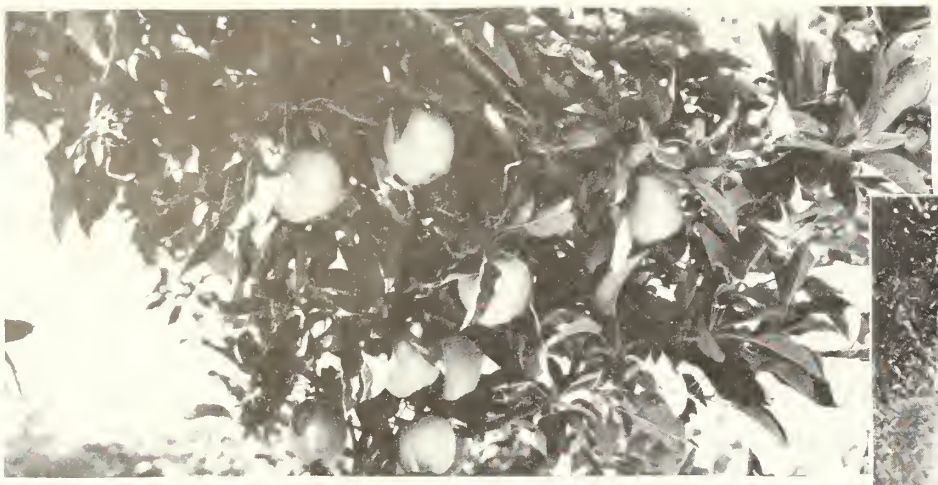
Jackson Gulch Dam Dedicated

Regional Director E. O. Larson was the official representative of Commissioner Michael W. Straus at the dedication of Jackson Gulch Dam, Mancos, Colo., on July 2, 1949.

In his address, Director Larson pointed out that although the people of Mancos Valley have been irrigating the land for 70 years, this project provides them with their first firm and dependable water supply. The Mancos project was primarily intended to provide supplemental water for the irrigation of more than 8,000 acres of land plagued by recurring shortages.

The project, which was authorized 9 years ago under the Water Conservation and Utilization Act, was completed 18 months ahead of schedule. ●

REMEMBER! A year's subscription to the RECLAMATION ERA makes a good Christmas gift—a year-round reminder of your thoughtfulness for only one dollar!



THINNING PAYS DIVIDENDS—for Weber Valley orchardists. If you can see the man's hand in the upper right-hand corner of the photo at left, you can get some idea of the size of these apples in July, and below is proof of the wisdom of this practice in the shape of the luscious harvested fruit. *Photos by F. A. Anderson, Region 4. Photo below copied from Kodochrome slide.*

Apples by the yardstick

by MORGAN A. KREEK, Salt Lake Area Office, Region 4, Salt Lake City, Utah

THE MAN WAS STANDING ON A LADDER, braced against an apple tree. His blue shirt clung to his back as he worked and his straw hat was tipped low to shade his eyes from Utah's blazing sun.

"You can't be picking apples in June," I called to him, "so, what *are* you doing?"

"Picking is right!" he grinned. "Thinning, we call it."

"What good does it do to pick those little green things?" I demanded incredulously.

"Makes the rest of them bigger," he replied.

"Look at that tree." He indicated one behind me. "Those are thinned exactly 6 inches apart. The ones that remain will be big, fine apples, and I'll have a crop from that tree again next year. If I didn't thin them I'd have a big crop of little apples, no market for them, and probably no crop next year. The trees bear every year this way!"

I had called on D. D. Harris, manager-secretary of the Weber River Water Users Association, to find out how fruit growers of the Weber River project, Utah, had produced the third highest yield of apples of any Reclamation project in 1947, a yield of 430 bushels per acre. Mr. Harris suggested that I call on some of the fruit growers and see their orchards for myself. This was my first stop.

As I subsequently talked with other orchardists in the Weber Valley I learned that thinning of the fruit was only one of the reasons for the fine apple yields in the project. Green manure is equally important. Commercial fertilizer knowingly applied, plenty of water, careful pruning, and endless fighting against insect pests also figure in the high production. Careful, painstaking, "yardstick" care all the way seems to be the formula that gets extra production.

In short, there is more work to successful apple culture than in producing any other fruit grown in Utah, I was informed.

As in most apple-producing areas, apple trees in Weber orchards are spaced 35 to 40 feet apart, although peach trees are often planted between them. Peach trees have a shorter life, usually not over 15 years, and are full bearing and producing an income before apple trees are ready to bear. By the time the apple trees are reaching their prime, about the tenth year, the peach trees may be ready for removal. An apple tree that is properly pruned and cared for may live four or five times as long as a peach tree.

Unlike peach trees, pruning of the apple trees is always done from the bottom up. In addition to the removal of dead and diseased wood each year, the lowest hanging branches or ends of branches are removed. This is to distribute the weight of the fruit evenly and to allow sunlight to reach every apple. Apple trees are not topped, as are peach trees, because they do not tend to grow too tall if pruned properly.

As to the use of green manure, it is the usual practice of Weber project orchardists to use crops such as rye on sandy soils, and vetch, or sometimes sweet clover or alfalfa, on heavier soils. The rye and vech planted in the fall are disked under each spring usually before the first irrigation. The alfalfa and sweet clover are usually disked under the second year. At this time commercial fertilizer broadcast at the rate of 10 pounds per tree is applied. Ammonium sulphate is the most commonly used. Some apple growers use a 16–20 nitrogen phosphate fertilizer every third year, applied at blossom time.

Irrigation "know-how" also plays an important part in the production of bumper apple crops.

Knowing when to irrigate is a matter of experience and close observation. "Water when needed" is the rule. When there is ample soil moisture the leaf coloring is dark green. As the soil moisture decreases, the leaf color grows lighter, the leaves start to curl and the need for water is evident.

Spraying, and spraying again and again, is of course another must for apple quality. The first spray of the season is lime sulphur for scale, spider, and mites. It is applied while the tree is still dormant. The next seven sprays are

for control of coddling moth, mites, and aphids. These sprays are given 10 days apart, starting with the first calyx spray. Arsenate of lead has been commonly used for many years but now DDT plus parathion is being used.

Good yields alone, however, do not justify all the labor and special equipment necessary to grow big apple crops. Successful marketing is the grower's ultimate goal and the end result that determines the financial success of his entire operation.

Unlike the pit fruits—cherries, peaches, and apricots—which have to be marketed immediately on maturing, apples may be picked and stored for winter marketing. Commercial cold storage plants are widely used for this purpose. Before storing, the apples are graded for size and color. The most popular variety in local markets is the red Delicions. Jonathan and Stamen Winesap are also popular winter varieties, with some Pearmain and Yellow Transparent (both earlier maturing apples) reaching the market.

Altogether, nearly 14,000,000 pounds of apples from the Weber River project were marketed in 1947, mostly in Utah, Wyoming, and Nevada. Some growers sell all or a part of their crop from roadside stands, direct to the consumer, a practice that is becoming increasingly important in the area. Others have developed regular markets with stores in the Salt Lake City and Ogden areas. One grower who has marketed his entire crop through such established outlets in local stores believes this is the most satisfactory way to sell.

Notwithstanding the bumper apple crops on the Weber River project, it is an interesting fact that apples have constituted a comparatively small part of the total crop production from the 90,000 acres of land deriving its late-season water supply from the Echo Reservoir. There are several reasons why farmers have not put more acreage into apples on a project that has experienced a remarkable increase in crop values since stabilization of its water supply was effectuated by completion of Echo Dam in 1931. One of the biggest is lack of water for undeveloped land.

One grower believes that apples could be made the major fruit crop in the Weber Valley if more water could be made available and better marketing methods and outlets were developed.

"The apple orchards in the Weber area could then be increased in size sufficiently to justify maintaining the necessary equipment and we could give the fruit the care and attention that would make apples the most important fruit crop in this area," he said.

The water supply for undeveloped lands will be forthcoming if the potential Weber Basin project is authorized. A planning report on the investigations of this project was submitted to the Eighty-first Congress in July 1949. If authorized and constructed, the Weber Basin project would provide, among other benefits, the additional water supply for expansion of apple orchards.

The proposed new construction would provide for several more reservoirs in the Weber River system ultimately controlling more than 300,000 acre-feet of water presently wasting into the Great Salt Lake.

The proven success of Weber Valley apple growers, using "yardstick" methods, suggested the possibilities for establishment of a large-scale apple industry in northern Utah. The potential Weber Basin project could make it a reality.

THE END

Reclamation's Crops—1948

FOR THE THIRD CONSECUTIVE YEAR, crops produced in 1948 on Federal reclamation projects were valued at more than one-half billion dollars. Prices received by farmers were somewhat lower, and production costs remained relatively high.

More land was irrigated, and the irrigated area for which the Bureau was capable of supplying water was extended to 5,380,015 acres, an increase of 213,232 acres over that reported in 1947. The inventory value of both farm machinery and livestock increased over that reported for 1947.

All was not rosy on the reclamation scene during 1948, however. Shortages in surface water supplies were again experienced on the Salt River project in Arizona and on the Rio Grande, N. Mex., Carlsbad, N. Mex., and Moon Lake, Utah, projects.

On the other hand the Central Valley project in California reported an increase of 25 to 40 percent above normal surface water supplies.

Irrigated crops average $113.76 per acre, with a total value of $534,623,541. Approximately 42 percent of the value of crops reported were specialty crops such as vegetables, fruits, nuts and sugar beets, 32 percent grain and forage used principally for livestock feeding, 11 percent cotton fiber, 10 percent seed crops, and the remaining 5 percent represented by miscellaneous crops and payments to water users by the Government and commercial agencies.

Since 1906 over $6,000,000,000 worth of crops have been grown on Federal Reclamation projects, the exact figure being $6,063,460,976. The volume of crops harvested in 1948 totaled 13,256,688 tons, a decline of about 4 percent from the 1947 production.

Population

The population on the 69,146 farms on regular Bureau projects and storage projects is estimated at 235,100 and the population on 23,322 farms served under Warren Act or special contracts is estimated at 93,400 making a total of about 328,500 people on 92,468 irrigated farms. Towns in and adjacent to these irrigation project areas, numbering about 370, have a population of approximately 1,298,000. The Reclamation area population, therefore, totals about 1,626,500. This does not include the large number of people in distant cities and towns who receive electrical energy from hydroelectric-power plants constructed in connection with multipurpose Reclamation developments, those who benefit by reason of flood protection nor the thousands of people who use the recreational facilities created by Reclamation storage reservoirs.

Irrigated farms served by Federal Reclamation have in-

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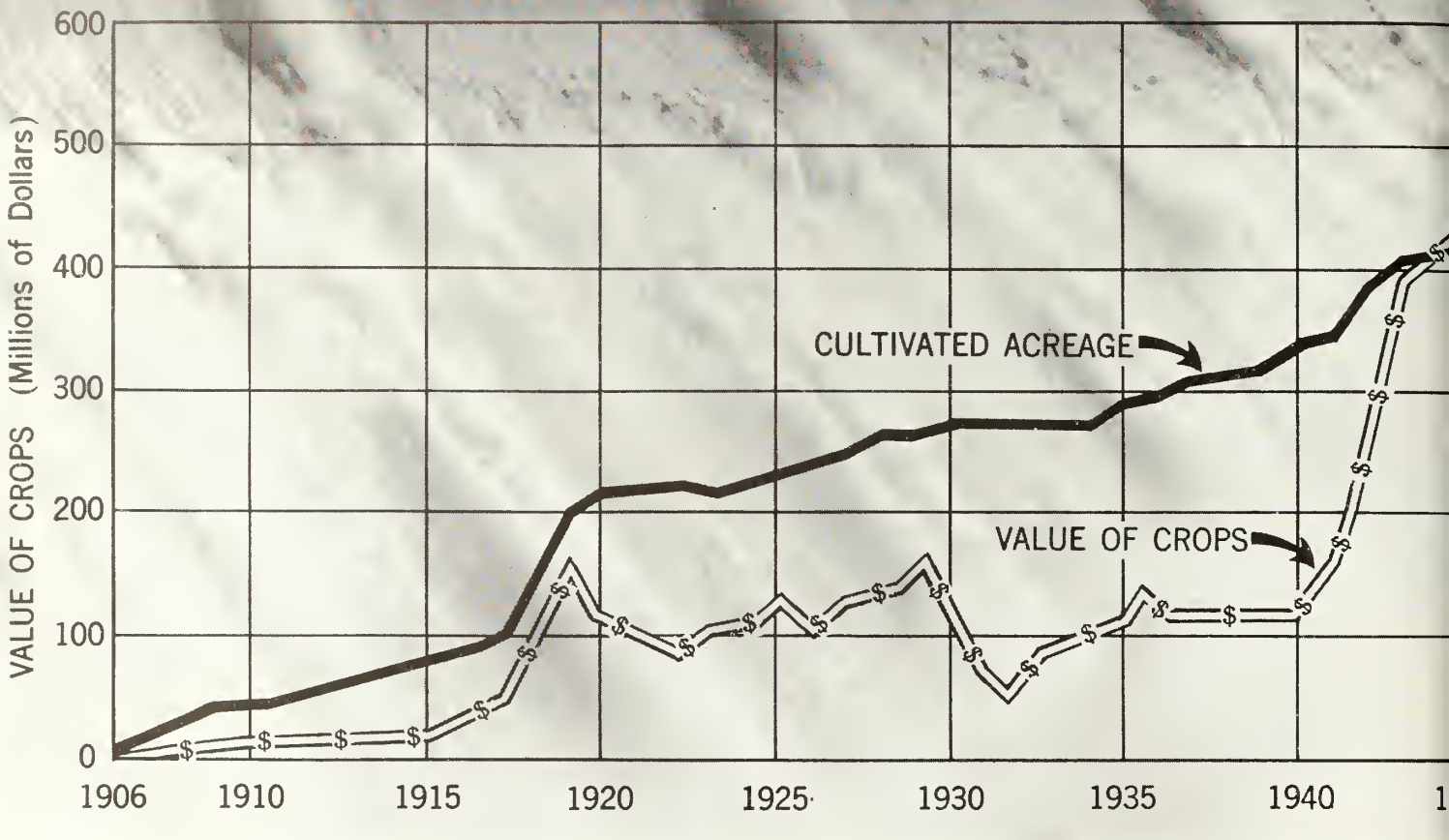

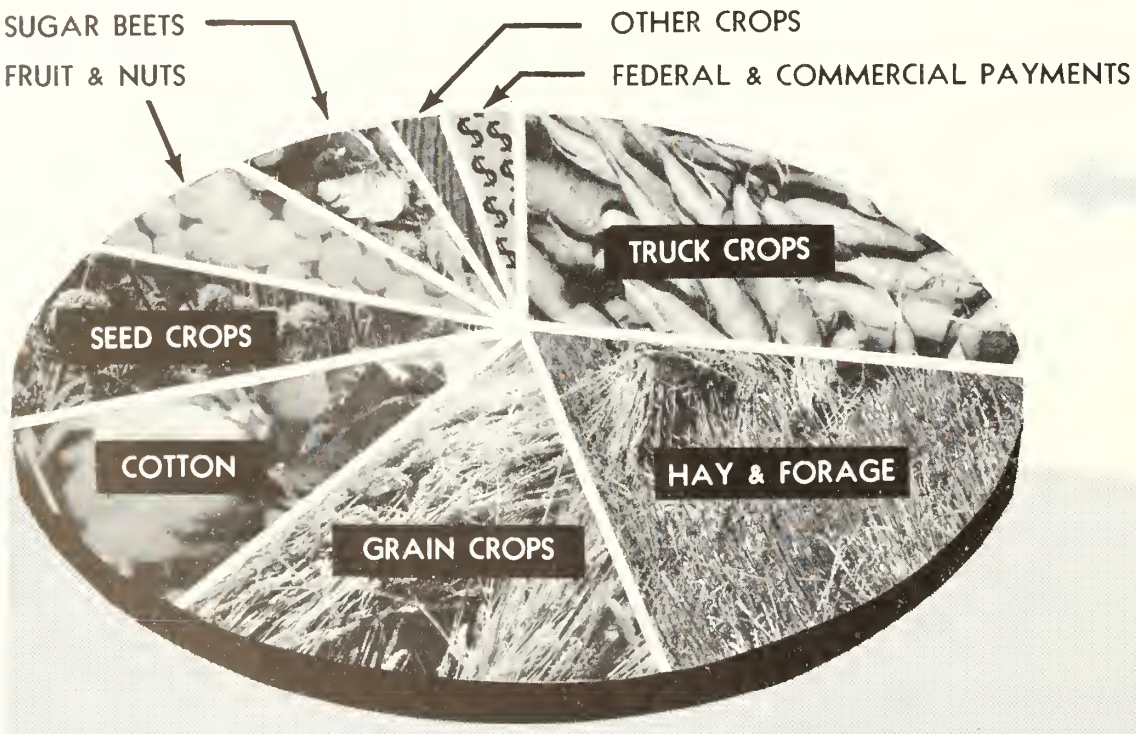

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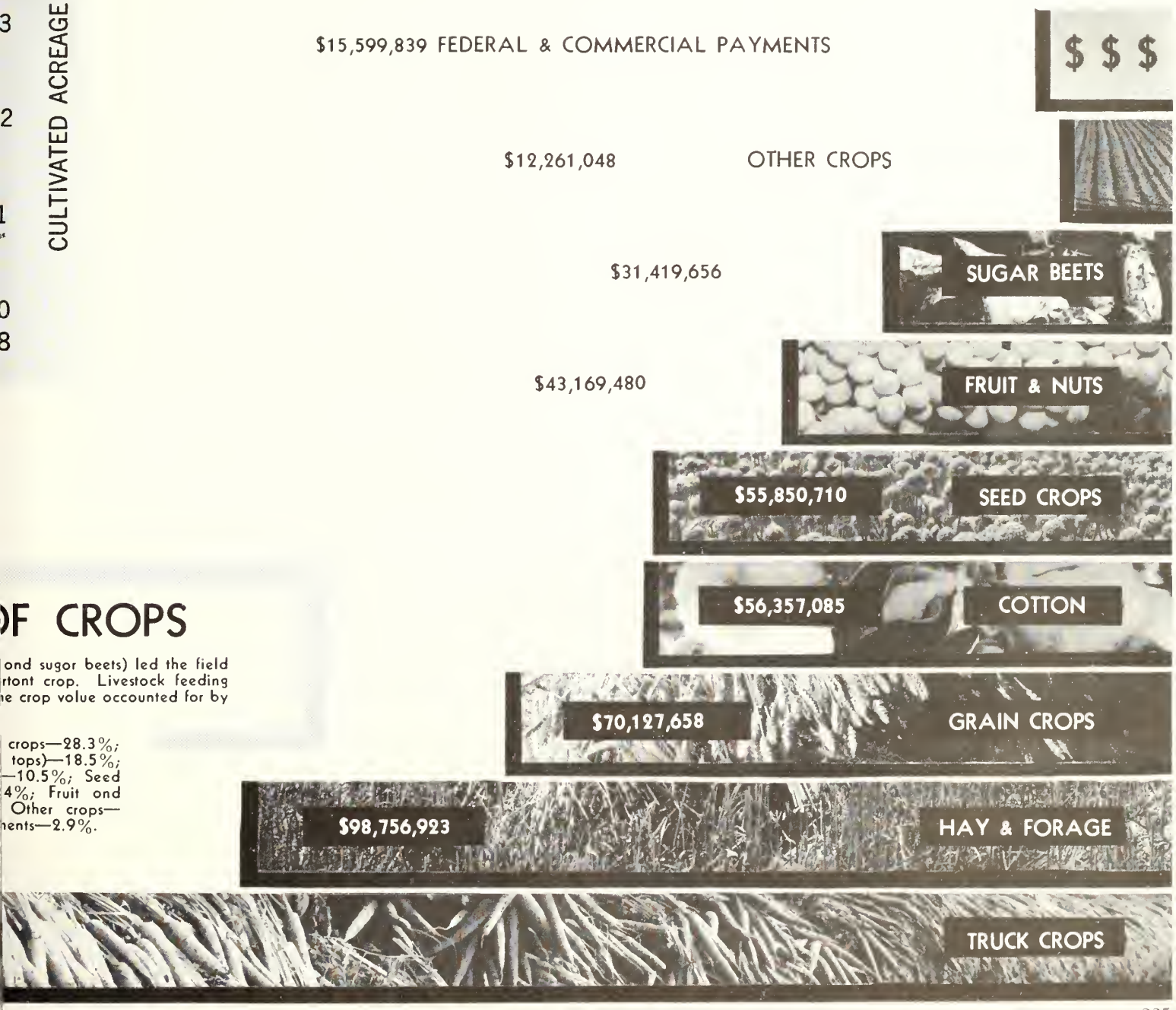
VALUE OF CROPS

MORE THAN HALF A BILLION DOLLARS' WORTH OF CROPS were produced in 1948 on Federal Reclamation projects for the third consecutive year, in spite of lower prices which the farmers received for the crops, and continued high production costs. Irrigated crops on reclamation farms averaged $113.76 per acre.

TOTAL VALUE $534,623,541



OF CROPS

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crops—28.3%;
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—10.5%; Seed
4%; Fruit and
Other crops—
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creased from 86,181 in 1941 to 92,468 in 1948 and the overall population of the farms and adjacent towns has increased during this same period from 1,088,500 to 1,626,500. In 1941, there were about 126 banks in which 237,600 depositors held about $269,000,000. In 1948, 563,400 depositors held $1,143,000,000 in 181 banking establishments.

Thus, Federal Reclamation, during and since World War II, has provided many opportunities for war veterans to establish homes on family size irrigated farms. The rapidly growing and prosperous towns and cities in and adjacent to these projects provide additional opportunities to veterans for the establishment of trades and professions. Public land has been opened and made available for settlement, since World War II, on the Klamath, Shoshone, Yakima, Sun River, Minidoka, Owyhee, Vale, Riverton, Yuma, Gila, and Columbia Basin Federal Reclamation projects. War veterans are given a preference in the award of these farm units and in all recent openings the farms have been awarded to veterans. As an example, all entrymen on the 216 farms opened in the Tule Lake division of the Klamath project and on the 114 farms opened in the Heart Mountain division of the Shoshone project are veterans.

Inventories of Livestock and Equipment

The inventory value of livestock and equipment of Federal Reclamation projects as of November 1, 1948 was $221,273,287 which exceeded the previous year's value by $37,352,699. Livestock were valued at $99,253,237 and equipment, including motor vehicles, at $122,020,050. Motor vehicles, including tractors, constitute about two-thirds of the value of farm equipment. Cattle represent about three-fourths of the inventory value of livestock. The value of sheep makes up about 12 percent of the livestock inventory, poultry 5 percent, hogs 4 percent, horses and mules 3 percent, and bees and other livestock 1 percent. Machinery inventory increased 27.7 percent over the 1947 level. Motor-vehicle inventory increased 30.8 percent while other machinery increased 22 percent. Although some of this increase is the result of increased prices, perhaps the major portion is actual increase in number of machines.

The number of horses and mules continues to decrease and average less than one per irrigated farm. The number of range cattle, range sheep, and poultry decreased from 1947 levels while the number of dairy cattle, beef cattle, farm sheep, and hogs increased.

Operation and Maintenance

Operation and maintenance expenses of the 23 projects under Bureau supervision amounted to $2,994,701 and revenues collected totaled $3,057,948, leaving a reserve of $63,247.

The total net supply of water on the 44 projects or divisions of projects for which data were summarized amounted to 11,471,546 acre-feet. Waste and losses from main canals, laterals, and farms was computed at 41.3 percent of the supply. However, in some cases the river channel is used as the main canal, and about one-half of the drainage and waste water is recovered and rediverted for use farther downstream. The volume of water delivered to the farms and other purchasers on these 44 projects totalled 9,329,800 acre-feet or 81.3 percent of the computed supply. The acre-feet delivered to the farms varied from .84 acre-feet per acre on the W. C. Austin project to 15.65 acre-feet on the Yuma Mesa division of the Gila project and averaged 3.53 acre-feet for all projects.

1948 Highlights by Regions

Region 1—Apples were late in maturing due to the late spring and exceptionally cool summer. Many were graded down because of size. The cherry crop was also adversely affected by frosts at blossom time and heavy rains at harvest time. Apricots lacked a market and a high proportion was unpicked; however, pears sold exceptionally well. The acreage and production of seed crops, although small in comparison with other crops, continue to increase. Hops have been found adaptable to the Boise and Owyhee projects as well as Yakima where they are a major crop on some farms.

Region 2—Frost in July on the Klamath project killed a considerable portion of the barley. The reduction in yield and the lower price resulted in about a 50 percent reduction in the value of this crop from 1947. Alsike clover seed production is becoming an important adjunct to the livestock industry. The development of bulk handling of grain and the construction of a starch and glucose plant to utilize cull potatoes are two important developments. Almonds, which occupy about one-eighth of the project area, had a poor set and yields were one-half those of the preceding year.

The availability from the Central Valley project of an adequate supply of surface water for use in the Contra Costa County water district is encouraging industrial and suburban home development.

Region 3—Water shortages in 1947 and 1948 were primarily responsible for shifts in crop production on the Salt River project. Acreages and crop values were higher for barley, grain sorghum, flax and cotton, and lower for vegetable crops. Increased acreages for these crops were largely at the expense of alfalfa.

Crop values on the Gila project were greater in 1948 than in previous years resulting primarily from higher prices of alfalfa seed and Bermuda grass seed and a further shift to flax and vegetables.

High returns on the Yuma project during 1948 also resulted from a continued shift to flax and vegetables. The record average yield of 31 bushels of flax per acre in 1948 is attributable to improved cultural practices and to favorable weather. Pre-irrigation and tillage operations prior to planting, plus weed control sprays applied by airplane, have done much to control weeds. Airplane spraying was done at a cost of about $15 per acre.

Improved yields are attributed in large measure to the widespread use of commercial fertilizer. In 1947 and in 1948 about 300 carloads of commercial fertilizer were used annually as compared with the use in 1942 of only 41 carloads. Loss of citrus fruit and winter vegetables due to freezing throughout southern California and other parts of the country resulted in increased demands for products of the Yuma project where frost damage was not severe.

The use of natural gas for pumping irrigation water in central Arizona is increasing rapidly.

About three-fourths of the sheep handled on ranges in Arizona are wintered in the irrigated areas. Most of the lamb crop moves directly to market from irrigated winter pastures. Custom feeding of cattle is a relatively new practice and has made rapid growth in recent years. At least 2,000 acres, and possibly much more of grapefruit, have been top-worked or rebudded from grapefruit to oranges.

Rain-making airplane flights, involving cloud-seeding, were made over the Salt River watershed with the expectation that approaching storms would be started earlier and prolonged beyond their normal duration. Three silver iodide generators are located on the ground to release vapors when clouds are overhead to promote the formation of ice crystals.

In the Imperial Valley of California, although truck and vegetable crops continue to hold top value in type of crop, flax took all honors as first in value of any single crop.

Region 4—Aside from the Newlands project, 1948 gross crop values were generally lower than in 1947. Decreases on the Pine River, Fruitgrowers Dam and Uncompahgre projects resulted from reduced fruit yields due to late frosts. The Moon Lake project reported low yields because of shortage of irrigation water. A high proportion of this project is in alfalfa and other forage crops which sustain many dairy cattle. There was no market on the Weber River project for about one-fourth of the peaches and 95 percent of the apricots, which were left unharvested.

Region 5—Although the water supply was limited on the Rio Grande and Carlsbad projects, the high acreage, yield and price of cotton resulted in record gross crop incomes from the projects. The Tucumcari project had several severe hail storms and an early fall frost.

(Continued on page 228)

Editor's Note:

The Bureau of Reclamation's Big Horn district includes the drainage basins of the Big Horn and Clarks Fork Rivers in Wyoming. In common usage the term "Big Horn Basin" includes the area north of the Wind River Canyon, which bisects the Owl Creek Mountains south of Thermopolis, and it is in this area that the Shoshone reclamation project is located. The Bureau's Riverton project is located in the Wind River Basin, which lies south of Wind River Canyon.

For many years, tourists having motored north through Wind River Canyon and nearing Thermopolis, were informed by means of a highway sign that they were approaching the "wedding of the waters," where the flow of the Wind River became the Big Horn River. For purposes of clarity, however, it is generally recognized that the Big Horn River is formed by the juncture of the Wind and Popo Agie Rivers near Riverton. This forms the curious circumstance of describing the location of Boysen Dam as being on the Big Horn River at the southern end of Wind River Canyon. Boysen Dam of the Boysen unit, Missouri River Basin project, is now under construction.

THE TRUE WORTH of a Hill of Beans

by R. VERNON ROBERTSON, Big Horn District, Cody, Wyoming, Region 6 (Regional Office at Billings, Mont.)

Top photo: Typical example of a ditchbank on a Willwood farm kept clean by pasturing. Immediately above: Combining beans on one of the farm units opened in recent years on the Heart Mountain division of the Shoshone project. At left: This latest labor-saving device, a conveyor belt type of bean elevator increases the efficiency of the farmers in the area. *Above photo by Joe Buller—left photo by Joe Buller and Charles Knell, Region 6.*

Never use the disparaging expression "*not worth a hill of beans*" around the Big Horn District in Wyoming.

Great Northern beans are the leading cash crop in this area—a typical western setting, flanked on the west by the massive Rocky Mountain range, on the east by the Big Horn range of mountains, the Pryor Mountains on the north and the Owl Creek Mountains running east and west, bisecting the district a few miles south of the town of Thermopolis, Wyo. The high mountain ranges snatch nearly all of the moisture from the air, leaving little for the valleys. However, they compensate for this thievery by furnishing, during the summer months, the numerous streams which feed the irrigation canals, bringing the desert valley soils into abundant production, creating irrigation projects that build and hold the large majority of the population in the Big Horn district.

People often ask, "How good is this desert land?" After all, it has only had the benefit of limited plant growth to build up the soil with humus, and the climate has a growing season containing only 130 frost-free days.

Beans tell the story. Conditions are favorable in many respects for high yields. In the arid climate there is usually a dry month of April to aid in land preparation and enough dry days late in May and early in June to get the planting done at the right time. The growing season is hot and comparatively cloudless, making for a vigorous plant growth. The autumn months are usually free from adverse weather conditions; enough so that crop losses due to weather are very small. The arid climate too, is an aid in checking the prevalence of crop diseases. Last but not least in importance is the adequacy of irrigation water. Experienced farmers know that water applied at the right time is the big secret of high bean yields. In the Big Horn district water is always available when needed.

Beans fit in well with a crop rotation system. They are harvested early in the fall, thus freeing the farmer for other fall work. They do little damage to the soil fertility, and finally, they are an easily marketed, good paying cash crop. Other crops grown in the average rotation system are grain, sweetclover, alfalfa, and sugar beets. The most progressive farmers also carry on a vigorous livestock pasturing and feeding program. Some are fortunate enough to have grazing permits in the national forests and on other public lands. This enables them to graze their livestock on public lands during the spring, summer, and fall months and fatten them on their farms when winter comes.

The cultural methods used in producing beans are just plain ordinary good farming practices. Where possible, the land is plowed in the fall. Otherwise, it has been found wise to plow in March or early April. The land is then harrowed and floated to produce a good seed bed. Then, to make up for the usual moisture deficiency, the land is corrugated in furrows 44 inches apart and then irrigated. After the

ground has dried sufficiently, the beans are drilled in rows 22 inches apart. This makes one irrigation furrow with a row of beans along each side. Before the beans come up, the land is harrowed vigorously once and sometimes twice to kill the weeds. Later, after the beans come up, a combination of various types of cultivator tools are used to cut out the weeds between rows and to cover the weed seedlings that come up in the bean row itself. This has to be an exact and neat operation to bury the weeds and leave the beans uncovered. If this method of weed control falls short, it becomes necessary to hire hand labor to chop out the weeds with hoes. Earl in the summer the second irrigation becomes necessary and in order to maintain optimum moisture conditions for the shallow rooted, moisture-sensitive, bean plants, it is the practice to apply water frequently and in small amounts thereafter for the rest of the growing season.

In the fall, between 90 and 100 days after planting, the beans are ready for harvesting. Tractor mounted steel cutting blades are drawn just beneath the surface of the ground, and the beans are then raked into windrows with a side delivery rake. There are two methods of threshing, the combine and the huller. The combine threshes from the windrow and the huller threshes from the stack or directly from the field as they are hauled in. Nearly all the towns in the Big Horn Basin have modern, large-capacity elevators that take care of the beans as fast as they come in.

3,000 Pounds of Beans Per Acre

Referring back to the question, "How good are these arid western soils?" there have been numerous instances where 3,000 pounds of beans have been grown per acre. This is, of course, much above the average. The good bean raiser talks about "ton beans" as his expected yield. It may be interesting to compare the district average with that of the Nation. Although in 1943 the projects of Riverton and Shoshone represented only 0.01 percent of the national acreage they produced 0.02 percent of the country's beans.

The Murrays, Earl and Bruce, typical Big Horn district farmers, live in the heart of the Willwood division of the Shoshone project. This division is located just across the Shoshone River to the south of Powell, Wyo. In the 20 years since it was first opened for settlement it has progressed from a barren desert area to one of the richest-producing areas in the Rocky Mountain region. Earl Murray is one of the original homesteaders on Willwood and has had a long, hard struggle in bringing the original barren soil into its present state of productiveness. He is now in partnership with his son, Bruce, who has homesteaded and bought units adjoining that of his father. Bruce is a graduate of the College of Agriculture of the University of Wyoming. While there he made such a splendid record that on graduation he was offered several attractive positions, but he declined all of them because his first love was farming. When he left the university, he bought a purebred Hampshire buck, two Percheron fillies, loaded the fillies in the trailer, the buck in the back seat of his car, and headed back for the Willwood.

Since that time beans, sheep, and sweetclover have assisted the Murrays in writing a success story. They now own 300 acres of highly productive cropland and each one of them owns a beautiful, well landscaped home. Both houses are showplaces on the Shoshone project. The Murrays climbed to prosperity via the beanstalk. They have kept careful records and over a period of years their yields have averaged 1,700 pounds per acre. This is 400 pounds more than the county average, and even an amateur economist knows that it is that extra 400 pounds per acre that builds the good house and finances a winter vacation trip to the South.

Bruce is still running the descendants of that purebred Hampshire buck that he bought from the university herd. This year he lambed out 102 ewes with a lambing percentage of 140 percent. This is just an example of high production on the Murray farm and it would be enlightening to find out how they do it.

In the first place they use no magic formula. They use the same cultural practices outlined earlier in the article. Probably the rotation practices and the livestock program gives the answer: 3 years in beans, 1 year in grain, 1 year in sweetclover pasture and enough alfalfa interspersed in the 300 acres to yield sufficient hay to feed the livestock. This usually totals about 30 acres. This program makes a comparatively high percentage of legumes which furnish nitrates and humus to the soil. Bruce says that sweetclover is a good soil builder. At the same time it furnishes an excellent, high yielding pasture on which he grazes the cattle and sheep.

In the fall after the crops are taken off, the livestock are turned out into the fields to clean up the bean straw and other roughage that remains. After this is done, the lambs and cull ewes are put on full feed for fattening. This makes a well-balanced program—one that often goes under the name "integrated agriculture." The hay and most of the grain raised is fed, the grain straw is used as bedding or plowed under, the bean straw is fed, the sweetclover is pastured and the manure resulting from the feeding operations is returned to the bean land. The beans and the lambs furnish the cash to build the fine homes and provide a comfortable standard of living. THE END

Reclamation Crops—1948

(Continued from page 226)

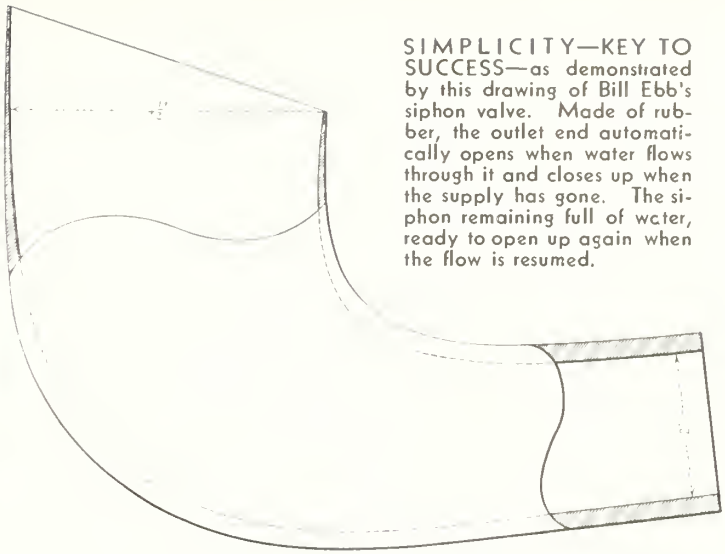
A considerable acreage of sorghums that replaced other crops lost by hail failed to mature. Quality as well as yield of cotton was reduced by the frost. On the Balmorhea project abnormally low rainfall and the use of irrigation water supplies on row crops resulted in reduced yields of grain and alfalfa.

REGION 6—Gross crop value in region 6 was about 17 percent lower than the 1947 level. This decrease is attributable largely to lower crop prices and to a reduction of sugar beet acreage. Owners of one sugar factory have indicated the factory might be moved if beet acreage is not increased. Extensive hail damage occurred on the Buffalo Rapids project, second division, and gross crop value was reduced 40 percent from the previous year.

REGION 7—Crop yields in 1948 were generally above those of 1947; however, prices were lower and gross crop value was therefore reduced. Income from sugar beets in the North Platte Valley was materially reduced because of warm weather continuing late in the season resulting in low sugar content of the beets.

Due to drought conditions in Wyoming, a considerable number of range sheep were brought to the Kendrick project for late summer grazing and winter feeding. Settlement on the Mirage Flats project is largely complete. Most of the farmers are young veterans, many of whom have had irrigation experience in the Platte River Valley. THE END

A ONE-ARMED OPERATION—Bill Ebbs shows how easy it is to work his siphon primer. Once set, it stays that way. *Photo by the author.*



SIMPLICITY—KEY TO SUCCESS—as demonstrated by this drawing of Bill Ebb's siphon valve. Made of rubber, the outlet end automatically opens when water flows through it and closes up when the supply has gone. The siphon remaining full of water, ready to open up again when the flow is resumed.

Bill Ebbs' Siphon Primer

by GARFORD L. WILKINSON, Amarillo, Texas, Region 5

EDITOR'S NOTE: The following article is published in The Reclamation Era as an interesting public service feature and as the fourth item in our "siphon symposium"—the current series regarding irrigation siphons. The siphon valve described in this article has not been tested by the Bureau of Reclamation nor does the Bureau substantiate claims made for it. Inquiries concerning the siphon valve should be directed to J. L. Harden, Business Manager, Wayland Baptist College, Plainview, Tex.

AN UNCOMPLICATED, INEXPENSIVE GADGET invented by a young ministerial student in a Texas Baptist College gives promise of being the answer to a heap of wishful thinking by every irrigation farmer who uses portable siphons. To Bill Ebbs, the ministerial student, the siphon priming valve is the answer to a prayer.

For however long irrigation farmers have used siphons, they have known of the general cussedness and back-breaking drudgery of priming those siphons. As a rule, the ordinary siphon is submerged in water. Each hand then firmly clasps the ends of the tube to prevent spillings as the tube is placed across the ditch bank. All too often the siphon loses its prime before the flow of water becomes automatic. The slightest jar, the least air bubble, may upset the desired action. When this happens the siphon setter has to begin all over again.

But Bills Ebbs, with his new device attached to the end of a siphon tube, merely dunks one end of the tube into the water, flips the curved tube across a ditch bank and the water flows as if it were coming from the old mill stream.

And there are other promising features about Bill Ebbs' priming valve for siphons. Water remains in the siphon several hours after the water has stopped flowing in the ditch. The siphon doesn't lose its prime; doesn't require resetting. Moreover, when the flow of water is resumed in the ditch, the Ebbs siphon valve automatically starts functioning again. Even more important, this device has water-saving properties, as it makes possible perfect control of the streams entering each furrow, and prevents waste which too often results from overlarge apertures or flows from the ditch.

Young Ebbs claims that with the use of his valve, a one-armed farmer could fill his line of 40 or 50 siphons twice as fast as a two-armed farmer could, using the standard model tubes. This is important. It means that a farmer can carry a supply of tubes under one arm and set his siphons with the free hand without having to unload his siphons every time he arrives at a spot where he needs to set one in action.

Ebbs' valve is extremely simple—so simple that farmers who have seen it operate wonder why they had not thought of it long ago. Made of rubber, various sizes are designed to fit any standard metal or plastic siphon. From the end where it slips on the siphon, the valve (see drawing) flares into an "L." A valve designed to operate on a 2-inch siphon measures about 4½ inches at the mouth or outlet. Other valves vary in proportion to the size of siphons on which they are fitted.

The valve, constructed entirely of heavy rubber, remains open while water is flowing through it. As the flow decreases, the valve opening also is reduced. When the flow of water ceases completely, the valve automatically closes tight.

The youthful inventor has given scores of demonstrations before groups of irrigation farmers assembled at the experimental farm owned and operated by the college. West Texas farmers who irrigate from wells are especially enthusiastic about the labor-saving features of the valve. A majority of these irrigators use electric power for pumping. An electric storm often interrupts the service. A flash of lightning near a well throws an automatic switch and pump-

ing ceases. The flow of water subsides in the irrigation ditches and the siphons lose their prime—they must be reset. Too often this happens at night. A farmer looks out across his fields toward the pump house. The electric light near the well is out. That's a signal for beginning many hours of unpleasant slogging through mud to reset the prime in the siphons.

Bill Ebbs declares that his valve attached to each siphon would make these frequent trips to the fields for resetting unnecessary because even after a lapse of several hours the valve would resume its operation as soon as the flow of water had returned to the main irrigation ditch.

The Bill Ebbs valve has not been placed in production for commercial use at the time this is being written. However, patent rights are pending and discussions are in progress with prospective manufacturers.

Though Bill Ebbs believes his invention will be a boon to irrigation farmers and agriculture generally, the real drama of the development goes far back beyond the end product.

Bill was reared on a west Texas farm. His father operated a blacksmith shop and did small machine work in a nearby town. Bill didn't get to finish high school. Instead, he spent the years of World War II marching and fighting with the One Hundred and Third Division's infantry across France and Italy and into Germany. One day the war was over and Bill returned to his home in Texas, firmly resolved to acquire an education and enter the ministry. He did enter school but was forced to withdraw when his father received an injury. Bill, foregoing his studies, helped his dad until the elder Ebbs recovered.

In the fall of 1948, Bill resumed his studies at Wayland Baptist College in Plainview, Tex. There, in assembly, the young ministerial student heard the college president speak about the school's proposed expansion program and the need for financial assistance. The proposal appealed to the serious-minded former GI. There was one thing in particular that kept running through his head.

"For those who can help, we welcome financial assistance," the college president said in the school convocation. "For those unable to assist at present," he had continued, "we recommend seeking a solution to our problems in prayer."

This was the essence of the president's message to the college students—Prayer.

Bill Ebbs took his problem to the Lord. He prayed to be shown a way.

"The idea for improving the siphons irrigation farmers use came to me in a flash," Bill recalled. "I was doing custom combining on some feed on a farm nearby. I had been thinking about doing something for the school."

Bill recalls that he was near the end of a row with his combine when he saw several of the farm owner's siphons scattered on the ground.

"Then is when the flash came to me," he said, simply.

"You may say it's background—working around my dad's blacksmith and machine shop when I was a youngster—but I say it was an answer to prayer," he asserted.

The student recalls that he later explained his idea to the college president who was impressed with the plan. The two men then went to J. L. Harden, the school's business manager. It so happened that the school's business manager formerly had been a mechanical engineer and an aircraft design engineer during the war. He was excited about the possibilities of the siphon valve.

In the following weeks, Mr. Harden and Bill, assisted by Prof. Claude Witten, head of the school's department of agriculture, made finished plans of the invention. The business manager then rushed to the United States Patent Office in Washington, D. C. Returning to Wayland College, Mr. Harden joined young Ebbs and his associates to demonstrate the device before prominent irrigation farmers. The reception of the contraption by farmers was most encouraging. Some refinements were made in the original working model, but the essential plan for its operation remained unchanged.

If the valve invented by Bill Ebbs does prove to be a successful marketable article that will result in profit, the money that is made from it will be used to help with the Baptist School's expansion program.

The 25-year-old ex-GI took his problems to the Lord. He will tell you, "There is real power in prayer." THE END

"Voice of America" Recording of Interior's Centennial Celebration Available

The State Department's "Voice of America" has made available to the United States Department of the Interior several copies of its radio show on the one-hundredth anniversary of the Department, entitled "1849—A Century of Conservation—1949." This is a dramatized documentary program with original music, telling the story of the accomplishments of the Department of the Interior, early activities in developing the West, featuring President Theodore Roosevelt's program for reclamation and how it has grown, and bringing the Department's activities up to date with a statement by President Truman and Secretary Krug.

Originally prepared by the "Voice of America" for overseas use, these transcriptions make up a 30-minute show cleared for domestic use, either for radio or group meetings. Playing the recording requires a machine having a speed of 33 revolutions per minute and a capacity for 16-inch recordings.

To avoid duplication and provide full use of the limited number of recordings, requests of all Bureaus and offices in the 17 Western States should be addressed as follows:

H. C. BLONK, Box 937, Reclamation Building, Fairgrounds, Boise. (Idaho, Washington, Oregon, and Idaho.)

MAX STERN, Box 2511, Old Post Office Building, Sacramento 10, Calif. Northern California.

W. J. WILLIAMS, Administration Building, Boulder City, Nev. (Southern California, southern Nevada and Arizona.)

M. C. CORBETT, 32 Exchange Place, Box 360, Salt Lake City, 8, Utah. (Nevada and Utah.)

G. L. WILKINSON, Old Post Office Building, Box 1609, Amarillo, Tex. (New Mexico, Oklahoma, and Texas.)

H. L. SYLTEN, Yale Building, Box 2130, Billings, Mont. (Montana, Wyoming, North Dakota, and South Dakota.)

R. L. WILLIAMS, 318 New Customhouse, Denver 2, Colo. (Colorado, Kansas, and Nebraska.)

For the eastern area all distribution will be handled from Washington and requests should be addressed to the heads of bureaus and offices or to the information office. This area includes all States east of the Dakotas and Texas. ●

I Wouldn't Trade Jobs

By DEE M. HARRIS, Assistant County Agent,
Franklin County, Washington

ABOUT THE AUTHOR

Dee M. Harris was born and raised on an irrigated farm in southern Idaho. He assisted his father in developing new land for irrigation on the Owyhee project and Payette division of the Boise project. During the war he worked for the Extension Service under the Farm Labor program, supervising Mexican and prisoner-of-war labor camps in Bannock and Jerome Counties, Idaho. He was graduated from the University of Idaho in 1948, majoring in soils and agronomy and minoring in soil bacteriology, soil chemistry, and dairy husbandry. Mr. Harris also has spent 2½ years as a missionary for the Church of the Latter Day Saints. His address is the Franklin County Courthouse, Pasco, Wash.

I WOULDN'T TRADE MY JOB WITH ANYONE.

That's a somewhat unusual statement, of course, but I have an unusual job.

My assignment is to advise and assist the first settlers on the first farms to be irrigated with Bureau of Reclamation water on the Columbia Basin project of eastern Washington, the largest development of its type in the Nation.

On May 15, 1948, the Bureau turned on the water in the 5,400-acre Pasco unit of the project. Although the project eventually will have more than a million acres under irrigation, this Pasco unit is the pioneer. It is the forerunner of large-scale settlement. It is the trial balloon—the pilot plant.

Problems being encountered on the 84 family-size farms are virtually the same as those that will be experienced on the nearly 14,000 farms that ultimately will be established throughout the project.

My job as assistant county agent in reclamation began June 1, 1948, when I was assigned to the Pasco unit by the Washington State Extension Service under a cooperative agreement with the Bureau of Reclamation.

Since then there's never been a dull moment!

On paper, my assignment might read like this: "Do everything you can to help the new farmer."

In actual practice, that is exactly what I'm doing. This job includes planning and laying out farm fields and farm irrigation systems, cropping and livestock programs, crop rotation and fertilizer requirements, locating and planning the farmstead, farm building plan, community development problems, and countless other problems involved in the development and operation of a new irrigated farm. Putting it in other words: I'm assisting in all phases of farm and farm home and community development.

PART OF THE DAY'S WORK—Dee Harris takes the "lay of the land" as pictured at the top of the page, and later on stands by as Mil W. Hoisveen, Chief of the Land Predevelopment Unit on the Columbia Basin project, points out to Pasco Unit Settler Robert Tschirky, a few tricks of the trade in irrigation farming. *Photos by Harold Foss, Region 1.*

The Pasco land is entirely new and requires clearing of sagebrush and range grass. Then comes leveling for gravity irrigation. One of my first jobs was working with Bureau of Reclamation surveyors in preliminary drafting and setting stakes for leveling. During the leveling I have to keep checking to see whether the necessary cuts and fills are made. Any leveling of new land out here should be finished by July 1. After that it becomes too dusty.

On the Pasco unit we have the traditional gravity irrigation and also sprinkler irrigation. In checking my figures, I find that the cost of leveling, floating, and so forth for gravity systems sometimes runs as high as $100 per acre. Some sprinkler systems can be installed for about this figure and are generally preferred to heavy leveling.

Before any sprinkler systems were installed, several meetings were held among engineers of the Extension Service, the

(Continued on page 236)

AMERICA'S VALLEY

by ROBERT E. STRUTHERS

North Platte River District, Casper, Wyoming, Region 7

(Regional Office at Denver, Colorado)

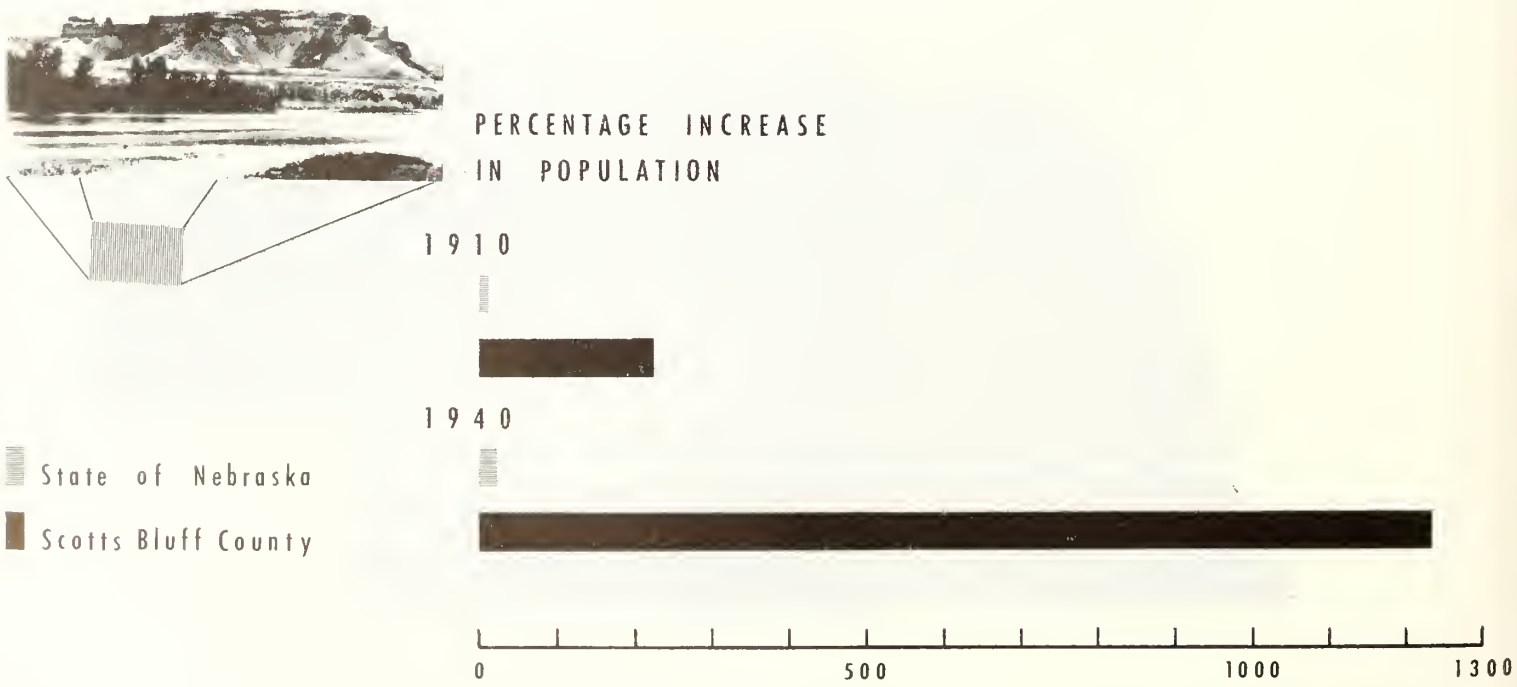
MANY PEOPLE INSIST that Scotts Bluff County is the best county in Nebraska. This county lies in the middle of one of the most progressive and prosperous irrigation developments in the world and, while less than half its area is irrigated, Scotts Bluff County is rated in agricultural productivity as being the best county in the State.

It has achieved this standing rather recently. Irrigation, without which the area would be famous only for its Oregon Trail and arid climate, came to the valley first in the 1860's. But the greatest development has taken place since 1905, when the Reclamation Service (now the Bureau of Reclamation) started building the dams and distribution system to serve the great North Platte irrigation project. With the full development of this project, the agriculture and industry of the valley grew by leaps and bounds. In 1900 there were 2,552 people in Scotts Bluff County; today there are more than 35,000. Where dry land agriculture supports but 3 people per square mile, some sections of the irrigated portion of the county support 50 persons to the mile.

For the sake of comparison we shall take a look at things in 1910, when the population of the county was 8,355 people. No land had been brought under the North Platte project at that date, even though Pathfinder Dam had been completed. At that time irrigation in eastern Wyoming and western Nebraska had been developed about as far as the flow of the North Platte River during the irrigation season would permit. Private capital had been spent in diversion and distribution systems to carry water to the farm lands lying adjacent to the river. In Scotts Bluff, Sioux, and Morrill Counties in western Nebraska about 192,150 acres had been thus developed. The town of Scottsbluff had 1,746 inhabitants. The one sugar factory in the valley had gone bankrupt and had undergone reorganization. The Burlington railroad, marking its tenth year of service at this point in the North Platte Valley, shipped into the town of Scottsbluff 1,448 carloads of freight from 14 States and shipped out 1,306 carloads of freight destined to 9 States.

For 30 years (roughly, since 1880) this area had been irrigated from the natural flow of the river by direct diversions and use. Irrigation water supplies during the irrigation season were often uncertain and inadequate, out-of-season flows were not conserved but ran off unused. Irrigation enterprises were usually small and privately financed, sometimes representing individual and sometimes cooperative efforts, nearly all having as prime characteristics undependable water supplies and legal difficulty over water rights and priorities.

HOW THE COUNTY GREW—The chart shows the percentage increase in the population of Scotts Bluff County contrasted to the population of the State of Nebraska. Superimposed on the chart is the Scottsbluff National Monument, the pioneers' "Lighthouse of the Plains" towering 800 feet above the irrigated valley farm lands. *Photo courtesy of the Scottsbluff Chamber of Commerce.*



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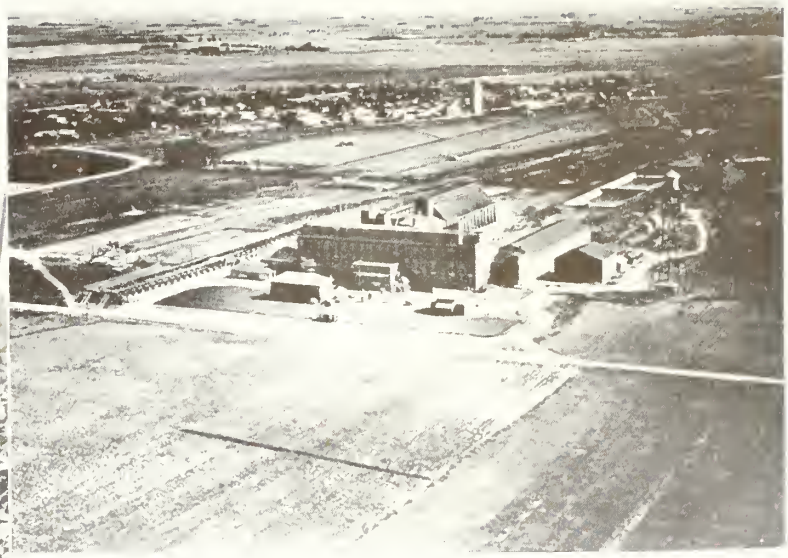

MODERN FARMING—UP-TO-DATE INDUSTRY—PROSPEROUS TOWNS are the keys to Scotts Bluff County's success. At left a farmer is using new irrigation aids: Siphon tubes and adjustable check dam. *Photo courtesy of the Business Farmer.* Above is a sugar factory, prosperous valley town, and productive farm lands in North Platte River Valley—a typical scene. *Photo courtesy of the Scottsbluff Chamber of Commerce.*

At this time, when private irrigation development had gone about as far as it could go, the Reclamation Service built Pathfinder Dam to store over a million acre-feet of surplus river run-off. From this giant dam and reservoir, one of the first six projects to be approved by the Reclamation Service for construction, thousands of new acres could be given a dependable irrigation water supply. Lands which were of excellent quality but which heretofore had been on higher terraces or were otherwise inaccessible could now be served. Storage and regulatory reservoirs, diversion works and canal systems were built to serve over 300,000 acres of land.

Today (almost 40 years later) there are about 410,000 acres irrigated in the upper North Platte River Valley in the counties of Morrill, Scotts Bluff, and Sioux in Nebraska and Goshen in Wyoming. Out of this total, 236,400 acres receive all their irrigation water supply from the North Platte project works and another 143,600 acres receive a supplemental water supply from permanent or temporary water service contracts with the Bureau. Of all the 410,000 acres irrigated, only 30,000 acres do not have contractual agreements for water service with the Bureau; but their water supply is directly improved by the Bureau's operations.

The best description of how these direct flow appropriators from the river are benefited by the Bureau's storage and river regulation can best be expressed in the words of the Hon. Michael J. Doherty, special master appointed by the Supreme Court of the United States to preside in the dispute between the States of Nebraska, Wyoming, and Colorado over the use of irrigation waters of the North Platte River:

. . . *since 1910, 70,650 acres* [of new land] *were brought under irrigation largely with supplies provided by return flow waters which developed from the operation of the* [North Platte] *project. The annual visible return flows rose from a negligible quantity in 1911 to 700,000 acre-feet in 1927.* . . . [and are] *attributable to the direct influence of the North Platte project and application of project storage water to lands in eastern Wyoming and western Nebraska. These return flows are in the nature of a "windfall" to irrigators who are so situated on the river to be able to avail themselves of their use, particularly those who are themselves without storage rights, and who, therefore, have to carry no burden of storage costs.*

Look what has happened since 1910 when the North Platte project was just getting started. While the population of the State increased but 10 percent, the population of Scotts Bluff County has increased four times the number of people in 1910. Population of irrigated areas in adjacent counties has increased in the same proportion. The town of Scottsbluff has grown from 1,746 people to nearly 15,000. There are now seven sugar factories in the valley where one was having a hard time making a go of it in 1910. These plants together can manufacture nearly 3,000,000 one-hundred pound bags of sugar annually.

A survey made by the Denver Post covering the railroad traffic of the valley shows that in 1947 freight shipments from the valley amounted to 23,155 carloads consisting of 8,310 cars of potatoes, 2,726 cars of cattle, 1,625 cars of sheep, 1,797 cars of beans, 2,137 cars of sugar, 1,601 cars of grain, and 4,959 cars of miscellaneous commodities. Inshipments for the same year totaled 14,387 carloads broken down into 695 cars of autos and agricultural implements, 1,349 cars of building materials, 2,753 cars of coal and coke, 220 cars of fruit and vegetables, 2,535 cars of livestock and 6,835 cars of miscellaneous commodities. Total freight traffic in 1910 before the North Platte project got going, was just 7 percent

what it was in 1947. Whereas in 1910 freight shipped out of the valley was destined for 9 States and inshipments were received from only 14 States; today every State in the Nation receives freight from, and ships freight to, this valley.

The 22 cities and towns in the area served by the North Platte project have nearly 80,000 people in their trade area. In the center of this prosperous area lies Scotts Bluff County which we cite because of its location in the irrigated section and because of its greater proportion of irrigated land (43 percent) than adjacent counties. The areas of irrigated land in adjacent counties are equally productive and the people just as prosperous. Of the 93 counties in Nebraska, Scotts Bluff, according to the United States Census and Farm Journal Research Inc., has the highest cash farm income, the greatest number of trucks and farm tractors on farms, the greatest value of farm machinery on farms, and rates either second or third among the counties in value of sheep and goats, value and bushels of seed crops produced, percentage of farm homes built since 1929 and value of household equipment.

Business is good here, too. The county ranks third in Nebraska in value of manufacturing and processing, some of the products of which are: meat-packing products, beans, potatoes, soft drinks, monuments, cabinet work, cement products, poultry equipment, ornamental ironwork, wagon boxes, ice cream, candy, potato chips, ice, pumps, books, fertilizer, farm machinery, sugar, refined petroleum products, dressed poultry, stock feeds, flour, canned food products, and many more. The census report indicates that Scotts Bluff county ranks first in value added to manufactured products and ranks second in value added to manufactured products per wage earner. The county also ranks second in wages paid per wage earner working in the manufacturing industries. It ranks with the better counties in the State in amount of retail sales per capita, effective buying income, numbers of refrigerators, radios, autos, and electrical systems on farms and percentage of rural homes using either electricity or gas for cooking. These impressive statistics add up to the fact that irrigation has made this valley a good place in which to work and live.

Today's traveler, driving along the all-weather highways paralleling the Oregon and Mormon trails, within sight of such historic landmarks as Ash Hollow, Windlass Hill, Courthouse Rock, Scotts Bluff, Chimney Rock, Register Cliff, Fort Laramie, and others, can view what man hath wrought by bringing together abundant water and arid land. Little wonder that it is often called by local people "America's Valley of the Nile!"

THE END

Reclamation Chiefs Hold Program Pow-Wow

On August 1 of this year the top-level officials of the Bureau of Reclamation met at Boulder City, Nev., to map out the program and policies for the fiscal year 1950. In opening the programming conference, Commissioner of Reclamation Michael W. Straus said, "In the 12 months of this fiscal year starting 1 month ago this morning, our authorized and financed program calls upon Reclamation to perform in 1 year work that exceeds the tasks performed by Reclamation during all the first 30 years of its 47-year existence."

During the conference, the value of running the Bureau's operations on a firm program, with foolproof schedules, up to date accounting and reporting methods and continued improvement of services to water and hydroelectric power users was stressed. No basic change in the organizational pattern of the Bureau of Reclamation was envisaged, as the regionalized pattern with ever-increasing delegations of authority from Washington and Denver to field officials has stood up under a 5-year test and is constantly improving operations.

The officials, in thorough agreement with the Departmental and Bureau policy of conserving water and lands, worked out practical devices to prevent (1) future soil and water losses (2) loss of storage due to sedimentation and (3) damage to Bureau structures. Much of this discussion was based upon the contents of the August 1949 issue of the RECLAMATION ERA.

All present agreed to continue with the cooperative program which has been so succesful through dovetailing the Bureau's activities with Federal, State, county, and local agencies whose interests coincide. Emphasis was placed on ways and means of improving relationships with water-users organizations and to continue to improve the provisions of new contracts. In this connection, one of the highlights of the meeting of the chiefs was the presentation of a check to Director of Operation and Maintenance Goodrich W. Lineweaver, by a representative of the Okanogan irrigation district.

This check, amounting to almost $13,000, represented the first tangible evidence of the successful culmination of many months of negotiations to execute amendatory repayment contracts for six reclamation projects which had suffered severe financial reverses and were no longer able to meet the provisions of what had become out-of-date and unrealistic contracts. The other five projects benefitting through the passage of Public Law 56 which protected the Federal Government's investment and at the same time made it possible for the water users to meet their obligations, were Klamath (Shasta View irrigation district), Uncompahgre (Uncompahgre Valley Water Users Association), Yakima (Kittitas reclamation district), Bitter Root (Bitter Root irrigation district) and Ogden River (South Ogden conservation district). ●

"THIRSTY ACRES" in Color and Sound

The Union Pacific Railroad's story of reclamation in the West, told with sound and color, in a 25-minute 16-millimeter film, has been in great demand as an entertaining and educational feature for all sorts of meetings, gatherings, and celebrations. "Thirsty Acres" tells the story of how water reaches 22,000,000 acres of the rich soils of the West and makes them some of the most productive in the world. It shows how to make the best use of water for irrigation, how thriving industries develop and towns come into being, when water, the life blood of the West, is spread upon our lands. This film was produced by Union Pacific Railroad with cooperation from State agricultural colleges, the Bureau of Reclamation, the United States Department of Agriculture's extension service and soil conservation service and many irrigation farmers. The film may be borrowed by contacting the Union Pacific Railroad Agricultural Development representative at Omaha, Nebr., Denver, Colo., Salt Lake City, Utah, Pocatello, Idaho, Boise, Idaho, or Portland, Oreg. Copies are also available by writing to the regional director at the regional offices of the Bureau of Reclamation at Boise, Idaho, Boulder City, Nev., Salt Lake City, Utah, Billings, Mont., or Denver, Colo. State conservationists of the Soil Conservation Service of the United States Department of Agriculture at Berkeley, Calif., Ft. Collins, Colo., Bozeman, Mont., Lincoln, Nebr., Swan Island, Portland, Oreg., Salt Lake City, Utah, and Pullman, Wash., also have prints of the film available on loan, as well as the visual education department, Montana State College, Bozeman, Mont.

RIGHT FROM THE SCRIPT—"Some unlined canals, less expensive in initial construction, carry water with little waste, although there is a higher degree of seepage in unfavorable types of soil." (Photo at top). "This man is using a V-shaped ditcher to dig a head ditch. These ditches are dug along the higher areas of the field so that outlets in them will permit water to flow into the furrows of the fields and gravitate naturally to the lower levels."

Booklet on "Sprinkler Irrigation" For Sale

"Sprinkler Irrigation" is the title of a new illustrated 61-page booklet prepared by the Bureau of Reclamation, United States Department of the Interior, now on sale by the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., priced at 20 cents a copy.

General information regarding the use of sprinklers for irrigation farming and special charts and tabulations useful in the design of sprinkler systems are included. Several typical designs are worked out to illustrate design methods, show typical systems and provide sufficient cost data to afford an idea of the range which may be expected and furnish comparisons between the annual cost of sprinkler and surface methods. ●

Blanket-of-Green Program Started in Arkansas

Although next door to, and outside the boundary of, the 17 reclamation States, Arkansas has a program which might well be adopted west of the ninety-seventh meridian. The August issue of the "Arkansas Extension Service Review," published monthly by the Extension Service, College of Agriculture, University of Arkansas in Little Rock, carried the following explanation of the scheme:

> The Blanket-of-Green program is, literally, just what its name implies. Green, growing crops make up the blanket. And the purpose of the program is to spread this blanket over a large part of Arkansas farmland. Goal for this year is 1,000,000 acres.
>
> Originated in 1946 by the Agricultural Extension Service, the Blanket-of-Green program serves a twofold purpose. It encourages Arkansas farmers to balance their agriculture by diverting some of their land from row crops into production of pastures and other feed for our growing livestock industry. And by so doing it helps build up and maintain our soil fertility.
>
> Farmers and farm leaders have long recognized the need for protecting soil against erosion and leaching of plant foods—especially during the wintertime. That's why we put extra emphasis on fall planting of small grains and winter legumes. But that's by no means the whole story. Winter legumes, small grains, and mixtures of the two furnish excellent winter grazing for livestock. If turned under in the spring, they help replenish our dwindling supplies of organic matter in the soil. And a good winter legume growth adds around 60 pounds of actual nitrogen per acre as well. ●

Revised Weed Control Booklet Ready

An up-to-date, illustrated, 140-page booklet, "Control of Weeds on Irrigation Systems" is now on sale at the Government Printing Office for 35 cents a copy. Organizations working closely with the Bureau of Reclamation on weed control programs may obtain free copies by writing the Commissioner or the nearest Regional Director. ●

18th Annual National Reclamation Association Convention Called

William E. Welsh (above), secretary-manager of the National Reclamation Association, has called the Eighteenth Annual NRA Convention to be held at Salt Lake City November 2, 3, and 4, with headquarters at the Hotel Newhouse.

Mr. Welsh took office as secretary-manager on May 15, 1949. Born in Nebraska, he lived in the Boise Valley since 1904 and has been an ardent proponent of reclamation practically all his life. He was graduated from the College of Idaho at Caldwell and joined the Navy in 1918, after which he was associated with various reclamation associations, being a water master for 24 years in the Boise River Valley. Mr. Welsh organized the Idaho State Reclamation Association and was secretary-manager of that organization from 1937 until he accepted the honor of becoming secretary-manager of the national organization last spring. •

I Wouldn't Trade Jobs

(Continued from page 231)

Bureau, the manufacturers of sprinkling systems, and the farmers. This worked out fine. The settlers decided what they wanted and how much they could pay. The companies submitted their offers and everyone was satisfied.

I feel that the job on the sprinkler systems is the biggest I've tackled so far. We all had our trials. Leaks developed on the main-line risers and at the couplings. But these and other troubles were ironed out and we had the satisfaction of seeing the first of four sprinkler systems throwing water during the 1948 season.

As things stand to date, the hammer and saw are by far the most-used tools on the project; people must have places to live. We have everything from tents to modern five-room houses. There are scatterings of war-surplus hutments and some trailers, too. The domestic water problem is a stickler. It hasn't been solved yet and most families haul their water from the Bureau's tap at the development farm in the unit. We have a school bus system and rural delivery. The R. E. A. lines are in. We're growing, bit by bit.

You can talk of your pioneering spirit of other days, but I can prove that the spirit still exists today just as strongly as ever.

Look at the case of R. P. Carter, who needed a dwelling for his family and couldn't get started on his house until fall. He had only the foundation and a pile of uncut lumber awaiting the hammer and saw. Cold weather was only days away.

Word was passed around. The men in the unit began gathering at the Carter place one Sunday. A dozen fellows, all of them with a lot of troubles of their own, started in on that pile of lumber. By evening they had put in the studdings, the rafters, some of the sheathing, and had even framed the windows and doors.

You who have participated in a "house raising" will understand me when I say that that Sunday was the most pleasant Sabbath I have spent in some time.

As assistant county agent, I'm sort of a greeter for the newcomers on the unit. We chat about crops, soil management, farmstead planning, leveling, schools, domestic water, and a dozen other things. Then, after the farmer gets started, we work together in solving the problems that arise from day to day. Maybe it's about feeding turkeys, leveling up the foundation of a new house, getting the right kind of seed, fixing a piece of machinery, or preparing ditches. The list is endless.

On the way home in the evenings, I often begin thinking about my job and try to appraise each day's accomplishments. I find satisfaction in well-developed fields, leveled and laid out in a manner that will curb erosion and make it possible for the farmers to produce and harvest their crops conveniently; several new homes planned for comfort and convenience of the settlers' families; and community development, which will make for cooperation among neighbors, and assure good schools and good roads.

Then I think of the pioneering spirit and the love of the land that has brought about this transition. I think of the small part I am playing and the hopes and desires that these settlers express to me.

Yes, it makes me humble and happy. And that is what I mean when I say I wouldn't trade jobs. THE END

Technical Report Released by TVA

The Tennessee Valley Authority has just announced the release of Technical Report No. 8 which describes the Watts Bar steam plant on the right bank of the Tennessee River near the upper end of Chickamauga Reservoir about 3,400 feet downstream from Watts Bar Dam. The report contains 380 pages of text and 123 illustrations and covers the planning, design, construction and initial operation of one of the most unusual plants of its kind.

Also included in the report is a comprehensive summary of the project costs, a complete statistical summary of physical features and many other data. Copies of the report may be purchased from the Treasurer's Office, Tennessee Valley Authority, Knoxville, Tenn., for $2.25 each. •

DO YOU KNOW • • •

• "Water is today our greatest undeveloped resource. Our streams and rivers offer us a possible total of 55,000,000 horsepower and of this less than 11,000,000 horsepower has been developed," was said by Former President Hoover in July 1928?

U. S. GOVERNMENT PRINTING OFFICE 1949

NOTES FOR CONTRACTORS

Contracts Awarded During August 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2628	Davis Dam, Ariz.-Nev	Aug. 10	Two 16,000/20,000-kva package-type substations for electric districts 2 and 4 substations.	Allis-Chalmers Mfg. Co., Denver, Colo	$333,088
2672	do	Aug. 15	Construction of Tucson-Coehise 115-kv. transmission line, using aluminum conductor, schedule 1.	R. B. Stovall Co., Dallas, Tex	498,538
2690	Central Valley, Calif	Aug. 10	Completion of Tracy pumping plant	Stolte, Inc., United Concrete Pipe Corp., Duncanson-Harrelson Co., and Ralph A. Bell, Oakland, Calif.	483,974
2698	Missouri River Basin, Wyo.	Aug. 2	Three metal-clad switch gear assemblies for Kortes power plant	General Electric Co., Denver, Colo	14,614
2699	Davis Dam, Ariz.-Nev	Aug. 19	Carrier-current relaying apparatus for Davis-Prescott and Davis-Hoover basic magnesium transmission lines, schedule 2.	Westinghouse Electric Corp., Denver, Colo	17,910
2703	Fort Peck, Mont	Aug. 10	Construction of Williston substation	Killoren Electric Co., Appleton, Wis	168,447
2705	North Platte, Nebr.-Wyo	Aug. 2	Construction of earthwork, lateral lining, and structures for lateral 29.4 and lateral 90.4, and rehabilitation of existing laterals, Fort Laramie Canal, schedules 1, 2, and 3.	Starr Construction Co., Scottsbluff, Nebr	50,083
2705	do	do	Construction of earthwork, lateral lining, and structures for lateral 90.4 and rehabilitation of existing laterals, Fort Laramie canal, schedule 4.	Harry F. Berggren and Sons, Inc., Scottsbluff, Nebr.	38,516
2707	Missouri River Basin, Nebr.-Kans	Aug. 10	Construction of earthwork, concrete canal lining, and structures for Courtland Canal.	J. A. Terteling and Sons, Inc., Boise, Idaho	1,266,056
2722	Colorado-Big Thompson, Colo	do	Construction of Olympus and Pole Hill Tunnels and access roads for Estes Park-Foothills power aqueduct.	Wunderlich Contracting Co., Omaha, Nebr	4,787,874
2732	Central Valley, Calif	Aug. 30	Construction of earthwork, concrete lining, and structures for Delta-Mendota canal.	Morrison-Knudsen Co., Inc. and M. H. Hasler Construction Co., Los Angeles, Calif.	4,273,872
2735	Boulder Canyon, Ariz.-Calif.-Nev	Aug. 30	Furnishing and installing one 62,500-kva generator for unit A9, Hoover power plant, item 1.	General Electric Co., Denver, Colo	920,923
2736	do	Aug. 30	Four 21,000-kva transformers for unit A9, Hoover power plant	Pennsylvania Transformer Co., Pittsburgh, Pa.	126,972

Construction and Supplies for Which Bids Will Be Requested by December 1949

Project	Description of work or material
Boulder Canyon, Nev	Construction of two masonry storage sheds at Federal garage, Boulder City, Nev.
Do	Installing equipment and performing alterations to water treatment plant at Boulder City, Nev.
Boulder Canyon, Ariz.-Nev	One oil-pressure actuator-type 150-foot-pound capacity governor with pumping equipment for 70,000-horsepower unit A9 turbine at Hoover power plant.
Central Valley, Calif	Construction of 26-mile concrete pipe distribution system from Friant-Kern Canal to supply the Southern San Joaquin Municipal Utility District.
Do	Construction of about 17 miles of 2,500-cubic feet per second capacity concrete lined Friant-Kern Canal.
Do	Construction of 8 miles concrete lined Delta-Mendota Canal.
Colorado-Big Thompson, Colo	Construction of about 5 miles of Poudre supply canal, 1,500-cubic feet per second capacity, near Fort Collins, Colo.
Do	Construction of about 5 miles of 115-kilovolt wood-pole transmission line from Flatiron substation, near Loveland, Colo., west to Polehill power plant.
Do	Construction of about 42 miles of 115-kilovolt wood-pole transmission line between Kremmling and Oak Creek, Colo.
Do	Installation of electric motors, pumps, and miscellaneous equipment, erection of towers and equipment in switchyard, and architectural finish work in Granby pumping plant.
Colorado River Front Work and Levee System, Calif.	Furnishing and erecting four houses at Needles, Calif.
Columbia Basin, Wash	Approximately 65,000 pounds of galvanized fabricated structural steel for 11.95-kilovolt station-service tie circuit towers and take-off structure, Grand Coulee power plant and switchyard.
Do	Construction of 15.5 miles of 3,100-cubic-feet-per-second capacity concrete lined West canal, near Quincy, Wash.
Do	Construction of about 13 miles of 3,800-cubic-feet-per-second capacity East Low Canal, and 3.3 miles of 2,000-cubic-feet-per-second capacity concrete lined Weber wasteway, located 5 miles east of Moses Lake.
Davis Dam, Ariz.-Nev	Approximately 260,000 pounds of galvanized fabricated structural steel switchyard structures for Mesa and Coolidge substations.
Do	Installing equipment and constructing 132,000-kilovolt-amperes Coolidge substation.
Davis Dam, Ariz.-Nev	Installing equipment and constructing 60,000-kilovolt-amperes Mesa substation.
Do	Construction of utility building, bridge deck and handrails across forebay channel, and miscellaneous roadway and parking lot surfacing at Davis Dam.
Gila, Ariz	Construction of 9.5 miles of 1,300-cubic-feet-per-second capacity concrete lined Wellton-Mohawk Canal, and relocation of 4.5 miles of county road, about 12 miles east of Yuma, Ariz.
Hungry Horse, Mont	Approximately 170,000 pounds of fabricated structural steel for transformer circuit take-off structure at Hungry Horse power plant.
Kendrick, Wyo	Approximately 60,000 pounds of galvanized fabricated structural steel towers for Kortes tap lines to Casper-Seminoe transmission line.
Minidoka, Idaho	Drilling and testing seven irrigation wells at North Side division, about 12 miles north of Rupert, Idaho.
Missouri River Basin, Mont	Three 12.78-foot by 21.78-foot hydraulically operated fixed-wheel gate hoists, including all control piping, valves, and pumps, for Canyon Ferry Dam penstocks.
Missouri River Basin, Nebr	Construction of one 3-bedroom residence, one 24-foot by 48-foot garage and laboratory building, and sewage disposal, water supply, and propane gas systems at Trenton damsite.
Do	Construction of roads, parking areas, beach, boat launching ramp, guard rail and posts, and fence at Medicine Creek Reservoir, near Cambridge, Nebr.
Do	Construction of roads, parking areas, beach, boat launching ramp, guard rail and posts, and fence at Enders Reservoir, near Enders, Nebr.
Missouri River Basin, N. Dak	Construction of 41 miles of 69-kilovolt wood-pole Bismarck-DeVaul transmission line, near Bismarck, N. Dak.
Missouri River Basin, S. Dak	Clearing part of Shadehill Reservoir site, about 13 miles south of Lemmon, S. Dak.
Missouri River Basin, Wyo	Construction of Keyhole Dam, an earth-fill structure 109 feet high and 3,300 feet long at the crest, located on Belle Fourche River 18 miles northeast of Moorcroft, Wyo.
Paonia, Colo	Construction of second section of Fire Mountain Canal on the north fork of the Gunnison River near Somerset, Colo.
Santa Barbara, Calif	Construction of 6.5 mile Tecolote Tunnel, and 1.8 miles of access road.

THE HONORABLE RICHARD J. WELCH OF CALIFORNIA

The Bureau of Reclamation deeply regrets to announce the sudden death of Representative from California Richard J. Welch, who died of a heart attack on September 10, 1949, at Needles, Calif. Congressman Welch was one of the nominees in the Reclamation Era's current "Hall of Fame" series, and a full story on his contribution to reclamation and conservation of natural resources in the United States will appear in our next issue.

STEEP BUT STABLE—The mountain slope above, densely covered with vegetation, has a stable soil mantle. Rain falling on sites like this—even at exceptionally high rates—is almost entirely absorbed and does not cause destructive run-off. **SLIPPING FAST**—due to fire which, by destroying the protective covering of plants and litter, made this steep slope (upper left photo) on the foothills above Salt Lake City, Utah, unstable. Much of any rain falling here runs off over the surface carrying with it large quantities of soil. **LATEST WRINKLE**—Roughing out contour trenches on a flood source area in the mountains of Davis County, Utah (below) holds the rainfall and prevents floods from starting. Mechanical treatment like this is needed to restore a watershed where plant cover depletion and soil erosion have reached advanced stages. *Photos submitted by Reed W. Bailey, author of "Understanding our Watersheds," on page 218.*

The Reclamation ERA

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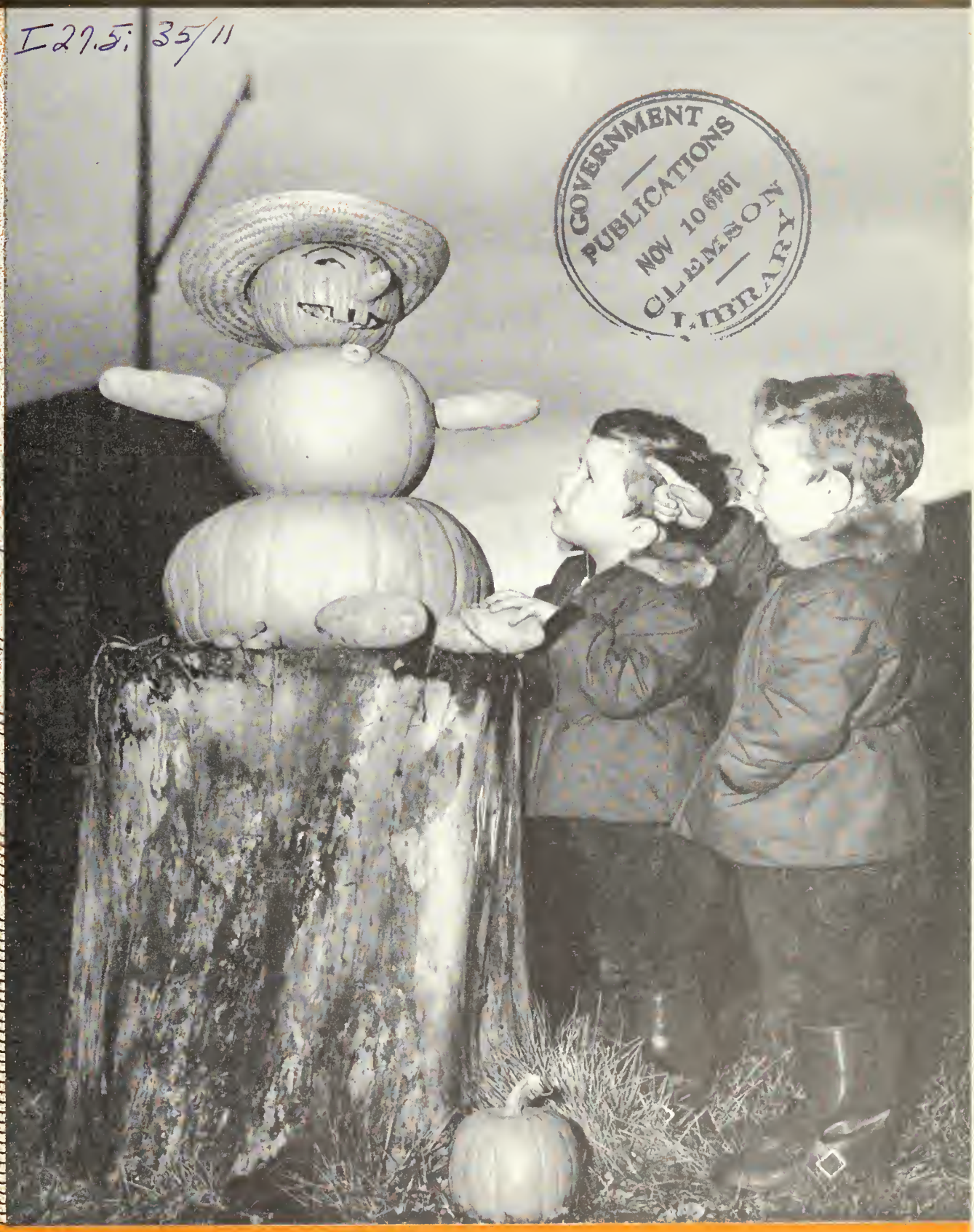

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Ruth F. Sadler, *Editor*

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30 YEARS AGO IN THE ERA

Over 100 years ago a statistician said, "In 100 years the world cannot feed itself." He was right, and had it not been that steam power was discovered and railroads built into the interiors and the agricultural machines and tools invented, his prediction would have come true.

Now, again, our alarmists predict that the earth will soon be incapable of supporting its increased population, and were it not for our modern inventions it doubtless would be true. But our gas engines and electricity are replacing our beasts of burden, and the horse and ox will soon be looked upon as relics of barbarism, only to be seen in zoological gardens.

(From the November 1919 issue of the RECLAMATION RECORD, predecessor of the RECLAMATION ERA, page 501, "Current Comments Gathered from the Project Press and People," by C. J. Blanchard, statistician, who stated the item was sent in by I. N. Pepper, the originator of Peppers Gardens.)

RECLAMATION PLACE NAMES IN THIS ISSUE

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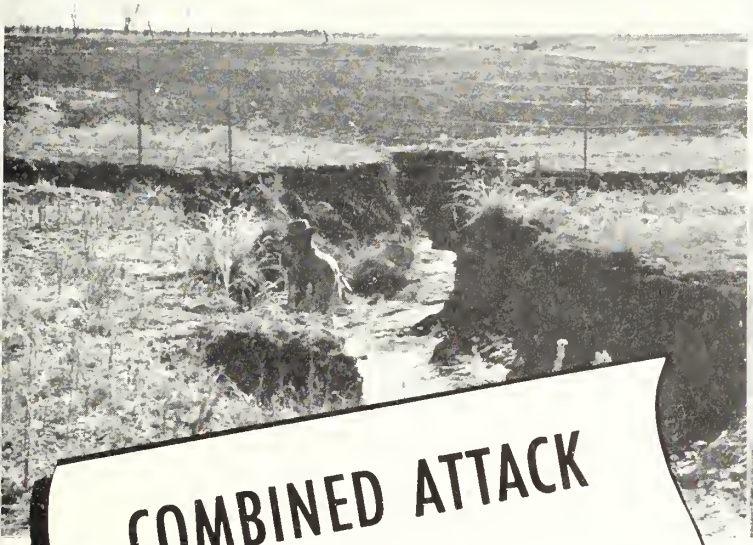

COMBINED ATTACK on EROSION

EROSION JUMPS THE FENCE—At upper left can be seen a boundary fence constructed on solid ground only 6 years ago between the private farm and the public land in the foreground, a view from Altus Reservoir. At upper right is a closeup view of Diversion Terrace No. 2 on the west side of the Altus Reservoir. *Both photos were taken by P. W. George of Region 5.*

by JOHN G. KOOGLER, Conservationist (Public Lands), Branch of Operation and Maintenance, Region 5, Amarillo, Tex.

A FENCE LINE IS NO BARRIER TO EROSION. This monster, which is continually gnawing away at our precious land resources and filling up the storage capacities of our reservoirs, respects no property lines, plays no favorites, and attacks all land properties alike irrespective of ownership. This is nothing new, but bears repetition and must be taken into account when dealing with the problem of saving soil and water.

Erosion's impartiality has been brought to our attention rather forcefully on the W. C. Austin project in Oklahoma where a coordinated counter-attack against this common enemy is now gaining momentum.

The W. C. Austin multiple-purpose project lies in parts of Jackson, Greer, and Kiowa Counties in the southwest section of the Sooner State. The project provides irrigation, flood control, municipal water supply, fish and wildlife conservation benefits, and recreational facilities. The storage and diversion works, consisting of Altus Dam and appurtenant structures, are on the north fork of Red River, 18 miles north of the city of Altus. Water is supplied from this reservoir to about 50,000 acres of irrigable land, all of which is in private ownership, and has been cultivated many years under dry farming conditions.

The Bureau of Reclamation acquired the lands occupied by the Altus Dam and Reservoir prior to construction. The land in this area which is above the normal high water level is under lease to the State of Oklahoma for recreational development and use in connection with Quartz Mountain State Park. Land above the reservation area is in private ownership and much of it is in cultivation. Obviously, conservation work on the public land alone would achieve little unless closely coordinated with the conservation program on adjacent privately owned lands.

Due to the topography and erosive qualities of the soils in the general area surrounding Lake Altus, surface and gully erosion is severe. A reconnaissance survey of the public land shows two separate conditions which contribute to its deterioration. First, erosion originating within the area itself; and second, headcuts and gullies created by outside sources, i. e., water originating above it outside the boundaries.

On the privately owned, nonirrigated, cultivated farm land surrounding the Altus Dam and Reservoir, surface soil and gully erosion is serious, and until recently little effort had been made to control it.

Approximately 24 square miles of public and private land drains directly into the reservoir. Soil Conservation Service made some initial soil classification surveys and estimated that each square mile erodes at least 6 acre-feet of soil per year.

Under the provisions of section 6 of the fourth plan of Government reorganization (H. D. 692, 76th Cong., 3d sess. 54 Stat. 1234) the Department of Interior, and subsequently by delegation the Bureau of Reclamation, is responsible for preserving the land under its jurisdiction through taking steps necessary to control erosion and prevent excessive sedimentation of works constructed by the Bureau.

Similarly, the Soil Conservation Service is charged with the responsibility of assisting private land owners in erosion

OUR FRONT COVER—Preview of Thanksgiving dinner on the Boise Project. Larry, left, and Gary Macomb, three-year-old twin sons of Mr. and Mrs. Jack Macomb of Boise, Idaho, show apparent intrigue over the pumpkin man which was created by attaching various crops grown on irrigated farms in Southwestern Idaho. *Photo by Stanley Rasmussen, photographer, Region 1.*

control problems. This agency cooperates with, and works through soil conservation districts. These districts are the mechanism through which private land owners have obtained the assistance required in solving conservation problems.

In recognition of the need for a coordinated program, the Bureau has adopted a policy of full cooperation in carrying out the soil and moisture program on the W. C. Austin project. The first step in the coordinated attack was achieved through the execution of cooperative agreements between the Bureau of Reclamation and the soil conservation districts of Greer and Kiowa Counties. The agreements provide for mutual assistance, and following their execution the districts, with the aid of technicians of the Soil Conservation Service, assisted by the Bureau of Reclamation's project staff, worked out plans for a conservation program on the W. C. Austin area that would fit into the over-all conservation plans of the soil conservation districts. The Bureau's conservation plan for the public land area calls for the construction of 11 detention dams, involving more than 30,000 cubic yards of material; 20 diversion terraces totaling approximately 2 miles in length; and the seeding of several hundred acres of abandoned farm lands as well as protective seedings for structures and drain ways. Actual work on this program was begun in fiscal year 1949 and to date 5 of the detention dams, 10 of the diversion terraces and 140 acres of seeding work have been completed. This work was performed by the Greer County soil conservation district and the Bureau through the use of soil and moisture funds. In addition, the W. C. Austin project forces installed five cattle guards to give recreation seekers ready access to the lake area and to keep trespassing livestock from overgrazing the reservation, particularly on newly seeded areas. Project forces have also seeded approximately 100 acres of canal rights-of-way as a stabilization measure and means of controlling annual weeds.

Much of the privately owned land in the soil conservation districts is being terraced and the area as a whole will demonstrate in a small way what can be expected from controlled watersheds. But continued wholehearted cooperation and expanded effort will be necessary in our counter-attack on the old enemy—erosion—if we are to repel his destructive assault which results in depleted watersheds, silted reservoirs, with consequent short water supply for irrigation projects.

THE END

Weber River Project Approved by President—With Reservations

President Truman signed Senate bill 2391, the bill to authorize the construction, operation, and maintenance of the Weber Basin reclamation project in Utah, with a statement to the effect that the bill was approved because it was considered basically sound, but several questions would have to be answered before any funds could be requested for construction.

Reasons given for this unusual, if not unprecedented, treatment of a reclamation bill, were that there was no evidence which indicated that normal procedures had been followed and that adequate review had been obtained prior to enactment of the bill. The President questioned the repayment period, allocation of cost to recreation, lack of interest on reimbursable irrigation cost and on reimbursable cost for municipal and industrial uses, lack of evidence of review by the Department of the Army and Department of Agriculture.

The Secretary of Interior plans to submit a report which endeavors to show that established procedures were adhered to in submitting the Weber Basin recommendation. •

BULWARK AGAINST SILENT INVADER—Strong, sturdy battlements must be erected to check the continuous, relentless advance of erosion and protect our valuable resources—soil and water. Here is the completed Detention Dam No. 2, on the west side of Altus Reservoir. *P. W. George photo.*

THE WINNERS AND CHAMPIONS—Ralph Friesian, Chairman of the Baard of Directars af the Seed Grawers Association, and K. E. Duling, abave, display the many ribbans which were wan at the Internatianal Livestack Expasitian at Chicago and the Royal Canadian Fair held at Taronto, Canada. At right is a clase-up af the prize-winning certified ladina claver seed itself, as praduced on the North Unit af the Deschutes praject. *Photos by Stanley Rasmussen af Region 1.*

Deschutes Project—Deep in clover

by HOLLIS OTTAWAY, County Extension Agent, Madras, Oreg.

Clover seed growers on the north unit of the Deschutes project in central Oregon are challenging the world in the production of high-quality seed.

That is no idle statement. It is backed up by an outstanding record which shows that clover seed produced in this area, newly irrigated by the Bureau of Reclamation, has been consistently winning top honors in all important seed shows in North America since the first seed was produced on the project in 1947. High in quality, the seed is demanding top prices in all the seed markets of the country and is bringing profitable returns to the growers.

Under the sponsorship of the Jefferson Seed Growers Association of Madras, Oreg., clover seed was entered in a number of seed shows in 1948. At the International Hay and Grain Show at Chicago, Deschutes growers won first, second, fourth, and fifth in the Ladino clover seed competition; first, second, and fifth in Alsike clover seed rating; second, third, fifth, seventh, tenth, and eleventh in Red clover seed.

At the Royal Winter Fair exhibition in Toronto, Canada, the following prizes were won: Ladino clover seed—first, second, third, fourth, and fifth; Alsike clover seed—second, fourth, and fifth; Red clover seed—second, third, fifth, sixth, and seventh.

One of the growers also won first prize in Red clover seed production at the Pacific International Hay and Grain Show in Portland, Oreg.

Clover seed production on the north unit of the Deschutes project was not started by accident or by trial and error methods, but is a program that was planned for the project by Mr. E. R. Jackman, State Field Agronomist of the Extension Service in cooperation with a local committee of farmers. Mr. Jackman was familiar with the climatic conditions, growing season, and soil characteristics of this particular area. He was familiar also with the conditions required for production of high-quality clover seed and knew that the conditions here were as nearly ideal for clover seed production as could be found in the Pacific Northwest. These advantages were pointed out to the local farmers' committee, which recommended that clover seed production should be one of the major agricultural enterprises of the project.

This committee also worked out recommendations to be followed in the production of clover seed. These recommendations included preparation of the seed bed; method, time, and rate of seeding; kind, rate, and time of application of fertilizer; and time and amount of irrigation water. Production methods recommended included irrigation, time of clipping or pasturing the first crop, and methods of harvesting. All of these recommendations have proven to be sound and have been of untold value to the clover seed producers of this area.

To further promote the production of high-quality seed on the project, the seed growers have organized the Jefferson Seed Growers Association. The officers of the association for 1949 are: Ralph Friesian, chairman; Hollis Ottaway, county agent, secretary-treasurer; J. A. Macy, vice chairman; and directors are Carl H. Coad, O. C. Hegepeth, Wiley Clowers, and K. E. Duling. The association is financed by $1 membership and 1 percent of small seed gross sales and one-half percent of small grain sales. These funds are used by the association for advertising, participation in seed shows, weed control, encouraging honey producers to bring in bees during flowering season, and encouraging the production of new small seeds.

The weed control program is a commendable activity of this association. It has purchased a large weed spray outfit and employed a full-time operator. The weed control operations cover the entire seed-producing area.

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PRIZE PACKAGES—All seed that has passed field inspection and purity test in the State Seed Laboratory is sealed and tagged in the cleaning plant, guaranteeing A–1 quality to the customers. *Photo by Phil Merritt, Region 1.*

The Bureau of Reclamation and State Highway Department are cooperating very closely with the association in this weed-control program.

Mr. Jackman recommended, among other things, that maximum clover seed production could be obtained, other factors being equal, with a minimum of one hive of honey bees per acre of clover seed. This has proven to be a fact on the north unit of the Deschutes project, as well as in other clover seed producing areas. The Jefferson Seed Growers Association has assumed the responsibility of encouraging honey producers to bring their bees into that area.

The growth of the clover seed industry on the 50,000-acre north unit has been rapid, as attested to by the table below:

Year	Ladino clover	Red clover	Alsike clover
	Acres	*Acres*	*Acres*
1946	0	20	20
1947	320	330	800
1948	1,400	900	1,700
1949 (estimate)	6,500	3,000	1,100

The first water was delivered to this project on May 18, 1946, and water was available for the full project in April 1949.

From information obtained for seed tested in the State Seed Laboratory, it is possible to determine the weighted average purity and average yield per acre for each of the seed crops tested. These averages are listed below:

Ladino clover seed—153,309 pounds of seed tested, 913 acres, 170 pounds average yield per acre, 99.79 percent pure seed. Highest yield in 1948 was produced by Robert Griffith, Jr., on 19.5 acres with an average yield of 510.5 pounds per acre.

Red clover seed—87,522 pounds of seed tested, 314.5 acres, 280 pounds average yield per acre, 99.72 percent pure seed. Highest yield in 1948 was produced by Denver Law on 26 acres with an average yield of 455 pounds per acre.

Alsike clover seed—615,000 pounds of seed tested, 1,500 acres, 410 pounds per acre average yield. The End

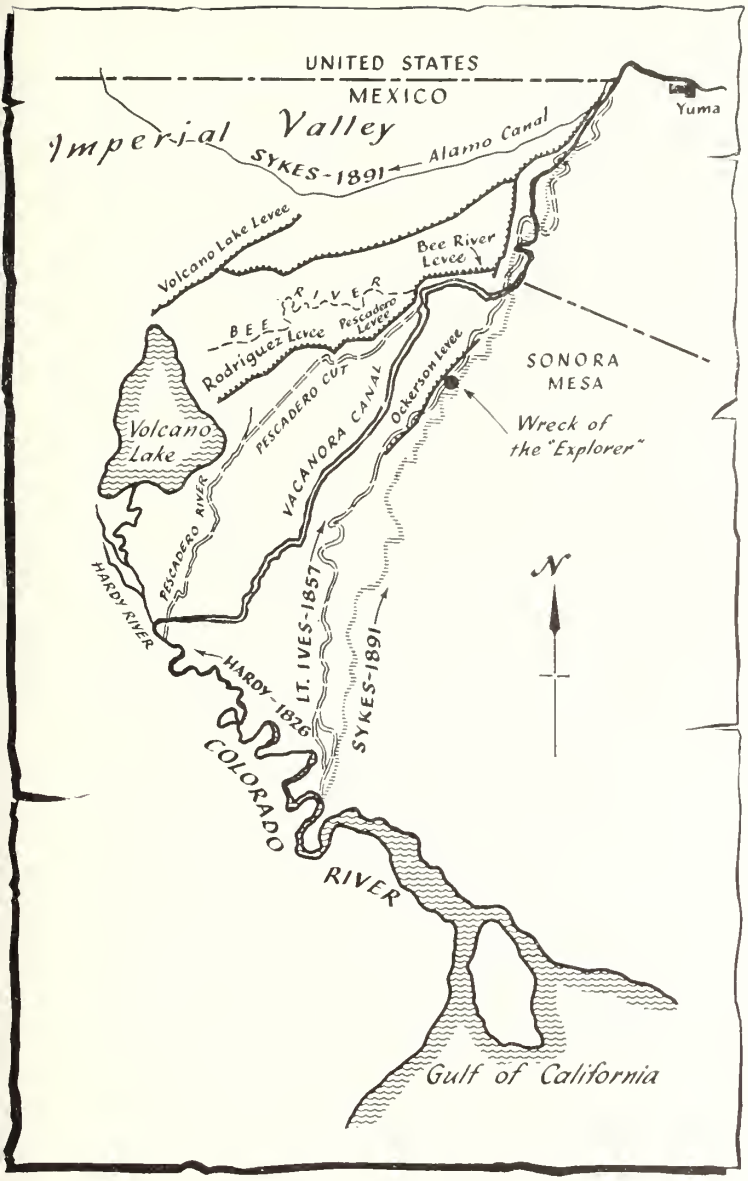
18th Annual NRA Convention to Honor Past and Plan for Future

In outlining plans for the Eighteenth Annual National Reclamation Association Convention to be held at Salt Lake City November 2, 3, and 4, Secretary Manager William E. Welsh said, "In view of the fact that the meeting at which the National Reclamation Association was first organized in 1932 was held at Salt Lake City, Utah, the association is giving special recognition to its founders on this, the eighteenth year of the organization, in the very city where it got its start. The NRA was first organized at the urgent request of former Commissioner of Reclamation, the late Elwood Mead. At that time the entire reclamation program found itself at its lowest ebb. Fearful of losing the ground it had already won from desert and mountain wilderness, a group was formed to revive reclamation and bring about a better understanding over all the Nation of the value of the program, what it had meant to the people of the West and the whole country, and what it could mean if a sound program could be mapped out to reclaim the many arid stretches of western land.

"We are asking the first President of the National Reclamation Association, Marshall Dana, owner and publisher of the Oregon Journal, to act as toastmaster at the banquet, have reserved special places for the charter members and plan to pay them fitting tribute.

"Another feature of this convention will be a repeat performance of our successful 'Water Users Day' on Thursday, November 3, with a 'grass roots' discussion in which one speaker from each of the 17 Western States will tell of the irrigation and reclamation problems as he sees them, from the standpoint of the irrigation water users in his State. To qualify as a speaker in the 'grass roots' forum, each representative must be a man who is not only living on, but making his living on, an irrigated farm in the State which he represents.

"Governor J. Bracken Lee of Utah will present the address of welcome, President of the National Reclamation Association Harry E. Polk will follow with a message to the convention, Commissioner of Reclamation Michael W. Straus will make a report, followed by the report of the secretary-manager. Among the featured speakers will be United States Representative John R. Murdock of Arizona, Senator Joseph C. O'Mahoney of Wyoming, Representative Wesley A. D'Ewart of Montana, President of the Association of Western State Engineers J. J. Walsh, Dr. C. E. Jacob of the University of Utah, and President of the National Association of Soil Conservation Districts Kent Leavitt." •



THE RIVER THAT DEFIES MAP-MAKERS—For hundreds of years the Colorado River Delta's maze-like turnings have fascinated and puzzled explorers. Its floods and break-throughs have also caused consternation among southwestern inhabitants as can be seen by the levees built to keep the river from its incorrigible urge to "go west" a la Horace Greeley.

THE COLORADO RIVER DELTA

PART II—

MEANDERINGS OF A RIVER

by Engineer C. P. VETTER, Chief, Office of River Control, Region 3, Boulder City, Nev.

After the first discovery and exploration of the Colorado River delta by Spanish conquistadores in 1539–40, almost 200 years passed before the area was again visited by white men. In 1701 Father Kino explored the delta, as did Father Consag in 1746.

Another century passed and in 1826, the British Lieutenant Hardy, in his small schooner, the *Bruja*, reached the river's mouth. Lieutenant Hardy was not a very good cartographer, but as far as can be judged from his maps, he missed the mouth of the Colorado proper and entered what is now called "Hardy's Colorado," to the west from which, through some slough, he must have reached the Colorado and proceeded upstream as far as the mouth of the Gila. He was followed in 1851 by the American Lieutenant Derby, who was instructed to investigate the mouth of the Colorado and the possibilities of bringing supplies by boat to the newly established military outpost at Fort Yuma. He, like Lieutenant Hardy, proceeded up the Hardy branch, but was unable to bring his ship through the connecting slough into the Colorado, so he proceeded upstream in a small boat until he met a party coming downstream from the Fort. Since he had thus completed his mission of making contact with the military outpost, he returned and it remained for Lieutenant Ives, in 1857, to bring his ship, the *Explorer*, from the Gulf up the river almost to the point where Hoover Dam now stands.

Lieutenant Ives made a careful map of the meandering river all the way from the Gulf to Black Canyon where Hoover Dam now stands. His map of the delta shows that the main channel of the river occupied the east portion of the delta along the edge of the Sonora Mesa. He indicated many channels going off to the west, but apparently he did not explore or map the Hardy Colorado, located to the west.

The *Explorer*, however, was not the first American vessel to enter the Colorado and proceed upstream. The years before the Civil War saw much activity along the lower river. The military post at Fort Yuma had been established for some time and had to be supplied with provisions. The immigrant trains heading west for California crossed the river in Yuma and these people too had to be fed. Also the country upstream was gradually being developed—some farms were being established in the lowlands and mining explorations were begun. So there soon developed a certain amount of traffic on the river. Several small steamboats—side-wheelers and stern-wheelers—were employed in this traffic between 1851 and 1868. Incidentally, two of the steamers were called *Colorado*, which also is the name of the Bureau of Reclamation dredge now at work in the swamp at Needles, Calif. With the coming of the Southern Pacific railroad to Yuma in 1877, the boat traffic quickly sickened and died. Except for Lieutenant Ives' explorations, the other boats were engaged in commercial traffic and did not bother to waste time on investigations. One thing is sure, however, that during that period the river followed the eastern edge of the delta.

There now entered upon the scene of the Colorado River delta a man who has come to know the country better than any other and who has spent more time in the delta than all previous explorers combined. For a period of 50 years beginning in 1890, Godfrey Sykes visited and traveled through

the delta almost every year in search of knowledge of its geographical features and its flora and fauna. In 1891 he made a map of the river between Yuma and the Gulf, and, although it differed from that of Lieutenant Ives, 34 years earlier, it nevertheless showed the river to occupy essentially the same portion of the delta, that is, the eastern part along the edge of the mesa. Not all the water, however, followed this channel and in the spring of 1891 Sykes went by boat from Yuma by way of the Alamo River into the Imperial Valley, reaching the site of the present town of Holtville.

Although several minor changes in the river delta occurred during the period 1890–1905, the main course of the river still was along the eastern portion of the delta. The situation was becoming unstable, however; the bed was building up and it was evident that the river was ripe for a major avulsion, or tearing asunder, and the only place the river could go was toward the west. Then in 1905 came the break-through into the Imperial Valley, and for 2 years the entire flow of the river was diverted that way. When the break was finally closed in 1907, the old river bed had deteriorated and vegetation had grown up so it was not possible for the river to return to its old course. Instead, it overflowed the country toward the west, but no definite channel was established at once, the river water being dissipated as sheet flow, gradually finding its way to Volcano Lake, at the foot of the Cocopah Range, and from that into the Hardy.

It was not until the great summer flood of 1909 that the river established a definite channel between its old course and Volcano Lake. This channel was given the name of Bee River.

The great silt mass carried by the river was deposited in Volcano Lake, gradually building up a silt cone which threatened to throw the river toward the north and back into the Imperial Valley. A levee—the Volcano Lake levee—was constructed to protect the Imperial Valley from overflow from Bee River, but the situation was very dangerous and the Congress of the United States was prevailed upon to make available the sum of $1 million for the purpose of closing the opening into the Bee River and returning the river to its original course along the Sonora Mesa. The work was placed in charge of a Colonel Ockerson.

Although the Bee River was dammed and levees built to confine the river to its old channel, the whole scheme failed in 1911 when the river flanked the Bee River Dam and returned to its westward course into Volcano Lake, with the attendant danger to Imperial Valley. There was nothing to be done but to further raise and strengthen the Volcano Lake levees to obtain additional protection. The river maintained this course until 1921.

As the Volcano Lake area was gradually rising because of the deposited silt, it was becoming evident that there was a limit to how high the protective levees could be raised to prevent overflow toward the north into the Imperial Valley. A plan was, therefore, developed for diverting the river into the Pescadero Channel, which hitherto had been simply a drainage channel located somewhat east of the Hardy. The plan was successful in that the connecting channel was cut and water diverted in January 1922, and thus, once again, the Colorado had a new channel.

It did not last long. The slope of the Pescadero Channel was too flat and silt began to accumulate. To prevent the river from returning to its former course along the Bee River, a levee was constructed in 1927 by Mexican irrigation companies along the west bank of the Pescadero between that river and the Bee River, and was called the Rodriguez levee. Although some protection was afforded by this levee, the bed of the Pescadero was still steadily rising.

As had been the case in 1905, when the failure of man-made works caused a radical change in the river's course, so it happened again in 1929, when the river broke into the Vacanora Canal which had just been completed as an irrigation canal heading from the Colorado at the point where the dam that closed the Bee River had been constructed. At first it was intended that the river should be diverted to the canal by means of siphons over the levee. These, however, did not work and the siphons were abandoned in favor of a direct opening. This caused disaster, and by November 1929 the entire river flowed into the Vacanora Canal, just as 24 years previously it had flowed into the canal leading to Imperial Valley.

The Vacanora Canal is the latest channel of the river. Below Yuma, the Colorado follows the old channel along the eastern edge of the delta to a point somewhat south of the Sonora boundary, from there west along the old course of Bee River to the closing dam and then south along the Vacanora Canal to a point where the river until recently disappeared and the water was dissipated as sheet flow in what has been referred to as the Vacanora cone. There was still no direct connection between the Colorado River and the Gulf and, in fact, had not been since the break-through into Imperial Valley in 1905.

With small changes this situation existed until a few months ago. It was then reported that a definite channel had been formed leading from the apex of the Vacanora cone toward the west to junction with the Hardy a few miles south of the settlement of El Mayor.

EXPLORERS OF TODAY—At extreme left, the survey party begins the first boat trip in over 40 years from Yuma, Ariz., to the Gulf of California. "THE EXPLORER" OF THE PAST—At left, Jose G. Valenzuela, engineer in charge, Mexican Section, International Boundary and Water Commission, and the author, examine remnants of Lieutenant Ives' ship, "The Explorer," now buried under the sands in the jungle of the Colorado River Delta. Above, navigation in Mexico across the Colorado River. *Photos submitted by the author.*

It was to explore this channel that a party, in a shallow draft power boat, left Yuma on April 14 of this year and reached the end of the Vacanora Canal the following day. From there the channel leading westward was located and, with considerable difficulty through swift water and many submerged stumps and logs, the stretch was traversed to the junction with the Hardy, at a point which is, at the present time, the limit of the influence of the tides. From that point south toward the Gulf, the Hardy rapidly widens. The tide marks on the banks become more and more pronounced and the extensive salt flats which form the head of the Gulf come into view.

For the first time, therefore, in more than 40 years a continuous channel exists from Yuma to the Gulf which is passable by small boats at all stages of the river. It is interesting to speculate on how this channel will develop in the future. It must be kept in mind that the enormous silt load which used to be carried into the delta by the river has decreased materially. Also, that large floods, instead of annual occurrences, have become a rarity.

The tides in the Gulf are still of great magnitude, however. At the time of our visit, another party measured a tidal fluctuation at the head of the Gulf of approximately 23 feet. These tides, coming in and going out twice in each 24 hours, are constantly eating away at the old silt deposits. At the present time, the tidal influence ceases at the westward end of the connecting channel. No doubt it will progress farther upstream and the connecting channel between the Vacanora Canal and the Hardy will be widened and become more easily navigable. At the same time the Hardy above the junction point will probably be sealed off by a sand bar. Even now there is barely 2 feet of water in the Hardy at the junction. How far the tides will penetrate inland is difficult to say. It probably will be centuries before they reach the lower boundary, if ever. There are now many shallow bends in the river, particularly where it enters the Vacanora Canal. If the river is not straightened by man in this reach, they will probably act as barriers to the upstream progression of tide water.

Conditions on the Colorado River below the border should be carefully watched, because anything that happens in the future in this region may have a pronounced effect upon conditions on the river within the United States. THE END

President Vetoes Vermejo Project Bill

On August 23, 1949, President Truman vetoed House Bill 3788, a bill to authorize the Secretary of the Interior to construct, operate, and maintain the Vermejo reclamation project, New Mexico.

In his message to Congress, the President gave as one of his reasons for vetoeing the bill the fact that repayment provisions had not been officially reviewed in the usual manner by the Department of Agriculture. He questioned the inclusion of sediment control, recreation, and fish and wildlife in the $1,170,920 proposed to be charged off against nonreimbursable benefits, as well as the costs allocated to flood control.

Concluding his message, the President stated, "The records indicate that there are 86 landowners and 45 farm operators within the Vermejo district. I sympathize fully with the situation in which they find themselves, and I recognize that in disapproving House Bill 3788 I am taking an action which they may at first find it difficult to understand. Nevertheless, I believe that they will accept my action as an indication of the need for basic legislation under which all projects requiring Federal assistance will be treated alike. Recommendations for such legislation are being developed for presentation to the next session of the Congress. If the Congress acts upon them promptly, little time will have been lost and there will be established principles for Federal aid which can be equitably administered over the years as needs arise."

Substitute bills (S. 2512 and H. R. 6175) have been introduced in the Congress. •

Reclamation's Hall of Fame

Nomination No. 3

Congressman RICHARD J. WELCH

by MAX STERN, Region 2, Sacramento, Calif.

Champion of workers and farmers, veteran of many congressional battles in behalf of the people, humanitarian, statesman, and one of western reclamation's best friends—such was the late Congressman Richard J. Welch of California, whose shining record nominates him for the newest niche in Reclamation's Hall of Fame.

Paradoxically enough, this staunch advocate of western development was born in New York State and did not arrive in California until he was 15 years of age. The superficial historian might wonder why an easterner could impartially support the interests of farmers, members of labor unions and of industry, Federal workers throughout the country, and Californians without at any time compromising his well-known integrity.

His secret lay in his belief in "Government of the people, by the people, and for the people." This was his yardstick, his guide, his battle cry.

By his works he is known, as he shunned publicity, to the point where very few people knew of his personal life, and even the date of his birth, February 13, 1869, was a matter of conjecture. At the time of his death, at 80 years of age, he was progressive and active enough to put many a younger member of Congress to shame.

The few facts which can be garnered about his early life indicate another of the reasons why his colleagues in the House of Representatives devoted hours of tribute to "a great Californian, and a great American" and for 5 days appended memorial statements to the Congressional Record. These facts show that he knew the people whom he represented, and always got first-hand information on the problems he helped to solve.

He could deal fairly with farmers and their problems because he actually worked on farms. He knew the workers, for he was an iron molder in San Francisco and trained himself to be an expert machinist. And he firmly belived, and saw demonstrated many times, that the prosperity of the cities depends chiefly on that of the farms that surround them.

Few members of Congress had enjoyed a longer and more honored career. In 1900 he was named deputy county clerk of the city and county of San Francisco, and since 1901, when he was elected to the State Senate, he had been a lawmaker of the Hiram Johnson school of progressive republicanism and had never been defeated for an elective office. In his typically brief and modest biography in the Congressional Directory, it is stated that he was elected a member of the California State Senate from 1901 to 1913, followed by 10 years as a member of the legislative body of the city and county of San Francisco. In 1926 he was elected to the Sixty-ninth Congress to fill an unexpired term and served as Congressman until his death. Only 21 House members had served longer at that time.

No man better understood the water and power needs of the farmers of California and the West, and none fought to meet those needs more earnestly. "It is regrettable," he used to say, "that there are so many people in this semiarid State whose only interest in water and power is to turn on a faucet or snap on a light switch."

While Congressman Welch was a labor stalwart and fathered many labor measures as ranking Republican member of the House Labor Committee, his chief recent fame in the West was as chairman of the House Public Lands Committee in the Eightieth Congress. As chairman he stood like Gibraltar against the assaults of special interests on the reclamation law and program—the 160-acre water limitation, public power, antimonopoly, and other democratic safeguards. He sponsored a bill to authorize study of means of transporting excess Columbia River water to California. He fathered a measure to make Folsom Dam a part of the Central Valley project. He opposed and defeated the Rockwell bill that would have upped power rates and irrigation costs. He brought his entire committee to California to travel through

the Central Valley project to see the vast project in the making and to hold hearings on controversial matters relating to its construction and operation. On this trip he preached unified and comprehensive development of California valleys by the Bureau of Reclamation under reclamation law.

"I have presided at meetings of my committee from Redding to Fresno," he said of these hearings. "The situation is the same everywhere. In the great Central Valley the lack of water is critical. Water is California's biggest problem. Water and power are the life-streams of our national defense and peacetime economy."

It was significant of his interest in western conservation that he died while on a mission for the Public Lands Committee. He and his devoted wife were en route East after a short House recess. In California he had attended the State Fair, an annual event that he boasted of never missing. On his way back to Washington he was joining other members of a subcommittee to inspect various Colorado River projects. As the train neared Kingman he was seized with a heart attack and he died at a Needles Hospital on September 10, 1949. As we say in the West, he died with his boots on!

Democrats and Republicans, easterners and westerners, joined in unanimous praise of what Congressman O'Sullivan of Nebraska called, "the greatest Republican legislator I have ever known in my 66 years of living."

In speaking before the House, Harry R. Sheppard, Democrat, and Representative from California, said, "Dick Welch served 48 years as an elected public servant, and during those years he contributed greatly to the development of the West and California. He was a friend, even though of a different political faith. A Republican, he was a friend of labor, the Government worker, and was a strong advocate of improvement in life for all Americans. He was a friend of public power, good roads, better living facilities, the farmer and the humblest workingman." Sketching the highlights of his friend's career, Mr. Sheppard cited Dick Welch's sponsorship of the Golden Gate Bridge, his role in backing the establishment of many major military and civilian installations in California. "As a Representative of San Francisco's Fifth Congressional District for 23 years," Mr. Sheppard said, "Dick Welch established a record seldom equaled by any individual Member of this great body. He not only served as a Republican Member of the House Public Lands Committee, but also on the Labor and Merchant Marine Committees, and in the last few years he concentrated much of his energy on the development of the Central Valley reclamation project and other reclamation, irrigation, and Indian problems of the western slope of the Rockies.

"Dick Welch was a quiet, gentlemanly person in all of his dealings with his colleagues and his associates. He was a kindly man, a persuasive man, and he was of firm convictions on the issues of the day. He differed with individuals, but there was no rancor. I admired him greatly, although at times we did not see eye to eye on various issues. He was a progressive individual in that he foresaw the needs of the Western States, particularly California."

Congressman Joseph W. Martin, Jr., Republican, of Massachusetts said, "Dick Welch was a splendid legislator, a man of high character and ability. Our country can ill afford the loss of men of his devotion to the public welfare." Speaker Sam Rayburn of Texas added, "his like comes this way too infrequently," and Earl C. Michener, Democratic Representative from Michigan remarked, "This is a better country because Dick Welch lived in it. His interest was always in the underdog and in the common man. He always thought in prospect rather than in retrospect. He was a leader of organized labor of the earlier vintage. He was ever proud of the union as he conceived it and was ever ready to advocate and defend the legitimate objectives of trade unionism. He was not a radical. He called himself a Progressive Republican. If more labor leaders entertained Dick Welch's concept of the functions and purposes of organized labor, the rank and file union member would be the beneficiary, and the country would be better off."

It remained for the Congressman from Massachusetts, John W. McCormack, a Democrat, to summarize most concisely Dick Welch's claim to fame, saying, "His knowledge of our Government and its fundamentals, what it stands for, its duties and responsibilities, and of legislation was profound. His courage was outstanding. He always followed his conscience. He voted his convictions. He did not respond to the voice and pressure of those seeking special privileges at the expense of the people. He did not vote as political expediency dictated. He voted his honest judgment.

"Dick Welch was always found fighting for the best interests of the people. Not only labor, but agriculture, and particularly those interested in flood control, public power, irrigation and reclamation, and conservation of our soil will, as they should, always remember Dick Welch and his able and courageous service in their behalf in this great and important legislative body."

"The cause of western reclamation under democratic processes never had a better friend than Dick Welch," said Reclamation Commissioner Mike Straus. "He will be sorely missed, but he will not soon be forgotten. We are proud to add his name to Reclamation's Hall of Fame." THE END

Large-Scale Central Valley Plan Goes to Congress

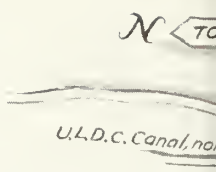
Secretary of the Interior Krug has submitted to Congress the Central Valley report covering basin-wide development. This report presents a comprehensive plan for full development of the valley's water and related resources and an inventory of potential projects.

The long-range plan includes 38 major multiple-purpose dams, 28 hydroelectric plants, canals, irrigation distribution facilities, transmission lines, and other works.

The estimated cost of the Central Valley project as now authorized is $440,000,000 and the new construction recommended for immediate authorization would cost approximately $150,000,000 at 1948 prices. •

Of California's 30 million acres of farm land, about 5 million acres are irrigated and these 5 million acres produce 85 percent of the State's two billion dollars' worth of farm crops.

LIFTING WATER TO LANDS OVER JORDAN



by MACK CORBETT, Region 4, Salt Lake City, Utah

On a late summer day in 1932, the main pumps of the Utah Lake Distributing Co. whirred to a stop, never to be used again for their original purpose in lifting precious water for irrigation from Utah Lake—Utah's counterpart of the Sea of Galilee.

For 14 summers these pumps had supplied water to nearly 10,000 acres of productive farm lands extending almost as far north as Salt Lake City.

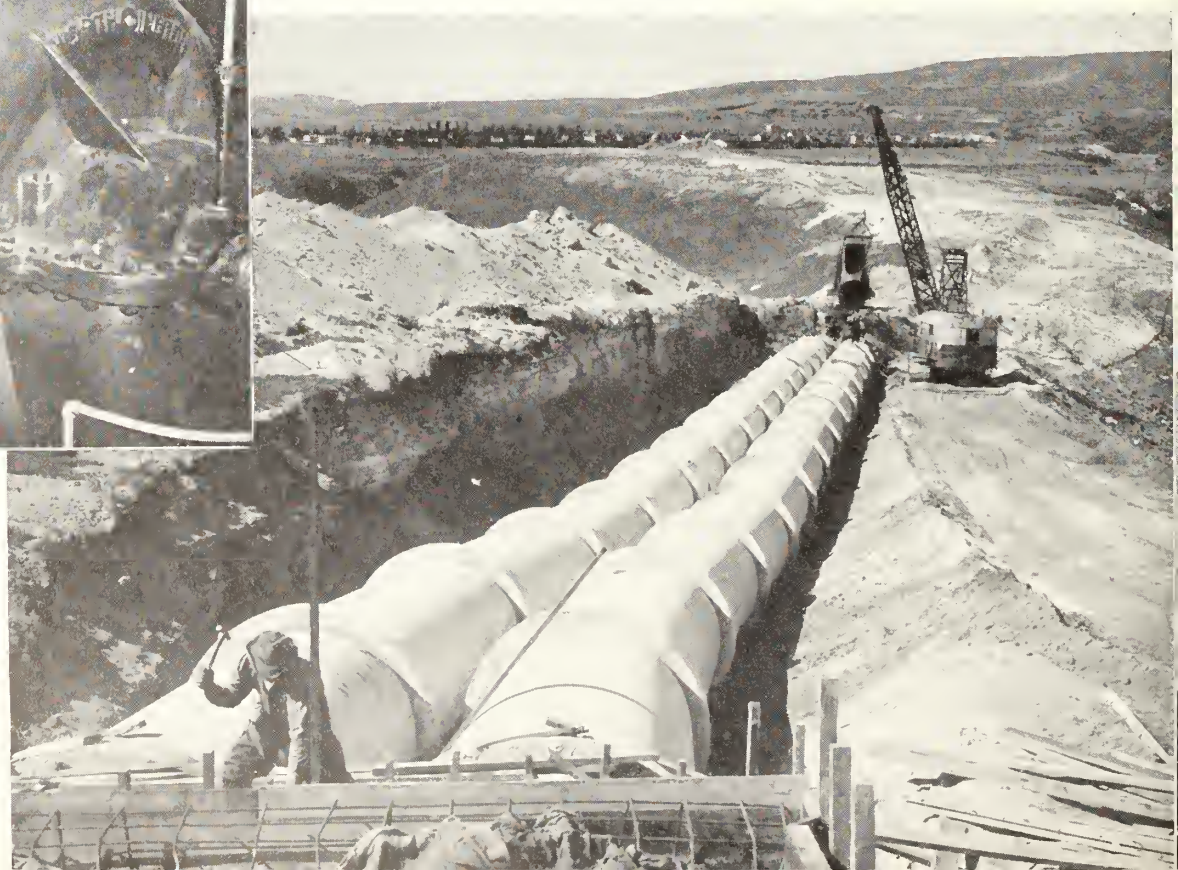
Beginning in 1929, however, costlier and costlier water flowed from the pumps as Utah Lake felt the effects of the West's great "early thirties" drought. The lake dwindled from 850,000 to 20,000 acre-feet, receding far away from its shallow shore line and making it necessary to dredge increasingly longer channels to the "stranded" pumps.

When dredging distances exceeded the quarter-mile mark in 1932, the company was forced to cease pumping operations altogether. Some 1,100 acres of lands thus bereft of a water supply were abandoned, except for some dry farming during World War II and some pumping to a limited acreage at the head of the ditch when the lake came back.

The bulk of the lands, lying in south Salt Lake County, have not even been dry-farmed, their owners letting them revert to weeds and June grass.

Partly because the Provo River project was authorized in 1937, no attempts were made to resume pumping directly from Utah Lake to the Salt Lake County lands. Directors of the moribund Utah Lake Distributing Co. saw in the new Federal reclamation undertaking a chance to get half of the water needed for their lands by gravity flow from the proposed Deer Creek Reservoir on the Provo River. They were also convinced that there was enough fall between Deer Creek Reservoir and their canal to provide the energy for pumping the other half of their needed water supply indirectly from Utah Lake, although a lot of complex details would have to be figured out by reclamation engineers.

Accordingly, the company subscribed to 15,200 acre-feet of water in Deer Creek Reservoir with the distant expectation of getting it into their defunct ditch via the Provo River and the existing Provo Reservoir Canal. The canal crossed



PRIMING THE PUMP—Above, G. J. Hornsby, hydraulic expert of the Bureau of Reclamation, primes the 65-second-foot capacity pump of the Jordan Narrows siphon and pumping plant. At right is the Jordan Narrows siphon prior to backfilling. The pipe is precast steel, reinforced concrete, of 69-inch diameter. *All photos by Farold H. Anderson of Region 4.*

AND THE WATER FLOWED THROUGH JORDAN in every direction, as can be seen in this simplified drawing of the main arteries of the Provo River project around the Jordan Narrows siphon and pumping plant. *Drawing executed by drafting and graphics section, based on artwork submitted by Region 4.*

the company's canal in a siphon at the Jordan Narrows, a narrow defile cut by the Jordan River (natural outlet of Utah Lake) where it flows between the peaks of the Wasatch and Oquirrh (pronounced *oh*-ker) mountains about 9 miles north of Utah Lake.

The Provo Reservoir Canal was to be enlarged under the Provo River project plan and could easily carry the company's 65 second-feet of Deer Creek flow. Moreover, it was at sufficient elevation to do some extra work if properly harnessed during delivery. This fitted in with the problem of using the company's old rights in Utah Lake, amounting to possibly 33,000 acre-feet. (Both the Deer Creek and Utah Lake waters were needed to supply the 130 second-foot flow needed for the company lands, especially if 1,000 acres of new lands were to come in.) The Utah Lake water could be released into the Jordan River which parallels the company canal enroute to Utah's "Dead Sea," the Great Salt Lake. At the Jordan Narrows where the canal and the river constrict, only a short distance would exist for getting water from the river to the canal. Since this distance consisted of about 100 vertical feet, pumping was still the problem, but the company did not care to incur any more costs for pumping.

It remained for modern irrigation engineering to provide the answers.

What was the elevation of the Provo Reservoir Canal where it plunges into the inverted siphon on the east edge of the Jordan Narrows? It was found to be 4,789 feet.

What was the average surface elevation of the Jordan River at this point? Only 4,487 feet, or an elevation difference of 302 feet ("head" as the engineers call it).

Next the design engineers for the Provo River project determined the elevation of the distributing company canal on the west slope of the Jordan Narrows to be 4,578 feet, a minimum of 91 feet above the Jordan River. Water would thus have to be raised this high to flow northward, but in order to get water to lands in Utah County on the south, the south branch of the old canal would have to be realined to start some 50 feet higher, at elevation 4,625, a total of 138 feet higher than the Jordan River.

With a fall of 300 feet, and a rise of less than half that distance on the other side, there would obviously be potential energy to spare in siphoning the distributing company's

WHEN WATER FLOWS, even after 13 years of disuse, the land produces. This budding crop of sugar beets is typical of fertile Salt Lake Valley lands brought back after a 13-year retirement by new water supplied Utah Lake Distributing Co. canal from Jordan Narrows siphon and pumping plant.

WHEN WATER IS SHUT OFF canals become choked with weeds and lands are abandoned. The south branch of the Utah Lake Distributing Co. canal above and the once-productive lands below stopped working in 1932 when pumping costs became prohibitive.

65 second-feet of Deer Creek water from the Provo Reservoir Canal across the Jordan Narrows to the south branch of the distributing company canal on the west bench. So the Bureau's design engineers logically reasoned: why not put a water-operated turbine and direct-connected pump on the Jordan River to harness the company's Deer Creek water as it falls to the bottom of the gorge? With a maximum pump lift of only 103 feet into the north canal, the engineers figured there would be enough excess energy developed to energize a 1,000-horsepower turbine for pumping water from the Jordan River and still have enough horses left to climb 138 feet to the higher south branch canal. A 1,000-horsepower turbine could drive a pump big enough and fast enough to lift 65 second-feet of water from the Jordan River to the north branch of the distributing company canal.

And with minor variations, this is precisely the way plans for the Jordan Narrows siphon and pumping plant have worked out, although the south branch of the company canal cannot be placed in operation until the company realines the south end of its canal as provided in contract arrangements. Deer Creek Reservoir was completed in 1941 and the Jordan Narrows siphon and pumping plant were completed this spring, being placed in operation for the first time on April 29, 1949, to serve lands under the north branch of the distributing company's canal.

Participation in the Provo River project has enabled the Utah Lake Distributing Co. to rehabilitate formerly irrigated lands in historic Salt Lake Valley. In addition, the company will be able to bring hundreds of acres of new lands under the ditch for the first time when the South Branch Canal is completed. Moreover, the company is no longer burdened with the cost of pumping by electricity, its drought-aggravated nemesis in 1932. By comparison the company's proportionate share in repaying the costs of the Deer Creek Dam, Provo Reservoir Canal enlargement, and Jordan Narrows siphon and pumping plant will be considerably less burdensome, especially after the last annual installment is paid and only the nominal proportionate cost of operation and maintenance remains.

At the same time, the Utah Lake Distributing Co. has reestablished its rights to use storage water in Utah Lake and, by taking advantage of the terrain, has saddled former pumping costs to the delivery of storage water from Deer Creek Reservoir—at no cost to anyone, except wear and tear on the pumping plant and 4,624 feet of various kinds of pipe comprising the combined siphon-penstock and discharge lines.

F. E. Seal, of Riverton, Utah, president of the rejuvenated Utah Lake Distributing Co., sums up the views of the water users after the first few months of operation very optimistically:

"We have had much more water so far this year under the new construction than we have ever had in the history of the canal, and the pump is operating at only two-thirds capacity. We are getting about 64 second-feet, half from the Jordan River and half from the Deer Creek Reservoir (the entire discharge of the turbine being bypassed into the pump discharge line). As soon as Camp Kearns is turned back to the farmers for rehabilitation as a farmed area, we will be able to use the maximum discharge from the pump of 90 second-feet (65 from the river and 25 from Deer Creek Reservoir).

"With the record flow of water in the north canal this summer, we are irrigating about 4,500 acres, figuring 1 acre of land to each share of water. We have 4,680 shares in the Riverton district of the company and 710 in the Camp Kearns or Hunter district. We had the same lands prior to 1932 when pumping from Utah Lake was abandoned, but we never did have enough water to equal the consumption that is being experienced this year with the first water from the Jordan Narrows siphon and power plant. This is the first year we have had what is properly called a full water supply.

"Our yield is bound to be increased, probably the biggest of record. The unusual first cutting of alfalfa proves that. It looks as though the grain crops will be equally good. Of course, a rainy spring has also contributed to the high yields.

"Aside from a selfish interest in my own 40-acre farm under the company ditch, it has been a wonderful satisfaction to me to see the many families (that went broke in the early 30's) return to their thistle-covered lands and rehabilitate them during the past three seasons. The new siphon and water-operated pumping plant is their guarantee that the failure of 1932 cannot happen again." THE END

The Water Must Be Delivered

A trouble-shooting conference was held at Ephrata, Wash., between September 9 and 12, 1949, to make sure the Bureau of Reclamation will reach its goal for the Columbia Basin project—87,500 acres to be available for irrigation by the spring of 1952. Ways and means of making certain the construction of laterals would be completed so that water would run down the ditches and the farmers would be ready to use it were mapped out at the conference which was attended by members of the Commissioner's staff of Washington, D. C., and was opened by Regional Director Harold T. Nelson. Columbia River District Manager Frank A. Banks told of the progress which had been made in power installations, discussed the problems which have caused delays in the irrigation construction and appraised the work which remains to be done. Assistant Secretary William E. Warne was present, and Operation and Maintenance Director G. W. Lineweaver represented the Commissioner at the conference.

According to the Ephrata conferees, the Bureau is now irrigating 1,800,000 acres in the Pacific Northwest. It has taken 40 years, and the Bureau now faces the problem of irrigating one-third of this amount during the next 2 years.

In addition to providing for distribution facilities for more than 87,000 acres, the Columbia Basin project must be transformed from a construction to an operating job with all the responsibilities entailed in the delivery of irrigation water, the settlement of the lands, the adequate assistance to settlers and cooperation with State colleges of agriculture and other State, Federal, and local agencies.

The conferees concentrated on three strategic problems: (1) completing one or two units in time to begin pumping water into the Grand Coulee Equalizing Reservoir in 1951, (2) assembling necessary design data, and (3) providing for personnel and housing. •

WATER REPORT

West-Wide Forecasts of 1949-50 Water Supplies Based on Work of the Western Snow Surveys

by PAUL A. EWING, Senior Irrigation Economist, and R. A. WORK, Senior Irrigation Engineer, both of the Soil Conservation Service, United States Department of Agriculture

By and large, 1949 was a pretty good year for irrigators. If there wasn't plenty of water everywhere, the shortages were fewer than usual, and the areas that suffered water shortages were even fewer. Areas protected by ample storage fared best of all.

How will 1950 fare? Well, an October compilation shows a somewhat spotted promise based on present reservoir carryover. On the whole the prospect isn't quite so favorable as was the case last year, but the winter is beginning early in parts of the West, and the outlook may rapidly change for the better.

In the following paragraphs the division of irrigation and water conservation, Soil Conservation Service, describes the results of its October 1 canvass of the storage and soil-moisture situation throughout the West and compares the 1949 run-off of western streams with what was indicated by the preceding April snow surveys.[1]

Accuracy of 1949 Run-off Forecasts

Departures of actual stream flow from the amounts forecast from April snow surveys were fairly numerous, but their net effect did not constitute a serious deviation from harmony.

The stream-flow year ends September 30, but on that date not many gaging-station records had been computed. From those at hand, however, the following statements relative to accuracy have been prepared. In a majority of cases the flow obtained was less than the forecast. Those departures are largely chargeable to subnormal precipitation at both mountain and valley stations during the run-off season.

Northwest and Pacific Coast

Columbia Basin (Washington, Idaho, parts of Montana, Wyoming, and Oregon).—Stream flow, as judged from very limited data at hand, did not equal the amounts forecast, as shown in the following tabulation. This was due to subnormal spring and summer precipitation. Throughout most of Columbia Basin, precipitation during April, May, and June was far below normal. This precipitation deficiency ranged from 39 percent below in eastern Washington to just slightly less than normal in eastern Idaho. Run-off to be expected from the snow pack under normal melting conditions was correspondingly reduced.

Gaging station	Forecast for April-September		Obtained *
	April 1	May 1	
	Acre-feet	*Acre-feet*	*Acre-feet*
Snake River near Heise, Idaho	4,900,000	4,600,000	3,795,150
Salmon River at Whitebird, Idaho	7,900,000	7,300,000	6,505,000

* Data of stream flow are provided by United States Geological Survey; are preliminary only and subject to revision.

Oregon.—As in the Pacific Northwest generally, spring precipitation was much below normal. This resulted in stream flow considerably less than was anticipated from the April 1 snow surveys and somewhat less than anticipated from the revised forecasts of May 1. April through June precipitation ranged from 33 percent of normal in Deschutes Basin to 96 percent of normal in South Central Oregon. For the State as a whole, precipitation was about 68 percent of normal for the April-June period.

Few flow records of forecast streams are as yet available, but all those at hand, as shown below, indicate that the forecasts were exceeded by measured April-September flow:

Gaging station	Forecast for April-September		Obtained *
	April 1	May 1	
	Acre-feet	*Acre-feet*	*Acre-feet*
Owyhee River above Owyhee Reservoir	600,000	520,000	475,000
Malheur River, North Fork	65,000	57,000	57,000
Upper Klamath Lake (inflow)	530,000	470,000	408,000
Rogue River, North Fork	377,000	370,000	367,000

* Data of stream flow are provided by United States Geological Survey; are preliminary only and subject to revision.

California.—The California water-supply outlook was satisfactory on April 1, but the drought which set in during April caused a reduction in expected flows of all California streams.

During April and May very little rain fell in either mountains or valleys; at some precipitation stations only a trace was recorded. In general, this had the effect of changing the May 1 outlook to 77 percent of normal, whereas in early April the expectancy was 90 percent. The actual run-off of the streams showed results of the dry run-off season. Scattered samples of forecast accuracies: Sacramento River, error of forecast 2 percent; American River, error 6 per cent; Tuolumne River, error 8 percent; San Joaquin River, error 13 percent; Kaweah River, error 6 percent.

In all cases except the Sacramento and Kaweah Rivers, the actual flows did not equal the run-off forecast, owing undoubtedly to the lack of late-season rains.

Intermountain Areas

Utah.—When the April 1 forecast was issued, run-off for most Utah streams was expected to exceed the average run-off for the last 10 years by 20 to 30 percent. Of the 10 stations for which stream-flow records are now available, 8 produced this amount or more. The average error of forecast was 14.4 percent.

On all streams reported, more than the average flow was produced, with the result that throughout the State, in spite of low precipitation during the summer months, the water supply was adequate to meet all irrigation needs.

Nevada.—Tentative reports indicate that run-off of important Nevada streams was less than forecast on April 1. Precipitation during the run-off season was approximately 20 percent below normal in eastern Nevada and about 30 percent below normal on the eastern slope of the Sierra. Error of forecast of the rise of Lake Tahoe was very small and will probably approximate 3 percent when the final readings are available.

[1] The division of irrigation and water conservation is the Federal coordinating agency of snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, other Federal bureaus, various departments of the several States, irrigation districts, and private agencies. The California State Division of Water Resources, which conducts the snow surveys in that State, contributed the California figures appearing in this article.

Rocky Mountain and Great Plains Areas

MONTANA.—Generally speaking, run-off in Montana fell somewhat short of the volumes anticipated from the existing snow pack both on April 1 and May 1. Precipitation much below normal during the run-off season accounted for part of the difference, and further accounting seems justified by the fact that melting conditions during May and early June were such as to prevent rapid snow melt. Days were warm but nights were cold, resulting in interrupted snow melt. Much of the snow melt entered the ground without contributing much direct overland flow to streams.

Run-off values are available for only one of the streams for which forecasts were made in 1949, i. e., Yellowstone River at Corwin Springs, as follows:

Gaging station	Forecast		Obtained	
	May-June	May-September	May-June	May-September
	Acre-feet	*Acre-feet*	*Acre-feet*	*Acre-feet*
Yellowstone River at Corwin Springs	1,250,000	2,050,000	1,164,000	1,769,000

In the following tabulation are the forecasts for Wyoming, Colorado, and New Mexico, for which data of run-off are now available. All the run-off data are preliminary only and in some cases are partly estimated:

Gaging station	Forecast for April-September		Obtained [1]
	April 1	May 1	
	Acre-feet	*Acre-feet*	*Acre-feet*
Rio Grande at Del Norte	850,000	800,000	[2] 849,000
Conejos River at Mogote	350,000	300,000	[2] 274,000
Rio Grande at Otowi Bridge	1,500,000	1,200,000	[2 3] 951,000
Rio Grande at San Marcial	1,200,000	1,000,000	[2 3] 800,000
Roaring Fork River at Glenwood Springs	950,000	900,000	[2] 995,000
Uncompahgre River at Colona	250,000	225,000	[4] 194,000
Colorado River near Grand Canyon	12,000,000	11,200,000	[2] 11,750,000
Shoshone River below Buffalo Bill Reservoir	925,000	875,000	[2 5] 650,000
North Platte River at Saratoga	950,000	900,000	991,000
Purgatoire River at Trinidad	50,000	45,000	[6] 49,000
Los Pinos River at Bayfield	350,000	300,000	[5] 325,000

WYOMING.—The irrigation-water supply ranged from normal to well above normal stream flows during the snow-melt season, but below normal during the late summer months. Where irrigation-water storage was not available, this condition resulted in a slight water shortage. On the Shoshone River, the run-off was normal but considerably less than expectations based on the heavy snow cover. In the Riverton area, the total stream flow was somewhat above normal and about as indicated by late-season snow surveys. Storage prevented any serious drought damage in this area. Soil-moisture conditions in northwestern Wyoming are now fair to poor and stream flow is generally below normal.

On the North Platte and Laramie Rivers, the summer flow exceeded any recorded since snow surveys were started in 1936. This situation was the result of the unusually heavy snow cover which existed on the watershed in April, May, and early June. The inflow to Seminoe Reservoir reached 12,800 second-feet the last week in June and remained near that point for several days. The reservoir filled during this time and heavy damage was caused to the outlet works of Seminoe and the construction work on Kortes Dam downstream. The by-pass tunnel at Kortes has a capacity of about 3,200 second-feet. As elsewhere in Wyoming, soil moisture is fair to poor and stream flow is now below normal.

The summer flow of the Green River in Wyoming is reported to have been about normal, as indicated by April and May snow surveys.

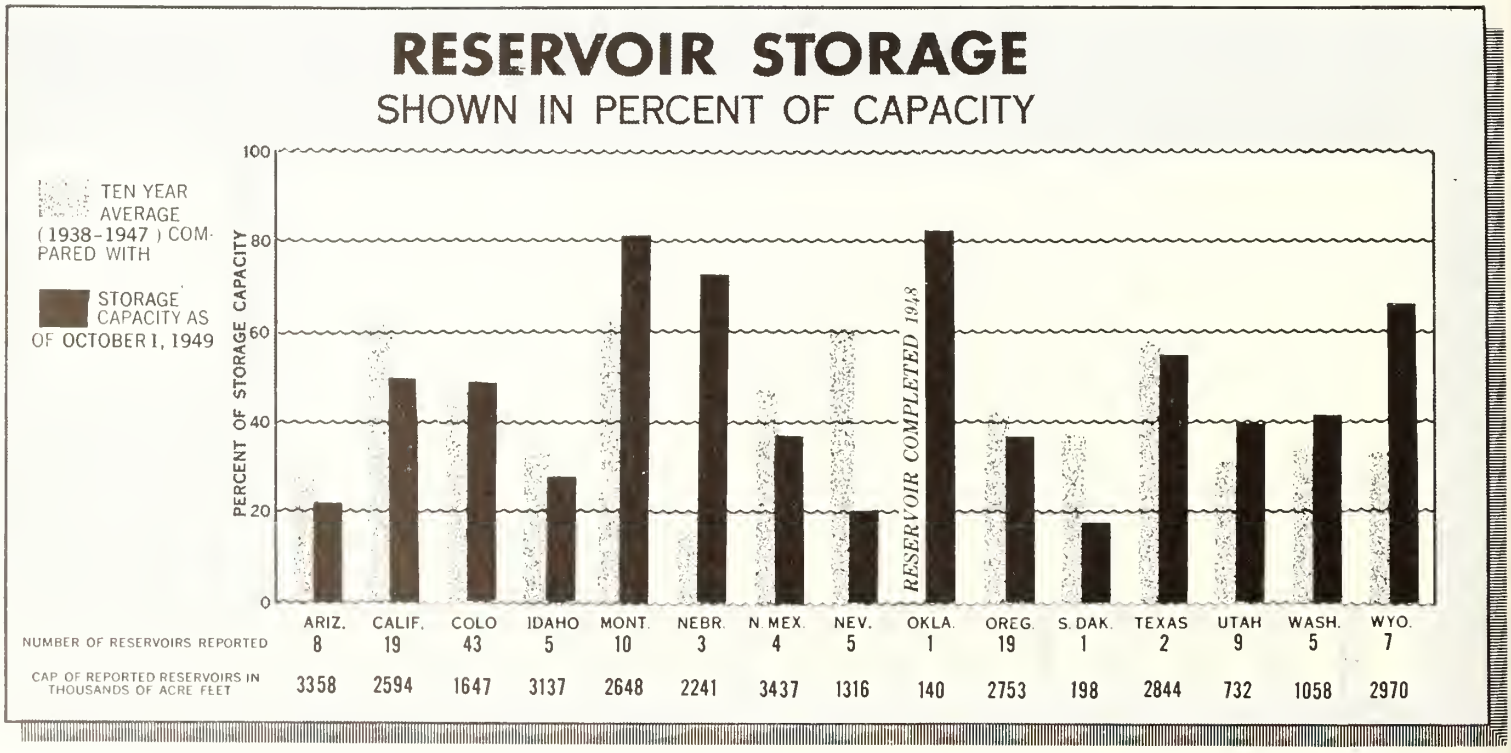
COLORADO.—Stream flow throughout the State of Colorado was above normal through the summer season, as forecast. Irrigation-water supplies were generally adequate with slight deficiencies in a few areas in late season. Current soil-moisture conditions are generally only fair except for the lower South Platte Valley where they are good.

In the South Platte Drainage, run-off during the snow-melt season was well above normal, but very little flood damage occurred. Owing to heavy rains in combination with the snow-melt season in northeastern Colorado, the South Platte peaked at about 15,000 second-feet at the Nebraska State line during the latter part of June. Rainfall during August and September was generally deficient, causing local

(Continued on page 230)

(Footnotes from opposite table)

[1] Preliminary data on run-off from United States Geological Survey except as otherwise noted.
[2] September flow estimated wholly or in part.
[3] Corrected for storage in El Vado Reservoir.
[4] Data from Uncompahgre Valley Water Users Association.
[5] Data from United States Bureau of Reclamation.
[6] Data from Water Commissioner of Colorado.



Not all reservoirs in all States are reported, but enough are reported to give a reliable index of each State's storage supply.
Figures are based on a 10-year average for 1938–47, with the exception of Idaho and Washington, where the 10-year average is 1937–46.
ARIZONA—Most State averages for reported reservoirs are for full 10-year period, but in a few cases reservoirs having shorter records are included.
CALIFORNIA—Does not include Spaulding System, Friant or Shasta reservoirs. September 30 storage in these reservoirs combined is 2,752,800 acre-feet, 53 percent of their combined capacity.
MONTANA—Does not include Fort Peck Reservoir (capacity 19,000,000 acre-feet). October 1 storage is 11,980,000 acre-feet.
NEVADA—Does not include Lake Mead Reservoir (capacity 31,140,000 acre-feet). October 1 storage is 22,110,000 acre-feet.

Water Stored in Reclamation Reservoirs

Location	Project	Reservoir	Storage (in acre feet)		
			Active capacity [1]	Sept. 30, 1948	Sept. 30, 1949
Region 1	Baker	Thief Valley	17, 400	2, 600	0
	Bitterroot	Lake Como	34, 700	5, 000	2, 800
	Boise	Anderson Ranch	464, 200	12, 100	12, 300
		Arrowrock	286, 600	65, 400	24, 500
		Deadwood	161, 900	69, 700	89, 600
		Lake Lowell	169, 000	41, 000	22, 500
	Burnt River	Unity	24, 600	7, 500	2, 500
	Columbia Basin	F. D. Roosevelt	5, 220, 000	5, 200, 000	5, 155, 000
	Deschutes	Crane Prairie	50, 000	48, 500	55, 000
		Wickiup	187, 000	24, 200	13, 900
	Minidoka	American Falls	1, 700, 000	664, 100	537, 100
		Jackson Lake	847, 000	234, 300	273, 100
		Lake Walcott	95, 200	87, 700	95, 200
		Grassy Lake	15, 200	12, 100	11, 900
		Island Park	127, 300	33, 200	29, 100
	Okanogan	Conconnully	13, 000	9, 700	5, 600
		Salmon Lake	10, 500	8, 200	6, 600
	Owyhee	Owyhee	715, 000	223, 700	328, 700
	Umatilla	Cold Springs	50, 000	9, 900	2, 200
		McKay	73, 800	18, 400	10, 300
	Vale	Agency Valley	60, 000	27, 400	10, 200
		Warm Springs	170, 000	1, 200	100
	Yakima	Bumping Lake	33, 800	7, 700	2, 700
		Clear Creek	5, 300	5, 300	5, 300
		Cle Elum	435, 700	197, 900	148, 800
		Kachess	239, 000	163, 800	98, 600
		Keechelus	153, 000	64, 900	127, 300
		Tieton	197, 000	111, 500	108, 600
Region 2	Central Valley	Millerton Lake	503, 100	132, 800	55, 100
		Shasta	4, 389, 100	2, 539, 700	2, 459, 300
	Klamath	Clear Lake	437, 500	135, 600	116, 600
		Gerber	94, 300	17, 900	11, 200
		Upper Klamath Lake	524, 800	235, 000	231, 100
	Orland	East Park	47, 900	26, 400	18, 800
		Stony Gorge	50, 000	4, 700	4, 100
Region 3	Boulder Canyon	Lake Mead	27, 935, 000	22, 002, 000	22, 828, 000
	Parker	Havasu	688, 000	631, 400	613, 400
	Salt River	Bartlett	179, 500	7, 200	8, 900
		Horse Mesa	245, 100	137, 700	166, 900
		Horseshoe	67, 000	100	500
		Mormon Flat	57, 850	25, 800	35, 200
		Roosevelt	1, 398, 400	5, 100	385, 600
		Stewart Mountain	69, 800	24, 300	34, 700
Region 4	Fruit Growers	Fruit Growers	4, 500	600	400
	Humbolt	Rye Patch	179, 000	52, 000	35, 500
	Hyrum	Hyrum	15, 300	5, 200	4, 900
	Moon Lake	Moon Lake	35, 800	1, 200	9, 700
	Newlands	Lahontan	273, 600	108, 700	72, 500
		Lake Tahoe	732, 000	277, 200	127, 200
	Newton	Newton	5, 300	1, 300	105, 500
	Ogden River	Pine View	44, 200	9, 600	11, 100
	Pine River	Vallecito	126, 300	59, 900	59, 900
	Provo River	Deer Creek	146, 800	104, 600	116, 000
	Scofield	Scofield	65, 800	1, 300	19, 900
	Strawberry Valley	Strawberry	270, 000	87, 000	104, 900
	Truckee River Storage	Boca	40, 900	24, 400	17, 600
	Uncompahgre	Taylor Park	106, 200	53, 500	65, 900
	Weber River	Echo	73, 900	7, 700	19, 013
Region 5	W. C. Austin	Altus	140, 000	49, 900	120, 800
	Carlsbad	Alamogordo	128, 300	6, 600	106, 200
		Avalon	6, 000	3, 000	5, 600
	Colorado River	Marshall Ford	810, 500	242, 800	509, 500
	Rio Grande	Caballo	345, 900	23, 700	67, 900
		Elephant Butte	1, 817, 000	543, 300	714, 400
	Tucumcari	Conchas	300, 000	225, 600	252, 400
Region 6	Belle Fourche	Belle Fourche	177, 500	100, 300	34, 200
	Milk River	Fresno	127, 200	94, 400	10, 400
		Nelson	66, 800	40, 300	----------
		Sherburne Lakes	66, 100	5, 400	9, 900
	Riverton	Bull Lake	152, 000	81, 300	71, 000
		Pilot Butte	31, 500	1, 500	3, 100
	Shoshone	Buffalo Bill	456, 600	338, 300	336, 100
	Sun River	Gibson	105, 000	40, 300	4, 300
		Pishkun	32, 050	16, 600	11, 300
		Willow Creek	32, 400	16, 200	1, 000
Region 7	Colorado-Big Thompson	Green Mountain	146, 900	128, 600	140, 900
	Kendrick	Alcova	190, 500	131, 200	156, 800
		Seminoe	970, 000	673, 200	801, 000
	North Platte	Guernsey	41, 050	19, 800	32, 000
		Lake Alice	11, 000	1, 000	1, 600
		Lake Minatare	57, 000	13, 700	5, 400
		Pathfinder	1, 040, 500	158, 400	469, 900

[1] Available for irrigation.

THEY COME FROM MILES AROUND to learn what irrigation has done, can and will do for their area. Here is a typical farmers' meeting at Hitchcock, S. Dak., at which the author gets down to earth and talks with the people from Beadle and Spink Counties. *Photo by Theodore Nikisch, Region 6.*

YOU CAN SEE FOR YOURSELF what good farming methods, plus an supply of irrigation water can do. Here is an aerial view of only part Huntley project in Montana with its 32,500 acres of fertile land.

GETTING INFORMATION TO THE GRASS ROOTS IN THE OAHE UNIT

by W. N. PARMETER, Settlement Specialist, Missouri-Oahe District, Huron, South Dakota, Region 6

GETTING IRRIGATION INFORMATION down to the "grassroots level" is sometimes more difficult than getting irrigation water down to the level of the grass roots.

That's why Bureau of Reclamation engineers and agricultural specialists working on the multiple-purpose development of the great Missouri River Basin project feel particularly encouraged by the practical curiosity being exhibited by dry-land farmers in South Dakota in the Bureau's big irrigation and power programs stemming out of the Missouri River development.

Although South Dakota farmers have prospered during the past 8 years of high returns on a dry-land farming basis, they are showing an increasing curiosity about irrigation possibilities in order to equip themselves for the future.

One of the best examples of practical curiosity stimulating the information program of the Bureau is that expressed by Wilford Hermann, a progressive farmer near Miller, S. Dak. He felt he could get some direct answers by writing to the Bureau of Reclamation, and the Missouri-Oahe district office of the Bureau, at Huron, was delegated to furnish Mr. Hermann the information he desired.

Following are the main questions as asked by Mr. Hermann, for which the answers have been prepared by the Bureau of Reclamation as far as information is now available:

Q. *What are some of the physical characteristics of the lands in the Miller vicinity of the Oahe unit area which are suitable for irrigation?*

A. (a) The soils near Miller in the Oahe area are primarily of the Barnes series. The Barnes and associated soil series which are sandy loams, loams and silt loams, are ideal for irrigation.

(b) About 75 percent of the land near Miller in the Oahe area is suitable for irrigation from the standpoint of water application.

(c) The general over-all drainage features of this area appear to be more favorable than other areas of the Oahe unit.

Q. *What are the initial costs of investment in preparation of land for irrigation?*

A. Land with sustained slopes up to 3 percent may require only light leveling. Irrigation structures such as drops, checks, and turn-outs, will be required to stabilize ditch grades. This cost will vary from farm to farm, depending largely on the amount of dirt to be moved in leveling and the structures to be installed.

Q. *How much water in acre-inches will be available for irrigation?*

A. According to the preliminary estimates, there should be about 19 acre-inches of water per acre available for delivery to each farm for irrigation during the growing season.

FARMING IS MADE EASIER with the two railroad lines shown in the background, which, together with the smooth flat roads throughout the project offer good transportation facilities for handling crops. *Photo by Arthur Fawcett, Region 6.*

Q. *What changes may result in size of farms and kinds of crops grown because of irrigation development in the James River Valley?*

A. With the development of irrigation in the James River Valley there will undoubtedly be a change in the acreage of the crops now grown as well as the introduction of many crops new to the valley. According to the history of irrigation projects in other semihumid areas, there will be a gradual change from the crops common to the area under dry-land farming to more intensified crops under irrigation. It is anticipated that the first change in the James Valley will be a gradual increase of some of the common crops, such as corn, alfalfa, and probably flax, and some reduction in small grains. There will also be some new crops introduced, such as sugar beets, soybeans, dry beans, small fruits, truck crops, and others.

Many of the farmers have had a fear of overproduction resulting from the irrigation of possible hundreds of thousands of acres in South Dakota. Many will remember when their corn and wheat were of little value due to "glutted markets." Since many of the crops new to the James Valley are more intensified than small grain or corn, the increased returns in dollars per acre may tend to attract operators in the Oahe area to shift from present dry-land crops to those in which there has been no overproduction. In addition, the drain on soil fertility under intensified cropping will tend to increase the use of legumes (alfalfa, clover, soybeans), and fertilizers to maintain the soils. The abundance of legume hay, together with the beet tops and pulp, will be conducive to dairy and livestock feeding. These changes have been the history of other irrigation projects.

Drought in a wet season has frequently taken place in the Oahe area. Average precipitation from 1904 to 1941 in Hand County was 17.10 inches, ample to produce abundant cereal grain crops if applied at the proper time during the growing season. However, both early and late season crops are grown. Early moisture deficiency reduces small grain yields, while feed crop yields are injured when most of the rain comes early in the season.

In addition to the change in crops, irrigation development on the Oahe unit of the James River Valley will also bring about a change in the size of farms. Irrigation development normally brings about a greater intensified agriculture and farm families generally find that 160 acres of irrigable land or less is all that is needed to produce a good family income. The average size of the farms in Hand County in 1945 was 734 acres.

Q. *Once it has been determined that land and water are adequate and suitable for irrigation development, what can landowners do to show that they want such development?*

Under Federal reclamation laws the Secretary of the Interior is authorized to contract with a water users organization satisfactory in form and powers to him. This means that the water users must organize themselves into a legal entity, such as an irrigation district, under the laws of the State. Generally speaking, to form an irrigation district in South Dakota, a petition must be filed with the board of county commissioners of the county having the greatest acreage within the proposed irrigation district. The petition must be signed by a majority of the electors of the proposed district, who own a majority of the whole number of acres owned or held in the proposed district. A copy of such petition and a map of the proposed district and other papers must be filed in the office of the State engineer. After the State engineer examines the papers, he submits a report on his findings to the board of county commissioners at the meeting set for the hearing of such petition. When the finding of the hearing is favorable toward organizing a district, the board of county commissioners will give notice of an election to be held in such proposed district, at which time the decision to organize or not to organize will be made by the qualified electors. An irrigation (or water users') district constitutes a legal entity authorized to contract with the Bureau of Reclamation regarding irrigation development and repayment of money expended in the construction of irrigation works.

Since all of the land in the proposed Oahe unit is privately owned and the people in the area lack irrigation background, the transition from dry-land to irrigation farming will be a period of many problems.

The South Dakota Extension Service, working in cooperation with the Bureau of Reclamation, is planning and carrying forward an extensive and continuing educational program in order to anticipate such problems and to solve them as they arise. THE END.

Water Report

(Continued from page 226)

shortage in water supplies. The snow cover on the watershed in late season was well above normal in northern Colorado and about normal above Denver. This condition was followed by similar patterns of summer run-off from mountain areas.

Although the summer flow of the Arkansas at Salida was expected to be about 90 percent of normal, heavy rains east of the front range caused extensive flood damage along the Arkansas Valley above Caddoa Dam. These rains occurred in June, leaving the soil moisture in the valley in excellent condition. Considerable water from the flood was stored by Caddoa Dam for irrigation use in the lower valley. Late-season rainfall was deficient, but no water shortage was reported. Soil-moisture conditions are reported as fair to poor.

The summer flow of the Rio Grande and its tributaries in San Luis Valley has been very high, as was expected from heavy mid-winter snow accumulation. The peak occurred about three weeks after the normal date and a lot of low snow had already melted. Owing to local precautions, little flood damage occurred in the valley area.

In the Colorado River Basin the total summer flow of tributary streams was somewhat above average. The snow cover on the upper Colorado, Fraser, and Blue Rivers was about normal. On the White, Yampa, San Juan, and Dolores Rivers the seasonal snow-melt run-off was unusually high. An estimated $100,000 flood damage is reported along the Dolores, mostly to highways and railroads. On unregulated streams in southwestern Colorado there were some reports of local water shortages after August 1. Stream flow on the Colorado River Main Stem and tributaries to the south is much below normal for this date. Rainfall has been deficient and soil-moisture conditions are poor.

New Mexico.—The irrigation-water supply along the Rio Grande in New Mexico has been satisfactory this past season. Although the peak discharges were not as high as expected, owing to the extended snow-melt season and lack of snow in late spring, flood damage occurred along the river. The snow-melt period extended well into July, providing considerable water for direct-flow irrigation. Local rains in August assisted in maintaining satisfactory soil-moisture levels. Current soil-moisture conditions in the Middle Rio Grande area are reported as good, but in San Luis Valley they are poor. Stream flow is about normal.

Owing to summer rains in eastern and southern New Mexico, the irrigation-water supply has been good on the Tucumcari project. A similar situation is reported for the Carlsbad project, despite an adverse early-season outlook.

South Dakota.—The water supply of the Belle Fourche project was somewhat inadequate and summer stream flow was below normal. Run-off from snow melt in the Black Hills was high, but lack of rainfall at lower elevations left the summer flow much below normal in Belle Fourche River. Soil-moisture conditions are poor.

Nebraska.—Soil-moisture conditions in western Nebraska are good and stream flow currently is about normal. Much of the summer flow was plains run-off in the South Platte drainage.

The Status of Storage

The October 1 status of the carry-over is as follows:

Northwest and Pacific Coast

October 1 storage as reported for reservoirs in Washington and Idaho is as follows:

Reservoir	Capacity	Active storage September 30	
		1949	1937–46
	Acre-feet	*Acre-feet*	*Acre-feet*
Washington:			
Yakima Basin (5 reservoirs)	1,058,500	486,000	352,700
Idaho and Snake River in Wyoming:			
Jackson Lake	847,000	273,100	357,900
Island Park	127,300	29,100	51,700
American Falls	1,700,000	537,100	541,400
Arrowrock	286,600	24,500	33,800
Lake Lowell	169,000	22,500	30,400

Oregon.—Nineteen reservoirs reporting show storage at 34 percent of capacity; the 10-year average for October 1 was 41 percent of capacity. The 1949 storage is 83 percent of the average.

California.—As the opening of the rainy season is approached, California's stored water is appreciably below the amount carried forward at the same date last year, only reservoirs on the Stanislaus holding more water than the amounts reported at the corresponding 1948 date. Thus 25 reservoirs above Sacramento and San Joaquin Valleys held 4,116,089 acre-feet on September 30, 1949, or 52 percent of capacity as compared with 4,592,337 acre-feet, or 58 percent of capacity on September 30, 1948. The 1949 storage was 90 percent of the 1948 total. By watersheds, the comparisons are as follows:

Watershed	Number of reservoirs	Capacity	Water stored Sept. 30	
			1948	1949
		Acre-feet	*Acre-feet*	*Acre-feet*
Sacramento	1	4,500,000	2,669,400	2,590,900
Feather	4	826,800	697,237	529,369
Yuba	3	244,800	168,321	118,889
Bear	1	7,200	800	600
American	2	30,200	19,618	19,087
Mokelumne	2	349,000	277,594	246,226
Stanislaus	3	145,500	22,103	25,316
Tuolumne	3	626,000	326,503	311,868
Merced	1	281,000	28,662	12,058
San Joaquin	5	854,400	382,099	261,776

Intermountain Areas

Utah.—Storage in a group of reservoirs is shown below.

Reservoir	Capacity	Water stored	
		1949	10-year average
	Acre-feet	*Acre-feet*	*Acre-feet*
Deer Creek	146,800	116,000	67,511
East Canyon	28,730	13,000	13,912
Echo	73,900	19,050	14,679
Hyrum Dam	15,300	4,900	3,257
Moon Lake	35,800	9,700	7,280
Pine View	44,200	11,100	15,100
Piute	84,750	10,090	12,320
Scofield	65,800	19,900	5,820
Sevier Bridge	236,000	87,780	95,121

Arizona.—Although precipitation on the main watersheds of Arizona for last summer was below normal, the water outlook for the State is better than for several years. As of September 30 the water held in the eight important reservoirs of the State was 22 percent of capacity or over three times the amount stored September 30, 1948.

Nevada.—Total available storage in five reservoirs was only 20 percent of available capacity while the 1938–47 average for October 1 was 60 percent. Available capacity of the five reservoirs is 1,316,000 acre-feet.

Lake Mead as of October 1949 contained 22,110,000 acre-feet available storage, which is 79 percent of available capacity. The 1938–47 average for this date was 81 percent of available capacity.

Rocky Mountain and Great Plain Areas

Montana.—Storage throughout the State is not considered low for this season of the year, as the 1949 water supply was sufficient where care and economy were exercised.

Wyoming.—Carry-over storage in the four major reservoirs on the North Platte is the highest since snow surveys were started, and now totals nearly 1,500,000 acre-feet. This may create a critical situation next year if the stream flow should be above normal.

Colorado.—In the South Platte drainage, the carry-over is slightly less than normal (except for Denver's municipal reservoirs). Carry-over of Arkansas Basin reservoirs is above average.

New Mexico.—Storage in Elephant Butte and Caballo Reservoirs increased above 250,000 acre-feet during the summer; the increase expected had been about twice that amount. Storage in El Vado Reservoir increased 150,000 acre-feet during the season.

South Dakota.—Storage in Belle Fourche Reservoir is 34,000 acre-feet, less than half the normal carry-over.

Nebraska.—Storage in Kingsley-Sutherland Reservoirs is now 1,600,000 acre-feet, which is the highest for October 1 since the system began to operate.

Oklahoma.—Storage in the W. C. Austin Reservoir is now 118,700 acre-feet or 85 percent of capacity. The reservoir has been full throughout most of the summer and the irrigation-water-supply outlook is excellent. This reservoir has just been completed to full capacity.

Texas.—Marshall Ford and Buchanan Reservoirs combined stored water was 55 percent of total capacity on October 1. This compares with a 10-year average storage, as of October 1, of 68 percent of total combined capacity. The End

Foster and Collins Go To Guam

Two engineers assigned to the chief engineer's office in Denver, Colo., E. E. Foster and W. E. Collins, were loaned to the United States Department of the Navy to give advice and recommendations to the officer-in-charge on the construction of the Fena River Dam, Island of Guam. They expect to complete their assignment by November 14. •

SERIOUS CONSIDERATION was given the public drawing conducted at Powell, Wyo., on September 23, 1949, to establish a priority by which applicants will be considered for 104 irrigable farm units open for homestead settlement on the Heart Mountain division of the Shoshone project. On hand to speak were (left to right) Governor Val Peterson of Nebraska, Governor Fred G. Aandahl of North Dakota, W. G. Sloan of Billings, Mont., Chairman of the Missouri Basin Inter-Agency Committee; Commissioner of Reclamation Michael W. Straus, Wyoming's Senior Senator Joseph C. O'Mahoney, and K. F. Vernon of Billings, Mont., Director of the Bureau's Region 6. *Photo by C. A. Knell and T. R. Broderick of Region 6.*

SETTLEMENT—*An End Objective*

by R. L. BRANAM, Region 6, Billings, Mont.

An end objective of the Bureau of Reclamation, the goal of settling worthy citizens on productive irrigated land, was met at Powell, Wyo., on September 23, when a public drawing was conducted to establish a priority by which applicants would be considered for 104 irrigable farm units opened for homestead settlement on the Heart Mountain division of the Bureau of Reclamation's Shoshone project in northwestern Wyoming.

One thousand seven hundred fifteen World War II veterans residing in 39 States and Alaska were eligible for the public drawing and, in the first 10 names drawn, were those of veterans from California, Oregon, Idaho, Montana, Texas, Oklahoma, Minnesota, and Wyoming. Wallace L. McClaffin of Ontario, Calif., took the number one position.

The 104 farms included in the third postwar opening of public lands on the Heart Mountain division contain an average of 116 acres of irrigable land and about 15 acres of nonirrigable land for pasture and other purposes.

An examining board composed of two Powell businessmen and a Bureau of Reclamation employee are now reviewing the application forms of the veterans whose names were drawn. If the applications are in order and meet the requirements, the applicants will be called for personal interview. If the interview is passed successfully, the applicants will be allowed to select farm units in the order established at the drawing.

Commissioner of Reclamation Michael W. Straus, who delivered the principal address and selected the first five numbers, declared that "settling worthy citizens on productive irrigated land is the strongest security that can be provided in these turbulent times."

The Commissioner explained that the only justification for planning and construction is the "final achievement of getting citizens on land—and here on irrigated land of assured water—that gives them the security and stability that the whole world craves and incidentally buttresses the national strength." Following a brief review of the program now under way for the resource development of the entire Missouri River Basin, Commissioner Straus said that "power revenue is the white hope of these future developments and the use of this revenue is best utilized on a basin-wide program. * * * The pooled revenue of the new power plants will help to irrigate new lands all over the Missouri River Basin."

Senator Joseph C. O'Mahoney, Wyoming's senior senator, who shared the speaking platform with Commissioner Straus, traced the history of irrigation and other natural-resource development in the West, particularly on the Shoshone project. He emphasized that with continued progress and the ever-increasing size of resource developments, the work can be accomplished only by the Federal Government acting as an agent of the people. However, he said, people throughout the Nation must not throw the entire load on the Government; they must take the initiative and should now organize a "Committee of the West" which will use the Government to bring about the development of the West.

Nebraska's Governor Val Peterson, a member of the Missouri Basin Inter-Agency Committee which met in Powell September 22, urged that "every citizen in an irrigated area in Wyoming fight for the completion of the Missouri River Basin project."

Governor A. G. Crane of Wyoming cautioned the new set-

tlers that they must work hard and faithfully to see their dreams come true in the empire they are building in the West.

"It is a privilege for members of the Inter-Agency Committee to witness the drawing for farm units because of the importance of new settlement in the Missouri River Basin." W. G. Sloan of Billings, Mont., chairman of the Inter-Agency Committee, said.

Other speakers on the program at Powell were Fred G. Aandahl, Governor of North Dakota; G. W. Lineweaver of Washington, D. C., Director of the Branch of Operation and Maintenance; K. F. Vernon of Billings, Director of the Bureau's Region 6; R. H. Workinger of Cody, Wyo., Manager of the Bureau's Big Horn district; Ed Althoff, Mayor of Powell; Hugh Smith, mayor of Cody; Don C. McClelland, president of the Powell Chamber of Commerce; George Gibson of Powell, a member of the examining board, and Paul Scheuneman, a Heart Mountain division homesteader.

One hundred of the one hundred and four farm units open for settlement are near Ralston, Wyo.; the remaining four are about 3 miles north of Cody—all in the general vicinity of the 114 farm units, containing about 11,000 acres, that were opened for homestead settlement in the fall of 1946 and the summer of 1947.

The new farms have never been cultivated. Canals, laterals, and other structures to bring the irrigation water to the farms have been constructed by the Bureau. Assistance may be secured by the homesteaders from the Bureau in the clearing and leveling of land and in the lay-out of farm ditches.

The soils are well adapted to irrigation farming, and major crops are expected to be beans, peas, alfalfa hay, sugar beets, clover, small grains, and potatoes. Livestock fattening and raising will be another major activity on the new farms.

At the September 23 drawing, 312 names were selected to allow two alternates for each available farm unit. States represented were Arizona 1; Arkansas, 1; California, 29; Colorado, 27; Idaho, 13; Illinois, 7; Indiana, 1; Iowa, 9; Kansas, 6; Maryland, 1; Minnesota, 2; Missouri, 3; Montana, 34; Nebraska, 26; New Mexico, 4; New York, 1; North Carolina, 1; North Dakota, 8; Ohio, 2; Oklahoma, 22; Oregon, 17; South Dakota, 3; Tennessee, 3; Texas, 16; Utah, 21; Virginia, 1; Washington, 3; Wisconsin, 3; and Wyoming, 47.

A similar drawing for 50 irrigable farm units on the Riverton project in central Wyoming was conducted on October 6 at Riverton, Wyo. THE END.

Artist's conceptian af what the Trenton Dam in Nebraska will look like when completed. Ground-breaking ceremonies were held on September 21, 1949, far the twelfth major dam ta be started by Reclamatian in the Missouri River Basin. *Drawing by M. H. Willsan.*

Power Rescue by Glendive-Miles City Lines

On July 21, the Montana-Dakota Utilities' 2,000-kilowatt generating unit at Miles City burned out. Within a few hours the company was able to energize, at 57,000 volts, the Bureau of Reclamation's 72-mile Glendive to Miles City transmission lines which parallel the existing lines of the company, and service was restored to the area.

On July 22, Acting Regional Director John R. Walker of the Bureau's Region 6 office in Billings, Mont., said, "Immediately following the burn-out, some Bureau irrigation and cooperative loads were dropped but we understand now that all service has been restored. These circumstances demonstrate very forcibly the over-all benefits to be derived from complete cooperation between private and public power."

All work on the Bureau's 115-kilovolt transmission line between Glendive and Miles City in Montana had been completed by the contractors and accepted by the construction engineer for the Fort Peck project. Due to delays in delivery of equipment, the substation at Miles City, which will permit the utilization of this line at its design voltage of 115 kilovolts, is not expected to be completed until the fall of 1950. In the meantime a temporary agreement had been reached with the Montana-Dakota Utilities Co. for the operation of this transmission line at 57 kilovolts until the completion of the Miles City substation.

The burn-out made it necessary to put the agreement into effect a few days in advance of the scheduled operation. The line was energized and put in service by the company at 4:40 a. m. July 22, 1949. The Glendive-Miles City line, a feature of the Fort Peck project, is a component of the over-all transmission line program in the Missouri Basin. •

Nalder Joins UN Team in Near East

One of reclamation's ace engineers, William H. Nalder, Chief Designing Engineer of the Bureau of Reclamation and one of America's foremost authorities on the design and construction of irrigation works, flew to Beirut, Syria, late in September this year to serve as staff advisor on irrigation for the United Nations Economic Survey Mission to the Near East, which was appointed by President Truman on August 26, with Gordon E. Clapp, of the Tennessee Valley Authority as chairman.

The mission has been given the emergency task of investigating every possible means of providing economic relief for Near East inhabitants and hundreds of thousands of war-displaced refugees in an area where irrigation water means life itself. More extensive development of the irrigation of the arid lands in the Near East may well turn out to be one of the major problems confronting the mission. •

U. S. GOVERNMENT PRINTING OFFICE: 1949

NOTES FOR CONTRACTORS

Contracts Awarded During September 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2673	Missouri River Basin, Wyo.	Sept. 14	Two 48-inch hollow-jet valves and two 48-inch ring-follower gates with accessories for outlet works at Boysen Dam.	Pacific Coast Engineering Co., Alameda, Calif	$45,650
2695	Davis Dam, Ariz.-Nev.	Sept. 7	Two 161,000-volt circuit breakers for Parker Gila Drop No. 4 tap, schedule 1.	Allis-Chalmers Manufacturing Co., Denver, Colo.	67,484
2696	Columbia Basin, Wash.	Sept. 16	One 5,000/6,250-kilovolt-ampere transformer for Quincy pumping plant switchyard, schedule 1, item 1a.	Moloney Electric Co., St. Louis, Mo.	25,589
2697	Davis Dam, Ariz.-Nev.	Sept. 14	One 12,500-kilovolt-ampere and six 50-kilovolt-ampere transformers for Coolidge substation, schedules 1 and 2.	do	29,902
2706	Missouri River Basin, Wyo.	Sept. 7	Two 100,000-pound radial-gate hoists for spillway at Boysen Dam.	Pacific Coast Engineering Co., Alameda, Calif.	19,640
2712	Columbia Basin, Wash.	Sept. 15	One motor-generator exciter set for units L1 to L6, Grand Coulee power plant.	Electric Products Co., Cleveland, Ohio	14,719
2718	Davis Dam, Ariz.-Nev.	Sept. 8	Carrier-current telemetering apparatus, telemeter instruments, recorders, switchboard, and associated apparatus for centralized power dispatching system, Davis power system, schedules 1 and 4.	Westinghouse Electric Corp., Denver, Colo.	149,000
2721	do	Sept. 21	Sixty-two 15,000-volt disconnecting switches for Coolidge substation.	A. B. Chance Co., San Francisco, Calif	13,309
2729	Missouri River Basin, Nebr.	Sept. 2	Construction of Gering substation additions	Long Construction Co., Billings, Mont.	79,082
2730	Davis Dam, Ariz.-Nev.	do	Galvanized steel towers and appurtenances for Mesa-Coolidge 230-kilovolt transmission line.	American Bridge Co., Denver, Colo	62,869
2733	do	Sept. 22	Installation of electrical, hydraulic, and other equipment for Davis Dam, power plant, and switchyard.	Donovan-James-Wismer and Becker, St. Paul,	1,508,803
2734	do	Sept. 29	Electrical equipment for Coolidge, Prescott, Mesa, Electric District No. 5, Tucson, and Cochise substations, and Phoenix dispatching office.	Westinghouse Electric Corp., Denver, Colo	100,971
2739	do	Sept. 15	Construction of 34,500-volt Yuma substation	R. B. McKenzie, Phoenix, Ariz.	22,920
2740	Paonia, Colo.	do	Construction of siphons and wasteway, Fire Mountain Canal	A. F. Burkhard, Hotchkiss, Colo	83,506
2741	Provo River, Utah	Sept. 19	Construction of Murdock diversion dam and Provo reservoir canal.	Vinnell Co., Inc., Alhambra, Calif	166,064
2745	do	Sept. 15	Construction of Duchesne diversion dam and sluiceway, and Duchesne tunnel and tunnel intake, schedule 5.	Grafe-Callahan Construction Co. and Rhoades Bros. and Shofner, Los Angeles, Calif.	4,379,961
2746	Colorado-Big Thompson, Colo.	Sept. 9	Construction of earthwork, concrete lining, tunnel, and structures for Horsetooth supply conduit, Horsetooth feeder canal.	G. L. Tarlton Contracting Co., St. Louis, Mo.	1,328,100
2747	Boulder Canyon-All-American Canal, Ariz.-Nev.-Calif.	Sept. 30	Construction of earthwork, pipe lines, and structures for unit 7; and reconstruction of Main canal, Sta. 6516+86.70 to 6517+00, Coachella Valley distribution system.	R. V. Lloyd and Co., Coachella, Calif.	2,070,089
2751	Columbia Basin, Wash.	Sept. 27	Four 16-foot by 19-foot 6-inch and two 14 by 19-foot radial gates for Black Rock check, Rocky Coulee check, and Rocky Coulee wasteway, East Low canal, items 1 and 2.	General Machinery Co., Spokane, Wash.	13,046
2751	do	do	Six 15,000-pound radial-gate hoists for Black Rock check, Rocky Coulee check, and Rocky Coulee wasteway, East Low canal, items 3 and 4.	Western Gear Works, Seattle, Wash.	11,900
2752	Boise, Idaho	Sept. 16	Construction of earthwork, structures, and surfacing for relocation of county roads at Cascade Reservoir.	Morgan Construction Co., New Meadows, Idaho.	107,646
2756	Davis Dam, Ariz.-Nev.	Sept. 23	Stringing conductor and overhead ground wire on the Davis Dam-Hoover Dam and Davis Dam-Parker Dam 230-kilovolt transmission lines.	Malcolm W. Larson, Denver, Colo	233,465
2758	Kendrick, Wyo.-Colo.	Sept. 14	Installing overhead ground wires on Cheyenne-Greeley 115-kilovolt transmission line.	Utilities Construction Co., Nashville, Tenn	35,482
2763	Gila, Ariz.	Sept. 15	Four 1,100-horsepower and three 1,850-horsepower synchronous motors for Wellton-Mohawk pumping plants 1 and 3.	Electric Products Co., Cleveland, Ohio	142,806

Construction and Supplies for Which Bids Will Be Requested by January 1950

Project	Description of work or material
Central Valley, Calif.	Construction of 19 miles of 230-kilovolt, double-circuit, steel tower transmission line from Elverta to Perkins, Calif.
Do	Construction of about 18 miles of earth-lined, Delta-Mendota canal near Firebaugh, Calif., and Firebaugh wasteway.
Do	Initial construction work on Elverta switchyard, 11 miles north of Sacramento, Calif.
Do	Completion of Shasta power plant, including installation of metal doors, windows, and miscellaneous metalwork.
Colorado-Big Thompson, Colo.	Construction of the Olympus siphon from Olympus Dam to Olympus tunnel, 3 miles east of Estes Park, Colo.
Do	Construction of about 42 miles of 115-kilovolt, 3-phase, single-circuit, wood-pole, H-frame transmission line between Kremmling and Oak Creek, Colo.
Do	Installation of electric motors, pumps, and miscellaneous equipment; erection of towers and equipment in switchyard; and architectural finish work in Granby pumping plant, 6 miles southwest of Grand Lake, Colo.
Columbia Basin, Wash.	Relocation of 6.5 miles of county road near O'Sullivan Dam, Grant County, Wash.
Do	208-volt and 460-volt heating and ventilating cabinets for Grand Coulee right power plant.
Do	Pumps having total capacity of 123.5-cubic feet per second for Quincy pumping plant.
Davis Dam, Ariz.-Nev.	Stringing overhead ground wires on 122.5 miles of Phoenix-Tucson 115-kilovolt single-circuit No. 1 transmission line.
Do	Installing equipment and constructing Mesa substation, 60,000-kilovolt-ampere capacity, at Mesa, Ariz.
Do	Construction of reinforced concrete control building and erecting steel structures for substation at Tuscon, Ariz.
Do	Construction of 21 miles of 34.5 kilovolts Wellton-Mohawk power supply transmission line near Yuma, Ariz.
Do	Supervisory control and telemetering equipment for Maricopa substation.
Do	Furnishing and erecting prefabricated steel warehouse at Parker Dam, Calif.
Do	System map for dispatcher's building at Phoenix, Ariz.
Davis Dam, Ariz.-Nev.	Galvanized, fabricated structural steel for Mesa and Coolidge substations.
Kendrick, Wyo.	Control board for remote control and telemetering of Kortes power plant, to be installed in Seminoe power plant.
Do	Construction of about 35 miles of double-circuit telephone line from Casper, Wyo., to Alcova, Wyo.
Missouri River Basin, Mont.	Construction of access road and streets; water, sewer, and electrical distribution systems; and buildings as follows: 2 five-room, 2 three-bedroom, 30 two-bedroom, and 5 duplex residences; 1 each office building, bunk house, laboratory, fire station and garage, and storage garage for Tiber dam Government camp, about 14 miles south of Tiber, Mont.
Do	Construction of 7,500-kilovolt-ampere substation, including installation of equipment, at Miles City, Mont.
Missouri River Basin, Nebr.	Relocation of 19 miles of single track railroad in reservoir area to be created by Trenton Dam near Trenton, Nebr.
Do	Construction of about 8 miles of Superior canal, near Bostwick, Nebr.
Missouri River Basin, Wyo.	Control board for generators, lines, and station service equipment, one 1,500-kilovolt-ampere, 4,160/480-volt, unit substation; one 125-volt d-c battery control distribution board; and two 125-volt d-c motor-generator sets for Boysen power plant.
Parker Dam Power, Calif.	Constructing 18 frame residences or furnishing and erecting prefabricated residences at Parker Dam, Calif.
Santa Barbara, Calif.	Construction of the 6.4-mile long Tecolote tunnel and construction of 1.8 miles of access road near Goleta, Calif.
Do	Construction of the 10-mile long 77 cubic feet per second capacity, Goleta section of the South Coast conduit, of 48-inch diameter reinforced concrete pipe, from end of Tecolote tunnel to Santa Barbara, Calif.
San Luis Valley, Colo.	Two 48-inch butterfly valves with operating mechanism and control for Platoro dam.
Shoshone, Wyo.	Construction of access road from U. S. highway No. 20 to Shoshone power plant, near Cody, Wyo.

The Reclamation Area

The Reclamation ERA

December

1949

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The Reclamation ERA

December 1949

Volume 35, No. 12

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NOTES FOR CONTRACTORS ..... Inside Back Cover

Ruth F. Sadler, *Editor*

Subscription rate $1 a year for persons residing in the United States and Canada; $1.50 a year for foreign subscriptions; special rate of 50 cents a year for members of water users' association.

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A Merry Christmas and a Happy New Year!

OUR FRONT COVER

CHRISTMAS WESTERN STYLE—Ed Breen, rancher-farmer of Tucumcari, N. Mex., heads toward home with the family's Christmas turkey hung from the pommel of his saddle and carrying a scrub cedar, freshly cut, for the children to decorate with all the trimmings for the holiday season. *Photo by D. B. Parker, Region 5 photographer.*

and THE BACK COVER

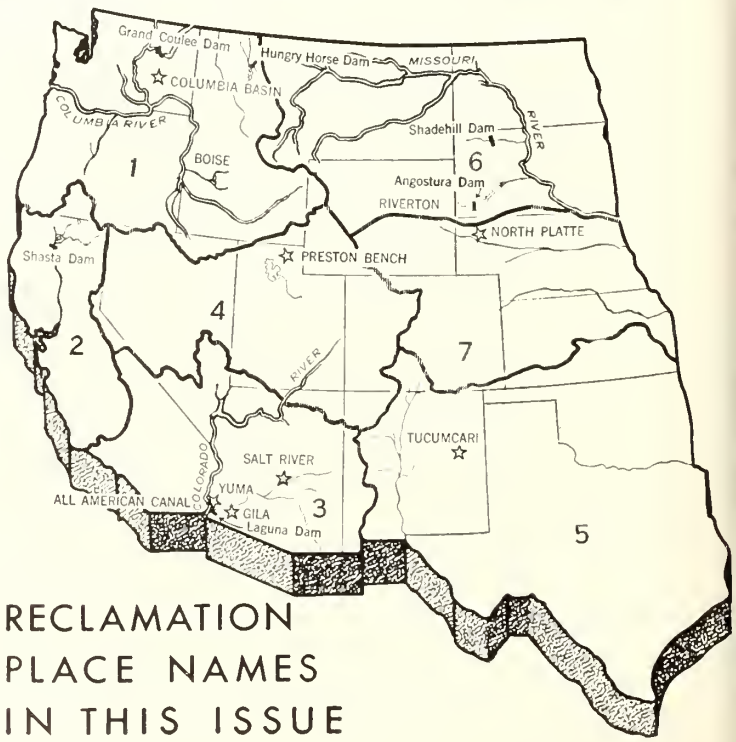
portrays another typical western scene, though of quite a different character. Here, near the Hungry Horse project, they travel on skis, as they enjoy a winter view, looking up Fawn Creek, a tributary to the South Fork of the Flathead River, about 1 mile downstream from the dam site. *Photo by A. E. McCloud, Hungry Horse photographer, Region 1.*

30 YEARS AGO

IN THE ERA

Irrigated farming means work. It is far easier to watch the gentle rain add the necessary moisture to the ground than to herd that water round for 24 hours a day and fight mosquitoes—but it is not quite so sure to produce a bumper crop. There is a big area that can be farmed under dry-land methods, but the area that can be irrigated is extremely limited and that means water should be used in an efficient manner and not wasted. Every second-foot that is allowed to go to waste means one less irrigated farm and that much less prosperity for the community. It behooves us to adopt methods of efficiency and economy in using water. Just because your contract gives you the right to 1½ acre-feet per acre does not mean that you should use that much water.

(From the December 1919 issue of the RECLAMATION RECORD, predecessor of the RECLAMATION ERA, page 571, Better Farming and the Benefits of Irrigation, by George O. Sanford, project manager, Sun River project.)



RECLAMATION PLACE NAMES IN THIS ISSUE

December 1949

Office and Project Directory

UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION

WASHINGTON OFFICE: United States Department of the Interior, Bureau of Reclamation
Washington 25, D. C.

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Denver Staff Offices of the Commissioner: United States Department of the Interior, Bureau of Reclamation, Denver Federal Center, Denver, Colo.

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Alaskan Investigations Office, Juneau, Alaska, Joseph M. Morgan, Chief

United Western Investigations Office, 222 South West Temple, Salt Lake City, Utah, J. Stuart Meyers, Acting Chief

REGIONS

REGION 1: Regional Office, Post Office Box 937, Reclamation Building, Fairgrounds, Boise, Idaho

Regional Director, H. T. Nelson; *Assistant Regional Director*, J. Lyle Cunningham; *Assistant Regional Director*, F. M. Clinton; *Assistant to the Regional Director*, William F. Rapp; *Regional Engineer (Branch of Design and Construction)*, D. S. Walter; *Regional O. & M. Supervisor (Branch of Operation and Maintenance)*, W. H. Tuller; *Regional Power Manager (Branch of Power Utilization)*, Don S. Campbell; *Regional Planning Engineer (Branch of Project Planning)*, E. N. Torbert; *Regional Programs and Finance Officer (Programs and Finance Division)*, A. W. Empie; *Regional Information Officer (Information Division)*, H. C. Blonk; *Regional Land Officer (Land Acquisition Division)*, W. B. Wallace; *Regional Counsel (Legal Division)*, H. R. Stinson; *Regional Personnel Officer (Personnel Division)*, V. L. Rushfeldt; *Regional Supply Officer (Supply Division)*, James M. McCool.

	Official in charge		Address
	Name	Title	
District and Project Offices			
Anderson Ranch Dam project	G. A. Swanson	Construction engineer	Anderson Dam, Idaho.
Central Snake River district	George N. Carter	District manager	214 Broadway, Boise, Idaho.
Boise-Payette construction field office	R. W. Adams	Construction engineer	P. O. Box 172, Caldwell, Idaho.
Boise-Payette O. & M. field office	John V. Walker	Irrigation manager	Notus, Idaho.
Cascade Dam field office	Earl Harmon	Construction engineer	P. O. Box 440, Cascade, Idaho.
Owyhee project field office	Paul L. House	Acting irrigation manager	Nyssa, Oreg.
Power division	F. E. Hulet	Power superintendent	Black Canyon Dam, Emmett, Idaho.
Columbia River district	F. A. Banks	District manager	Coulee Dam, Wash.
Irrigation division	H. A. Parker	Supervising engineer	P. O. Box 368, Ephrata, Wash.
Deschutes project	J. W. Taylor	Construction engineer	1044 Bond St., Bend, Oreg.
Hungry Horse project	C. H. Spencer	do	Columbia Falls, Mont.
Lewiston Orchards project [1]	Wilfred L. Karrer	do	Weisberger Bldg, 5th and Main, Post Office Box 621, Lewiston, Idaho.
Minidoka project	J. F. Spofford	Superintendent	1359 Hanson Ave., Burley, Idaho.
Palisades project	I. Donald Jerman	Project engineer	Palisades, Idaho, Mail Address: Post Office Box 1259, Idaho Falls, Idaho.
Yakima project	O. W. Lindgren	Superintendent	P. O. Box 1377, Federal Bldg., Yakima, Wash.
Kalispell area planning office	Charles S. Hazen	Planning engineer	Ford Bldg., Post Office Box 97, Kalispell, Mont.
Salem area planning office	Lee McAllister	do	460 N. High St., Salem, Oreg.
Walla Walla area planning office	M. Boyd Austin	do	Bldg. T-208, Walla Walla City-County Airport, Post Office Box 718, Walla Walla, Wash.

[1] Also project office for the Hayden Lake Unit of the Rathdrum Prairie project.

REGION 2: Regional Office, Post Office Box 2511, Old Post Office Building, Sacramento 10, Calif.

Regional Director, R. L. Boke; *Assistant Regional Director*, R. S. Calland; *Assistant Regional Director*, Phil Dickinson; *Assistant to the Regional Director*, U. J. Gendron; *Regional Engineer (Branch of Design and Construction)*, A. R. McGinness; *Regional O. & M. Supervisor (Branch of Operation and Maintenance)*, J. G. Lindley; *Regional Power Manager (Branch of Power Utilization)*, B. W. Creim; *Regional Planning Engineer (Branch of Project Planning)*, S. A. Kerr; *Regional Programs and Finance Officer (Programs and Finance Division)*, T. K. Vasey; *Chief, Land and Right of Way Division*, Joe H. Leech; *Regional Information Officer (Information Division)*, Max Stern; *Regional Counsel (Legal Division)*, L. O. Graham; *Regional Personnel Officer (Personnel Division)*, H. F. Osborne; *Regional Supply Officer (Supply Division)*, H. F. Halliday.

	Official in charge		Address
	Name	Title	
District and Project Offices			
Delta district	C. H. Kadie, Jr.	District manager	Post Office Box 928, Stockton, Calif.
Tracy pumping plant	O. G. Boden	Construction engineer	Post Office Box 570, Tracy, Calif.
Transmission lines	H. W. Thomson	do	Elverta, Calif.
Klamath project	E. L. Stephens	Project manager	Post Office Box 312, Klamath Falls, Oreg.
Sacramento Valley district	James K. Carr	District manager	Post Office Box 302, Chico, Calif.
Shasta and Keswick Dams	Edward Helgren	Construction engineer	Redding, Calif.
Orland project	R. W. Hollis	Watermaster	Orland, Calif.
Santa Barbara project	E. R. Crocker	Project manager	Post Office Box 701, Goleta, Calif.
Tulare Basin district	J. W. Rodner	District manager	318 Patterson Bldg., Fresno, Calif.
Friant-Kern Canal	R. K. Durant	Construction engineer	Friant, Calif.

Projects or Divisions of Projects of Bureau of Reclamation Operated by Water Users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	Stewart Dolby	President	Marion Hewlett	Keating, Oreg.
Belle Fourche	Belle Fourche irrigation district	Newell, S. Dak	Oliver G. Rose	do	Vern Hafner	Newell, S. Dak.
Bitter Root	Bitter Root irrigation district	Hamilton, Mont	Pearl Wilcox	Superintendent.	Elsie W. Oliva	Hamilton, Mont.
Boise (Arrowrock division)	Board of control	Boise, Idaho	Forrest Sower	Manager	W. J. Farrell	Boise, Idaho.
Boise (Payette division, Notus unit)	Black Canyon irrigation district	Notus, Idaho	C. W. Holmes	Superintendent.	H. W. Van Slyke	Notus, Idaho.
Burnt River	Burnt River irrigation district	Hereford, Oreg	Edward Sullivan	Manager	Harold Hursh	Huntington, Oreg.
Carlsbad	Carlsbad irrigation district	Carlsbad, N. Mex	J. C. Howard	do		Carlsbad, N. Mex.
Deschutes (Crane Prairie Storage)	Central Oregon irrigation district	Redmond, Oreg	O. E. Anderson	Superintendent.	J. M. Shively	Redmond, Oreg.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Arthur Donlan	President	Ralph P. Scheffer	Huson, Mont.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	Frank Hart	Manager	William Griffith	Cory, Colo.
Grand Valley	Grand Valley Water Users' Association	Grand Junction, Colo.	W. J. Chiesman	do	C.E.Blumenshine	Grand Junction, Colo.
Grand Valley, Orchard Mesa	Orchard Mesa irrigation district	Palisade, Colo	Don S. Leslie	Superintendent.	C. J. McCormick	Do.
Grand Valley, Mesa County	Mesa County irrigation district	Clifton, Colo	Otto Thyret	do	H. B. Smith	Palisade, Colo.
Grand Valley, Palisade	Palisade irrigation district	do	S. F. Patterson	do	W. E. Funk	Do.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Robert S. Leighton	Secretary-manager.	R. S. Leighton	Lovelock, Nev.
Huntley	Huntley project irrigation district	Ballantine, Mont	A. J. Bowman	Manager	H. S. Elliott	Ballantine, Mont.
Hyrum	South Cache Water Users Association	Hyrum, Utah	Lavor J. Hatch	Superintendent.	Lamont M. Allan	Wellsville, Utah.
Klamath (Langell Valley division)	Langell Valley irrigation district	Bonanza, Oreg	R. E. Thomas	President	Leland W. Pettegrew.	Bonanza, Oreg.
Klamath (Pumping division)	Horsefly irrigation district	do	Donald V. Philpott.	do	J. F. Heyden	Do.
Lower Yellowstone	Districts 1 and 2	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney, Mont.
Milk River (Chinook division)	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	A. L. Benton	Chinook, Mont.
	Fort Belknap irrigation district	do	George Niebauer	do	M. A. McCarthy	Do.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	do	LeRoy G. Powell	Harlem, Mont.
	Paradise Valley irrigation district	Zurich, Mont	J. O. Wilson	Superintendent.	J. F. Sharples	Chinook, Mont.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H.M.Montgomery	Do.
Minidoka (Gravity division)	Minidoka irrigation district	Rupert, Idaho	Roy Cunningham	Manager	G. E. Nickerson	Rupert, Idaho.
Minidoka (Pumping division)	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	do	Frank O. Redfield	Burley, Idaho.
Minidoka (Gooding division)	American Falls Reservoir district No. 2	Gooding, Idaho	B. W. Powell	do	NancyM.Haddock	Gooding, Idaho.
Minidoka (Upper Snake River)	Fremont-Madison irrigation district	St. Anthony, Idaho	Melvin Luke	do	R. Willis Walker	Rexburg, Idaho.
Moon Lake	Moon Lake Water Users Association	Roosevelt, Utah	Louis Galloway	do	Louis Galloway	Roosevelt, Utah.
Newlands	Truckee-Carson irrigation district	Fallon, Nev	Phillip Hiibel	Superintendent.	J. R. Hannifan	Fallon, Nev.
Newton	Newton Water Users Association	Newton, Utah	Henry Sutherland	Watermaster	Joseph R. Tuddenham.	Newton, Utah.
North Platte (Interstate division)	Pathfinder irrigation district	Mitchell, Nebr	G. H. Storm	Manager	Joe F. Osback	Mitchell, Nebr.
North Platte (Fort Laramie division)	Gering-Fort Laramie irrigation district	Gering, Nebr	T. P. Winchell	Superintendent.	Charles G. Klingman.	Gering, Nebr.
	Goshen irrigation district	Torrington, Wyo	Austin P. Russell	do	Mary E. Harrach	Torrington, Wyo.
North Platte (Northport division)	Northport irrigation district	Northport, Nebr	Mark Iddings	do	Mrs. Mabel J. Thompson.	Bridgeport, Nebr.
Ogden River	Ogden River Water Users Association	Ogden, Utah	David A. Scott	do	G. D. Cardon	Ogden, Utah.
Okanogan	Okanogan irrigation district	Okanogan, Wash	N. D. Thorp	Manager	N. D. Thorp	Okanogan, Wash.
Pine River	Pine River irrigation district	Bayfield, Colo	S. K. Newman	Superintendent.	James F. Gore	Oxford, Colo.
Post Falls	Post Falls irrigation district	Post Falls, Idaho	Howard McGinley	President	Ben Morehouse	Post Falls, Idaho.
Provo River (Deer Creek division)	Provo River Water Users Association	Provo, Utah	J. W. Gillman	do	E. A. Jacob	Provo, Utah.
Salt River	Salt River Valley Water Users Association	Phoenix, Ariz	O. L. Norman	Manager	J. F. Griswold	Phoenix, Ariz.
Sanpete (Ephraim division)	Ephraim Irrigation Co	Ephraim, Utah	George A. Jorgensen.	President	Joseph H.Thompson.	Ephraim, Utah.
Sanpete (Spring City division)	Horseshoe Irrigation Co	Spring City, Utah	Rudolph Hope	do	James W. Blain	Spring City, Utah.
Seofield	Carbon water conservancy district	Price, Utah	Ray Walters	do	A. N. Smith	Price, Utah.
Shoshone (Garland division)	Shoshone irrigation district	Powell, Wyo	Everett Stout	Manager	Harry Barrows	Powell, Wyo.
Shoshone (Frannie division)	Deaver irrigation district	Deaver, Wyo	Robert W. Fifield	do	William P. Peebler	Deaver, Wyo.
Stanfield	Stanfield irrigation district	Staufield, Oreg	Emmett Myers	Superintendent.	Mabel M. Richards.	Stanfield, Oreg.
Strawberry Valley	Strawberry Water Users Association	Payson, Utah	William Grotegut	President	Robert E. Huber	Payson, Utah.
Sun River (Fort Shaw division)	Fort Shaw irrigation district	Fort Shaw, Mont	A. R. Hanson	Manager	A. R. Hanson	Fort Shaw, Mont.
Sun River (Greenfields division)	Greenfields irrigation district	Fairfield, Mont	D. R. Davies	President	H. P. Wangen	Fairfield, Mont.
Truckee River Storage	Washoe County water conservation district	Reno, Nev	Chester Taylor	Manager	E. S. Yoakum	Reno, Nev.
Umatilla (East division)	Hermiston irrigation district	Hermiston, Oreg	Roy W. McNeal	do	Roy W. McNeal	Hermiston, Oreg.
Umatilla (West division)	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	do	A. C. Houghton	Irrigon, Oreg.
Uncompahgre	Uncompahgre Valley Water Users Association	Montrose, Colo	Jesse R.Thompson	do	H. D. Galloway	Montrose, Colo.
Vale	Vale Oregon irrigation district	Vale, Oreg	Walter C. White	do	Walter R. Ulrey	Vale, Oreg.
Weber River (Salt Lake Basin)	Weber River Water Users Association	Ogden, Utah	D. D. Harris	do	D. D. Harris	Ogden, Utah.
Westland	Westland irrigation district	Hermiston, Oreg	Ed Nunn	do	Al Langenwalter	Hermiston, Oreg.
Yakima (Kittitas division)	Kittitas reclamation district	Ellensburg, Wash	G. L. Sterling	do	G. L. Sterling	Ellensburg, Wash.
Yakima (Sunnyside division)	Sunnyside Valley irrigation district	Sunnyside, Wash	David C. Brooks	do	Pauline Osterhout	Sunnyside, Wash.
Yakima (Tieton division)	Yakima-Tieton irrigation district	Yakima, Wash	Guy Finley	do	Guy Finley	Yakima, Wash.

U. S. GOVERNMENT PRINTING OFFICE: 1949

Grand Coulee's 12th Generator Joins Team of World's Mightiest Power Plant

When the twelfth big 108,000-kilowatt generator at the Grand Coulee Dam went into commercial operation on September 30, 1949, it boosted the installed rated capacity of the world's largest power plant to 1,316,000 kilowatts and its peaking capacity to approximately 1½ million kilowatts, or 2 million horsepower. As the newest generator began pouring energy into the Northwest power pool, the plant rounded out September by breaking all previous records for hourly, daily, and monthly output.

Known as R–3, the generator is the third to be completed in the East Powerhouse this year. Six more equally large generators are to be assembled there in the next 2 years—three in 1950 and the final three in 1951. When the full team of 18 of the world's largest generators are operating at the dam in the fall of 1952, the installed rated capacity will be 1,974,000 kilowatts, including 30,000 kilowatts from three small station-service units of 10,000 kilowatts each. The peaking capacity of the plant then will be approximately 2,280,000 kilowatts. The 12 units now operating could supply sufficient power to illuminate 3 million homes.

Since March 22, 1941, when the plant first began producing electricity, it has turned out more than 41½ billion kilowatt-hours of power, of which more than 40 percent has gone to aluminum plants, 31 percent to privately owned utilities, 18 percent to private utilities, and the remainder to other industries, including the atomic energy installations at Hanford, Wash. •

Gold Medals for Enginers Williams and Patch

On October 14, 1949, Secretary of the Interior J. A. Krug announced that Roy B. Williams, assistant district manager, and Orin G. Patch, chief concrete engineer of the Bureau of Reclamation's Columbia River district at Coulee Dam, Wash., had been awarded the Department of the Interior Gold Medal and Distinguished Service Certificate for superior contributions to the advancement of the Nation's vast multiple purpose water conservation program in the West.

Mr. Williams, who retired on October 28, at the age of 61, after more than 37 years of active duty, helped guide the Bureau of Reclamation through nearly four decades of progress in developing the land and water resources of the West. He worked in the States of Montana, Arizona, Nevada, California, and Washington, and as Assistant Commissioner for two years in the Nation's Capital. The irrigation projects which now stand as monuments to his engineering ability include the Milk River and Sun River projects of Montana, the Kittitas Division of the Yakima project and the Columbia Basin project of Washington, the Boulder Canyon project of Arizona and Nevada, the All-American Canal and the Gila projects in Arizona and California, and the Central Valley project of California, where he supervised the building of Friant Dam and its canal system.

Mr. Patch terminated more than 28 years of Federal service, at the age of 70 on September 30, and has been closely associated with the development of the arts of concrete control and replacement since 1927, prior to the advent of the water-cement ratio theory upon which modern concrete control is based. He was extremely active in the development of ideas, methods, processes and equipment for the improvements of concrete and its products.

Upon learning of the honor bestowed on these two men, Reclamation Commissioner Michael W. Straus said, "Both Mr. Patch and Mr. Williams are nationally known for their preeminence in their respective professional fields, and both have well earned the gratitude of the Nation, and particularly those directly affected by the irrigation, hydro electric power, and other advantages of the Bureau's comprehensive water development program." •

Boise Project Farms Opened for Settlement

On October 5, 1949, at 2 p. m., the Bureau of Reclamation started receiving applications from veterans of World War II and others for 4,500 acres of irrigated public land, consisting of 50 farm units, in the Black Canyon area of the Boise Federal Reclamation project in southwestern Idaho, which were opened for homestead entry.

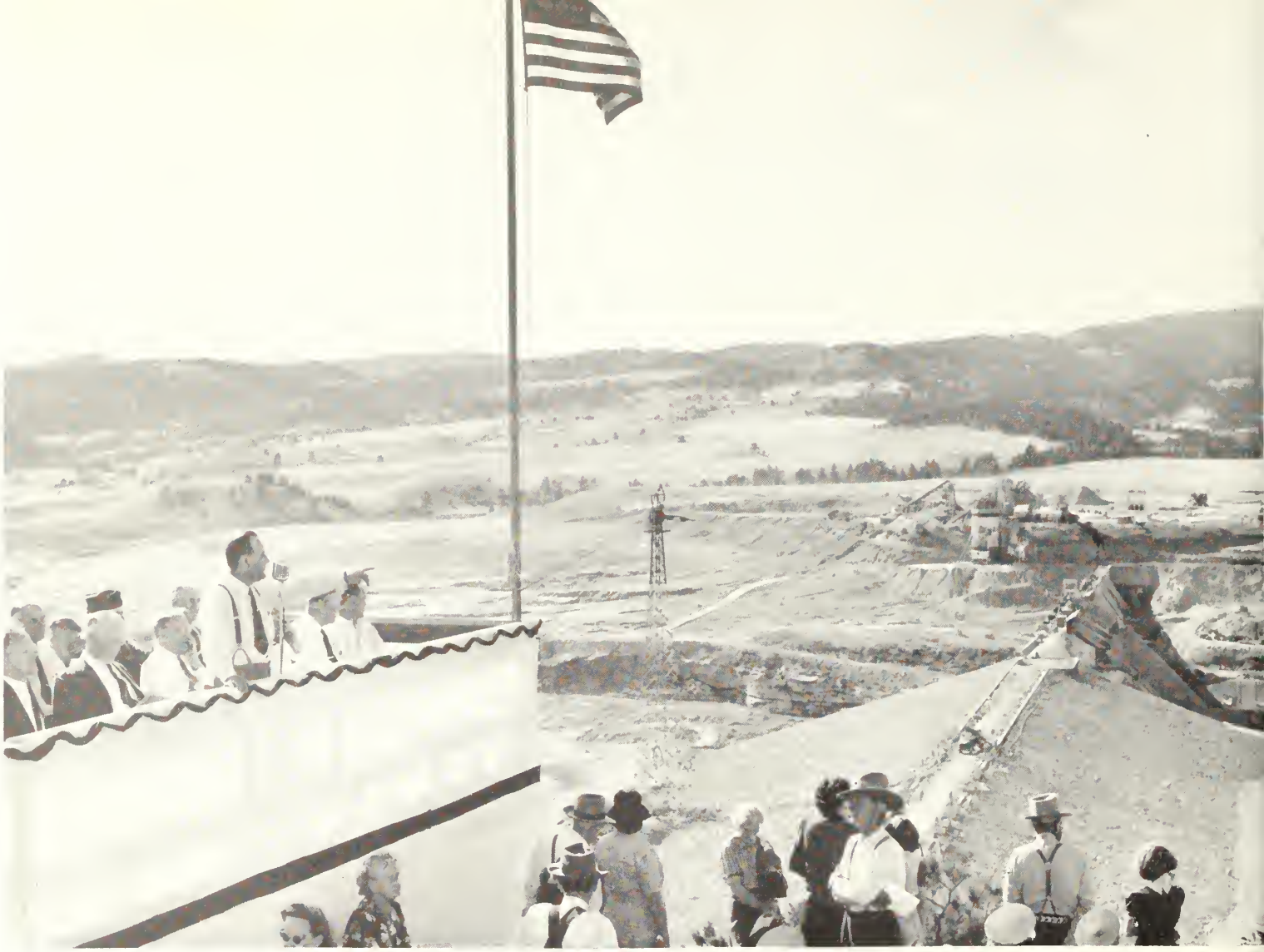
Qualified war veterans—both men and women—and a small number of homestead relinquishers, who homesteaded or filed desert land entries in the area many years ago, which they later relinquished in anticipation of project development under the Carey Act, will have preference for the units. All applications received by 2 p. m., on January 3, 1950, will be considered as simultaneously filed.

Homesteaders do not have to pay for the land but must pay a small homestead entry fee, an annual operation and maintenance charge, and the pro rata share of the construction costs. The latter may be repaid over a period of years, interest free. The homestead area is situated immediately north of Caldwell and Middleton, Idaho. The units vary in size from approximately 51 to 138 irrigable acres each. All of the land is either still in sagebrush or was burned off a number of years ago. Adjacent cultivated lands are largely devoted to dairying and other types of livestock farming, and the production of alfalfa, pasture, clover, wheat, oats, barley, and peas.

The public land units will be awarded to qualified entrymen in the order in which their names are publicly drawn by lot from a bowl at a date to be set later. Applications will be reviewed by a local examining board to determine whether the persons fully qualify for homesteading irrigated public lands. To qualify, applicants must meet certain minimum requirements. In general, they must have 2 years of farm experience, $3,500 in liquid capital or assets useful in development of an irrigated farm, good character and industry, and the physical ability to do the required farm work. Applicants also must meet the principal qualifications of Federal homestead laws.

Successful applicants must, within six months after their homestead entry is approved, establish residence on the land and must cultivate at least half the irrigable acreage in their farm unit for 2 years before receiving full title to the land.

Full details of the opening are contained in Boise Project Public Notice No. 41, available together with application blanks and instructions, by writing to the Bureau. •



ANGOSTURA SHOWS

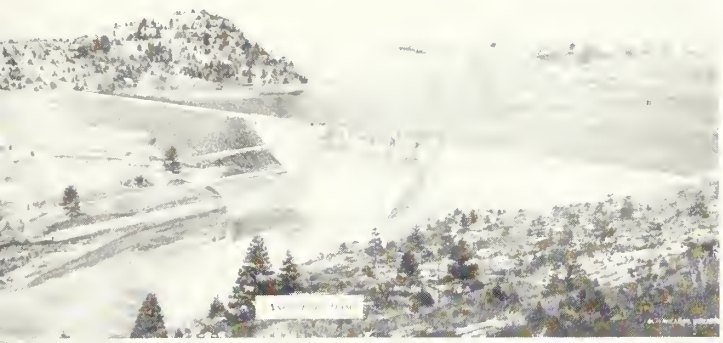
ALMOST 70 YEARS AGO, two lonely cattle ranches, with livestock grazing over the free range, were the only signs of civilization in the area where now the Angostura unit of the Missouri River Basin project in South Dakota nears completion.

On September 29, 1949, crowds of people converged upon a site 10 miles southwest of Hot Springs, S. D., to dedicate and celebrate the completion of the Angostura Dam, first unit of the Missouri River Basin project to be completed by the Bureau of Reclamation.

This 187-foot-high concrete gravity dam, near the mouth of Red Canyon, in addition to conserving and controlling the Cheyenne River, a tributary of the Missouri, will provide additional benefits. In fact, Angostura can boast another notable "first" in one of these multiple-purpose functions. It is the first unit of the basin-wide plan to arrive at that stage in its development where a recreational plan has been fully adopted. In June 1949 representatives of the Bureau, the Park Service, Fish and Wildlife Service, and Forest Service met at Hot Springs, S. Dak., and agreed to an arrangement whereby the Forest Service will construct, operate, and maintain recreational areas at Angostura Reservoir.

The history of the Angostura unit is not unlike that of many of the projects which have been constructed by the Bureau. The cattle range of 1880's became dotted with homesteaders in the early 1890's. In Custer and Fall River Counties, where the Angostura unit is located, many of the seekers after land came from Iowa. Some of the descendants of these early pioneers have remained in the area, to tell the stories of the dry years of 1910–11, followed by the exodus of the disgruntled speculators and discouraged homesteaders, which in turn was followed by a wave of land purchases by a relatively few individuals who formed large holdings.

In the next few years the remaining farmers and businessmen in the area became convinced that irrigation was the only hope for saving their families from disasters like that of 1910–11. They formed themselves into various organizations, considered a site for a diversion dam to promote an irrigation project, and persuaded the South Dakota legislature to appropriate money for making a field reconnaissance.



NEAR THE FINISH—First honors go to the first Missouri Basin irrigation project to be started and completed by the Bureau of Reclamation. At extreme left, K. F. Vernon of Billings, Mont., who directs the Bureau's activities in Region 6, emphasizes the benefits which the people of Fall River and Custer Counties will receive as a result of the construction of Angostura Dam. At immediate left M. H. Willson's artist's conception of the completed dam, and lower left, a busy construction scene from the top of the canal outlet works, looking upstream and showing the 72-inch pipe for canal water, and the dam in the foreground. *Photos by Thomas R. Broderick of Region 6.*

THE WAY

AT THE START—On Friday, August 23, 1946, 3,000 people saw the beginning of the Bureau's first Missouri River Basin unit development. Inset, a pioneer at the celebration. *Photographs by C. L. Conoway of Region 6.*

In 1913, a former State engineer, who had just returned from South America, was hired to do the job—and that is how Angostura was named. Engineer Derr made a hydrographic survey of the Cheyenne River and found that the original proposed diversion dam would be lower than the irrigation project. By that time his appropriation was spent, but with money raised by Hot Springs boosters, he surveyed up the river to a point known as Jackson narrows, which so reminded Derr of a South American gorge of the same name that he named the narrow dam site Angostura and so referred to it in his report to the Governor. The word "Angostura" in addition to being the name given to the bark of a South American shrub or small tree which is used as an antimalarial remedy and other medicinal purposes, is the Spanish name for "narrows." Derr's South American assignment had been at the Angostura River in Bolivia, near Cochamba. The present Angostura dam site is not the site named by "Homer" Derr—but on a site once known as the Horse Camp site.

In the matter of a name, Angostura Dam has to relinquish its claim to being the "first." So far as it is known, it is actually the fourth large structure in the Western Hemisphere to bear that name, the others being the Angostura of northeastern Sonora in Mexico, the Angostura in South America, and the Angostura diversion dam located near Belem, N. Mex., on the Rio Grande just above the Jemez River.

A later survey was made in 1917 by C. T. Pease of the Reclamation Service, but it was not until the Water Conservation and Utilization Act was approved on August 11, 1939, that any tangible progress was made toward building the dam. At that time South Dakota people tried to interest Congress in constructing a unit under the provisions of the W. C. U. Act, and the Farm Security Administration of the Department of Agriculture became interested in developing a unit to resettle and rehabilitate distressed farmers in that region. The Secretary of Agriculture and the Secretary of the Interior submitted a joint agreement and recommendation to the President and the project was approved on March 6, 1941, with money made available less than 2 weeks later, on March 15, 1941, for a project of 16,210 acres of irrigable land, based on a plan drawn up by the Bureau of Reclamation.

However, a provision in the W. C. U. Act, as amended October 14, 1940, limited funds to $1,000,000 per project, and this, along with an alleged lack of a suitable power market in the immediate area, held up the project until it could no longer come under the provisions of the W. C. U. Act.

In the meantime the Works Project Administration received funds for surveys and foundation explorations so that a construction estimate could be made available. The

(Continued on page 252)

Reclamation's Hall of Fame

Nomination No. 4

◄ **RUFUS WOODS**

(Photo by Major Hutton, Coulee Dam, Wash.)

THIS IS THE REAL STORY of how a million acres—the world's largest reclamation project—became a reality. How Rufus Woods, with a team and a program, translated and verbally sparked ideas into action.

This is the story of the 30-year fight for power and reclamation in the Northwest. It is a story about the men who were on the firing lines of man's battlefield where natural water resources were converted for the benefit of mankind in peace and war.

If all goes well, the Bureau of Reclamation hopes to have the first water on 87,500 acres of the Columbia Basin project in eastern Washington by the spring of 1952.

Back of this reclamation of arid land was an idea. Rufus Woods and his newspaper, The Wenatchee Daily World, alone, among all the dailies in the State hammered away just as effectively as the workmen today who cut deeply through the terrain of Grant County.

It was not an easy or popular road that Rufus chose. But misinformation, ridicule, threats, intimidation, did not deter his steady and consistent effort.

It all started on July 18, 1918, in Ephrata, heart of the land of sagebrush and jackrabbits.

Rufus, as usual, was "beating the bushes" for news in his old Ford. He was in Ephrata to talk things over with a lawyer friend, Billy Clapp, and Gale Matthews. They recalled, in this meeting, that in 1902 at Quincy, homesteaders raised 40 bushels of wheat to an acre. Then the rolling prairie went dry. Water alone could save them.

Columbia River's Human Dynamo
RUFUS WOODS

by HOWARD E. ORDWAY, Wenatchee, Wash.

But how would they get water on this land?

Clapp told Rufus and Gale Matthews, "What we need is a dam across the Columbia, and let the water come down Grand Coulee."

Rufus banged his fist on the table saying, "By golly, Billy has it!"

He told the boys in the newsroom, "Play it like a circus. Play big things big."

And Rufus played this story big on July 18, 1918. The Daily World came forth with a glaring headline:

"FORMULATE BRAND NEW IDEA FOR IRRIGATION GRANT, ADAMS, FRANKLIN COUNTIES, COVERING MILLION ACRES OR MORE

LAST AND NEWEST AND MOST AMBITIOUS IDEA CONTEMPLATES TURNING OF COLUMBIA RIVER BACK INTO ITS OLD BED IN GRAND COULEE, THE DEVELOPMENT OF A WATER PLANT EQUAL TO NIAGARA AND THE CONSTRUCTION OF THE GREATEST IRRIGATION PROJECT IN THE WORLD—FIRST CONCEIVED BY WILLIAM CLAPP OF EPHRATA, WASHINGTON.

Rufus refers to that first article, which appeared on July 18, 1918, as the "Signal gun which brought on the battle for Grand Coulee which lasted for 23 years" when the dam was completed.

Rufus was never a person to get so enthusiastic that he did not take counsel. He called in others to get their opinion. He always worked with a team, with such men as James O'Sullivan, Albert S. Goss, national grange master, W. R. Powell, and Ed Southard.

But on the horizon appeared a great cloud. That cloud was *opposition*. Following the article by Rufus Woods on July 18, 1918, there came on December 7 of the same year a proposal to irrigate the lands of central Washington by a main ditch of 134 miles in length with 62½ miles of tunnels from Albeni Falls, Idaho. But this plan contemplated no power with which to help pay the bill.

Then there was the plan to build a low dam for power at Kettle Falls. The Daily World, solidly behind the Grand Coulee program, protested the issuance of a permit for a dam at Kettle Falls.

"They're trying to wreck our dam site," Rufus told the late James O'Sullivan. "Here's one hundred dollars, Jim. Go out and organize the landowners and the community clubs to save the site and the program."

Thus came into being the Columbia River Development League. Rufus was made president and Jim O'Sullivan, secretary. Both served through the years. In time it grew to include 32 organizations, such as chambers of commerce, granges, organized labor groups, and landowners, with committeemen all over the State.

Once in a while Rufus would get impatient. He wrote to the late U. S. Senator Wesley L. Jones, saying he thought things were dragging in the Capitol. Jones answered by attaching a rider on the appropriation bill for $350,000. This would make a comprehensive survey of the Columbia River from the Snake River north. Along with it went a survey to the mouth of the stream.

When the United States Army Engineers issued Report 308 on the Columbia River, Grand Coulee was spotted as the key structure, the first dam to be built. The Bureau of Reclamation was authorized to build it. But, prior to this, there was an official organization authorized by the Legislature of the State of Washington. This was the Columbia Basin Commission. The full weight and prestige of the growing Daily World was thrown back of the survey. Well it might, for the Army Engineers' Report No. 308 gave the green light to make Grand Coulee Dam the key structure of the Columbia River development.

Rufus and his newspaper, The Daily World, stood alone for 13 years among all the dailies, urging the core-drilling, engineering, and subsequent construction of Grand Coulee Dam.

Once the original 308 was completed by that outstanding Army engineer, Maj. John S. Butler, the next move was for legal machinery in the State of Washington. The Columbia Basin Commission bill was passed. Rufus, a Republican, was named by the Democratic Governor, Clarence D. Martin, as one of five members. He has been a member ever since, whether the Governor was Republican or Democrat.

Grand Coulee Dam came in the nick of time. Upon completion in 1941, it was worth 50 divisions in the field to our armed forces. Half of the aluminum produced in the United States during the war came from mills using Grand Coulee power. It provided the power for airplanes, ships, and the atomic bomb plant at Hanford. It kept the Northwest arsenal of democracy humming for the successful prosecution of the war. Contrary to what many thought, demand for power increased after the war's end.

The interest of Rufus in power and irrigation has made tremendous demands on his energy and time. Rufus has served continuously on the Bonneville Power Advisory Council organized by Dr. Paul Raver. Installation of the generators continues. Rufus was present and made the first talk when the tenth was installed last May at the dam, as President Truman threw a switch in the White House.

Rufus has the common touch, and he loves people. He listens to their stories and problems. When he takes a train, Rufus knows most of the passengers by the time he reaches his destination. In exchange for their stories they get the Woods story and the real story behind the Grand Coulee Dam and the project. In short, Rufus makes them real "Christians," that is, the Columbia Basin variety.

In recent years, Rufus has been honored and recognized.

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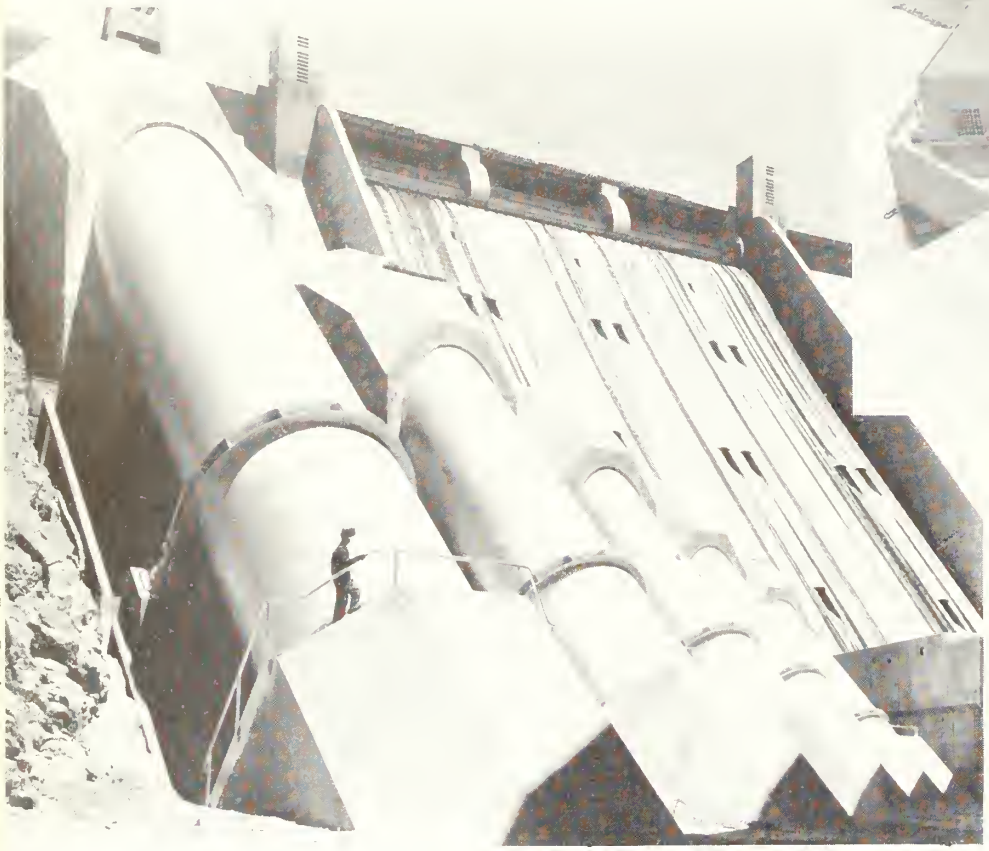
DURABLE BEAUTY—For the Shasta Dam penstock sections (below) just outside the powerhouse which are coated with a zinc chromate-aluminum paint system, and the drum gate on top of the dam (at right) where a vinyl-resin base gray primer is being brushed on the sandblasted surface. *Photo below by Ben D. Gloho, Chief Photographer, Region 2, and photo at right by W. H. Colby, also of Region 2.*



PAINT JOB AT SHASTA

by CHARLES B. MASIN, Engineer, Branch of Design and Construction, Denver, Colo.

WITHIN RECENT YEARS the huge economic loss resulting from the corrosion of metals has aroused the attention of engineers throughout the world. One estimate places the annual replacement of iron and steel products, which have deteriorated due to inadequate protection against corrosive environments, to be as high as 2 percent of the total tonnage in use. Being fully aware of this waste the Bureau of Reclamation is steadily pursuing a program of preventive engineering.

Painting operations that have been carried out at Shasta Dam in the last year offer some examples of the latest Bureau practices in the fight against corrosion.

The upstream and downstream skinplates and the pier plates of three large drum gates on top of the dam were painted with a six coat vinyl-resin base paint system. This system is one of the latest additions to the list of paints approved for use on Bureau structures. It was selected because previous laboratory and field tests indicated it would best withstand the variety of deteriorating conditions encountered by a protective coating for drum gates, namely, continuous and intermittent immersion in water, exposure to the heat and actinic rays of the sun, and abrasion by metallic seals. The aluminum finish of the vinyl system also adds to the inherent beauty of Shasta Dam.

The bottom skinplates and the plates, beams, and rivets on the inside of the drum gates were protected by a three coat coal-tar base paint system (CA–50). After years of use on Bureau structures, this material, when properly applied, has proven its ability to protect steel under such continuous immersion and severe condensation conditions as will be found in the drum gates.

The five 15-foot diameter penstocks at Shasta Dam convey Shasta Lake water to the turbines in the power plant. The intake is several hundred feet below lake level and consequently the water flowing through these large pipes is rather cold, generally below 50° Fahrenheit. During the warm months of the year, atmospheric moisture condenses on the cold exterior surfaces of the penstock. This wet condition would result in early failure of conventional machinery or aluminum paints designed for normal atmospheric exposure. CA–50 was not considered for this service because the penstock exteriors are exposed to the direct rays of the sun, which would tend to shorten the life of the coal-tar coating. The vinyl-resin paint would have proved durable, but the fact that a fast-drying paint acquiring abrasion resistance quickly was not required, dictated the use of a less expensive system. This consisted of a rust inhibitive wash, a zinc chromate-aluminum priming coat, and two aluminum finish coats in a water-resistant phenolic resin varnish. Thus Shasta Dam penstock exteriors are now coated with a bright aluminum finish.

The interiors of the penstocks were coated with a hot applied coal-tar enamel. This material is generally accepted by private and public water and power organizations as

being the most durable paint lining for water-bearing steel pipe. Their concensus is that under normal conditions, coal-tar enamel, properly applied, will protect the steel for at least 40 years. Coal-tar enamel was applied to Shasta Dam penstocks at temperatures near 500° Fahrenheit and at an average thickness of three thirty-seconds of an inch.

Bureau of Reclamation engineers continually conduct laboratory and field research on the latest products advanced by the paint industry. Their objectives are to find paints and protective coatings that in terms of durability, material and application costs, and simplicity of application will be more desirable than existing selections.

In June of this year 20 different test coatings were applied to 160 lineal feet of the interior of Penstock No. 5 at Shasta Dam. Of all the coatings tested in the laboratory these had, in general, shown the most promise for preventing corrosion of steel continually immersed in water.

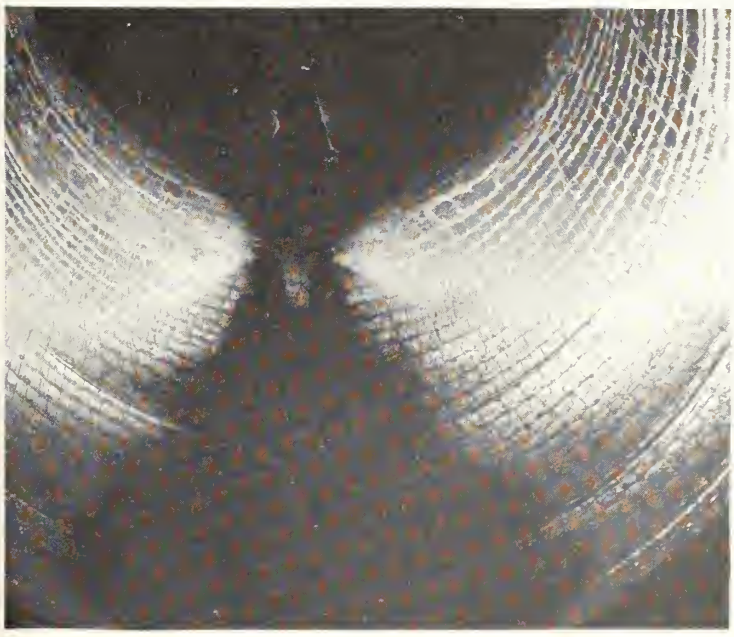
Among the cold applied coatings were paints with phenolic, vinyl, vinyl-neoprene, vinyl-thiokol, treated fish oil, Saran emulsion, synthetic rubber, and coal-tar bases.

Among the hot applications were blown asphalt applied by daubing, microcrystalline wax applied by liquid spray, and phenolic plastic, thiokol, and zinc metal applied by flame spray.

These test applications at Shasta Dam will provide performance data under actual service conditions. As time goes on periodic inspections will reveal which coatings do not satisfactorily protect submerged steel. By the time tests are complete, it is hoped that several coatings in the group can be classed as outstanding. THE END

APOLOGIES TO ASSOCIATED PRESS—The photo credit for the excellent photograph of the late Congressman from California, Richard J. Welch, which appeared on page 220 of last month's issue was inadvertantly omitted. We beg the pardon of the Associated Press which kindly made this photo available to us for publication.

LASTING UTILITY—For the interior of one of the penstocks at Shasta Dam was achieved by applying a coal-tar enamel coating by the hand-daubing method. *Photograph by W. H. Colby, photographer, Region 2.*



NRA Lauds Bureau's Progress

At one of the largest annual conventions of the National Reclamation Association, held at the birthplace of the NRA, Salt Lake City, Utah, on November 2, 3, and 4, about 1,600 members of the Association were in attendance and took an active part in the proceedings, including many prominent western water users, as well as such notables as Senator Joseph C. O'Mahoney of Wyoming, Governor J. Bracken Lee of Utah, Representatives Murdock of Arizona, and D'Ewart of Montana, Assistant Secretary of the Interior Warne, Commissioner of Reclamation Straus, and top officials of the NRA itself.

This year the delegates reaffirmed their policies of last year, with renewed emphasis upon the national economic necessity for conserving and using to the best advantage the soil and water resources of the West.

The delegates went on record as supporting the program and policies of the Bureau of Reclamation, heartily endorsing the progress which had been made toward liberalizing the reclamation laws, to make it possible under present conditions for water users to meet their contractual obligations and at the same time insure the investment of the Federal Government. Resolutions were passed concerning H. R. 1770 or similar legislation, the "joint liability" clause, and non-reimbursable benefits.

For the second year the National Reclamation Association stated its opposition to any division between different departments of the Government of the functions authorized under the Reclamation Law and now performed by the Bureau of Reclamation. The convention reaffirmed its opposition to valley authorities and stood firmly behind the present basin development program in which the Bureau of Reclamation and the Corps of Engineers cooperate.

They also passed resolutions heartily endorsing the progress already made by the Bureau and urging continuing action on the program of cooperation with Land Grant Colleges and agricultural agencies, and harmonizing the activities of Federal, State and local agencies dealing with the various phases of reclamation development.

Again a legislative committee was formed to follow up the resolutions and recommendations brought forth at the convention which included such topics as development of hydroelectric power along with irrigation developments, Federal Power Act amendment, a small projects division in the Bureau, "Home Rule" for reclamation projects, extension of financial credit and assistance to settlers, adjudication of Federal water rights, domestic water construction, inventory of western resources, and integration of recreational and fish and wildlife benefits into basin development plans.

Many expressions of gratification were heard concerning the action of the 81st Congress in eliminating the "Straus-Boke rider" from the 1950 appropriations, thus permitting Commissioner of Reclamation Straus and Region 2 Director Boke to receive their salaries retroactive to the date on which they went off the pay roll, January 31, 1949.

Excellent arrangements were made for the convenience and entertainment of the delegates and a heartfelt resolution was passed expressing thanks to the many organizations and persons contributing to the success of the convention. •

The Reclamation Farmer Foots the Bill

FIGHTERS TURNED FARMERS comprise the majority of new settlers on reclamation farms who share the obligations to the Federal Government for repaymen along with the old-timers. Above is the homestead of Ray Gardner, a veteran of 6 years' war service, mostly in the Pacific area. This ex-sailor now ha 23 acres of land on which he took 2 cuttings of hay the first year and on which he has built a three-room house He is married and has a young so Eugene, who is also thriving on the Roza-Yakima farm. *Photograph by Stanley Rasmussen of Region 1.*

by C. L. NAFFZIGER, Chief, Division of Allocation and Repayment, Branch of Operation and Maintenance, Boulder City, Nev., Region 3

"YES, IT'S TRUE, FARM PRICES HAVE BEEN GOOD THE PAST FEW YEARS, AND THE MAJORITY OF FARMERS HAVE MADE MONEY, BUT WHAT ABOUT THE FUTURE?"

That reaction is typical of most farmers, particularly those who went through the severe price drop in 1920–21 and the depression of 1929–33. Both of these periods had a long, continuing effect on a farm economy which during World War I geared itself to operate in an atmosphere of continued prosperity. How can Reclamation, an agency of the Government, and the water users, avoid the economic traps of the past? What is the irrigation farmer's financial position today?

While the prosperity of agriculture generally during and following World War II has been of a wider scope and longer duration, farmers have charted a conservative course. Mortgage indebtedness skyrocketed during World War I, but this time has remained at a low level. In fact, it has declined since 1940, as farmers paid cash or made a substantial down payments when buying land, thereby assuring that their equity would not be jeopardized by a downward adjustment in prices.

Farmers in the arid West for the most part are water users, and as such think in conservative terms about scheduling repayment obligations for the construction, extension, or rehabilitation of irrigation projects, in order that an undue burden will not be created in later years. Water users, like other citizens, are good Americans who are unwilling to assume an obligation that they know they will be unable to pay, or wherein they will get into financial difficulty because of a rigidly inflexible payment schedule. The knowledge of water users, and of the Bureau of Reclamation concerning repayment problems, has been drawn from the well of practical experience over the past 47 years since the original Reclamation Act was signed by Theodore Roosevelt on June 17, 1902. From this experience has come a gradual revision of reclamation law which recognizes the impracticability of repaying all project costs over a short space of time.

Difficulty with the 10-year repayment period, provided for in the original Reclamation Act, was due to costs higher than first envisoned, and led to passing of the Reclamation Extension Act on August 13, 1914, extending the repayment period to 20 years. Even with the initial projects, which were constructed at a cost in many cases of less than $100 per acre, water users were unable to meet the obligation assessed against them by public notice in such a short period (and

with the accelerating rates provided) when at the same time they were endeavoring to place their land under cultivation, build a home, and assume other unusual expenses. Speculative land values also contributed to the hardships experienced by early settlers.

By 1923 the Secretary of the Interior recognized the difficulties facing reclamation farmers in meeting their repayment obligations and formed a Fact Finding Committee to survey the reclamation development of the West and make certain recommendations for the benefit of Congress. In addressing the opening meeting of this Committee on October 15, 1923, the Secretary said in part:

Annual reports on some projects indicate their insolvency and pending failure. Out of the 28 projects only one has met its obligations as they fell due. Long extensions of time for payments due are being urged individually and by projects. The original 20-year period for payment is expiring on certain projects, and an additional 20-year extension is being asked. In one instance, such extension is to be preceded by a 5-year moratorium.

The Fact Finding Committee, after a lengthy investigation, found that the scheduling of construction charges under section 2 of the Reclamation Extension Act (which required a payment of 6 percent of the construction cost, during each of the last 14 years of the 20-year repayment period) resulted in a cost too high for the average project farmer to bear, and recommended in the Fact Finders' Report of 1924 a variable repayment plan based on a percentage of average gross crop income for the 10 preceding years.

The Fact Finders' Report also proposed the classification of land and the levying of different construction charges against different classes of land. These recommendations, and others, were incorporated in the Fact Finders' Act of December 5, 1924.

A number of projects, particularly in the northern part of the Reclamation area, took advantage of subsection F of the Fact Finders' Act, which provided for an annual construction charge equal to 5 percent of the average gross annual income for the 10 next preceding calendar years.

The 40-year repayment period, under the Omnibus Adjustment Act in 1926, replaced the percentage plan, and under the Reclamation Project Act of 1939, continues to serve as a guidepost to project repayment, although the latter included provision for variable repayment. Several projects have taken advantage of the variable repayment feature.

In special instances, where the inability of proposed projects to repay construction costs within 40 years has been demonstrated by payment capacity studies, extensions in time have been granted by the Congress in authorizing legislation. Examples are the Lewiston Orchards project in Idaho, and the Gila project in Arizona, which will be required to repay construction costs in 50 and 60 years, respectively.

One of the primary difficulties of repayment contracts, recognized by the Special Repayment Commission appointed in 1938 to survey reclamation problems, was the inflexibility of repayment contracts. Rigid payments year after year without recognition of shifting economic conditions are unrealistic. With extended periods of low farm prices, such as occurred in the 1930's but which were not contemplated at the time repayment contracts were executed, the water users had available no means for substantial adjustment. The only alternative was appeal to Congress for revision of contracts, extension of repayment periods, or moratoria.

With passage of the Reclamation Act in 1939, the way was opened to tie project repayment into gross crop income. A number of variable repayment plans in amendatory and new repayment contracts have been the outcome of the variable repayment plan authorized in the Reclamation Project Act.

The Gila reauthorization bill (Public Law 272, approved July 30, 1947) went even further in recognizing the necessity of flexibility in the repayment contracts, to be executed by the water users. The law states that the Secretary may provide for a system of variable payments, with the method of computation to be established during the negotiation of the repayment contract. Equitable apportionment between land classes is also authorized, the only limitation being that the annual installments may not be spread over a period exceeding 60 years.

House bill 1770, which is now pending before the Congress, recognizes the need for general application of flexible repayment provisions in contracts with irrigation districts and water users' associations along the lines of those in the Gila reauthorization bill, and would provide for the establishment of such variable repayment formula as the Department of the Interior and the contracting district or association agree upon.

Over the years two things particularly have become evident in irrigation repayment policy—first, that the cost of project construction must be scheduled over a period sufficiently long so that annual payments required of the water users are within their repayment ability and, secondly, that annual payments are sufficiently flexible to enable water users to cope with the vicissitudes of our cyclical economic system. With water charges geared closely to repayment ability, the number of irrigation districts getting into economic difficulty during periods of depression should be markedly decreased.

The dollar is the yardstick to which the Reclamation farmer's bill is tailored, but while there are always 100 cents to the dollar, sometimes those dollars are harder to get—sometimes easier, too. When prices are low, gross farm income of course is down, but net income is down even more because expenses are often inflexible and adjust more slowly than farm prices. So, too, when prices of farm commodities are up during periods of prosperity, operating expenses (while also going up) do so more slowly. In prosperous periods, when dollars are plentiful, the Reclamation farmer can readily meet payments on construction charges in excess of the average. During depression, when dollars are scarce, payment of the average amount due in many instances causes hardship, even though payments have been scheduled over a sufficient period to be well within the Reclamation farmers' average repayment ability.

The Reclamation Project Act of 1939 establishes a ceiling and a floor—not more than 200 percent, nor less than 15 percent of the annual installment. Over the 39 years, 1910–48, using these limitations, a variable payment formula based upon the ratio of prices received by farmers to prices

(Continued on page 246)

Venezuela—"Little Venice" of South America

by JOHN L. MUTZ, Area Engineer, Albuquerque, N. Mex., Region 5 (Headquarters at Amarillo, Tex.)

On May 14, 1948, the Commissioner of Reclamation forwarded a letter to "All Regional Directors" advising that the Department of State had received a request from the Venezuelan Ambassador Señor Dr. Gonzalo Carnevali, for the services of an engineer. The assignment would be for a period of 2 months; the purpose to help study and determine the most adequate and economical method for the conservation and maintenance of canals in Venezuela and to aid in selecting the type of equipment and machinery required for these jobs.

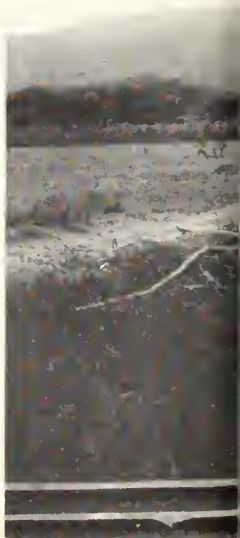
The author was selected for the assignment and after several months of processing, which involved clearance by the F. B. I., transfer of funds, obtaining passports (Mrs. Mutz accompanied the author), taking the necessary innoculations and being vaccinated, and making other arrangements, Caracas, Venezuela, was reached on October 29, 1948.

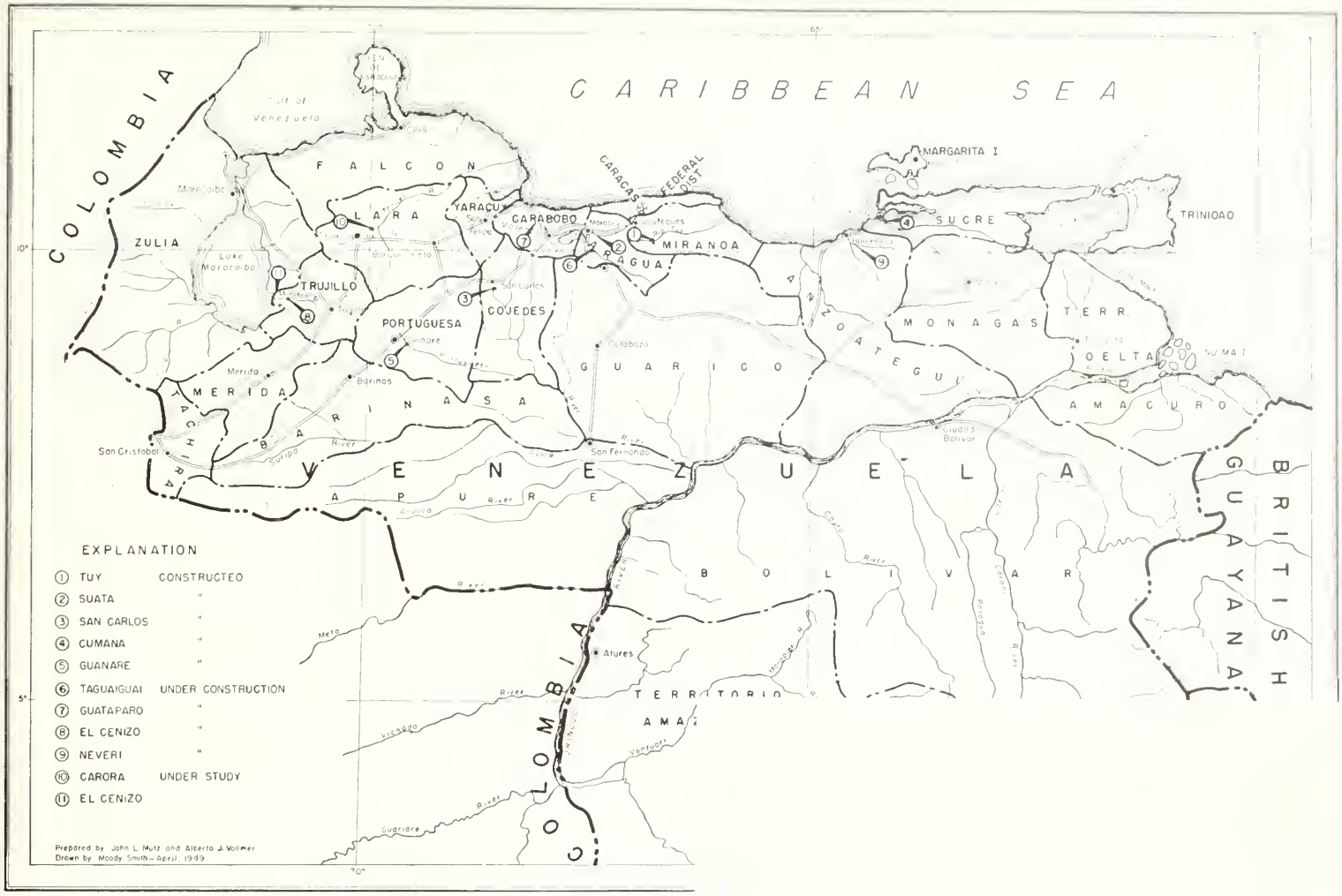
As is the case with many "Norte Americanos," we had only a very general conception of what lay ahead. After all, is not Venezuela in the tropics, and is it not a country of plentiful rainfall where bananas, coffee, sugar cane, and other crops requiring rather moist conditions are grown? Also, does not the name Venezuela mean "Little Venice" which in itself implies many lakes which only exist where there is ample precipitation?

We found that Venezuela is a country of many contrasts and only two well defined seasons. The annual precipitation varies from 10 inches along the northern sea coast to 140 inches in some of the jungle areas in the southern part of the country. It has a definitely dry season known as "Verano" from November through March and a wet season known as "Invierno," from April to October. (Editor's Note: Although "verano" is the Spanish word for spring, and "invierno" means winter, the seasons are reversed below the equator.) In many areas there are extended periods of time during which the rainfall is less than two-tenths of an inch. Because of this low rainfall, the Caribbean Oil Co., in connection with a refinery it is building, is constructing a plant for distilling fresh water from sea water. Fresh water shortage also is a problem on the island of Margarita, located off the northeast coast of Venezuela and noted for its pearls and native artwork. Here, water is provided by tankers from the mainland. With a 12-month growing season and erratic precipitation, it was evident immediately why there is a need for irrigation in Venezuela.

The country has a total area of 352,000 square miles with a population of 3,500,000. The area is slightly less than that contained in the States of Texas and New Mexico and has a population density about that of Colorado. Nearly two-thirds of the country is mountainous, leaving only one-third which is sufficiently level for farming.

IT PAYS TO ADVERTISE must be a slogan adopted by our South American friends, as evidenced by the huge letters on the Guataparo Dam at the top of the column of photographs at left. **THE WEED PROBLEM** is as acute in Venezuela as in the United States. The center photo shows native laborers on the Tuy project cleaning out an irrigation ditch to free it from weed infestations. **CLEANLY CONSTRUCTED** concrete outlet gates on the Suata project (at left) show the great similarity existing between South and North American structures, as do the photos of the feeder canal on the Suata project (immediate right) and the spillway of the Guataparo dam (extreme right). *All photos by the author.*





The Venezuelan Government is well supplied with funds derived largely from its fabulous oil resources—and it has the world's greatest oil-producing reserve. The Government has recognized the need for developing the irrigation potentialities and is now pursuing a well-planned course of action in carrying out a much needed irrigated agricultural program by using funds which are obtained from a 50–50 split of the oil produced.

During the past 8 years a number of American technicians have been employed to aid in developing Venezuelan irrigated agriculture. Among them are W. L. Powers, de-

partment of soils, Oregon State College; J. B. Bond, consulting engineer; A. W. Newcomer and M. R. Lewis of the Bureau of Reclamation. Many Venezuelans have visited the United States to study our irrigation and conservation methods. Some of them are: Dr. Gustavo Padilla, Chief of the Division of Agroeconomica; Pedro Castillo, Head of Operation and Maintenance; and Henry Delgado, Head of Conservation, all in the Ministry of Public Works, and Alberto J. Vollmer, a native of Caracas, who prepared the map accompanying this article, while working and studying in Region 5.

The Venezuelans have made detailed and semidetailed land classification studies on several hundred thousand acres of land, and it was interesting to note that Bureau of Reclamation standards are used. Copies of the Bureau's Land Classification Manual were also much in evidence.

The following table lists the projects completed by the Government, those under construction, and some of those under study:

Name	Location	Acreage	Type of works
Constructed:			
Tuy	Miranda	3, 700	Direct diversion.
Suata	Aragua	8, 500	Storage.
San Carlos	Cojedes	12, 000	Direct diversion.
Cumana	Sucre	6, 200	Do.
Guanare	Portuguesa	3, 700	Do.
Subtotal		34, 100	
Under construction:			
Taguaiguai	Aragua	22, 000	Off-stream storage.
Guataparo	Carabobo	7, 500	Storage.
El Cenizo	Trujillo	20, 000	Direct diversion.
Neveri	Anzoatequi	3, 500	Do.
Subtotal		53, 000	
Under study:			
Carora	Lara	15, 000	Do.
El Cenizo	Trujillo	200, 000	Storage.
Subtotal		215, 000	
Total		302, 100	

FROM FARM TO FACTORY—Typical of agricultural industry in Venezuela is this scene near Barquisimeto where sugar cane is being hauled to the processing plant where it will be converted to brown sugar.

The crops which are and can be grown are numerous. In part they are bananas (about 14 varieties), sugar cane, coffee, corn, tobacco, cotton, rice, many citrus fruits, practically all types of vegetables, with the exception of head lettuce, and many tropical fruits and vegetables with interesting names, such as, oyster plant, soursop (the fruit is pear-shaped with a slightly acid, fibrous pulp), guava, sapodilla (its latex yields chicle, and the fruit has a sweet brownish pulp), avocado, Mango, papaya (an oblong fruit which has a pulpy flesh. It can be eaten raw but also is boiled and used as a vegetable), cacao, and breadfruit.

In addition to the work undertaken directly by the Venezuelan Government in the production of food, the Venezuela Basic Economy Corporation has been established by Nelson Rockefeller. This corporation obtains contributions from Creole, Caribbean, and Mene Grande Oil Companies for the production and distribution of fish, poultry, cattle, and agricultural products.

When I arrived in Venezuela, my job boiled down to determining the proper type and amount of equipment required to mechanize the operation and maintenance of the irrigation projects of Tuy, Suata, San Carlos, Cumana, and El Cenizo in order to reduce the operation and maintenance costs. Contracts have been made between the national government and individual land owners within the irrigation projects for the reimbursement of construction costs and payment of operation and maintenance costs. As the maintenance is largely accomplished by hand labor, the cost is now running between 65 and 90 bolivares (a bolivar is worth about 30 cents) per hectare, approximately 2½ acres, or between $8 and $11 per acre. At the same time, the operation and maintenance contract in one case provides for a payment of 12 bolivares per hectare, or about $1.50 per acre. In spite of this fact, the government is doing an excellent job in maintaining the works. In some cases it was found that the canals and laterals were of inadequate size because of failure to anticipate the peak demands of crops for water. This is not an uncommon error and corrections can be made at a nominal cost.

I prepared individual reports and recommendations for equipment and operating organizations for the consideration of the "Direction de Obras de Riego." These reports summarized my analyses of canal and lateral capacity requirements and recommended ways and means of making improvements. I also prepared an outline for drainage studies in an area of valuable lands which are highly impregnated with salts. This is a particularly interesting matter because it demonstrates the farsightedness of the Venezuelans in recognizing the need for the preservation and reclamation of lands susceptible to irrigation.

It was of great interest to us that the Oronico River, which is entirely in Venezuela territory, is one of the great rivers of the world. Also, Venezuela has the world's highest cataract which is known as Angel Falls and has a total drop of 3,300 feet—about 20 times greater than Niagara. We could not help speculating on their potentialities as producers of hydroelectric power.

I left Venezuela with the feeling that my efforts were very much appreciated and that my recommendations would be

(Continued on page 246)

Ambassador Caffery *tours Reclamation area*

by IAN A. BRIGGS, Chief, Division of Land Use and Settlement, Branch of Operation and Maintenance, Region 3, Boulder City, Nev.

President R. D. Searles, and Manager O. L. Norman of the Salt River Valley Water Users Association and I, met Ambassador Jefferson Caffery at the Phoenix, Ariz., airport on late Friday afternoon, July 29 and proceeded to the Westward Ho Hotel where the Ambassador was photographed and interviewed by members of the press, mainly representatives of the Arizona Republic and Phoenix Gazette. This was the beginning of an 8-day tour during which we showed the Ambassador five projects, the Salt River Valley, Gila, Yuma, All-American Canal and the Colorado River Front Work and Levee System, along with various units and divisions of these projects and privately owned irrigation works in the area.

On Saturday morning President Searles took Ambassador Caffery and me on an automobile tour over most of the eastern section of the Salt River Valley project. The Ambassador was particularly interested in the irrigation systems, the ways and means provided for supplementing hydroelectric power and in agricultural operations. We stopped at the Salt River Valley water users' steam plant at Tempe and at other points of interest, including the Recker Brothers packing shed where workers were busily engaged in packing honeydew melons. We pointed out to the Ambassador methods of diverting, transporting and applying irrigation water, and examples of different methods of irrigation farming. He was especially interested in the development of new land being brought under cultivation in the Scottsdale area.

During the Ambassador's sojourn he was entertained at several dinner parties, banquets and informal meetings at which he talked with representative farmers and others interested in the agricultural industries of this area.

On Sunday and Monday the Arizona National Guard made a plane available to the Ambassador and we were able to conduct him on a full inspection air tour of the Salt River, Verde River, Agua Fria River, Wellton-Mohawk division of the Gila project, Imperial and Laguna Dams, the Gila project pumping plants and Unit B Auxiliary project, and a portion of the Yuma project.

During the next few days the Ambassador toured Imperial Valley, and the Coachella Valley. He was much impressed by the business-type operations at the Imperial irrigation district project, by the large-scale farm operations, and the methods used in handling the irrigation of large tracts of land. He also marvelled at the great amount of care shown on this and other projects in the extremely meticulous methods of leveling the land and permitting the utmost efficiency of operation. He noted particularly several specialized pieces of equipment, such as the land plane. In the Coachella Valley he was much interested in the crops grown. The fact that the Coachella Valley produces 95 percent of the dates grown in the United States was of interest to him since the remaining date production of the world is in the Near East. He noted citrus crops, grapes and vegetables, and commented particularly on the differences which he observed between the family-size farm development of the Coachella Valley, and the large-scale farming in the Imperial Valley, noting the lack of homes or residences on large stretches of land at Imperial, and the large number of homes at Coachella. He greatly enjoyed the opportunities presented to him throughout his visit to inspect distribution systems, and observe operations like the making of concrete pipe and its installation in the field.

At each meeting with farmers or businessmen in the area, the Ambassador discussed briefly some of his experiences during his five years in Paris as Ambassador to France, and some of the problems with which he expected to be faced in

TOURIST AND GUIDES—From left to right, Ian A. Briggs, Ambassador to the Near East Jefferson Caffery, Regional Director (Region 3) E. A. Moritz, and Assistant Regional Director L. R. Douglass. *Photo by Horry W. Myers of Region 3.*

EDITOR'S NOTE: This report of Ambassador Caffery's trip to Reclamation's counterpart of the area in which he will be stationed is printed here due to its significance to the President's point four program.

Ambassador Caffery saw more than just irrigation farming and mammoth structures during his visit to the Reclamation area. He saw a new vista opening for United States Ambassadors and other American dignitaries who are to be stationed in reclaimed or to-be-reclaimed lands overseas. Here, within the borders of the United States, he told his chief, George C. McGhee, new Assistant Secretary of State for Near Eastern and African Affairs, is a gigantic and proven demonstration of what can be done to raise the standard of living of people now maintaining a precarious existence in arid and semi-arid climates. Accordingly, members of the diplomatic corps who are destined for posts in the Near East, Middle East, and Africa, will now be required to know something about the domestic reclamation program from first-hand observation, so they can say to the people overseas, "We know what can be done, we know how it can be done, because we have seen the proof, and America's know-how and show-how is at your disposal." Since Mr. Caffery returned from his trip, the Ambassador to Saudi Arabia, J. Rives Childs, and the Ambassador to Iraq, Edward S. Crocker 2d, have taken the "reclamation tour," which is arranged on a reimbursable basis between the Department of State and the Bureau of Reclamation.

his new post in Egypt, in connection with the proposals to bring under irrigation new areas of land in Egypt as well as in other parts of the Near East. The Ambassador stressed as one of the responsibilities facing the Near East countries, and indirectly the United States, the obligation for making every provision possible for the production of food supplies through irrigation or otherwise to meet the needs of the expanding population of these countries.

Upon leaving region 3, the Ambassador repeatedly voiced his appreciation of the opportunity to observe at first-hand the conditions which he deemed would be similar to those in Egypt. He was grateful for having seen many of the different crops grown in this region which either had originated in Egypt or were similar to the varieties of crops grown there. He considered, for example, that his close observation of long staple cotton which came originally from Egypt would make his task overseas a bit easier and that he was fortunate in being able to tell the Egyptian officials and farmers that he had seen their type of cotton grown successfully in the Southwest irrigated area of the United States.

The Ambassador was unstinting in his praise of Bureau and project officials, and members of water users' and other groups for the courtesies shown him and for the entertainment which they provided. Special mention should be made of Mr. Marcel Forman, president of the Yuma Valley Water Users' Association; Mr. B. A. Weiss, and president Evan T. Hewes of the Imperial irrigation district; and J. H. Snyder, manager of the Coachella Valley County water district, for their hospitality and cooperation. The End

RUFUS WOODS

(Continued from page 237)

Whitman College presented him with a doctor of letters degree in 1933. Life, Time, and Fortune have followed the Woods story in narrative and pictures. Recently, Holiday magazine did a story on the Northwest and the Columbia, including an article and colored picture of Rufus. A page in Pathfinder, five pages in Look; radio programs like The Passing Parade, Cavalcade of America, and Edgar Guest devoted entirely to Rufus Woods; such nonfiction books as Richard Neuberger's Our Promised Land, Gunther's Inside USA, Nard Jones' Evergreen Land, and Murray Morgan's The Columbia, have kept the exploits and history of the Columbia before the American people.

Rufus is the best friend the "grass-roots" of the Northwest ever had or can hope to find. They seek him out and watch his Wenatchee Daily World for the latest chapter and official word on the project. He has made The Daily World a family newspaper that puts the smallest Main Street on page one.

The Daily World has told the story and paved the way for the basin. Through the years Rufus has paid his own expenses on the many trips East—16 in all before the Basin Commission was organized. During the formative years of the program when there was no Basin Commission, this travel money came out of Rufus' pocket. Last year his per diem expenses to the State for the nonsalaried job totaled $160—his only demand for all the time, energy, and enthusiasm he has shown for a $500,000,000 project.

Rufus Woods has been the human dynamo that has kept the Reclamation project on page one in the press of the Nation. He is a symbol of what individualism, working with a program and the willing help of other progressive men on a team, can achieve. The End

The Reclamation Farmer Foots the Bill

(Continued from page 241)

paid would have resulted in repayment of just as much or more money to the United States than the straight annual payment, assuming that no moratoria were required under the latter and granted by the Congress. Experience during the depression years demonstrated the necessity of relief from a fixed annual contractual burden and Congress granted moratoria.

With variable payment plans in universal use, the Reclamation farmer could meet his construction obligation in depression by acquiring 15, 20, or 30 cents out of the normally required dollar, offsetting his low payment, and when dollars were plentiful again, by payments of up to 200 cents for each dollar in the average annual installment. With general acceptance of these variable provisions contained in the Reclamation Project Act of 1939, the repayment problem would be simpler, both for the Bureau of Reclamation, charged with the responsibility of enforcing the repayment provisions of Reclamation Law, and for the Reclamation farmer who foots the bill. The End

VENEZUELA—"Little Venice"

(Continued from page 244)

given full consideration and probably would be carried out. It was my impression that the Venezuelans look upon technicians from the United States with considerable respect and wish to adopt our methods insofar as possible. I also found them not lacking in ingenuity in utilizing native plants and trees in erosion and sediment control works. For example, a nursery has been developed for mahogany trees which will be transplanted to watershed areas for erosion control and utilized as a source of lumber—of which there is a scarcity in the northern part of the country. The End

Oscar Chapman Named Secretary of the Interior

Effective December 1, 1949, former Under Secretary of the Interior Oscar L. Chapman will step in the top position of Secretary of the Interior, succeeding J. A. Krug.

Mr. Chapman was appointed Assistant Secretary of the Department of the Interior on May 4, 1933, by President Franklin D. Roosevelt. On March 27, 1946, he was promoted to Under Secretary of the Department, serving longer continuous service in the "Little Cabinet" than any man in history.

Believing, as he does, in the wise development of our natural resources, Mr. Chapman has had through the years a lively interest in the conservation and full utilization of our resources. This interest and the many years he has served in the Department of the Interior have made him one of the Nation's authorities on resource matters.

Cover Your Siphon and Cut Costs

(Number 6 in the Reclamation Era's Siphon Symposium)

by FLOYD M. ROUSH, Chief, Irrigation Operations, Branch of Operation and Maintenance, Region 7, Denver, Colo.

When I became manager of the Goshen irrigation district on the North Platte project in 1938, I found the district had been experiencing considerable difficulty with badly leaking concrete siphons. Sure enough, when water was turned into the ditches that spring, one siphon in particular developed a set of beautiful geysers. While not as spectacular as Old Faithful, the streams nevertheless spurted 15 to 20 feet into the air. The siphon crossed some pasture land, and while the loss of water was small, the spurting water created a nuisance along the siphon, and water erosion damaged the earth cover.

This structure was a 42-inch diameter reinforced concrete inverted siphon, constructed without expansion joints. It had an over-all length of about 1,500 feet and carried irrigation water across a gently sloping valley. The maximum head on the siphon was around 50 feet.

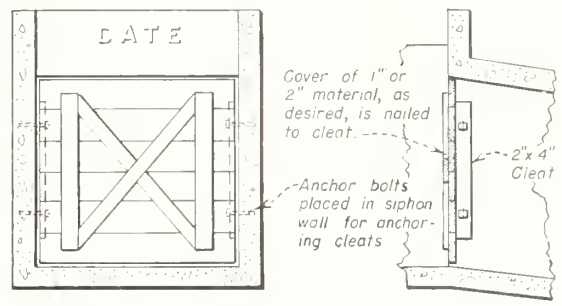
After shutting off the water, repairs were made by encasing the siphon with a reinforced concrete band 18 inches wide and 8 inches thick over each crack. This method of repair was used because of its simplicity. It was much easier than carrying materials down into the siphon where the maintenance crew would have had to work in extremely cramped quarters, considering the small diameter of the siphon.

While repairs were in progress, I inspected the inside of the siphon and found new cracks, which appeared to be caused by contraction and expansion of the concrete. Upon entering the siphon, I noticed at once that a strong air current was passing through it. This might be causing part of the trouble! Excessive contraction or shrinking may have occurred when extremely cold air currents passed through the siphon, particularly during periods of severe winter weather.

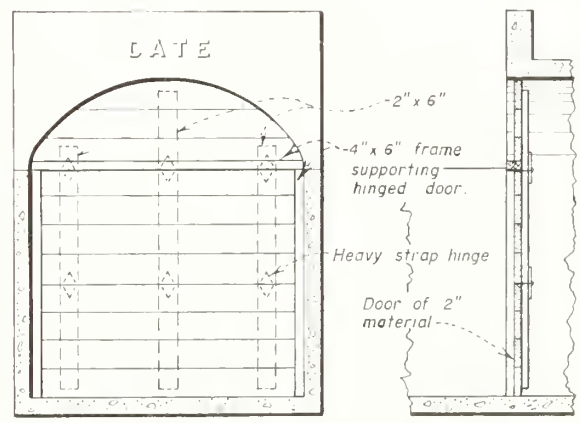
This siphon, as well as most of the others in the project, extends in an east-west direction which is in line with the prevailing winds of that area. The canal and transition sections leading to the siphon acted as a funnel, thereby forcing the wind directly into the siphon barrel.

It was then I conferred with the others on the spot and we agreed that if the air currents were stopped by plugging the portals during the nonirrigation season, thereby retaining the natural heat in the siphon from the surrounding earth material and cover, less cracking would occur and the trouble minimized or ended.

At the close of the irrigation season, we fitted all siphon portals with covers constructed of 2-by-4 and 1-inch lumber. The covers were constructed so they could be easily removed a short time before water was turned into the ditches and could be used again the following year. (Since then, we found that some projects use canvas curtains for covering the portals.) In addition, all bare and thin spots in the earth cover over the siphons were reinforced to a minimum soil thickness of 18 inches. A bull dozer was used to push additional cover over the siphon. We also discovered that if possible the cover should be maintained to a depth which will prevent frost reaching the siphon barrels.



COVER FOR A SIPHON



UPPER PORTAL OF TUNNEL WITH HINGED DOOR

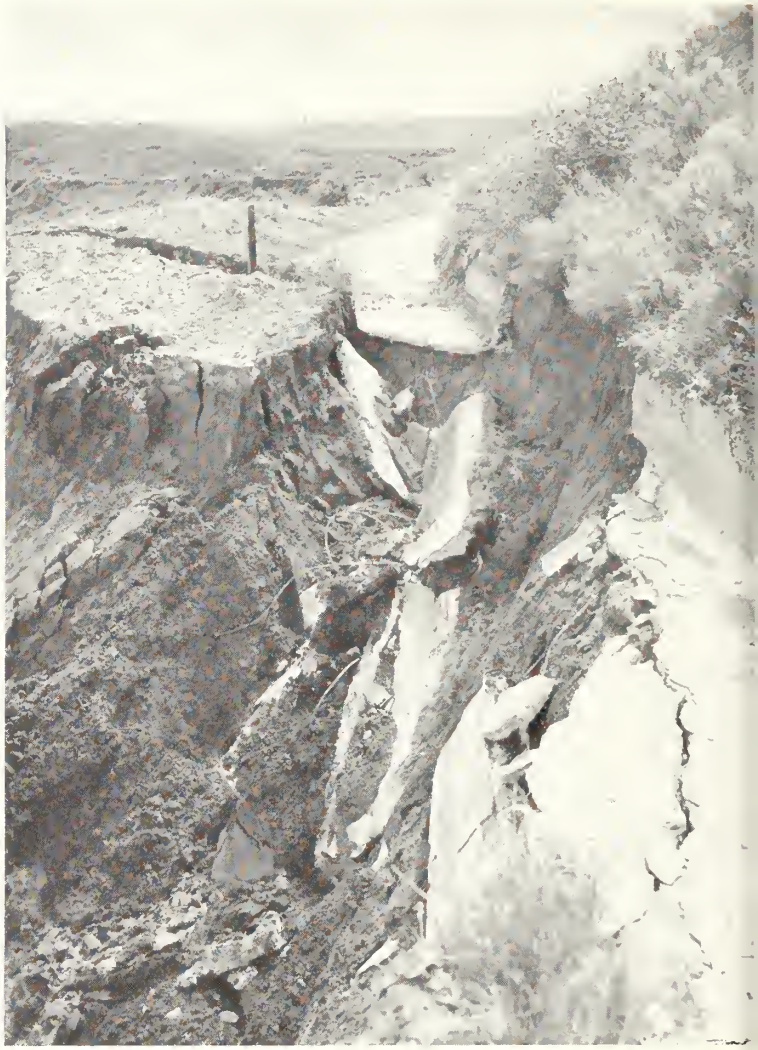
The result has been that little or no trouble is being experienced from leaky siphons such as occurred prior to the installation of covers.

Similarly, some private irrigation districts have unlined tunnels where slacking of the rock occurs on the ceiling and walls, particularly where it passes through a shale or limestone formation. It has been found that this slacking can be checked by the installation of wooden swinging doors on each portal. The doors should be hinged at the top and in the middle so that the bottom half opens automatically when the canal is one-half or less full. Then as the canals fills, the upper half will open. When the water is shut off in the fall, the doors automatically close, thereby stopping damaging drafts or winds from circulating through the tunnel. The End

PRESTON BENCH

A One-Year Achievement

by E. K. THOMAS, Area Engineer, Logan, Utah, Area Office, Region 4



PRESTON BENCH is a *rara avis* ("rare bird" to nonstudents of Latin) in Bureau of Reclamation annals.

This project was authorized by Congress, designed, and constructed all in one year, which included one of the most severe western winters in history.

The southwestern Idaho project was authorized on June 15, 1948, and $453,000 appropriated for construction. Work started in October 1948, on the 1,125-foot Station Creek Tunnel, 15.6-mile Mink Creek Canal and miscellaneous appurtenant structures. It was completed on September 6, 1949, only 14 months after authorization and 11 months after construction got under way.

The new canal and tunnel replace the historic Preston, Riverdale and Mink Creek Canal which, despite frequent and costly interruptions due to landslides, has been serving the highly productive lands near Preston, Idaho, since 1899.

This old privately constructed canal, for more than half a century irrigated about 4,000 acres of highly developed land in the vicinity of Preston. Incidentally, the town of Franklin near the project is believed to be the oldest community in the State of Idaho.

The old canal, when first put into operation in 1899, diverted water from Mink Creek, a tributary of the Bear River, and extended approximately 22 miles along steep terrain before emerging onto the smooth lands comprising the irrigated area. The last 3 miles of the canal crossed the Bear River Bluffs, north of Preston, where at disconcerting intervals during past years, landslides destroyed several sections of the canal.

By 1946, the Preston, Riverdale & Mink Creek Canal Co., a mutual irrigation organization that owned and operated the old canal, had literally, as well as figuratively gone downhill fast, and had lost all hope of maintaining its water supply. The irrigators faced financial ruin.

In late 1946, the Bureau of Reclamation undertook investigations of the best means of maintaining the water supply for the lands under the failing canal. Engineers investigated the possibility of pumping and tunneling to avoid

BEFORE—AND AFTER—Above, a sample of the landslides which threatened the security of the Preston Bench farmers. At left, the finished section of the new Mink Creek Canal in an entirely different, and safe, location. IT WAS A HARD WINTER—but in spite of snowdrifts, like the one shown at upper right which covered the outlet of Station Creek Tunnel, the work went on. In the next photo a construction crew is trimming the walls of the tunnel, in March 1949, and below can be seen the completed portal and open transition at the outlet end in July of the same year. The photo in the lower right-hand corner catches the crew as it places a 42-inch double rubber gasket concrete pipe section of the Birch Creek Siphon. *All photos by E. C. Christensen, except that of the landslide which was taken by E. K. Thomas, and the photo of Mr. Christensen and James Kostoff at the completed tunnel outlet—photographer unknown.*

the difficulties involved in conveying water across the unstable bluff area. They also considered the diversion and storage of water from other streams, and a higher canal line extending from Mink Creek on an entirely new alinement, and on stable terrain.

The third plan for establishing a new canal line in entirely different terrain seemed most logical and a report recommending this construction was submitted to the Commissioner of Reclamation in September 1947. As a result of this report Congress authorized construction of the Preston Bench project on June 15 and funds for construction were appropriated on June 25, 1948.

By mid-October, slightly over 3 months after appropriation of funds, a repayment contract had been completed, all construction had been advertised, and all three contractors were at work.

To achieve this predetermined goal, surveys for plans and specifications and the necessary acquisition of rights-of-way had to be completed by the middle of August.

Bids for the tunnel construction and three schedules of the canal were opened on October 6 and 7, and all contracts were awarded and notices to proceed given within 5 days after the bid openings.

The successful bidders were as follows: Station Creek Tunnel—Thatcher Construction Co. of Ogden, Utah; Schedule No. 1 of the Mink Creek Canal (5 miles)—Leland Knudson of Ogden, Utah; Schedules Nos. 2 and 3 of the Mink Creek Canal (10 miles)—LeGrand Johnson of Logan, Utah. Schedule No. 1 of the canal included headworks, two siphons with lengths of 228 and 912 feet, a Parshall flume, a 170-foot bench flume, a wasteway, and other minor structures in addition to the canal earthwork. Schedules Nos. 2 and 3 included a wasteway and several minor structures in addition to the canal earthwork.

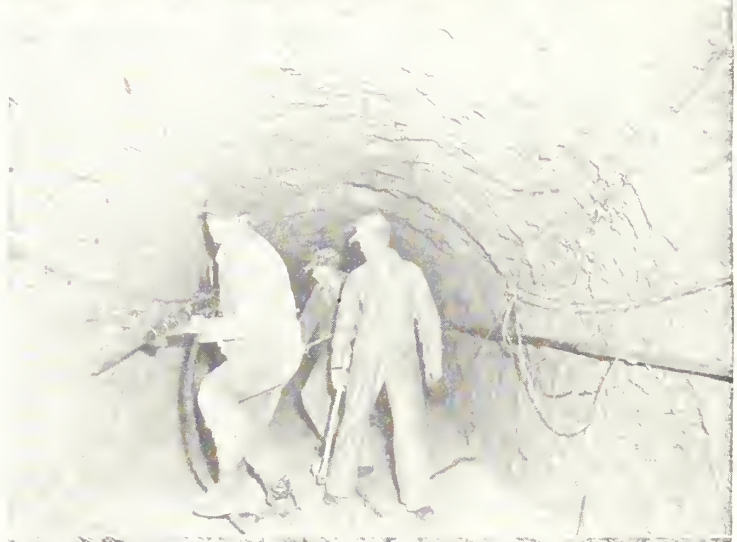
Despite the severe winter of 1948–49, which retarded the construction operations, the work proceeded very satisfactorily. The 8½-foot diameter Station Creek Tunnel, which was driven through volcanic rock and lined with concrete, was completed on July 9, 1949. Schedules Nos. 2 and 3 of the canal were completed on July 20, 1949. Schedule No. 1 of the canal was completed in September 1949.

The cost of the project, amounting to about $430,000, will be repaid by the Preston Riverdale and Mink Creek Canal Co. under contract with the United States. Fortunately for the irrigators associated with the canal company, the old canal has functioned fairly satisfactorily during the 1949 irrigation season, with careful operation and a reduced flow of water.

By the beginning of the 1950 irrigation season, it seems probable that landslides will destroy parts of the old canal, but this is no longer a matter of tragic concern to the irrigators.

Now the farmers on the project can continue to produce their alfalfa, cereals, sugar beets, canning peas, tomatoes, vegetables, fruit and berries, without having to keep a "weather eye" upon the former precariously perched canal on the hills.

The new project has been completed, is ready for service, and will deliver economically and reliably more water than the Preston irrigators have ever had before. THE END



South Dakota Celebrates Shadehill Dam Construction

Some people might call it a small dam—and in contrast to Hoover, Grand Coulee, Shasta and the in-the-making Hungry Horse, perhaps it is. But Shadehill Dam, a part of the Grand Division of the Missouri River Basin project, will perform a big job for the people around the Grand River, near Lemmon, S. Dak.

Shadehill Dam will provide a much-needed stable supply of Dakota irrigation water, and in addition its more than 2-mile-long (12,900 feet) stretch will protect the low-lying valley from floods, hold back silt, and furnish a recreation spot for people of the area.

With these facts in mind, the irrigation committee of the Civic Association of Lemmon, S. Dak., arranged a formal celebration of the beginning of construction on September 2, 1949. Belated though this event might seem to be (construction work actually began last spring) it was nonetheless enthusiastically attended and the fact that the participants could watch the work going on at full swing added to the gala atmosphere of the occasion.

Members of the irrigation committee are H. R. Jackson, chairman, Art Svendby, D. I. Chapman, Vaughan Papke, Dennis Bierschbach, and Al Bratzel.

Raymond F. Lund, Rapid City, S. Dak., president of the South Dakota Reclamation Association, was master of ceremonies at the celebration. Principal speaker was Hon. Francis Case, member of Congress from the West River district in South Dakota. Other speakers were Governor George T. Mickelson of South Dakota; Ross Davies, Huron, S. Dak., State conservationist, Department of Agriculture; K. F. Vernon, Billings, Mont., director, region 6, representing the Bureau of Reclamation and the Department of the Interior, and W. G. Sloan, chairman, Missouri Basin Inter-Agency Committee. Prior to the speaking program a concert was presented by the Lemmon Municipal Band under the direction of Norman Sampson.

F. J. Reeder, vice-president, Lemmon Civic Association, introduced the speakers at the luncheon held in Lemmon before the celebration at Shadehill Dam site. Speakers were Governor Mickelson, A. M. Eberle, Dean of Agriculture, South Dakota State College, and J. W. Grimes, acting district manager of the Bureau's Missouri Oahe district.

The prime contract for the construction of Shadehill Dam was awarded December 31, 1948, on the contractor's low bid of $5,116,796.75. The dam will be an earthfill structure 122 feet high and 12,900 feet long. Irrigation, flood control, silt retention, and recreational uses are among the proposed multiple purposes of Shadehill Dam and Reservoir.●

WORK CONTINUES—As the crowd below witnesses a formal celebration ceremony of the beginning of construction of Shadehill Dam, shown at right as engineering artist M. H. Willson conceives it. At upper right, Congressman Francis Case throws the switch that sets off the powder charge as the official opening blast. Others, in the usual order, are Raymond F. Lund, President of the South Dakota Reclamation Association and master of ceremonies; K. F. Vernon, Region 6 Director, and W. G. Sloan, Chairman, Missouri Basin Inter-Agency Committee. *Photographs by Donald H. Demarest, Region 6 photographer.*

Riverton Farms for Veterans

DADDY GOT PRIORITY—W. E. Rawlings of Billings, Mont., assistant director of the Bureau of Reclamation's Region 6, congratulates Erwin Roberts, whose father, Hersey B. Roberts of Bozeman, Mont., won priority number 12 for consideration for the award of an irrigable Riverton project homestead. Mrs. Roberts is between the two men, and watching is Arthur J. Over of Loma, Mont., who won number 16 in the public drawing.

Van C. Sorensen, an Aurora, Utah, veteran, was the number-one man at a public drawing conducted October 6 at Riverton, Wyo., to establish a priority by which 841 World War II veterans from 40 States and Alaska will be considered for the 50 irrigable farm units open for homestead settlement on the Bureau of Reclamation's Riverton project.

An examining board composed of local residents and a representative of the Bureau of Reclamation will give Sorensen's application a more thorough review. If the application is in order and meets the minimum requirements, Sorensen will be called for a personal interview. If the interview is passed successfully, he will be given first choice of the 50 irrigable farm units. Because of the possibility that some veterans will not pass the examinations, 150 names were drawn to allow two alternates for each available farm unit.

Principal speakers at the event, held in the American Legion Hall, were E. J. Utz of Washington, D. C., head of the land use and settlement division of the Bureau of Reclamation's branch of operation and maintenance; W. E. Rawlings of Billings, Mont., assistant director of the Bureau's Region 6; Ralph H. Workinger of Cody, Wyo., manager of the Bureau's Big Horn District; and T. C. Thompson, deputy secretary of state of Wyoming. Also participating were Mayor T. E. Knight, A. J. Garner, a veteran who won a farm unit at the first postwar opening; Blair Stouffer, local commander of the American Legion; James Jewett, local commander of the Veterans of Foreign Wars; Miss Orpha Fulkerson, reigning Riverton Rodeo Queen, and George W. Boyd, superintendent of operation and development for the Riverton project.

Inquiries concerning the available homestead units were received from more than 10,000 persons residing in every State except Rhode Island and from the District of Columbia, Alaska, Canada, Canal Zone, Hawaii, Puerto Rico, and Guam.

The farm units open for settlement contain 5,912 acres of irrigable land. The farms average about 118 acres of irrigable land and contain some nonirrigable land for pasture and other purposes.

The Riverton project, located in Fremont County near Riverton, Wyo., was authorized in 1918. Construction of the irrigation features was started in 1920 and water was available for irrigation in 1925. The water supply for the area now under cultivation and those areas to be opened to settlement comes from Wind River and its tributaries, with principal storage at 152,000 acre-foot Bull Lake Reservoir, located upstream from the diversion works and off the main stream of the Wind River. Water is diverted by the Wind River Diversion Dam and carried to the existing portions of the project through the Wyoming Canal. About nine miles from the head of the canal, water is diverted through a drop to the 1,600-kilowatt Pilot Butte power plant and then into the 30,000 acre-foot Pilot Butte Reservoir, where it is re-regulated for use in the Pilot Canal. Pilot Butte power plant is interconnected with the Bureau's transmission system throughout Wyoming. The Wyoming Canal continues to the northeast from the power drop.

The plan for the Riverton project calls for the irrigation of about 96,000 acres of land. Forty-two thousand acres were placed under irrigation before World War II. In the summer of 1947, 55 farm units, containing about 7,000 acres of land, were opened for homestead settlement to veterans of World War II. The construction of new canals, laterals and other irrigation structures made possible the opening of the present area of 50 units in the summer of 1949. Water supply features for an additional 284 farm units, containing about 41,000 acres, are being constructed by the Bureau. The new lands are to be opened for homestead settlement during 1951 to 1954.

Crops produced during the last 3 years alone on the Riverton project exceed $6,000,000 in value, with principal crops being commercial beans, sugar beets, small grains, hay and forage, seeds, vegetables, and truck. •

Angostura Shows the Way

(Continued from page 235)

Bureau matched the WPA allocation, sponsored the project and as a result, detailed preconstruction work, with basic design and construction data, was available by 1942.

Angostura was one of the many reclamation projects which had to mark time during World War II, but it was included in the Missouri River Basin plans as set forth in Senate Document 191, Seventy-eighth Congress, second session, which plans, with some revision, were approved and the initial stages authorized by the Congress in section 9 of the Flood Control Act of 1944 (58 Stat. 891), and the contract for the construction of Angostura Dam was awarded on June 28, 1946.

At the ground-breaking celebration on August 23, 1946, Assistant Secretary of the Interior, then Acting Commissioner of Reclamation, William E. Warne, said, "The Angostura Dam holds number one place today in the roster of reclamation projects, for it has the distinction of being the first irrigation unit to be constructed under the coordinated Missouri River Basin plan of the Bureau of Reclamation and the Corps of Engineers . . . Although the Angostura will not be a giant like Grand Coulee nor a behemoth like Boulder (now Hoover Dam) it will have an important role in the regeneration of your valley . . . Angostura's special job is to help the people in Fall River and Custer Counties raise more crops from their fertile lands. Through irrigation it will rehabilitate and stabilize more than 16,000 acres of lands now dry farmed . . .

"I have been told that under present conditions of uncertain water supplies, farming in this area returns an amazingly low average annual cash income per acre. Irrigation of these good South Dakota lands will increase present income many fold.

"Stabilization of agriculture through irrigation of your lands will provide a solid economic base for industrial advancement . . . Today as we celebrate the beginning of work on the Angostura Dam, we can predict future years of prosperity for you and the other folks in this great valley . . . In conserving the water of the West and using it for the best interests of you, the people of the West, we are fulfilling the responsibility assigned to us by the Congress."

On the same day, Harvey F. McPhail, director of Power Utilization for the Bureau said, "With the inauguration of the Angostura Dam—first irrigation project of the Bureau of Reclamation to be started under the Missouri Basin development—low-cost water joins low-cost power in a partnership that augurs agricultural and industrial advancement for this vast region . . . Today we are beginning work on Angostura Dam, designed primarily for irrigation. But in the future, Angostura will also have its power development. A hydroelectric plant will be built to furnish energy for downstream pumping units that will add additional irrigated acreage and provide more good farm lands, capable of sustained agricultural production."

And this year, on September 28, 1949, the day before the people of South Dakota celebrated the completion of the Angostura Dam, Commissioner of Reclamation Michael W. Straus addressed a meeting of the South Dakota Reclamation Association, and said, "While others engaged in academic argument, you and your Reclamation partner drove the development and stuck to their job and Angostura Dam was finished while others debated . . . first honors must go to Angostura and you people here today are to be congratulated for it. Without your cooperation, the Bureau of Reclamation could never have gone ahead as rapidly as it has and we can share our satisfaction here today, on the eve of the dedication program . . .

"Tomorrow, you will be celebrating the completion of the conservation and control structure that will make possible the irrigation of Cheyenne Valley land. But that's only half the job. The next great day is when there is water in the ditch and the farmer starts his irrigation operations. I am pleased to learn that a development committee has been organized to assist in the formation of an irrigation district with representation from local land owners and the Soil Conservation Service. The fact that the county agricultural agent is also a member of this committee emphasizes the interest and activity of all agencies of your government in bringing closer to realization the day when Angostura Reservoir water will be beneficially used.

"Upon the formation of an irrigation district and the assurance of a repayment contract, the Bureau of Reclamation can proceed with the irrigation-distribution canals and laterals while the preparation of the farm units to receive irrigation water goes forward. Now that the dam is so near completion, construction of the distribution works should proceed rapidly during the period when water is being stored for future use.

"The appropriation of funds necessary for this development should enable us to deliver water for crop production in 1952. I want to acknowledge the support of Representative Francis Case right through from the time the Wheeler-Case Act was passed, before the war. It was this act which authorized the Federal Government to buy up most of the Angostura unit lands. These lands, to be offered for sale to war veterans will, in effect, provide a new frontier replacing the dwindling supply of homestead lands.

"Irrigation, power, flood control, recreation, fish and wildlife development, and municipal and industrial water are bound up in the future of the Missouri Basin project. And so I say to you while congratulating you on finishing the first dam on the authorized project, to look to the future. Our past accomplishments are only a starter. In South Dakota, as elsewhere in the Missouri Basin, there's still a big job ahead."

And Angostura shows the way. THE END

CHRISTMAS GIFT SUGGESTION

No shopping in crowded stores, no thumbing through mail order catalogues, just send one dollar to the Bureau of Reclamation, Washington 25, D. C., or a check to the Treasurer of the United States, with the name and address of the person to whom you wish to send a gift subscription to the Reclamation Era. Sign your own name, too, and we will send a gift certificate with your name enscribed to the friend or relative who will receive a year-round reminder of your thoughtfulness at Christmastime—twelve up-to-date, informative issues of the official Reclamation magazine.

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NOTES FOR CONTRACTORS

Contracts Awarded During October 1949

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
2715	Columbia Basin, Wash	Oct. 20	108 current transformers and miscellaneous materials to add to existing 6,900-volt switchgear, Grand Coulee left power plant.	Allis-Chalmers Mfg. Co., Denver, Colo	$12,300
2725	Colorado-Big Thompson, Colo	Oct. 17	Construction of Flatiron-Longmont-Leyner and Leyner-Brighton 115-kilovolt transmission lines, using aluminum conductor, schedules 1 and 4.	J & J Construction Co., Oklahoma City, Okla	297,767
2728	Davis Dam, Ariz.-Nev	Oct. 14	Fabricated structural steel for Mesa and Coolidge substations	Flint Steel Corp., Tulsa, Okla	46,240
2737	Boulder Canyon, Ariz.-Calif.-Nev.	Oct. 7	1 vertical-shaft 70,000-horsepower hydraulic turbine with pressure regulator for unit A9, Hoover power plant.	Newport News Shipbuilding and Dry Dock Co., Newport News, Va.	530,870
2744	Davis Dam, Ariz.-Nev	Oct. 17	Miscellaneous structural steel for bus structure, hatch covers, and crane runway for Davis power plant.	Vulcan Rail and Construction Co., Maspeth, N. Y.	24,332
2755	Central Valley, Calif	Oct. 6	3 distribution board assemblies, 1 each oil purifier, compressor, and miscellaneous power boards, and 1 heating and ventilating board for Tracy pumping plant, schedule 1.	Phillips and Edwards Electric Corp., San Francisco, Calif.	23,781
2766	Davis Dam, Ariz.-Nev	Oct. 20	Fabricated structural steel for Mesa and Coolidge substations	Likens Mfg. Co., Huntington Park, Calif	26,850
2767	Colorado-Big Thompson, Colo	Oct. 17	Electrical and mechanical installations for Estes and Marys Lake power plants, switchyards, and penstock gatehouses, gate controls for Olympus Dam, and Prospect conduit intake structure, schedules 1 and 3.	Flora Construction Co., Denver, Colo	204,327
2767	do	do	Architectural and structural work and heating and ventilating systems for Estes and Marys Lake power plants and penstock gatehouses, schedules 2 and 4.	N. G. Petry Construction Co., Denver, Colo	99,265
2768	Central Valley, Calif	Oct. 20	Construction of Tracy switchyard	Stolte, Inc., United Concrete Pipe Corp., Duncanson-Harrelson Co., and Ralph A. Bell, Oakland, Calif.	978,720
2774	do	Oct. 18	Steel partitions for Tracy pumping plant	Los Angeles Sales and Service Corp., Vernon, Calif.	16,495
2787	Columbia Basin, Wash	Oct. 31	Construction of earthwork, Sta. 7+20 to Sta. 466+49.57, Potholes East Canal	Guy F. Atkinson Co., Portland, Oreg	937,602
2788	Davis Dam, Ariz.-Nev	Oct. 21	Bird guards and pans for Davis Dam-Hoover Dam, Davis Dam-Prescott, and Prescott-Phoenix 230-kilovolt transmission lines.	Bethlehem Steel Co., San Francisco, Calif	23,949
2793	Missouri River Basin, Wyo	Oct. 27	Construction of Lusk Substation, Transmission Division, Wyo	Long Construction Co., Billings, Mont	11,625
2795	Colorado-Big Thompson, Colo	Oct. 20	Reconstruction of State highway (U S 34) and completion of access road to Granby pumping plant.	Colorado Constructors, Inc., Denver, Colo	156,294
2797	Office of Chief Engr., Denver, Colo.	Oct. 28	Erecting 5-million pound Universal Testing Machine in Bldg. 1-B, Denver Federal Center.	Eichleay Corporation, San Francisco, Calif	18,820
R1-H H10	Hungry Horse, Mont	Oct. 18	Clearing part of Hungry Horse Reservoir site	Coleman H. Dykes, Knoxville, Tenn	508,950
B-480	Central Valley, Calif	Oct. 14	Aluminum conductor, Elverta-Tracy 230-kilovolt transmission line	Reynolds Metal Co., Louisville, Ky	248,909
R2-67	Central Valley	Oct. 18	Furnishing steel towers for Elverta-Perkins 230-kilovolt transmission line	Bethlehem-Pacific Coast Steel Corp., San Francisco, Calif.	239,280

Construction and Supples for Which Bids Will Be Requested by February 1950

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	69-kilovolt circuit breakers and disconnecting switches for Nevada State switchyard.
Do	Construction of blacksmith and sand-blasting shops, alterations to roadway ramp, and removing parapet wall and installing handrailing at Hoover dam.
Do	Construction of additional rooms in the present Hoover power plant.
Central Valley, Calif	Construction of 19.3 miles of 230-kilovolt double-circuit, steel tower transmission line from Elverta to Perkins, Calif.
Do	Construction of about 18 miles of earth-lined Delta-Mendota canal and Firebaugh wasteway, near Firebaugh, Calif.
Do	Completion of Shasta power plant, including installation of metal doors, windows, and miscellaneous metalwork.
Colorado-Big Thompson, Colo.	Construction of Olympus siphon from Olympus Dam to Olympus tunnel, 3 miles east of Estes Park, Colo.
Do	Construction of about 42 miles of 115-kilovolt wood-pole transmission line between Kremmling and Oak Creek, Colo.
Do	Construction of about 5 miles of 115-kilovolt wood-pole transmission line from Flatiron substation, near Loveland, Colo., west to Pole Hill power plant.
Do	One 48,000-horsepower vertical-shaft hydraulic turbine for Pole Hill power plant.
Columbia Basin, Wash	Relocation of 6.5 miles of county road near O'Sullivan Dam, Grant County, Wash.
Do	208-volt and 469-volt heating and ventilating cabinets for Grand Coulee right power plant.
Do	Two 55-cubic feet per second and four 59.5-cubic feet per second centrifugal pumps for Quincy pumping plant.
Davis Dam, Ariz.-Nev	Stringing overhead ground wires on 152 miles of Phoenix-Tucson 115-kilovolt single-circuit No. 1 transmission line.
Do	Construction of reinforced concrete control building and erecting steel structures for substation at Tucson, Ariz.
Do	Construction of 21 miles of 34.5-kilovolt Wellton-Mohawk power supply transmission line near Yuma, Ariz.
Do	Galvanized fabricated structural steel for the 13.8-kilovolt installations at Mesa and Coolidge substations.
Hungry Horse, Mont	Fabricated structural steel for transformer circuit take-off structure at Hungry Horse power plant.
Kendrick, Wyo	Galvanized fabricated structural steel towers for Kortes tap lines to Casper-Seminoe transmission line.
Do	Construction of about 35 miles of double-circuit telephone line from Casper to Alcova, Wyo.
Do	Furnishing and erecting 1 control house building for new Casper substation.
Missouri River Basin, Mont	Construction of access road, streets, and parking area; water, sewer, and electrical distribution systems; and buildings as follows: 2 permanent 3-bedroom, 7 temporary 3-bedroom, and 12 temporary 2-bedroom residences; fire station and garage, 12-car storage garage, office building, laboratory, and bunkhouse for Tiber Dam Government camp about 14 miles south of Tiber, Mont.
Missouri River Basin, Mont.—(Continued)	
Do	Construction of 7,500-kilovolt-ampere substation, including installation of equipment, near Miles City, Mont.
Do	Construction of Missouri diversion dam on the Missouri River near Fort Peck, Mont. Major components are to be a concrete spillway gate structure about 650 feet long and 30 feet high for fourteen 42- by 18-foot radial gates, a concrete headworks structure for three 25- by 16-foot radial gates with a total discharge capacity of 7,500-cubic feet per second, and 2,600 feet of earth dikes.
Missouri River Basin, Nebr.	Relocation of 19 miles of single track railroad in reservoir area to be created by Trenton Dam near Trenton, Nebr.
Do	Construction of about 55 miles of 115-kilovolt wood-pole transmission line between Alliance and Chadron, Nebr.
Do	Installing equipment and constructing 20,000-kilovolt-ampere Sidney substation, 1 mile north of Sidney, Nebr.
Do	Construction of roads, parking areas, beach, boat launching ramp, guard rail, posts and fence at Medicine Creek Reservoir.
Do	Construction of roads, parking areas, beach, boat launching ramp, guard rail, posts and fence at Enders Reservoir.
Do	Construction of 3-bedroom caretaker's residence, one 24- by 48-foot garage and laboratory building, and sewer, water supply, and propane gas systems at Trenton Dam.
Missouri River Basin, S. Dak.	Clearing Shadehill reservoir site about 15 miles south of Lemmon, S. Dak.
Missouri River Basin, Wyo.	Control board for generators, lines, and station-service equipment, one 1,500-kilovolt-ampere unit substation; one 125-volt distribution board; and two 125-volt motor-generator sets for Boysen power plant.
North Platte, Wyo	Furnishing and erecting 250-foot steel elevator walkway on the downstream side of Pathfinder Dam.
Palisades, Idaho	Construction of about 18 miles of Forest Service road at Palisades reservoir site, about 56 miles southeast of Idaho Falls, Idaho.
Santa Barabara, Calif.	Construction of 6.4-mile Tecolote tunnel and construction of 1.8 miles of access road near Goleta, Calif.
Do	Construction of 10-mile Goleta section of the South Coast conduit, of 48-inch diameter reinforced concrete pipe, from end of Tecolote tunnel to Santa Barbara, Calif.
Vale, Oreg	Replacing Little Valley siphon, about 17 miles west of Vale, Oreg.
Yakima, Wash	Furnishing and installing four cylinder gate guides at Cle Elum Dam, about 7 miles northwest of Cle Elum, Wash.