The Reclamation Era

February 1957

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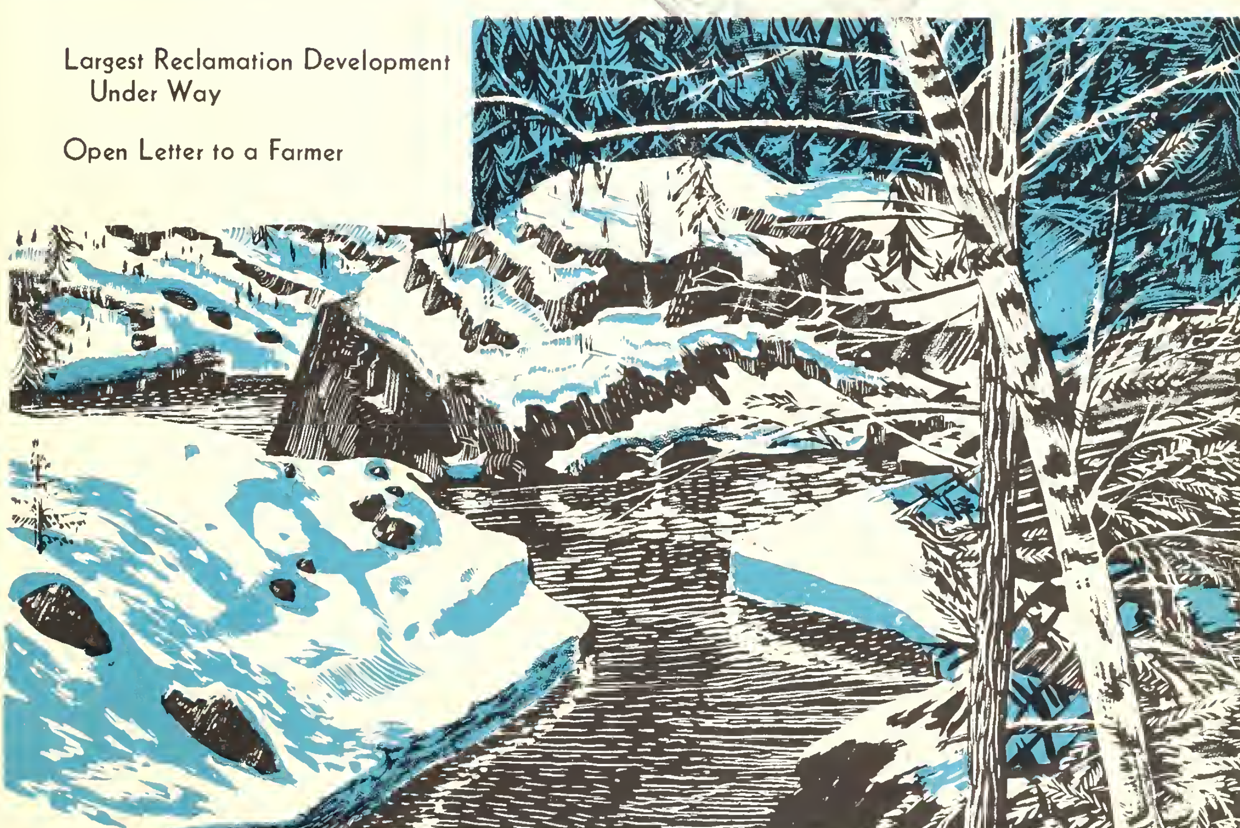

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The Reclamation Era

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Thirty Years Ago In The Era

Crop rotation is a farm practice which may be used by the farmer to increase the productivity of the soils as effectively as by the use of manure or commercial fertilizers.

DESIGN AND ILLUSTRATIONS by Drafting and Graphics Branch
Bureau of Reclamation, Washington, D. C.

J. J. McCARTHY, Editor

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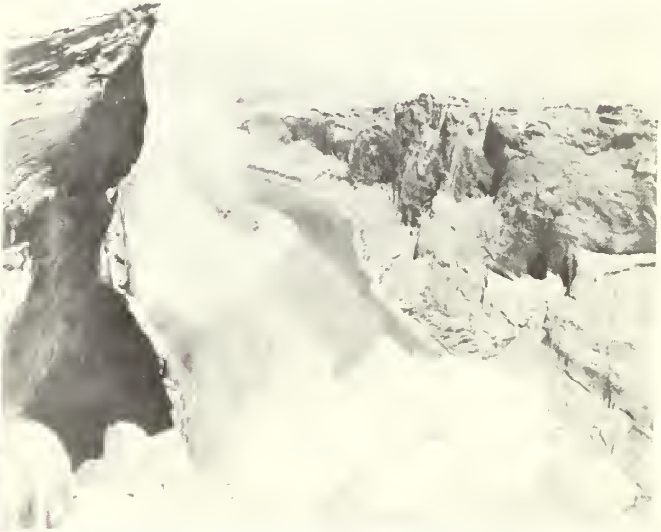
LARGEST RECLAMATION DEVELOPMENT UNDER WAY



PRESIDENT DWIGHT D. EISENHOWER in the Cabinet Room at the White House presses golden key starting construction on the Colorado River Storage Project. With the President is Secretary of the Interior Fred A. Seaton. Above: GROUND-BREAKING at Glen Canyon Dam site. Presidential photo by Abbie Rowe, National Capital Parks.

The Story of the Colorado River Storage Project

by C. B. JACOBSON
Chief, Upper Colorado River Office

PRESIDENT EISENHOWER officially initiated construction on the Colorado River Storage Project and Participating Projects on October 15, 1956, by pressing a golden telegraph key at his White House office to give the signal for explosions at the Glen Canyon and Flaming Gorge dam sites. A construction contract had been awarded on October 1 for drilling the right diversion tunnel at the Glen Canyon dam site, and the explosion signaled by Ike ripped loose rock from the canyon wall at and above the outlet portal as the first step in the tunnel construction. At the Flaming Gorge dam site, the explosion stripped rock from high on the left abutment.

Prominent officials from the States and communities of the Upper Colorado River Basin and representatives of the Bureau of Reclamation were present at both dam sites to receive the President's signal and to view the historic explosions.

Thus, October 15, 1956, is the construction birthday of the Upper Colorado River development program which had been authorized by the Congress and signed into law by President Eisenhower on April 11, 1956, as Public Law 485, 84th Congress.

The Colorado River Storage Project and Participating Projects, as the authorized basinwide development is called, is the largest single authorization in the history of Reclamation. This authorization provides for the initial phases of the ultimate development plan for the Upper Colorado River Basin.

High on Canyon rim of Glen Canyon Dam site Senator Arthur V. Watkins (center) of Utah, speaks to President Eisenhower via a special telephone-public address system hookup at the ceremony. L. to R.: L. F. Wylie, Project Construction Engineer, Glen Canyon Dam; Senator Watkins; E. O. Larson, Regional Director, Region 4.

Four units for storage and power are authorized under the Colorado River Storage Project. They are the Glen Canyon Unit, on the main stem of the Colorado River in northern Arizona at a point about 15 miles upstream from Lee Ferry on the boundary between the upper and lower Colorado River basins; Flaming Gorge Unit on the Green River in northeastern Utah; the Curecanti Unit of 3 or 4 dams and powerplants on the Gunnison River in Western Colorado; and the Navajo Unit on the San Juan River in Northern New Mexico. The construction of 11 irrigation and multiple-purpose projects participating in the upper basin plan is also authorized. Five of these participating projects (Silt, Paonia, Smith Fork, Florida, and Pine River Extension) are in Colorado; three are in Wyoming (LaBarge, Seedskadee, and Lyman); two are in Utah (Central Utah and Emery County); and one (Hammond Project) is in New Mexico. The Eden Project now nearing completion in Wyoming will also be assisted by the power revenues from the Colorado River Storage Project.

The initially authorized group of storage units and participating projects will result in construction of 17 dams which will provide nearly 36 million acre-feet of reservoir capacity; over 1,200,000 kilowatts of hydroelectric installed capacity; 48,800 acre-feet annually of water for municipal and industrial uses; a full water supply for 132,000 acres of new land; and a supplemental water supply for 240,000 acres of land now suffering from shortage of irrigation water.

The combined water surfaces of the reservoirs will approximate 400 square miles. Tremendous opportunities for recreational activities will be offered, such as swimming, boating, fishing, picnicking, camping, and enjoyment of scenic areas heretofore inaccessible to the general public.

The 17 dams, if placed one on top of the other, would rise to a height of ¾ mile; end-to-end, they would extend more than 6 miles. About 60 million cubic yards of earth materials and about 6 million yards of concrete will go into these dams.

The haulage of cement and pozzolanas for the 5,000,000 cubic yards of concrete to be placed in Glen Canyon Dam alone would require the delivery of 20-ton truck loads at 45-minute intervals around the clock for 4 years.

Construction of the 4 authorized storage units and 11 participating projects will require an estimated 185,000 man-years of labor. This labor requirement would be split into two parts—⅓ at the site of construction and ⅔ in the off-site production of necessary materials and in meeting transportation and administrative needs. The basic materials, such as iron, steel, copper, aluminum, cement, and lumber, must come from far-flung sources. From their beginning as raw materials to final finished products delivered to the project sites, thousands of man-years of labor are required in mines, forests, transportation, processing, fabrication, distribution, and administration. Thus, every state in the Nation will be beneficially affected.

Glen Canyon Dam is the largest of the storage

GROUND-BREAKING explosion at Flaming Gorge Dam site. View is looking downstream to the dam site. Photo by F. H. Anderson, Region 4.

units. It will rise 700 feet above bedrock and create a reservoir of 28 million acre-feet extending 186 miles up the Colorado River. The crest length of the dam will be 1,400 feet, and the volume of concrete will total about 5 million cubic yards. The 8 generating units to be installed in the powerhouse will have a total capacity of 900,000 kilowatts. The total construction cost, including an apportioned share of the authorized transmission system, is estimated to be $421 million.

The right diversion tunnel at the Glen Canyon dam site is now being excavated. Access roads to the dam site are now under construction. An alternate route for U. S. Highway 89 will cross Glen Canyon on the highest steel arch bridge in the United States at a point 870 feet downstream from Glen Canyon Dam. Bids for construction of this bridge were opened on December 18. About 2 years will be required to complete construction of this magnificent steel bridge.

The prime contract for Glen Canyon Dam will be awarded in the spring of 1957, according to present schedules. The prime contract will include construction of the dam, the powerhouse, the left diversion tunnel, the lining of both diversion tunnels, and the two cofferdams needed to divert the Colorado River during construction of the dam.

Diamond core drill operating near axis of Flaming Gorge Dam site. Photo by F. H. Anderson, Region 4.

L. to R.: Interior Secretary Fred A. Seaton; President Dwight D. Eisenhower; Reclamation Commissioner W. A. Dexheimer in the Cabinet Room at the White House. Photo by Abbie Rowe, National Capital Parks.

Flaming Gorge Dam will rise about 500 feet above bedrock and have a crest length of 1,200 feet. About 1 million cubic yards of concrete will be placed in constructing this high dam. The reservoir behind Flaming Gorge Dam will extend 94 miles upstream, nearly to the town of Green River, Wyo. About 4,000,000 acre-feet of water will be impounded. The estimated cost is $57 million.

A temporary access road is now being built from Linwood, Utah, to the Flaming Gorge dam site. Drilling of the single diversion tunnel at the Flaming Gorge dam site will be under contract by early summer. Present plans call for issuance of the invitation for bids on the prime contract in October 1957.

As specified in the authorizing legislation, construction of the Curecanti Storage Unit must be delayed pending completion of a feasibility report. Economic consideration of the Curecanti Unit involves comparative designs and estimates of several combinations of dams, powerplants, and reservoirs on the reach of the Gunnison River near Gunnison, Colo.

Field investigations are underway at the Navajo dam site. Construction of access roads and other facilities are planned for spring of 1957. Navajo Dam will be used primarily in connection with New Mexico's contemplated new uses of San Juan

(Continued on p. 22)

UNDERWATER TELEVISION TEST AT SHASTA DAM

by A. W. SIMONDS
Engineer, Commissioner's Office
Denver, Colo.

With the present development of industrial television for underwater use, a great field of view which has formerly been seen by relatively few people, has now become visible to many. Formerly, this field, which lies beneath the surface of water ranging from a few feet to many feet in depth, could be seen only by divers, but now by means of the television camera, it can be seen by many observers above the surface.

Sunken hulks of ships, wrecks of crashed airplanes, and the under sides of modern ships are only a few of the objects which have been brought to view by means of TV. Its use is of particular interest to the Bureau of Reclamation as a means of examining the underwater conditions of hydraulic structures. In this field the underwater use of TV offers many potential opportunities.

Formerly, the examination of underwater conditions of hydraulic structures required the services of one or more divers with their accessory equipment. This arrangement has not been satisfactory at times because the conditions observed and described by the divers and communicated to the surface by telephone to parties concerned, are affected by the personal reactions of the diver. This personal factor enters into the verbal description transmitted, and may considerably alter the impressions on the minds of the parties at the surface. With a portable television camera adapted for underwater use, the surface parties can see the actual conditions which exist under water. This viewing, supplemented by a diver's commentary, enables the observers on the surface to obtain exact knowledge of existing conditions.

At present there are a number of commercial diving operators who are making use of TV equipment for underwater surveys. Inasmuch as this is a relatively new procedure, considerable interest has been shown in this method by organizations having essential underwater installations. In August 1955, a west coast diving firm offered to demonstrate its underwater TV equipment at Shasta Dam, a major structure on the Central Valley Project in California. The Bureau of Reclamation cooperated by making available barges, compressed air, electricity and other necessary items.

PREPARING THE DIVER FOR DESCENT.

The place selected for the demonstration was in the spillway bucket near the Shasta Powerplant. In this area several of the spillway apron steps were known to be damaged by erosion and cavitation, and the diving firm offered to examine some of the damaged areas with its equipment for the demonstration. By mutual agreement, arrangements were made for the demonstration.

The divers used two barges; one 18 by 40 feet for observers and a smaller one about 8 by 12 feet for an operating base. A small rowboat was available for emergency use. Compressed air was supplied from the Shasta Powerplant to the barge through a 2-inch diameter hose which was connected to a receiver sufficiently large to hold a reserve supply of air for one diver for about a 10-minute period. The individual equipment for the diver consisted of a watertight suit complete with boots, helmet, and telephone.

The TV equipment consisted of a television camera, a control unit, and two monitors. The television camera was a small unit mounted in a

TV CAMERA and light in watertight case—above. At right: CONTROL UNIT and monitors for underwater TV.

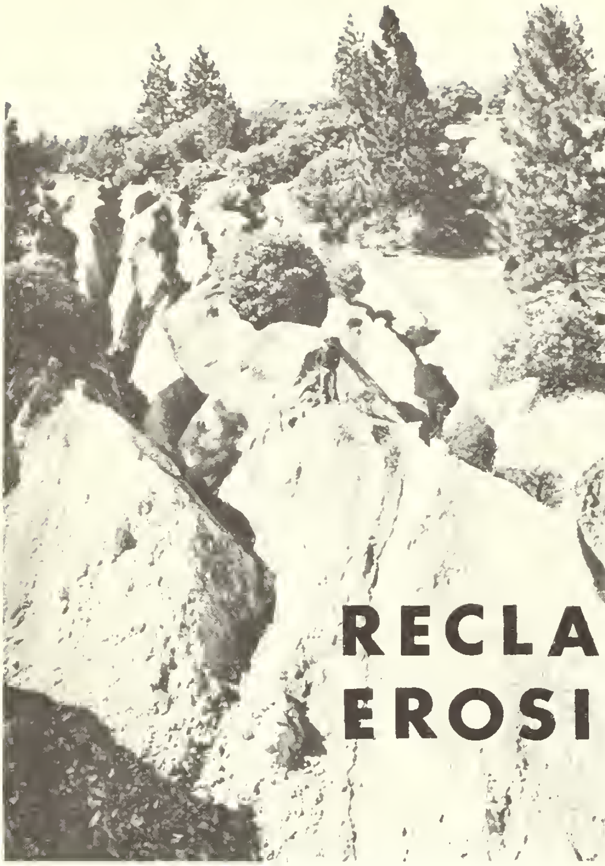
watertight cylindrical case about 10 inches in diameter by 30 inches long, having a suitable handle for carrying. A 1,000-watt underwater lamp was mounted on the forward end of the case for illuminating the area to be viewed. The camera was connected to the control unit by means of a multiconductor cable. When in use, the camera was carried under water by the diver who aimed it at the object desired for scanning.

Two monitors were provided for the group of about 25 observers. Both of these were mounted on a table on the larger barge. A tent had been erected on the barge to provide a darkened area for viewing the images shown on the monitors.

The diver with the TV camera made a descent into the spillway basin where the water was about 38 feet deep. He walked transversely on the spillway apron downstream from the spillway apron steps. The images of these steps appeared on both monitors on the barge and showed that the concrete at the downstream faces and sides of some of the steps had been eroded severely in a few places. The concrete had been worn away to a depth of several inches at several piers, sufficiently to expose the reinforcement steel. The diver carried a carpenter's folding rule, painted white, which was used to point out the defects. The images of the rule appearing on the monitors were not clear enough to read the inch markings, but the depth of the erosion could be estimated by the 6 inch sections of the rule which were readily discernible.

The images shown on the monitors were clear enough in most cases for the observers to see the exposed aggregate of the concrete. It was only when the diver walked through an accumulation of muck or silt in the plant growth on the bottom of the apron and stirred it up that the images became too cloudy to show anything.

This demonstration proved conclusively that TV is a useful and practical means of making underwater surveys of the submerged parts of hydraulic structures. ###



EROSION SCARS typical of "smelter flume" area near Shasta Reservoir. *J. D. Leeper Photo.*

RECLAMATION AND EROSION CONTROL

by L. G. TEMPLE
Soil Conservationist
Region 2, Sacramento, Calif.

The disintegration of rock into soil by the action of wind, water, freezing and thawing, is a natural phenomenon which never stops. Many aeons passed before man appeared upon the scene and then only in places where through erosion, enough soil had been formed to support plant life.

For thousands of years man led a nomadic life, due to his top soil becoming impoverished, blown away by high winds, or washed away by floods. As the earth's population increased, so the demand for soil to grow food increased, and man began to realize that the answer was not in flight, but in conservation and fertilization.

Until relatively recent times conservation of our natural resources was more or less a hit and miss proposition, with too little coordination, and little or no effort made to inform the general public of the seriousness of the problem.

When the question of soil conservation arises, inevitably the question is asked "How much will it cost?" When we consider the fact that some three billion tons of top soil are lost each year in these United States by excessive erosion, and that 600 to 1,000 years are required to form one inch of top soil, a more important question may well be "How much is our Nation's future worth?"

For many years the Bureau of Reclamation has been cognizant of the many soil erosion problems and that while much has been done, much more work remains to be done to reduce the loss of top soil to a minimum. These problems are of particular interest to the Bureau when they affect lands or facilities under its jurisdiction, as illustrated in the Keswick Dam area.

From about 1900 until 1925 three smelters were in operation along the Sacramento River in the canyon north of Redding, Calif. The acrid fumes from these smelters completely denuded the west watersheds of all vegetation, between the old towns of Keswick and Kennett. With an annual rainfall in excess of 60 inches, mostly between October and April, falling upon these barren and rugged slopes, the terrain was reduced to a maze of gullies, with the eroded soil, sand, gravel and even large rocks going into the Sacramento River.

Prior to the construction of Shasta Dam and Keswick Dam, the eroded material from the watersheds was carried through the canyon and down the valley, by the annual flooding of the river. After the dams were constructed, this material could no longer be sluiced out of the canyon, but remained in the reservoirs.

Since 1925, considerable natural recovery of plant material has taken place, principally Manzanita and several species of Ceanothus. A planting program of conifers by the C. C. C. camps produced fair results. The U. S. Forest Service also established plantations of conifers in several places on the watersheds. These attempts to reforest the watersheds were valuable contributions, but were not the answer to a serious problem, as the gullies continued to grow deeper and wider, undercutting many of the conifers.

One of the principal interests of the Bureau of Reclamation was to find a practical solution to the erosion problem, in order to increase the potential lives of the reservoirs. Therefore a study of the watersheds was started in 1946. After some two years of investigation and experimental work, a three-phase plan of control was adopted, with all three phases being carried on concurrently according to the seasons.

Phase 1: Construct a series of check dams in all gullies, using brush and rocks available at the dam sites, trapping as much eroded soil as possible, and at the same time reducing erosion by breaking the velocity of the water flowing down the gullies.

Phase 2: Plant broadleaf seed, seedlings and cuttings of broadleaf plants at check dams and on denuded areas. Broadleafs established at check dams provide living barriers after the brush has decayed and on the denuded areas they will eventually provide protection against "raindrop erosion," also their roots and fallen leaves will provide further protection against surface erosion.

Phase 3: Reforestation of the entire watersheds with Ponderosa and Jeffrey pines. This is the long range phase, and while it is very important in the overall plan, it could not accomplish the desired results alone.

Considerable experimental work with various species of broadleaf plants indigenous to this region was carried out for the purpose of finding plant material which would produce the best results for the least amount of money and time expended.

Obviously the numerous types of grass used successfully against surface erosion on rolling land would be of little or no value on these rugged slopes, subjected to torrential winter rains and long, hot, dry summers.

Several species of plants which were known to be excellent for the purpose, had to be discarded due to propagation difficulties and excessive labor costs. Some species so discarded include Wild Blackberry, Wild Grape, Toyon, and several species of Ceanothus. Fortunately, natural distribution of these plants by birds and animals is very encouraging.

Those species which have proved advantageous and comparatively inexpensive to establish are Redbud, Willow, Acacia, Spanish Broom, Oleander and several species of Oak. All seed, acorns and cuttings are harvested locally by our own crews, thus only labor and transportation costs are involved.

Ponderosa and Jeffrey pine seedlings are purchased from the U. S. Forest Service under a cooperative agreement, at a nominal price.

Construction of a series of check dams in all gullies provides the mechanical means of holding eroded soil for immediate results, and the soil thus trapped provides the medium for plant growth. Each check dam breaks the velocity of the water flowing down the gullies and as long as the dams remain intact the gullies do not grow deeper.

The worst gullied condition is found in deep

Above: EROSION CONTROL. Overall view of 8-foot rock dam. Below: PONDEROSA PINES which made exceptionally good growth. ***Photos by J. D. Leeper and H. Colby.***

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clay with little or no rock available for dam construction, therefore most of the check dams are constructed with Manzanita brush. The species of manzanita used in check dam construction is a large shrub or small tree, with spreading stiff branches, and hard, oily wood, which decays slowly.

These brush dams are very effective if properly constructed, and failures have been small in number, probably less than 1 percent. The cutting of this brush for dam construction offers no serious erosion problems, as the ground under manzanita is literally covered with seed and it germinates readily when the overhead brush is removed.

During 1950 and 1951 we were quite concerned about the pine seedlings being severely trimmed by rodents and deer. We put into effect a poisoning campaign against rodents but there was little or no difference noted between heavily poisoned and unpoisoned areas. However, by late spring of 1952, there was ample proof that the severe trimming killed few, if any seedlings. Even a large percentage of seedlings cut off below the needles survived. We did notice that pine seedlings so damaged have heavier trunks, with spreading growth habits.

A survival check on 4 test plots of pine seedlings, over a period of 3 years showed the following results:

	Percent
North slope	94
East slope	76
South slope	35
West slope	60
Average survival	66.25

KESWICK WATERSHED view from cut bank above railroad looking southeast at wash into Keswick Lake. ***Photo by J. D. Leeper.***

Treatment of the Keswick Reservoir watersheds was given priority over the Shasta Reservoir watersheds, due to the much smaller capacity of the Keswick Reservoir. Treatment of the Keswick watersheds will be completed by the end of 1957 fiscal year.

The watersheds will be observed for several years for the effectiveness of treatment and its potential need for supplemental treatment.

As of May 18, 1956, the following work had been accomplished on the Keswick watersheds:

Check dams constructed (all types, sizes)	157,483
Pine seedlings planted	2,038,941
Oak (acorns) (all species; 120 to pound) pounds	59,571
Broadleaf seedlings planted	176,314
Broadleaf seed planted (pounds)	785
Willows, willow cuttings planted	302,459

Unfortunately we cannot lay claim to having found a panacea for all erosion problems, in fact, so many factors must be considered that each erosion control project requires treatment according to existing conditions. It is believed, however, that the "Three-Phase Plan" is the best answer to this particular problem. ###

New Recreational Folder Available

A new recreational folder, entitled "Reclamation's Recreational Opportunities," has been published by the Bureau.

The folder lists 140 reservoirs on Reclamation projects throughout the 17 Western States. It also contains information as to specific locations of these reservoirs· the name and location of the administering agency and specific facilities available, such as swimming, fishing, boating, hunting, camping, picnicking, and lodging. The folder also contains a map on which the name and location of each reservoir is indexed.

Copies may be purchased for 15 cents each or $9.50 per hundred from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

"EACH YEAR over 1,000,000 acres of cultivatable land is going into homesites, industrial and commercial developments, defense establishments, highways, airports, and other nonagricultural uses."—D. A. Williams, Administrator, Soil Conservation Service.

The how and the why of wildlife and windbreak plantings are told in this

OPEN LETTER to A FARMER

ABOUT THE AUTHOR

For many years, the author has been in charge of the Game and Fish Department habitat development program, with particular emphasis on the less-known species of shrubs, grasses and legumes.

by GLENN KINGHORN

REPRINTED FROM "COLORADO OUTDOORS", MAY–JUNE '56

Mr. JOHN FARMER,
Star Route, Prairie View, Colo.

DEAR JOHN: So you want to landscape your farm "for the birds." By "the birds" I assume you mean pheasants, not the "city birds" who chase them; and I assume that you want both beauty and some wind protection as well.

If you want wildlife around, why not include other upland game—rabbits, quail, mourning doves—and maybe a few deer? You know there are now wild deer in every county in Colorado. Might as well grow your own, what?

. . . and you didn't tell me too much about the farm you wish to landscape. I assume it's in the eastern half of Colorado, probably dryland. If it's irrigated, any good nurseryman can help you. There are hundreds of plants that will thrive with irrigation. I'll get to them later.

If your farm is on the dryland that's a "goose with different markings." Any kind of a planting on dryland calls for extra care and planning. That area—the eastern 40 percent of Colorado—is part of what John C. Calhoun called the "Great American Desert." Homestead acts, timberclaim acts, and numerous other methods were tried to encourage development of the drylands.

Books have been written, Mr. Farmer, about what happened to your dry farm, and the difficulty it had in becoming a farm, but little attention has been given to what happened to the game that called it home a century ago.

The chance to help make it a home for game and birds intrigues me very much. While you're doing that, you can also add improvements that will mean dollars to you in many other ways:

1. Landscaping around your buildings will add greatly to their appearance, hence to their value. (I'll quote some figures for you sometime—they're astounding.)

2. Protection from wind and storms will pre-

Planting machines have been developed in recent years which can be trailed behind any vehicle and which can be adjusted to any planting depth down to 15 or 16 inches.

Species of crabapples have reached four feet in two growing seasons and withstood drouth, jackrabbits and winds, but they had very careful cultivation and were kept free from weed competition.

Farmers on the Canadian prairies have learned to stop blowing snow and pile it up on their lands for the benefit of their crops. They cross-plant their fields—checkerboarding is one term often used up there—and have reduced winds as much as three-fourths, cut soil blowing and evaporation. They learned to live with the climatic conditions. The province of Saskatchewan has provided as high as 205 million seedlings per year to a total of 100,000 farm units during the past 55 years.

vent livestock losses almost sufficient to pay for the windbreak developments.

3. Windbreaks and cross-field plantings, like they make in Canada, will eliminate soil blowing, during dry years, pile up *your* snow and a lot of that from your neighbor's farm on *your* farm, instead of allowing it to blow on into Kansas or Oklahoma. You could add 6 to 10 inches of moisture to your land almost any year, simply by trapping the snow that falls plus that which blows over your farm. Think of the insurance on crops from that much more moisture! In wet cycles you might be able to eliminate a whole year of summer fallowing.

4. * * * and think of the extra food and cover such plantings would make for pheasants, quail, rabbits, doves, and we mustn't forget the deer for they'll be there when the cover and browse get thick enough. Heck! You might be selling one day hunting permits at a dollar a throw before too long—and with the kind of hunting you might create, sportsmen would be glad to pay it!

5. With all those trees and shrubs, think of the haven for songbirds! They would come in handy in controlling insect pests on your crops.

6. Don't overlook the chances of getting a lot of fruit trees and shrubs in your plantings. Your place could be a mighty popular farm on week-ends—let your neighbors pick fruit on shares and you could go fishing and still keep the Missus busy canning.

If you like asparagus, try some in the rows between the trees. It does very well, stops blowing in sandy soils, and birds like the seed. After the second season you should have enough to freeze for your winter supply.

Now—are you satisfied that your idea is even better than you thought? If you are, let's get down to planning it.

First, if you don't have plenty of water you'd better summer fallow all areas to be planted. Store up enough moisture to assure that the trees and shrubs can grow. The first week or 10 days after transplanting is the critical period for any plant.

Second, visit your local nurseryman or county agent. Get his advice. Make a detailed plan so you'll know what comes next—you probably won't be able to do everything the first year. Then order your plants for delivery when you are ready for them. For your plantings around the house you will want larger stock and can get it the first year. For your field plantings it may take a year for the nurseryman to grow or secure the seedlings. Get your order in early.

Actually, Mr. Farmer, there are so many ways of landscaping your farm that I don't know where to start. So many things are involved: kind and depth of soil; average rainfall in your area; slope of your land and its drainage; direction of prevailing winds; size of your cultivating equipment—see what I mean?

Suppose we try to strike an average. You want a windbreak on the windward side of your home and farm buildings. Keep it far enough away—at least 200 feet—so it won't pile the snow right against your house, or machine sheds or into your corrals during blizzards. Be sure to leave a 15-

or 20-foot strip on both sides for a fireguard—and keep it clean!

I suggest at least 3 rows; 5 would be better. I'm enclosing a little sketch listing some of the plants you might try. You've got a wide choice of low shrubs for the outside (or windward) row. You may alternate various species, but they should be planted 2 or 3 feet apart. They will form the low "skirt" for your windbreak and "slowup" ground blizzards that are so frequent in your region.

The second row should be of taller shrubs or small trees, 12 to 16 feet inside the first row. Plants should be spaced 10 to 15 feet apart.

In a 3-row planting the inside row—about 16 to 20 feet from the second—might consist of shrubs similar to the outside, but I prefer evergreens—either pines or Colorado blue spruces and Rocky Mountain red cedars. They should be 10 to 12 feet apart to make a dense planting when they get larger. Spruces take a little more water, but they are worth it.

In case you wish a 5-row windbreak, the center row should be at least 20 feet from those on either side. I might mention that of those species mentioned on the sketch, hackberry is best, but a slow grower; Siberian elm grows fast, but breaks under snow and isn't too winter hardy; and cottonless cottonwoods are O. K. only if you have plenty of water or a high watertable. The plants should be at least 20 feet apart.

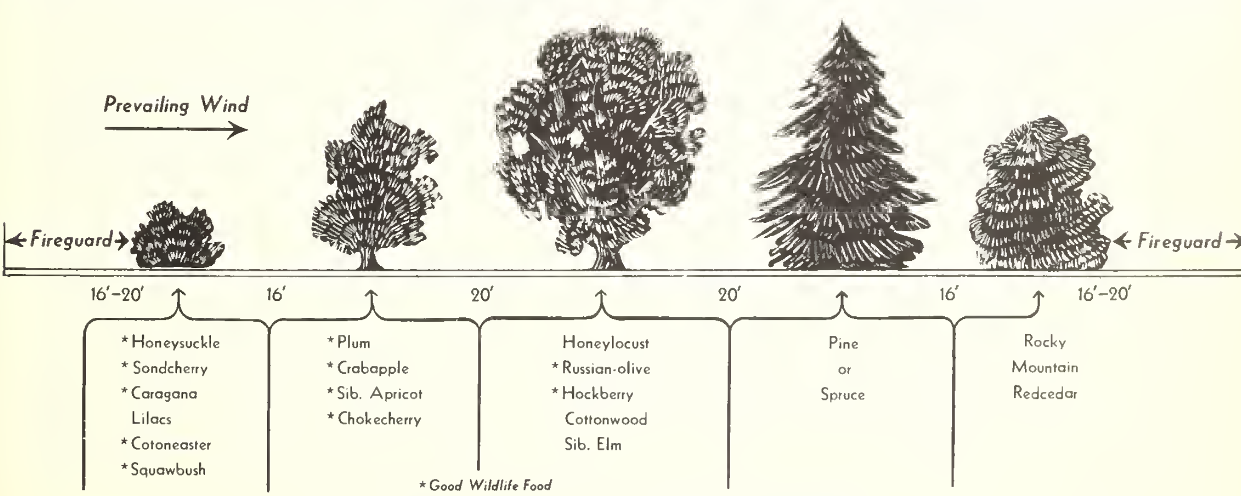
The fourth row could consist of some of the smaller trees or taller shrubs used in the second row, but I prefer to use evergreens in both the inside rows—pines or spruces in the fourth row and red cedars in the fifth, on the side toward the house. That gives the evergreens the protection of the other three rows while they are getting established, and the extra snow that would be piled up around them in the wintertime would almost guarantee their making excellent growth.

Anyhow—it will be those inside rows you will see from your home. Why not have a nice evergreen windbreak to look at the year 'round? Then, too, ever notice how pheasants and quail love evergreens, especially in the winter? They would be holding conventions right in your own front yard—visible from your picture window.

And deer? I almost forgot. They'll be there, too. I well remember an old doe and her fawn that lived in my plum thicket not over 75 yards from my back door on the farm. They kept the falling apples cleaned up each fall, jumped the fence and got fat in the neighbor's cornfields, but returned to the thicket each evening for their fruit.

Of course, your planting is one thing, and taking care of it is another. Don't line out more planting than you can keep cultivated and clean of weeds. If you can haul water to the tiny seedlings a few times the first spring, that will help them get started right. Everything depends on that first 2 or 3 weeks after planting. Those species I mentioned above are very resistant to drouth, and will start easier than most others. But—until they get started to grow, you have nothing.

Competition from weeds and lack of cultivation have killed millions of seedlings that have been planted on farms all over eastern Colorado—and, for that matter, up and down the High Plains of



Here's a closeup of a 5-ROW PLANTING.

Top Photo: Colorado blue spruce, Rocky Mountain redcedar and Western yellow pine—planted in 1923 on the high plains of eastern Colorado and spaced 16 by 16 feet, have withstood two severe periods of drouth, formed a considerable area of forest floor, and provided cover and some food for uncounted hundreds of game birds and animals. Immediately above: Native plum, choke cherry, Siberian apricots and crabapples are doing fine on sandy soils south of Akron, Colo. Note older planting of hackberry and elm at extreme right. At right: Dwarf caragana and honeysuckle, with Siberian elms between, have withstood 3 years of drouth (2- to 5-inch rainfall) mainly due to excellent, clean cultivation.

At left: Squawbush, plum and elm, with Russian olive and caragana on inside, have formed a good windbreak in 5 years in east-central Colorado—right in the heart of the drouth area. Below: Siberian apricot not only produces a goodly supply of fruit about every other year, but it makes a beautiful small tree or large shrub for the second row of a dryland planting. Note native plum at extreme left. Bottom photo: Sandcherry, native plum and Siberian elm are thriving early in their growing season, in spite of drouth.

the Dakotas, Montana, Eastern Wyoming, Western Nebraska, and Kansas. I suspect that not over 2 percent of what homesteaders and others have planted has grown. But those that have been given good care, even in drouth years, have survived, grown into sturdy specimens, and made HOMES out of what used to be only homesteaders' "soddies" or farmers' houses.

Another idea before I close, Mr. Farmer. The way those Canadian farmers have stopped the winds and piled up the snow on those vast prairie lands to the north of us! You can see from the photos I'm enclosing that they've carried it 'way past the experimental stage. It's amazing what crops they are growing up there where the snows never used to stop until they reached the wooded areas of eastern Manitoba and Ontario.

Single rows of caragana, interspersed with Manitoba maple (we call it boxelder) planted every 20 to 40 rods across great fields—making a giant checkerboard of the area—have done wonders. The Dominion Government ran tests which showed that *the wind velocity could be reduced by four-fifths at a distance of 50 feet inside a 1-row planting*, and even by one-fourth at 250 feet from it. The farmers started in earnest about 30 years ago and now are planting millions of seedlings each year.

It's an idea! You might try some honeysuckles or caragana or possibly some of the hardier crabapples to break up the wind out in your fields. Leave enough room at the ends of the rows to move your machinery from field to field.

In the event that you may wish to put your wildlife or windbreak plantings on some of your irrigated land, let's look at points which should be considered:

1. Don't overlook the fact that water costs money in our Western States. Use those species of plants which don't require too much water yet which grow rapidly under reasonable irrigation and reach utility size within 2 or 3 years. In my opinion the cost of extra water needed for good windbreaks is money well spent but some folks disagree.

2. You can use closer spacing between rows under irrigation than on the drylands—just wide enough to permit each species to develop without crowding or being crowded by adjacent plants. Be sure your cultivating equipment works well in the row-spacing you select.

Ponderosa or Western Yellow Pine have grown to 5 and 6 feet in almost pure (blow) sand in 6 years.

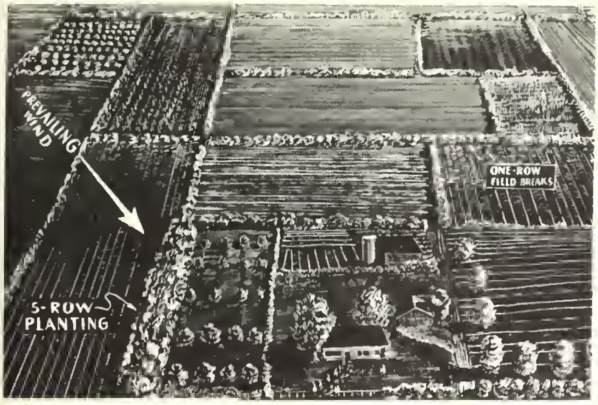
3. A much greater selection of species is available to you where you can irrigate. Consult your local nurseryman, county agent or some of the technicians with the Bureau of Reclamation, Soil Conservation Service or your Game and Fish department. Include some commercial varieties of fruits in those center rows—apples, cherries, plums, apricots, pears, peaches, etc. You might even plant 1 or 2 rows of grapes on the inside. You see the possibilities are much greater for variety when you have irrigation water.

4. One word of caution—don't irrigate your planting too late in the summer. I find that 6 to 8 weeks before first frost will keep the plants in good condition until time for them to go dormant.

Now—just a few odds and ends.

You want pheasants. Contrary to what some folks would have us believe, pheasants love to be around people, if they are not disturbed too much and frightened. I have had them eat with my chickens right in the barnyard. Aerial censuses in South Dakota showed a high proportion of the pheasants actually using shelter adjacent to farmyards.

So—no matter where you make your farm landscape plantings, if they are dense enough and provide protection from storms, you will have bird cover, and sooner or later the birds will find it. And if you want the right species of trees and shrubs there will be plenty of winter food with which they can supplement their daily ration of waste grain from your fields. Several of my good friends who also like to have plenty of birds



AERIAL VIEW of typical planting plan.

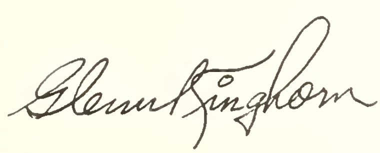
around have been leaving strips of grain or other seed crop around the edges of their fields just for the birds. It really pays off in "birds in the bag."

Heck—I've just touched the high spots of the questions you raised.

Some day when you have the time, make a simple sketch of your place. Put on the exact dimensions from buildings to roads, drives, fields, etc. Let me know something about your rainfall, soils, etc., and I'll work out a detailed plan for you.

Or—if you're in a hurry, talk with your nurseryman or county agent or both. And in any case, good luck!

Yours for more birds, better hunting, and a buck next fall,



P. S.—I'm enclosing a couple of sketches—kind'a rough but they may help you with your plans—showing how the finished plantings might look on your place. Also, some pictures of what others have been able to do with trees and shrubs.

Incidentally this SOIL BANK with its Conservation Reserve feature looks like a boon to the farmer who wishes to make a windbreak or wildlife planting. It pays for land preparation, for the planting stock, and for the cultivation for 1 or 2 years. I don't know the regulations in each State but in Colorado these payments are quite substantial—from 50 to 75 percent of the actual cost—and that's a definite help. I understand that most of the Game and Fish departments in the Western States are cooperating with the administrators of the Soil Bank so it might be a good idea to contact them. Through the Federal Pittman-Robertson Act, each State's Wildlife Conservation department is helping the sportsmen to improve game habitat of all kinds. Certainly they can furnish the technical help you will need to plan your improvements properly and they might also have suggestions for getting substantial financial help in landscaping your farm "for the birds."—K.

The Editor's Column

The following facts have been gleaned from the United States Department of Agriculture's statistical summary, dated November 1956. We hope that you find them helpful.

Heavy supplies and strong demand again characterize the farm market this fall. Export prospects are good, notably in cotton, citrus fruits, wheat, and fats, and oils. Contributing are prosperity abroad, failure of some foreign crops, and Government export programs.

Domestic consumers are spending 5 percent more for food this year than last and consumer income is expected to increase with continued expansion in economic activity.

All-crop total was estimated on October 1 at close to 1955 and only a shade below the 1948 peak. Production is continuing heavy in livestock and poultry and dairy products. Though heavy marketings have depressed prices in recent months, index of mid-September prices received by farmers was a little above a year ago.

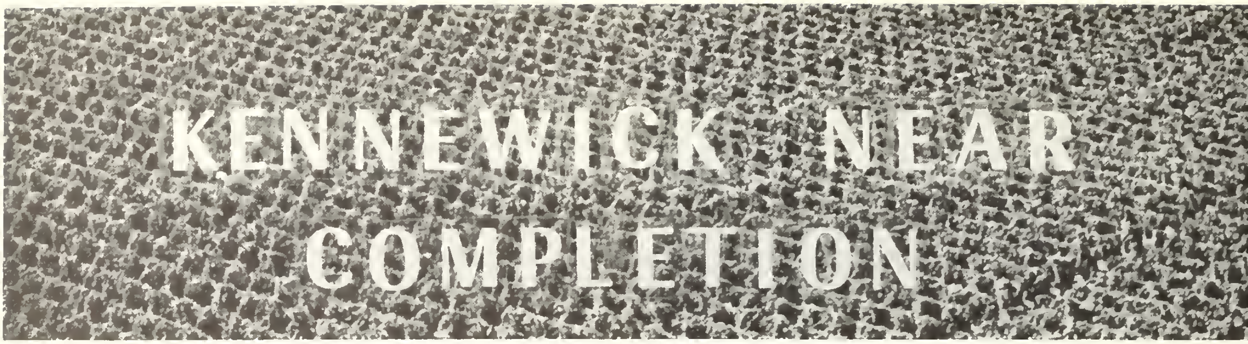
Fruit

Prices for oranges and deciduous fruits may run a little higher than last fall. Early and midseason orange crop is up 4 percent according to October estimates but exports are expected to increase. Deciduous production is down 1 percent with supplies of apples, grapes, and cranberries forecast smaller, but pears and dried prunes are higher.

Vegetables

With production up 16 percent, fall prices of fresh vegetables are expected to be somewhat lower than a year ago. Bigger supplies than in 1955–56 also are in view for processed vegetables. Farmers are expected to harvest 11 percent more

Continued on Page 20



KENNEWICK NEAR COMPLETION

by W. L. KARRER, Construction Engineer, Kennewick Division
Bureau of Reclamation, Kennewick, Washington

Major construction on the Kennewick Division of the Yakima Project in Washington drew to a close as this issue of the *Era* went to press. This Division is the fifth Division of the rich and fertile Yakima Project to be developed. As construction is practically completed, except for several miles of drains, studies are under way to assess the present feasibility of providing irrigation water to some 6,700 acres, which although an integral part of the project, were deferred during the original construction for later development.

Over half a century of dreams, plans, and hard work is represented in the Kennewick Division. At the turn of the twentieth century, private interests planned ways to bring irrigation water to the lands in the Division area. Even today traces remain of the work done by horse-drawn scrapers on the more easily constructed canal stretches. In 1912 the Northern Pacific Railroad made plans for irrigating the area, but did not follow through. Studies of the potential development were initiated by the Bureau of Reclamation in 1916, but the Division did not prove economically justifiable until the addition in 1946 of the Chandler Powerplant to the Project plan.

Construction of the Kennewick Division was authorized by the Congress in 1948 on the basis of the plan of development advanced in the Bureau of Reclamation 1946 report. In 1952 construction funds were appropriated and construction was started early in 1953.

The Kennewick Division will supply water to 14,500 acres of new lands and will also provide a gravity supply to 4,600 acres of old irrigated lands within the Kennewick Irrigation District which are now served by electric pumps. The Division

Hundreds of rows of neatly kept Concord grapes in a vineyard near Kennewick. Photo by Pomeroy, Region 1.

Aerial view of Yakima River near Prosser, Wash., showing irrigated land in contrast to virgin sagebrush. Photo by Stan Rasmussen, Region 1.

area lies wholly in Benton County, Wash., at an elevation of 500 to 700 feet above sea level, and forms a strip about 1 mile wide extending from Chandler on the south side of the Yakima River in a southeasterly direction a distance of 50 miles. The lands lie near the Tri-Cities of Richland, Pasco, and Kennewick about 15 miles from the Hanford works of the Atomic Energy Commission. The Division is served by two railroads, by river navigation to the Pacific Ocean, and by an excellent highway system. An oil pipeline from Utah serves the area with liquid fuel, and a 21-inch natural gas line from Colorado has recently been placed in service.

The Division area is quite arid, receiving only 7 inches of moisture annually, and has a growing season of 210 days. Sunshine can be expected 90 percent of the time during the summer months. The soils are fine sandy loams, and since the irrigable lands generally are quite steep, much of the irrigation will be by sprinkler methods. Specialized crops such as asparagus, mint, grapes, and soft fruits will be the main crops grown.

Division lands were in the most part privately owned, but a part of the lands were in public ownership. These public lands were divided into 17 farm units, averaging slightly over 97 acres per unit, which were opened to homestead entry in June of this year. There were 774 applicants for the units and on June 22, 1956, a drawing was held to select the successful applicants. Persons whose names are drawn had to prove that they qualify for the homesteads to assure successful settlement of the units.

The water supply for the Kennewick Division comes from Yakima River storage and also from return flows from the 460,000 acres of irrigated land upstream. The system was designed for a diversion of 5 acre-feet per acre with an estimated 1.5 acre-foot loss through evaporation and percolation, leaving 3.5 acre-feet per acre delivered over the farm weir.

In 1932 the Kennewick Irrigation District, irrigating approximately 5,000 acres, entered into a contract with the Bureau of Reclamation to rehabilitate its distribution system and pumping plant. To supply the power for the pumps, a 2½ mile canal was constructed from the Prosser Division Dam to where a penstock dropped the water 40 feet developing power which had a name plate capacity of 2,400 kw at the Prosser Powerplant. This powerplant was abandoned following con-

PROSSER POWERPLANT. Photo by T. R. Smith.

CHANDLER POWER AND PUMPING PLANT.

struction of the 12,000 kilowatt Chandler Powerplant of the Kennewick Division.

At the Chandler forebay, penstocks drop the water 118 feet into the power and pumping plant that has two 6,000 kilowatt generator units, and two 167 cubic feet per second hydraulic pumps with provision for a third for future development for 6,700 acres in the deferred area, now under study.

The irrigation canal for the first 5 miles has a designed capacity of 500 cubic feet per second to care for the eventual development of the 6,700 deferred acres. This canal continues for 45 miles and follows along the north exposure and base of a low steep range of hills known as the "Horse Heavens." The two main laterals are the Badger East and the Highlands Feeder Lateral, the first being 16 miles and the second 5 miles in length. Since most of the area served lies on fairly steep slopes and in fine silty loam soils, the majority of sublaterals are in pipe.

A second hydraulic pump, 25 miles from the head of the irrigation canal, makes use of the falling head of water released to serve the district's 4,600 acres of old lands. This pump at the Amon Siphon lifts 20 cubic feet per second 175 feet in elevation and serves 1,000 acres of new lands.

RICHARD LEE'S mint farm has produced mint oil that brought him a gross profit of $700 per acre. Photo by Stan Rasmussen, Region 1.

To restore the salmon and steelhead runs in the Yakima River, two fish ladders are being constructed through the Prosser Diversion Dam, together with a complete rehabilitation of the present fish screens just downstream from the diversion works. The river channel, through the shallow riffle sections between Prosser and the Chandler power and pumping plant, will be deepened to concentrate the flow to provide better fish passage during low water periods. To better protect upland game, 25 miles of fencing is planned along the downstream toe of the irrigation canal, where bushes will be planted for winter shelter for birds.

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FOUR STATES IRRIGATION COUNCIL MEETING

Floyd E. Dominy was a speaker at a luncheon meeting of the "Four States Irrigation Council," on January 10, 1957. The Council, composed primarily of representatives of irrigation organizations in the four States of Colorado, Kansas, Nebraska, and Wyoming, held its sixth annual meeting on January 10 and 11 at the Denver Federal Center. Mr. Dominy, who is Chief, Division of Irrigation, with headquarters in Washington D. C., discussed irrigation development in the United States and also reported on Reclamation activities he studied on a recent trip to Holland.

R. J. Walter, Jr., Regional Director, Region 7, Denver, Colo., served as Director-at-Large at the request of the Council and assisted in arrangements and development of the program for the 2-day meeting. The program included a wide range of subjects on irrigation of particular interest to the group.

APPOINTMENTS AND RETIREMENTS

A. NORMAN MURRAY

R. S. CALLAND

ARTHUR B. REEVES

CHARLES H. CARTER

PALMER B. DeLONG

Five major personnel changes occurred in the Bureau's Denver and Regional offices in time to make this issue of the *Era*.

These include the appointments of three Assistant Regional Directors, the retirement of the Chief of the Division of Irrigation Operations in the Bureau's engineering office in Denver and the retirement of the Assistant Regional Director in Region 2.

Assistant Regional Director Robert S. Calland for Region 2, Sacramento, California, was succeeded by A. NORMAN MURRAY. Mr. Calland, a native of Summerfield, Ohio, and a graduate in Civil Engineering from Ohio State University, had been with the Bureau since 1914. Commissioner W. A. Dexheimer wrote to Mr. Calland "On the occasion of your retirement I want to commend you on your long service to the Bureau of Reclamation and your contribution to the resource development of the West."

MR. MURRAY, a graduate of Long Beach City College, received his degree in Civil Engineering at Washington State College. He had an active engineering career with private corporations prior to joining the Bureau in 1939. He has advanced steadily as an engineering administrator since he became associated with the Bureau including service with the Corps of Engineers in World War II, where he was assigned to work on the design and testing of military bridges. He was serving as Acting Assistant Regional Director at the time of his appointment.

He is a member of the American Society of Civil Engineers, and resides with Mrs. Murray and their two sons in Sacramento.

ARTHUR B. REEVES, Chief of the Division of Irrigation Operations in the Bureau's engineering office in Denver, retired from Government service, November 30. Although Mr. Reeves retired after 43 years of Government service, he actually began his distinguished career in 1910, almost 47 years ago, on the Bureau's North Platte Project in Nebraska, where, after construction of the project facilities had been completed, he served as Superintendent of the Goshen Irrigation District for 4 years.

He is a recognized authority in the field of irrigation engineering. The esteem with which he is held was attested to by the scores of letters he received on the occasion of his retirement acknowledging his accomplishments and his generous contributions to the careers of other engineers.

Mr. Reeves graduated as a civil engineer from Iowa State College in 1910. He is a member of the American Society of Civil Engineers and a member of the United States National Committee of the International Commission on Irrigation and Drainage. He is author of numerous technical articles and papers on the design and construction of irrigation facilities.

The appointments of Charles H. Carter and Palmer B. DeLong as Assistant Regional Directors for Region 4, Salt Lake City, were announced by E. O. Larson, Regional Director.

These appointments are part of the increased staffing required to handle the greatly expanded Reclamation program in Region 4. Construction is in progress on the Eden, Provo River and Weber Basin projects and has started on Glen Canyon and Flaming Gorge Dams, initial key structures in the comprehensive Colorado River Storage Project.

MR. CARTER was born in Vernal, Utah, and graduated from Utah State Agricultural College in Civil Engineering. He joined Reclamation at Echo Dam in 1928 and has completed 28 years in Government service. His assignments include 5 years in Denver on designs for some of the Bureau's largest dams and a year in the Commissioner's office in Washington. He was Office Engineer during construction of many Bureau projects in the State of Utah.

Mr. Carter has been Regional Engineer since 1946 and has also served as Acting Assistant Regional Director during the past two and one-half years.

MR. DeLONG, a native of northern Utah, received his Civil Engineering degree from the Utah State Agricultural College. He joined the Bureau as Junior Engineer at Green River, Wyoming, following graduation, and served in positions of increasing responsibility at various locations in Wyoming until 1946. He was then placed in charge of project investigations in the Green River Basin. Studies completed and project reports issued under his direction include the Seedskadee, Lyman and LaBarge participating projects recently authorized with the Colorado River Storage Project. Since 1950, in addition to his project planning activities, Mr. DeLong as head of the Rock Springs office has supervised construction of the Eden Project. ###

Editors Column

Continued from Page 15

potatoes this fall than last, and farm and retail prices are relatively low. Drop in sweetpotato production points to materially higher prices than for the 1955 crop.

Wool

Returns to producers will be above those of last year. Lower prices on the 1956 clip will be more than offset by incentive payments on the 1955 clip.

Livestock

Production of livestock and livestock products in 1956 will break a record for the eighth consecutive year. Hog production is down from last fall but beef output is close to last year's high. More cattle were placed on feed this summer than last, and sales of short-fed stock are likely to rise for the next few months. This points to seasonal price reductions for choice and prime steers. Mid-October hog prices were a little above a year ago. Hog prices probably will move down more slowly this fall than last.

Diary

Milk production is at a peak rate. Milk and butterfat prices are again increasing less than seasonally this fall but continue slightly above a year ago. Milk prices have gone up less than feed since last winter but milk-feed price ratio is still above average.

"Idaho and its natural resources"

SPORT SCENES at Idaho's Sun Valley were filmed with this ski-mounted camera.

Idaho, with more reclamation project acreage than any other Western State, is the subject of a new 16-mm. motion picture in sound and color recently released by the Bureau of Mines, U. S. Department of the Interior.

Produced in cooperation with the Richfield Oil Corp., the film traces the development of the Gem State from the arrival of Lewis and Clark in 1805. It shows how integrated irrigation and power projects have paced the economic growth of Idaho and enabled it to become an important producer of farm and dairy products, minerals, and lumber. Colorful glimpses of snow-fed streams, lakes, and rivers emphasize the natural beauty and grandeur that have made the State a tourist's wonderland.

The 30-minute film includes informative sequences on mining and processing of zinc, lead, antimony, and many other minerals as well as farming scenes that show raising of the famed Idaho potato, sugar beets, and other principal crops on irrigated land. It also contains many authentic hunting and fishing scenes and a fast-moving skiing episode photographed at Sun Valley.

"Idaho and Its Natural Resources" is available on free short-term loan for showing to the Grange, water-users' associations, co-ops, 4–H clubs, civic groups, schools, colleges, and other organizations. Prospective borrowers should write to the Bureau of Mines, Graphic Services Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Prints of "Idaho" also can be borrowed from the University of California, Extension Division, Department of Visual Education, Berkeley; University of California, Department of Visual Instruction, 405 Hilgard Avenue, Los Angeles 24; Idaho State College, Educational Film Library, Pocatello; Museum of New Mexico, Museum Film Service, School of American Research, Santa Fe; North Dakota Agricultural College, Division of Supervised Study, State College Station, Fargo; Oregon System of Higher Education, Department of Visual Instruction, Corvallis; Library Association of Portland, Portland, Oreg.; Texas Education Agency, Division of Curriculum Development, Austin; East Texas Bureau of Visual Education, Kilgore; West Texas Cooperative Audio-Visual Services, Texas Technological College, P. O. Box 4380, Lubbock; and University of Wyoming, Audio-Visual Teaching Aids, Laramie.

Some of the non-Bureau centers may make small service charges for use of the film. #

WOMEN VOLUNTEERS WANTED FOR ERA

The Secretary or some other officer of each and every organization of women on our projects is requested to take her pen or typewriter in hand and write to J. J. McCarthy, Editor of Reclamation Era, *and outline her views as to how the* Era *may best serve the interests of our project women. The same invitation is extended to every woman not connected with a women's organization.*

The Era *wishes to be of service to everyone on the projects—men, women, boys, and girls. Just now the call is for women volunteers; without whose cooperation this proposed feature of the* Era *cannot be a complete success. Write today!*

LARGEST RECLAMATION DEVELOPMENT

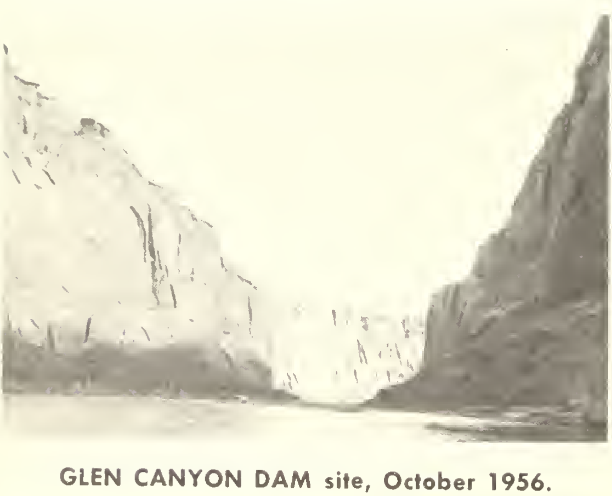
(Continued from p. 3)

River water under the proposed Navajo Irrigation Project, and the proposed San Juan-Chama Project.

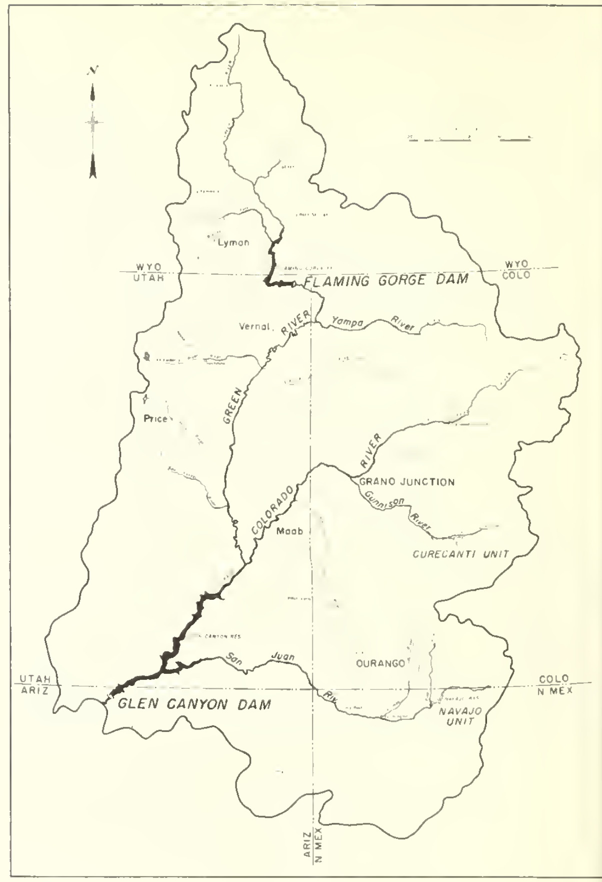
Construction on the participating projects may commence in fiscal year 1958. Work could be started on the Seedskadee Project in Wyoming, the Paonia Project in Colorado, and the Vernal Unit of the Central Utah Project. Under an orderly program of development, 10 or more years may be required to get all 11 participating projects underway, and it may require up to 25 years to complete the more complicated phases of the large Seedskadee and Central Utah Projects.

The Congress, in authorizing the initiation of the Upper Colorado River development, declared that it was not its intention "to limit, restrict, or otherwise interfere with such comprehensive development as will provide for the consumptive use by States of the Upper Colorado River Basin" of their apportioned water. On the contrary, the Act directs the Secretary of the Interior to continue the investigations of additional units of the Colorado River Storage Project and the participating projects and to report the results of these investigations to the States, President, and the Congress. The Public Law 485 specifically lists 24 such projects for priority consideration.

The 4-storage units and the 11 participating projects authorized for construction constitute the nucleus of an overall basin plan to which subsequent additions will be authorized as the



GLEN CANYON DAM site, October 1956.



needs arise in the development and use of Colorado River water alloted to the Upper Basin by the Colorado River Compact of 1922. At the present time, the Upper Basin is consuming about 2½ million acre-feet of its annual allotment of 7½ million acre-feet. Completion of the features initially authorized by Public Law 485 will increase consumptive water use in the Upper Basin by about 1 million acre-feet, raising the total use to 3½ million acre-feet.

Except for very minor amounts allocated to recreation and flood control (less than 1 percent of the total) the entire construction cost of the Upper Colorado River development will be repaid by the water and power users of the Upper Basin during a period of 50 years after completion of construction of each unit or project. In addition, interest will be paid on the costs allocated to power and municipal water, which constitute about two-thirds of the estimated total construction costs.

Over a period of 50 years (except for the Paonia and Eden Projects whose repayment periods were set by previous law), the irrigators will repay

HIGH SCALERS going over the top of right abutment—Glen Canyon Dam site.

that portion of the direct irrigation costs which is within their repayment ability. That part of the irrigation costs above the irrigators ability to repay within their respective repayment periods will be repaid from power revenues.

Power revenues in excess of those required to repay direct power costs—construction, O & M, interest, etc., will be used through a Basin Fund to assist irrigation developments in the Upper Basin States as follows: 46 percent to Colorado, 21½ percent to Utah, 15½ percent to Wyoming, and 17 percent to New Mexico.

The prospective credits to the Basin Fund from the initial storage and power units will be ample to provide the financial assistance needed by the initial group of participating projects.

In summarizing the importance of the basin-wide development program for the Upper Colorado River, Commissioner of Reclamation, W. A. Dexheimer, recently stated:

"*These things can be done at reasonable cost and are good investments whether done by local people, the States, or the Federal Government. The returns in stable, prosperous farms and communities; the returns in business and industrial activity; and the returns in local, State and Federal taxes will more than pay the cost of Upper Colorado River development in a very short period of years. In addition, we will have opportunities for recreation so vitally needed for our enjoyment of better living and particularly needed to accommodate a growing population with more leisure time, paid vacations, and early retirement.*

"*Whether you view the water conservation and development features of this program as farmers, industrialists, retailers, or just plain vacationers, I think you will find they are very worthwhile.*"

SHASTA LAKE REFORESTATION

Reforestation and erosion control on denuded areas in the mountains surrounding Shasta Lake will be accomplished under a recently announced cooperative agreement between the Bureau of Reclamation of the United States Department of the Interior and the Forest Service of the United States Department of Agriculture.

In making known this joint effort, Regional Director Clyde H. Spencer, of the Bureau, and Regional Forester Charles A. Connaughton, stated that the particular area involved is on the western shore of the lake. They stated the principal purpose to be accomplished is to provide forest cover and small dam-like structures aimed at preventing the further erosion of soil into the lake, which is the 4,500,000 acre-feet capacity reservoir impounded by Shasta Dam.

The barren condition of the area dates back to the time when the old mining town of Kennett, now covered by several hundred feet of water, was the center of an extensive copper smelting operation. Toxic fumes from the smelter killed off the trees and other vegetation on the slopes and poisoned the ground. For many years the bare slopes retained enough poisons to prevent any appreciable vegetation taking hold. Year after year the soil was washed by heavy winter rains into the gullies and canyons, and more recently, into the lake. At the present time the ground has been cleared of poisons sufficiently to allow the reestablishment of forest cover.

Subject to congressional appropriations, the work will extend over a period of 5 years, until June 30, 1962, and is expected to cost between $75,000 and $80,000 per year.

Since National Forest lands are involved, the work is to be planned and performed by the Forest Service, subject to review by the Bureau of Reclamation, and with funds made available by that agency. It will follow the general pattern of watershed reclamation and treatment accomplished earlier by the Bureau of Reclamation on the denuded slopes in the vicinity of Keswick Reservoir.

The program is scheduled to get under way next year with planting. The installation of erosion control structures will follow as rapidly as they can be planned and placed. Field work will be under the direction of Forest Supervisor Paul W. Stathem, Shasta-Trinity National Forests.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-4602	Parker-Davis, Arizona-California.	Dec. 7	Construction of a multi-channel microwave radio communication system between Phoenix, Ariz., and Parker Dam, Calif.	Westingbouse Electric Corp., Pboenix, Ariz.	$209, 593
DC-4697	Missouri River Basin, Wyo.	Oct. 25	Completion of Glendo powerplant and switcbyard	Eagle Construction Corp., Loveland, Colo.	1, 120, 447
DS-4712	Weher Basin, Utah	Nov. 28	One 2,000-bp and two 2,900-bp vertical-sbaft, hydraulic turbines for Wansbip and Gateway powerplants.	James Leffel and Co., Springfield, Ohio.	190, 000
DS-4713	Weher Basin, Utah	Oct. 10	One 1,500-kva and two 2,250-kva vertical-shaft generators for Wanship and Gateway powerplants.	Electric Machinery Mfg. Co., Minneapolis, Minn.	172, 194
DS-4723	Chief Joseph Dam, Wash	Oct. 4	Four horizontal, centrifugal-type pumping units for Brewster Flat pumping plants, Schedule 2.	C. H. Wbeeler Mfg. Co. Economy Pump Division, Philadelphia, Pa.	55, 456
DC-4733	Solano, Calif	Oct. 5	Construction of eartbwork, concrete canal lining, and structures for Putah South Canal, Sta. 338+85.12 to 1017+00; and McCoy Creek wasteway.	Vinson Construction Co., Phoenix, Ariz.	2, 143, 907
DC-4736	Columbia Basin, Wash	Sept. 28	Construction of earthwork, concrete lining, and structures for Burbank canal laterals, Block 3.	Lewis Hopkins Co., Pasco, Wasb.	302, 708
DC-4738	Middle Rio Grande, N. Mex.	Oct. 10	Construction of earthwork, clearing, and structures for irrigation rehabilitation of Belen Unit 1.	Ricbey Construction Co., St. Johns, Ariz.	156, 355
DC-4739	do	Oct. 24	Construction of earthwork, clearing and structures for irrigation rehabilitation of Nortb part of Socorro Unit 1, Schedule 1A.	Badger Lyncb, Albuquerque, N. Mex.	146, 728
DC-4739	do	do	Construction of earthwork, clearing and structures for irrigation rehabilitation of Nortb part of Socorro Unit 2, Schedule 2A.	Joseph C. Hastings, Albuquerque, N. Mex.	102, 321
DC-4739	do	Oct. 25	Construction of earthwork, clearing, and structures for irrigation rehabilitation of the Soutb parts of Socorro Units 1 and 2, Schedules 1B and 2B.	J. F. Schroeder Sons, Ordway, Colo.	256, 819
DS-4745	Colorado River Front Works and Levee System, Arizona-California-Nevada.	Nov. 6	One 12-inch hydraulic suction dredge for Lower Colorado River	Commercial Steel Fabricators, Inc., Seattle, Wash.	234, 700
DC-4747	Colorado River Storage, Arizona-Utah.	Oct. 1	Construction of right diversion tunnel for Glen Canyon Dam	Mountain States Construction Co., Denver, Colo.	2, 452, 340
DC-4749	Columbia Basin, Wash	Oct. 10	Construction of radial gate cbeck drop for Potboles East canal, Sta. 1369+11.	Cberf Brothers, Inc., and Sandkay Contractors, Inc., Ephrata, Wash.	108, 580
DC-4750	Missouri River Basin, Wyo.	Nov. 16	Two 33,500-hp, vertical-shaft hydraulic turbines for Fremont Canyon powerplant.	Newport News Shiphuilding & Dry Dock Co., Newport News, Va.	608, 750
DC-4751	Central Valley, Calif	Oct. 19	Construction of Trinity River bridge superstructure on the county road relocation, Sta. 5+55 to 8+50.	Bos Construction Co., Berkeley, Calif.	135, 860
DS-4753	Ventura River, Calif	Oct. 30	Steel pipe for Casitas Dam	Kaiser Steel Corp., Fabricating Division, Napa, Calif.	141, 776
DC-4756	Colorado River Storage, Arizona-Utah.	do	Construction of earthwork and structures for Waterholes Canyon bridge and 20 miles of access highway for Glen Canyon dam.	W. W. Clyde and Co., Springville, Utah.	1, 011, 820
DC-4758	Columhia Basin, Wash	Oct. 25	Construction of earthwork and structures for Block 79 laterals and wasteways, West canal laterals.	Henly Construction Co., Inc., Yakima, Wash.	437, 864
DS-4760	Rogue River Basin, Oreg	Nov. 30	One 23,500-hp, 600-rpm, vertical-shaft, hydraulic turbine; one governor; guard valve; and inlet pipe for Green Springs powerplant.	Allis-Chalmers Mfg. Co., Denver, Colo.	373, 245
DC-4762	Central Valley, Calif	Nov. 26	Construction of earthwork, structures, and surfacing for connecting access road from Highway 299 to Trinity River crossing.	Monte W. Brown, Redding, Calif.	696, 867
DC-4763	Solano, Calif	Nov. 26	Construction of county road bridge over Putah diversion dam pool.	C. S. Phillips Construction Co., Inc., Petaluma, Calif.	112, 530
DC-4766	Chief Joseph Dam, Wash	Dec. 12	Construction of Brewster Flat pumping plants, discharge lines, and switchyards.	Ward Construction Co., and Alton V. Phillips, Seattle, Wash.	847, 584
DC-4767	Columbia Basin, Wash	Nov. 27	Construction of White Bluffs pumping plant No. 1, switchyard, laterals, and discharge lines, Block 20.	Syblon-Reid Construction Co., Warden, Wash.	235, 146
DC-4768	Weber Basin, Utah	Nov. 28	Construction of Wanship and Gateway powerplants and switchyards.	Davis and Butler Construction Co., Salt Lake City, Utah.	445, 093
D-4771	Chief Joseph Dam, Wash	Dec. 13	One 2,400-volt motor control equipment assembly for the hooster pumping plant of the Brewster Flat pumping plants.	Cutler-Hammer, Inc., Denver, Colo.	46, 990
DS-4772	Missouri River Basin, S. Dak.	Dec. 18	Two 230-kv power circuit breakers for Sioux City substation	Brown Boveri Corp., New York.	104, 450
DC-4782	Missouri River Basin, Mont.	Dec. 27	Construction of Helena Valley tunnel and canal, Sta. 3+14.30 to 149+00.	Guy H. James Construction Co., Oklahoma City, Okla.	2, 095, 041
DC-4796	Rio Grande, N. Mex	Dec. 10	Reconductoring 72 miles of Elephant Butte-Socorro 115-kv transmission line.	Lively Electric Co., Borger, Tex.	235, 386
100C-259	Minidoka, Idabo	Oct. 3	Construction of two 3-hedroom and two 2-bedroom residences and warehouse for Unit A pumping plant, and near Rupert, Idaho.	Wright Brothers, Rupert, Idaho.	64, 820
100C-262	do	do	Construction of open drains for Unit A; and Group 4 of Unit B	Duffy Reed Construction Co., Twin Falls, Idabo.	159, 044
100S-263	do	Nov. 16	Deep well pumping units for 17 wells	Layne and Bowler Pump Co., Los Angeles, Calif.	165, 045
117C-388	Columbia Basin, Wasb	Oct. 3	Construction of Grand Coulee Dam tour center	Ruud Construction Co., Spokane, Wash.	92, 150
117C-402	do	Nov. 15	Construction of compacted eartb lining for reaches of existing lateral EL68 and construction of culvert, Block 45.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	198, 489
200C-326	Central Valley, Calif	Oct. 1	Constructing foundations and furnishing and erecting prefabricated metal auto shop and vehicle storage huildings for Tracy pumping plant and switchyard.	J. L. Webster, Galt, Calif	99, 984
400C-68	Colorado River Storage, Arizona-Utah.	Nov. 8	Completion of gravel surfacing from tbe Arizona-Utah state line to Glen Canyon dam site, Wahweap Creek road, and construction of airstrip.	Ford-Fielding, Inc., Provo, Utab.	36, 801
400C-71	Weber Basin, Utah	Oct. 2	Construction of earthwork for stahilization of slide areas on Gateway canal, Sta. 342+00, 358+00, and 397+50.	Fife Construction Co., Brigham City, Utah.	71, 093
400C-73	Weber Basin, Utah	Nov. 28	Construction of recreation area access road and livestock road relocation for Wanship reservoir.	R. M. Jensen, Contractor, Salt Lake City, Utah.	76, 312

Construction and Material for Which Bids Will Be Requested Through March 1957 [1]

Project	Description of work or material
Central Valley, Calif.	Pinning loose rock on the Folsom Powerplant tailrace channel wall and extending the concrete training wall. Near Folsom.
Chief Joseph Dam, Wash.	Constructing the Brewster Flat Distribution System will include 8,000 feet of 4- to 30-inch steel pipe, 12,000 feet of 4- to 12-inch asbestos-cement pipe and appurtenant structures. Near Brewster.
Colorado-Big Thompson, Colorado.	Constructing an outdoor-type powerhouse with a reinforced concrete substructure, installing a 6,300-horsepower turbine and a 4,500-kw generator, and constructing a reinforced concrete intake structure and an access road. Near Loveland.
Colorado River Storage, Arizona.	Constructing the 700-foot-high concrete arch Glen Canyon Dam with a 1,500-foot-long crest, excavating and lining with concrete a diversion tunnel on the left side of the river 41 feet in diameter and 2,900 feet long, and constructing an indoor-type powerplant 665 feet long, 112 feet wide, and 160 feet high, located about 500 feet downstream from the axis of the dam. The powerplant substructure and intermediate structure is to be of reinforced concrete and the superstructure of structural steel with concrete enclosure. On the Colorado River, about 125 miles north of Flagstaff.
Do	Furnishing and erecting one 2,000,000-gallon elevated steel water tank with a minimum water surface of 55 feet above footings for the Glen Canyon Community facilities, about 125 miles north of Flagstaff.
Do	Constructing about 290 residences and facilities for a 2,000-person community at Glen Canyon. About 125 miles north of Flagstaff, Arizona, and 70 miles east of Kanab, Utah.
Colorado River Storage, Utah.	Excavating in open cut and in tunnel for the 1,350-foot-long, 26-foot-diameter unlined right abutment diversion tunnel at the Flaming Gorge Dam site. On the Green River, 40 miles north of Vernal.
Columbia Basin, Wash.	Earthwork and structures for about 4 miles of unreinforced concrete-lined canal with a 12-foot bottom width and about 3 miles of unlined canal with a 36-foot bottom width. Wahluke Canal, 9 miles south of Othello.
Do	Earthwork and structures for about 85 miles of laterals and wasteways, and constructing 8 minor relift pumping plants. 10 miles northwest of Mesa.
Do	Earthwork and structures for about 80 miles of unlined laterals, wasteways and drains with bottom widths varying from 14 to 2 feet. About 10 miles northeast of Beverly.
Do	Constructing DW38, 33, 36, 38A and W654D drains. Block 72, near Quincy.
Do	Constructing about 3.5 miles of deep and semi-deep drains on the DE44.5 system. Block 43, near Warden.
Do	Constructing 6 open drains on the DE229 lateral system in Blocks 41 and 42, near Moses Lake.
Do	Constructing 3 drains on the DW36 and DW35.8G systems in Block 72, near Quincy.
Do	Constructing the DPE221A drain, extending 3 deep drains on the DPE216 system in Block 49, and constructing the DPE224C drain in Block 11, near Othello.
Do	Deepening about 2.5 miles of DE229 drain, extending 2 culverts, reconstructing about 12 drain inlets, deepening about one mile of EL31 wasteway, and removing and reconstructing a county road bridge in Block 42; deepening 8 drains in Blocks 41 and 42; and constructing about one mile of deep and semi-deep drains on the DE53.5 and DE53.5A systems; constructing a road crossing and 3 pipe drain inlets in Block 43. Near Warden and Moses Lake.
Do	Deepening one drain, constructing 7 new drains, 2 wasteways, and one pumping plant in Block 45, near Othello.
Do	Furnishing, placing and stockpiling gravel for road surfacing in Block 18, near Connell.
Do	One 3-phase, 2,000-kva, 13.2-kv delta to 2.4-kv delta, class OA, outdoor power transformer with 3 high-voltage, station-type, tank-mounted lightning arresters for White Bluffs Pumping Plant No. 1.
Do	One indoor, 2,500-volt, full-voltage starting controller for four 600-horsepower synchronous motors for White Bluffs Pumping Plant No. 1.
Eklutna, Alaska	Constructing a 34.5-kv bay at Anchorage Substation. Work will include constructing concrete foundations, furnishing and erecting steel structures and a one-day extension of existing 34.5-kv bus structure, and installing a 34.5-kv circuit breaker and associated electrical equipment. Near Anchorage.
Do	One duplex-type control board panel for the Anchorage Substation.
Gila, Ariz	One synchronous, motor-driven, vertical-shaft, centrifugal-type pumping unit with a capacity of 275 cfs at a total head of 54 feet for the Yuma-Mesa Pumping Plant.
Do	One duplex-type control board panel for the Casper Substation.
Michaud Flats, Idaho.	Constructing 7.5 miles of welded steel pipe laterals for sprinkler-type irrigation. Near American Falls.
Minidoka, Idaho	Earthwork and structures for about 7 miles of open laterals with bottom widths of from 4 to 2 feet, from 14 wells. Near Rupert.
Do	Additional drilling on eleven 8-, 12-, and 16-inch-diameter drainage wells, and drilling and casing four 16- and 20-inch drainage wells with depths of from 200 to 400 feet. Near Rupert.
MRB, Kansas	Constructing the 2,150-foot-long earthfill Woodston Diversion Dam with concrete ungated overflow spillway 150 feet long, gated sluiceway, and gated canal headworks involving placement of about 1,800 cubic yards of concrete. On the South Fork of the Solomon River about 9 miles west of Woodston.
Do	Earthwork and structures for about 10 miles of Courtland West Canal with bottom widths varying from 12 to 6 feet and about 28.5 miles of open laterals. Near Courtland.
MRB, Montana	Constructing the 75-foot-high, 2,800-foot-long earthfill Helena Valley Dam with outlet works for municipal water supply, canal headworks, and about one mile of operation and maintenance road. About 6 miles northeast of Helena.
Do	Four 7-foot 2-inch by 4-foot 8-inch bulkhead gates, seats and guides for turbine draft tube. Estimated weight: 5,875 pounds each. For Helena Valley Pumping Plant.
Do	One hydraulically-operated cylinder hoist for a 12.78- by 21.78-foot fixed-wheel gate. Estimated weight: 20,000 pounds. For Helena Valley Pumping Plant.
Do	One hydraulic control system for fixed-wheel gate hoist consisting of high-pressure oil pump, pipe fittings and valves, and necessary electric controls enclosed in a metal cabinet. Estimated weight: 3,000 pounds. For Helena Valley Pumping Plant.
Do	One hydraulic control system for 2 butterfly valves consisting of high-pressure oil pump, pipe fittings and valves, and necessary electric controls enclosed in a metal cabinet. Estimated weight: 5,000 pounds. For Helena Valley Pumping Plant.
Do	Three 5,000-kva, 110–69–34.5-kv mobile autotransformers complete with trailers.
MRB, Nebraska	Earthwork and structures for about 13.5 miles of canal with bottom widths varying from 16 to 10 feet, about 2 miles of 6-foot bottom with canal and about 2 miles of 3-foot bottom width laterals. Driftwood Canal, near McCook.
Do	Constructing open drains and appurtenant structures near Sargent.
Do	Relocating and rewiring the starter and the control and power supply equipment for three 50-horsepower pump motors at the Franklin South Side Pumping Plant near Franklin.
MRB, Nebraska-Kansas.	Constructing 11 pump turnouts, 4 gravity turnouts, and one timber farm bridge on canals between Harlan County Dam and Lovewell, Kansas.
Do	Earthwork and structures for about 4.4 miles of drain, including corrugated metal pipe drainage inlets,sheet pile and riprap drops, and extending a precast concrete pipe siphon; and constructing a 30-inch precast concrete pipe wasteway on the Franklin Canal, near Red Cloud, Nebraska.
MRB, North Dakota.	Constructing footings and furnishing and erecting steel towers for about 160 miles of single-circuit, 230-kv transmission line. Work will include clearing right-of-way and furnishing and installing fence gates. From Fargo, North Dakota, to Granite Falls, Minnesota.
Do	Constructing additions to Fargo Substation will include constructing foundations, furnishing and erecting steel structures, and installing a 115/69-kv, 25,000-kva autotransformer and associated electrical equipment. Near Fargo.
Do	One 3-phase, 5,000-kva, 110- to 34.5-kv, class OA, outdoor power transformer with 3 low-voltage, station-type, tank-mounted lightning arresters. For the Watford City Substation.
MRB, South Dakota.	Installing tile drains and regrading Watertown Substation yard area. At Watertown.
Do	Constructing open and closed drains on the Angostura Unit, near Hot Springs.
Do	Constructing footings and furnishing and erecting steel towers for about 65 miles of single-circuit, 230-kv-transmission line.
Do	Constructing additions to the Sioux Falls Substation will include grading and fencing an additional area, constructing concrete foundations, furnishing and erecting steel structures and installing one 230/115-kv, 100,000-kva autotransformer, 115-kv power circuit breaker and associated electrical equipment. Near Sioux Falls.

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The *Reclamation* Era

MAY 1957

IN THIS ISSUE:

ESIDENT SURVEYS DROUGHT AREA
UMID STATES FARMERS DISCOVER IRRIGATION

Official Publication of the Bureau of Reclamation

The Reclamation Era

MAY 1957 Volume 43, No. 2

In this issue . . .

DESIGN AND ILLUSTRATIONS by Drafting and Graphics Branch
Bureau of Reclamation, Washington, D. C.

J. J. McCARTHY, Editor

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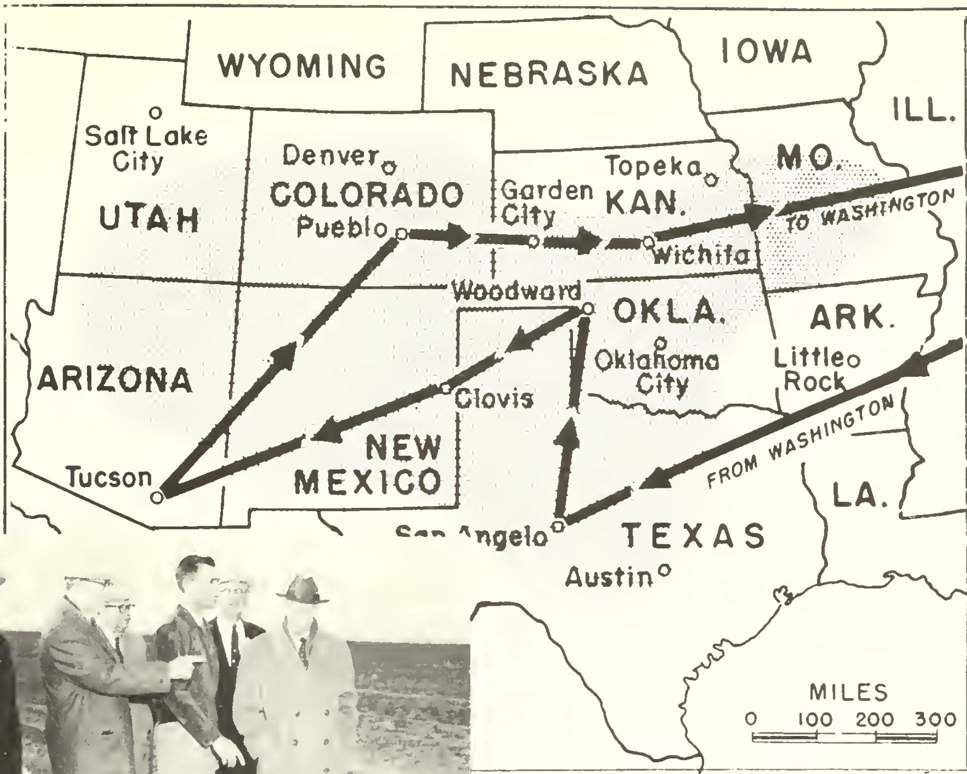
* * *

30 Years Ago in the Era

Let us develop the resources of our
 land,
Call forth its powers,
Promote all its great interests,
To see whether we also,
In our day and generation,
May not perform something to be
 remembered.

—*Daniel Webster.*



Left to right: Interior Secretary Fred A. Seaton, Agriculture Secretary Ezra Taft Benson, San Angelo County Agent Ed Hyman, Wilbur Block, Vice Chancellor D. W. Williams of Texas A&M College System, and President Dwight D. Eisenhower at Mr. Block's farm in San Angelo, Texas. *All Photos in this article by Abbie Rowe, National Capital Parks.*

President Surveys Drought Area

by OTTIS PETERSON

PRESIDENT EISENHOWER has injected renewed vigor into water resources development as the result of a personal "look-see" in the critical southwest drought area in January.

In his State of the Union message earlier in the month, the President said "*water is fast becoming our most valuable resource*" and then called for even greater comprehensive planning for the maximum multipurpose development of our river systems.

In the course of a flying trip to Texas, Oklahoma, New Mexico, Arizona, Colorado and Kansas, the President surveyed the immediate drought situation and emergency measures which are being taken to meet the crisis. But in concluding the trip at a Great Plains planning meeting at Wichita, Kansas, on January 15, the President included the following long range water and land management needs:

> Editor's Note: Mr. Peterson, Assistant to the Commissioner, Information, toured the drought area in the accompanying press plane.

1. Develop further usage of our land and water resources, by range improvement and better management of watersheds.

2. Continue and expand research in better land and water use, in weather forecasting, in evaporation and transpiration reduction methods, and in saline water conversion. Further research and improvement in weather services to agriculture are needed. This includes monthly and seasonal forecasting that will better equip farmers and ranchers to adjust their operations to the climatic problems of these states.

3. Achieve maximum conservation and storage of surface and ground waters for agricultural, industrial and municipal purposes.

Going the whole route with the President were Secretary of the Interior Fred A. Seaton and Commissioner of Reclamation W. A. Dexheimer. They were called upon on several occasions to explain existing and potential water development projects which could assist in alleviating any drought situation.

PRESIDENT EISENHOWER at farm of Raymond Worrell, Clovis, N. M.

Left to right foreground: Carl Peoples, President Eisenhower, and Secretary Benson inspecting results of drouth at Mr. Peoples' farm, Woodward, Okla. Gentleman at left rear is unidentified.

Both Secretary Seaton and Commissioner Dexheimer made it plain that a reclamation project will not prevent drought but explained that the production from irrigated land is invaluable in times of drought by stabilizing the economy to a degree and particularly in providing feed for livestock herds.

The first stop, Sunday night, January 13, was at San Angelo, Texas. At a Monday morning breakfast, Harry Burleigh, head of the Bureau of Reclamation area investigations office at Austin, Texas, explained the proposed San Angelo project and the Gulf Basin investigations for the President and a group of about 25 people.

The President visited farms in the immediate vicinity of San Angelo, Texas; Woodward, Oklahoma; and Clovis, New Mexico, before stopping at Tucson, Arizona, for the second night of the tour, Monday, January 14. The following morning, during a stop at Pueblo, Colorado, he visited the ranch of E. A. Davis, traveling through territory which will be served by the Fryingpan-Arkansas Project.

Particularly striking was the contrast between irrigated lands on one side of the canal, where sugar beets had been harvested last fall, and sun-baked range land on the upland side which has been so dry for the last 3 years that cattle and sheep have been kept off of it. This has been necessary to save the little grass still on the range and prevent major erosion.

While the President was on his tour, a planning group was busy at Wichita on both emer-

Secretary Seaton and President Eisenhower at The Earl Byrd Ranch, San Angelo, Texas. These cattle were fed cottonseed pellets and prickly cactus burned by a flame thrower to make it edible.

PRESIDENT EISENHOWER getting FIRST HAND REPORT at the Earl Byrd ranch. With him (L. to R.) are Secretary Seaton, Vice Chancellor Williams, and County Agent Hyman.

gency and long range measures for drought alleviation. N. B. Bennett, Jr., Chief of Project Development, represented the Bureau of Reclamation on the subdivision particularly concerned with water utilization and conservation. Harold H. Christy of Pueblo, National Reclamation Association Director for Colorado, chairmanned this group.

A reexamination of storage space in existing reservoirs was urged by this group as a means of saving additional water through the drought years if the runoff permits. This was the principal immediate relief which the conference believed could be provided from water conservation projects. In the long range picture, the group looked to a pickup in investigation, authorization and construction of future projects and accelerated research programs in such vital fields as evaporation loss and saline and brackish water purification.

# # #

THE PRESIDENT meeting the Wilbur Block family and friends.

Cachuma's Recreation Record

View of concessionaire's boat dock, mooring area, tackle shop, and snack bar. *Photo by D. E. Creighton, Jr.*

In developing and managing the Cachuma reservoir area for recreational use Santa Barbara County, California, has pioneered procedures and methods which may provide useful guidance to other localities in which reservoirs are situated or proposed. The steps which the County took in reaching its decision to manage the area and the pattern which it has established for administration have been so successful that they merit recording as an example for others to consider.

Before reservoir construction started, when the Cachuma Project was still in the planning stage, a report on the recreational potential of the Cachuma reservoir area was prepared by the National Park Service. The preparation of such reports is customary procedure in Reclamation planning. The report of the Park Service showed that the recreational use would be high. It did not indicate whether recreational use should or should not be permitted since this is a matter of local and State regulation and policy. However, the advisability of such use was considered very carefully by the County Water Agency. The consensus of Agency representatives at a meeting in November 1947 was that boating and angling be permitted. Concerning administration of recreational use the National Park Service recommended that it be a County responsibility.

by EVERETT A. PESONEN
Conservationist
Bureau of Reclamation
Sacramento, California

The first step toward possible County management was taken on March 19, 1949, when the Board of Supervisors designated the County Planning Commission as the agency to coordinate matters pertaining to planning and development of the Cachuma reservoir area. The Board also directed that the Planning Commission call together as an advisory committee the representatives of local, State, and Federal agencies which had an interest in planning, protecting and administering the reservoir and its shorelands.

This committee was considered necessary because the hillsides around the reservoir are highly inflammable during the fire season and subject to severe erosion if burned or over-grazed. Advice was needed particularly on the amount of land needed for fire and erosion control and, even more importantly, for adequate sanitary and pollution control. Serving on the Advisory Committee were representatives of the County fire protection, road and health departments, the U. S. Forest Service, Soil Conservation Service, National Park Service, State Division of Fish and Game, Division of Highways, Water Pollution Control Board, State Recreation Commission, and the Bureau of Reclamation.

As a first step toward determining the amount of land needed, a map was prepared showing a suggested acquisition boundary. This map was carefully reviewed by the advisory group and the suggested boundary inspected on the ground. With certain alterations it was recommended to the Planning Commission, and by the Commission through the Board of Supervisors to the Bureau of Reclamation. In addition, the advisers looked with favor on an emergency zoning ordinance, contemplated by the Planning Commission for control of private lands bordering the area suggested for acquisition. Subsequently, the recommended acquisition boundaries were accepted by Reclamation, and the contemplated zoning ordinance was adopted by the Board of Supervisors.

With the area for acquisition and control established, steps were taken next to prepare a public use plan for these lands. The Bureau of Reclamation again enlisted the aid of the National Park Service, this time to work with the County in preparing a master plan for recreational development. The master plan outlined the locations best suited to recreational use, together with a suggested system of roads, parking areas and utilities to serve the proposed uses and facilities, including camp grounds, picnic grounds, boat launching sites, etc. Suggested layouts for some of these facilities were also included.

The County authorities, realizing that they were breaking new ground, took particular care to keep the public informed of developments as each move was made. The press, aware that the moves being made by the county were significant, gave space generously to all meetings and to the plans which were formulated. The general layout plan for the reservoir area, for example, was published in a local newspaper and discussion on development of the area was featured in a citizens' conference

Continued on page 50

BELOW: Artist's conception of Cachuma Dom by M. H. Willson, Bureou of Reclomotion, Denver, Colo.

ABOVE: View of boat docking area, Cachuma Reservoir, looking easterly with Dock of Tri-Valley Yacht Club in foreground. *Photo by D. E. Creighton, Jr.*

Riverton's Alfalfa Seed Crop

Cattle on pasture—Dave Anderson lease—Cottonwood Bench Development Farm, 1956.

The Riverton Project, located in the Wind River Basin of west-central Wyoming, is becoming one of the important alfalfa seed producing areas of the United States. Like other irrigated areas of the West, the average seed yields are relatively high and dependable. The producing areas on the Riverton Project are new lands, having been brought into production since 1949. The areas are particularly adapted to the production of Foundation and registered seeds because they meet the isolation requirements.

The importance of alfalfa seed to the Riverton Project is best illustrated by the records of production. Average yields have varied from 100 pounds to over 400 pounds per acre, with some fields producing as high as 1,000 pounds per acre. Production of Certified seed on the Project in 1950 amounted to 268,454 pounds from 2,641 acres. In 1953, the total acreage increased to 5,923 acres and the production was 2,586,678 pounds. The production in 1955 was 2,326,975 pounds of cleaned blue-tagged certified seed from 6,990 acres. Production and acreage figures for the 1956 season are not available at this time; however, it is believed that there has been a slight increase in acreage and perhaps a yield of only 1,000,000 pounds. The causes for the reduced yield in 1956 have not been determined.

The varieties produced on the project are Buffalo, Ladak, Atlantic, Grimm, Vernal, Rhizoma and Narragansett. In 1956, nearly one-fourth of the acreage in the United States producing foundation legume seed under the National Foundation Seed Project was in Wyoming. Nearly all of this acreage was on the Riverton project.

The production of new varieties of alfalfa seed in the past have failed or have been seriously delayed because the early seed increases were used to plant meadows or pastures. The more recent program for increasing the seed production of new varieties follows a definite generation sequence, with the first one or two generations being used as stock seed for planting other seed-producing fields. Such a sequence is breeder, foundation, registered, and certified seeds. The breeder seed is that maintained by the originating station. Foundation seed is harvested from fields planted with breeder seed; registered seed is harvested from fields planted with foundation seed; and certified seed is from fields planted with registered or foundation seed. Foundation and registered seed are stock seed and are used to plant other seed fields. With some varieties, Vernal and Narragansett alfalfa for example, the registered seed class is omitted. The National Foundation Seed Project was organized to help supply these stocks.

The National Foundation Seed Project is a co-

by ROY C. VAN DREW,
Project Manager
Riverton, Wyoming

operative endeavor of approximately 37 State agricultural experiment stations; State certification agencies; the Forage and Range Section, Field Crop Research Branch, Agricultural Research Service; and the Commodity Credit Corporation. Its function is to place breeder seed of improved varieties with the better experienced seed growers in the cooperating States for the production of foundation seed. The various agencies cooperate closely in placing the breeder seed with the growers, supervising the production, and processing the foundation seed. The Commodity Credit Corporation contracts with the grower for the production of the foundation seed, finances the purchases and storage of the seed, and then distributes it through experiment stations and certification agencies to other seed producers. Mr. John G. Dean, Jr., of the Agricultural Research Service is in charge of the program of the National Foundation Seed Project. Mr. Charles M. Rincker, manager of the seed certification for the State of Wyoming, Dr. William A. Riedl, Wyoming Agricultural Experiment Station, the Fremont County Extension Service, the Fremont County Seed Growers Association, and the Bureau of Reclamation have been the cooperating agencies responsible for the interest and activity of the program on the Riverton project.

During the preliminary investigations made in 1954 by Mr. Dean, and Dr. Riedl for increasing the program of the National Foundation Seed Project on the Riverton project, it was found that several well qualified seed producers were available but these producers did not have land with the necessary isolation. Further investigation revealed that several hundred acres of unentered

Alfalfa seed—Barrett lease—Cottonwood Bench, 1956.

Certified Narragansett alfalfa seed—Barrett lease—Cottonwood Bench, 1956.

lands on Cottonwood Bench under the control of the Bureau of Reclamation were suitable if they could be made available to the qualified producers. The Bureau of Reclamation welcomed the opportunity to cooperate with the other agencies in the seed production program and immediate steps were taken to negotiate leases with two qualified producers for lands to be used in the production of Narragansett and Vernal Foundation seed. One hundred thirty-eight acres of these varieties were planted with breeder seed in 1955. In 1956, additional areas totaling approximately 4,000 gross acres were leased to qualified producers. During the year, approximately 700 acres were seeded using breeder, foundation or registered seed. It is estimated that 1,500 additional acres will be placed in production during 1957.

It is interesting to note the importance of the seed producing areas in the irrigated section of the West to over-all grass and legume seed production and requirements of the United States. Approximately 80 percent of the grass and legume seed used in the United States is in the States of the Corn Belt, the Cotton Belt, and the hay and pasture regions. The average seed yields of crops such as alfalfa in these areas are low and uncertain, thus they are dependent upon the western States for most of the forage seeds that they plant. The annual seed requirements are approximately 200,000,000 pounds. Only approximately one-half or 100,000,000 pounds of these requirements can be supplied with certified seed at the present time.

Alfalfa seed production on the Riverton project certainly assumes a role of major importance.

Shasta sets record

Shasta Dam, as a tourist attraction, chalked up an all-time record during 1956. Martin H. Blote, Regional Supervisor of Irrigation and Power in the Bureau of Reclamation's Sacramento office, stated that 296,168 visitors checked in at the dam. The U. S. Forest Service, which administers the recreational facilities of the reservoir behind the dam, estimates that 636,448 tourists and local people visited the lake during the past year. The number of registered visitors to the dam itself totaled almost 50 percent over 1955. The year 1946 set a previous high record for the number of visitors, with 278,575.

A scenic highway provides access to the dam and reservoir area and to view points. A vista house for the accommodation of visitors is maintained at the dam, along with parking areas. Conducted tours over the dam and into the interior of the structure are available for a small fee.

# # #

LARGE STREAMS of water like this often conducive to excessive waste through runoff. *Photo by Stan Rasmussen, Region 1.*

HOW TO CUT IRRIGATION WATER LOSSES

by CLIFF ASHBURN
Extension Farm Management Specialist, Scotts Bluff Experiment Station, Scottsbluff, Nebraska

How can we stretch the irrigation water to go farther on the local farm?

The best answer would be to take an inventory of the present irrigation system and see where water is being lost. There are four main factors for the losses of irrigation water on the local farm. It is estimated that 50 percent of the water turned in at the farm headgate is lost by the following factors.

1. Distribution losses.
2. Runoff or waste water at the lower end of the field.
3. Deep percolation.
4. Evaporation.

Distribution losses of water can be lowered by the use of a sprinkler system, by using gated pipe, by lining irrigation laterals, and by the use of underground pipe. Water losses are high when leaky pipe joints are used as well as other faulty equipment.

Gopher holes are another way water is lost. A good distribution system can save water, save labor and lead to more efficiency. The weed and erosion problems can also be held to a minimum where a good distribution system is maintained.

RUNOFF DOES NOT AID CROP

Runoff or waste water at the lower end of the field is not doing the crop much good. This is true whether gravity or a sprinkler system is being used. The method of spreading water should be designed for the soil type and slope. Where water is applied faster than the soil will take it, there will be runoff, erosion and a waste of water. The size of tubes used is very important. Some farmers are using two tubes and then cutting back to one after the water reaches the lower end of the field or next cross ditch. A sprinkler system should be designed according to slope and intake rate of the soil.

EXCESS WATER caused by poor drainage. *Photo by Stan Rasmussen, Region 1.*

LABOR SAVING irrigation tubes in use can be seen in foreground. *Photo by Norton F. Novitt, Region 7.*

Bench leveling or fields leveled to Soil Conservation Service specifications will also aid in controlling runoff and other methods of saving water. Where fields are quite level, some are plowing a furrow at the lower end that helps control runoff or waste water.

It is very easy to waste water on a light sandy soil because of deep percolation. This not only causes a waste of water, but also contributes to the loss of plant nutrients. The basic intake rate of a light sandy soil will be from 5 to 6 gallons of water per 100 feet of row. The first time over or until water reaches the lower end of the field a larger stream may be needed and then cut back. Because of the high intake rates, it is hard to push water very far down the row.

CHECKING PENETRATION of irrigation by gated pipe. *Photo by L. C. Axthlem.*

IRRIGATE SHORTER ROWS

The deep percolation loss on sandy land can be minimized by irrigating shorter rows and using tubes according to the slope, head of water and length of run. A soil auger is a good tool for measuring the depth that the water has penetrated. Deep percolation below the root zone of the plant is a waste of water. More frequent irrigations would help eliminate deep percolation losses on sandy soils.

Irrigation water is lost by evaporation, but this is hard to control as exposed water will evaporate. Again, underground systems and gated pipe will give some help in lowering the loss by evaporation.

Some research work in western States is being done to lower evaporation losses in stored reservoirs. Chemicals are being used on the surface of the water to lower the evaporation losses, but this could create other problems.

A good distribution system, controlling runoff or waste water, eliminating deep percolation and controlling evaporation will make more water available for the crops on our local farms. Taking an inventory of the irrigation system can help make the system more efficient and save water.

REPRINTED FROM THE BUSINESS FARMER, FEBRUARY 1, ISSUE, SCOTTSBLUFF, NEBRASKA

WILLIAM R. WALLACE DEAD

The passing of William R. Wallace on January 29 takes from the scene another of those great men of vision who pioneered the development of our water resources. (See *Reclamation Era*, March 1953.)

He not only had the foresight to realize the importance of water in the future of the West but he also possessed the determination necessary to convince his fellow westerners, the Congress and the Nation.

He sacrificed his time, effort and personal gain to further the development of the West and its water and land.

When Reclamation was threatened, he took a personal hand to see that water resources development kept rolling. On occasion, when investigative funds for a particularly important project ran out, he dug into his own pocket to finance them.

Not only Utah but all the West will long remember with gratitude "Uncle Billy's" outstanding leadership in Reclamation. He will be missed as a great leader and personal friend.

Water Report

OUTLOOK FOR 1957 WATER SUPPLY OF THE WEST

by HOMER J. STOCKWELL
Snow Survey Supervisor, Soil Conservation Service
Fort Collins, Colorado
and
NORMAN S. HALL
Snow Survey Leader, Soil Conservation Service
Reno, Nev.

PALISADES PROJECT RESERVOIR. Looking upstream from below Elk Creek. *Photo by Phil Merritt, Region 1.*

Except in a few isolated areas of western United States, 1957 streamflow from snowmelt will be less than it was last year.

No extremely heavy snow pack was measured in the Pacific Northwest mountains this April 1 as contrasted to extremely heavy snow packs found there a year ago. Water supplies for irrigation and power over the states of Montana, Idaho, Oregon and Washington are expected to be reasonably adequate to meet demands.

In the extreme drouth areas of the southwest there generally has been some improvement over a year ago, but the shortage of water is definitely serious. Prospective supplies for parts of Colorado, Utah and California will be deficient. Severe shortages, comparable to the past two years or more, are in prospect for New Mexico and Arizona. Streamflow will be below average for most areas in California. Late season shortages may be expected where carryover storage is not adequate.

In view of the seasonal outlook over the West, good water management practices are a must again this year. It is important to note that in many areas of the West a water supply even better than average is no longer sufficient to meet the increasing demands. If maximum benefits are to be obtained from the use of water, there must be an increased concern on the part of each user to see that the available water is used efficiently.

Forecasts of 1957 irrigation water supplies in the West are based on April 1 measurements by the U. S. Department of Agriculture, Soil Conservation Service and many other [1] organizations on about 1,300 snow courses. Water content of the snow, soil moisture conditions under the snow as well as in irrigated areas, and the amount of carryover storage in nearly 200 reservoirs are considered in appraising the supply outlook.

Although runoff will be about average in the Pacific Northwest, only isolated areas will experience water shortages. Water supplies will exceed the usual demands along the main streams in Montana, Idaho, Washington and Oregon. As usual, some shortages are expected on smaller tributaries without adequate storage. Because of heavy streamflow last year, and the resulting carryover, storage in irrigation reservoirs is above normal. Mountain soils are wet and soils in irrigated areas are in fair to good condition as far as moisture is concerned. This favorable outlook extends from the Northwest to northern and cen-

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several states, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that state, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that province and likewise contributed the information here for British Columbia.

tral Utah and the Colorado river drainage of western Wyoming and Colorado.

Mild water shortages may occur on Wyoming and Colorado streams, east of the Continental Divide. Winter snow pack has been much above normal, but years of drouth have reduced the amount of water to be expected from a generous snow pack. Unless summer rainfall is above normal, rather severe shortages of water will be experienced on the lower reaches of the South Platte in Colorado and the Arkansas in Colorado and Kansas. Soil moisture conditions, particularly near the mountains, were improved by major early April storms on the plains.

The outlook for the Rio Grande in New Mexico is substantially improved over 1956 but continued water shortages will be experienced, especially in New Mexico. In Arizona, the water supply is again critical, similar to the past several years. Water demands far outstrip surface supply. Less reservoir storage is available than for any recent year. No surface water is available from San Carlos reservoir on the Gila river. It's dry! Extensive use of ground water to supplement surface water for irrigation will be needed in New Mexico and Arizona. The prospective lack of streamflow extends to southern parts of Utah and Nevada.

Streamflow in California and Nevada will be below normal. In California's Central Valley surface water may become critically short in late season on streams which do not have carryover storage. Shortage may also be expected for coastal areas and southern California. Considerable dependence will be placed on importations. In Nevada, irrigation season water supplies will be normal in Paradise Valley, north of Winnemucca, and fair to poor in other areas depending on storage rights.

Forecasts for the major streams of the West for the April-September 1957 period as compared to normal, include:

Columbia River at The Dalles—104,000,000 acre feet or 107 percent

Missouri River at Toston—2,040,000 acre feet or 80 percent

Colorado River at Grand Canyon—10,100,000 acres feet or 100 percent

Rio Grande at Otowi Bridge—700,000 acre feet or 82 percent

Sacramento River inflow to Shasta Reservoir—1,650,000 acre feet or 89 percent

San Joaquin below Friant—750,000 acre feet or 59 percent

The accompanying chart showing the status of reservoir storage, and a map indicating the approximate runoff forecast for each area, summarize the 1957 water supply outlook for the West. In the following paragraphs the water supply outlook by states is briefly reviewed:

ARIZONA The shortage of water continues. Last fall was dry with reservoir storage critically low. Heavy precipitation in January was followed by warm weather which induced early snowmelt and a good yield of water was obtained. The flow of the Tonto river will be above average for the season, but the overall yield of the Salt and Verde river systems is expected to be about three-quarters of normal. The January storms were not effective on the Gila and San Francisco watersheds.

Total water available on the Salt and Verde rivers will be enough to forestall any serious cutback of water for the Salt River Valley users. They will again have to draw heavily on underground water, further lowering the water table. Unless heavy rains occur, water in storage this fall will be very low.

No surface water from snowmelt runoff will be available to users below San Carlos reservoir.

BRITISH COLUMBIA April 1 snow course readings reveal normal runoff for the southern mainland Coast, Kootenay, Columbia, and Fraser watersheds of British Columbia. Below normal water supplies are anticipated for the southern Okanagan, Similkameen, Skagit, and Vancouver Island basins. Light snow cover is general in these areas.

In the lower elevations of central and southern interiors, day-time heating for March reduced the snow pack considerably. At higher elevations little of the winter's snow has melted.

CALIFORNIA The Department of Water Resources reports the water supply conditions as of April 1, 1957, are below average in all of the state except the extreme northern portion of Sacramento river. Seasonal precipitation is generally below normal even with February and March precipitation above normal in the north.

Snow pack in the Cascade and Sierra Nevada mountains still is significantly below April 1 expectancy. Effective snow line elevation varies from 5,000 feet on the Yuba to 8,000 feet on the Kern river. During the first six months of the 1956–57 water year, runoff was below average in most areas of the state. However, in northern areas, near or above average runoff occurred during February and March in most major rivers. Water stored on April 1 in California reservoirs is 60 percent of capacity, or 115 percent of average for April 1. Carryover from the previous water year is responsible for high storage.

Water supply forecasts prepared by the Department of Water Resources show snowmelt runoff for Cascade and Sierra Nevada mountains considerably below average. It varies from 33 percent on the Tule river in the south to 89 percent on the Sacramento river in the north. Late season water shortages may occur where carryover storage is inadequate.

COLORADO Snowfall is above normal in the mountains and water supplies should be adequate for most areas of the western slope. Limited shortages are expected on the South Platte, Arkansas and Rio Grande with rather severe shortages in the lower reaches of the Platte and Arkansas rivers. Reservoir storage is low, but with spring rainfall some opportunity will be provided for partial replacement. The outlook is the best since 1952, but shortages will occur in he heavier demand areas. Soil moisture conditions are good on the irrigated areas of the

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Humid States Farmers Discover Irrigation

by

W. J. LIDDELL, Vice President

Dixie Irrigation Company, Memphis, Tennessee

"Man, I've spent a lifetime draining this country and I'm certainly not going to help put water back on it." Such was the remark of a farm machinery dealer in the delta county of northeast Arkansas when asked to sell irrigation equipment.

His friends and customers do not share his belief, however. They had helped to drain land, too. Then they found that every year crop yields were hurt because of drouth. It might be of short duration or maybe it would be a long one. In any event it meant less money would be theirs in the fall; less money to repay the crop loan at the bank, less to pay the hands, less to spend for clothes, appliances, new cars, and machinery.

Irrigation came early to some places in the east. From irrigating rice fields it was just a step to watering cotton and pasture in Arkansas and Louisiana. Irrigation of vegetables in Florida and New Jersey was the only answer in preventing ruinous losses from frequent, irregular drouths.

All over the east many a crop has burned up from lack of moisture, and yet along side the field flowed a fine stream of water. It wasn't that the farmers were unmindful of the possibilities of irrigation. They weren't. But the job seemed too great. That is, until sprinkler irrigation came along with its lightweight portable pipe and pumps.

Investigating the cost of the new systems, many growers found it possible to more than repay the cost of the equipment from increased yields of a single crop. On lower value crops more than one year is generally required for the recovery of the investment. Since the life of the equipment is 15 years or longer and maintenance costs are quite low, a rapid return is not compulsory for the investment to be economically profitable.

The Citizens and Southern Bank in Georgia 2 years ago made a careful study of its 6-year experience record in financing irrigation loans. So impressed were the officials with the repayment records and profits made by irrigation farmers, that they drastically expanded their already excellent program in financing irrigation. Their policy of helping the Georgia farmer to help himself has not only continued to benefit farmers, but also the communities, and the State as a whole, not to mention the bank itself.

Under the Federal Housing Administration program of the U. S. Department of Agriculture loans have been completed in the last two years for the installation of irrigation on 120,000 acres in 31 eastern States. Insurance companies, commercial credit companies and other lending agencies are continuing to enter and expand their participation in the irrigation finance field. The Agricultural Conservation Program in most States encourages farmers to develop their irrigation potential by making allowances for pond development, land leveling and soil improvement practices.

Irrigation research in the East has increased from a handful of minor projects before World War II to multiple projects in every State. A continuing survey of these projects and their results has been undertaken by the Sprinkler Irrigation Research Committee of the American Society of Agricultural Engineers under the direction of Chairman E. H. Kidder. This information is available to anyone interested.

The Agricultural Research Service program of the U. S. Department of Agriculture in irrigation research includes around 25 separate phases of investigation. Federal-grant funds have enabled every State Experiment Station to add timely and worthwhile projects for studying and developing irrigation practices and methods.

One of the early Federal-State projects was started in 1945 in Georgia. The useful information given out by projects such as this is exemplified in a recent report by John R. Carreker, project supervisor. From 5 years of irrigation studies 1952–1956, it is indicated that the optimum moisture requirements of cotton are 16 inches during the 90-day growing period from May 28 to August 27. Greater or lesser amounts reduced yields.

About 3 inches of moisture can be obtained from the soil. The balance, averaging 4.3 inches per month, must be furnished by rainfall or irrigation. The grower must see to it that his cotton has available its daily quota of .20″ of moisture if it is to make top yields. Irrigation produced yields of 3,257 to 3,621 pounds of seed cotton, while on unirrigated plots yields were 1,952 pounds of seed cotton per acre. During this period rainfall and soil moisture supplied 11.15 inches to the crop.

At Lewisburg, Tennessee, the Dairy Experiment Station reports an average increase of $99 per acre in terms of milk production over and above the

Above: Nelson Brown, Clarksville, Tennesse over 2,200 pounds per acre on his burley fo be moved while main is under pressure l McUmber shows visitor operation of his valv to pump and shutting off pressure. Below r tion plans beside one of their three 14″ *courtesy of the author.*

ypes of irrigated tobacco. He has averaged
Below left: Sprinkler lateral in this orchard can
ed mechanism in foreground. Below: R. R.
e can shut off and move lateral without going
mber and Alonzo Womble discuss their irriga-
nfield, Tennessee. *All photos in this article*

cost of pasture irrigation from 1951–1954. A survey of Kentucky tobacco growers showed increases due to irrigation averaged over $350 per acre.

Producers of shade tobacco grown for cigar wrappers in Connecticut and north Florida all say the same thing—they wouldn't plant their expensive crop without having their irrigation systems ready to go into action. They haven't failed to use them as some time during the season in any year since they have first started irrigating.

Over 130 different crops are irrigated in the East. Portable sprinkler systems are used on more than 80 percent of the farms. About 10 percent use permanent overhead sprinkler systems, about 5 percent use ditches, 2 percent gated pipe, and less than 5 percent use flooding. Sprinklers are the most popular method of application because of the rolling topography, limited soil depths or water supplies, small degree of skill required to operate, and the excellent control afforded. However, in areas where land forming is being done and in other places where it can be used, gated pipe is mushrooming in popularity.

Self-propelled and mechanical move systems are beginning to interest the eastern irrigator. His dislike for the muscle-power requirements of hand-moving pipe over large acreages has caused him to study the possibilities of rearranging his small, cut-up fields and to raise the extra investment capital needed for the mechanical systems. Labor-saving devices, methods, and equipment continue to be the number one concern of farmers, industry and researchers alike.

The tremendous task of educating would-be

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Nelson Brown stands in alley cut out for his irrigation pipe. Loading pipe off and on a trailer proves to be the easiest way to move.

technicians, interested farmers, and new irrigators has been accomplished with particular credit due a number of agencies. The Agricultural Extension Services schedule meetings each year on a country-wide and sometimes on a State-wide basis. Colleges have added courses in irrigation to their agricultural and engineering curricular; they have held many short courses in irrigation open to the public.

To irrigation industry itself is due no small amount of credit. In addition to numerous meetings for farmers and dealers held by individual firms, the Sprinkler Irrigation Association through its Educational Director, develops a program of irrigation clinics in various States in cooperation with local representatives of the Soil Conservation Service, the Extension Service, FHA, colleges, vocational agricultural teachers, bankers, businessmen and farm leaders. To date, more than 20 clinics have been held to instruct farmers, irrigation dealers, and technicians in the best known practices in dealing with their irrigation problems.

Every kind and type of irrigation has been practiced somewhere in the East. While there have been many stories of success, there have been a few failures. Much more research and education is needed. Obviously crops of high value can be made to pay off under irrigation in spite of blunders, mistakes, and poor management.

Lower value crops, such as beef pastures, require skilled management to make profitable returns from irrigation. The University of Illinois pointed this out from their 6 years of experiments. The returns from using irrigation hardly paid for their labor and operating costs, to say nothing of interest, taxes, depreciation, and amortization of investment. Irrigation in itself never makes a good farmer out of a poor one; but it can help a good farmer do a better job. Because lots of good farmers in the humid States are finding this out, irrigation is rapidly becoming a standard practice in their farm program. ###

IDEAS WANTED

Have you a good idea on a short cut or labor-saving device to share with other water users on Reclamation projects? Send it in to the Editor, *Reclamation Era*, Bureau of Reclamation, Washington 25, D. C. The writing does not have to be fancy. Just make certain you have the answers to Who, What, Where, When, Why, and How in your story. As for pictures, a rough sketch or snapshot would serve the purposes. Remember, this is the only official publication of the Bureau of Reclamation, the only periodical devoted entirely to the interests of water users on projects served with facilities made available by the Bureau. It is your magazine, and will be as good as you can make it. By helping others you will also help yourself. Send your item in today.

Spuds? Eat 'em Jacket and all, Says Stanek

The best-dressed potatoes, nutritionally, wear their jackets to dinner! May Stanek, Colorado A and M College extension nutritionist, says that jacket cookery for both boiled and baked potatoes saves the most in food value—saves time in preparation. Of the two methods, she says, boiling conserves more vitamins than baking.

Even though weight watchers often scorn potatoes, Miss Stanek says one medium-sized potato has no more calories than an apple or banana. It's the gravy, butter and other fats that, used in large amounts, really pile up the calories.

Although the potato is a good and inexpensive source of energy, Miss Stanek adds that by eating potatoes daily you can get as much as one-fourth of your vitamin C quota, plus some B vitamins, iron and other minerals.

When preparing hash-browns, use potatoes that have been chilled thoroughly in the refrigerator. They will absorb less cooking fat, Miss Stanek points out.

Reprinted from Colorado A&M News

View of Lowland site on Prairie near Cedar Bluff Reservoir in Kansas. *Photo courtesy of author.*

Improving Our Grasslands

by DR. GERALD W. TOMANEK
Professor of Biology
Fort Hays Kansas State College
Hayes, Kansas

Our grasslands are a heritage which we should appreciate and understand. An area of 320 acres of native grassland near Cedar Bluff Reservoir in Kansas was leased by the Bureau of Reclamation to Fort Hays Kansas State College for preservation and study. For many years this area has been very lightly grazed and for the past few years it has been unused. Areas of this nature, which are in climax or near climax condition, are used by Government technicians and ranchers in classifying the range conditions of grazed pastures. These areas are used as a control, and the degree of degeneration that is found in grazed pastures is used as a criterion for classifying them. Climax areas are becoming very rare in the Great Plains. There is a definite need to preserve some of these areas in various localities so that Government technicians and ranchers will have some type of measuring stick to determine the range condition of grazed pastures. Other values derived from the preservation of grassland areas such as the one at Cedar Bluff are their esthetic value and their use for research projects. Grasslands are beautiful and they should be protected so that generations of the future might know what they were before being wrecked by the plow or overgrazing. Since areas of this type are rare, it is quite important that research data be collected and published on the climax plants and animals that inhabit them. Many practical applications of data of this nature are possible even though they are not always apparent.

This grassland area of 320 acres can be divided into three general sites: uplands, breaks, and lowlands. The uplands are located on the high ground and are generally quite level. The soil is deep and mature. Principal grasses on this site are the short grasses, buffalo and blue grama.

Other taller grasses such as western wheatgrass, side-oats grama, and big bluestem are found growing in buffalo wallows and other depressions. Three-awn grasses and squirreltail are scattered through the short grasses. The breaks are located on the slopes and are characterized by a shallow soil underlaid with fragmented rocks but have soil in the crevices. The two principal grasses on this site are blue grama and side-oats grama. A greater percentage of taller grasses is found here, such as big bluestem, little bluestem, and switch grass. This site also supports a large population of broad-leafed plants whose flowers add a great deal of color to the landscape. The lowland is the best watered site of all since it catches all the run-off from the other two. Hence it supports a lush growth of taller grasses such as big blustem, switch grass, western wheatgrass and tall dropseed.

Over twenty research projects have been started on this prairie, but space will not permit description of all of them. However, a few can be listed and one or two explained in detail to illustrate the nature of the information that *can* be obtained. Some of the things being studied are forage yields of different sites, a description of the natural plant and animal communities, effects of mulch on growth of vegetation, effects of inundation on shoreline vegetation, chemical composition of important plants, continuous record of soil moisture, effects of grazing on composition, long-term changes in vegetation in relation to climate, effects of dusting, natural succession of plants and animals on disturbed areas, effects of native animals on plants, population studies of native animals,

View of Break site on Prairie near Cedar Bluff Reservoir, Kansas. ***Photo courtesy of author.***

and many more. The long-term lease will make some of these studies very valuable because continuous records can be collected over a period of nearly 50 years.

One of these studies that might help illustrate the importance of researches of this nature is the effect of grazing on composition. The conditioning of a native pasture is determined by the composition of the vegetation or, in other words, the percentage of total vegetation made up by different species. The climax vegetation is used as a control. If a native species decreases in abundance as a result of grazing, it often is called a decreaser; if it increases, an increaser; if it was not part of the climax and comes in as a result of grazing, it is an invader. The vegetation on this undisturbed prairie was compared to that of neighboring prairies which had been subjected to different intensities of grazing. The changes in composition of the principal species are shown in table 1.

Table 1. *Composition changes (percent) of principal species on different sites as a result of grazing. Ng—nongrazed, Mg—moderately grazed, Hg—heavily grazed*

Grasses	Uplands			Breaks			Lowlands		
	Ng	Mg	Hg	Ng	Mg	Hg	Ng	Mg	Hg
Buffalo grass	51	76	89	13	25	45	2	5	32
Blue and hairy grama	42	22	11	42	38	38	5	6	12
Side-oats grama	1	0	0	34	32	14	6	29	29
Western wheatgrass	2	0	0	0	0	0	5	12	10
Big bluestem	2	0	0	8	2	0	60	38	9
Little bluestem	0	0	0	5	2	0	0	0	0
Switch grass	0	0	0	0	0	0	17	8	3

Continued on page 51

Field Sanitation Through WEED CONTROL

by **FRANK M. FEFFER, President Arizona Fertilizers, Inc. Phoenix, Arizona**

Probably one of the most neglected and yet one of the most important phases of any farming operation is field sanitation. By sanitation we mean the cleaning of fence rows and ditchbanks of weeds, and the prompt plowing or discing of harvested fields to prevent weeds and unwanted crops from going to seed and thus preventing a weed problem in the subsequent crop.

It sounds as if we were talking about weed control—we are—but field sanitation goes much further than that. Weed control or field sanitation not only kills the unwanted plants that rob the soil of nutrients and our most precious resource, water, but also is a great aid in controlling harmful insects and diseases.

A list of some of our most common Arizona weeds and the insects for which they serve as hosts is as follows:

Weeds	*Insect Pests*
Bullhead	Aphid, cowpea; Spider mite, desert
Cantaloupe, volunteer	Aphid, cotton or melon
Carelessweed	Aphid, cowpea; Armyworms, beet and yellow-striped; Leafhopper, small green (empoasca)
Cressa	Spider mite, desert
Globemallow (sphaeralcea)	Aphid, green peach; Whitefly of cotton
Helistrope, wild	Lygus
Horsenettle (blueweed)	Aphid, green peach; Thrips of cotton; Whitefly of cotton

Weeds	*Insect Pests*
Jackass-clover	Cabbageworm, southern.
Jimpsonweed (datura)	Aphid, green peach; Borer, potato stem
Johnsongrass	Aphids, corn leaf and rusty plum; Borer, lesser cornstalk
Knotweed (polygonum)	Aphid, cowpea
Lambsquarter (goosefoot)	Aphids, cowpea and green peach; Leafhopper, beet
Malva	Aphid, green peach; Whitefly of cotton
Mustard, wild	Aphids, cabbage and turnip; Caterpillar, diamond-back moth; Chinch bug, false
Nightshade	Aphid, green peach; Leafhopper, beet; Whitefly of cotton
Ragweed (ambrosia)	Whitefly of cotton
Russianthistle	Aphids, cowpea and green peach; Leafhopper, beet
Tidestromia	Fleahopper, cotton

Many of our insect pests of economic importance in Arizona are included in this table. The list could include more weeds and more insects, but those weeds and insects indicated do several million dollars worth of damage each year.

Most of the virus disease of our crop plants are insect borne from weed hosts that act as virus reservoirs and help to perpetuate diseases. For example, there are many strains of mosaic viruses which infect potatoes that are usually transmitted either from weed hosts of the virus or from diseased potatoes to healthy potatoes. Lettuce moasic is aphid spread and several weeds are not only suspected to be reservoirs of the disease but serve as hosts of the disease-spreading aphids.

There are many insect pests that feed and breed on weeds and migrate from them to crops that become serious pests. One of the prime examples is the lesser cornstalk borer. Johnsongrass is one of its favorite weed hosts. There is hardly a grain sorghum grower in Arizona that did not experience at least some trouble from this pest during the 1956 season. Many thousands of acres of hegari and maize were replanted because of the widespread infestation of the lesser cornstalk borer. Field sanitation would have at least been helpful in alleviating this serious situation.

But the main economic loss due to weeds is not by being hosts to insect pests and diseases. Just the presence of weeds in and around our fields actually causes more economic loss by several million dollars than do insects and diseases combined. Weeds are the most expensive crop the farmer grows, or tries to grow. They rob his soil of nutrients and water; they compete with his crop plants for light and growing room. They also cost him for the hoeing, the cultivating, the burning, and the chemical control dollars he spends in trying to kill them and many times control is wasted or inadequate.

Weed control is sadly overlooked by many farmers. Ditchbanks and fence rows are often neglected until someone has some free time to chop and spray; rather than doing this important job as a regular farm chore. Much of the cultivating and hoeing in fields would not have to be done if fence rows and ditchbanks were kept clean, because it is in the fence rows and ditches that most of the weed problems start. Look at a field sometime and notice where most of the weeds are. You will find them usually along the margins, particularly next to fence rows and ditches, or ask a farmer why he has a strip of Johnsongrass through his field. He will usually answer that a ditch used to be there.

With modern methods of weed control, there is no excuse for growing such an expensive crop as weeds that can only be harvested at a loss. Adequate field sanitation can make money without planting a crop or adding an acre. A large quantity of the water that really should be available for crop consumption is being stolen by our enemies, the local weeds. ###

ALFALFA SLIDE SET FOR LOAN

A slide set—Successful Alfalfa—You Can Grow It—has been assembled in cooperation with many of our college agronomists. This is composed of 40 slides in color and is accompanied by a suggested script. The set is built around "10 steps to successful alfalfa production." While it tells a rather complete story it is designed to supplement local slides.

This set is available on loan for 10 days from:

American Potash Institute
Midwest Office
Life Building
Lafayette, Indiana

When writing for it please indicate when needed. Sets will also be sold at cost—$8.00.

SIGNS OF THE TIMES

Sign on a highway near Superior, Nebraska, city limits: "Fine of $1 for every mile in excess of 25 miles per hour. Pick out the speed you can afford." *Reprinted from Bureau of Reclamation "Safety Record"*

WATER REPORT

Continued from page 36

western slope. As a result of heavy April snows, soil moisture conditions on the east slope are fair to good.

IDAHO Seasonal snow pack in the Idaho mountains varies from slightly above normal in the north to a little less than normal in the south. The main stem of the Snake river is above normal with excellent carryover storage. There will be greater use of this storage because of the additional supply in the new Palisades reservoirs. The Kootenai river has the first near normal snow pack for several years. April storms could raise the streamflow considerably above normal.

Southern tributaries of the Snake river have had excellent winter flows. The water supply outlook is good where there is storage but late season shortages may occur where there is none.

Due to February rains, soil moisture conditions are above normal at high and low elevations. The mountain watershed soils are primed to yield maximum runoff.

KANSAS Water supply outlook along the Arkansas river in western Kansas is poor. There is practically no storage in John Martin reservoir and prospects for storage from snowmelt runoff are negligible. Soil moisture conditions are poor even with high precipitation in recent weeks.

MONTANA The April 1 water supply outlook in the Missouri basin is generally good and slightly better than reported on March 1. In the Yellowstone basin the outlook is close to normal at the headwaters, but dwindles to about 86 percent of normal at Sidney. The Columbia basin outlook in Montana is generally good on the Flathead but only fair along the Clark Fork to the junction of the Flathead. Recent storms have not materially improved the water supply outlook.

Irrigation reservoir storage is 98 percent of normal and all reservoirs should fill with the spring runoff.

NEBRASKA Unless summer rainfall is normal or above there may be some water shortages in western Nebraska. The inflow to the major reservoirs in the North Platte in Wyoming is expected to be above normal but carryover storage for the older North Platte area is limited. As of April 1 soil moisture in irrigated areas is deficient. Water supply outlook is similar to that of last year. Storage on Kansas river tributaries is adequate for present irrigation requirements.

NEVADA Runoff on the Owyhee river and Humboldt river ranges from 75 to 87 percent of normal. Eastern Nevada snow pack measured 65 percent of normal while the southern part reported at 40 percent of normal.

Streams flowing into Nevada from the California Sierra mountains will flow from 85 percent on the Little Truckee to 75 percent at Lake Tahoe. Moving south, the Carson river watershed is being forecast at 70 to 80 percent and the Walker river watershed 50 to 70 percent.

In general, all users of reservoired water can expect adequate supplies. Irrigators depending on natural flow will experience late season shortages.

NEW MEXICO The flow of the Rio Grande through New Mexico will be more than for any year since 1952. Inflow to the Middle Rio Grande Valley will be about 75 percent of normal, and to Elephant Butte about 50 percent.

Continued severe shortage of surface water is almost certain for the Middle Rio Grande and southern New Mexico area. Use of groundwater will again be necessary at about the same rate. Storage is less than 10 percent of normal on the New Mexico section of the Rio Grande. The water supply outlook for the Carlsbad and Tucumcari projects is poor, principally due to lack of reservoir storage and drouth in irrigated areas.

OKLAHOMA Irrigation water prospects on the Lugert-Altus Irrigation District are poor. There is no inflow to Altus reservoir. Soil moisture conditions are good but the 9,500 acre feet stored in the reservoir as of April 1 will supply only a small fraction of normal water demands.

Aerial view of ANCHOR DAM site—Owl Creek Unit of the Missouri River Basin Project in Wyoming

OREGON Deficient irrigation water supplies are anticipated only in portions of the Crooked river basin and in some of the small watersheds which head below the mountain snow zone. Most irrigation reservoirs are filled or can be filled in the next few weeks. Mountain and valley soils are wet. Water content of snow increased more than normal during March. Mountain soils are not frozen.

Over two-thirds of Oregon's twenty large irrigation reservoirs are filled to capacity. None are less than 85 percent except McKay which is 70 percent of capacity. Storage in these reservoirs is 134 percent of the 1938–52 average.

And adequate supply of irrigation water is foreseen for much of Oregon. Important irrigated areas for which poor to fair water supplies are foreseen this season are as follows: Burnt river above Unity reservoir; Grande Ronde above LaGrande; McKay, Birch, Butter, and Willow Creeks in Umatilla and Morrow counties; Crooked river basin except for Ochoco creek; Cow creek on the South Umpqua; Applegate and Illinois rivers in Rogue basin and many low-elevation tributaries of the Rogue; Silver Lake, Chewaucan, and Warner Lake basins; and the Silvies river area.

SOUTH DAKOTA Less than normal streamflow will occur from snowmelt. Reservoir storage is about one-half that of a year ago. Some shortage in the Black Hills area must be expected.

TEXAS The irrigated area of West Texas along the Rio Grande will experience a continued severe shortage of water. Low storage in Elephant Butte and about one-half normal inflow will again limit water supplies to about one-third of normal. The outlook for the irrigated area below Red Bluff reservoir on the Pecos is poor. Storage is only about 15 percent of that of a year ago.

UTAH Water supplies for practically all areas in the central and northern part of the state are expected to be good. A few watersheds may yield 5 to 10 percent less than average, but the supply should still be adequate. Seriously short supplies are still expected in the southwest for users served by the Sevier and Virgin rivers and the smaller streams originating in the same area. Although supplies for users served by the main Sevier river are expected to be poor, they will be fair to good for those served by the smaller tributaries below Piute reservoir. In the Uintah basin the upply outlook is good in the west but only fair in the east. Late season shortages can be expected on Ashley and Brush Creeks, and the Uintah and Whiterocks rivers.

WASHINGTON Streamflow from snow packs will vary from 88 to 108 percent of normal. Irrigation reservoirs contain about 10 percent more than last year. Mountain soils are wet. Streamflow will be much less than a year ago, but the total supply will meet all irrigation demands. Storage in power reservoirs is generally less than normal but these reservoirs will fill during snowmelt.

WYOMING Except for the main stem of North Platte in southeastern Wyoming and the Snake river in the northwest, streamflow will be less than normal in 1957. Adequate supplies will be available in the Snake river and the Green river and its tributaries. Some shortage may be expected in smaller Wind river tributaries in the Big Horn basin. Unless summer rainfall is above normal, shortages will occur east of the Big Horn mountains.

The irrigated area served directly by the North Platte should have an adequate supply if it receives average or better summer rainfall. As of April 1 soil moisture conditions were only fair. The Wheatland area on the Laramie river will not have an adequate supply. Streamflow will be slightly less than normal. There is no storage water available.

# # #

New Recreational Folder Available

A new recreational folder, entitled "Reclamation's Recreational Opportunities," has been published by the Bureau.

The folder lists 140 reservoirs on Reclamation projects throughout the 17 western States. It also contains information as to specific locations of these reservoirs, the name and location of the administering agency and specific facilities available, such as swimming, fishing, boating, hunting, camping, picnicking, and lodging. The folder also contains a map on which the name and location of each reservoir is indexed.

Copies may be purchased for 15 cents each or $9.50 per hundred from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Water Stored in Western Reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Storage (in acre-feet)		
			Active capacity	Mar. 31, 1956	Mar. 31, 1957
Region 1	Baker	Thief Valley	17,400	18,900	17,400
	Bitter Root	Lake Como	34,800	17,400	11,800
	Boise	Anderson Ranch	423,200	115,200	208,300
		Arrowrock	286,600	182,600	276,300
		Cascade	654,100	211,700	358,800
		Deadwood	161,900	84,500	73,500
		Lake Lowell	169,000	143,200	143,100
	Burnt River	Unity	25,200	18,400	22,000
	Columbia Basin	F. D. Roosevelt	5,072,000	4,123,000	2,102,000
		Equalizing	761,800	742,700	528,900
		Potholes	470,000	258,000	307,500
	Deschutes	Crane Prairie	55,300	50,000	55,000
		Wickiup	187,300	200,000	200,000
	Hungry Horse	Hungry Horse	2,982,000	1,637,900	1,364,400
	Minidoka	American Falls	1,700,000	1,456,200	1,672,000
		Grassy Lake	15,200	12,700	13,900
		Island Park	127,200	110,300	122,900
		Jackson Lake	847,000	325,200	149,400
		Lake Walcott	95,200	96,300	102,400
	Ochoco	Ochoco	47,500	41,700	44,700
	Okanogan	Conconully	13,000	8,500	9,800
		Salmon Lake	10,500	9,500	9,500
	Owyhee	Owyhee	715,000	550,500	696,700
	Umatilla	Cold Springs	50,000	49,400	45,200
		McKay	73,800	57,900	52,400

Location	Project	Reservoir	Storage (in acre-feet)		
			Active capacity	Mar. 31, 1956	Mar. 31, 1957
Region 1	Vale	Agency Valley	60,000	49,400	58,700
		Warm Springs	191,000	115,100	192,800
	Yakima	Bumping Lake	33,700	3,200	27,100
		Cle Elum	436,900	181,100	367,000
		Kachess	239,000	141,900	206,700
		Keechelus	157,800	54,200	131,600
		Tieton	198,000	95,600	160,400
Region 2	Central Valley	Folsom	920,300	391,700	556,600
		Keswick	20,000	19,300	17,300
		Lake Natoma	8,800	8,300	6,900
		Millerton Lake	427,800	112,000	238,400
		Shasta	3,998,000	3,382,500	3,561,900
		Vermillion	125,100	(1)	(1)
	Klamath	Clear Lake	513,300	430,800	396,000
		Gerber	94,300	77,000	87,300
		Upper Klamath Lake	524,800	394,100	465,200
	Orland	East Park	50,600	50,200	49,900
		Stony Gorge	50,000	28,600	50,800
Region 3	Boulder Canyon	Lake Mead	27,207,000	10,720,000	11,502,000
	Davis Dam	Lake Mohave	1,809,800	1,718,000	1,689,700
	Parker Dam Power	Havasu Lake	688,000	616,000	639,200
	Salt River	Bartlett	179,500	68,000	123,000
		Horse Mesa	245,100	231,000	162,000
		Horseshoe	142,800	2,000	68,000
		Mormon Flat	57,900	57,000	50,000
		Roosevelt	1,381,600	229,000	159,000
		Stewart Mountain	69,800	66,000	63,000
Region 4	Eden	Big Sandy	38,300	9,800	11,100
	Fruitgrowers Dam	Fruitgrowers	4,500	2,300	1,800
	Humboldt	Rye Patch	190,000	40,200	63,100
	Hyrum	Hyrum	15,300	11,600	12,000
	Mancos	Jackson Gulch	9,800	2,200	900
	Moon Lake	Midview	5,800	5,200	4,800
		Moon Lake	35,800	11,200	9,300
	Newlands	Lahontan	290,900	197,400	251,900
		Lake Tahoe	732,000	480,000	597,600
	Newton	Newton	5,300	3,100	2,500
	Ogden River	Pineview	44,200	4,200	15,400
	Pine River	Vallecito	126,300	48,000	22,600
	Provo River	Deer Creek	149,700	86,600	82,700
	Scofield	Scofield	65,800	8,700	6,000
	Strawberry Valley	Strawberry Valley	270,000	152,600	141,800
	Truckee Storage	Boca	40,900	10,400	22,100
	Uncompahgre	Taylor Park	106,200	40,600	25,300
	Weber River	Echo	73,900	37,400	36,700
Region 5	W. C. Austin	Altus	162,000	35,700	8,900
	Balmorhea	Lower Parks	6,500	6,200	5,800
	Carlsbad	Alamogordo	122,100	85,000	4,600
		Avalon	6,000	900	2,500
		McMillan	38,700	32,100	17,400
	Colorado River	Marshall Ford	1,835,300	706,600	603,400
	Rio Grande	Caballo	340,900	10,700	4,200
		Elephant Butte	2,185,400	181,200	63,500
	San Luis Valley	Platoro	60,000	0	1,000
	Tucumcari	Conchas [2]	465,100	161,100	55,400
Region 6	Missouri River Basin	Angostura	92,000	8,400	33,500
		Boysen	710,000	2,500	192,600
		Canyon Ferry	1,615,000	1,154,500	1,012,400
		Dickinson	13,500	5,400	3,900
		Fort Randall	3,900,000	1,586,500	1,752,200
		Heart Butte	218,700	68,400	46,900
		Keyhole	130,000	20,800	2,600
		Shadehill	300,000	84,400	76,400
	Belle Fourche	Belle Fourche	185,200	98,800	49,900
	Fort Peck	Fort Peck [2]	14,877,000	416,700	1,743,700
	Milk River	Fresno	127,200	93,500	110,200
		Nelson	66,800	38,500	49,400
		Sherburne Lakes	66,100	23,100	21,100
	Rapid Valley	Deerfield	15,100	10,600	8,600
	Riverton	Bull Lake	152,000	55,300	63,200
		Pilot Butte	31,600	23,300	21,800
	Shoshone	Buffalo Bill	380,300	117,200	116,400
	Sun River	Gibson	105,000	74,600	41,900
		Pishkun	30,100	16,300	16,200
		Willow Creek	32,400	28,200	24,000
Region 7	Colorado-Big Thompson	Carter Lake	108,900	53,000	71,900
		Granby	465,600	31,100	37,800
		Green Mountain	146,900	40,500	50,200
		Horsetooth	141,800	69,300	91,400
		Shadow Mountain	1,800	1,300	1,500
	Missouri River Basin	Bonny	167,200	38,700	38,400
		Cedar Bluff	363,200	74,900	68,700
		Enders	66,000	35,300	34,100
		Harlan County [2]	752,800	92,600	66,100
		Harry Strunk Lake	85,600	24,700	27,700
		Swanson Lake	249,800	60,000	88,400
	Kendrick	Alcova	24,500	3,600	11,500
		Seminoe	957,000	212,800	240,100
	Mirage Flats	Box Butte	30,400	19,500	16,700
	North Platte	Guernsey	39,800	32,400	(1)
		Lake Alice	11,200	1,200	10,900
		Lake Minatare	59,200	15,600	18,600
		Pathfinder	1,010,900	464,400	313,100

[1] Not reported.
[2] Corps of Engineers Reservoir.

HATFIELD CHILSON—NEW UNDER SECRETARY

HATFIELD CHILSON of Loveland, Colorado, was nominated as Under Secretary of the Interior on February 26, 1957.

Mr. Chilson has been Assistant Secretary for Public Land Management since October 29, 1956.

A prominent water attorney in the Rocky Mountain area, Mr. Chilson had been retained as attorney for the Colorado Water Conservation Board from 1954 until entering Federal service with the Department of the Interior. From 1949 until 1954 he was a board member of the Northern Colorado Water Conservancy District at Loveland. He served in 1946–48 as district attorney for the 8th Judicial District of Colorado, and had been city attorney for Estes Park since 1936. He has been a member of the American Bar Association since 1937, and was admitted to practice before the United States Supreme Court 1954. He was a member of the Colorado State Board of Law Examiners for 3 years.

Mr. Chilson was one of the leaders in organizing the Big Thompson Conservation District in northern Colorado, and participated prominently in the successful effort for enactment of the Colorado River Storage Project legislation. He was born in Pueblo, Colorado, on November 22, 1903, and earned his law degree from the University of Colorado in 1927. He was admitted to the bar in his native State the same year.

His extensive legal as well as administrative background qualify him thoroughly for the second ranking position of the Interior Secretariat.

Mr. Chilson married the former Marian Cole, and they have one son, John Hatfield Chilson, a student at Dartmouth College, Hanover, New Hampshire. #

COOPERATION AT COLORADO A & M

Colorado A & M College's civil engineering department and the U. S. Geological Survey have been granted a $25,000 fund by the U. S. Department of the Interior to finance a study being carried out in the college's hydraulics laboratory.

Everett V. Richardson of USGS is the project leader for that agency and Dr. Maurice L. Albertson, professor of civil engineering, is the college's representative in charge of the project. Albertson has been a part-time consultant to USGS over the past 10 years. During that time his research has continued, both in the A & M laboratories and under field conditions, on the flow of water in open channels such as irrigation canals, natural streams and rivers, drainage canals, and hydroelectric power and navigation channels.

This research eventually demonstrated a possible means of reaching long-needed solutions to the problems involved in designing artificial open channels and in regulating natural streams. One such problem being studied intensively at A & M under the new grant is that of the sediment (silt, sand and gravel) encountered in diverting water and in building storage reservoirs, diversion canals and other structures associated with the control and conveyance of water.

Another major problem rating immediate attention is the designing of stable channels that will retain their shapes and require little maintenance. Successful design will greatly lower costs of the initial construction and the maintenance of irrigation canals.

Other research now under way at A & M will greatly increase the accuracy of the "Water Supply Papers" published by the U. S. Geological Survey.

Eighty-four Years Of Reclamation

Above: JAMES C. BEVERIDGE, the Bureau's Records Officer, pictured with Commissioner W. A. Dexheimer at a farewell luncheon upon his retirement after completing 44 years of service with the Bureau. Below: DONOVAN S. "PAT" KOONTZ, Attorney in the Solicitor's Office, shows Mrs. Koontz the gifts he received at a farewell luncheon upon his retirement after 42 years of Government service, 40 of which were spent with the Bureau of Reclamation.

Population Trends

The following data have been excerpted from The Kiplinger Washington Letter of December 22, 1956:

Total population of the United States grows so fast you lose track of it. 40 years ago, 100,000,000. 10 years ago, 141,000,000. Now 170,000,000. By 1957, 221,000,000 . . . and that's a lot of people to be fed, clothed, housed, and otherwise serviced . . . potential customers within our system. A lot of people to do the work, too . . . as they mature and become able. People will overflow the landscape around the cities . . . farther than now. They will migrate to new places, and fill up areas now sparsely settled. They will lead new lives of their own . . . with new patterns, new standards.

Where People Are Moving To—and From

Now look at growingest areas of United States: Florida, fastest growing of the big States, percentagewise . . . up 36 percent past 6 years. Means addition of 1,000,000 people. California, up 27 percent in the past 6 years. But this adds some 2,900,000 people. Mountain States, well up. Nevada 55 percent; Arizona 41 percent; Colorado 22 percent; New Mexico 20 percent; Utah 18 percent. Other fast-growing States: Delaware 26 percent; Maryland 20 percent; Michigan 18 percent; Texas 16 percent; Ohio 15 percent; Oregon 13 percent; Indiana 12 percent; Washington 12 percent; Louisiana 12 percent. Lagging behind the average of United States: New England, excepting only Connecticut. Others lagging: New York, Pennsylvania, North Carolina, Georgia, Illinois, Wisconsin, Minnesota, Iowa, Nebraska, Dakotas, Montana, Idaho, Missouri, Oklahoma, Kentucky, Tennessee, Alabama. Actually losing population: Maine, Vermont, West Virginia, Mississippi, Arkansas. States not listed are near United States average . . . 11 percent in past 6 years. #

U. P. Movie Available

"Fresh From the West," a new Union Pacific Railroad movie depicting the harvest, packing and shipping of fresh vegetables from the irrigated West, is now available for loan to groups interested in irrigation. Prints are obtainable from Joe Jarvis, UP Agricultural Agent at 1416 Dodge Street, Omaha, Nebraska. #

Cachuma's Recreation

Continued from page 29

on recreational use of the reservoir. That was in October 1952. The Board of Supervisors, following the citizens' conference and publication of the master plan, held a public hearing at which there was wide representation from many segments of the community. Support for county administration was practically unanimous. The Board of Supervisors, following the public hearing, established a park division in the County Public Works Department and created a Park Commission to advise the division on matters of policy. A county park superintendent was employed by the Board to assume direct responsibility for administration of the area.

Operation and development began in 1953. About $100,000 was invested in 1953–54 for capital improvements, and a system of fees and charges for entry to the area and for use of the facilities was established. Concessions were let for boat rental and related services. The reservoir has not yet filled and good pasture on the exposed lake bed areas has been utilized through grazing leases providing additional revenue. Revenues from this source will be reduced as the reservoir fills but revenues from recreation should increase.

Cachuma reservoir is designed for long-term hold-over storage. Since the dam was completed 4 years ago, drought has prevailed and the reservoir has not filled. Recreational use, however, has increased each year. The story is best summarized in the following tabulation of receipts from fees and charges and of the costs for development, operation and maintenance:

REVENUES

	1953–54	1954–55	1955–56	Totals
Season passes	$9, 157. 00	$13, 466. 50	$17, 157. 00	$39, 780. 50
Camping permits	1, 086. 00	4, 839. 45	12, 300. 70	18, 226. 15
Boat licenses	1, 714. 96	8, 094. 00	11, 825. 00	21, 633. 96
Parking fees	4, 528. 00	14, 683. 44	22, 668. 30	41, 879. 74
Concessions	967. 71	3, 842. 93	8, 437. 81	13, 248. 45
Grazing leases	4, 593. 60	5, 493. 89	6, 337. 44	16, 424. 93
Total revenues	22, 047. 27	50, 420. 21	78, 726. 25	151, 193. 73
Operation and maintenance	21, 096. 33	39, 640. 39	50, 262. 33	[1] 110, 999. 05
Depreciation (Using 15-year average life on capital outlay valued at $183,273.19)				26, 472. 74
Total costs including depreciation				137, 471. 79
Net revenue for 3 years of operation				13, 721. 94

[1] This does not include costs to the County for Administration other than at the Park, or costs of work by the Public Works Department Maintenance Division.

More than 80 percent of the 593,000 visitors to Cachuma come from Los Angeles and its environs. Through payment of fees they contribute toward the development and maintenance of the area, thus relieving the county of what would otherwise be an unfair burden.

Before concluding that all reservoir areas can be as successfully operated as Cachuma a word of caution is in order. At Cachuma the terrain favors controlled access to the area at a single point, thus simplifying collection of fees and reducing collection costs. Many reservoirs have several logical points of access and collection costs could be high in proportion to receipts, unless recreational use is extremely heavy. Scattered development also means high costs for capital outlay, again excepting those locations where the use of each developed area approaches a maximum. Each reservoir thus becomes a special development and management problem. Nevertheless, the experience at Cachuma should be valuable to those agencies which are managing or which expect to manage recreation at reservoir areas. # # #

BOOKS

IRRIGATION ENGINEERING

VOLUME II

by Ivan E. Houk

John Wiley & Sons, Inc.

New York

The second volume of IRRIGATION ENGINEERING, by Ivan E. Houk, has recently been published by John Wiley & Sons, Inc.

Now a consulting engineering in Denver, Mr. Houk was for many years on the staff of the Assistant Commissioner and Chief Engineer of the Bureau of Reclamation of the Department of the Interior.

The first volume of this work, published in 1951, dealt with the hydrological and agricultural phases of irrigation engineering.

The second volume emphasizes the practical requirements that must be kept in mind in evaluating irrigation feasibilities, planning irrigation projects, designing structures, and constructing all features of irrigation systems. It includes discussions of necessary land and water studies and of project settlement problems, as well as chapters dealing with water conveyance and distribution systems and with all types of structures.

WATER FOR AMERICA

The Story of Water Conservation
by Edward Graham and William Van Dersal

This is a comprehensive survey of water conservation in America—what has been done and what remains to be done. And it is a remarkable story about one of the most important substances on earth—a substance that we take for granted, yet one that all living things depend on for continuing life.

In a topical presentation the authors have included here the importance of water and our dependence on it, how it is used in industry, on the farm and in the home, what the methods of conservation are, the importance of conservation, and the pleasure water gives. The photographs, facing each page of text, dramatize and enhance the factual material.

OXFORD UNIVERSITY PRESS

DO YOU KNOW:

That Glen Canyon Dam on the Utah-Arizona border, only a few miles above Lee Ferry, will create a reservoir which will be capable of storing 26 million acre-feet of water.

This is more than enough to cover the entire State of Rhode Island 30 feet deep.

LETTERS

ORGANIC FARMING!

Dear Sirs: Would you please favor me with a copy of your November issue. A group of farmer friends in Mexico would like to read the article re Gillett's organic culture.

(Sgd.) P. A. Ingrason
c/o *Hotel McCoy*
El Paso, Texas.

Dear Sirs: I read with great interest the article in the November issue on Mr. Gillett's organic method of farming. I hope to see more articles along this line, as I believe this natural method will have a very beneficial influence on the health of the soil and on our own health.

Sincerely,
(Sgd.) L. Fencl
Our Lady of Lourdes Mission
Porcupine, South Dakota.

We will try to fill your request in an early issue.—Ed.

GRASSLANDS

Continued from page 42

This type of information greatly helps ranchers to judge the condition of their ranges and to be aware of whether their range is improving or degenerating. For example, a pasture which was mostly buffalo grass would probably have a past history of heavy grazing. Buffalo grass is a good grass, but it simply will not produce as much forage as some of the taller grasses (Table 2). When increasers such as buffalo grass start replacing decreasers such as big bluestem, a rancher knows that his range is degenerating.

Information of this kind should be obtained all over the country where native grasslands are an important part of the economy. Areas such as the one set aside by the Bureau of Reclamation at Cedar Bluff Reservoir are a necessity in obtaining such information. These areas must be set aside soon or prairies such as this one will disappear, and we will soon forget what our native climax grasslands were like. ###

Table 2. *Forage yields (lbs. per acre) of principal species of grass on different sites of Cedar Bluff prairies (1952)*

Grasses	Upland	Breaks	Lowland
Buffalo grass	1, 253	1, 548	0
Blue grama	1, 337	980	0
Side-oats grama	1, 667	1, 186	0
Western wheatgrass	2, 097	0	4, 941
Big bluestem	3, 804	2, 410	6, 013
Little bluestem	0	2, 406	0
Switch grass	0	0	5, 873

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DS-4764	Missouri River Basin, S. Dak.	Jan. 8	One 75,000/100,000/125,000-kva (230/161-kv) autotransformer for Sioux City substation.	Legnano Electric Corp., New York, N. Y.	$168,500
DC-4774	Columbia Basin, Wash.	Mar. 4	Construction of earthwork and structures for Royal Branch canal laterals, wasteways, and drains, Block 85.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	888,968
DC-4779	Colorado River Storage, Utah-Wyo.	Jan. 4	Construction of earthwork, structures, bridge, and surfacing for temporary access road to Flaming Gorge Dam, Sta. 0 + 00 to 402 + 00.	Wangsgaard Construction Co., Logan, Utah.	143,912
DC-4783	Missouri River Basin, Mont.	Mar. 8	Construction of Helena Valley pumping plant	Misco-West Coast, Seattle, Wash.	1,056,383
DC-4786	Missouri River Basin, Neb.-Kansas.	Jan. 14	Construction of earthwork and structures for Courtland canal, Sta. 2472 + 48 to 2809 + 00; Miller canal, Sta. 0 + 00 to 456 + 32.4, and laterals, wasteways, and drains.	Bushman Construction Co., St. Joseph, Mo.	1,014,168
DC-4792	Missouri River Basin, Kansas.	Jan. 18	Construction of earthwork and structures for Kirwin South canal, Sta. 0 + 52 to 860 + 50, laterals, and drains.	Bushman Construction Co., St. Joseph, Mo.	990,261
DC-4793	Missouri River Basin and Kendrick projects, Wyo.	Jan. 17	Construction of earthwork, structures, bridge, and surfacing for access road to Fremont Canyon powerplant and surfacing Alcova powerplant access road and parking area.	Knisely-Moore Co., Douglas, Wyo.	479,353
DS-4795	Missouri River Basin, Mont.	Mar. 21	Two vertical-shaft, 5,000-hp, 325-rpm hydraulic turbines and two vertical-shaft centrifugal pumps for Helena Valley pumping plant.	James Leffel and Co., Springfield, Ohio.	345,270
DC-4800	Colorado River Storage, Ariz.-Utah.	Jan. 21	Construction of Colorado River bridge for Glen Canyon Dam	Kiewit-Judson Pacific Murphy, Emeryville, Calif.	4,139,277
DC-4801	Missouri River Basin, Wyo.	Feb. 14	Construction of Fremont Canyon powerplant and power conduit.	Coker Construction Co., Peter Kiewit Sons' Co., and Condon-Cunningham, Inc., Omaha, Nebr.	14,434,000
DC-4803	Central Valley, Calif.	Feb. 12	Construction of Clear Creek tunnel	The Shea Co., Henry J. Kaiser Co., Morrison-Knudsen Co., Inc., Macco Corp., and Raymond Concrete Pile Co., Alhambra, Calif.	36,644,556
DC-4804	Central Valley, Calif.	Feb. 11	Construction of earthwork, structures, and surfacing for county road improvements from Trinity River bridge to Trinity Dam.	Monte W. Brown, Redding, Calif.	792,423
DS-4805	Colorado River Storage, Ariz.-Utah.	Jan. 4	Materials for 100-foot by 320-foot steel warehouse for Glen Canyon Dam and powerplant.	Allison Steel Mfg. Co., Phoenix, Ariz.	164,081
DC-4807	Eden, Wyo.	Jan. 30	Construction of earthwork and structures for laterals and drains in Farson area and drains in West Side area.	Asbell Brothers Construction, Riverton, Wyo.	940,608
DC-4819	Missouri River Basin, Neb.	Feb. 1	Construction of Culbertson canal siphons, Sta. 300+60 to 690+15, using monolithic concrete in siphon barrels, Schedule 1.	Adler Construction Co. Rapid City, S. Dak.	678,833
DC-4824	Central Valley, Calif.	Mar. 8	Construction of Trinity Dam	Guy F. Atkinson Co., M. J. Bevanda, Charles L. Harney, Inc., Ostrander Construction Co., A. Teichert and Son, Inc., and Trepte Construction Co., Inc., South San Francisco, Calif.	48,928,101
DC-4829	Chief Joseph Dam, Wash.	Mar 12	Construction of earthwork, pipelines, and structures for Brewster Flat distribution system, Brewster Flat Irrigation District.	Hanning and Gonzales, Portland, Oreg.	433,833
DC-4831	Missouri River Basin, Wyo.	Mar. 27	Construction of Anchor Dam (concrete) and access road	Foley Brothers, Inc., St. Paul, Minn.	2,289,052
DS-4836	Santa Maria, Calif.	Mar. 26	Four 7-foot by 12-foot outlet gate valves for outlet works at Vaquero Dam.	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	348,750
100C-253	Michaud Flats, Idaho	Mar. 13	Construction of pipe laterals for Areas 1 and 3	Mel Brown Co., Idaho Falls, Idaho	157,411
100C-275	Minidoka, Idaho	Jan. 22	Construction of earthwork and structures for Unit B relift pumping plants and laterals from 20 wells.	Olof Nelson Construction Co., Logan, Utah	167,633
100S-276	Minidoka, Idaho	Feb. 12	Sixteen pumping units for wells	Layne and Bowler, Inc., Memphis, Tenn.	172,528
117C-416	Columbia Basin, Wash.	Mar. 7	Construction of earth and concrete lining and structures for East Low canal laterals, Block 18.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	107,738
117C-420	Columbia Basin, Wash.	Mar. 21	Construction of earthwork for deep drains, Blocks 41, 42, and 43.	Duncan Construction Co., Moses Lake, Wash.	133,445
400C-72	Weber Basin, Utah	Feb. 14	Construction of earthwork and structures for Syracuse (B-5) drain.	R. W. Coleman Co., Ogden, Utah.	144,500
701C-429	Missouri River Basin, Nebr.	Mar. 4	Construction of earthwork and structures for additions and extensions of Bartley and Cambridge canals and laterals.	Bushman Construction Co., St. Joseph, Mo.	154,871

Construction and Materials for Which Bids Will Be Requested Through June *

Project	Description of work or material
Central Valley, Calif.	Constructing a 102-inch precast concrete pipe siphon, 83 feet of which will be in a tunnel under the Southern Pacific Railroad; 50 feet is to be jacked under U. S. Highway 99W and about 102 feet laid in open trench for the Corning Canal, south of Red Bluff.
Collbran, Colo.	Constructing the 144-foot-high Vega earth dam and appurtenant structures, and relocating about 5 miles of county road. About 10 miles east of Collbran.
Colorado–Big Thompson, Colo.	Furnishing and installing an electrical fish screening device 160 feet long with depth varying from 5 to 20 feet in Willow Creek Reservoir at the intake to the Willow Creek Pump Canal, about 8 miles north of Granby.
olorado River Storage, Ariz.	Constructing a one-story light steel frame municipal building about 224 feet long and 36 feet wide, a one-story wood-frame laboratory building about 54 feet long and 39 feet wide, a 360- by 144-foot steel frame administration building, a 160- by 48-foot steel frame fire, police headquarters building, a 225- by 36-foot steel frame dormitory, a 150- by 70-foot steel frame garage, a sewage treatment plant and about 290 residences and facilities for a 2,000-person community at Glen Canyon. Work will include streets, water and sewer main. About 120 miles north of Flagstaff, Arizona, and 70 miles east of Kanab, Utah.
Do	Constructing base course and bituminous surfacing, and guardrail for 25 miles of access highway from Bitter Springs to Glen Canyon Dam site, about 120 miles north of Flagstaff.
Do	Oiling 7 miles of road to the Arizona-Utah State Line, constructing 0.75 mile of access road, and constructing and surfacing Vista Point parking area at Glen Canyon Dam site, about 70 miles east of Kanab, Utah.
Colo. River Storage, Utah.	Constructing about 80 residences, facilities including streets, sewage collection system, and a water distribution system for a 1,000-person community, a 105- by 36-foot wood-frame administration building, a 39- by 54-foot wood-frame laboratory, a 100- by 30-foot concrete masonry garage and fire station, and a 24- by 60-foot wood-frame conference hall. At the Flaming Gorge Community, about 40 airline miles north of Vernal.
Do	Constructing 7.5 miles of bituminous-surfaced access road to left abutment of Flaming Gorge Dam, about 40 airline miles north of Vernal.
Do	Constructing a pumping plant building and installing two 250 gpm pumping units with a head of 800 feet, and chlorination equipment; furnishing and installing 13,300 feet of 6-inch insulated discharge line on piers, 2,500 feet of 8-inch supply line to community, and constructing a 250-foot pipe suspension over the Green River and a 500,000-gallon steel water storage tank. At the Flaming Gorge Community, about 40 airline miles north of Vernal.
Columbia Basin, Wash.	Constructing about 3 miles of 12-foot bottom width concrete-lined Wahluke Canal. South of Othello.
Do	Constructing the 165- to 29-cfs-capacity wasteway channel about 9 miles long, 15 miles west of Mesa.
Do	Constructing 7 drains and one pumping plant in Block 45, near Othello.
Do	Constructing pumping plants near Ephrata and Othello.
Do	Constructing and deepening drains near Warden, Othello, Moses Lake, Quincy, and Ephrata.
Do	Constructing two 3-bedroom frame residences with separate double garage; two 2-bedroom frame residences with attached garages and full basements; constructing an office building, storehouse, general purpose shop, equipment shelter building; one 2-bedroom frame residence with attached garage and full basement; two 2-bedroom frame residences with full basements, a separate 2-car garage, and one pumphouse in Block 81, near Quincy, Burke, Moses Lake, and Smyrna.
Grants Pass, Oregon.	Constructing fish screening device ahead of pump intake structure at right end of the Savage Rapids Dam, east of Grants Pass.
Kendrick, Wyo.	Earthwork and structures for about 8 miles of open drains, near Casper.
Middle Rio Grande, N. Mex.	Removing spoil piles along the settling channel; cleaning, rehabilitating and providing for power operation of the gates at the dam; constructing a concrete skimmer wall in canal intake structure; a reinforced concrete training wall 10 feet high and 100 feet long in sluiceway channel, and driving steel sheet piling for 350 feet of training walls in the Rio Grande River channel, upstream from the dam. Angostura Diversion Dam, north of Bernalillo.
Middle Rio Grande, N. Mex.	Clearing and cleaning about 9.5 miles of laterals and constructing turnouts, checks, drops, culverts, siphons, drainage inlets and wasteways. Belen Unit 3, between Isleta and Belen.
Minidoka, Idaho	Earthwork and structures for about 7 miles of open laterals with bottom widths of from 4 to 2 feet, from 14 wells. Near Rupert.
Do	Completing 5 Unit B relift pumping plants including furnishing and installing electrical equipment, on the North Side Pumping Division.
Do	Installing pumping units, furnishing and installing complete electrical systems and other minor miscellaneous completion work for 57 deep irrigation wells. Near Rupert.
MRBP, Mont.	Earthwork and structures for about 23 miles of 16- to 6-foot bottom width earth canal with about 4 miles of compacted earth lining and about one mile of concrete lining. Helena Valley Canal, near Helena.
MRBP, Neb.	Earthwork and structures for about 38 miles of canal with bottom widths varying from 16 to 3 feet and about 35 miles of unlined laterals with bottom widths varying from 6 to 3 feet. Near McCook.
MRBP, Wyo.	Two 25,263-kva, 0.95 power factor, 11,500-volt, 257-rpm, vertical-shaft, hydraulic-driven, indoor-type, synchronous generators for the Fremont Canyon Powerplant.
Rogue River Basin, Oreg.	Constructing the 67-foot-high Keene Creek Earth Dam and appurtenant structures; the 6-foot-diameter, 2,100-foot-long, concrete-lined Cascade Divide Pressure Tunnel; 4,250 feet of 60-inch-diameter monolithic concrete, precast concrete pipe or steel pipe pressure conduit; and the 6-foot-diameter, 5,000-foot-long concrete-lined Green Springs Pressure Tunnel. About 16 miles by road southeast of Ashland.
Do	Constructing about 8 miles of the 60-cfs-capacity concrete-lined Howard Prairie Delivery Canal, including about 3 miles of reinforced concrete rectangular flume section, a 48-inch concrete pipe siphon about 1,200 feet long and the earth and rockfill Little Beaver Creek Diversion Dam. Near Ashland.
Do	Constructing the outdoor-type, single-unit Green Springs Powerplant, penstock and switchyard. About 11 miles southeast of Ashland.
Do	Clearing about 2,000 acres, including about 490 M f. b. m. of merchantable timber of mixed species. Howard Prairie Reservoir site, about 27 miles east of Ashland.
Do	Constructing buildings and camp facilities at Howard Prairie Dam, near Ashland.
Solano, Calif.	Constructing about 8.7 miles of 7-foot bottom width concrete-lined canal, including monolithic concrete box siphons, precast concrete pipe siphons, turnouts, checks, culverts and bridges. Putah South Canal, west of Fairfield.
Ventura River, Calif.	Work will include constructing a 500-foot-long rock weir, a 60-foot-wide gated spillway, a 500-cfs-capacity canal headworks, a Parshall flume, a concrete-lined canal 5.25 miles long, with culverts, drainage inlets and bridges, a 78-inch-diameter siphon, and a reinforced concrete chute-drop terminal structure into Casitas Reservoir. Robles Diversion Dam and Robles Casitas Diversion Canal, north of Ventura.
Do	Earthwork and structures for 25,800 feet of 42- and 54-inch precast concrete cylinder pipe line and 141,700 feet of 12- to 39-inch precast concrete pipe (pretensioned) or mortar-lined and mortar-coated steel pipe lines. Near Ventura.
Weber Basin, Utah.	Earthwork and structures for about 15 miles of Uintah Bench Laterals of precast concrete pipe, modified prestressed steel cylinder pipe, mortar-lined and coated steel pipe and cast iron pipe or asbestos-cement pipe; 2 small reservoirs; and one pumping plant with 4 outdoor, horizontal booster units. South of Ogden.
Do	Constructing about 4 miles of precast concrete pipe line and a concrete-lined equalizing reservoir. Davis Aqueduct Trunk Lines, near Salt Lake City.
Do	Constructing the 37,600-foot-long Willard Dike averaging 3 feet high and 40 feet wide, excavating drains, constructing corrugated metal pipe drainage structures, and grading and surfacing an access road. Southwest of Willard.

* Subject to change.

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The Reclamation Era

AUGUST 1957

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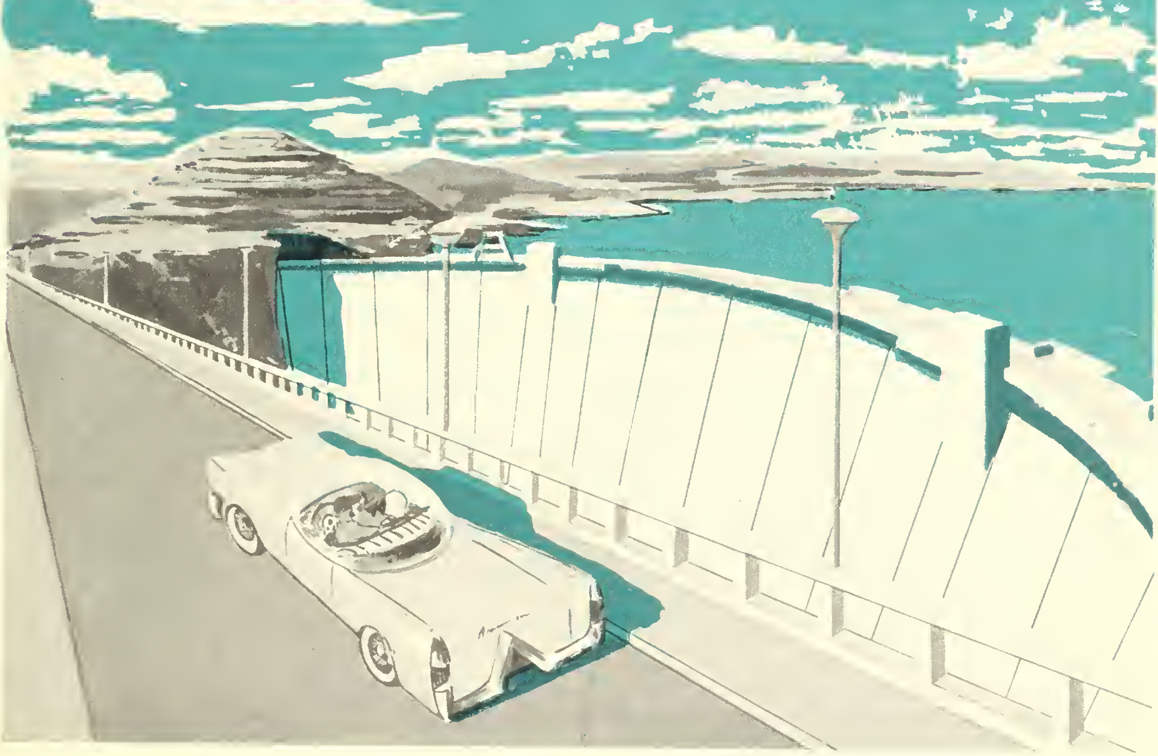
KEY CONTRACT AWARDED FOR COLORADO RIVER STORAGE PROJECT

RECREATION AT COLUMBIA BASIN



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The Reclamation Era

AUGUST 1957

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In this issue . . .

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Thirty Years Ago in the Era

May 10, 1927, was a gala day for Orego[n] Federal and State authorities, engineers, [a] good representative group of farmers an[d] their families, and businessmen journeye[d] to the McKay Dam to take part in th[e] celebration marking the release of the firs[t] storage water from the McKay Reservoi[r].

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Bureau of Reclamation, Washington, D. C.

J. J. McCARTHY, Editor

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Key Contract Awarded for *Colorado River Storage Project*

by C. H. CARTER,
Assistant Regional Director, Region 4,
Bureau of Reclamation,
Salt Lake City, Utah

With the opening of bids on the prime contract for Glen Canyon Dam, the Bureau of Reclamation launched the $938 million Upper Colorado River development program. Bids were opened on April 11, 1957—exactly 1 year to the day after President Dwight D. Eisenhower signed Public Law 485 authorizing construction of the initial four storage units of the Colorado River storage project and the initial 11 participating projects.

Kanab, a small picturesque town in southern Utah, where the Hollywood film producers make cowboy movies on location, was the site of the bid opening. The Bureau of Reclamation office in the old school building was obviously too small to accommodate the bid opening crowds so bids were opened in the gymnasium of the new Kanab High School, where the decorations for a high school dance set the scene for what must have been the Bureau's most festive bid opening.

While the locale was outwardly festive, 750 people had assembled to witness the opening of bids for the largest single contract in the history of the Bureau of Reclamation.

A tenseness filled the air! How high would the bids run? What would happen if bids were way above the engineer's estimate? Would the Upper Colorado River program be delayed? These, and scores of other questions were heard on every hand.

Finally, the 10 a. m. bid opening time arrived, and the time-honored, machinelike procedures began. By chance, the first bid read by L. F. (Lem) Wylie, project construction engineer for Glen Canyon Dam, was the low bid submitted by Merritt-Chapman and Scott of New York, $107,955,122!

With this short announcement, the Upper Colorado River basinwide development was launched. Glen Canyon Dam—the key to the entire development—was assured. The third highest dam in the world with the third largest reservoir in the world and the seventh largest hydroelectric powerplant in the United States would be built.

Two additional joint-venture bids of about $118 million and $120 million were received; but Merrit-Chapman and Scott's bid of $108 million—more than $27 million below the engineer's estimate of $135,608,170—was the best. The contract was awarded and notice to proceed issued on April 29.

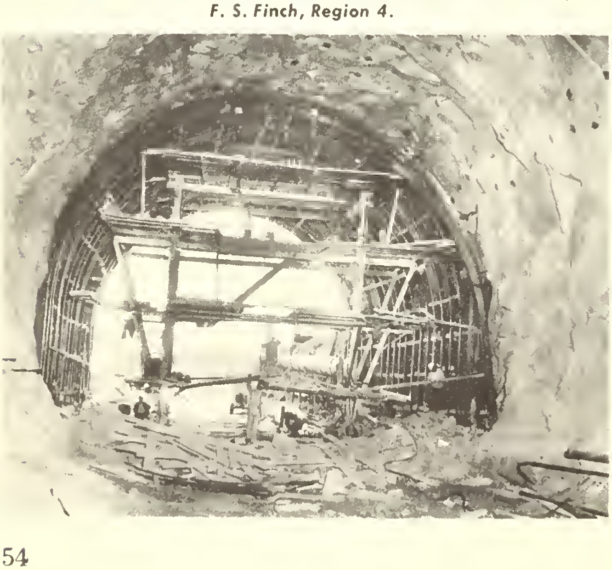
Upper left: William Denny, (left) vice president, Merritt, Chapman & Scott; and L. F. Wylie, construction engineer, following bid opening. Upper right: Bids opened before audience of over 700 interested spectators. ***Photo by F. B. Slote, Region 4.***

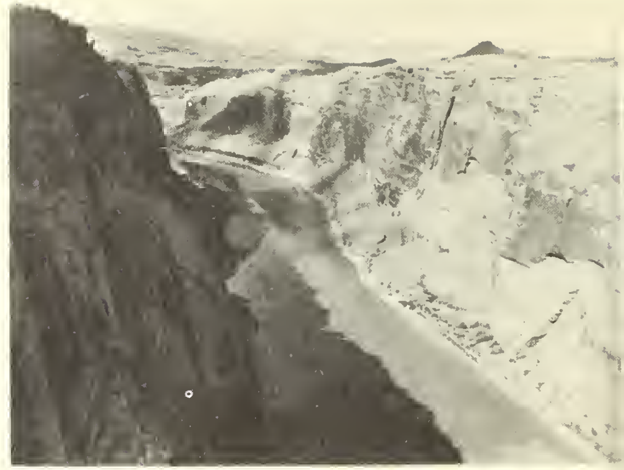
Glen Canyon Dam is located on the Colorado River in Arizona at the lower margin of the Upper Colorado River Basin. At this point, Glen Canyon Dam can store the erratic flows of the Colorado River to assure steady releases to the Lower Colorado River Basin in accordance with the Colorado River Compact. Only with this control of the Colorado River can upstream diversions for beneficial, consumptive uses on a large scale be made every year, year-in and year-out.

Power revenues from the Glen Canyon Dam powerplant of 900,000 kilowatts will repay about 75 percent of the $938 million cost of initially authorized works plus interest on the power investment. Revenues from the sale of Glen Canyon power will be placed in the basin fund along with revenues from other sources to repay in full all reimbursable costs.

Merritt-Chapman and Scott's bid of $108 million on the prime contract for Glen Canyon Dam clearly assumes great significance. Glen Canyon Dam, which is the essential feature of the Upper Colorado Basin plan of development, is now under construction. Flaming Gorge Dam in Utah, Navajo Dam in New Mexico, and the Curecanti unit of several dams in Colorado will be undertaken in timely progression. Flaming Gorge Dam and Reservoir will provide about 4 million acre-feet of storage and 100,000 kilowatts of installed generating capacity; Navajo Dam and Reservoir, more than 1½ million acre-feet of storage; and the Curecanti unit, 1¼ million acre-feet of storage and 152,000 kilowatts of installed generating capacity.

Placing steel in north right portal of tunnel. ***Photo by F. S. Finch, Region 4.***





View of Glen Canyon where water will be several hundred feet deep after completion of the dam.

Construction work at the Glen Canyon damsite began with the first blast of rock from the right canyon wall on October 15, 1956, as President Eisenhower gave the signal from his desk in Washington, D. C., in a historic telephone network ceremony. The Mountain States Construction Co. of Denver, Colo., thus began work on a $2.5 million contract awarded on October 1, for excavating the right diversion tunnel. As this is written in May 1957, more than 1,000 feet of the approximately 45-foot diameter tunnel had been driven. Completion of the 2,768-foot-long tunnel is scheduled for December 1957.

Access road construction to the Glen Canyon damsite was started immediately. An alternate route for U. S. Highway 89 received prompt approval. This alternate highway will leave the present U. S. 89 at Bitter Springs, Ariz., reach northward 25 miles to the Glen Canyon damsite; cross Glen Canyon on the highest steel arch bridge in the United States; and extend generally westward 72 miles to join with U. S. 89 at Kanab, Utah.

The 25 miles of primary highway from Bitter Springs to the damsite will be completed and surfaced by late fall of 1957 at a total cost of about $3,700,000.

The 1,271-foot long, 700-foot high, 38-foot wide steel arch bridge across Glen Canyon, about 900 feet downstream from the damsite, is under contract for $4,139,277 to the Kiewit-Judson Pacific Murphy combine. Work on the bridge abutments is now well under way. Completion of the bridge is scheduled for early in 1959. The "hanging" of

3,500 tons of structural steel across this chasm will be a spectacular undertaking.

A 7-mile graveled road has been built by the Bureau of Reclamation from the damsite to the Utah-Arizona State line. It is expected that the State of Arizona will bring this road up to primary highway standards at an early date.

The State of Utah will soon have all of the remainder of the new Alternate U. S. 89 from the State line to Kanab under construction contracts.

A new town, which has been named Page, Ariz., (after former Commissioner of the Bureau of Reclamation John C. Page), is now under construction on Manson Mesa about 2 miles from the damsite on the southeast side of the Glen Canyon. Estimates of peak population for Page, in which Government and contractor personnel will live, range from 8,000 to 12,000. The nearest existing towns are Flagstaff, Ariz., (also the closest railhead), which is 135 miles from Glen Canyon damsite and Kanab, Utah, 72 miles.

Merritt-Chapman and Scott's $108 million prime contract calls for the following major work items: (1) Drilling of left diversion tunnel, (2) lining both left and right diversion tunnels, (3) building two cofferdams to divert the river during construction, (4) constructing the concrete dam from bedrock to crest, (5) constructing the powerhouse and related features, and (6) drilling and lining the spillway tunnels. A total of 5,200,000 cubic yards of concrete will be placed in the Glen Canyon Dam and appurtenant works, with 4,770,000 of that total in the dam proper.

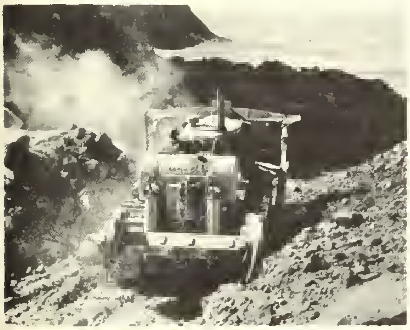
The steel in reinforcing concrete, in penstocks and outlets, and in many other installations will total 35,340 tons—a quantity of steel sufficient to produce more than 20,000 low-priced automobiles.

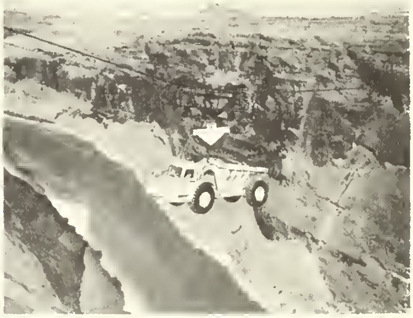
The time allowed for completion of the prime contract is 2,500 days, or nearly 7 years. A completion contract will be entered into to finish construction of the powerhouse, including installation of the generating equipment.

Glen Canyon Dam is a truly great engineering undertaking. It will rank with Hoover and Grand Coulee Dams which have been acclaimed by the American Society of Civil Engineers as two of the seven modern engineering wonders of the United States.

But great as Glen Canyon Dam will be as an engineering wonder, its greatest worth is found in the benefits which it creates by making the entire Upper Colorado River Basin development possible.

Completion of the initially authorized 4 storage units and 11 participating projects will create benefits estimated to total about $57 million annually! These benefits will result by making abundant water and power resources available to the upper basin States of Colorado, New Mexico, Wyoming, and Utah. Irrigation and industrial developments utilizing water and power will produce the primary benefits.





Clearing Bittersprings Road, drilling bridge abutment; and *lowering construction equipment into Glen Canyon.* Photos by F. B. Slote, and F. S. Finch, Region 4.

Population estimates reveal clearly the significance of the benefits to be achieved in the upper basin States. The present population of the upper basin States is nearly 3½ million people. By 1975, the population of this intermountain empire is expected to reach about 5,200,000 without the Upper Colorado development. But, it is estimated that development of the upper Colorado River Basin will swell the population by another 1 million persons, bringing the anticipated 1975 population to 6,200,000 people or nearly double the present population!

The real benefits of any resource development are revealed in terms of economic opportunities for people; the creation of economic support for

Continued on page 73

Weeds Move Faster Than People

Weeds are synonymous with irrigation. The history of irrigation and the weed problems of mature irrigation projects are proof of that hypothesis. Men of vision recognize, as did Jethro Tull, when he wrote in 1731, "It is needless to go about to compute the value of damage the weeds do, since all experienced husbandmen know it to be very great, and would unanimously agree to extirpate their whole race as entirely as in England they have done to wolves, though much more innocent and less rapacious than weeds."

The agricultural leaders of Grant County recognized the weed potential of the land when it is irrigated. Three years prior to the delivery of water to the Columbia Basin project farm leaders of the county which had at that time fewer than 100 irrigated farms, compared to the present potential of more than 6,000, met with representatives of State, county, railroad, farm organizations and others interested in the project, to discuss methods of organizing "A Weed District." Farmer and businessmen committees were appointed for the county as a whole and for the communities of Moses Lake and Quincy. These committees functioned as best they could under the circumstances. It was difficult to convince the owners of this potentially irrigated land of the threat of weeds. Without visible evidence of the existence of weeds the majority could not be convinced that a threat was manifest.

In 1951, the State Crop Improvement Association, acting through the County Crop Improvement Association, advocated the production of Foundation, Registered and Certified seeds in this area. There developed a kindredship between the Crop Improvement Association and the weed committees that had been working for years to make the people "weed conscious." It was necessary for weed control to become an integral part of farm management if the area was to retain its advantage in seed production. In 1953, the Crop Improvement Association, with the aid of farm leaders and United States Bureau of Reclamation officials equally concerned with weed control, met with the county commissioners and requested that a county extension agent be hired who would devote the major portion of his time to the development of a countywide weed control program. The Commissioners were in agreement; they recognized the need; and in February of 1954, the author began working toward such a goal.

A program that would be felt immediately and yet have sufficient value to grow with the basin as new farms were developed would necessitate the tying together of many varied interests. A meeting, attended by area representatives of the Bureau of Reclamation, the Fish and Wildlife

by BEN ROCHÉ

Grant County Extension
Service Weed Specialist
Grant County, Wash.

Service, the State Game Department, the Soil Conservation Service, the Parks and Recreation Department, the State College of Washington, the County Engineers Office and the County Extension Service, was held. The many phases of weed control were discussed. Many actions, each of which would make a good story, have come about directly or indirectly from this interagency discussion. Recognizing that people pass through definite stages in the acceptance of anything new, namely: Awareness, interest, evaluation, trial and adoption, our program has been given many means of expression. The use of some 300 colored slides representing weeds, the problems and control measures; the use of working models representing the weed seed screens recommended for cleaning waterborne weed seed from irrigation water; the use of a regularly scheduled radio program, always given on current weed control problems; the use of cooperative publications and of a flair for the printed word; the use of some 350 individual farm visits during the first year of the program; the loaning of spray equipment to farmers and in some cases giving them their first supply of the needed chemical; the use of every opportunity to speak on any phase of weed control to any type of organization, be it garden club or State experiment station; the use of some 75 demonstration plots, demonstrating the effectiveness of different chemical and cultural methods on farms and adjacent to county roads; the building of interest in weed identification and control among 4–H boys and girls; the use of live, potted specimens for fair displays along with pictures

WEED SEED SCREEN—Del Suggs, Reclamation weed specialist, inspecting screen adapted by Ed Kerr, Quincy, Wash., farmer. ***Photo courtesy of author.***

Left to right: Oscar Schorzman, farmer-director, Quincy weed district; Ben Roché; Bob Johnson, settlers assistant county agent, Quincy, Wash.; Ralph Plank and Elmer Gerken, farmer-directors, Quincy weed district. ***Photo courtesy of author.***

that tell the story of weed control. These and many other methods of obtaining and holding the interest of the people have been and are being used.

The formation of community-sized weed districts seemed the best place to begin organizing. General education work would be continuous while weed district formation would be emphasized in those areas having expressed a desire for a control district.

The Quincy district, an area including some 60,000 acres of irrigable land, had been hampered in its early stages of formation by the growth rate of the community. Men who were natural leaders were spread so thinly over a series of community development projects that the proposed weed district was being neglected, unintentionally. The committee was called together and the petitions were tabulated. The number of acres needed to fulfill the required 51 percent was assigned to the members of the committee. Another year went by without obtaining the required signatures for the acreage. Weed control and the desirability of a weed district was discussed before all groups that expressed an interest. Articles from the Extension Office were given to the local newspapers regularly. The enthusiasm of the reorganized weed district committee was beginning to wane when a field planted to mint roots came up to a fine stand of Perennial Sow Thistle. The location of this 60–acre field of Sow Thistle was in the center of the most valuable farmland in the community. Farmers experienced in other sections of the country, particularly the Midwest, now recognized the need for a weed district. Signed petitions were submitted and a hearing was requested. A bouquet

LARRY REEKER, Ephrata, Wash., 4–H boy, wins top spot in State weed identification contest two consecutive years. *Photo courtesy of author.*

of Perennial Sow Thistle was presented to the county Commissioners at the hearing. Grant County Weed District No. 1, the Quincy District, was created in the fall of 1955, too late to provide a feasible budget for the forthcoming year. Law thereby prevented actual operation in 1956. No funds, but a year to prepare their first budget and to ground themselves prior to issuing their first required policy statement.

The farmers of the Moses Lake area, upon hearing of the success in the Quincy area, requested a weed meeting. The committee that had been appointed 2 years before and men that had been working around the edges for several years combined forces. Committeemen contacted previous acquaintances from other irrigated areas. Committeemen with organizational or fraternal affiliations used these as a means of contacting landowners. Members of the soil-conservation district offered their land ownership lists and their office as committee headquarters. Within 3 months the petitions were signed and a hearing was called. In February 1956, Grant County Weed District No. 2, containing approximately 48,000 acres, was formed. The new officers of the Moses Lake District thus had until fall to become organized, prepare a budget, and prepare a district policy for the year 1957.

The countywide educational program has been continuous during the formation of districts 1 and 2. Other areas are contemplating district formation and their participation as organized districts is very much to be desired in the overall, long-time program. Emotions played a part in the Quincy area, friendly competition was basic in the Moses Lake movement, but these factors were in addition to the definite stages of acceptance which had readied these people for organized weed control. Various backgrounds of the people may tend to combine two or more of these stages, enabling individuals to take them all in one step; the majority will be slower however. A countywide weed program, in district form, is practical and desirable. We believe that we can obtain that goal and carry the people with us in a period of ten years. The present trend in agriculture, that of reduced labor per unit, of output and increased acreage under one managership, should make organized weed control easier to sell than it has been during the past three decades. # # #

GRAND COULEE IN COLOR

Illumination in color of the waterfall plunging over Grand Coulee Dam will begin late this summer following completion of a $150,000 light installation program authorized by Congress.

The spillway will be illuminated at the rate of 3.4 foot-candles. By comparison, the moon provides an illumination of one-tenth of one foot-candle.

The spillway will have a color program involving a 20-minute operation, automatically timed, during which colors will change repeatedly. Basic colors are white, amber, red, blue, and green.

The lighting of the falls a third of a mile wide and as high as a 30-story building, has aroused tremendous interest in the lighting industry, General Electric reported that it has "stirred more interest in the illumination field than anything else that has occurred in the last 15 years." Retired specialists were brought back to work by the company to work on the specifications. A major difficulty that had to be resolved was to manufacture nonfade glass for the various colors.

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If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

What's New In Beet Seed Development

by C. E. CORMANY, Chief Agronomist
Holly Sugar Corp.
Colorado Springs, Colo.

Spectacular things are occurring in the breeding of new varieties of sugar beets. True hybrid varieties and the long awaited monogerm type of seed are here. Hybrid sugar beets are producing 5 to 15 percent more sugar per acre than old standard varieties.

As the plant breeders progress in their research, the increases will be even greater. These hybrids are more disease resistant, sweeter and higher yielding than regular sugar beets.

By the use of inbreds, each with special merits, the combinations and recombinations may result in fantastic improvements in the yielding ability of the crop. Such was the case with corn, and it gave new life to Corn Belt agriculture.

The word "hybrid" implies greater vigor and bigger yields than either parent and therefore more profit per acre. Hybrid vigor and these other desirable features are now available for sugar beets.

True hybrids in the sugar beet plant were hard to get. Each sugar beet flower heretofore has borne both the male and female parts, causing self-pollination, and it was not until a U. S. Department of Agriculture scientist, Dr. F. V. Owen, discovered male sterility in the flowers of some sugar beet plants that hybridization became practicable. This meant that these plants produced no pollen themselves, and any seed produced on them had to be pollinized from other plants. The resulting seed was a true hybrid.

The complicated technique of securing this male sterile phase of a variety has been systematized so that the plant breeders can now develop a "male sterile equivalent" of almost any variety. These male sterile equivalents are then used as the female parent for hybridizing.

The possibilities for many and varied combinations provide a new and promising field of research. With this method varieties resistant to

MODERN GREENHOUSES in use in many locations are a valuable aid in speeding the plant breeders' work with hybrids and monogerm varieties. ***All photos in this article courtesy of the author.***

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SUGAR BEETS of the third backcross in the development of a monogerm variety for commercial use. The greenhouse each winter saves a year's time in the development cycle.

two diseases can be developed by using the male sterile female of one and the pollen plant of the other parent.

Actual combinations of leaf spot and curly top resistance, of root rot and leaf spot resistance, and even combinations of all three have been made. Many other combinations are in the making now.

True hybrids for commercial use can be made by planting companion variety strips in a seed beet field—one strip, the larger, being the female (male sterile) parent and the other strip, the smaller, being the pollinator or male parent. The seed produced on the female strip is the hybrid, and the seed borne on the male parent is discarded.

Of great importance at this time is the development of monogerm sugar beet seed. The seed of the regular multigerm sugar beet is really a seed cluster containing from 1 to 5 true seeds, all of which usually germinate and form a thick mass of closely associated seedlings. Picture what an improvement it will be when each seed ball contains but one true seed, such as corn, beans, wheat and other crops.

Monogerm means "single germ." This type of seed is being developed now for commercial varieties of sugar beets for all areas.. The monogerm "gene" was found in 1948 in a sugar beet seed field in Oregon by a "displaced" Russian sugar beet scientist, Dr. V. F. Savitsky, employed by the Beet Sugar Development Foundation. (*This organization includes all the beet sugar companies of America, and its function is to coordinate scientific research and education as related to sugar beets. Headquarters is at Fort Collins, Colo.*) He increased the progeny from the two monogerm plants he had found.

Mother roots of these were distributed to the plant breeders of the various sugar companies and others. These research specialists are now introducing this monogerm character into their best present day varieties, largely by the backcross method. In a few years probably all sugar beet seed will be of the monogerm type.

Monogerm seed will have larger embryo sizes containing a much greater reserve of starchy plant food in each seed than our present varieties. It will be planted at a lower rate per acre (fewer seeds per foot of row) and possibly a trifle deeper into better soil moisture conditions, with a resulting seedling stand ideally distributed within the row.

Monogerm seed will encourage complete spring mechanization of the crop, eliminating the need of hand labor for thinning and, with the proper use of chemicals for controlling weeds, should add to the efficiency of sugar beet production.

Another comparatively new and interesting phase of sugar beet research is the development

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TYPICAL BEET SEED field near Phoenix, Ariz. Ten varieties of hybrids are being grown in the area for experimental work.

Compressed Air vs. Drought

Bubbles released at lower reservoir levels would bring cool water to the surface and markedly reduce evaporation

by ABRAHAM STREIFF

DR. ELWOOD MEAD (Deceased)
Commissioner of Reclamation—1924–36

Traveling Southwest in mid-summer from the lush green fields, cool pine woods and limpid lakes of Maine, vistas of verdure soon commence to spread out into Midwest farm flatlands already flecked with yellow, stubbled harvest fields and browning, sunburnt grass areas. Still farther along in the dry belt arid perspectives loom and pass and dust clouds, wind-blown from sandbars green-fringed only where water reaches thirsty roots, trail over hidden distant rivers.

The "expanding and contracting desert," as Isaiah Bowman referred to the climatic pendulum, once more swirls dust over vast reaches from Texas to Wyoming. For thousands of years man has dwelt, seemingly by preference, in regions of dwindling rains; indeed, civilization was born where rains begin to tarry and turn back. The Near East deserts are inexhaustible ruin histories of once thickly settled, irrigated empires that rose and fell in a bewildering succession from one millennium to the next. For 6,000 years irrigated realms have driven the desert hard to its sovereign haunts. The sagebrush-covered open spaces of dry plain and rock-strewn wasteland in the United States still remain and were marked the "Great American Desert" on old maps of the West.

Though much has been accomplished through modern engineering efforts, we still waste too much of that most precious of all elements—water. Half a century ago, Maj. Sir Hanbury Brown wrote about Indian irrigation: "If all the works conceivable are constructed in the Punjab and the Sind, 60 percent of the surface flow would still escape by the rivers to the sea." Fifty years later Prof. O. W. Israelsen stated in a book on irrigation that less than one-third of the water diverted for irrigation is consumed by growing crops. Waste of water continues unabated.

In U. S. Geological Survey Circular 229 (1952), the former Commissioner of Reclamation, M. W. Straus, said: "Lake Mead is the key reservoir for the distribution of Colorado River water to Arizona and portions of Nevada, Utah, and New Mexico. Without water this area would almost be uninhabited, and the bulk of the supply comes from the lower Colorado. Every drop is precious; the demand far exceeds the supply. For this reason the Bureau of Reclamation is obli-

Reprinted from Compressed Air Magazine, August 1955.

Editor's Note: The Department of the Interior and the Bureau of Reclamation are greatly interested in evaporation problems and the Bureau is taking the lead in an investigation of mono-molecular films as an evaporation suppressor. There are other methods of suppressing evaporation that undoubtedly would bear investigation. This article explains one approach to the problem. The problem is so important that any reasonable proposal should be investigated. The author of this article, Mr. Abraham Steiff, is a consulting engineer of Quebec, Canada.

HOOVER DAM in the Black Canyon of the Colorado River, Arizona-Nevada, with Lake Mead in background.

gated to remove every possible source of error in its handling of the water of Lake Mead. The evaporation loss cannot be prevented, but accurate knowledge of evaporation permits more efficient use of the remaining water."

Loss through evaporation is stupendous. According to the report of river control work and investigations, Lower Colorado River Basin, the annual evaporation measured by floating pans and corrected for rainfall is about 100 inches, or 8.35 feet. For the 120,000-acre surface area of Lake Mead this amounts to a million acre-feet per year. For all the reservoirs in the Southwest the combined loss is, indeed, serious. Fortunately, the actual recorded loss between inflow and outflow is much smaller, and the figure given is the maximum rate of evaporation during the hottest months of the year during which corrective measures as herein discussed, should be applied.

An editorial that appeared in the October 1948 issue of this magazine (Compressed Air Magazine) under the title *Precious Water* reviewed the situation clearly. As therein foreseen, the water problem has increased in scope. The value of 1 million acre-feet of water is emphasized by the fact that the 912-foot-high Grand Dixence Dam is being constructed in Switzerland in order to impound 40,000 acre-feet of water. Exceeding Hoover Dam in height (726 feet), it is being built to store only one twenty-fifth of the amount of water lost by evaporation in Lake Mead alone!

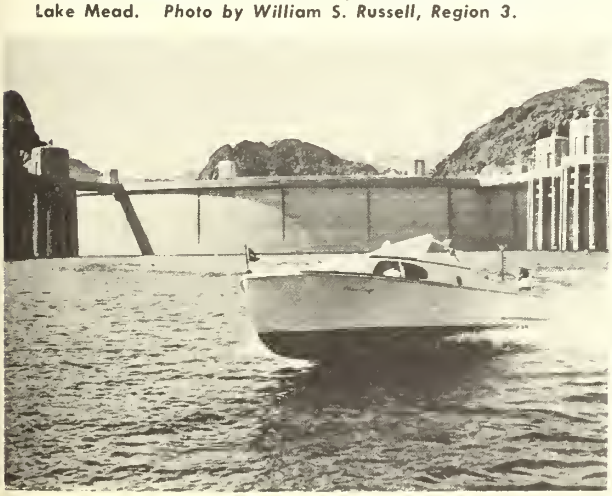
The late Commissioner of Reclamation Elwood Mead wrote in 1904 that "a California spring flowing 1 cubic foot per second recently sold for $50,000." At that rate, and allowing for the devaluation of the dollar since then, the water lost through evaporation at the Hoover Dam Reservoir, which is equivalent to 1,382 cubic feet per second, might be valued at $346 million today. Water for Texas rice culture costs some $13 per acre-year, while that supplied by the Colorado aqueduct when constructed was estimated at $18 per acre-foot.

The Government's saline-water program has set a limit of 12 cents per 1,000 gallons, or $39 per acre-foot, for irrigation water. In the Neches Valley in Texas, located in the rain belt near the Louisiana border, the industrial water rate is already $50 per million gallons for quantities of 1 million a day, with a minimum monthly payment of $1,500. Near Corpus Christi it was 24 cents per 1,000 gallons, or $78 per acre-foot, 4 years ago.

Obviously, the price of water is climbing under the pressure of rapid depletion and insatiable demand. Decreasing the losses is equivalent to increasing the supply. If evaporation cannot be prevented it might possibly be reduced. Nature herself shows us on a vast scale how this might be brought about. For a solution let us travel to the shores of the Caspian Sea, which is about 730 miles long and 260 miles wide. This large body of water is all that remains of the great central sea which once extended from the Euxine (Black Sea) to the Polar Sea. As a result of this isolation, the Caspian loses more water through evaporation than its drainage basin supplies, and it is still falling. In 1890 it was more than 80 feet below the level of the Black Sea. At that time Elisee Reclus wrote: "If it were to rise to the original level, it would cover the surface of the steppes for several hundred thousand square miles and completely inundate the Volga River Valley below Saratov."

The Caspian is divided into three distinct parts which differ greatly from one another in depth and salinity. The northern section, a vast marsh, is nowhere more than 50 feet deep and has a salt

HOOVER DAM—The upstream face of the dam is an impressive background for the speedboat enthusiasts on Lake Mead. ***Photo by William S. Russell, Region 3.***



SECTION OF SOAP LAKE SIPHON, Columbia Basin Federal Reclamation project, State of Washington. ***Photo by H. E. Foss, Region 1.***

content of 0.0016. There the Terek, the Ural and especially the Volga River discharge so much fresh water into it that the sea provides water for drinking purposes. The deeper central basin extends to a spur of the Caucasus, and in the southern end, which is mostly surrounded by high mountains, soundings of 2,953 feet have been logged. In both these areas the average salinity is only 0.009, or one-half that of the Black Sea, which would seem to indicate a considerable decrease in the saltiness of the Caspian since its separation from that body of water. This is borne out by the shells of marine creatures found on the plains once covered by the Caspian and by shelfish of the same but smaller species now inhabiting the latter, for the size of the shells is proportional to the salt content of the water.

This decrease in salinity is explained by the fact that water evaporates at a different rate at different temperatures. As along the Gulf Coast of Texas, the waves of the Caspian throw up banks of sand in front of shallow bays along its shores, thus converting gulfs and creeks into lagoons. Sea water enters the latter through narrow channels, and because the water is not deep it is considerably warmer than that in the open sea. Evaporation is consequently greater, and sea water flows in to restore hydrostatic equilibrium. The lagoons therefore become depositories of salt. When storms or dry periods cause them to be isolated, the water rapidly evaporates and leaves layers of salt in them.

Reservoirs of this kind may be studied all along the circumference of the Caspian. A former bay

Pleasure boating on Lake Mead, Arizona-Nevada. Photo by William S. Russell, Region 3.

not far from Novo Petrosk is divided into a large number of basins, which present every degree of saline concentration. The same condition exists farther south near the Bay of Alexander and at the extreme end of the northern section in the sea arm of Karasu (black water). There the water is 0.057 part salt, exceeding in salinity the Gulf of Suez, the saltiest body of water.

On the east shore of the Caspian is the remarkable inland sea, rather than lagoon, called the Karaboghaz (black abyss). According to Reclus, a current from the open sea was always running into it through a narrow channel at a speed of 3 knots. The east winds retarded it and the west winds increased it, but it was never less than 1½ knots. Caspian seafarers and Turkoman nomads who inhabited its shores were impressed by the inexorable flow rolling over the shoals into the "black gulf," which none ventured to navigate because they believed it to be an abyss into the underworld.

Baer estimated that the Karaboghaz receives daily 350,000 tons of salt from the Caspian. Seals are no longer found there. A sounding line, when scarcely out of the water, is covered with saline crystals. Thus nature demonstrates that evaporation from cool water is less than from warm, and that water should be cooled to reduce evaporation. The next step is to find a cold medium that will serve to cool the surface waters. Actually, the reservoirs themselves can provide it, for they are virtually unused iceboxes.

The greater part of the Southwest has severe winters and hot summers. In the winter months the icy waters sink to the bottom; in the summertime warm water floats on top of the lower, colder layers. The density of the warmer water is from one- to three-thousandths less than the density of the colder strata. This is characteristic of all lakes in temperate regions and produces the familiar phenomenon of annual "turnover" in spring and fall. The deeper, colder layers demonstrate their presence in many ways. For instance, on the bathing beaches of Lake Michigan a rising east wind blows the water westward. When that happens, warning signs are posted and the up-welling icy water immediately causes the beaches to be deserted.

Unequal temperatures and densities bring about so-called density currents. The Office of River Control of the Bureau of Reclamation publishes annual reports containing graphs of the temperature, density and other factors in relation to the depth of Lake Mead. From these the following example is taken. On April 17, 1950, at Mile 334.9, where the water is approximately 400 feet deep, the temperature at the surface was 64° F.; 150 feet down it was 54°. Six months later the temperatures at the same levels were 84° and 58°, respectively.

Studies at Lake Hefner, Okla., have produced what is known as the Hefner formula. Applying this to certain average conditions it is found that evaporation would be:

0.057 inch per day at 55°
0.276 inch per day at 67°
0.415 inch per day at 80°

From this it may be seen that a drop of 13° reduces evaporation to two-thirds of the value at 80°.

Compressed air has long been used successfully to bring warm water from the bottom to the top for varying purposes even when the difference in temperature was small. To keep trash racks of hydroelectric stations ice-free, for example, air under pressure has been introduced through perforated pipes at the bottoms of intakes to make warmer water rise and thus prevent the formation of ice at the surface. This has been possible even in the case of shallow intakes. Similarly, air released from pipes lowered through holes cut in ice near frozen spillway gates effectually clears

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Dredging

On The Colorado

Conservation of the Lower Colorado River's limited water supply is one of the major benefits of the Bureau of Reclamation's channelization program on the river in the vicinity of Needles, Calif.

Reclamation's 20-inch hydraulic suction dredge has been at work in the badly aggraded and meandering section of the river above and below Needles for the past 8 years, cutting new channel sections to restore the stream's flow to a defined channel. By realining the river, water formerly lost through evaporation and transpiration is being saved for much needed use by downstream farms and by cities and factories in the Pacific Southwest.

Channelization of the river above and below Needles was necessitated by the normal aggradation of the riverbed as aggravated by effects of the construction of large dams. The 11-mile stretch between Needles and Topock had so deteriorated that by 1944 it had spread out to form a swamp area several miles wide, where slow movement of the river allowed the deposition of silt on which grew willows, tamarisks, cattails, and other swamp vegetation. The dense growth increased the water surface elevation and promoted large water losses from evaporation and plant transpiration.

To remove the threat to Needles from a high-water table, which in the lower section of the city had risen above the ground, and, to avoid the danger of disastrous inundation should the flow of the river be increased by flood releases from Hoover Dam, Congress appropriated funds in 1944 for emergency measures. The Bureau of Reclamation hurriedly constructed protective works to provide temporary protection for the city and the Santa Fe Railroad which runs through the valley, and initiated investigations

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by PAUL A. OLIVER, Project Manager
Colorado River Front Work and Levee System
Bureau of Reclamation
Needles, Calif.

The Bureau of Reclamation's Columbia Basin project has enhanced the recreational values of the Columbia Basin area in the State of Washington. This region is fast becoming one of the Nation's most popular recreational developments. For your pleasure the following are offered:

SWIMMING
FISHING
BOATING
HUNTING
CAMPING
PICNICKING
LODGING

Recreation A

Columbia Basin

COMMITTEE OF NINE AND ADVISORY MEMBERS—1957: Standing: Frank O. Redfield, manager, Burley Irrigation District; Robert W. Ferebauer, manager, American Falls Reservoir District No. 2; David W. Dick, manager, Idaho Irrigation District; Merle L. Tillery, superintendent, Minidoka project; Leo D. Murdock, director, Aberdeen-Supringfield Canal Co.; Clifford N. Scoresby, director, Progressive Irrigation District; Lawrence Duffin, Minidoka Irrigation District. Seated: Alex Coleman, secretary, Committee of Nine; Lynn Crandall, watermaster, Snake River District No. 36; N. V. Sharp, chairman, Committee of Nine; Leonard E. Graham, vice chairman, Committee of Nine; R. Willis Walker, director, Fremont-Madison Irrigation District; J. H. Silbaugh, president, North Side Canal Co. *(Photo by Melville's Studio, Idaho Falls, Idaho)* March 1957.

Upper Snake River's Committee of Nine

One of the West's most colorful and effective irrigation organizations is the Committee of Nine of Idaho's Upper Snake River Valley. Although essentially an advisory group dealing with distribution of the Snake River waters in the area from Bliss, Idaho, to the headwaters in Jackson Hole, Wyo., the group has gained State and National recognition in its efforts to promote Snake River irrigation through cooperation of State, Federal, and local interests.

The committee was first established in April 1919, and consisted of the following members: J. T. Fisher, Alfred Ricks, and J. R. Thompson, representing the North Fork Protective Association; Christian Anderson, P. J. Davis, and D. H. Blossom, representing the Farmers Protective Irrigation Association; and J. D. Wheelon, R. E. Shepherd, and Frank A. Banks, representing the Minidoka and Twin Falls projects. Watermaster John Empey was appointed chairman, and John Lee was the first secretary. The membership on the Committee of Nine was arranged to give representation by geographical areas, with three members representing the water users diverting water from the North Fork of the Snake River, three members representing users diverting water in the upper valley above Blackfoot, Idaho, and three members representing the users diverting water below Blackfoot.

The original purpose of the Committee of Nine was to assist the district 36 watermaster in solving the complex water distribution problems of the Upper Snake River. The advisory group proved so successful in developing solutions to the water-distribution problems, that it soon became recognized as the spokesman for all the irrigation interests in watermaster district No. 36, representing over 1 million acres of irrigated land. The influence of the group has steadily increased through the years until its advice and recommendations are sought by legislators and State of Idaho officials on such matters as water-

by JAMES F. DUMAS, Administrative Officer
Minidoka Project, Burley, Idaho

MINIDOKA PROJECT—Aerial view of North Side Pumping Division. *Photo by Phil Merritt, Region 1.*

right legislation for both surface and ground waters, on interstate river compacts, and on development of the State's water resources.

The Federal Government has for many years recognized the Committee of Nine as an unofficial advisory group to the Bureau of Reclamation in the development of the Upper Snake River Valley, and the project superintendent of the Minidoka project serves as an advisory member on the committee. The vast majority of the lands in district 36 are dependent to a large degree upon storage water furnished from Jackson Lake and Grassy Lake Reservoirs in Wyoming, and from Island Park and American Falls Reservoirs in Idaho. These reservoirs were constructed by the Bureau of Reclamation, and are operated by the Minidoka project. The costs of construction and the annual O. & M. costs are being repaid by the water users of district 36, and in line with the Bureau of Reclamation policy the water users are accorded a full voice in recommending operating procedure and reviewing the costs of operation and maintenance. This is one of the important assignments of the Committee of Nine. Representing over 50 canal companies and irrigation districts receiving water under separate contracts, this compact organization meets each year with Minidoka project officials to review and approve the reservoir operating budgets. It also makes an annual inspection tour of the reservoirs each year in behalf of the water users.

The Committee of Nine was officially recog-

JACKSON LAKE DAM, *Moran, Wyo., Photo by Phil Merritt, Region 1.*

AMERICAN FALLS DAM and spillway section, American Falls, Idaho.
Photo by Phil Merritt, Region 1.

nized by the Department of the Interior in the negotiation of contracts for sale of storage rights in the new Palisades Reservoir and remaining space in American Falls Reservoir. The group assisted the water allocations committee in determining the amount of space to be sold to each contractor, and negotiated directly with the Bureau of Reclamation in arranging for contract provisions relating to water savings, exchanges of water rights between Jackson Lake and American Falls Reservoirs, and the payment terms. The contracts as finally signed in 1952 specifically provide for approval of the Committee of Nine to adjustments in storage space allocations, for prior approval of winter releases of storage water for power generation, and consultation on all other matters of contract administration relating to water use.

As a nonpolitical organization interested solely in irrigation farming the Committee of Nine has gained considerable prestige through its unbiased support of reclamation projects such as the Palisades project, and the proposed Burns Creek regulating reservoir which was recently introduced in a bill before Congress. Its individual members are active in National Reclamation Association affairs, and national legislation and policies which affect farming and irrigation.

At a typical meeting in Burley, Idaho, on December 15, 1956, the Committee of Nine considered problems concerning water rights of the Bureau of Reclamation's Michaud Flats project, and the Bureau of Indian Affairs' Michaud Division of the Fort Hall project. It reviewed and approved the amount of water flows to be maintained for power generation at Minidoka Dam, and the payment to be made to the Minidoka power system for curtailment of production during 1956. The committee discussed and approved the 1957 operating budget for Bureau of Reclamation reservoirs, and received a report on snow surveys in the watershed areas. Regional Director H. T. Nelson of the Bureau of Reclamation reported on the progress of the Palisades project construction, and discussed the proposed Burns Creek regulating reservoir. Other items

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Teamwork At Alamogordo

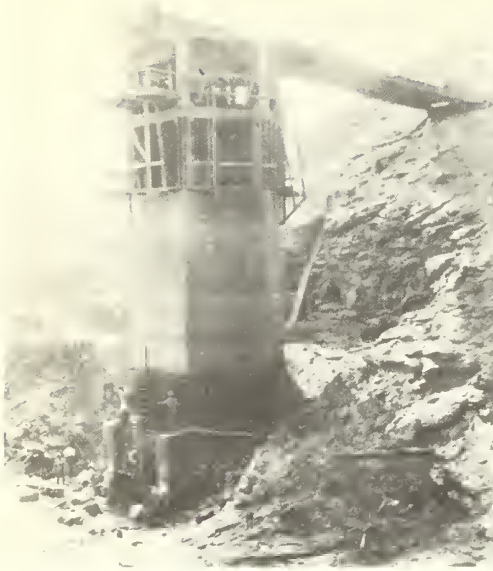
by RUSSELL B. LEDYARD
Assistant Regional Engineer
Region 5, Amarillo, Tex.

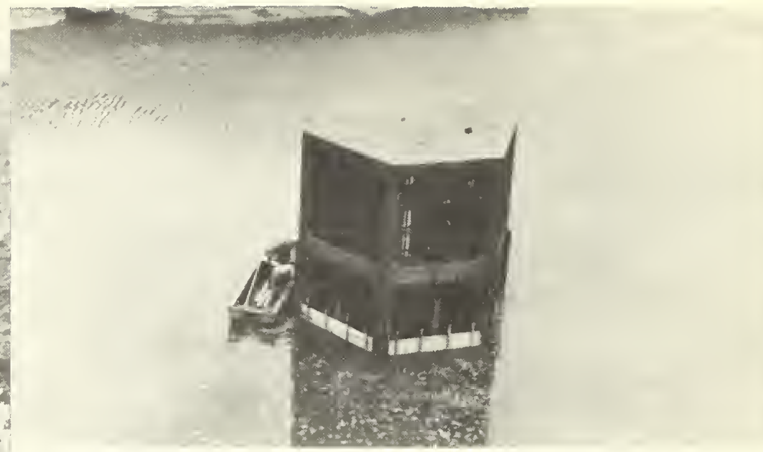
Skin divers and unusual construction methods were resorted to by the contractor in placing the concrete tunnel plug in the trashrack of Alamogordo Dam under his recent contract with the Bureau of Reclamation. This work, completed in November 1956, consummated nearly 8 years of awaiting satisfactory water conditions and perfecting plans to save as much water as possible for the Carlsbad project water users and the fishing interests. Complete cooperation of local interests, the New Mexico Fish and Wildlife Commission, the Carlsbad Irrigation District, and the contractor with the Bureau of Reclamation made this possible. The work, although extremely hazardous, was accomplished quickly through the efficiency of the contractor.

The Alamogordo Dam on the Pecos River, 14 miles north of Fort Sumner, N. Mex., was completed by the Bureau of Reclamation in September 1937 to furnish storage for the Carlsbad Irrigation District. Diversion of the river during construction was through the outlet tunnel which was to be closed when the dam was completed. The concrete closure plug was never placed because of the need to store as much water as possible for the next irrigation season, and the desirability of water in Alamogordo Reservoir to facilitate necessary repairs on McMillan Dam, located downstream, during the winter months of 1937. Instead of placing the tunnel plug, closure was made by installing a "temporary" steel bulkhead gate in the 10-foot diameter tunnel, which in 1956 was under 50 feet of reservoir silt.

The danger of postponing replacement of the temporary steel bulkhead gate became accelerated each year because if it should rust out sufficiently to cause failure of the gate, serious damage and possible loss of operative control of the dam could result. Over the years the water elevation in the reservoir was never low enough to perform this work, and no one desired to release the small storage, especially in an area where every drop of water was needed. The Southwest has been in a drought for the last few years and the water of the Pecos River is vital to all in the Pecos Valley.

In August 1954, conditions appeared favorable to perform this work. Specifications were issued, bids requested, and one bid, in the amount of $21,330, was received. However, before award could be made and the reservoir lowered to permit access to the trashrack structure, rains over





At left: Trashrack structure at Alamogordo Dam during original construction in 1937. Above: Shows method of bulkheading off flow through trashrack.

the Pecos watershed raised the water surface and the work was indefinitely postponed.

Two years later in October 1956 conditions again appeared favorable and new specifications were issued for the job. Eight bids were received on October 30, 1956. The low bid of $12,579, by Miller, Smith & O'Hara, Inc., of Albuquerque, N. Mex., was accepted. Award and notice to proceed were issued on November 1 by Robert W. Jennings, regional director of region 5.

The work involved several problems of emergency action and full cooperation from the Carlsbad Irrigation District, the New Mexico Fish and Game Commission, local fishermen, residents of Fort Sumner, and the contractor. The trashrack structure and inlet tunnel are located about 300 feet upstream from the crest of the dam, in the reservoir area. The concrete plug was then located 68 feet down at the bottom of the structure. Original plans were to perform the work with an empty reservoir since the silt had built up to the entrance of the outlet structure. Draining the reservoir, however, meant a loss of water and fish, and a decision was reached to leave about 8 feet of water for saving the fish, and a change order was issued to cover the new contract requirements. The New Mexico Fish and Game Commission, aided by local fishermen and citizenry, moved to the dam site to spread a protective screen around the outlet structure to salvage or prevent the fish from going downstream. The contractor cooperated. Releases were started on November 5 and completed on November 7. The water was maintained at this low elevation through November 12, and then allowed to build up in the reservoir. The contractor was required to move in immediately, complete the job, and get out before the water inundated his work.

He ran into unexpected trouble in placing the stop logs and in sealing out the water of the trashrack structure. He hired six skin divers from the Lubbock (Tex.) Skin Divers Club to assist in cleaning out the debris around the trashrack and in placing and forming a seal around the stop logs of the trashracks in the murky water. These skindivers repeatedly dived into the dark silt-laden water. Working in the water during November, at an elevation of 4,200 feet, was a cold, laborious job, but these amateur skin divers demonstrated their ability to perform this unusual task. A practically watertight seal was accomplished to allow the contractor's employees to work in safety while pouring concrete almost 50 feet directly below in the outlet tunnel.

By November 14 at 8 a. m., final operations were started. Concrete equipment was set up on the upstream slope of the right abutment of the dam and was conveyed by a chute to a bucket on one of two barges forming a bridge from shore to the trashrack structure. The concrete was carried from the bucket at the end of the chute to the trashrack structure and then by use of a tremie tube with a funnel-shaped upper end, the concrete was fed vertically down through the

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Key Contract Awarded

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1 million persons by 1975 through construction of the initially authorized features of the Colorado River storage project and the participating projects indicates the very great magnitude of the benefits which will result in the short span of less than 20 years.

Expansion of irrigation water supplies will result in the long-range permanent chain of direct and indirect benefits which always attend irrigation developments in the arid West. The storage dams at tributary, upstream locations and the distribution canal and lateral systems on the participating projects will supply irrigation water to about 130,000 acres of new land and will provide supplemental water to about 230,000 acres of lands short of water late in each irrigation season. The total dollar benefits from these currently authorized irrigation projects will exceed $10 million annually.

About 25 additional potential participating projects are scheduled for priority investigation in the authorizing legislation. These would provide irrigation water for nearly 1 million acres of land, of which almost one-half would be new land and the balance presently irrigated farm land needing a supplemental water supply.

Control and use of water for municipal supply is also an important aspect of the upper Colorado River development program. Water for the anticipated rapid urban growth in the upper basin States is a critical need which will be met.

Water and power are ingredients essential to those industries which will be established to develop the tremendous, but now largely dormant, mineral resources in the upper basin States.

Steel ribbing being lowered 700 feet to bottom of canyon for use in right diversion tunnel. ***Photo by F. S. Finch, Region 4.***

Hoist entrance to exploration tunnel on left canyon wall. ***Photo by F. S. Finch, Region 4.***

The largely undeveloped mineral reserves of the upper basin States await development and use to meet the increasing national needs for domestic and defense materials. These reserves include large quantities of coal and petroleum; the principal United States sources of uranium, vanadium, and molybedenum; three-fourths of the Nation's phosphate ores; the world's greatest source of rare hydrocarbons; and much of the United States supply of gold, silver, lead, zinc, manganese, copper, bismuth, antimony, and magnesium. The mineral reserves of the central and eastern United States are being rapidly depleted, and the Nation will look to the mineral storehouse of the Upper Colorado River Basin to meet many future requirements.

Shale oil offers great reserves as yet untouched. It is estimated that a reserve 1,000 billion barrels of petroleum are available in the oil shales in the 16,500 square-mile area in the upper basin where Colorado, Utah, and Wyoming meet.

Phosphate materials—1.6 billion tons or three-fourths of the United States reserves—occur in the upper basin States, and await power as the foundation stone for a new industrial development.

Recreation is one additional important benefit of the upper basin development which needs to be mentioned. Hoover Dam and Lake Mead, visited by more than 2 million persons each year, offer evidence of the recreational values which result.

The 186-mile long Glen Canyon Reservoir will open up the beauties of a canyon seen at present only by a mere handful of people each year.

The Colorado River storage project and the participating projects, with Glen Canyon Dam as the key structure, is a long-range undertaking. Widespread national, as well as regional and local, benefits will result. New employment opportunities will be created. Enlarged purchasing power will develop for manufactured goods produced throughout the Nation. The broadened tax base will increase the direct taxes paid to the Federal Treasury which in a short time will exceed the construction investment. With award of the prime contract on Glen Canyon Dam on April 29, 1957, the basinwide development program has begun.

Commissioner of Reclamation W. A. Dexheimer has summarized the importance of the basinwide development of the Upper Colorado River as follows:

"These things can be done at reasonable cost and are good investments whether done by local people, the States, or the Federal Government. The returns in stable, prosperous farms and communities; the returns in business and industrial activity; and the returns in local, State, and Federal taxes will more than pay the cost of Upper Colorado River development in a very short period of years. In addition, we will have opportunities for recreation so vitally needed for our enjoyment of better living and particularly needed to accommodate a growing population with more leisure time, paid vacations, and early retirement.

"Whether you view the water conservation and development features of this program as farmers, industrialists, retailers, or just plain vacationers, I think you will find they are very worthwhile."

# # #

WOMEN VOLUNTEERS WANTED FOR ERA

The Secretary or some other officer of each and every organization of women on our projects is requested to take her pen or typewriter in hand and write to J. J. McCarthy, Editor of Reclamation Era, *and outline her views as to how the* Era *may best serve the interests of our project women. The same invitation is extended to every woman not connected with a women's organization.*

Compressed Air vs. Drought

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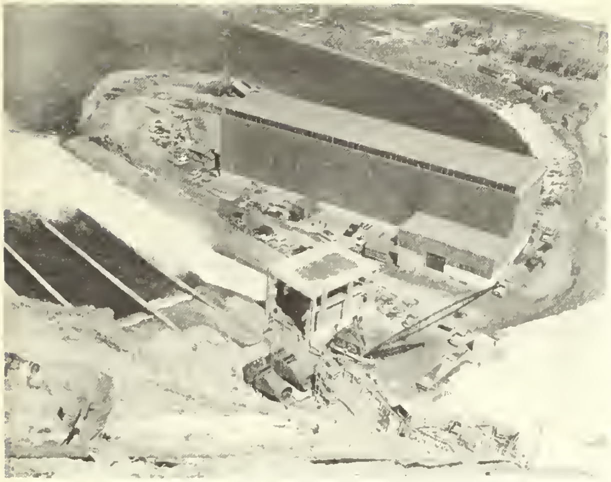
away the obstruction in 1 day's time. This procedure is followed by waterpower plants on the Ausable River in Michigan where the winters are severe. In much the same way sawmills in the North Country keeps channels open in their millponds so logs can be floated to the mills the year round.

To reduce loss of water through evaporation, this procedure might be used in reverse. The Lake Hefner experiments revealed that during a 483-day period condensation rather than evaporation occurred on 56 days. The large unused volume of cold water in the lower levels of the Hoover Dam basin could be raised at least in part by means of compressed air and mixed with the surface water to lower the temperature and thereby lessen evaporation. To apply this method to a reservoir like Lake Mead would be a big job, but preliminary analyses of the complicated problems involved seem to indicate that it is feasible.

The author has conducted experiments in Texas and made many calculations as to what could be done by the use of specially equipped motorboats—floating versions of truck-mounted compressors. These could cruise around in the early morning when the water is coolest at the surface and could cover a great area in a short time. Considering that little power is required merely to circulate, not lift, the water in a lake (the difference in density is only 1/1000 part or so), the idea is not nearly so impracticable as it might appear at first hand.

Large losses demand extensive corrective measures—a routine matter in this day of huge projects. Research is needed, of course, to gather exact data. There is no difficulty involved in making measurements of evaporation by means of pans floating on the surface in areas where a compressed-air line has been lowered, and the comparative efficiency of stationary and mobile installations could easily be studied. The experiments would cost relatively little and should be undertaken because the time is not far off when the West, especially, will have to conserve every acre-foot of water if it is to remain productive. The iceboxes are there. Why not make use of them through the simple medium of bubbles of air? # # #



PALISADES DAM AND POWERPLANT NEARS COMPLETION. This multiple-purpose dam will provide flood control, irrigation storage, and power for the Upper Snake River Area. *Photo by Norm Clayton, Region 1.*

Upper Snake River's Committee of Nine

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considered were a proposal to seek a court decree on new floodwater rights for various Snake River canals, and possible sale of additional American Falls and Palisades storage space to the Minidoka Irrigation District.

Members of the committee are elected each year at the time of the annual watermaster district No. 36 meeting. All canal companies and irrigation districts are represented by their officers and directors at that meeting, and the representatives from each of the three geographical areas meet separately to elect their Committee of Nine members for the ensuing year. The membership for 1956 consisted of N. V. Sharp, chairman, and Alex Coleman, secretary (each of whom has held his position since 1949), and members J. H. Silbaugh, Clifford Scoresby, R. W. Walker, Leonard Graham, D. W. Dick, Leo Murdock, and Frank Redfield. Advisory members of the Committee of Nine were Lawrence Duffin from the Minidoka Irrigation District, E. G. Gooding of the American Falls Reservoir District No. 2, and Merle L. Tillery, superintendent of the Minidoka project. Lynn Crandall, who is now serving his 28th consecutive year as watermaster of district No. 36, also attends each meeting in his official capacity as watermaster.

Meetings of the Committee of Nine are open to the public, and individual water users, irrigation organizations, municipalities, and State or Federal bodies are invited to participate in the discussions and present any proposals for consideration by the group. Attendance at the meetings often runs from 50 to 100 or more, depending upon the subject to be discussed. In this manner, the Committee of Nine has become firmly entrenched as a leading advocate, and through its use, as an outstanding example between local interests and State and Federal Governments.

In recognition of its achievements in the fields of conservation and irrigation, the Department of the Interior's Conservation Award was presented to the Committee of Nine at its meeting in Idaho Falls, Idaho, in March, 1957. Regional Director H. T. Nelson of the Bureau of Reclamation, Boise, Idaho, made the presentation for the Department. In his letter presenting the award to the committee, Secretary of the Interior Fred A. Seaton said:

"It is a pleasure to grant the Committee of Nine the Conservation Service Award of the Department of the Interior in recognition of outstanding work since its inception in 1919 in aiding the overall development of land and water resources of the Snake River Basin.

"Representing the various water users' groups in the Snake River Valley, the committee has brought about a beneficial and effective program of resource development. Throughout the years its broad experience and fair consideration of all viewpoints have made it the focal point of discussions on resource development programs in the upper Snake River area and have also increased public appreciation of the many difficult and complex problems involved in land and water resource development.

"The enclosed Conservation Service Award certificate carries with it the appreciation of the Department of the unselfish public service which your committee has rendered and is continuing to provide. # # #

IDEAS WANTED

Have you a good idea on a short cut or labor-saving device to share with other water users on Reclamation projects? Send it in to the Editor, *Reclamation Era*, Bureau of Reclamation, Washington 25, D. C. The writing does not have to be fancy. Just make certain you have the answers to Who, What, Where, When, Why, and How in your story. As for pictures, a rough sketch or snapshot would serve the purposes.

First water delivery ceremony, Kennewick Division, Yakima Project, Wash., April 26, 1957. Left to right: Floyd E. Dominy, Chief, Division of Irrigation, Washington, D. C.; United States Senators Warren G. Magnuson and Henry M. Jackson; Walter Crayne, Kennewick Irrigation District Board; Orvel L. Terril, Kennewick Irrigation District Board chairman; W. A. Sloan, Kennewick Irrigation District Board; Van Nutley, Kennewick Irrigation District manager; E. J. Brand, Kennewick Irrigation District manager (retired); O. W. Lindgren, superintendent, Yakima project; Don A. Creswell, president, Franklin County Irrigation District; H. T. Nelson, regional director, Boise, Idaho; W. L. Karrer, construction engineer, Kennewick Division.

The Editor's Column

The following facts have been gleaned from the United States Department of Agriculture's "Agricultural Situation," dated May 1957. We hope that you find them helpful.

Total farm output in 1957 is likely to be down for the first time in 7 years. United States demand for farm products should continue strong since consumer income is expected to stay higher than a year earlier. Export demand also is strong with farm products moving to foreign markets at a record rate.

Some reduction in supply and good demand should hold farmers' prices a little above the 1956 level, through 1957. Livestock prices probably will average above those of 1956; crop prices, lower. Supports for cotton, major feed grains, and oilseeds are lower than in 1956. Supports for most other products are about the same.

Feed Grains

Large supplies of feed grains are again likely in 1957–58, though they may be a little under this year's record. Prospective acreage is slightly larger, but large cuts in high-yielding corn and oats may hold down production.

Average yields on the prospective acreage would result in a production of about 119 million tons, 10 million less than in 1956. But carryover into 1957–58 will be up about 7 million tons. Large supplies of high protein feeds are also in prospect, at least as large as in the current season.

Cotton

Shipments of cotton abroad continue heavy, building a total this season which may top 7 million bales. Exports in the season ending in June 1956 were 2.2 million bales. Total use (including exports) is expected to be about 15.8 million bales, up 4.4 million bales from the preceding season.

The increase is entirely due to higher exports since domestic use is running below the previous season. A reduction in stocks by about 2.5 million bales is expected on August 1, 1957.

Teamwork at Alamogordo

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trashrack structure for a distance of approximately 50 feet. More than usual care had to be taken in this operation to avoid segregation of the concrete. It took 15 hours to place the concrete.

Men and equipment worked continuously for 36 hours in the final phases of the work. Six hours were required to clean the tunnel, 12 hours for placing forms and steel, 15 hours for placing concrete and 3 hours of clean-up. Coordination of operations was the keynote in the contractor's efficient organization.

When the work was completed and accepted by the Government on November 17, 1956, 17 days after award of the contract, the cost was well below the allocation. The local people were well satisfied with the Bureau's job of saving the fish and salvaging water in this drought stricken area, and safety of the operative control of the dam was assured.

The work was under the direct supervision of Bert Levine, acting construction engineer, and two inspectors, Allen W. Kendrick and Carl J. Lethgo. # # #

Dredging on the Colorado

Continued from page 65

to find a permanent solution to the problem. Reclamation engineers concluded that only by establishing a new river channel at certain points along the river in that area could the river again be confined to a definite course to reduce the flood danger and lower the high-water table. The 20-inch hydraulic suction dredge was constructed and placed in operation to carry out this plan which to date has been very successful. The water in the river at Needles has dropped several feet since completion of the Needles-Topock dredged channel.

The dredge's most recent achievement is a 1.9 mile-long channel out 5 miles north of Needles through which the Colorado River now is flowing. This new channel bypasses the streamflow around a badly aggraded and meandering stretch of the old riverbed.

The dredge recently cut through to the river from the 1.9-mile channel which has been under construction since last August 16. At the time of the breakthrough, the water surface in the river was 3 feet higher than that in the dredged channel. A short time after the river entered the new channel, the water in the dredged channel had risen to the level of that in the river and flow in the new channel had been established.

Named after the river in which it was first launched early in 1949, the huge dredge is extending the channelization work upstream. In cutting the 1.9-mile section, the dredge was headed upstream on a predetermined alinement roughly paralleling the old riverbed. At a point some 8,500 feet upstream from the lower end of the dredged channel where the bank separating the new channel from the river narrowed to only a few feet, the dredge cut through to the river to permit a flow at that time of some 5,000 cubic feet per second to enter the new route.

As the dredge's cutter head chewed away at the earth barrier separating the new and existing channels, its pump forced the earth and other dredged material through an 1,800-foot pipeline to the far river bank where it was discharged to form the channel levee. As the dredge cuts new channels to straighten out, deepen, and realine the river, such dikes are thrown across the old riverbed to isolate its abandoned sections and dry them up.

BUREAU'S DREDGE SHOWN IN NEW CHANNEL north of Needles, Calif. The dredge recently cut through to the Colorado River, pouring through opening in left center of picture into new channel. Dredged material was discharged at right to close old channel. ***Photo by R. C. Middleton, Region 3.***

This new section of channel on the river was dredged in widths varying from 180 feet to 360 feet, depending upon nature of materials excavated and levee material required, with the expectation that the summer flows of the river will widen the channel to the desired 450-foot width. The excavated depth varies from 15 feet to 23 feet and about 1,400,000 yards of material were dredged to complete the channel in this reach of the river.

The 1.9-mile channel is the third closed or "bobtail" cut to have been made by the dredge since it was placed in operation. The first was a portion of the 11-mile cut between Needles and Topock; the second, a 2.2-mile channel about 7 miles upstream from Needles. The dredge is scheduled to cut another 3½ miles of channel this year. Much of the work on the river this year upstream of Needles will be concerned with closing the gaps between the previously constructed sections of levee upstream from Needles.

Channelization and construction of other protective works along the silted and meandering stretches of the river will be a continuing major construction activity until maximum benefits in conservation of water for downstream water users and protection of the areas along the river from flood damage have been achieved.

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Sugar Beet Development

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of polyploids. This is a complicated breeding system of changing the chromosome number in the plant by chemicals or otherwise. The resultant sugar beet plants are generally larger and may contain more sugar. The seed catalogues now list polyploids of several kinds of vegetables and flowers at fancy prices. The use of polyploids in sugar beets is being studied extensively and their characters may be incorporated into the hybrid monogerm sugar beet seed of the future.

Many other characteristics of the sugar beet are being studied with an eye to overall improvement. All new varieties, whether they be hybrids, monogerms, polyploids or inbreds, are tested for factors which affect quality. All breeding stock is subject to numerous detailed tests to determine the amount of sodium, potassium, raffinose, etc., which may aid or limit sucrose storage

Beet seed breeding plot showing seed plants with paper bags placed over the flowers. This technique is used in securing inbreds and hybrids.

in the beet root or be a hindrance in sugar recovery in the factories.

Sugar beet seed development is all directed toward varieties with greater efficiency in the production of the crop. Higher yields are necessary in sugar beets as well as in corn and other crops, if the grower is to realize the maximum return per acre for his crop. Mechanization of farming is here to stay. The harvesting of the sugar beet crop by machinery now is 100 percent in America, and full spring mechanization of the thinning operations is progressing rapidly.

The U. S. Department of Agriculture and several of the State agricultural experiment stations maintain staffs of highly specialized personnel doing extensive research of many kinds on sugar beets. Several of the sugar companies have large research departments with highly trained specialists—agronomists, plant breeders, plant pathologists, entomologists, chemists—who devote all their time to the betterment of the crop. The most modern laboratories, greenhouses, root cellars and specialized equipment are used .

With all this concerted effort toward sugar beet improvement, we can expect better varieties of sugar beets in the immediate future. ###

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

HOOVER SEWAGE PLANT IN OPERATION

Sewage from Hoover Dam and powerplant is now being treated before being discharged into the Colorado River.

The Bureau of Reclamation recently placed in operation its new treatment plant at the dam and powerplant to eliminate the possibility of river pollution from this world-famed structure.

The plant was built by Longley Construction Co., Inc., Las Vegas, Nev., under a $43,645 contract awarded last May. Funds were appropriated by Congress and the facility was programed for completion in fiscal year 1957.

The plant was designed by the Bureau of Reclamation, Office of the Commissioner and Chief Engineer, Denver, Colo., assisted by Consulting Engineer Richard R. Kennedy of San Francisco, noted authority on sewage disposal. It meets the requirements of the Departments of Health of the States of Arizona and Nevada, according to Boulder Canyon Project Manager L. J. Hudlow, who has supervision of the dam and powerplant.

Appropriation of funds for construction of the plant followed protests from fishermen and other sportsmen and domestic water users downstream who believed pollution from the dam and powerplant created health problems.

Statistics show that during a peak 4-hour period, 2,000 tourists visit the dam and powerplant. There are some 200 operating personnel in the dam and powerplant during an 8-hour shift, except on holidays and weekends when there is an average of 75. Nearly a half million tourists, besides the operating personnel, use the sewage facilities of the dam and powerplant each year.

The sewage discharged into the Colorado River averages less than 25 gallons per minute with an average flow of the river below Hoover Dam exceeding 5 million gallons per minute. However, the sewage treatment will eliminate any possible danger resulting from discharging sewage from the dam and powerplant into the river.

The sewage treatment plant at Hoover Dam, located in the lower penstock access tunnel on the Arizona side of the river, is a complete activated sludge unit, designed for a 32-gallon-per-minute average peak flow, operating with high efficiency so that the effluent, before discharge into the Colorado River below the dam is as follows:

1. Approximately 10 parts per million biochemical oxygen demand with positive oxidation, with a maximum of 25 p. p. m. BOD as an extreme.
2. Free chlorine residual and dissolved oxygen.
3. 10 p. p. m. suspended solids with 25 p. p. m. as an extreme maximum.

The effluent is disinfected with chlorine before being discharged into the river. The digested sludge is removed by tank truck.

During a 4-hour period of peak flow, 7,680 gallons of sewage will be treated. This sewage, which comes from the dam, powerplant, valve houses, and exhibit building, is collected by a pipe system in the dam and powerplant and is delivered to the sewage plant by pumps. # # #

A HALF CENTURY OF PROGRESS

The water users of the Klamath project, California-Oregon, celebrated 50 years of successful operation in May. Construction of the project was authorized in 1905 and the first delivery of irrigation water through the federally constructed facilities was made on May 16, 1907. In its first year of operation water deliveries were made to 8,900 acres. Today service is provided to about 200,000 fertile acres, much of which was once the submerged bed of Tule Lake.

Through the half century the Federal Government has invested about $14.7 million in construction. During this period the gross value of crops produced amounted to about $350 million. Federal tax revenues since 1940 have accumulated to total about $95 million. These and other revealing facts are presented in a short report prepared by the Bureau at the request of the Committee on Interior and Insular Affairs, House of Representatives. The report entitled "A Half Century of Progress on the Klamath Federal Reclamation Project" was published by the committee as "Committee Print No. 7."

"EACH YEAR over 1,000,000 acres of cultivable land is going into homesites, industrial establishments, highways, airports, and other nonagricultural uses."—D. A. Williams, Administrator, Soil Conservation Service.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-4728	Rogue River Basin, Oreg.	June 4	Construction of main canal structures, station 123+00 to 829+00, Medford and Rogue River Valley irrigation districts.	Ausland Construction Co., Grants Pass, Oreg.	$113,462
DC-4735	do	May 7	Construction of earthwork, pipelines, and structures for Yankee Creek siphon and Antelope Creek siphon and wasteway, Medford canal rehabilitation, Medford irrigation district.	Cherf Bros., Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	181,270
DC-4816	Missouri River Basin, S. Dak.	May 21	Construction of stage 04 additions to Sioux Falls substation	Lindstrom Construction Co., Grand Forks, N. Dak.	149,997
DC-4818	Rogue River Basin, Oreg.	Apr. 3	Furnishing and installing one 16,842-kv.-a., 600-r.p.m., vertical-shaft generator for Green Springs powerplant.	Pacific Oerlikon Co., Tacoma, Wash.	283,668
DC-4825	Colorado River Storage, Ariz.-Utah.	Apr. 29	Construction of Glen Canyon Dam and powerplant	Merritt-Chapman and Scott Corp., New York, N. Y.	107,955,522
DC-4834	Missouri River Basin, Iowa.	Apr. 4	Construction of 161-kv. and 230-kv. additions to Sioux City substation.	Union Electric Co., Phoenix, Ariz.	194,777
DC-4844	Missouri River Basin, S. Dak.	Apr. 30	Constructing foundations and furnishing aud erectiug steel towers for 67 miles of Utica Junction-Sioux Falls 230-kv. transmission line.	Lipsett, Inc., Yankton, S. Dak.	1,316,411
DC-4845	Missouri River Basin, N. Dak.-Minn.	do	Constructing foundations and furnishing and erecting steel towers for 165 miles of Fargo-Granite Falls 230-kv. transmission line.	Lipsett, Inc., Yankton, S. Dak.	3,097,440
DS-4847	Missouri River Basin, S. Dak.	May 3	Three 5,000-kv.-a. spare mobile power transformers, each with a trailer transport, for Region 6.	General Electric Co., Denver, Colo.	148,293
DS-4850	do	May 6	Three 20,000/26,667/33,333-kv.-a. autotransformers for Sioux Falls substation.	American Elin Corp., New York, N. Y.	329,955
DS-4852	Missouri River Basin, Wyo.	Apr. 19	Construction of earthwork, structures, and surfacing for access road, Glendo Dam and reservoir, schedule 1.	Peter Kiewit Sons' Co., Sheridan, Wyo.	108,741
DC-4856	Columbia Basin, Wash.	Apr. 12	Furnishing and installing spillway flood-lighting system at Grand Coulee Dam, using colored lighting system, schedule 1.	Westcoast Electric Co. of Washington, Inc., Seattle, Wash.	150,010
DC-4858	Missouri River Basin, Mont.	do	Construction of Helena Valley Dam	Cherf Bros., Inc., and Sandkay Contractors, Inc., Ephrata, Wash.	357,606
DC-4859	do	May 14	Construction of earthwork and structures, except siphons, for Helena Valley canal, station 149+02.5 to 572+50, schedule 1.	Miles and Williams, Kennewick, Wash.	205,032
DC-4859	do	do	Construction of earthwork and structures for monolithic concrete siphons for Helena Valley canal, schedule 2.	A and B Construction Co., Helena, Mont.	312,160
DC-4864	Rathdrum Prairie, Idaho.	May 13	Construction of Hayden Lake pumping plant and furnishing and installing water distribution system, schedules 1 and 3.	Intermountain Co., Boise, Idaho.	340,527
DC-4865	Colorado River Storage, Ariz.-Utah.	do	Furnishing and erecting 150,000-gallon elevated steel water tank and 3,000,000-gallon steel storage reservoir for Glen Canyon community facilities, schedules 1 and 2.	Pittsburgh-Des Moines Steel Co., Santa Clara, Calif.	189,190
DS-4866	Central Valley, Calif.	May 7	Three 84-inch ring-follower gates with hydraulic hoist, hanger, gate position indicator, and one set of handling equipment for outlet works and auxiliary outlet works at Trinity Dam.	Hardie-Tynes Mfg. Co., Birmingham, Ala.	198,375
DC-4872	Michaud Flats, Idaho	do	Construction of earthwork and structures for Main Canal—East.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	581,569
DC-4874	Missouri River Basin, Nebr.-Kans.	May 10	Construction of earthwork and structures for Courtland West Canal, Station 0+00 to 517+42, and laterals, wasteway, and drains.	Bushman Construction Co., St. Joseph, Mo.	790,196
DC-4877	Rogue River Basin, Oreg.	May 27	Construction of earthwork, concrete canal lining, and structures for Howard Prairie delivery canal, station 0+09 to 539+00; and Soda Creek diversion dam and feeder canal.	Cherf Bros., Inc., Sandkay Constructors, Inc., and S. Birch & Sons Construction Co., Ephrata, Wash.	1,636,739
DC-4881	Solano, Calif.	June 7	Construction of earthwork, concrete canal lining, and structures for Putah South canal, station 1017+00 to 1476+25.52.	Marshall & Haas, Belmont, Calif.	1,186,826
DC-4884	Missouri River Basin, Kans.	June 13	Construction of Woodston Diversion Dam	Ace Construction Co. and M. and A. Construction Co., Omaha, Nebr.	541,957
DC-4887	Colorado River Storage, Ariz.-Utah.	May 28	Placing bituminous surfacing and constructing guardrail for 25 miles of access highway and construction of Manson Mesa airstrip, Glen Canyon Dam.	Alexander Construction Co., Inc., Minneapolis, Minn.	1,517,413
DC-4888	Columbia Basin, Wash.	June 25	Construction of earthwork and structures for WB5 wasteway No 1, Wahluke Branch canal laterals, block 20.	Arthur R. Sime, Kennewick, Wash.	321,157
DC-4890	Colorado-Big Thompson, Colo.	June 6	Construction of Big Thompson powerplant and switchyard	Davis & Butler Construction Co., Salt Lake City, Utah.	461,226
DC-4894	Cachuma, Calif.	June 19	Modifications of pressure reducing valve stations and meter stations of South Coast conduit, Goleta, Carpinteria, Montecito, and Summerland distribution systems.	J. E. Young Pipe Line Contractor, Inc., Los Angeles, Calif.	198,398
DS-4913	Commissioner's Office, Denver.	June 24	One alternating, current calculating board addition, including a device that is capable of maintaining the real power output (watts) of the unit at a predetermined value, for power systems studies.	Electronic Contractors, Portland, Oreg.	145,874
100S-281	Minidoka, Idaho	Apr. 12	Thirteen deep-well pumping units for wells, schedule 1	Layne & Bowler, Inc., Memphis, Tenn.	159,093
100S-282	do	Apr. 23	Motor control equipment for 40 deep-well pumping units, schedules 1 and 2.	Delta Switchboard Co., Stockton, Calif.	106,270
100S-284	do	do	Six 200-kv.-a., fifteen 150-kv.-a., eighteen 100-kv.-a., nine 75-kv.-a., fifteen 37½-kv.-a., and twenty-one 25-kv.-a., distribution transformers with lightning arresters for distribution substations for 40 wells.	R. E. Uptegraff Mfg., Scottdale, Pa.	126,221
100S-288	Snake River, Idaho	Apr. 25	Aerial photographs and topographic maps of 122,000 acres of Long Tom unit, second increment.	McIntire and Quiros, Inc., Los Angeles, Calif.	88,710
117C-429	Columbia Basin, Wash.	June 7	Furnishing and installing water service, drain, and sewer piping for residences in Mason addition at Coulee Dam, Wash.	Grant County Plumbing & Heating Co., Inc., Ephrata, Wash.	47,153
117C-432	do	May 31	Deepening 6.7 miles of DW240 wasteway, block 76	Utility Construction Co., Ontario, Oreg.	85,989
200C-350	Solano, Calif.	June 14	Furnishing and erecting 70 miles of right-of-way fencing around Lake Berryessa.	El Dorado Fence Co., Inc., Oakland, Calif.	244,759
400C-83	Colorado River Storage, Ariz.-Utah.	June 13	Construction of earthwork, structures, and surfacing for Arizona-Utah State line to Vista Point road and parking area, Glen Canyon Dam site.	W. W. Clyde & Co., Springville, Utah.	55,453
700C-435	Missouri River Basin, Nebr.	May 21	Construction of earthwork and structures for surface drains and repair of Walworth wasteway for Sargent canal.	Central Drainage and Construction Co., Sargent, Nebr.	93,993
701C-439	Missouri River Basin, Nebr.-Kans.	June 24	Construction of earthwork, concrete lining, and structures for Franklin drain 1-1-11; Franklin canal wasteway, station 2388+78.2; and additions and extensions to Franklin lateral system.	Platte Valley Construction Co., Grand Island, Nebr.	171,608

U. S. GOVERNMENT PRINTING OFFICE: 1957 O—430110

Construction and Material for Which Bids Will Be Requested Through September 1957[1]

Project	Description of work or material
Central Valley, Calif.	Constructing a 25-cfs-capacity, 2-unit, outdoor-type pumping plant.
Collbran, Colo	One 3-foot 6-inch by 3-foot 6-inch and two 2-foot 3-inch by 2-foot 3-inch, high-pressure gates, including hoists and transitions for Vega Dam. Total estimated weight: 50,000 pounds.
Colorado-Big Thompson, Colo.	One 4,160-volt switchgear assembly for the control of 4,500-kv.-a. generator for the Big Thompson Powerplant.
Colorado River Storage, Ariz.	Constructing the Page Government community. Work will include constructing about 200 three-bedroom residences with 1,150 to 1,200 square feet of floor space. The specifications may include an option for an additional 150 residential lots for private development. About 135 miles north of Flagstaff.
Do	Constructing a 360- by 144-foot steel-frame administration building, a 146- by 70-foot steel-frame fire station and garage, a 225- by 36-foot steel frame dormitory, and a 144- by 48-foot steel-frame police building.
Do	Constructing a river pumping plant, a chemical feed house, a high-lift pumping plant, about 12,000 feet of 10-inch steel and 12-inch steel, cast iron or asbestos cement pump discharge line, a filtration plant, and a wash water recovery pond, erecting 60-foot-diameter presedimentation and sedimentation tanks and installing pumps and motors, and furnishing and installing additional pumps, motors, control equipment and all appurtenant apparatus.
Colorado River Storage, N. Mex.	Constructing facilities for the 140-person Navajo Government community. Work will include constructing about 15 residences, furnishing and erecting a trailer washhouse, constructing a street, a sewage collection and disposal system, and a water supply and distribution system. About 39 miles east of Farmington.
Do	Constructing a 3-bedroom residence. About 39 miles east of Farmington.
Colorado River Storage, Utah.	Constructing a 105- by 36-foot wood-frame administration building, a 54- by 39-foot wood-frame laboratory, a 100- by 30-foot concrete masonry garage and fire station, and a 60- by 24-foot wood-frame conference hall. At the Flaming Gorge community, about 16 miles southeast of Linwood.
Do	Furnishing and erecting seven 5-car prefabricated metal garages. At the Flaming Gorge community.
Columbia Basin, Wash.	Constructing about 3 miles of 2-foot bottom width concrete-lined canal and 2 turnout structures. Wahluke Canal, south of Othello.
Do	Earthwork and structures for about 60 miles of laterals and wasteways, and constructing 8 minor relift pumping plants. Block 20, northwest of Mesa.
Do	Earthwork and structures for about 4 miles of concrete-lined laterals and 1 mile of wasteways. Block 401, near Moses Lake.
Do	Placing blended compacted earth lining in 4,950 feet of laterals. Blocks 86 and 87, about 18 miles northwest of Othello.
Do	Earthwork and structures for deepening 6.5 miles of open drains. Blocks 41 and 42, near Moses Lake.
Do	Deepening the DW239B and DW238C systems. Block 78, south of Quincy.
Do	Five motor-driven, horizontal, centrifugal-type pumping units. Radar pumping plant.
Deschutes, Oreg	Constructing a 1-story combination office, warehouse and shop building 38 feet wide by 61 feet long. At Madras.
Gila, Ariz	One 4,160-volt motor control switchgear assembly for control of 2,250-hp. synchronous motor for the Yuma-Mesa pumping plant.
Gulf Basins, Tex	Drive boring, sampling, and penetration resistance testing for the Toledo Bend Dam site on the Sabine River.
Middle Rio Grande, N. Mex.	Removing spoil piles along the settling channel cleaning, rehabilitating and providing for power operation of the gates at Angostura Diversion Dam. North of Albuquerque.
Do	Rehabilitating Cochiti Diversion Dam on the Rio Grande, west of Santa Fe.
Do	Earthwork and structures for a 2,000-c. f. s. channel 9 miles long and a 600-foot-long timber bridge. North of Socorro.
Do	Earthwork and structures for a 2,000-c. f. s. channel 1 mile long a 265-c. f. s. canal 1 mile long a 2,000-c. f. s. tunnel liner plate culvert under a railroad. Socorro area, about 14 miles north of Socorro.
Do	Clearing, cleaning, and shaping about 13 miles of laterals, wasteways, and acequias and constructing appurtenant structures.
Do	Earthwork and structures for a 2,000-c. f. s. channel 3 miles long. About 20 miles south of San Antonio.
Do	Clearing, cleaning, and shaping about 10.4 miles of laterals, removing structures and constructing new structures.
MRB, Colorado	Removing 25-kv. metering equipment and installing 69-kv. metering equipment and supporting steel structure. Muddy Pass, about 27 miles northwest of Kremmling.
MRB, Montana	Constructing about 23 miles of 16- to 6-foot bottom width canal and appurtenant structures. Helena Valley Canal, near Helena.
Do	Constructing about 6.3 miles of open drains. Helena Valley (north side), near Helena.
MRB, Nebraska	Constructing concrete headworks structure with two 10- by 16-foot radial gates; constructing earth dike 1,400 feet long with riprap protection; repairing existing diversion structure, installing two 14- by 9.5-foot radial gates and constructing a timber bridge. Culbertson Diversion Dam, near Palisade.
Do	Placing 75,000 cubic yards of sand embankment against the earth dike at the Milburn Diversion Dam and placing 300 cubic yards of 24-inch deep gravel blanket. About 20 miles northwest of Sargent.
Do	Earthwork and structures for 12 miles of unlined canals, wasteways, and drains. Near McCook.
Do	Earthwork and structures for about 10.5 miles of Meeker Extension Canal and 2 dikes about 40 feet high. Near McCook.
MRB, South Dakota.	Reconstructing and repairing Lateral 15.8. Near Oral.
Do	Applying about 40,000 square yards of bentonite lining to the Angostura Canal. Near Oral.
Do	Constructing additions for the Granite Falls Substation.
MRB, Wyoming	Two 25,263-kv.-a., 0.95 power factor, 11,500-volt, 257-r. p. m., vertical-shaft, hydraulic-driven, indoor-type, synchronous generators for the Fremont Canyon Power plant.
Do	Six 7,400/9,250-kv.-a., OA/FA, 11.2–115/66.4-kv., single-phase power transformers for the Fremont Canyon Powerplant.
Provo River, Utah.	Constructing 2,000 feet of 46-kv. transmission tie line, 1,400 feet of 2.4-kv. camp supply and signal communication lines, and 250 feet of 2.4-kv. aeration plant service line. At the Deer Creek Powerplant, about 16 miles northeast of Provo. (Readvertisement of Specifications No. 400C–81.)
Rogue River Basin, Oreg.	Constructing the Keene Creek Earth Dam and appurtenant structures, the Cascade Divide and Green Springs 6-foot-diameter tunnels, and the 60-inch-diameter, 8-inch shell thickness, monolithic concrete, precast concrete pipe or steel pipe Green Springs Pressure Conduit. About 16 miles southeast of Ashland.
Do	Constructing about 8 miles of Howard Prairie Delivery Canal, and the Little Beaver Creek earth and rockfill diversion dam and appurtenant structures. Near Ashland.
Do	Removing wood stave pipe siphon and constructing pipe siphon about 1,500 feet long. Near Medford.
Santa Maria, Calif.	Hydraulic controls for four 7- by 12-foot outlet gates for Vaquero Dam. Estimated weight: 12,000 pounds.
Shoshone, Wyo	Modifying the Buffalo Bill Dam to include a new outlet works. On the Shoshone River, west of Cody.
Do	Four 4- by 5-foot high-pressure gates. Estimated weight: 182,000 pounds. For Buffalo Bill Dam.
Solano, Calif	Constructing about 8.7 miles of concrete-lined canal. Putah South Canal, west of Fairfield.
Ventura River, Calif.	Constructing a 500-foot-long rock weir, a 60-foot-wide gated spillway, a 500-c. f. s.-capacity canal headworks, a Parshall flume, a concrete-lined canal 5.25 miles long, with culverts, drainage inlets and bridges, a 78-inch-diameter siphon, and a reinforced concrete chute-drop terminal structure into Casitas Reservoir. Robles Diversion Dam and Robles Casitas Diversion Canal, north of Ventura.
Do	Earthwork and structures for 25,800 feet and 141,700 feet of precast concrete pipe. Near Ventura.
Do	Furnishing and installing a complete automatic control and telemetering system for a municipal water district. Vicinity of Oak View and Ojai.
Do	Three 2,400-volt and two 440-volt motor control boards, Upper Ojai and Rincon Pumping Plants.
Do	Four sets of chlorination equipment. About 80,000 pounds.
Washita Basin, Okla.	Constructing the 101-foot-high earthfill Fort Cobb Dam. On Pond Creek, north of Fort Cobb.
Weber Basin, Utah.	Earthwork and structures for about 15 miles of Uintah Bench Laterals, 2 small reservoirs; and one pumping plant. South of Ogden.
Do	Clearing reservoir and fencing reservoir right-of-way. Pineview Reservoir, east of Ogden.
Do	Constructing recreational facilities. Wanship Reservoir area, 38 miles east of Salt Lake City.
Do	Constructing two 6-room, brick veneer residences. At Gateway Powerplant, southeast of Ogden.
Yakima, Wash	Furnishing and erecting about 26 miles of protective fencing. Near Kennewick.

[1] Subject to change.

United States Department of the Interior
Fred A. Seaton, Secretary

Bureau of Reclamation, W. A. Dexheimer, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington 25, D. C.

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The Reclamation Era

NOVEMBER 1957

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Irrigation in the Midwest

New Assistant Commissioner Named

Official Publication of the Bureau of Reclamation

The Reclamation Era

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DESIGN AND ILLUSTRATIONS by Drafting and Graphics Branch
Bureau of Reclamation, Washington, D. C.

J. J. McCARTHY, Editor

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IRRIGATION IN THE MIDWEST

A Review by the Federal Reserve Bank of Chicago. Reprinted from its monthly publication. Business Conditions December 1956

Artificial watering of growing crops traces back hrough antiquity to the transition of mankind rom pastoral societies to agrarian cultures. The ncient pyramids of Egypt, for example, were rected by workers fed through the use of a crude ype of irrigation. The occasional introduction f new techniques has enabled the practice to perist and spread throughout its history of several housand years. A relatively recent method—prinkler irrigation—shows signs of giving the ld usage one of its most spectacular boosts.

A farm equipment trade publication has estinated that by 1960 a total of 400,000 farms in the Jnited States will be irrigating 40 million acres, bout 10 percent of our cropland. In 1954 some 00,000 farms irrigated less than 30 million acres. This projected increase would require the investnent of something like $500 million in new capital, nost of it for sprinkler irrigation equipment. Although the above projection may be overly optinistic, it nevertheless indicates the potentialities hat this development may contain.

Arid and humid areas

In the United States irrigation was largely conned to the arid West until recently. In that area he predominant method of applying the water nvolved the flooding of field from canals and trenches supplied by river reservoirs, or deep wells in some cases.

Although east of the Great Plains average annual precipitation is sufficient for most Temperate Zone crops, the moisture supply varies considerably from year to year, as does its distribution within the year. Hence, even in humid areas natural precipitation does not guarantee a fully adequate moisture supply throughout a crop's entire growing season. This can cut the yield substantially, especially if the water deficiency occurs at critical stages in the plant's development. Consequently, the output of many

GENERAL VIEW of Irrigation setup.

crops can be raised considerably by irrigation even in humid areas.

Artificial watering on a commercial scale is a rather expensive practice. Installation of the equipment requires a large investment outlay, and annual costs of operating the equipment are high. For this reason, in the eastern half of the United States—where irrigation is not subsidized by Government-developed water supplies—the usage gained its first footholds in areas specializing in the commercial production of vegetables, because these return a high value of output per acre and are especially sensitive to a steady supply of moisture.

In this part of the country, the water is typically applied by sprinklers—large-size relatives of the type commonly seen watering lawns. The water is obtained from wells, streams or ponds and is pumped to the sprinklers through portable

States along the Atlantic Seaboard and in the Appalachian and Delta regions, as well as in the Corn Belt States of Missouri, Ohio, and Illinois.

Irrigated acreage in District States

Size of farm	Acres irrigated (thousand acres)		Total crop acres 1954
	1949	1954	
Under 100 acres	7,067	11,251	7,438,96
100 to 219 acres	5,065	12,497	30,036,64
Over 219 acres	20,531	38,847	34,360,27
Total	32,663	62,595	71,835,88

Source: U. S. Bureau of the Census.

Irrigated acreage in Illinois leaped from 1,510 acres in 1949 to 6,789 in 1954. (Total cropland harvested in Illinois comes to about 20 million acres.) Several other States in the Seventh Federal Reserve District had earlier experience with

At Left: This 800-gallon per minute irrigation well on the farm of Harry Haeder enabled him to maintain his livestock feeding program from irrigated crops when dryland crops in the immediate area were almost a complete failure. Center: Sprinklers in operation. At right: James Popple operating sprinkler system.

pipes. Where a considerable area is involved, the apparatus is moved around the field in order to supply moisture to all parts of it. Obviously, the development of lightweight aluminum pipe has been a boon to this activity.

Sprinklers spreading swiftly

In 1954, according to the Bureau of the Census, a total of 2.6 million acres of farmland was irrigated in the 31 States east of the Great Plains, i. e. east of a line from North Dakota to Texas. Although 10 times as many acres were irrigated in the West, the total in the humid region represented a jump of 73 percent during the previous 5 years, compared with an increase of only 10 percent in the West. In the humid area, very large percentage gains were scored by a number of

the practice. Michigan and Wisconsin had significant amounts of irrigated acreage already in 1949 (see chart). Nevertheless, those acreages nearly doubled in the succeeding 5 years, with most of the increase occurring on fruit and vegetable farms, the types that previously had accounted for most of the irrigation in that region. In Illinois, Indiana, and Iowa most of the gain in sprinkled acreage occurred on cash grain (primarily corn) farms, although Indiana also showed a significant addition on grain and meat animal farms.

Irrigation in the Seventh Federal Reserve District is not primarily a small farm phenomenon. In both 1949 and 1954 the bulk of the sprinkled acreage was found on farms exceeding 219 acres in size. However, the largest percentage increase between those two dates occurred on farms in the

VIRGIL O. SISSON prepares to check soil moisture as he begins first irrigation of grain sorghum.

99–219-acre size class which includes the majority of District farms.

Water and corn

A considerable amount of experience has now accumulated concerning the irrigation of corn in the Midwest. Purdue University specialists report that irrigation "doubles and triples" corn yields in some sections of Indiana. A 3-year test in northern Illinois showed an average corn yield of 144 bushels per acre on sprinkled land against a 50-bushel yield on nonirrigated soil. In a 4-year Wisconsin test nonirrigated corn averaged 45 bushels per acre whereas full irrigation *plus heavy fertilization* boosted the yield to 96 bushels. Tests by Iowa State College on heavy Iowa soils in 1955 showed an average gain of 40 bushels per acre due to irrigation.

CONTRAST: Corn in foreground damaged beyond production because of draught. Corn in background shows Luxuriant tall growth which resulted in timely application of irrigation water coupled with good fertility practices.

These tests were conducted for periods of only 1 to 4 years, whereas a longer span of time would be desirable for conclusive results. However, an Iowa study of rainfall records has disclosed that there were an average of more than three "dry periods" in June, July and August each year during the past 20 years at Ames. A dry period was defined as 10 or more consecutive days during which there was no more than one-quarter inch of precipitation on any day. "Every year in the past 20 had at least one period of 13 or more days with no effective rainfall; sometimes these periods last 20 days or longer."

COOPERATION—Maurice G. Hill begins final irrigation of his corn with help from his wife who has become very proficient in setting irrigation siphon tubes.

This State study suggests that irrigation of corn might be warranted merely from the standpoint of supplying supplemental moisture during dry spells. However, an important additional advantage of artificial watering lies in the fact that it permits other changes in crop production practices. For example, it has been known that highest corn yields can be obtained from good soils if heavy applications of fertilizer are used along with dense stands of plants, i. e., more than 15,000 per acre. However, moisture deficiency can sharply reduce the effectiveness of fertilizer, and dense stands may actually reduce yields in dry

(Continued on page 104)

Dominy Named Reclamation's Assistant Commissioner for Legislative Liaison

INTERIOR SECRETARY SEATON Presenting Formal Commission of Office to Assistant Commissioner Dominy

Secretary of the Interior Fred A. Seaton recently announced the appointment of Floyd E. Dominy as Assistant Commissioner for Legislative Liaison of the Bureau of Reclamation. Mr. Dominy, who has been with Reclamation 11 years, has served as chief of that agency's Division of Irrigation since 1953.

Secretary Seaton said the appointment was recommended by Commissioner of Reclamation W. A. Dexheimer. Mr. Dominy will assist in representing the Bureau of Reclamation before the Congress on legislative and budget matters.

"The creation of a new office of Assistant Commissioner for Legislative Liaison and the selection of Mr. Dominy to fill that position will greatly assist the Bureau of Reclamation in carrying forward its important program," Secretary Seaton said. "Mr. Dominy, because of his broad knowledge of western irrigation and agriculture, will add important operating knowledge to the immediate top level of the Bureau's staff."

Mr. Dominy joined the Bureau of Reclamation in April 1946, as Chief of the Allocation and Repayment Branch of the Operation and Maintenance Division. He became Assistant Director of the Division in 1950 and Director in 1953. Under the Bureau's reorganization in December 1953, he became Chief of the Division of Irrigation.

Beginning his professional career as teacher of vocational agriculture in Hillsdale, Wyo., Mr. Dominy became county agricultural agent in Campbell County in 1934 and continued in that job until the fall of 1938. He became field agent for the Western Division of the Agricultural Adjustment Administration in 1938 and served until 1942, when he became Assistant Director of the Food Supply Division, Office of the Coordinator of Inter-American Affairs. In this position, he was responsible for developing and directing an emergency food supply program in cooperation with various South and Central American countries.

During World War II, from 1944 to 1946, he served as a lieutenant in the United States Navy. As a military government staff officer on islands of the Pacific reoccupied by Allied forces he was responsible for the development and administration of agricultural programs.

Mr. Dominy was born in Hastings, Nebr., in 1909. He was educated in the Hastings public schools and Hastings College. He obtained his B. A. degree in agriculture from the University of Wyoming in 1932. He has done postgraduate work at the University of Wyoming and Columbia University. He married Alice M. Criswell of Hastings. They have three children and now reside in Oakton, Fairfax County, Va. # # #

Recreation Plans For Pineview Reservoir

Ogden, Utah, and the surrounding area are growing rapidly in population, industrially and especially in water demands. To help meet the water needs, the Bureau of Reclamation constructed the Pineview Dam in 1935–37. This rolled-earth structure, which backs up the Ogden River is 7 miles east of Ogden. It was originally designed to store a maximum of 1,786 surface acres of water.

It was not long before it became apparent that recreation was the dominant use of the water surface and shoreline. Thousands of people swarmed from the Ogden area—Utah's second most thickly populated section—to seek relaxation at Pineview Reservoir.

The nearest other large fresh-water body was Utah Lake, 70 miles from Ogden.

In 1941, the late President Franklin D. Roosevelt, by proclamation, reserved certain lands around the Pineview Reservoir to be included within the Cache National Forest for national forest purposes, including recreation use. This original reserved area proved to be entirely inadequate for the development of a national forest public recreation program as the adjacent shoreline lands under public ownership, were too narrow, steep and rocky. This made it impossible to develop recreation facilities with sufficient shoreline reservation and provisions for sanitation to protect the quality of the water stored.

However, the lack of facilities did not deter an ever-increasing number of people from using Pineview Reservoir for recreation. During the past few years, the number of annual recreation visits to the area have been close to one-half million. If additional development were possible, this number could easily grow to 759,000 visits or about one-half the number that visit Yellowstone National Park each year.

by DONALD B. PARTRIDGE
Landscape Architect
U. S. Forest Service
Intermountain Region
Ogden, Utah

The water needs of the growing Ogden area soon outgrew the water supply available from Pineview Reservoir. In 1955, the Bureau of Reclamation moved to help solve this problem. In July of that a year, work got under way to raise the dam from its 61-foot height to 90 feet, increasing the storage capacity of the reservoir from 44,200 acre-feet to 110,000 acre-feet. The maximum surface area was increased from 1,786 to 2,874 acres.

Plans for expansion of the reservoir capacity intensified the land community interest in the development of provisions for increased recreation use and facility construction. Appropriations for enlargement of Pineview Reservoir by the Bureau of Reclamation included funds for acquisition of lands adjacent to the reservoir as well as funds for the planning and development of the recreation resources.

The stage was not set for the recreation-planning phase of the Pineview Reservoir development program.

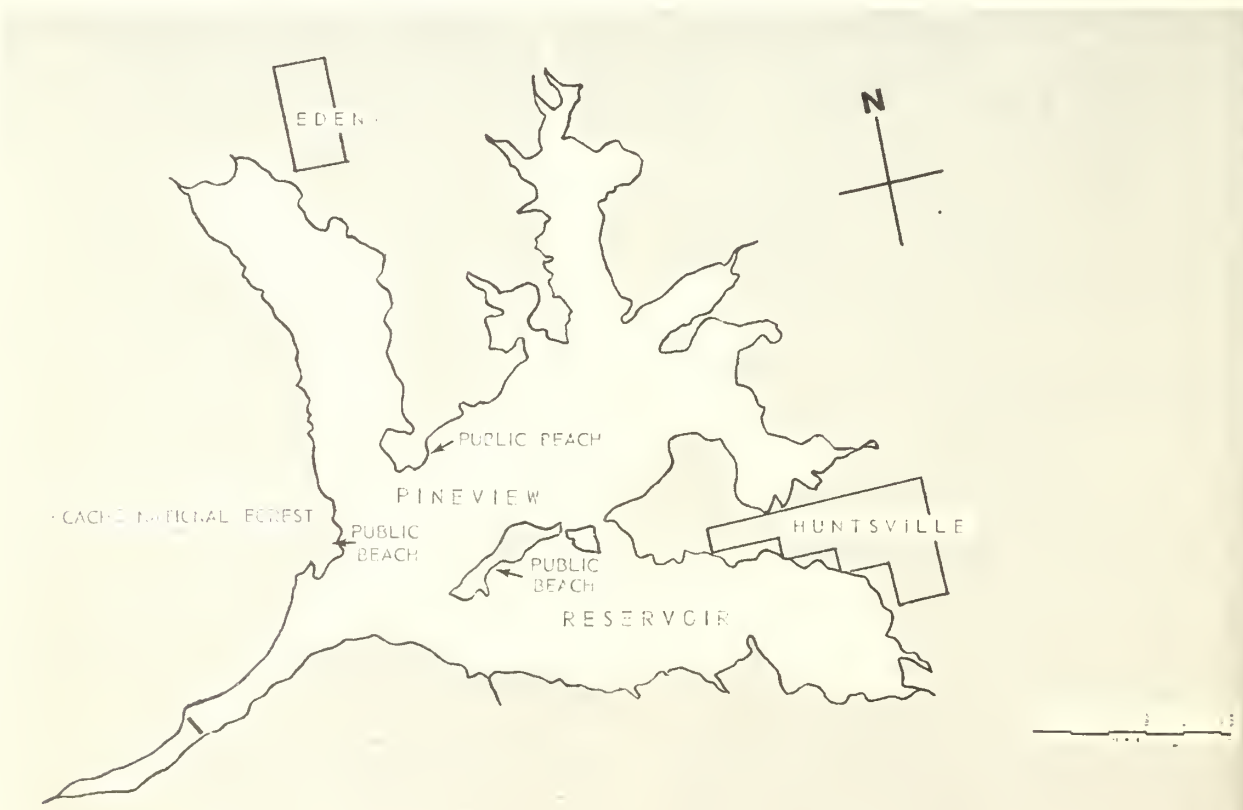
A good close working relationship and understanding evolved between officials of the various agencies concerned. The recreation development of the Pineview Reservoir area is a cooperative program between the Bureau of Reclamation and the U. S. Forest Service. Officials of the National Park Service represented the Bureau of Reclamation and advised them in the classification and planning phase of this program.

A general development or classification plan for Pineview Reservoir was completed and approved in 1951 by officials of the Bureau of Reclamation, National Park Service and U. S. Forest Service.

This classification plan was then followed by the recreation master plan prepared on a larger scale, using Bureau of Reclamation survey maps, enlarged aerial photos and field checks of the preliminary plans for each area. The master plan illustrates the ultimate recommended recreation development desirable.

The Weber Basin Conservancy District and an interested group of Ogden citizens are assisting in

Simplified Drawing of Pineview Recreational Plan.



ENLARGEMENT of Pineview Dam—Weber Basin—Utah. Highway tunnel near the right margin of the picture, now filled with rock identifies the original height of Pineview Dam—*Photo by Stan Rasmussen.*

a program to acquire additional land around the perimeter of the reservoir. Only a part of the recreation development program can be accomplished with the lands now in Government ownership.

The recreation master plan was prepared by the U. S. Forest Service in cooperation with the Bureau of Reclamation and the National Park Service and was approved in 1956. It provides for the development of approximately 640 acres around the reservoir for various types of recreation, including public recreation areas, semipublic, commercial, and summer home areas. The capacities in terms of people per day including the following:

Type	Number of areas	Capacity
		People
Public recreation	15	6,100
Overlook parking	Numerous areas	800
Semipublic	10	1,400
Commercial	4	2,300
Summer home	1	300
Total		10,900

It should be noted that the original general development plan approved in 1951 provided for facilities to accommodate 3,825 people in camp and picnic grounds. The new recreation master plan provided for an additional 2,250 users by 1965.

The master plan has been prepared with the primary concern for sanitation. Camp and picnic facilities are located at least 100 feet back from the high water line and all sanitation improvements are located a minimum of 200 feet back. These provisions are included in the plan to protect the quality of the reservoir waters and assure delivery of a safe domestic water supply to the city of Ogden.

Other factors considered in the master plan

WATER SKIERS on Pineview Lake—*U. S. Forest Service Photo.*

involved provision for public safety, fire protection and adequate and safe water supplies for the recreation users.

The planning phase of Pineview Reservoir under the direction of the U. S. Forest Service is now well along with funds provided by the Bureau of Reclamation in anticipation of a recreation construction program, during the coming year.

A supplemental memorandum of agreement between the Bureau of Reclamation and the U. S. Forest Service for planning, development, and administration of recreation lands around Pineview Reservoir is now in the process of being approved. When this agreement is completed, the next stage or development phase of the Pineview program will be initiated. # # #

"POSTPONE THAT EVIL DAY"

"As has been well said here, the available acres per capita in this country are decreasing at a tremendous rate, and we may reach a state some time where research and conservation won't be able to altogether take care of it. But we want to postpone that evil day as far as we can." Senator Richard B. Russell, Senate Agricultural Appropriations Hearings, fiscal year 1958.

439138 O—57——2

N.R.A. Convenes At Salt River

PRESIDENT THEODORE ROOSEVELT.

PHOENIX, ARIZONA—This Sunshine Capital of the Southwest will host reclamationists from 17 Western States November 6–7–8 at the 26th annual convention of the National Reclamation association, theme of which will be the 100th anniversary of the birth of the "father of reclamation"—Theodore Roosevelt.

With the Salt River Project, the nation's first major reclamation venture, inaugurating and perpetuating the financial foundation for the Salt River Valley, the site is most fitting for the convention, especially since it will serve as a springboard for a year-long national observance of the Teddy Roosevelt Centennial.

The Salt River Project was organized shortly after the National Reclamation Act, sponsored by Senator Henry C. Hansbrough, of North Dakota, and Representative Francis Newlands, of Nevada, was passed by the 57th Congress and signed into law June 17, 1902, by President Roosevelt.

Less than 9 years later, Mr. Roosevelt, who declined the candidacy for President at the end of his second term in 1908, came to the Valley to dedicate the huge masonry dam named for him. The structure, which hobbled the rampant waters of the Salt, still holds the distinction of being the highest rock masonry dam in the world.

Dedication of Roosevelt Dam was the launching point of the Project which has since constructed five additional storage reservoirs on the Salt and Verde Rivers. Harnessing of the two streams and its attendant flood control and water storage facilities proved to be a godsend to the Valley, known to natives and newcomers as Valle Del Sol (Valley of the Sun).

In the years before reclamation the Valley always faced the problem of too much or too little water. Flash floods, usually occurring in the spring when the mountains shook off their winter blanket of snow, swept away the farmer's handiwork and then in summer the streams disappeared in the sand to become nothing more than dusty ribbons meandering through a desolate wasteland.

However, the miracle of reclamation and irrigation wrought an abrupt change and the Valley's development, since the advent of the Project, has been of the amazing variety. And with an estimated 1,200 to 1,500 new residents moving into Arizona per week there will be no change in the foreseeable future.

Rainfall on the Salt and Verde watersheds is approximately the same as it was before the Project backed the rivers up into lakes, but a similar amount of stored water is now sustaining a half million people instead of the 11,000 existing here then. Prior to 1900 the entire assessed valuation of Maricopa County, of which the Project is the heart, was in the neighborhood of $10,000,000 while the 1957 figure soared to near the half billion mark.

Although the Project's original 241,000 acres have shrunk to 239,000 through the development of subdivisions to accommodate the heavy influx

BEFORE AND AFTER—Cultivated and virgin desert areas appearing in the two photos graphically describe Arizona's Salt River Valley "BEFORE" and "AFTER" organization of the Salt River Project, the Nation's first major Reclamation project. This project has produced nearly $300 million worth of crops in the last 5 years.

of new residents, agriculture still provides the basic economy of the Valley. In the past 5 years the Valley's fertile acres have produced crops valued at nearly $300,000,000.

Reclamationists, who last met here in 1947, will see the many vast complexion changes in Phoenix and environs during the past decade. A committee headed by R. J. McMullin, general manager of the Salt River Project and president of the Colorado River Water Users' Association, was hard at work ironing out a well-rounded program of entertainment for the visitors as this issue of the *Era* went to press.

Stage backdrops, printed programs, tour brochures and many other accouterments associated with the 3-day conclave will carry out the theme of Teddy Roosevelt Centennial. One of the outstanding tour features will be the Rough Riders Roundup luncheon at the Salt River Project Employees' Recreation Association area with the piece de resistance being husky charcoal-broiled steaks.

J. H. (Hub) Moeur, president of the Arizona Reclamation Association and Arizona director of the National Reclamation Association, along with Mrs. Moeur, will be the official host and hostess for the convention. Among the list of topnotch speakers for the occasion are Under Secretary of the Interior Hatfield Chilson; Bureau of Reclamation, Commissioner Wilbur A. Dexheimer; United States Senator Clinton P. Anderson, of New Mexico, former Secretary of the Department of Agriculture; Arizona Gov. Ernest W. McFarland; and Arizona's own senatorial delegation, Carl Hayden and Barry Goldwater, and Senator Frank A. Barrett of Wyoming.

Mr. Murray Walker, president of the Association of Western State Engineers, is also scheduled to be a speaker at the convention.

Other Interior Department and Bureau of Reclamation officials selected to attend the 24th Annual Convention of the NRA were Associate Solicitor, Water and Power, Edward W. Fisher; Assistant Commissioners of Reclamation Floyd E. Dominy and E. G. Nielsen; Assistant to the Commissioner, Information, Ottis Peterson; Acting Chief, Division of Irrigation, William I. Palmer; and Chief, Division of Project Development, N. B. Bennett. # # #

30 Years Ago in the Era

PRINCIPLES WHICH SHOULD BE INCLUDED IN SUCCESSFUL LAND SETTLEMENT

Settlers must be selected. Developing farms under irrigation requires a certain amount of capital and certain definite qualities. Without these only disappointment can result.

They must be settled on the land, not in isolated units, but in groups or colonies of sufficient size to secure economic and social advantages.

There must be aid and direction in the preparation of the land for irrigation. In this, cooperation is important. Settlers working as a community can do many things better than as individuals working alone.

Many settlers who love farming and who, if given a chance, wil lbecome good farmers, have inadequate capital. They should be helped to get a start by means of credit banks or other special arrangements.

Markets must be studied, crop rotations suggested, and a program of marketing worked out suited to the conditions which govern transportation from the producers to markets.

The payments of the initial years must be made as easy as possible.

The aim should be ownership of small farms rather than tenancy on larger estates.

ELWOOD MEAD
Commissioner of Reclamation

COLUMBIA BASIN'S PARTNERSHIP PROGRAM

by E. H. NEAL

Irrigation Supervisor, Columbia Basin Project, Ephrata, Wash.

On the Columbia Basin irrigation project in the State of Washington the directors of each of the three Irrigation Districts call public meetings each winter to discuss the common problems of the Districts and the water users. These annual "stockholder" meetings have been held in each Irrigation District, usually in January or February every winter since water deliveries to the project lands began. They have been well attended, some meetings having as many as 125 persons present and always those present have evidenced their interest by questions and comments.

This big irrigation project for which facilities are now completed to serve 350,000 irrigable acres and which eventually will serve 1 million acres was organized into three Irrigation Districts because of the widespread area and to give as much local representation as possible to the various communities. The Quincy Columbia Basin Irrigation District is in the northwest portion of the project, with headquarters at Quincy. The East District in the northeast part of the project with headquarters at Othello, and in the southern part of the project is the South District with headquarters at Pasco. Quincy is 20 miles west of the project headquarters at Ephrata, Othello is 45 miles southeast of Ephrata, and the headquarters of the South District at Pasco is 90 miles southeast of Ephrata. Due to the size and distances, the problems of communication between the Irrigation District and its "stockholders" and the Bureau of Reclamation and the landowners and water users have required considerable attention.

The programs at the different annual stockholder meetings have varied. Subjects discussed have covered a wide range, including the functions and policies of the Irrigation District Boards, water allotments, policies in water delivery and charges and assessments for water services, the Columbia Basin Act and features, and repayment contracts. Considerable time has been given in various of the meetings to discussion of irrigation practices and how to meet the problems peculiar to the soil and climate of the Columbia Basin. In recent years drainage problems and financing drainage have been subjects of considerable interest. In all of the meetings there have been ample opportunities for water users to present problems of general interest and for discussion of such problems. In addition to discussions by directors and secretaries of the Irrigation Districts, the Extension Service, Research Workers from the Experimental Stations, and Bureau officials have taken part in the programs. Meetings of this kind present a good opportunity to discover water users' problems; to acquaint them with reasons for Bureau policies and to strengthen cooperative relationships. An example of how the meetings work:

George Crane, who owns and operates a farm in one of the lighter soils areas, speaks—"Mr. Chairman, I had to use 6½ acre-feet of water my first year to grow beans. My allotment is 4 acre-feet. I should not have to pay excess water rates on that 2½ acre-feet. If 6½ acre-feet are required to grow beans, how much will be required to grow alfalfa?"

The chairman called on the Bureau's Irrigation Division representative, who explained briefly that more water is often required the first year in preparation for leveling, to fill the rootzone, and because of inexperience in handling water in this area. He then called on a land-classification man who explained how this particular soil was being studied in the light of recent irrigation experience to see if an increase in water allotment was justified. A Settler's Assistance Extension Agent then told of where to look for ways of saving water, and of the assistance towards more efficient irrigation that could be obtained from the Extension Service or the Soil Conservation Service.

The results have been that on the Columbia Basin Project there is a well-informed group of water users who have an understanding of both Irrigation District and Bureau of Reclamation policies and the special problems of irrigation and production on the soils peculiar to the Columbia Basin Project. More important, the water users have become acquainted with their elected officials water user's organization. While the project area

Onion sacks create a "FOREST" on the farm of Bill Hattori near Moses Lake, Washington—*Photo by H. E. Foss.*

and have had an opportunity to present their complaints and gripes.

The monthly meetings of the Irrigation District Boards, are, of course, open to the public and all the Boards extend invitations to all their water users to come before the Board and present their problems.

It is the announced policy of the Bureau of Reclamation to transfer the responsibility for operation and maintenance of irrigation facilities to water user organizations as soon as the facilities are complete and reasonably stabilized, and the water user's organization is competent, willing, and financially able to operate and maintain the works.

This time is some years in the future on the Columbia Basin Project, but active steps are being taken to prepare the way for this transfer of the operation and maintenance responsibility to water user's organization. The District boundaries do

HERBERT SWOFFORD irrigating netted-gem potatoes on his Royal Slope Division farm—*Photo by Stan Rasmussen, Region 1.*

Closeup shows Bob Faw, left, and a harvest hand sacking peas on his Columbia Basin farm—*Photo by F. B. Pomeroy, Region 1.*

not coincide with the distribution systems. The District boundaries in a general way follow artificial boundaries, while the irrigation system, using good engineering practice, is based on topography without regard to the artificial lines of the District boundaries.

A major premise in the project plan set forth in the repayment contracts is that location on the irrigation system, and the method of furnishing water to the lands, whether from the so-called gravity system or by pumping from that system, is not to be the basis for assessing operation and maintenance charges at different rates by reason of the method of water delivery. It is agreed, however, that it is in the best interests of the project for the operation and maintenance charges to be related to the relative productivity of the lands.

It is believed that the operation of the project, when the water users are willing and able to take over, should be through some form of an operating agency under the supervision of the elected directors of the three districts. In addition to the necessity for such, due to the engineering features of the system and the desire to equalize charges, there are many economies and efficiencies that will result from operation as a single entity.

To prepare the way for such eventual operation by the water users, a very close-working relationship between the Bureau of Reclamation Staff (Irrigation Division) which is now operating the facilities, and the Directors of the Irrigation Districts has been established. # # #

Fertilizer Growth Helps Keep Farming Our No. 1 Industry

(*Reprinted from Rural Marketing, April 1957*)

"American agriculture is the Nation's biggest industry—4,800,000 farms with an equity of $149 billion and spending for operation of its farm plant between $12 and $14 billion a year on machinery, equipment, buildings, fertilizers, feed, petroleum products and other goods and services."

To keep the Nation's number one business in high gear requires use of the latest methods and materials, continues Vincent Sauchelli, chief agronomist of the Davison Chemical Co., division of W. R. Grace & Co., Baltimore. "The two most important factors responsible for the tremendous productive capacity of American farms are the expanded usage of power equipment and chemiical fertilizers."

Sauchelli goes on to say, in an article in Chemurgic Digest, that chemical fertilizers are an "indispensable tool" in today's farming operations and make possible a "substantial part" of cash farm income. "It is estimated that about 30 percent of the country's crop production can be attributed to the use of fertilizers," he adds.

"Today's commercial farmer is using mechanization, good management practices, fertilizers better suited to his soil needs as determined by soil tests, and better seed and breeds of livestock to enable him to succeed.

"Manual labor and animal power have yielded to automotive and machine power, and animal droppings to balanced chemical fertilizers."

Continues Sauchelli: "Since 1939, consumption has hit a new high record each year. In 1955, American farmers used about 21 million tons of fertilizer, almost 40 percent more than in 1946 and valued at more than $1 billion.

"It is fair to say that, for every dollar invested in fertilizers, the average return is from $3 to $5. Many of our commercial crops could not be grown in many sections of the country without the aid of fertilizers. Twenty-five to fifty percent of the production of cotton, tobacco, citrus fruits, potatoes and many vegetable crops comes from fertilizers."

As for America producing more food and fiber than it consumes, Sauchelli predicts that present day surpluses "will be envied" a generation hence when, by 1975, about 200 million Americans will need at least 30 percent more food than is now being produced. # # #

The Handicapped Pull Own Weight on Reclamation Team

In cooperation with the President's Committee on NATIONAL EMPLOY THE PHYSICALLY HANDICAPPED WEEK, proclaimed by Hon. Dwight D. Eisenhower October 6–12 we present this year's story of handicapped people in the Reclamation area who are pulling their own weight.

IONE CARROLL—*Photo by N. F. Novitt, Region 7.*

Mrs. IONE CARROLL, by accepting the fact of a physical handicap, has kept it from being a disability. Capable Ione carries out her full and uninterrupted duties as a clerk-stenographer in the Region 7 headquarters at Denver just as though she didn't have a stiffened and braced leg that results from poliomyelitis.

Doctors at Lander, Wyo., were baffled when 22-month-old Ione Marion was paralyzed within a matter of hours—back, right hip, and right leg. In 1927, the dread term "polio" was unknown, and months went by before the paralyzing illness was identified.

Today, Ione is one of the Nation's most grateful boosters of the Shrine Hospital for Crippled Children at Salt Lake City. Entering at about 4 years old, she underwent surgery and remained a year. Although she first walked at the age of 6 with the aid of crutches and braces, she returned to the hospital every 6 months until she was 16.

Since May 1951, Ione has had stenographic duties in Region 7, specializing in statistical shorthand and typing. Her present assignment, appropriately, is in the Programs and Budget Branch. Last May she was married to Lawrence W. Carroll, employee of a wholesale dry goods company.

"Ione asked, when she came into this office, to be treated just the same as anyone else would be," said E. T. Seeley, branch chief. "We've done just that. And I can honestly say her job performance is excellent, not impaired or even influenced by her handicap."

HELEN FRAUSE, despite polio handicap in both legs, was not kept from earning five awards and other honors before coming to work in the Commissioner's office as a dictating machine transcriber. Although her only means of locomotion is crutches, she is by far the most cheerful employee in her unit, as she considers her problems her own and no one else's.

Miss Frause was stricken with polio when she was 9 years old. She spent 10 months in a hospital, and, she says, it took another 14 months to get back to normal.

Upon graduation from the eighth grade, she was presented with a bronze plaque, a pin, and a certificate by the Boulder County (Colo.) American Legion Post for outstanding scholastic work. In 1952, 1953, and 1954 she won the top cash prize offered each year by the Boulder County Elks for writing articles on what she did to compensate for her handicap and what her goal was after graduation.

During her senior year at Louisville (Colo.) High School she was president of the Louisville chapter of the Future Business Leaders of America, an organization composed of commercial students in high schools and colleges. She was also president of a high-school commercial honorary society and won that organization's award for outstanding high-school commercial scholarship.

Upon graduation she was selected to address the convention of the Mountain and Plains States chapters of the FBLA held in Denver in June of 1955. She was the only high school student so honored.

Miss Frause had been with Reclamation just over 7 months when her performance earned a promotion, and her cheerful attitude has caused many a "major" problem of other employees to melt into insignificance.

FOREST HOOVER, a staff sergeant, was aboard a Douglas bomber that took off on a training flight from Tonapah, Nev., to Tacoma, Wash., in 1943. Five hours later, out of fuel, and surrounded by stormy weather, the plane crash-landed in a cold and isolated area of central Idaho. In the crash, Forest's right foot was jammed and broken. During the 16 days the bomber crew waited for rescue the foot was frozen, and by the time medical attention was available, amputation was necessary. After 7 months' hospitalization, he was discharged.

Now, 12 years later, that experience probably seems like a bad dream to Forest as he cheerfully goes about his duties as an engineering aid engaged in technical investigations of Hoover Dam and Lake Mead on the Boulder Canyon Project.

It doesn't seem quite right to speak of Forest as a handicapped person because he has so overcome his disability that his fellow workers never think of him as such. His work takes him into some rugged terrain around Lake Mead above Hoover Dam, along the Colorado River below the dam, and also into the interior of the dam

HELEN FRAUSE.

where he is required to negotiate steep stairways and narrow passageways carrying a load of instruments and equipment. Despite these conditions Forest always seems to manage to do a little more than his share.

SALT RIVER PROJECT

More than a score of persons, handicapped in varying degrees and with a number of veterans in their midst, are on the employment roster of the Salt River Project in Central Arizona and in every case adjustment has been successful.

Project executives are fully cognizant of the importance of the "employ the physically handicapped" program and the plan is applied wherever and whenever possible.

CLAUDE AXTELL, account clerk in the Project irrigation service department, and CLYDE GORDON, offset printer in the Project print shop, are outstanding examples of employees who have adjusted to compensate for their handicaps, although AXTELL is somewhat of a junior partner in the combination.

In 1956, AXTELL underwent surgery for amputation of both legs, the left leg above the knee in May and the right below the knee in October, a circulatory condition necessitating the treatment.

When he was first employed by the Project, AXTELL was assigned to the field as a special service zanjero (ditch or water tender) in subdivisions, but after 3½ years of this work his physician recommended inside duties because moisture was aggravating his condition. His transition into the handicapped category was a gradual one. Several toes were removed from each foot before the decision was finally made to amputate his legs.

For a fellow who played 8 years of semipro football and always led an active life you'd think the amputation of his legs would tend to dim his anticipation of the years to come. But not so for AXTELL. He submitted to the amputations with the same fighting spirit he displayed years ago while playing safety man and fullback in Susquehanna, Pa., viewing the surgery as something to relieve his suffering rather than a hindrance the rest of his life.

FOREST HOOVER—*Photo by F. S. Finch, Region 3.*

GORDON's right leg was crippled by polio when he was 16 years old, but he staged a successful comeback now the handicap is no deterrent so far as his work and recreation are concerned. He was stricken with infantile paralysis while a sophomore in high school at Connersville, Ind., the disease withering the tendons of his right leg. Shortly after dismissal form the hospital, he learned to walk with the aid of a chair, then graduated to crutches and a cane. Finally he was fitted with a heavy brace enabling him to discard other walking aids.

His improvement was such that he reentered high school and extended his activities to playing center on his church basketball team. During his final years in high school the coach noticed his sharp interpretation of baseball plays, as well as his unlimited courage, and urged him to apply for admission in the Indiana High School Umpires' Association.

For a quarter of a century GORDON "called 'em as he saw 'em" and traveled thousands of miles umpiring baseball and softball games, han ling about 150 contests a year. However, in 1948, GORDON curtailed his activities on the diamond and sought other employment to supplement his income. That was when he became associated with the Project, and has since developed into a top employee in the print shop where practically all of the Project's printed material is produced.

Currently he is booking agent for the Arizona Umpires Association and recently was selected as an alternate umpire for the Arizona-Mexico League.

MAROLF BERYL BERGER began his Government career on October 2, 1939, at La Junta, Colo., as an Engineering Aid for the Soil Conservation Service on a short-

MAROLF BERYL BERGER.

JOHN E. ROBINSON with Mrs. Blanche Reuber, appointment clerk—*Photo by Ed McCloud, Region 1.*

GEORGE G. SCHOEPKE.

term appointment. In January of 1940 he accepted a temporary appointment with the Forest Service at Fort Collins, Colo., and worked there until coming to work for the Bureau of Reclamation on October 19, 1940, as a Junior Engineer, at Pueblo, Colo. He was furloughed on August 19, 1941, to enter the Armed Forces. He served in the Field Artillery and rose to the rank of major.

In the Italian Campaign of World War II Mr. Berger received injuries which resulted in the loss of both legs. He returned to duty with the Bureau in the Project Planning Office at Oklahoma City, Okla., as an Engineer P–2 on January 7, 1946. Despite his handicap he has always been able to perform all duties to which he was assigned. He has never delegated field work to his assistants when he felt that the field work required his attention. Although most of his work is performed in the office, he quite frequently goes to the field to perform Hydrology inspection or work. He has progressed to the position of Chief of the Hydrology Section of the Oklahoma City Office.

His cheerful and willing attitude and versatile ability has made him a well liked and highly respected employee and citizen.

GEORGE G. SCHOEPKE was stricken with poliomyelitis at the age of 11 years. He was hospitalized for the following year. Both legs were completely paralyzed and his back and right arm were partially paralyzed. Through physiotherapy treatments and a grim determination over a 5-year period, Mr. Schoepke regained the partial use of one leg and the full use of his back and arm. He now gets around very well with crutches and drives his own car.

Mr. Schoepke's career in Government service began in 1944 with the Corps of Engineers in St. Paul, Minn. He transferred to the Bureau of Reclamation at Parker Dam, Calif., in 1946.

Now employed by the Middle Rio Grande Project at Albuquerque, N. Mex., as a Supervisory Draftsman in the Design Branch, Mr. Schoepke's handicap seems to be no handicap at all. His pleasant personality and excellent drafting ability have won the friendship and esteem of all who know him.

COLUMBIA BASIN PROJECT

The Columbia Basin Project is quite proud of its record in placement of handicapped and disabled employees throughout all segments of its operations.

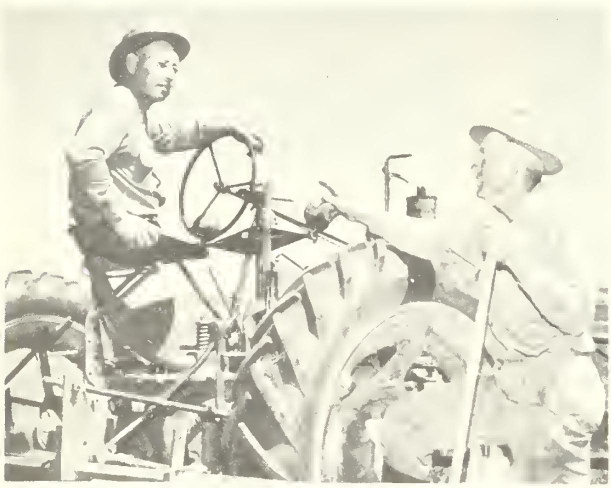
JOHN E. ROBINSON, who, as a result of a serious disease contracted while with the Seabees in Okinawa during World War II, was required to have his right leg amputated. He was forced to give up his interest in a lucrative building construction business. His experience and educational background, although not sufficient to qualify him as a professional engineer, provided him with the background to take on a desk-type job that required the ability to work with, understand, and write up engineering specifications. Previously, only professional engineers were used in this type of work. Although classified by the Veterans' Administration as 100 percent disabled, we feel that this man is ideally suited to the job to which he has been assigned.

HARLAN G. STANLEY is a farmer in the rich agricultural empire which has sprung out of a desert on the Columbia Basin Irrigation Project. But he has to do his farming without legs—his were amputated at the hip when he was 8 years old.

Stanley, who was raised on a farm in southeastern Kansas, returned to farming when he came to the Columbia Basin only after he had piled up a good work record in other lines.

During World War II, he was a sheet metal man for the Boeing Airplane Co., in its Seattle plant, a job in which he asked for no favors from his fellow workers and one in which he turned out his share of vital aircraft assembly.

The 45-year-old Stanley is 35½ inches tall and says, "I figure I'd be about 5 feet 8 inches tall if I had legs."



HARLAN G. STANLEY, *sitting on tractor with his partner* **GEORGE F. ROESBERRY**—*Photo by Ed McCloud, Region 1.*

Artificial limbs have been dismissed "as a nuisance" by Stanley who explains he has been fitted for them and can get around but the stubs of his legs are too short for efficient use of artificial legs. His legs were lost as a result of blood poisoning which developed from bruises. He also lost the middle finger of his left hand at the same time.

Though many people turn to a desk job or other sedentary work when they lose a limb, Stanley found that kind of work was not for him. "It gives me a case of nerves and I wind up with indigestion. I have to be able to move around."

He bought a 200-acre unit and then, realizing there would be things on the farm impossible for him to do, he took in George Roesberry, 46, as a partner on a sharecrop basis. Roesberry came to the farm last fall and Stanley followed this spring.

In spite of his handicap, Stanley operates all the farm machinery and drives his own car—one on which he rigged up hand controls for clutch and brake and with a throttle which is controlled by shoulder action.

FREDERICK C. BYRNES is employed as a Physical Science Aid in the Soils Laboratory of the Missouri-Souris Projects Office in Bismarck, N. Dak. He holds a bachelor's degree in soil science from the University of Connecticut and a masters degree from Oklahoma A. & M. Mr. Byrnes was employed by the Bureau of Reclamation in Montana from June 5, 1950, to July 3, 1953, and in Wyoming from April 2, 1956, to September 30, 1956, as a Soil Scientist (Land Classification and Survey). It was, however, necessary to separate him from this position because his impaired vision and hearing made it impossible for him to get a State driver's license and therefore he was unable to operate a vehicle for transportation to and from the work sites. He has a hearing loss of 65 percent. His vision was impaired as a result of scarlet fever when he was a child.

Now that his duties are confined to laboratory work, his physical handicaps are not so critical and he is doing an excellent job. # # #

FREDERICK C. BYRNES.

Subscriptions

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All subscriptions should be sent direct to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Requests for changes in mailing address, renewals, and separate copies should also be sent direct to that agency.

Water Report

By Homer J. Stockwell
Snow Survey Supervisor, Soil Conservation Service, Fort Collins, Colo.
and
Norman S. Hall
Snow Survey Leader, Soil Conservation Service, Reno, Nev.

Willamette Valley—Scenic view of the North Santiam River—*Photo by Stan Rasmussen, Region 1.*

Water supplies in western United States during the summer of 1957 were better than anticipated in early spring. Snowfall in the mountain areas was unusually heavy during the late spring months ranging up to 300 percent of normal for the period. Cool temperatures prevailed. Maximum snow packs of record for June 1 were recorded at high elevations in a few places. Precipitation during the snowmelt season was above normal. Runoff from snowmelt was well distributed over a long period. The relationship between streamflow and water demand was almost ideal for supplying immediate requirements and improving reservoir storage. This improvement in reservoir storage, coupled with relatively wet mountain soils tends to indicate a fair to good water supply for 1958 if snow pack next winter is near normal.

This favorable 1957 water report and 1958 outlook does not extend to southern New Mexico, the highly developed Salt River Valley of Arizona, nor to southern California. In this southwest area, streamflow from the heavy snow pack was not as much as would have been expected some years ago. The years of drouth had taken a toll of water reserves which could not be recovered in one good snow year. Average surface water supply in these areas is far short of meeting demands. These facts must be considered in appraising relative water conditions.

Yet, on the fringe of the last year's drouth area in Colorado, Utah, New Mexico, and Wyoming, the improvement in water outlook was remarkable. Last spring, reservoir storage was down, mountain soils were dry, and irrigated areas had experienced drouth. Mountain snowfall was well above normal but the outlook was considered only fair. Precipitation during April and May was so much above normal that the entire outlook changed. Delay in snowmelt caused concern as to the possibility of local snowmelt floods. Action was required by local agencies in widely separated places to alleviate possible flood damage. Due to lack of demand, a high proportion of streamflow was stored and is still available for future years.

In the more favored region of the Pacific Northwest where water supplies have been adequate for most needs in recent years, total streamflow was also more than expected on April 1. Especially heavy streamflow occurred in May and early June. For the remainder of the summer months streamflow was below normal. On the main stem of the Columbia River streamflow was among the lowest of record for August and early September, causing adjustment in power production schedules. Flows were tending to increase at the end of September. A similar pattern of summer streamflow occurred in Montana, Idaho, Nevada, and California.

Considering the size of the final snow pack, extremely high peak flows were rare. Minor flood damage occurred in isolated areas of Utah, Colorado, and Washington. In all of the West, streamflow from snowmelt extended over a long period—from April to early August.

The flow for April–September of the major streams of the West is indicated by the following tentative records in approximate percent of normal. Colorado River at Grand Canyon, 130 percent; Rio Grande at Otowi Bridge, 110 percent;

Missouri River at Toston, 105 percent; Columbia River at The Dalles, 100 percent; Sacramento River inflow to Shasta, 103 percent; San Joaquin below Friant Reservoir, 81 percent.

Mountain soil moisture conditions are reported as fair to good as of this date except for the mountain areas of Washington, Oregon, and Idaho.

Looking forward to 1958, and assuming a normal snow pack, water supplies will be good where carryover storage is well above normal. Exceptions are the heavy demand areas of the Southwest. Where reservoir storage is not available water supply will depend entirely on next winter's snow pack and rainfall during the growing season.

This analysis is again presented in the *Reclamation Era* through the courtesy of the authors, and *Mr. R. A. Work*, Head, Water Supply Forecasting Section.

In the following paragraphs water conditions by States are briefly reviewed along with a summary of present conditions that will affect the 1958 water supply.

ARIZONA—Above average summer rains improved the water outlook. Most benefit has been to the range lands in the southeastern and central eastern sections of the State. Water holes filled and range grasses had good moisture conditions. Reservoir storage for irrigation still remains low at about 60 percent of average and 12 percent of capacity, excluding storage on the Colorado River. It is only slightly better than last year. Above average winter runoff will be required to supply adequate storage for next year's irrigation. Overdraft of the ground water supply continues in order to supplement the limited surface water supply.

CALIFORNIA—The California Department of Water Resources reports that water conditions during the spring and summer months were generally satisfactory in all areas north of the Tehachapi Mountains. South of Tehachapi Mountains water shortage continued to be a significant problem.

Precipitation during May was much above normal in most portions of the State, resulting in near normal runoff in streams of the Central Valley, north coastal and Lahontan areas. April–July unimpaired runoff of major Central Valley streams was 10,860,000 acre-feet as compared with normal runoff of 13,020,000 acre-feet. Runoff of streams in the central and south coastal areas, however, was much below normal.

All major reservoirs serving the Central Valley, with the exception of Isabella (data not available for water supply table) on the Kern River, filled during the runoff period. This was a major factor in producing adequate water supplies in the Central Valley during the irrigation season.

As of October 1, 1957, there were 6,759,540 acre-feet of water stored in 38 major reservoirs serving the Central Valley. This was about 117 percent of 10-year average (1947–56), 65 percent of usable capacity for that date, and about 500,000 acre-feet less than that in storage on October 1, 1956.

COLORADO—For the first time in 5 years water supply was adequate for all irrigated areas. Water supply outlook changed from fair to excellent during April and May when snow pack increased up to 300 percent of normal. Streamflow over the State was well above average with a few streams flowing near a maximum of record. Cool temperatures during the snowmelt period resulted in delayed melt, relatively low peak flows, and an extremely favorable distribution of snow melt in regard to time. Rainfall in irrigated areas cut demands during the summer. Storage in irrigation and municipal reservoirs increased from a dangerously low point to the present favorable carryover. Overall storage has increased from only 20 percent of capacity last spring to about 70 percent of capacity as of this date. Improvement of storage has relieved the previous critical water supply outlook for the city of Denver.

For the 1958 season the outlook is more favorable than for any year since about 1949. In addition to excellent carryover storage, mountain soils are relatively wet in direct contrast to recent years. In areas where subsoil moisture is used for irrigation, ground water has been brought back to desired levels. With an average snow pack during the 1957–58 winter season, water supplies for next year should be reasonably adequate for the State. If snow pack is less than average, limited shortages can be expected for areas of the eastern slope lacking large supplemental water supplies.

IDAHO—Early snow surveys of 1957 indicated a near normal water supply for central areas and considerably below normal for the northern and southern portion. Above normal snowfall late in the winter improved the outlook. By April 1 near normal flow was indicated for all Idaho streams. An especially wet May substantially increased runoff prospects and in many cases actual runoff was greater than expected.

Idaho had a good irrigation season with high carryover storage for next year. Total reservoir storage is considerably better.

The water outlook for next year is good on rivers with storage, such as the Boise, Payette, and Snake. Water supply for the smaller southern tributaries of the Snake is subject almost entirely to the snow pack accumulation and spring rains of each individual year.

Watershed soils are very dry due to limited precipitation throughout the summer. Watershed recharge from fall rains or from snowmelt next spring will require significant amounts of water.

KANSAS—Water supplies for the irrigated area along the Arkansas River were adequate except for early season. Streamflow in the Arkansas River was high in Colorado. Storage behind John Martin Reservoir available for irrigation early next season is nearly 10 times normal (data not available for water supply table).

MONTANA—The 1957 agricultural season has been outstanding. Irrigation water was plentiful; spring rains were well spaced for time and volume; dry land wheat farms experienced good yields. Range land produced above average forage for livestock. Hay crops have been average or better and good harvest season weather was experienced.

Streamflow from the snow pack maintained above average stages throughout the growing season. Current reservoir storage holdover is good. No drouth conditions have been reported. If 1958 snow pack proves near normal, water supply outlook will be favorable.

NEBRASKA—Streamflow in the North and South Platte Rivers provided adequate water supplies for irrigated areas in western Nebraska. Precipitation has been slightly better than average. Storage in the large reservoirs in Wyoming is well above normal. With near average mountain snow pack and 1958 summer precipitation the outlook for next year is good.

NEW MEXICO—Water supply for the 1957 season was much improved over the past 4 years but did not allow for full recovery from an extended drouth. Summer rainfall was much above average in northern New Mexico, but below average in the south. Because of the unfavorable outlook in the spring and several years of drouth, reduction in crop acreage was extensive. The unusual increase in snow pack in the northern New Mexico and southern Colorado section of the Rio Grande watershed in the late spring months caused snowmelt season streamflow to be greater than expected. The combination of decreased demands and greater than expected streamflow resulted in some increase in storage on the Rio Grande and its tributaries. Reservoir storage capacity on the

Rio Grande is great enough to store 2 to 3 years of normal streamflow, but presently contains less than one-third of capacity and only about one-half of the 1938–52 average. It will take even more favorable runoff years to relieve the concern as to water shortage along this stream.

Crop conditions along the Pecos in New Mexico were fair to good with favorable late summer streamflow caused by rainfall on the headwaters of the stream. Water supplies were fairly good along the Canadian and excellent on the San Juan.

NEVADA—Cool temperatures and above normal precipitation during April and May improved water supplies throughout the State. All major reservoirs, except Rye Patch Reservoir on the lower Humboldt River, were filled during the spring runoff. With runoff less than the 1938–52 average, filling was accomplished because of good carryover storage from the previous year.

Ample water was available for irrigation and other needs. Cool temperatures caused slow melting of the mountain snow pack resulting in a long-sustained runoff. Even water users on unregulated streams had sufficient supplies. This has been one of the best runoff seasons in Nevada in recent years.

Lovelock Valley, served by Rye Patch Reservoir on the lower Humboldt River, ended this irrigation season with carryover storage of about 53,000 acre-feet. This represents above 30 percent of capacity or 62 percent of the October 1, 1938–52 average and is the best since the fall of 1953.

Current fall precipitation in the mountain watersheds is improving the prospects for next year's water supply. Without this timely precipitation watershed soils would likely remain dry until snowmelt next spring. Before appreciable 1958 runoff occurs, these mountain soils must be primed either from fall rains or spring snowmelt.

State-wide reservoir carryover storage for next year is good. The larger reservoirs contain near normal or above the October 1, 1938–52 average while some of the smaller reservoirs are below the October 1 average. However, the current fall mountain precipitation plus good carryover storage point to another good water supply next year if 1958 snow pack should prove near normal.

State-wide reservoir storage as of October 1, 1957 is 58 percent of usable capacity and 106 percent of the October 1, 1938–52 average.

OKLAHOMA—In contrast to outlook last spring, water supply for the Altus Project in western Oklahoma proved good in 1957. Summer rainfall was above normal. At the end of the season the W. C. Austin Reservoir contained about 85,000 acre-feet of water or about one-half of capacity. Storage in this reservoir is dependent on runoff from local rainfall.

OREGON—With the exception of irrigated areas served from small, low-elevation streams, water supply in Oregon has been adequate as was expected last spring. Streamflow ranged from near normal to 20 percent above normal. Some excellent fall rains have occurred this year, but mountain watersheds in eastern Oregon are not as thoroughly primed as a year ago.

Carryover water supplies in irrigation reservoirs are 114 percent of average.

SOUTH DAKOTA—Soil moisture conditions throughout the State are about average for this time of year. Reservoir storage is less than that for the past few years, standing at 88 percent of the past 5-year average. Water supplies in the Black Hills for 1957 were close to average.

TEXAS—Along the Rio Grande in western Texas, water supplies for crops planted were reasonably adequate. A substantial reduction in acreage occurred as a result of the extreme shortage of early irrigation water. Carryover reservoir storage from last year was practically nonexistent. The area near Pecos served by Red Bluff Reservoir had practically no surface water in sight and only a limited amount of feed crops were planted. The 20,000 acre-feet now stored in Red Bluff Reservoir has a high salt content (data not available for water supply table). In the pump-irrigated areas of Texas, crop conditions were good. Storage as of October 1 in the large reservoirs of central and eastern Texas has improved substantially over that for the past 4 or 5 years.

UTAH—Irrigation water supplies have been adequate throughout most of the State this summer. While a few small areas in the southwestern part of the State have reported water shortages, no major shortages of serious consequence occurred.

Above normal rainfall in late spring and early summer months greatly improved the water situation in southern Utah. Cool weather delayed snowmelt so that streamflow held up during the later summer months much better than would normally have been the case. Spring storms, while increasing streamflow, also made it possible to eliminate early irrigation and to save reservoir water.

In central and northern areas the cool, wet spring built up abnormally heavy snow packs at the higher elevations which subsequently resulted in some flood damages.

All reservoirs in the State, with the exception of those on the Sevier River, have ended the season with average or better supplies to be carried over to next year. On the Sevier River, however, combined storage in Otter Creek, Piute and Sevier Bridge Reservoirs (data not available for water supply table) is only one-third of average so that a heavy snow pack is needed here this winter to assure adequate supplies for next summer.

WASHINGTON—During the irrigation season of 1957, water supplies were generally adequate throughout the State. Runoff from the winter snow pack was very heavy during the month of May. High water conditions were experienced along some of the streams in the State and several local areas were flooded from flash water early in the year. With heavy runoff during May, the total irrigation runoff was above that expected. May was the only summer month when streamflow was above normal. Precipitation during the latter part of the irrigation season was generally below normal in the high mountain watersheds. Watershed soil moisture conditions, therefore, are very poor.

September precipitation for the Yakima Valley was the lowest on record. Total reservoir storage as of October 1 is much below normal. The five irrigation reservoirs on the Yakima River now store water to 18 percent of capacity. Unless a normal or above amount of snow falls on the upper watershed this winter, irrigation supplies for the coming season could be short.

WYOMING—Surface soil moisture in irrigated areas ranges from normal to well below normal. However, subsoil moisture throughout Wyoming is considerably above normal for this time of year due to heavy summer rainfall. Assuming that subsequent precipitation for October proves close to average, range land should enter the winter with good moisture conditions.

Because of the especially heavy precipitation during the late spring and early summer months, streamflow in Wyoming was substantially above that expected from snowmelt runoff, particularly in the North Platte Basin. Irrigation water supply for the 1957 season was therefore more than adequate for the State.

Present reservoir storage is 132 percent of normal and will provide an adequate carryover for the 1958 seasonal requirements.

# # #

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the ERA that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

CROP REPORT

Four new projects and 291,066 acres were added to the irrigated service area of Federal Reclamation projects in 1956, bringing the total area subject to irrigation service to 7,658,801 acres.

The area irrigated in 1956 was 6,400,143 acres from which 6,263,852 acres of crop were harvested.

Crop harvests in 1956 were valued at $951.6 million, a greater value than ever before reported from Reclamation projects. This represented an average value of $148.69 per irrigated acre. Most crop prices were higher than in 1955 and the general rise in prices received for farm products added $78.3 million to the crop value.

Crop yields were also generally higher, carrying total production to new records. The long term upward trend in crop yields was continued and has resulted in the following improvements since 1940: Corn, 100 percent; onions, 53 percent; cotton, 50 percent; barley, 43 percent; and potatoes, 36 percent.

Forage crops were produced on 46.9 percent of the net area irrigated on all Reclamation projects, and 24.3 percent of the irrigated lands were utilized in producing cereals. The crops within these two groups, totaling more than 15.4 million tons, are utilized principally as livestock feeds, generally in the local areas of production.

Over 5.9 million tons of fresh vegetables, fruits, and nuts were produced from 739,782 acres of irrigated lands in 1956, and dry miscellaneous food crops such as dry beans, sugar beets, mint, hops, etc., totaling over 6.5 million tons were produced from almost 666,000 acres.

Following the pattern of the past, cotton was the most highly valued crop harvest, followed by alfalfa, potatoes, and sugar beets. These crops, along with grapes, wheat, lettuce, apples, and pasture, constituted 60 percent of the total value of the Reclamation harvest in 1956. Data on crop production by crop groups follow:

Crop group	Irrigated crops		Gross crop value	
	Acres	Percent of total	Dollars	Percent of total
Cereals	1, 560, 894	24. 39	103, 740, 325	10. 90
Forage	3, 001, 023	46. 89	180, 814, 785	19. 00
Field crops, miscellaneous	1, 115, 178	17. 42	265, 202, 730	27. 87
Seeds	278, 198	4. 35	30, 748, 600	3. 23
Vegetables	466, 518	7. 29	179, 160, 636	18. 83
Fruits and nuts and miscellaneous	295, 819	4. 62	165, 831, 115	17. 42
Other [1]			26, 125, 465	2. 75
Total reported	6, 717, 630	104. 96	951, 623, 656	100. 00
Less: Multiple cropped	453, 778	7. 09		
Plus: Soil-building crops	14, 623	. 23		
Cropland not harvested	121, 668	1. 90		
Total	6, 400, 143	100. 00	951, 623, 656	100. 00

[1] Additional revenues from Federal and commercial agencies.

A dollarwise evaluation fails to fully appraise the importance to the Nation's health and welfare of the $336 million worth of fresh fruits, vegetables, and nuts grown under Federal irrigation in 1956. These protective and body-building foods and the products were made available by irrigation of our many acres of special climate and soil resources in the West, the duplication of which would be practically impossible elsewhere in the country.

More than 2.5 million persons received irrigation, municipal, and industrial water service through project facilities in 1956. Half a million of these people live on the 134,000 farms which the projects serve. A growing rate of urbanization of farmlands is thought to be revealed in the 1956 data.

The Reclamation sugar beet crop provides 22 percent of the Nation's sugar supply. Irrigation of the sugar beets on Federal projects sets the pace for yields throughout the country. In 1956 Bureau projects produced some 2 billion pounds of sugar. Irrigation thus plays a highly strategic role in national security by its contribution of this important food crop.

The 77 Reclamation irrigation projects, located throughout the 17 Western States, are divided into 7 regions for administrative purposes. States located mainly within each region are as follows: Region 1—Washington, Oregon, Idaho, and Western Montana; Region 2—California, except southern portion; Region 3—Arizona, Southern California, and Southern Nevada; Region 4—Nevada, Utah, Western Colorado, and Southwestern Wyoming; Region 5—Texas, New Mexico, Oklahoma, and Southern Kansas; Region 6—Eastern Montana, North Dakota, South Dakota, and Northern Wyoming; Region 7—Eastern Colorado, Nebraska, Northern Kansas, and Southeastern Wyoming.

Region 1, with 2,265,209 acres of irrigated lands, the largest in area irrigated of the seven Bureau Regions, produced crops valued at $269 million. This Region contains 35 percent of the irrigated lands and accounted for 28 percent of the total value of crops produced on all Reclamation projects in 1956. Region 3, with less than half as much irrigated land as Region 1, produced crops valued at $233 million, or 24 percent of the total production from all Federal projects during the same year.

Each of the 17 Western States participated in the Reclamation harvest for 1956. Idaho had a larger acreage of irrigated project lands than any of the other States, followed by California, Colorado, Washington, Oregon, Arizona, Nebraska, Utah, and Montana. The gross value of crops produced on Federal projects located in California was higher than for the other Western States; however, the average gross crop value per acre was highest for Arizona, followed by Texas, California, Washington, New Mexico, Oklahoma, etc., respectively. Irrigated acreage and crop value data are presented for each State as follows:

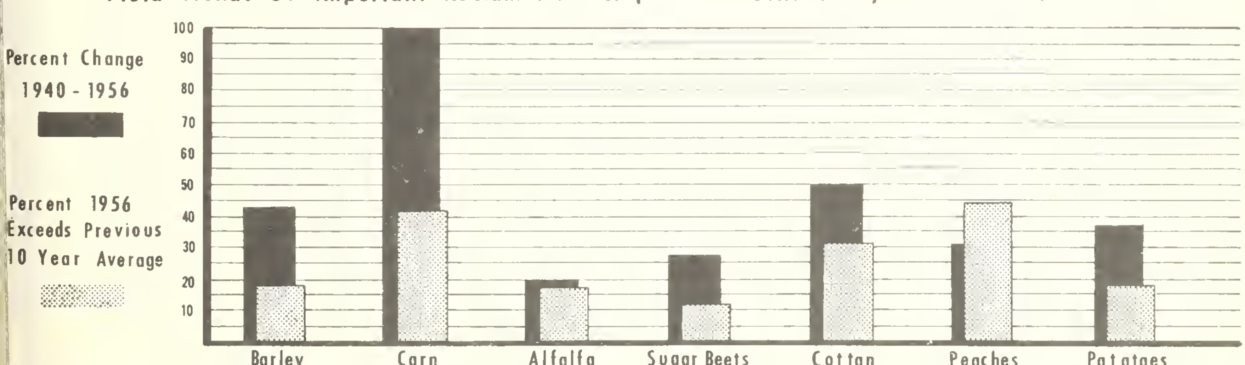
State	Projects or major divisions	Irrigated acreage	Gross crop value	
			Average per acre	Total
	Number	*Acres*	*Dollars*	*Dollars*
Arizona	4	361, 634	298. 55	107, 967, 149
California	6	1, 334, 201	254. 89	340, 072, 542
Colorado	9	790, 845	102. 22	89, 840, 639
Idaho	8	1, 387, 448	89. 40	124, 041, 675
Kansas	1	5, 347	75. 71	404, 812
Montana	11	252, 010	49. 72	12, 529, 580
Nebraska	4	290, 969	98. 47	28, 651, 418
Nevada	3	107, 004	60. 72	6, 497, 442
New Mexico	6	198, 629	174. 18	34, 596, 253
North Dakota	5	26, 939	62. 90	1, 694, 430
Oklahoma	1	39, 296	126. 41	4, 967, 207
Oregon	13	407, 658	112. 51	45, 865, 829
South Dakota	3	71, 915	46. 12	3, 316, 977
Texas	2	63, 125	273. 08	17, 238, 242
Utah	9	272, 295	73. 88	20, 117, 232
Washington	3	569, 614	192. 82	109, 831, 715
Wyoming	5	221, 214	58. 72	12, 990, 424
Total	93	6, 400, 143	148. 69	951, 623, 656

The cumulative value of all Reclamation harvests has reached $12.3 billion. This cumulative value appears to be growing at the rate of 50 percent each 5 years with an indicated tendency toward an even greater rate of growth.

Continuing the watchful appraisal of the Nation's decreasing margin of agricultural potential it appears that current agricultural imbalances will soon disappear in the advance of population growth. Irrigable land loss is occurring at the rate of 1 million acres per year and population is growing at the rate of 3 million a year. The role that the reclamation of arid lands contributes to cushion the inevitable effect of these converging forces should be increased before the time of ultimate need. The country need not follow in history the countless procession of broken nations which, once wealthy and opulent, failed to heed the counsel of those who advised action before the crisis appeared.

# # #

Yield Trends Of Important Reclamation Crops Have Consistently Increased Since 1940



SHOWERS FOR YOUR HOGS MAY SAVE YOU MONEY

Showers for hogs on their way to market may be good for your bankroll as well as for the animals, Agricultural Marketing Service says. Tests are still underway.

Agricultural Marketing Service transportation specialists testing a new built-in shower for trailer-trucks used in transporting hogs to market found that hogs hauled in these trucks maintained their weight much better in hot weather. And none in the sprinkled trucks died, while six died in the unsprinkled trucks.

Under present conditions, hog weights are apt to shrink as much as 4 percent en route to market. In a normal truckload of 22,000 pounds, this can mean from 700 to 800 pounds of meat lost—and money was spent putting those pounds on the animals.

In addition, more than $4 million worth of hogs arrive dead at United States market every year under today's conditions.

In a series of 16 tests with the new and inexpensive device, this is what AMS found:

Two trailers were used in each test in a 330-mile run which lasted over 11 hours. Each trailer had an average load of 110 hogs. In one trailer, there was no change from current conditions. In the other, the driver used the device to give his hogs a 21-minute shower immediately before departure. In addition, he made four 10-minute stops en route and showered the animals at each stop.

It wasn't difficult. The driver simply used a galvanized pipe and a water faucet. A fine mist spray then refreshed the hogs without ruining the sawdust which had been used as litter.

At each stop, the sprinkled hogs appeared more comfortable. They were quieter. They reclined more and foamed less at the mouth.

The spray had a direct cooling effect on the animals. The water moistened the sawdust, and the hogs cooled themselves by lying down on the bedding. The air inside the sprinkled trailers averaged 3.4° F. cooler than the air inside the unsprinkled trailers.

On this series of trips 6 dead hogs were found in the unsprinkled trailers. All the hogs in the sprinkled trailers were alive.

The average weight loss per trip in the unsprinkled trailers was 724 pounds, or 3.3 percent. The sprinkled hogs lost, on the average, only 498 pounds, 2.27 percent.

Finally, sprinkled hogs yielded a higher slaughtered "hot weight," averaging nearly half a pound per animal. In the average trailer load, this made a difference of 103 pounds which would otherwise have been lost. # # #

Water Stored in Western Reservoirs

Operated by Bureau of Reclamation or Water Users except as noted

Location	Project	Reservoir	Storage (in acre-feet)		
			Active capacity	Aug. 31, 1956	Aug. 31, 1957
Region 1	Baker	Thief Valley	17,400	(1)	(1)
	Bitter Root	Lake Como	34,800	8,300	6,700
	Boise	Anderson Ranch	423,200	375,100	312,900
		Arrowrock	286,600	29,200	22,700
		Cascade	654,100	356,600	458,500
		Deadwood	161,900	129,000	121,800
		Lake Lowell	169,000	37,400	18,800
	Burnt River	Unity	25,200	7,900	5,000
	Columbia Basin	F. D. Roosevelt	5,220,000	5,221,000	4,914,000
		Equalizing	761,800	764,500 N	649,600
		Potholes	513,000	174,800 N	146,200
	Deschutes	Crane Prairie	55,300	32,000 N	(1)
		Wickiup	187,300	115,000 N	69,000
	Hungry Horse	Hungry Horse	2,982,000	3,011,100 N	(1)
	Minidoka	American Falls	1,700,000	867,200 N	553,500
		Grassy Lake	15,200	14,000 N	11,900
		Island Park	127,200	83,500 N	65,400
		Jackson Lake	847,000	527,300 N	663,400
		Lake Walcott	80,000	94,000 N	95,400
	Ochoco	Ochoco	47,500	27,900 N	20,500
	Okanogan	Conconully	13,000	8,500 N	6,300
		Salmon Lake	10,500	10,400 N	(1)
	Owyhee	Owyhee	715,000	468,300 N	484,500
	Umatilla	Cold Springs	50,000	11,100 N	6,400
		McKay	73,800	20,300 N	15,000
	Vale	Agency Valley	60,000	21,000 N	15,200
		Warm Springs	191,000	104,900 N	97,300

Water Stored in Western Reservoirs—Continued

Location	Project	Reservoir	Storage (in acre-feet)		
			Active capacity	Aug. 31, 1956	Aug. 31, 1957
Region 1—Continued	Yakima	Bumping Lake	33, 700	17, 400	14, 800
		Cle Elum	436, 900	309, 100	153, 200
		Kachess	239, 000	186, 900	131, 900
		Keechelus	157, 800	76, 600	35, 400
		Tieton	198, 000	148, 500	71, 900
Region 2	Cachuma	Cachuma Reservoir	201, 800	37, 700	34, 200
	Central Valley	Folsom	920, 300	560, 300	580, 900
		Keswick	20, 000	19, 200	19, 300
		Lake Natoma	8, 800	7, 700	8, 100
		Millerton Lake	427, 800	198, 500	153, 300
		Shasta	3, 998, 000	3, 322, 900	3, 167, 200
		Vermillion	125, 100	(1)	(1)
	Klamath	Clear Lake	172, 300	365, 200	299, 100
		Gerber	94, 300	52, 500	52, 300
		Upper Klamath Lake	524, 800	380, 300	268, 100
	Orland	East Park	47, 900	22, 400	15, 500
		Stony Gorge	50, 000	22, 600	21, 700
Region 3	Boulder Canyon	Lake Mead	27, 207, 000	13, 266, 000	21, 498, 000
	Davis Dam	Lake Mohave	1, 809, 800	1, 314, 000	1, 387, 400
	Parker Dam Power	Havasu Lake	688, 000	651, 000	634, 600
	Salt River	Bartlett	179, 500	6, 000	66, 000
		Horse Mesa	245, 100	204, 000	216, 000
		Horseshoe	142, 800	4, 000	7, 000
		Mormon Flat	57, 900	53, 000	46, 000
		Roosevelt	1, 381, 600	7, 000	30, 000
		Stewart Mountain	69, 800	33, 000	55, 000
Region 4	Eden	Big Sandy	35, 000	11, 000	30, 600
	Fruitgrowers	Fruitgrowers	4, 500	500	2, 100
	Humboldt	Rye Patch	179, 000	43, 400	62, 900
	Hyrum	Hyrum	15, 300	5, 300	5, 500
	Mancos	Jackson Gulch	9, 800	1, 800	9, 400
	Moon Lake	Midview	5, 800	3, 600	4, 400
		Moon Lake	35, 800	4, 700	21, 100
	Newlands	Lahontan	290, 900	208, 200	159, 400
		Lake Tahoe	732, 000	676, 800	632, 400
	Newton	Newton	5, 300	100	600
	Ogden River	Pineview	44, 200	13, 500	28, 200
	Pine River	Vallecito	126, 300	46, 100	107, 900
	Provo River	Deer Creek	149, 700	103, 600	118, 100
	Scofield	Scofield	65, 800	8, 500	41, 700
	Strawberry Valley	Strawberry Valley	270, 000	137, 600	156, 000
	Truckee Storage	Boca	40, 900	21, 100	4, 600
	Uncompahgre	Taylor Park	106, 200	62, 500	108, 000
	Weber River	Echo	73, 900	16, 700	29, 300
Region 5	W. C. Austin	Altus	166, 300	22, 700	104, 000
	Balmorhea	Lower Parks	6, 500	300	1, 900
	Carlsbad	Alamogordo	131, 900	2, 200	60, 600
		Avalon	6, 000	1, 300	(1)
		McMillan	38, 700	16, 000	(1)
	Colorado River	Marshall Ford	1, 835, 300	550, 800	703, 500
	Rio Grande	Caballo	340, 900	5, 700	22, 300
		Elephant Butte	2, 185, 400	39, 000	516, 500
	San Luis Valley	Platoro	60, 000	3, 500	49, 500
	Tucumcari	Conchas [2]	465, 100	87, 400	75, 800
Region 6	Missouri River Basin	Angostura	92, 000	37, 000	69, 400
		Boysen	710, 000	525, 300	543, 000
		Canyon Ferry	1, 615, 000	1, 417, 600	1, 375, 800
		Dickinson	13, 500	3, 700	5, 000
		Fort Randall [2]	3, 900, 000	1, 506, 800	1, 830, 400
		Heart Butte	218, 700	57, 600	65, 700
		Keyhole	270, 000	12, 100	1, 700
		Shadehill	300, 000	80, 700	82, 500
	Belle Fourche	Belle Fourche	185, 200	15, 400	37, 600
	Fort Peck	Fort Peck [2]	14, 877, 000	1, 856, 300	2, 840, 200
	Milk River	Fresno	127, 200	82, 000	65, 700
		Nelson	68, 800	39, 900	49, 800
		Sherburne Lakes	66, 100	40, 200	17, 200
	Rapid Valley	Deerfield	15, 100	8, 300	10, 200
	Riverton	Bull Lake	155, 000	124, 400	137, 100
		Pilot Butte	31, 600	12, 000	11, 000
	Shoshone	Buffalo Bill	380, 300	326, 500	322, 300
	Sun River	Gibson	105, 000	46, 000	31, 400
		Pishkun	30, 100	17, 300	7, 700
		Willow Creek	32, 400	23, 800	18, 200
Region 7	Colorado-Big Thompson	Carter Lake	109, 100	19, 100	77, 400
		Granby	465, 600	192, 400	395, 300
		Green Mountain	146, 900	134, 300	146, 300
		Horsetooth	141, 800	39, 200	94, 200
		Shadow Mountain	1, 800	1, 100	1, 300
	Missouri River Basin	Bonny	39, 900	37, 400	40, 300
		Cedar Bluff	176, 800	77, 600	198, 100
		Enders	36, 000	29, 500	30, 500
		Harry Strunk Lake	33, 900	18, 400	34, 100
		Swanson Lake	116, 100	65, 300	111, 700
	Kendrick	Alcova	30, 300	20, 600	27, 500
		Seminoe	993, 200	374, 800	977, 400
	Mirage Flats	Box Butte	30, 400	5, 300	13, 200
	North Platte	Guernsey	44, 200	21, 800	26, 800
		Lake Alice	11, 400	3, 800	3, 400
		Lake Minatare	57, 800	6, 500	31, 200
		Pathfinder	1, 010, 900	33, 600	224, 300

[1] Not reported.
[2] Corps of Engineers Reservoir.

(Continued from page 83)

years. The sheer threat of inadequate water—that is, the mere uncertainty connected with lack of irrigation—undoubtedly has held planting and fertility practices below optimum levels. Several observers report that installation of irrigation equipment usually should be accompanied by a 50 to 100 percent boost in fertilizer application in order to utilize soil potentialities most fully. "For best results, fertility, water, and plants per acre should all be high."

In view of the results obtained through irrigation, it may seem surprising that the practice is not already more widespread in the Midwest. Undoubtedly part of the explanation is provided by the cost of the necessary equipment. Pump, pipe, and sprinklers cost from $40 to $80 per acre irrigated, depending on the location of the water supply, the layout of the fields and the farmer's taste in machinery.

The cost of obtaining the water supply is even more variable. Irrigation requires a lot of water; almost 30,000 gallons are needed to cover 1 acre with 1 inch of water. Sprinkler systems in this region vary considerably in capacity, squirting

ROBERT BROWN adjusting sprinkler head on his system.

from 200 up to 1,500 gallons per minute. At the rate of 500 per minute it takes about 1 hour actual sprinkling time to cover an acre with an inch of water.

Sometimes the water is secured from streams that flow throughout the year, and sometimes small reservoirs are constructed to impound surface runoff in rainy seasons. Frequently shallow wells or sump holes are dug near creeks to utilize both surface runoff and underground water. Where the flow from these holes is small, the water is pumped into reservoirs over a period of time with the supply being drawn down when irrigation is necessary. Other systems rely exclusively on underground water, although some of them also utilize small reservoirs for storage.

Six-inch aluminum pipe in 20-foot lengths is used for sprinkler line. Two men move one-half mile of pipe from one setup to another in approximately 50 minutes, moving two joints at a time.

Most of the Seventh District is underlaid by water-bearing strata yielding more than 50 gallons per minute to individual wells of suitable depth and dimensions. Moreover, the ground water level is close to the surface in the Midwest compared with the West where deep wells are also used to some extent to provide irrigation water. Some Midwest farms have underground supplies capable of yielding more than 800 gallons per minute from a single well. It is the judgment of authorities that irrigation as currently practiced in the Midwest is feasible for a high percentage of farms in this region.

If the required water can be secured from a stream, pond, or shallow well, the cost of securing the supply may be relatively low. However, the costs mounts rapidly if a deep well with a wide bore, sometimes up to 3 feet in diameter and several hundred feet deep, is required. A deep well may cost $5,000 or more. It behooves a farmer to seek technical advice before having such a hole drilled; its particular location can make a lot of difference in the cost. Also, the water laws should be investigated before a large investment is made in an irrigation system. Although these laws are quite indefinite in most Midwest States, in general they prohibit one user from interfering with normal uses of other users.

Complete sprinkler systems—water supply plus distributing equipment—require an investment of from $40 to $200 per acre, with the average around $90 in the Midwest, according to a company which fabricates and installs the equipment.

Various authorities are pretty well agreed on the annual cost of operating sprinkler system. Iowa State College places the figure between $20 and $30 per acre. A company that sells the apparatus estimates average annual cost per acre for a typical installation in this region as follows:

Interest cost	$4.50
Insurance and taxes	.45
Depreciation	6.00
Electric energy for power	4.00
Labor	8.00
Maintenance	3.00
Total annual cost per acre	$25.95

Although such an addition to production costs is sizable indeed, the profitability of installing a system must be appraised in view of the additional output and revenue that can be obtained through use of the practice. Assuming that over a number of years corn yields can be boosted an average of 40 bushels per acre (using the figure reported in the Iowa test results) and further assuming that the corn can be sold for an average price of $1 per bushel, the additional revenue produced by the innovation would amount to $40 per acre, $24 in excess of the added cost. Under these circumstances, the investment would pay for itself in 4 years. This probably explains why the use of irrigation is expanding rapidly in the Midwest despite the large investment and high annual operating cost associated with it.

Man's never-ending quest to control and improve his environment has led to a continual succession of technological advances in methods of agricultural production. Successful innovations involve the altering of methods of production in such a way that the average cost of production is reduced. Income is improved for at least those farmers who adopt the usage reasonably early in the process. As the process comes into general use and the price of the product declines, the benefits tend to accrue to consumers and the whole economy shares in the gains.

Sprinkler irrigation is one of the more spectacular innovations that have been added recently to the tool kit of farming practices in this region. However, the economic effects of a widespread adoption of irrigation probably would be similar to those following most other improvements in farm technology.

The size of the individual farm business would be expanded, although in this case not necessarily the acreage. Capital investment per acre (and labor too) would be increased, and farm production would depend to an even greater extent on purchases of nonagricultural materials and services. The organization and operation of a farm business would become even more complex and difficult, and the premium on good management would be widened even further.

Because of the larger investment required to obtain an efficient farm business, fewer people who desired to obtain such a unit would be able to do so out of their own funds. Consequently, the demand for farm credit probably would expand further. Additional operating credit might also be needed to finance the higher annual outlays associated with use of the equipment.

Part of the uncertainty associated with vagaries of weather would be eliminated and total farm production would be boosted. The larger supply would tend to depress prices, but the average cost of producing a bushel of corn would be reduced for those farms which irrigated successfully. For tracts on which cost dropped more than price, land values would tend to rise especially if permanent installations like wells and reservoirs were incorporated into the real estate. Level land with easily accessible water supplies might rise in value prior to the installation of irrigation facilities, merely in anticipation of their future use.

For the most part, these economic effects would be extensions of current trends. However, if irrigation is widely practiced in this region—and the usage is spreading rapidly at this time—those trends may be significantly accelerated. # # #

ANDREW CARLSON checks pressure reading on sprinkler lateral irrigating alfalfa.

C. H. SPENCER SUCCEEDED BY B. P. BELLPORT

Reclamation Commissioner W. A. Dexheimer recently announced the retirement of Regional Director Clyde H. Spencer, with headquarters at Sacramento, Calif. At the same time, he announced the appointment of Bernard P. Bellport as his successor. Mr. Bellport, at the time of his appointment, was construction engineer on the Solano Project in California.

Commissioner Dexheimer acceded to Mr. Spencer's request for retirement after 38 years of continuous service with the Bureau of Reclamation. It became effective September 15.

"We are reluctant to see Mr. Spencer leave the Bureau of Reclamation," Commissioner Dexheimer said. "He has made an outstanding contribution to Reclamation, not only in a long career as a construction engineer but during 4 years of administrative service as the Director of Region 2. However, Mr. Bellport has had 21 years of service with the Bureau and is well qualified to succeed to this important position."

Region 2 comprises the Central Valley of California and coastal drainage basins extending as far north as the Klamath Project on the California-Oregon border.

Mr. Bellport, a 50-year-old native of La Crosse, Kans., is a graduate of the Colorado School of Mines and has been with the Bureau of Reclamation since 1936. His entire Bureau career has been devoted to work on the Central Valley Project until 1952, when he became construction engineer in charge of the Solano Project, which is also located in the Central Valley. He was construction engineer for the Delta-Mendota Canal and the Tracy Pumping Plant of the Central Valley Project immediately prior to the Solano Project assignment. He received a superior accomplishment award in 1951 for his work on the Central Valley Project.

Virtually Mr. Spencer's entire career up to his appointment as Regional Director, in 1953, was devoted to construction projects. He was construction engineer for the Hungry Horse Dam on the South Fork of the Flathead River in Montana, from 1947 to 1953. Under his supervision, this third highest and fourth largest concrete dam in the United States was finished well ahead of schedule and well under the cost estimates. Mr. Spencer and his staff were accorded a unit citation for their work on this project. Mr. Spencer has also received the Department of the Interior's Distinguished Service Award.

Mr. Spencer had previously been on Bureau of Reclamation construction jobs in Utah, Idaho, Oregon, and Colorado. # # #

SIXTEEN FARM UNITS ON WELLTON-MOHAWK DIVISION, GILA PROJECT, TO BE SOLD BY RECLAMATION

Sixteen full-time farm units totaling 2,903 acres will be sold by the Bureau of Reclamation on the Wellton-Mohawk Division, Gila Project, Arizona, Secretary of the Interior Fred A. Seaton recently announced.

Veterans will have preference in applying for all units not allotted to exchange applicants under the act of August 13, 1953. Applicants should apply to the Bureau of Reclamation office at Yuma, Ariz. The filing period for receiving applications closes at 2 p. m. (MST) November 27, 1957.

Commissioner of Reclamation W. A. Dexheimer said that the farm units to be sold are in the fertile Gila Valley, ranging from 28 to 60 miles east of Yuma, Ariz. Irrigation water to serve the land is diverted from the Colorado River at Imperial Dam, northeast of Yuma, and flows through the Gila Gravity Main Canal before entering the Wellton-Mohawk Canal System.

The farms range in size from 115 to 163 irrigable acres and will be sold at prices varying from $496 to $787 per farm, depending on improvements, size of unit, and the classes of land contained therein.

To be eligible for the purchase of a farm unit, applicants must have had 2 full years of farm experience after the age of 15, or have educational or vocational experience which can be substituted for a maximum of one of the years of farm experience, and must meet certain other qualifications of character and industry. Applicants also must possess $5,000 in excess of liabilities. This capital requirement may be in cash or other assets available for development of the farm unit.

Exchange applicants are exempt from these requirements.

An examining board comprised of local agriculturists will review the qualifications of applicants according to the priority established in a drawing to be held shortly after the close of the simultaneous filing period. The farms then will be offered for sale to the qualified applicant in the order of their priority.

Veterans who are given preference in applying for farm units must have served for a period of at least 90 days in the Armed Forces since September 16, 1940, and must have been honorably discharged.

# # #

BOOKS

ROADS, RAILS, AND WATERWAYS

by Forest G. Hill

The United States emerged from the War of 1812 with half a continent to conquer and half a century of peace in which to do it. The only thing that stood in the way was a lack of transportation facilities, and this deficiency could only be corrected by a combination of labor, capital, and the one service no private source could provide—engineering skill. Private industry could supply the first two factors, but the critical skill came from the Engineer Department of the Federal Government.

As part of the War Department, the Engineer Department—including the Corps of Engineers, the Topographical Engineers, and West Point—served as the Nation's department of public works and its chief technical agency. It explored the West, surveyed for roads, canals, and railroads, lighthouses, and other public works, and made the United States Military Academy the Nation's first, and for several decades its leading, engineering school.

These Army engineers, who for decades had a near monopoly of this technical skill and who played such an effective role in promoting the westward movement, have been generally ignored by historians up to the present. Forest G. Hill presents in this book a full picture of their many, varied, and crucial activities between 1815 and the Civil War. It will interest students of economic history, military history, and the history of transportation and the westward movement, as well as the general reader.

University of Oklahoma Press, Norman, Okla.

WATER TREATY VOLUME AVAILABLE

A book entitled "DOCUMENTS on the USE and CONTROL of the WATERS of Interstate and International Streams: COMPACTS, TREATIES, and ADJUDICATIONS," has been published by the Government Printing Office.

This volume, edited by T. Richard Witmer, Office of the Solicitor, Department of the Interior, is the first complete collection of such Compacts, including decisions of the Supreme Court in the field of interstate and international water rights ever published.

Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $2.

LETTERS

HUMID STATES FARMERS

Dear Sirs: I have just read with much interest the May 1957 issue of "The Reclamation Era" and particularly the article by Mr. W. J. Liddell, Vice President, Dixie Irrigation Co., Memphis, Tenn., entitled "Humid States Farmers Discover Irrigation."

If entirely agreeable with you and Mr. Liddell, to whom I am furnishing copy of this letter, I would like the privilege of reproducing this article in our Atlantic Coast Line Agricultural and Livestock Topics, which is a monthly paper mailed without charge.

Your early advice will be very much appreciated.

Yours very truly,

/s/ A. R. Howard,
General Agricultural and Livestock Agent, Atlantic Coast Line Railroad Co., Wilmington, N. C.

Reprint permission was gladly granted. —Ed.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-4898	Collbran, Colo	July 12	Construction of Vega Dam and relocation of county road	C. F. Lytle Co., Sioux City, Iowa.	$1,707,145
DC-4901	Weber Basin, Utah	do	Construction of Willard dike, levee, and access road, Schedule 1	Jack B. Parson Construction Co., Smithfield, Utah.	349,400
DC-4910	Grants Pass, Oreg	Sept. 10	Construction of fish screen structure for Savage Rapids Dam	Peter Kiewit Sons' Co., Medford, Oreg.	126,452
DC-4912	Colorado River Storage, Arizona-Utah.	Aug. 8	Construction of sewage treatment plant for Page, Ariz	W. W. Clyde & Co., Springville, Utah.	221,445
DC-4918	Ventura River, Calif	Aug. 20	10 horizontal, centrifugal-type pumping units for Ventura Avenue pumping plants Nos. 1 and 2 and Ojai Valley pumping plant, Schedule 1.	Food Machinery & Chemical Corp., Peerless Pump Division, Indianapolis, Ind.	212,206
DC-4922	Middle Rio Grande, N. Mex.	July 31	Construction of earthwork, clearing, and structures for irrigation rehabilitation, Belen Unit 3.	Badger Lynch, Albuquerque, N. Mex.	142,283
DC-4924	Colorado River Storage, Arizona-Utah.	Aug. 22	Construction of field laboratory building, municipal building, and warehouse for Page, Ariz.	Security Construction Co., Salt Lake City, Utah.	358,709
DC-4927	Weber Basin, Utah	Aug. 16	Construction of earthwork, pipelines, and structures for trunkline 10.0 (West Farmington) and trunkline 18.8 (Woods Cross), Davis aqueduct.	Thayn Construction Co., Salt Lake City, Utah.	585,273
DC-4928	Columbia Basin, Wash.	Sept. 16	Enlargement of Potholes East canal, Sta. 299+40 to 376+32, Schedule 3.	Peter Kiewit Sons' Co., Vancouver, Wash.	209,755
DC-4928	do	Sept. 18	Enlargement of Potholes East canal, Sta. 770+00 to 1157+02, Schedule 6.	Arthur R. Sime, Kennewick, Wash.	302,967
DC-4932	Middle Rio Grande, N. Mex.	Aug. 20	Construction of earthwork, clearing, and structures for irrigation rehabilitation, Belen Unit 4.	Boswell Construction Co., Albuquerque, N. Mex.	167,955
DC-4933	Colorado River Storage, Arizona-Utah.	Sept. 10	Construction of water-supply system for Page, Ariz	Southern Engineering & Construction Co., Inc., Long Beach, Calif.	1,054,694
DC-4934	Missouri River Basin, Nebr.	Aug. 22	Construction of earthwork and structures for Driftwood canal, Sta. 812+17 to 1563+15; Driftwood subcanal, Sta. 0+00 to 293+78; Driftwood subcanal lateral system and drains.	Bushman Construction Co., St. Joseph, Mo.	1,374,034
DC-4936	Shoshone, Wyo	Sept. 6	Construction of left abutment outlet works and rehabilitation of penstock intakes for Buffalo Bill Dam.	Long Construction Co., Inc., Billings, Mont.	680,460
DC-4937	Ventura River, Calif	Sept. 11	Construction of Robles diversion dam and Robles-Casitas diversion canal, utilizing precast-concrete pipe in 78-inch diameter siphon, Schedule 2.	M. H. Hasler Construction Co. and F. W. Case Corp., Los Angeles, Calif.	1,531,599
DC-4938	Missouri River Basin, Mont.	Sept. 18	Construction of earthwork and structures for Helena Valley canal, Sta. 626+63.52 to 1842+69.05.	Cherf Bros., Inc., and Sandkay Contractors, Inc., Ephrata, Wash.	947,885
DC-4943	Columbia Basin, Wash.	Sept. 27	Construction of earthwork, concrete canal lining, and structures for Wahluke Branch canal, Sta. 171+13.4 AH to 333+20.	Thompson Construction Co. and George W. Lewis, Kennewick, Wash.	613,028
DC-4944	Middle Rio Grande, N. Mex.	Aug. 29	Rehabilitation of Angostura diversion works	Crocker Construction Co., Denver, Colo.	125,704
DC-4949	do	Sept. 20	Construction of earthwork, clearing, and structures for irrigation rehabilitation, Belen Unit 5.	C. R. Davis Contracting Co., Albuquerque, N. Mex.	213,464
DC-4955	Central Valley, Calif	Aug. 30	Furnishing and installing armature winding for generator unit No. 5 at Shasta powerplant.	General Electric Co., Denver, Colo.	220,000
100C-299	Minidoka, Idaho	July 24	Completion work for 57 wells, Groups 5, 6, and 7	Electric Pump & Equipment Co., Inc., Twin Falls, Idaho.	193,880
117C-430	Columbia Basin, Wash.	July 9	Construction of two 3-bedroom residences, one 2-car garage, pumphouse, storehouse, shop and office for Burke Watermaster headquarters and Block 77, Schedules 3 and 4.	Pete Winter, Builder, Ephrata, Wash.	116,949
117C-437	do	July 12	Construction of deep drains DE49 and tributaries, Block 43	Utility Construction Co., Ontario, Oreg.	112,340
117C-454	do	Sept. 5	Construction of earthwork, concrete lining, and structures for Block 401 laterals and wasteways, East Low canal laterals.	Duncan Construction Co., Moses Lake, Wash.	139,858
400S-86	Colorado River Storage, Arizona-Utah.	July 17	Liquefied petroleum (propane) gas service, including furnishing and installing storage tanks and piping, for Page, Ariz.	Petrolane Gas Service, Inc., Long Beach, Calif.	155,725

Construction and Materials for Which Bids Will Be Requested Through December 1957*

Project	Description of work or material
Central Valley, Calif.	Constructing about 12.5 miles of 12- to 45-inch concrete pipelines, 2 pumping plants and appurtenant structures, for the Southern San Joaquin Municipal Utility District, Unit 1 Extensions, near Delano.
Colorado River Storage, New Mexico.	Furnishing and erecting a prefabricated metal building for use as a garage, fire station and warehouse, at the Navajo Dam Government Community, about 39 miles east of Farmington.
Colorado River Storage, Utah.	Constructing a 105- by 36-foot wood-frame administration building, a 54- by 39-foot wood-frame laboratory, a 100- by 30-foot concrete masonry garage and fire station, and a 60- by 24-foot wood-frame conference hall, at the Flaming Gorge Community, about 16 miles southeast of Linwood.
Do	Constructing a water supply system for the Flaming Gorge Community.
Columbia Basin, Wash.	Constructing 6,100 feet of open ditch drains and wasteways, modifying structures, and deepening 2,600 feet of W38 wasteway, in Block 72, southeast of Quincy.
Columbia Basin, Wash.	Earthwork and structures for a 5,300-cfs-capacity, 8-foot bottom width, concrete-lined canal, about 10 miles long, including a radial gate diversion structure, a timber bridge and a 2,000-foot-long rectangular concrete terminal chute into the Columbia River. Esquatzel Diversion Channel, near Pasco.
Do	Earthwork and structures for about 3,000 feet of 2-foot bottom width wasteway channel, in Blocks 41 and 42, near Moses Lake.
Do	Furnishing and sowing about 350 acres of lateral and wasteway banks in Block 18, west of Connell, and Block 85, northeast of Beverly.
Do	Earthwork and structures for deepening 3.9 miles of open ditch drains, including road and lateral crossings, and removing and/or salvaging concrete and metal pipe, in Block 78, south of Quincy, and earthwork and structures for deepening 6.5 miles of open ditch drains in Blocks 41 and 42, near Moses Lake.

*Subject to change.

Construction and Materials for Which Bids Will Be requested Through December 1957*—Continued

Project	Description of work or material
Columbia Basin, Wash.—Con.	Two motor-driven, horizontal, centrifugal-type pumping units, each with a capacity of 20 cfs at a total head of 102 feet for the initial installation at White Bluff Pumping Plant No. 2.
Fort Peck, Mont., and MRBP, North Dakota.	Clearing rights-of-way, furnishing and installing fence gates, constructing footings, and furnishing and erecting steel towers for about 309 miles of single-circuit, 230-kv transmission line from Fort Peck Power plant, near Fort Peck, through the Dawson County Substation, near Glendive, Mont., to the substation at Bismarck, N. Dak.
Gila, Ariz.	Removing and replacing damaged concrete canal lining and constructing an 80-foot-wide reinforced concrete overchute, 180 feet long, across the Wellton-Mohawk Canal, near Yuma.
Middle Rio Grande, N. Mex.	Constructing about 2.5 miles of 250-cfs-capacity canal, including timber bridges, multiplate arch culvert, drainage inlet and concrete drop. Atrisco Feeder Canal (North Reach Extension), north of Albuquerque.
Do	Constructing about 11.5 miles of the Atrisco Feeder Canal road, placing gravel blanket on canal banks, and laying corrugated metal pipe for drain and wasteway inlet structures, near Albuquerque.
Minidoka, Idaho	Riprapping dikes northwest of Rupert.
MRBP, Colorado	Reconductoring about 65 miles of the Greeley-Beaver Creek 115-kv woodpole transmission line. Between Greeley and Brush.
Do	Removing a 6,000-kva transformer, three 115-kva lightning arrestors, and six 115-kv fuse disconnecting switches, and constructing concrete footings, minor steel structures and a 12- by 28-foot concrete block addition to the substation building, and installing a 12,000-kva autotransformer, three 115-kv disconnecting switches, and one 115-kv interrupting switch, and carrier relaying equipment, at the Sterling Substation, at Sterling.
Do	One 8,000/10,000-kva, 110–7.2/12.47-kv, 3-phase power transformer for Loveland Substation, near Loveland.
MRBP, Kansas	Earthwork and structures for about 3.2 miles of 12-foot bottom width unlined canal and about 2.8 miles of 12-foot bottom width compacted earth-lined canal, including concrete check, precast concrete pipe siphons and a drainage inlet. Osborne Canal, near Stockton.
MRBP, Montana.	Earthwork and structures for about 15 miles of unlined open ditch laterals with bottom widths varying from 6 to 3 feet. Spokane Bench Laterals, near Helena.
MRBP, Nebraska.	Constructing 3.2 miles of 440- to 250-cfs-capacity open ditch drains with 4 drop structures, and constructing 4.6 miles of 12- to 6-cfs-capacity open ditch laterals including 13 turnouts and 11 siphons. Near Red Cloud.
Do	Constructing 12 steel pipe and concrete pump turnouts, and earthwork and structures for about 0.9 mile of 3-foot bottom width open ditch lateral extension. Meeker, Cambridge, and Bartley Canals, between Trenton and Edison.
MRBP, Nebraska-Kansas.	Constructing 2 wasteway structures, 3 sheet-pile and riprap drops, 2 baffled-apron drops, 8 pump turnouts, 5 corrugated-metal pipe drainage inlets, about 1.4 miles of open ditch drain with bottom widths varying from 74 to 20 feet, and relocating about 0.25 mile of 3-foot bottom width open ditch lateral. Bostwick Division, between Republic City, Nebr., and Scandia, Kans.
MRBP, South Dakota.	Furnishing and stringing three 954,000 CM ACSR conductors and two 0.5-inch high-strength, steel overhead ground wires for the 67-mile-long, steel tower Utica Junction-Sioux Falls 230-kv Transmission Line, and installing 9 switches at the Utica Junction Tap Station. Between Lesterville and Sioux Falls.
Do	One 8,000-kva, 110 to 41.8-kv, 3-phase power transformer, with load-tap-changing to regulate the low voltage output for Summit Substation.
MRBP, Wyoming.	Two 114-inch butterfly valves for the Fremont Canyon Powerplant. Estimated weight: 270,000 pounds
Do	One 14- by 18-foot fixed-wheel gate for the Fremont Canyon Powerplant. Estimated weight: 112,000 pounds.
MRBP, Wyoming—Con.	Six bulkhead gates, seats, guides and lifting frame for draft tubes for the Fremont Canyon Powerplant. Estimated weight. 38,000 pounds.
Palo Verde Diversion, Arizona-Calif.	Constructing one or two 3-bedroom residences including sewage disposal systems, near Palo Verde Diversion Dam, northeast of Blythe.
Riverton, Wyo	Earthwork and structures for 4.9 miles of closed drain on the Wyoming Canal. About 25 miles northwest of Riverton.
Rogue River Basin, Oreg.	One 13,500/18,000-kva, 4.16/69-kv, 3-phase power transformer for the Green Springs Powerplant.
Solano, Calif	Earthwork and structures for about 8.7 miles of the 7-foot bottom width concrete-lined Putah South Canal, including monolithic concrete box siphons, precast concrete pipe siphons, turnouts, checks, culverts and bridges. Near Fairfield.
Ventura River, Calif.	Furnishing and erecting 5 circular steel tank reservoirs or constructing 5 circular prestressed concrete reservoirs ranging from 250,000 to 3,500,000 gallons, near Ventura.
Do	Clearing about 1,900 acres of trees and brush, and removing fences and buildings from the Casitas Reservoir site, near Ventura.
Do	Construction 5 outdoor-type pumping plants including control buildings with concrete masonry unit walls and roofs of metal joists with wood decks and built-up roofing to house the electrical control equipment. Work will include installing electrical control cubicles and the following electrically driven horizontal pumping units at each plant: 4 of 50-cfs total capacity for Ventura Avenue No. 1 Pumping Plant, 3 of 48-cfs total capacity for Ventura Avenue No. 2 Pumping Plant, 3 of 20.7-cfs total capacity for Ojai Valley Pumping Plant, 2 of 8.2-cfs total capacity for Upper Ojai Pumping Plant, and 2 of 6.4-cfs total capacity for Rincon Pumping Plant. North of Ventura.
Wapinitia, Oreg	Constructing the 57-foot-high earthfill Wasco Dam, containing about 50,000 cubic yards of material, with crest length of 370 feet, and appurtenant structures. On Clear Creek, about 35 miles west of Maupin.
Washita Basin, Okla.	Constructing the 101-foot-high Fort Cobb earthfill dam, including spillway and outlet works and constructing about 2,400 feet of access road and improving about 3,200 feet of county road. On Pond Creek, north of Fort Cobb.
Weber Basin, Utah.	Earthwork and structures for about 15 miles of Uintah Bench Laterals of precast concrete pipe, modified prestressed steel cylinder pipe, mortar-lined and coated steel pipe and cast iron pipe or asbestos-cement pipe: 2 small reservoirs; and one pumping plant with 4 outdoor, horizontal booster units. South of Ogden.
Do	Constructing 4 pumping plants consisting of 2 outdoor, sump-type plants of 8- and 13-fcs capacities, an outdoor, flat-slab-type plant of 4-cfs capacity: and an indoor-type plant of 5-cfs capacity. Work will also include constructing about 4 miles of 15- to 36-inch reinforced concrete, pretensioned reinforcement (steel cylinder type) pipe, discharge lines, and trunklines. Sand Ridge, East Layton and Val Verde Pumping Plants, between Salt Lake City and Ogden.
Do	Constructing 6 concrete stream measuring controls on the Ogden River and its tributaries, east of Ogden.
Do	Constructing recreational facilities including access roads, culinary water system, irrigation ditch, boat ramp, fireplaces, shelters, restrooms and landscaping at the Wanship Reservoir area, 38 miles east of Salt Lake City.
Do	Constructing two 6-room brick veneer residences with floor spaces of about 1,180 square feet, full basements and a double garage, at the Gateway Powerplant, southeast of Ogden.
Yakima, Wash	Earthwork and structures for 7,380 feet of 8- and 10-inch asbestos cement pipelines. Work will include jacking 43 linear feet of 30-inch corrugated metal pipe under railroad. West of Kennewick.
Do	Jacking 84 linear feet of 30-inch corrugated metal pipe under railroad, about 10 miles west of Kennewick.

*Subject to change.

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United States Department of the Interior
Fred A. Seaton, Secretary

Bureau of Reclamation, W. A. Dexheimer, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington 25, D. C.

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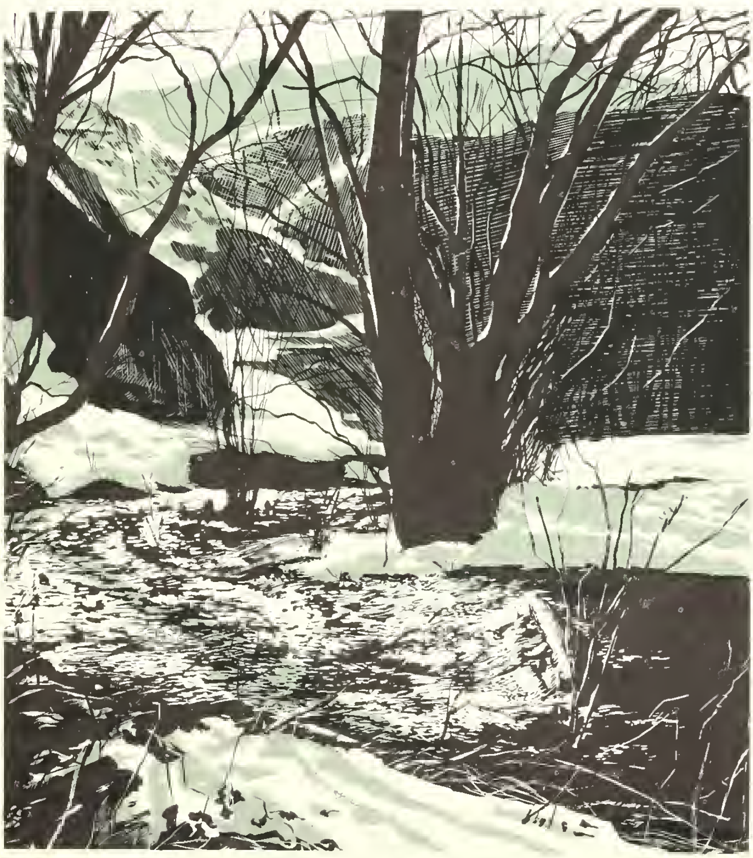
The *Reclamation* Era

FEBRUARY 1958



Official Publication of the Bureau of Reclamation

The Reclamation Era

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In this issue . . .

DESIGN AND ILLUSTRATIONS by Drofting and Grophics Bronch
Bureau of Reclamotion, Woshington, D. C.

J. J. McCARTHY, Editor

Issued quarterly by the Bureou of Reclamotion, United States Department of the Interior, Woshington 25, D. C. The printing of this publication was approved by the Director of the Bureau of the Budget, April 5, 1955.

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Reclamation and Hurricane Audrey

Audry comes home with a vengeance. She docked herself within a stone's throw of the icehouse.—*All photos by the author.*

That the Bureau of Reclamation, located as it is n the 17 Western States, would play a useful, hough somewhat indirect, role in the wake of Iurricane Audrey's attack on Louisiana, may ap- ›ear a little surprising. Neverthless, such did ake place with myself as the "fortunate" partic- pant.

A little background is desirable. Public Law 75, enacted by the 81st Congress, provides for id by the Federal Government in alleviating uffering and damage and in repairing essential ›ublic facilities resulting from major disasters. Recognizing that major disasters cannot be "pro- ramed," the law further provides that engineers, ealth officials, procurement specialists, etc., from 'ederal agencies may be "drafted" to meet the eak requirements of multiple disasters. In 1953 ne Federal Civil Defense Administration was assigned the responsibility of administering Public Law 875, thus placing them in charge of natural disasters (tornadoes, hurricanes, etc.), as well as manmade disasters (wars).

The unprecedented floods last spring in Texas, Oklahoma, Louisiana, and Arkansas highly overtaxed the personnel of the FCDA Regional Office at Denton, Tex. Some 70 engineers from several different Federal agencies were drafted to help in the large task of providing Federal aid. As one of these "draftees," I was on an engineering inspection of damaged public facilities in Arkansas when Audrey hit. The apparent magnitude of Audrey warranted my immediate transfer to Cameron, the heart of the Louisiana coastal

by D. R. CERVIN
Chief, Design Branch, Region 5,
Amarillo, Tex.

area that was struck. For the next 3 weeks I lived an experience that can never be forgotten, that wouldn't be traded, and that, I hope, never will be repeated.

Before discussing the active work of helping the stricken area, there follows a short review of the geography of the area, the storm, and the broad scope of the damage.

Cameron Parish is the southernmost parish (county) in Louisiana. It is about 75 miles from east to west and averages about 20 miles from north to south. The entire area is predominantly marshy with numerous wildlife sanctuaries.

Calcasieu Lake divides the area in an east-west direction with the east area nearly double the west. There are just 2 centers of population: several towns such as Hackberry and Grand Lake in the northern part of Calcasieu Lake, and a continuous strip from the parish seat, Cameron, just south of the lake and near the gulf, to within 7 miles of the east parish boundary. A much lesser number live west of Cameron, principally in Johnson's Bayou and Holly Beach. The population along the coast was reportedly about 4,000. There are about 2,500 elsewhere in Cameron Parish. The entire area is exceedingly low, possibly rarely exceeding 15 feet above sea level. The south half is uniformly lower than the north, most of it only a few feet above high tide. Homes are generally constructed on 12- to 18-inch concrete blocks without further foundation, typical of fishing villages. However, during the past 5 to [illegible] years considerable prosperity has been enjoyed by the coastal area and many fine brick veneer homes with continuous but shallow footings have been erected.

During early morning of June 27 a record wind-blown high tide hit the beach just slightly ahead of the hurricane. By 4:30 a. m. water was waist deep in the homes. All who could escaped to the fine modern courthouse which eventually housed close to a thousand people. Many could not get there, and sought refuge in the few two-story houses available, in their attics or on their roofs, tied to sturdy trees, or were just victims of the storm and tried to ride it out on rafts from the broken panels of their homes. Of course, a large number had already evacuated, those staying believing that the storm might not hit until the following day. Audrey reached its peak intensity at 7 a. m. and did not abate until 2 p. m. The water reached a maximum depth at 10 a. m.

The intense damage provoked by Hurricane Audrey was from the eastern edge of Johnson's Bayou to the east part of Grand Chenier, a distance of over 50 miles. Johnson's Bayou is protected by a small rise in elevation; east of Grand Chenier is a swampy area with few inhabitants. Peak damage was done across this entire strip inland to the intercoastal canal, a distance of 1[illegible]

HOLLY BEACH—This desolate scene is hard to believe. Before "Audrey" there were 32 all-year homes, and 200 beach cabins on this site.

Below: ONE MONTH OLD, $35,000 home. Rupert Doxey's family of five actually rode in this house to the tree line shown in photo during the hurricane. Finally, all 5 tied themselves to adjoining trees and held on for 7 hours until they were rescued.

IMPOSSIBLE for a home to have greater destruction than this? No; over one-third of all homes were reduced to complete rubble, and the resulting debris has been distributed over several hundred square miles of swamps

niles. The damage between the coastal homes ind the intercoastal canal was principally confined to cattle losses—some 40,000.

This was one of those rare disasters where the words "100 percent" may be freely used. Close to 100 percent of the structures suffered intense damage; in many cases 100 percent damage. Actually, only the Cameron Courthouse was relatively undamaged, and it had 6 feet of water in the basement. Much incalculable damage was done to records, and several thousand dollars in donated labor and equipment were necessary to clean up and repair the basement. Only a couple dozen homes were fit to live in after the storm, and then only after a large number of people simultaneously moved in and cleaned up. Excluding Cameron, where the many trees and closeness of homes prevented total eradication of any one home, at least one-third of the homes were totally demolished and blown or washed to the intercoastal canal. In Holly Beach every one of the 32 permanent homes and 200 rental cabins have totally disappeared except for bowled-over concrete foundation blocks. The picture on page 2 is a grim reminder of this unbelievable situation.

With such fantastic destruction, where hundreds of homes were torn into shreds, where an entire area 75 miles wide and over 10 miles long was covered with water, generally over a person's head, and where gale velocities around 80 m. p. h., with gusts of 135 m. p. h., raged for nearly 7 hours, it seems almost miraculous that "only" 335 died and 190 are missing. In the words of Val Peterson, "This is the greatest single disaster in terms of death and suffering that I have ever seen."

The first 2 days after the storm were spent almost entirely in rescuing humans and evacuating people. The air fairly buzzed with helicopters and airplanes, every available piece of seaworthy equipment was pressed into service, and marsh buggies charged into the ever dangerous and greatly enlarged swamps on their missions of mercy.

While searching for the living, the grim task of recovering the dead also went on. The first 200 were easily found—they died in their homes, sometimes actually drowned in their attics, were caught in piles of debris, or simply drowned in the new 8-foot sea. But the other 135 repre-

REMNANTS of a well-built brick business building.

sented one of the most intensive body hunts in history. The swamps cover several hundred square miles. With literally millions of broken pieces of debris and thousand of dead cattle piled up in a heterogeneous fashion, it was impossible to even find the bodies except by helicopter. When a body was located a flagged bamboo pole was set as a marker and the bearings and distance from a central point was given to marsh buggy drivers. The difficulty of finding the markers and the 4 to 5 miles per hour maximum speed through the swamps limited body recovery to not over 10 a day. Even this work had to be curtailed after 2 weeks due to the intense activity of heat and salt water on the remains. Without benefit of an organized search, bodies are still being recovered.

The work of the FCDA starts from the time a disaster appears to be of a magnitude great enough to warrant a Presidential declaration of "This is a disaster area," to the final payment for eligible work, in the case of the hurricane possibly 2 years later. The word "eligible" is very important. As already pointed out, the law generally provides for removal of debris of wreckage, elimination of safety and health hazards, and the minimum restoration of public facilities. Within the law itself and later by administrative determination there are many angles and slants to consider regarding what is eligible work. The general rule is this: Public facilities may usually be repaired; however, private property may be worked on only if health or safety factors are involved.

FCDA's "modus operandi" for helping out in a disaster is: "Move in as observers" even before the area is declared a "disaster area," assist the State in determining what the initial request by the governor should be, secure the money from the Federal Treasury and transfer to the State Treasury, prepare or supervise preparation of estimates for eligible work, assist the local government in preparing an application which utilizes these estimates, review and approve these applications which permit the using of a part of the Federal funds, make interim engineering inspections, audit the work, and make final payments for the eligible work.

It is evident that only a small amount of this could be participated in during the 3 weeks spent in Cameron.

My principal assignment during the 3-week detail was in connection with debris and wreckage removal.

The amount of debris scattered in Cameron is hard for one to visualize who has not been there. Even pictures do not do it "justice." One way of describing the scene was that no grass could be seen. So many scores of homes a little south of Cameron were blown into the town area and then torn into panels, pieces, and rubbish by the intensity of Audrey, that nearly all of the grassed areas were covered with wood.

There were two basic conditions that imposed an ultra severe problem, even by major disaster standards, in setting up a construction organization that could efficiently remove debris. Condition 1: Practically every house, structure, and public utility was damaged almost 100 percent, thus is was difficult for natural distaster operators to even find a place to get started. Condition 2: The closest metropolition area, Lake Charles, is

Continued on Page 20

Destroyed filling station. The stockpile of tires is for burning cattle.

something new in fish protection

by H. W. THOMSON
Chief, Tracy Operations Field Branch,
Region 2, Bureau of Reclamation,
Sacramento, Calif.

When the Tracy pumping plant on the Central Valley Project in California was in the design stage, one of the requirements was to provide a fish screen. The fish screen was to protect sport fish, that is, salmon and striped bass, from entering the canal and being destroyed on the farmland to which the water flowed. This sounds easy, and was thought to be a relatively simple problem to solve at the time. However, it did not prove to be easy. The physical situation is that the Tracy pumping plant inlet is at one corner of the delta formed by the Sacramento and San Joaquin Rivers, and during the heavy pumping season, which is also the fish migratory season, most of the channels in the delta have water flowing toward the pumping plant. The fish to be caught are principally striped bass and salmon in the very small fingerling stage. These fish are on their way to the ocean and are consequently drifting downstream and are too small to avoid the entrance to the canal.

Initially, an experimental setup was provided in a temporary bypass canal inlet. This pilot fish screen provided several methods of trapping fish, of which the primary method was to install pipes at intervals along the screen, and as the fish traveled back and forth along the screen they would eventually be sucked in through holes in the pipes and carried to a holding pond. Whenever sufficient fish were on hand, they would be drained into a barge and transported down river to a suitable location and there released.

Other methods, such as various types of traveling screens, were tried, but all of these methods had very little success. Either they did not catch fish or they injured the fish severely.

Finally, the present method was evolved, of which the simplest description is that the structure resembles a venetian blind with the slats, called louvers in this instance, placed vertically in the water instead of horizontally as we normally see a venetian blind. Picture No. 2 shows the final arrangement with the line of louvers running at an angle across the intake canal, four entrance bypasses for fish, and the crane which is used periodically to raise louver sections so that debris may be washed off. The young fish, which incidentally go downstream and out to sea tailfirst, apparently instinctively fear the small ripples caused by the vertical slats since such disturbances are usually caused by rocks upon which they can be left high and dry to perish. Attempting to avoid this disturbance, they exert themselves sufficiently to move along parallel to the row of verti-

General view of holding tanks, secondary louver, and pumping plant areas.—*Photo by E. S. Ensor, Region 2.*

DELTA-MENDOTA CANAL—Side view of trash rake on trash rack structure.—*All photos in this article, except otherwise noted, by J. L. Brown, Region 2.*

cal slats and are carried into 1 of 4 bypasses. The result is that the bulk of the water passes through the slats and on to the pumping plant while that small portion which enters the four bypasses contains a large part of the young fish. The concentration of fish in the bypass pipes is expected to be approximately 40 times greater than the normal concentration in the main channel.

Ahead of the primary louver is a trash rack which prevents floating debris from entering the intake canal. Picture No. 1 shows the operation of a device for removal of this debris, averaging 15 to 18 tons a day. This rake is arranged so that the debris is carried over the top and falls into a dump truck.

The fish, carried through bypass pipes, proceed to two sets of secondary louvers (see picture No. 3). Here they are further concentrated to an expected density of approximately 640 times greater

View of primary louver looking downstream. Hoist is used to raise louvers.


2

than in the inlet canal and are routed to holding tanks shown in picture No. 4. An additional function of the secondary louvers is to separate the fish from mossy water. Screened moss-free water is introduced along one side of the secondary lover structure. The louvers direct the fish


3

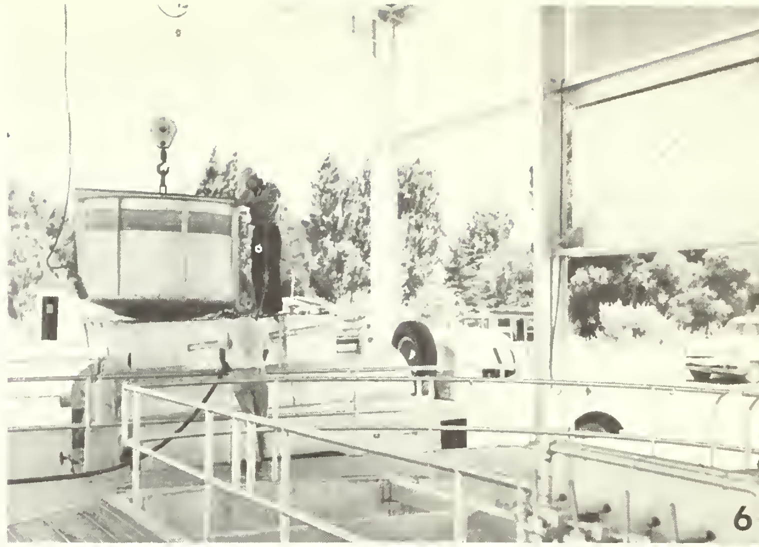
Looking downstream in secondary channel.

into this clean water while the moss-laden water passes through the louvers and is pumped back into the canal.

The holding tanks have a screen that keeps the fish from going out of the tank as the water passes through (see picture No. 5). Approximately 15,000 fish are all that can be held in 1 tank or transported in 1 truckload. When this number of fish has been collected the water is lowered and the bucket shown in picture No. 6 is lowered by a crane to the bottom of the tank as shown in picture No. 5. The screen is raised a few inches and all the fish and the remainder of the water flow into the fish bucket. The bucket is then lifted out of the tank and moved laterally by the same crane to the end of the structure where the contents are released into a tank truck to be carried down the river and released.

Counting of the fish is done by sampling a 5-minute count of the fish every 2 hours. This

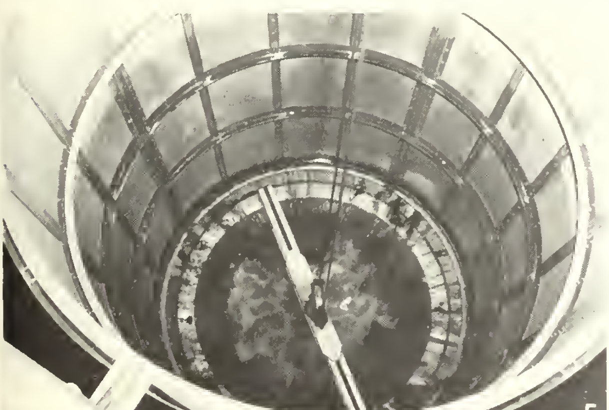
DELTA MENDOTA CANAL—Fish holding tanks.



Fish being loaded into tank truck from fish transporting bucket.

counting is done by putting the 5-minute collection of fish in a small basket as shown in picture No. 7. The fish can then be removed a few at a time, species and number determined, and the fish returned to the tank alive. Picture No. 8 shows more plainly the various sizes of fish and other small debris that are caught.

The new system has been in operation approximately 6 months, and evaluation tests are now in



Fish transporting bucket in position to collect fish in holding tank.

process and will be continued for 2 seasons. No quantitative results are available as yet, but indications are that the new structure and method is many times more effective than any of the previous methods. We have caught as many as 100,000 fish in a day, but since the run of fish peaks rather sharply, the maximum for 1 month so far has been 1,900,000. After the 2-year-test program has been completed and analyzed, any necessary revisions will be added to the present system. Indications are that we have found the most effective fish screen that has yet been devised for saving fingerlings as small as five-eighths inch long.

Because the Tracy fish-collecting facility is a unique structure with no history of experience behind it, its efficiency, both mechanically and biologically, is being carefully evaluated. Here again the Fish and Wildlife Service is participating. The results of the first season's operations, which began in February, are shown in table at end of the article.

Continued on page 19

Making a fish count showing the counting box and net.

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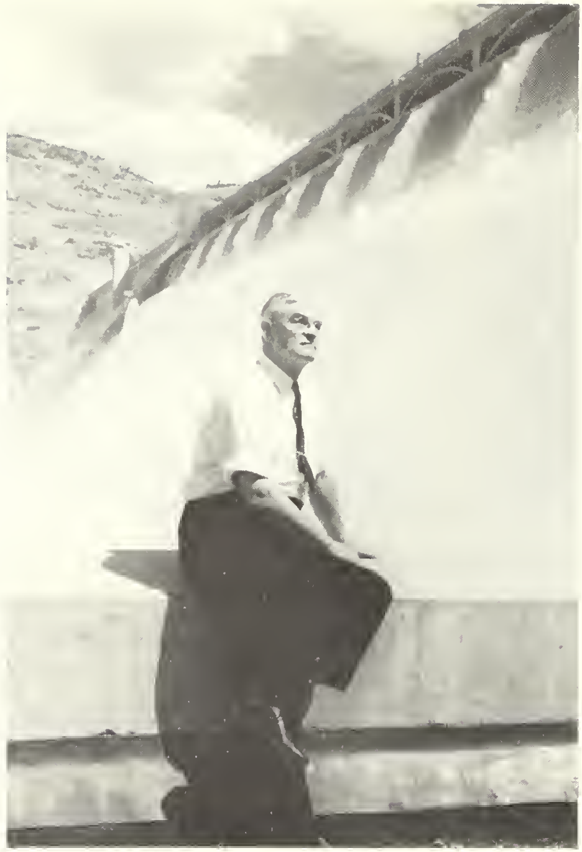


Frank A. Banks Dies

Frank A. Banks, builder of Grand Coulee Dam and other major Reclamation Bureau structures, died on December 14 of a stroke in San Marino, Calif. He was 74.

Mr. Banks, a native of Saco, Maine, started as a $65-a-month survey gang rodman in Montana in 1906 when the Reclamation Bureau was 4 years old.

Commissioner Dexheimer said: "A record of his career is almost a history of reclamation in the Northwest."

Mr. Banks, described as a mild-mannered man, often was offered positions in private industry and with foreign governments at several times his salary with the Bureau. He always turned them down.

Among the dams he helped build were the Jackson Lake Dam on the Snake River in Idaho; the American Falls Dam, also on the Snake River; the Arrowrock Dam, Boise River, Idaho; the Owyhee Dam, Owyhee River, Oreg., and the Thief Valley Dam on the Powder River in Oregon.

In addition to designing the Grand Coulee Dam in Washington, he worked on other features of the vast Columbia Basin project, including the construction of the world's largest pumping plant there.

President Truman in 1950 presented Mr. Banks with the Gold Medal for Distinguished Service, the highest honor of the Interior Department.

He retired in 1950, but continued to serve as an adviser to the Bureau on a number of projects.

Mr. Banks joined the Bureau shortly after graduating from the University of Maine.

Two years ago Mr. Banks was elected an honorary member of the American Society of Engineering. He is survived by his wife and two children. # # #

Shoshone's Golden Jubilee

Left to Right: Mr. A. G. Lucier, Mrs. Ida Schacht, Mrs. Margaret Robinson, Mrs. Lulu Shoemaker, Mr. and Mrs. A. D. Hardy, and Mr. and Mrs. F. M. Kittle browse through the brochures presented to them as a memento from the Bureau. Standing (left to right): W. A. Dexheimer, Commissioner of Reclamation, and F. M. Clinton, Regional Director, Region 6, also enjoy viewing the many pioneer and modern scenes in the book.

SHOSHONE'S GOLDEN JUBILEE marked the 10th Annual Water Users Conference for Region 6 which was held in Powell, Wyo., on September 5 and 6.

The conference was attended by 130 water users from the States of Wyoming, Montana, North Dakota, and South Dakota. It was highlighted by the fact that the Garland division of the Shoshone project in Wyoming was celebrating 50 years of water service. The theme of the conference was tied into the 50-year celebration. Adjacent to the conference hall, one-half of a city block was devoted to a display of old and new equipment. This display was arranged to have the old and the new equipment placed side by side so that people could recall vividly the progress that has been made in development of farm machinery, operation and maintenance equipment, cars and trucks over the years. The display brought hundreds of visitors, and many memories of the "old days" were brought back to the oldtimers. Here, once, again, was an opportunity to relive the days that are now history.

Inside the conference hall, seven large display boards gave a pictorial history from the beginning of construction of the project in 1904 to the present time. The pictures depicted the growth of the town of Powell, Buffalo Bill Dam, and the project. The pictures made one feel proud of the wondrous works that had been accomplished in the last 50 years. It brought back a new appreciation and wonderment of the great desire and determination of the pioneers to cut out homes and farms in this raw sagebush land. It made one think and realize how much the present day generation takes for granted, and how little thought is given to what went on before its time. There was also a display of the old and new in farm home conveniences from the hand-turned washing machines, irons, kerosene lamps, foot warmers, to the latest in stoves, refrigerators, etc.

A banquet was held at the Powell Country Club on the evening of September 5, honoring the original homesteaders who had been on the project 50 or more years. To qualify as an honor guest, one had to still hold ownership to his original farm unit that was homesteaded at least 50 years ago. There were eight honored guests: Mrs. Lulu Shoemaker, Mrs. Margaret Robinson, Mr. and Mrs. Azro Hardy, Mr. and Mrs. Francis Kettle, Albert Lucier, and Mrs. Ida Schacht. To each guest was presented a booklet with a certificate from the Regional Director honoring their 50 years of effort on the project. The booklet contained a short story of the history of the project and a pictorial history of the project from the beginning of construction. These mementos will

by R. M. FAGERBERG,
Bureau of Reclamation,
Powell, Wyo.

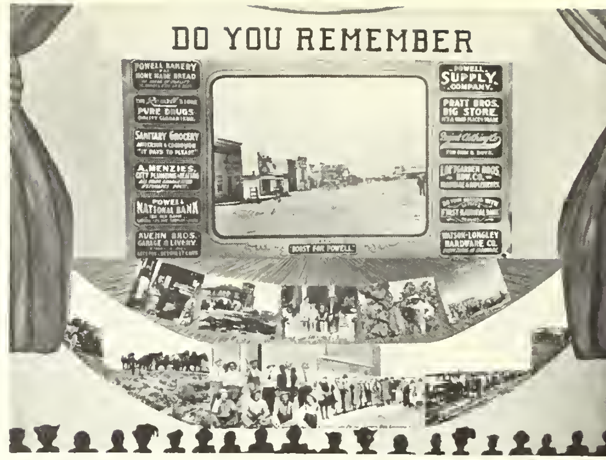
be cherished by the honored guests and serve to bring back many wonderful memories for years to come.

The banquet hall was filled to overflowing by the out-of-town guests, local water users, businessmen, and friends of the honored guests. Reclamation Commissioner W. A. Dexheimer was the guest speaker at the banquet, and he spoke on the 50 years of progress on the Shoshone project and the need for a sound water policy for America.

The Water Users Conference held in Billings, Mont., in January 1957 had elected to hold a conference in the field on one of the projects in an effort to study firsthand problems that faced various projects. In previous years the conference had always been held in Billings, Mont., during January, because this was the month when most of the water users felt they could leave the chores at home.

The Shoshone project water users extended the invitation to visit their project and the conference accepted. There was a great deal of apprehension on the part of the planning committee because the conference had to be programed between bean cutting and bean harvesting time. In June the dates were set and in July preliminary programs were sent to over 200 irrigation districts in the 4-State area. All irrigation districts were invited regardless of whether they represented Federal or private irrigation projects constructed by private companies. This again was a new effort on the part of the conference to have all people interested in irrigation problems get together and talk over their problems.

H. L. Hart and Reclamation Commissioner W. A. Dexheimer inspecting a pioneer model of an International truck during the 10th Annual Water Users' Conference in Powell, Wyo.

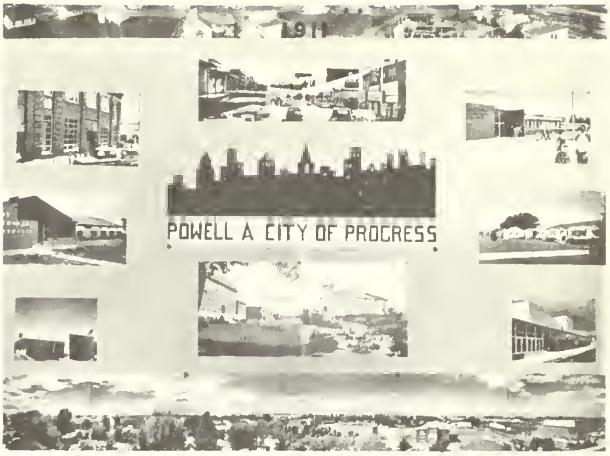


Display Panel, used at 10th Annual Water Users' Conference, featuring oldtime photos of people and scenes on Shoshone project.

Followup programs were sent out in August for reservations. A very fine response was received, and it soon became apparent that if everyone came, there would be a shortage of hotel and motel accommodations in Powell. Unfortunately, rainy weather set in over the 4-State area in the latter part of August and delayed harvest of the cereal grains, cutting of beans, and other farmwork. As a result, many of the reservations were canceled. However, even with the cancellations, 130 were in attendance at the conference. The wives were invited to the conference, and a special program of interest was provided for the ladies. They visited the outstanding school system in Powell, the new farm homes on the project, and the new Northwest Community College in Powell.

The first day was spent in the conference hall discussing subjects such as operation and maintenance equipment, control of water weeds, closed and open drains, canal lining and seepage control, saline soils and their reclamation, and rehabilitation and betterment loans. Each discussion was led by a man who had given much time and study to that particular subject and was qualified to enlighten the group on any questions that might arise.

Speakers included R. J. Willson and R. R. Reed, from the Bureau's Denver office; Dr. Howard Haise, from Colorado State University; and



At left: A true western style chuckwagon breakfast, served through the courtesy of the Powell Chamber of Commerce. Commissioner Dexheimer is shown receiving his helping as other members of the conference eagerly await their turn. At right: This panel shows progress of city of Powell from a small settlement in 1911 to a modern city in 1957 All photos in this article by Charles A. Knell, Region 6.

Jesse Hodgson, from Montana State College.

Without a doubt the highlight of the entire conference was a breakfast sponsored by the Powell Chamber of Commerce on the top of Polecat Bench overlooking the entire project. The breakfast was set for 7:15 a. m., and it required 35 minutes of driving time from Powell over highways and sagebrush land. In the beginning there was a little grumbling over the fact the conferees had to get up so early in the morning and wait so long for breakfast. However, when the group arrived and saw the panoramic view of the project and were served a fine breakfast, consisting of orange or tomato juice, hot sweet rolls, hot buttered toast, fried potatoes, bacon, eggs, coffee, and a cigar, all complaints vanished. There were approximately 110 attending the breakfast.

Demonstration of a Briscoe sloper, shown sloping the banks and clearing weeds on a lateral on Garland division.

The tour began after breakfast with a stop at a canal-lining demonstration. Demonstration plots were set up for bentonite, asphalt, vinyl plastic membrane lining, and a check plot without a membrane lining. The comparative water losses computed on a loss in cubic feet per square foot per 24 hours on the wetted perimeter were given for each of the test plots. During the stop a representative of one of the companies manufacturing the catalytic asphalt for membrane lining discussed the properties of the asphalt. A demonstration of applying the asphalt at 450° Fahrenheit was shown on 2 test plots. A demonstration of concrete "guniting" was shown to the group on rubble riprap.

The tour continued, and a stop was included on the problems arising from drainage of slopes up to 11 percent. The tour continued to the Buffalo Bill Dam, and lunch was furnished by the Willwood Women's Club at the Willwood Community Center.

The afternoon portion of the tour consisted of a Briscoe sloper cleaning demonstration on laterals clogged with silt and weed growths and a propane weed-burning demonstration on control of weeds on lateral banks.

The demonstrations were enthusiastically received by the tour members, and the general consensus of opinion was that a great deal of benefit had been derived from this conference where actual field demonstrations supplemented conference discussion. # # #

ASSISTANT COMMISSIONER "STAN" CROSTHWAIT RETIRES

As this issue went to press, Interior Secretary Fred A. Seaton announced that Stanley W. Crosthwait, Assistant Commissioner of the Bureau of Reclamation since 1953, would retire effective January 31, 1958.

Mr. Crosthwait, Assistant Commissioner for Administration, has had more than 40 years of experience in handling administrative and personnel problems in the Federal Government. He was appointed to his present position on November 30, 1953.

Mr. Crosthwait was born in Greenfield Center, N. Y., December 24, 1898, and received the B. S. degree in electrical engineering from George Washington University in 1928.

He began his public career in the Bureau of Ordnance, Navy Department, in May 1916, and in September 1925 transferred to the Bureau of Internal Revenue in the Treasury Department.

In October 1925, Mr. Crosthwait accepted a position in the Appointment Division of the Department of Commerce, and later served as Chief of the Administrative Division, Aeronautical Branch, until July 1934.

After a tour of duty as Administrative Assistant with the National Power Policy Committee, he joined the Department of the Interior in October 1934. He also served with the Public Works Administration. He was Director of Personnel for the Bureau of Indian Affairs from February 1936 to June 1941, leaving that post to become Executive Officer in the Office of Petroleum Coordinator for War.

He left that position for military duty, serving with the U. S. Air Force from August 1942 to January 1946, as a colonel, a rank he still holds in the Air Force Reserve.

Mr. Crosthwait became Associate Director of Supply for the Bureau of Reclamation at Denver, Colo., in February 1946, and was promoted to Director of Supply in November, transferring to Washington in the same position in January 1947.

He is married and lives at 4205 Sheridan Street, Hyattsville, Md.

# # #

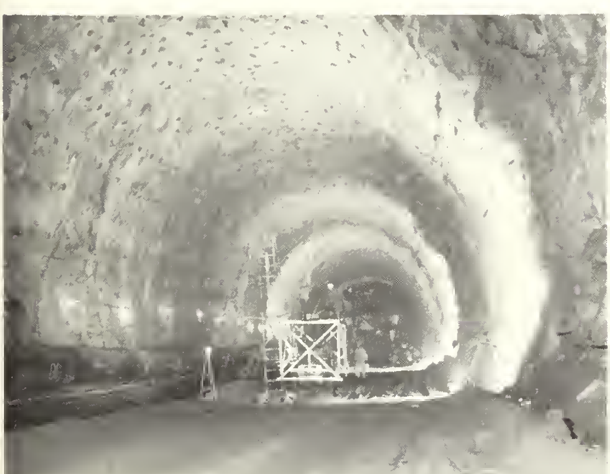
Glen Canyon Dam

This suspension footbridge provides ready access to both sides of the Colorado River. It also provides an excellent view of the river—700 feet down—through steel mesh which serves as a deck.—*Photo by A. E. Turner, Jr., Region 4.*

In mid-October of 1956 the President of the United States, via a telegraphic signal from the White House, fired the first blast of rock at the Glen Canyon Dam site. With this signal President Eisenhower marked the beginning of construction on a project which includes the largest single construction contract ever administered by the Bureau of Reclamation.

When completed, the Glen Canyon unit of the upper Colorado River storage project will cost nearly $326 million, and will serve as the key structure in the upper Colorado development.

Prime contract for the construction of the dam and powerplant went to the Merritt-Chapman & Scott Corp., of New York City, on a low bid of $107,955,122. Since the beginning of construction,



Bureau of Reclamation inspectors use a "Sunflower" device to check the arch of the right water diversion tunnel for the Glen Canyon Dam.—*Photo by A. E. Turner, Jr., Region 4.*

FLASH FLOODS through an unimproved section of the Kanab-Glen Canyon highway are a constant headache to construction workers.

LUNCH TIME at the Page Accommodation School. Students park on the front doorsteps as teacher Henry Howe relaxes for a few minutes. School now teaches all grades through high school and boasts 200 pupils.—*Photo by Fred S. Finch, Region 4.*

Temporary headquarters of the Burea[u] from the Glen Canyon Dam site. [...] of 1,300, Kanab has grown in a [...] people.—*Photo by F. B. Slote, Regio[n]*

High-scaling brothers, W. D. Jackson, front, and J. R. Jackson, of Mesa, Ariz., drill out the skewbacks for the Colorado River bridge at Glen Canyon. They work some 200 feet down the canyon wall suspended by cables.—*Photo by F. S. Finch, Region 4.*

the contractors have radically changed the face of the Glen Canyon Dam construction site.

In late October 1957 a 2,760-foot water-diversion tunnel was completed and construction immediately started on a second diversion tunnel on the opposite canyon wall. Drilling companies have started work at both portals of an access tunnel from the canyon rim to the river level for the powerhouse. This tunnel will be almost 2 miles long when finished.

The prime contractor has started excavation on both spillways, and will later drill spillway tunnels to be tied into the lower portions of the diversion tunnels. Merritt-Chapman & Scott Corp. has now moved all administrative offices from Kanab to the dam site.

Bridge abutments for the Colorado River bridge have been built by the Kiewit-Judson Pacific Murphy Co. Skewbacks have been drilled out in the east canyon wall and work is progressing on the arch footings on the opposite side. The contractor anticipates the heavy steel erection on the bridge will start this month.

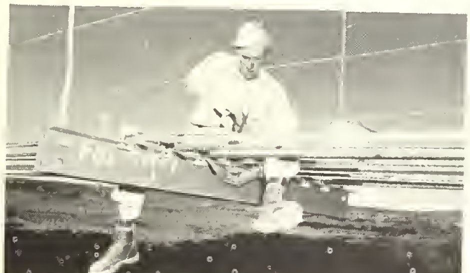
Page, Ariz., named in honor of the late Reclamation Commissioner John C. Page, the Government city to be built by the Bureau of Reclamation, will be well underway by the middle of this

is located at Kanab, Utah, 76 miles
ourist city with a normal population
o a population of more than 3,000

year. To relieve the housing shortage temporary Transahomes were erected, and a school is in operation offering education in all primary and secondary grades. Reclamation officials plan to move all employees and offices to the new city in the near future.

Glen Canyon Dam will be the second highest dam in the United States, being surpassed in height only by Hoover Dam near Boulder City, Nev. The reservoir will impound over 28 million acre-feet of water and will reach 186 miles up the Colorado River and 71 miles up the San Juan River in New Mexico. # # #

Steel rigger Bill Wilds bolts floor cable locks in place on the footbridge spanning Glen Canyon of the Colorado River—*Photo by A. E. Turner, Jr., Region 4.*



Trailer park on the outskirts of the city of Kanab on U. S. Highway 89—*Photo by F. B. Slote, Region 4.*

Modern commissary store, Page, Ariz.—*Photo by A. E. Turner, Region 4.*

Most spectacular part of all road construction for the Glen Canyon Dam is this 300-foot cut through the Echo Cliffs near Bitter Springs, Ariz.—*Photo by Fred S. Finch, Region 4.*

Frontier With A Future

Parker-Davis System Dispatchers' Office—View of the "system diagram board," which pictures the major segments of the entire system with Hoover powerplant at the upper right and the Yuma-El Centro area at the lower left of the diagram.

PART ONE

Supplying system loads at minimum cost consistent with good service is one of the major aims of the modern day power system dispatching organization. The art has become more scientific, and the requirement much more exacting in recent years.

The need of many of the electric-power distributors in the areas served by the Parker-Davis project for supplying low-cost power to a rapidly growing power market for such loads as irrigation pumping, industrial, commercial, and domestic, was one of the compelling reasons which necessitated the establishment of a central power system dispatching center in Phoenix, Ariz.

The pleasant climate in southern Nevada, southern California, and Arizona has always been one of the chief attractions of the area. This resulted in development of the area for growing much of the Nation's food, particularly winter crops, dates, and citrus. The ideal climate, together with the scenic beauty of the area, has also been a major tourist attraction.

After a dynamic period of progress dating back to 1945, the Pacific Southwest area has emerged among the national leaders in growth of population, personal income, manufacturing employment, farm income, retail sales per capita, motor-vehicle registrations, and bank capital and deposit growth. Any day of the year, any place you want to go in this large Pacific Southwest section of the Nation, you can hear, see, and feel the growth. No wonder it's called the "Frontier with a Future"!

Electric-power development, wherein service is provided at minimum cost, has played a major role in this areawide recordbreaking activity.

Possibly the largest contributing factor in the development of a power system, and the dispatch-

by WILLIAM M. DOAK, Chief, Systems Operation Division, Parker-Davis Project Office, Phoenix, Ariz.

ing organization necessary to operate it, is the geography of the territory served. The location and distance between the major load centers and other interconnected utilities on the system, the location of suitable sites for establishing hydroelectric generating stations along with the necessary transmission and communication facilities that result from such locations, all influenced the development of the methods and the overall arrangement of the Parker-Davis system as a whole.

The Colorado Basin extends from Wyoming on the north into Mexico on the south, and from the western slope of the Rocky Mountains to the Gulf of California—an area of 242,000 square miles in the United States and 3,000 square miles in Mexico. The Parker-Davis power system serves the territory extending from Clark County, Nev., on the northwest; to Imperial County, Calif., on the southwest; to Cochise County, Ariz., on the southeast; or a territory extending about 300 miles east and west by approximately 500 miles north and south. There are several major, as well as colorful, cities in this area, including Las Vegas and Henderson, Nev.; El Centro, Brawley, and Calexico in Imperial Valley, Calif.; Prescott, Yuma, Phoenix, and Tucson, Ariz.; and San Luis, Old Mexico; and many others too numerous to mention, each with its concentration of load. The distance between the major load centers varies from approximately 60 to 100 miles.

The Parker-Davis power system presently consists of 2 dams, 2 hydroelectric powerplants, nearly 1,600 miles of high-voltage transmission lines, and 36 substations. Power is transmitted at 230 kv., 161 kv., 115 kv., 69 kv., and 34.5 kv. There are 19 interconnections with other utilities, many of which have generating facilities of their own. The substations on this system have a combined transformer capacity approaching 2 million kv.-a., including the transformer capacity at the powerplants.

The hydroelectric powerplants are located at Parker Dam and Davis Dam, with interconnections between these plants and Hoover powerplant.

Parker powerplant has 4 hydroelectric generating units, each with a nameplate rating of 30,000 kw., or a plant capacity of 120,000 kw.

Davis powerplant has 5 hydroelectric generating units, each with a nameplate rating of 45,000 kw., or a plant capacity of 225,000 kw.

In addition to the 345,000 kw. combined capacity of these 2 plants, the system also transmits

Here are shown the 53 telemeters presently installed. The radio transmitter is in the foreground. The office is open 24 hours a day, with 2 system dispatchers on duty each 8-hour shift.

DATE PALMS—Typical of the diversity of crops in the area is this date palm in a grove near Mesa, Ariz. Mesa, a land of figs, dates, citrus, melons, truck crops, cotton, and grains, has a population of 18,000 and a trading area population of 65,000.

165,000 kw. and 155,000 kw. of Hoover powerplant capacity for the Arizona Power Authority and the Colorado River Commission of Nevada, respectively. The 1,600 kw. of Siphon Drop powerplant, located on the Yuma Main Canal near Yuma, Ariz., is also connected to the system, making a total of 667,700 kw. of hydroelectric generation under the dispatching control of the system dispatchers located in Phoenix, Ariz. The project also transmits 200,000 kw. of steam power from the Arizona Public Service Co.'s new Saguaro steam electric generating station connected to the project's 115-kv. transmission system. Southern Nevada Power Co.'s new 100,000-kw. Clark steam electric generating station located near Las Vegas, Nev., is directly connected to the project's 230-kv. system at Basic substation. The Parker-Davis system dispatchers are directly concerned with a total generation of 967,000 kw. In addition, the power systems directly interconnected with the Parker-Davis system have a combined capacity in excess of 1,000,000 kv.-a. In the event of disaster resulting in a permanent loss of all or part of the system generation, it would be possible to reroute a portion of this interconnected generation over the Parker-Davis system.

CENTRAL SYSTEM DISPATCHING OFFICE

The general offices of the Parker-Davis project are located approximately 5 miles west of downtown Phoenix, and directly across the street from the Arizona Public Service Co.'s "Phoenix" steam electric generating station. The steel-reinforced concrete central dispatch building, adjacent to the project's general office building, houses the Chief of the Power Dispatching Branch, the Assistant Branch Chief, and 10 system dispatchers.

All intelligence essential to system load dispatching system scheduling, and systemwide operations is continuously available to the dispatchers who are responsible for the safe, efficient, and dependable operation of the power system.

The key feature of this central dispatching office is the large curved telemetering instrument and system diagram board. This board is approximately 80 feet long and 12 feet high. The 53 telemeters presently installed and the system dispatching diagram can be seen in the accompanying photographs. The functions of the telemeters will be explained in the second part of this article.

SYSTEM DISPATCHERS' OBJECTIVES

The objectives of the system dispatchers are: (1) To see that the operations on this power system are conducted in such a manner as to provide for the maximum and efficient use of water available for power generation, consistent with flood

Yuma citrus crops have little fear of severe frosts. It can grow a wide variety of crops in the summer or winter. Lettuce is harvested early, and brings top prices in eastern markets.—*Photo by Harry W. Meyers.*

control, irrigation, and other releases; (2) to provide uninterrupted service to project customers; (3) to provide adequate system stability and voltage levels; (4) to allow for the construction and installation of new or replacement facilities; and (5) for the complete coordination of the project's systemwide operations and maintenance programs with those of the interconnected utilities.

All of these responsibilities constitute a very important function essential to the successful operation of this portion of the interconnected power systems of the Pacific Southwest. Government owned and leased telephone circuits, carrier-current voice channels, microwave, and the project's network of base-mobile and point-to-point radio channels are used for communication in accomplishing these objectives. Nowhere in the Nation does electric power mean more to present life and future development than in this vast area.

Part 2, the concluding part of this article, will appear in the next issue of the Era. # # #

CROP SURPLUSES NEARING AN END

RECLAMATION COMMISSIONER DEXHEIMER presented another well-reasoned case for multipurpose water development projects, with special emphasis on the role Federal power revenues play in footing the bills.

As a speaker in the lecture series on conservation at the 84th annual convention of the Chautauqua Institution at Chautauqua, N. Y., Mr. Dexheimer first spiked what he called a "misapprehension" about reclamation and farm surpluses. "We are constantly asked," he said, "why the Federal Government should invest money in irrigating farmlands when it is paying out billions for surplus crops."

Westerners already know the answer. Five basic crops make up 87 percent of the Nation's agricultural surpluses. Of these, reclamation produces no tobacco; only half of 1 percent of corn and rice, less than 2 percent of wheat, and less than 5 percent of upland cotton.

Surpluses or no, Mr. Dexheimer declared "we are rapidly running out of farmland." Every year another million acres goes out of crop production, and another 3 million mouths have to be fed. In 5 years or less, he predicted, farm surpluses will cease to be a problem, and the Nation will face instead "an approaching crisis in our agricultural production." #

FISH PROTECTION

Continued from page 7

DELTA-MENDOTA CANAL—Typical catch for the fish count showing the number of fish caught in a 5-minute period.

While the following figures do not reveal what proportion of the fish is being caught, they do show that the numbers are substantial and seem to amply vindicate the selection of the louver principle in fish collection, at least in the Tracy situation. The program of measuring catch to escapement initiated in 1957 will continue through 1958.

1957	Striped bass	Salmon	Catfish	Other	Total
February					[1] 97,000
March	33,512	3,288	52,461	33,610	122,871
April	33,920	116,684	85,396	20,348	256,348
May	20,952	85,407	73,168	51,071	230,598
June	237,830	11,600	102,036	72,588	424,054
July	1,101,218	512	785,093	47,972	1,934,795
August	330,112	312	88,918	36,192	455,534
September	12,192	192	5,664	2,424	[2] 20,472
Total					3,541,672

[1] Estimated.
[2] Fishing terminated for season on Sept. 11 due to low volume of pumping and small catch.

Editors note:

The Department of the Interior granted cash awards totaling $12,000 to the 3 employees who were considered to have contributed the most to the development of the above described fish protection facilities. This was the largest such grant in Interior's history.

# # #

RECLAMATION AND HURRICANE AUDREY

Continued from Page 4

52 miles away with only 2 connecting roads; thus there was little opportunity to conveniently and efficiently fall back on a willing neighbor.

Nevertheless, in less than a week after Audrey hit, over 400 paid laborers, from as far as 150 miles from Cameron, began commuting daily in the cleanup operations. The Louisiana State Highway Department furnished a top construction engineer and about 20 pieces of equipment. Close to 40 additional construction vehicles were rented from a contractor. There were additionally about 15 pieces of equipment that were donated. These often arrived within a day of the storm, and did a yeoman job of the first debris removal from main streets. Much of this equipment remained for 2 or 3 weeks' work. The armed services also contributed generously, particularly during the early chaotic period.

Although the bulk of the cleanup had to be done in Cameron, there were 50 additional miles of small communities and homes near the gulf and 1 or 2 towns well inland requiring extensive removal of debris. This extensive area, coupled with a large commuting construction organization put together in a matter of hours, could hardly be expected to be very efficient. However, within 2 weeks the unwieldy, hastily-put-together construction organization developed into a reasonably well-oiled, efficient producing crew.

The total estimate for debris clearance exceeded one-half of a million dollars. It was necessary that this estimate be prepared well in advance of completion of the work in order that Federal funds could be made available early. The importance of securing funds cannot be overestimated, since the Cameron Parish (county) treasury could only pay 3 days' wages of the hired labor, and the wiped-out condition of practically everyone precluded the expectation of normal revenue for many months.

Although debris clearance was my principal work assignment, it was by no means all. The problems were legion; the conferences to work them out were innumerable; the hours worked were generally the "awake" hours of a day; Saturdays, Sundays, and holidays were alike. All problems revolved around the basic fact that practically all people and the parish government were without funds. The average person was not only broke, but he had not collateral with which to borrow. He was without means to obtain the essentials necessary to bring a semblance of order to his home; such as shovels, gloves, crowbars, saws, hammers, lawn hoses, water pumps, water pipe for essential repairs, etc. If he had some money, he would have to travel 50 miles for the simplest purchases as no stores or filling stations were open. Even then transportation was a problem, as most automobiles were destroyed, with only partial insurance coverage. Further, their means of making money had been removed as their jobs were gone. Thus, their least need often required considerable planning.

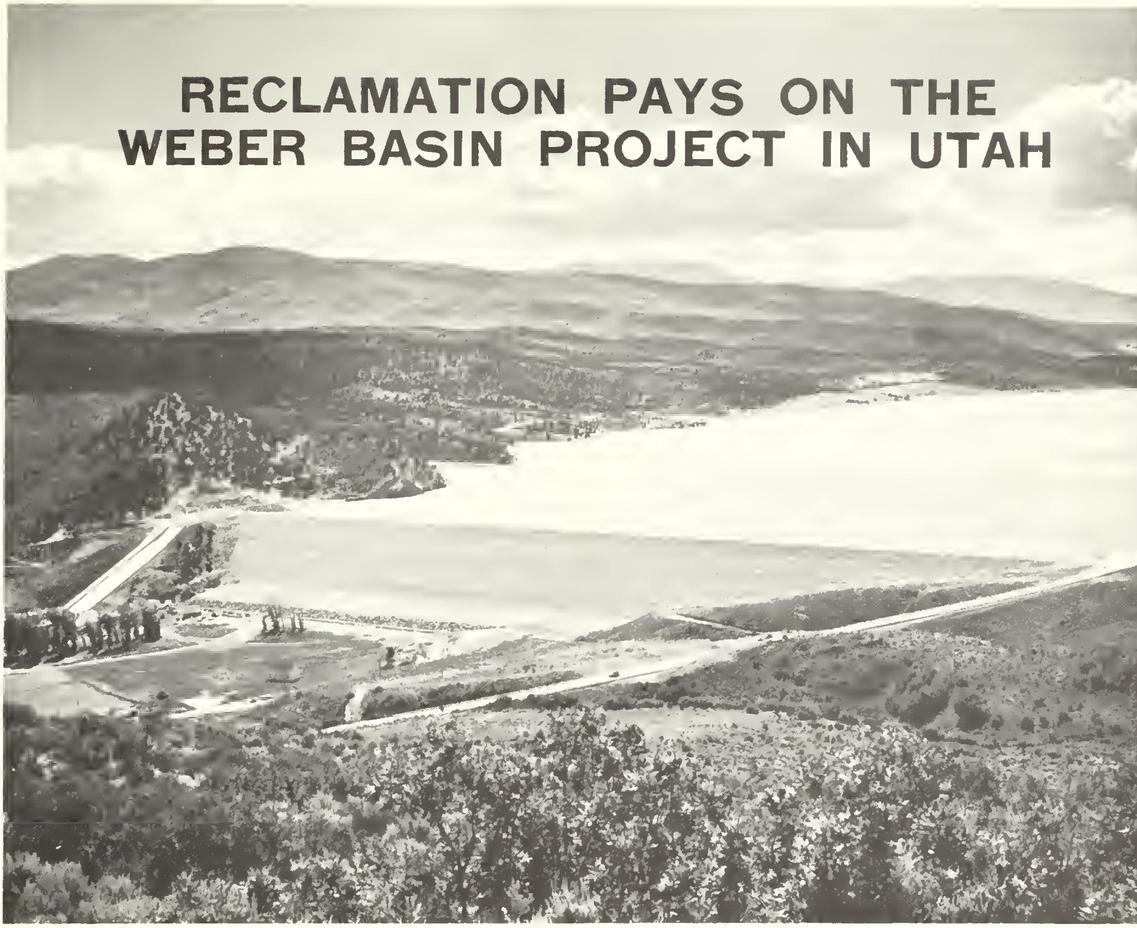
A FREAK OF THE STORM—This fully gabled roof settled relatively undamaged on the ground after losing its ground floor.

Through all these problems, the patience and appreciation of these people were amazing. These fishermen are indefatigable workers, never complaining. And they thank you, from the bottom of their hearts, for all you do for them. Far too often what is done is too little; sometimes nothing is accomplished. But they still thank you for the effort, and mean it. # # #

Hungry Horse Concrete Gains in Strength

Recent laboratory tests of 10-inch diameter drill cores from Hungry Horse Dam representing interior concrete placed from 5 to 8 years ago, indicate continued strength development of the dam's concrete. The 8-year-old cores indicate a compressive strength of 5,460 pounds per square inch, a gain of 420 p. s. i. since 1952 when similar tests were made.

RECLAMATION PAYS ON THE WEBER BASIN PROJECT IN UTAH



WANSHIP DAM—Weber Basin Project, Utah.—*Photo by Stan Rasmussen.*

The first phase of Utah's $70,523,000 Weber Basin (reclamation) project is largely completed, and limited water service was begun in July 1957 to meet the urgent needs for municipal and industrial water and for irrigation of farmland. The project was conceived, designed, and constructed by the U. S. Bureau of Reclamation in response to the need for additional water supplies of the people residing in the drainage area of this important stream—the Weber River. The Weber Basin project is a model "multiple purpose" development, theoretically harnessing for beneficial uses all of the remaining water resources of the Weber River.

Developments for use of Weber River water prior to the Weber Basin project were undertaken by organized groups, by individuals, and by the Federal Government. Many private companies and individuals have contributed greatly to the development of an extensive network of canals that carry water to more than 100,000 irrigated acres. These same groups have also built many small reservoirs with an aggregate capacity of about 40,000 acre-feet. The final development was the Weber Basin project, which involves the "last roundup" of water in the Weber River drainage area.

The Weber Basin project development is designed to utilize the waters of the Weber River and its tributaries not yet put to beneficial use. Project construction includes reservoirs and other conveyance facilities, drainage works, and groundwater development. Specifically, the beneficial uses of the expanded water supply are primarily for municipal, irrigation, and industrial purposes, and secondarily for pumping power, development of fish and wildlife facilities, recreation facilities, and flood control.

The major storage features will consist of 5

by HAROLD E. ELLISON
President of Weber Basin Water Conservancy District, Layton, Utah

GATEWAY CANAL, Weber Basin Project, near Peterson, Utah.—*Photo by F. H. Anderson.*

reservoirs with a combined total capacity of 373,000 acre-feet of water. The 2 key reservoirs in the first phase (the project is being built in 2 phases)—Wanship and Pineview—are completed. Other essential features of the first phase for diversion, conveyance, and stored water are the Stoddard diversion works, the Gateway canal, the Gateway tunnel, the Davis and Weber adqueducts, and the Slaterville diversion works.

These first-phase storage-diversion and transportation facilities produce 76,000 acre-feet of water, 20,000 of which will be used for municipal purposes and 56,000 acre-feet for irrigation purposes. The second phase of the project development will produce an additional 110,000 acre-feet of water, of which another 20,000 acre-feet will be utilized for municipal and industrial purposes and the remaining 90,000 acre-feet for irrigation. This will create a firm water supply of 186,000 acre-feet for the Weber Basin project area.

Irrigation benefits will arise for providing supplemental water to 24,400 acres now only partially irrigated, and a full "new water" supply to 51,210 acres.

The Weber Basin project stood the test of economic feasibility solely because of its multiple-purpose features. The area was rapidly moving into a municipal and industrial water famine. In addition, many splendid acres of irrigable land were remaining unproductive because of lack of irrigation water. Industrial development in the area was grinding to a slow halt because of limited water supply. Practically all of the communities in Davis and Weber Counties were so short of water that restricted delivery was imposed annually during the high use periods.

When the Weber Basin project was authorized on August 29, 1949, by the Congress of the United States, the statute carried a provision that a contract guaranteeing repayment of construction costs must be executed between the Bureau of Reclamation and an entity that had taxing powers. The Water Conservancy Act of Utah provided an answer to this requirement, and the Weber Basin Water Conservancy District was legally created on June 26, 1950. In due course a contract was signed on December 12, 1952, under which the district would repay the United States the reimbursable costs of the project. These reimbursable costs total more than $57 million and include the costs for constructing the major facilities for storage and transportation of water, plus other programs such as drainage.

There still remained the need for facilities for treating water to be used for municipal and industrial purposes. The responsibility for providing treatment plants and delivery systems was accepted by the conservancy district. The district financed construction of these water-treatment and delivery systems through the sale of a bond issue which, when fully completed, will amount to about $10 million. Thus, the total costs involved in the Weber Basin project, including the nonreimbursable items, will exceed the $70 million mark.

The contract and bond issues created a firm partnership between the district and the United States, providing first for the repayment by the district of the reimbursable amounts for construction of project facilities, and for the operation of the project after its total completion; and second, for the responsibility of financing, constructing, and operating the treatment plants which were to receive the raw water from the reclamation project and convert it to usable domestic water.

The district proceeded with its particular responsibilities and now has built and put into operation three sizable filtration plants and the necessary pipeline systems, and domestic water of excellent quality is now being delivered to the communities in Davis and Weber Counties along the Wasatch Mountain front.

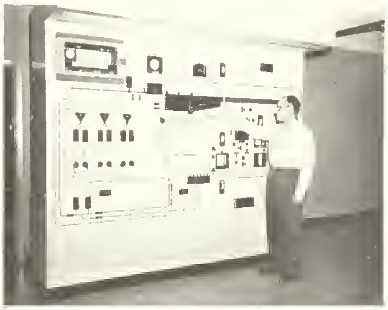
The combined capacity of the treatment plants is 40 second-feet of water, or about 26 million gallons daily. The plant designated as No. 2, located southeast of Ogden City, receives its raw water from the Weber aqueduct, which is the north leg of the aqueduct system starting at the west portal of the Gateway tunnel; plant No. 3, located at the intersection of Hill Field Road and U. S. Highway 89 in Davis County, and plant 4, located east of Bountiful City, obtain their raw water from the south leg of the aqueduct system, known as the Davis aqueduct. These three plants adequately provide for and produce the needed domestic water for the municipalities. (The original plan of the district was to build four plants. Plant No. 1 on the Ogden River was designed by the conservancy district, but, upon request, was actually built and is now owned and operated by the city of Ogden.)

Construction on the first phase of the Weber Basin project has been continuous. Adequate Federal appropriations have permitted uninterrupted work. First construction started with the boring of 3.3 miles of tunnel through the mountain which parallels the Weber River, starting at Gateway on the east and emerging at the mouth of Weber Canyon on the west. The first construction was marked by a ceremony and blasting operation on January 9, 1953, at the west portal of the tunnel, at which Federal Government, district, and State officials were present, as well as representatives of water groups.

Construction progress continued at a rapid pace, and on May 9, 1957, the second event of great significance to the Weber Basin project occurred with the dedication of the recently completed Wanship Dam and Reservoir in Summit County and the first storage of Weber Basin project water began. Wanship Dam is the key upstream retention facility around which the delivery of first-phase water revolves. More than a thousand persons attended the dedicatorial ceremony at the dam site, at which time Utah's senior Senator, the Honorable Arthur V. Watkins, presented the dedicatorial address, and the gates controlling the outlet works of the dam were officially closed by the U. S. Commissioner of Reclamation, the Honorable W. A. Dexheimer.

During the 1957 runoff season, a total of 59,000 acre-feet of water was stored in Wanship Reservoir, only 1,000 acre-feet less than its capacity. It is interesting to note that this reservoir has an unusual distinction in being allowed to fill to capacity the first year of its use.

The third and most encouraging date in the first phase development was in July 1957 when the stored waters from the Wanship Reservoir were released and turned into project and district facilities for beneficial use by irrigators, industries, and municipalities.



At left: Water purification plant No. 2, of the Weber Basin Conservancy District. Center: Control panel of the plant. Mr. Harold Dean, Weber Basin Project Office, explains its operation. At right: End of Gateway Canal. Tunnel entrance at left Future powerplant in the center. Spillway and upper end of wasteway at right.—*Photos by F. H. Anderson, Region 4.*

The Weber Basin project is very complicated in its general design and plan of operation. The total storage capacity will exceed normal annual requirements by 2½ times. Thus, provision is made not only for water delivery in years of low precipitation and runoff, but also for water exchanges that will assure ample water delivery and full crop production in years of short supply. Provision for such heavy carryover does materially increase the cost of the project, yet it is most essential if the needs of the people are to be fully satisfied on a long-range basis. It is estimated that, with the production of the watersheds and with the carryover provisions of the project, there will never be an inadequate municipal water supply, and rarely will there be a shortage, even, of irrigation water.

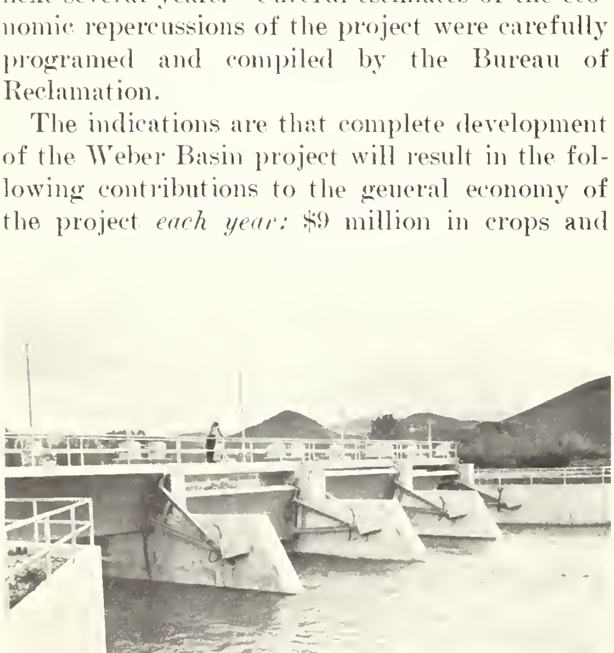
The Weber River has always produced what is considered sufficient water for the total economy of the drainage area, but much of it is produced below any points where it would be possible to retain it or use before it flows into the Great Salt Lake. Thus the Weber Basin project was designed to capture that water after it has done full duty, and store it for exchanges for beneficial consumptive and nonconsumptive uses. The water now diverted out of the Weber River to irrigate lands in the lake-plains areas will be turned out of the river at the Stoddard diversion dam and used on the foothills sections in Davis and Weber Counties, served by the Davis and Weber aqueducts, and the added storage in the enlarged Pineview Reservoir. The complications involved in administration are many; yet they have a common, practical solution, made possible because of Utah's water distribution practices in accordance with rights established under supervision of the State engineer's office and the statutes which fully provide for the exchanges.

It must be recognized that the principal purpose of the Weber Basin project is to increase the beneficial use of the area's natural resources—the land and the water—which, in turn, will directly affect the municipalities, the industries, and the rural areas within the project. The final test of the economic value to the area of the Weber Basin project can be determined only after history records the equation of economic benefits in the next several years. Careful estimates of the economic repercussions of the project were carefully programed and compiled by the Bureau of Reclamation.

The indications are that complete development of the Weber Basin project will result in the following contributions to the general economy of the project *each year:* $9 million in crops and livestock; $1,500,000 in State and county taxes; $256,000 in fish, wildlife, and recreation benefits; $500,000 in interest in increased financing; $4 million in increased day labor earnings. Taking into consideration a decrease annually of $202,000 in flood damages, the increased contributions to the general economy derived from the Weber Basin project will amount to more than $16 million each year.

In addition, over the 60-year repayment period, land values will be increased $1 million; investments in buildings, machinery, and equipment will total $12,600,000; and purchases of farm supplies will be increased by $5,300,000.

The Weber Basin project once again demonstrates that "reclamation pays"—in Utah and elsewhere in the West. # # #



STODDARD DIVERSION DAM.—*Photo by Stan Rasmussen.*

Oranges and Grapefruit, Larger Crops

The statistical summary of the United States Department of Agriculture reports that the Nation's 1957–58 Early and Midseason orange crop, forecast at 73.3 million boxes, will top the 1956–57 crop by 3 percent. Larger crops in all citrus States except California where a 22 percent smaller production of navels and miscellaneous oranges is in prospect. Florida's 59 million boxes of Early and Midseason oranges (including 3 million Temples) will top last year by nearly 9 percent; production in Texas, Arizona, and Louisiana is expected to top last season by 25 percent.

U. S. grapefruit crops 1957–58 harvest) is expected to total 45.3 million boxes, 5 percent above last year. #

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

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If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

The Whirlybird Patrol

The Parker-Davis project operates and maintains 2 powerplants, 36 substations, and approximately 1,500 miles of high-voltage transmission lines in southern Nevada, southeastern California, and Arizona.

Electric power from this system serves city and rural dwellers, and it is the aim of the project personnel to maintain uninterrupted electric service to all. This is important to the farmer and cattleman who depend upon a reliable supply of electric power to accomplish the many and varied tasks being performed on the modern-day farm and ranch. Without electric power, water for irrigation and stock would cease to flow. Excessive or prolonged delays in the restoration of service could result in crop damage and other severe losses to the rural people located in these areas.

Arizona is a lot of things to a lot of people, and there is a lot of Arizona—113,956 square miles of it—and every one of those square miles has something to offer and each square mile is different from the next. This is also true of the Nevada and southern California areas served by the project. A lot of very interesting and very diversified scenery and terrain is crowded within these areas in the three States in which the project operates.

Arizona, for example, spreads out in all directions, and it goes up and down in just as merry a manner, resulting in innumerable headaches and problems to the engineers responsible for electric-power-system operations and maintenance.

In elevation, Arizona varies from 137 feet above sea level near the Mexican border southwest of Yuma to Humphrey's Peak in the San Francisco Range near Flagstaff, which pokes its head 12,655 feet into the air. Within these low and high points are three general geographical regions, typical desert in the southwestern part, a forested mountain region in the central and eastern parts, and the high wind swept plateau region to the

by WILLIAM M. DOAK,
Chief, System Operations Division,
Parker Davis Project Office,
Phoenix, Ariz.

northwest. Variety, indeed, puts spice in our transmission line maintenance.

Whims of elevation in Arizona also account for the whims of our weather, and as a result, still more pressing problems are heaped upon the shoulders of the power line maintenance crews.

In resolving some of the terrific problems associated with the operations of the power system, the Parker-Davis project took a close look at the helicopter.

We consider the helicopter's exclusive ability to rise and descend vertically and to hover motionless at any height makes it literally a flying "jack of all trades." Mountains, rivers, marshlands, woods, water, or lack of roads present no obstacles. Isolated spots that cannot be reached by any land vehicle become easily and quickly accessible by helicopter. A helicopter flies direct, requiring landing sites hardly larger than its own size. When there is not sufficient area on which to land, ground contact can be made by the helicopter's hoist, which lowers personnel and equipment to the desired location, with actual landing being made nearby.

Prior to purchasing the helicopter, the project made a 3-month trial use of a helicopter by contract with a private company. Convinced by this trial that such an operation was feasible and very economical as compared with other methods of operation, a helicopter was purchased early in 1951.

The results during the past six years have exceeded our expectations. Substantial savings in cost of line patrol have accrued over the conventional method of patrol by linemen in jeeps and

TRIAL USE of the helicopter pictured here near Coolidge, Ariz.

Parker Davis project's helicopter landing at the Arizona Public Service Co.'s Saguaro steam plant near Redrock, Ariz.—*Photo by Arizona Public Service Co.*

pickups. During the past six years our costs for line patrol, including salaries, operation, maintenance, and depreciation have averaged about $18,000 per year. For the past 3 years, the costs are running less than $15,000 per year. This helicopter patrol is considerably cheaper than ground patrol of the same frequency and quality.

Furthermore, the quality of helicopter patrol is superior to ground patrol. The observer is in a comfortable position, slightly above and to one side of the line. He is not forced to gaze into a glaring sky, and he is thus able to quickly detect minor troubles in structures, fittings, or conductors before they become serious. Many possible future power outages are thus avoided.

In addition to its use for routine patrol, the helicopter is particularly useful and valuable in emergencies in locating trouble causing line outages. In case of a permanent line fault, the helicopter can get underway and cover a 100-mile stretch of line in less than 2 hours over desert or mountainous terrain that would take ground patrols many hours to cover. Outages are quickly located, the description of the trouble and equipment and materials needed for repairs are radioed back to headquarters and line crews dispatched with minimum loss of time to repair the trouble and restore service. This is of particular interest to farmers and ranchers operating within irrigation districts and REA's served by the project who have no source of standby power. The hazard of crop losses due to lengthy outages is greatly reduced, and the inconvenience of interruptions to homes and business throughout the area we serve is greatly minimized. # # #

WEED CONTROL BY SLIDE RULE

A standard pocket slide rule can be modified to make a handy calculator of weed control spray rig problems in the field as well as in the office. Figure 1 shows how this was done by E. G. Cakin, weed control specialist for the Tracy Operations Field Branch of the Central Valley project in California.

The rule he modified is a K & E No. 4907 B, which is made of white plastic, has the regular C, D, CF, DF, and CI scales on the front face and an inch and metric rule on the edges of the back. The basic modification consisted in inscribing nozzle spacing marks above the DF scale and marking the CF scale for miles per hour, the C scale for gallons per minute, and the D scale for gallons per acre.

To locate the points for inscribing the nozzle spacings, a problem is worked out to give a certain nozzle spacing in inches. Figure 2 is an example of such problem. To obtain a coverage of 150 gallons per acre, with nozzles spaced 18 inches apart and discharging 2.25 gallons per minute per nozzle, the rig must travel at a speed of 4.95 miles per hour.

As in the example shown, set 2.25 on C scale over 1.5 on D scale. Above 4.95 on CF scale inscribe a mark for a nozzle spacing of 18 inches. Remove the slide, reverse its direction, and set 18 on the CF scale in line with the 18-inch mark on the DF scale. Inscribe any desired nozzle spacings on the DF scale from the corresponding points on the positioned CF scale and the rule is completed.

To be more usable in the field, Mr. Cakin has inscribed on the back of his rule a chart giving the discharge in gallons per minute for the most used nozzles, and various formulas and conversion factors.

Along with replacing long hand calculations and charts and nomograms, this rule is still usable as a regular slide rule. # # #

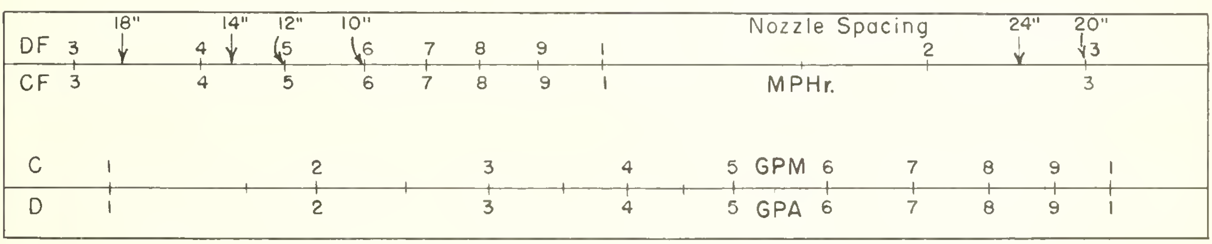

Figure 1 Detail of standard slide rule with special inscription

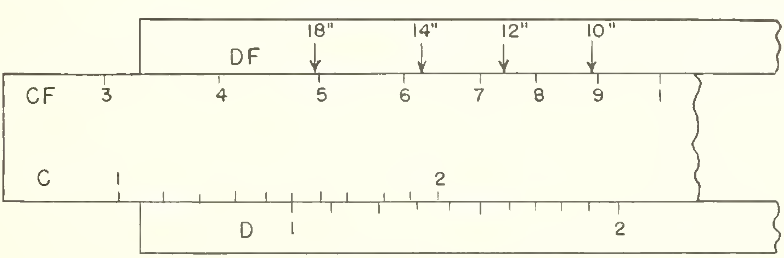

Figure 2 Detail for example

Construction and Materials for Which Bids Will Be Requested Through March 1958

Project	Description of work or material
Boulder Canyon, Nev.	Removing 3,500 square feet of terrazzo and underbed from the Safety Island floor and replacing with 2.25-inch-thick concrete underbed and 1-inch-thick terrazzo. The terrazzo has a complex and elaborate design involving strips, discs, plaques, and lettering in addition to the usual divider strips. Near Boulder City.
Central Valley, Calif.	Constructing twelve 18- and 24-inch-diameter pump turnouts with 4- by 6-foot meter boxes, two 24-inch-diameter gravity turnouts and modifying a turnout structure. Delta-Mendota Canal, between Gustine and Volta.
Do	Structural steel trashracks for Trinity Dam. Estimated weight: 700,000 pounds.
Columbia Basin, Wash.	Placing compacted earth lining in about 3 miles of laterals in Block 40, north of Moses Lake and Blocks 85, 86, and 87, about 18 miles northwest of Othello.
Do	Placing concrete lining in about 6 miles of laterals in Block 77, about 14 miles south of Quincy, and Block 701, west of Soap Lake.
Do	Earthwork and structures for about 8 miles of open-ditch drains. Work will include about 3 miles of drain extensions and deepening about 1.75 mile of drain. Block 72, east of Quincy, Block 87, northwest of Othello, and Block 49, southwest of Othello.
Do	Furnishing and installing 19 gear-motor drive units and automatic controls including stilling wells for conversion of manually-operated radial gates to automatic operation. Potholes East Canal, about 12 miles west of Eltopia, and West Canal, about 20 miles northwest of Othello.
Do	Constructing shop, residences, and service buildings for Wahluke Watermaster Headquarters in Block 20, south of Othello.
Do	Constructing additional protective fencing for pumping plant installations at various locations on the project.
Do	One 32- by 20-foot radial gate including embedded metalwork for the Esquatzel Diversion Canal. Estimated weight: 45,000 pounds.
Colorado River Storage, Utah.	Constructing a water supply system for the Flaming Gorge community. About 16 miles southeast of Linwood.
Colorado River Storage, Ariz.	Constructing a 344- by 144-foot administration building (part permanent and part temporary), a 146- by 70-foot garage and fire station, a 112- by 29-foot dormitory, and a 96- by 48-foot police building. At Page, about 135 miles north of Flagstaff.
Crooked River, Oreg.	Constructing the 186-foot-high earth and rockfill Prineville Dam, containing 1,350,000 cubic yards of material, crest length of 780 feet, and appurtenant structures. On the Crooked River, about 21 miles southeast of Prineville.
Fort Peck and Missouri River Basin, Mont. and N. Dak.	Furnishing and erecting steel towers for about 309 miles of the single circuit, 230-kilovolt, Fort Peck-Dawson County-Bismarck Transmission Lines. Work will include clearing rights-of-way, furnishing and installing fence gates and constructing footings. From Fort Peck through Glendive, Mont., to Bismarck, N. Dak.
Gila, Ariz	Constructing 2 reinforced concrete baffled apron drops and excavating for floodway channels to the Texas Hill Floodway. Near Growler.
Do	Constructing one 40- by 60-foot office building of block-type construction, and furnishing and erecting one 40- by 60-foot prefabricated steel shop building. At Yuma.
Little Wood River, Idaho.	Raising the earthfill Little Wood River Dam 42 feet and constructing a spillway and an addition to the outlet works. On the Little Wood River, about 11 miles northwest of Carey.
Do	Clearing 1,060 acres of cottonwoods and willows and 60 acres of aspens and brush from the Little Wood River Reservoir area, north of Carey.
Middle Rio Grande, New Mex.	Converting three 15-foot 4-inch by 9-foot 3-inch multiplate corrugated metal pipe arch road culverts to check structures by installing slide gates at inlets to pipe arches and extending the lengths of the pipe arches in the conveyance channel. Rio Grande, near Socorro.
Minidoka, Idaho	Earthwork and structures for open ditch laterals from 4 wells. Ten miles northwest of Paul.
MRB, Nebraska-Kansas.	Furnishing and installing 5 fixed radio stations and 25 mobile sets. No houses will be required. At Courtland, Kans., and Franklin, Red Cloud, Superior and Cambridge, Nebr.
MRB, North Dakota.	Two 230-kilovolts and five 14.4-kilovolts potential transformers; two 230-kilovolts, 1,200-ampere, 5,000-millivolt-amperes interrupting capacity power circuit breakers and two 14.4-kilovolts, 2,000-ampere, 1,500-millivolt-amperes interrupting capacity power circuit breakers. For Fargo substation.
MRB, South Dakota.	Constructing the 82- by 74-foot, one-story Watertown power system dispatching building with concrete masonry unit exterior walls and interior partitions having wood studs and dry walls on both sides. Work will include installing a sewerage system. Near Watertown.
Do	Constructing additions to the Summit substation. Work will include grading and fencing an extension to the substation, constructing concrete foundations, furnishing and erecting steel structures, and installing a 110/41.8-kilovolts, 8,000-kilovolt-amperes transformer, two 46-kilovolts circuit breakers and associated electrical equipment. Near Summit.
MRB, Wyoming	Two 144-inch butterfly valves for the Fremont Canyon powerplant. Estimated weight: 270,000 pounds.
Do	One 750-kilovolts station service unit substation with 750-kilovolts standby capacity for the Fremont Canyon powerplant.
Do	Trashracks for intake structure at Fremont Canyon powerplant. Estimated weight: 164,000 pounds.
Parker-Davis, Arizona.	Painting the exteriors of 48 houses and 32 garages at Davis Dam, 32 miles west of Kingman; at Parker Dam, 12 miles northeast of Parker; and at Coolidge, Mesa, and Tucson.
Rogue River Basin, Oreg.	Constructing the 115- to 85-cubic-feet-per-second-capacity Dead Intian Collection Canal, about 3,000 feet long, a rockfill-type diversion dam about 5 feet high and 100 feet long, and headworks structure; constructing the 25-cubic-feet-per-second-capacity Conde Creek Collection Canal, about 2.5 miles long, a rockfill-type diversion dam 5 feet high and 75 feet long, and headworks structure; and constructing improvements to the Grizzly Creek channel, about 1.5 miles long. Work will include constructing road crossings, drops, drain inlets and timber bridges. About 15 miles northeast of Ashland.
Do	Relocating the Hill Cemetery from the Emigrant Reservoir area near Ashland.
Shoshone, Wyo	Constructing 5.1 miles of closed drain and 0.76 mile of open ditch drain. Fourteen miles northeast of Cody.
Ventura River, Calif.	Furnishing and erecting 5 circular steel tank reservoirs or constructing 5 circular prestressed concrete reservoirs ranging from 250,000 to 3,500,000 gallons. Four tanks are to be 40 feet high with diameters of 130, 115, 90, and 70 feet and one tank is to be 24 feet high with a 44-foot diameter. Near Ventura.
Do	Constructing 5 outdoor-type pumping plants including control buildings with concrete masonry unit walls and roofs of metal joists with wood decks and built-up roofing to house the electrical control equipment. Work will include installing electrical control cubicles and the following electrically driven horizontal pumping units at each plant: 4 of 50 cubic feet per second total capacity at Ventura Avenue No. 1; 3 of 48 cubic feet per second total capacity for Ventura Avenue No. 2; 3 of 20.7 cubic feet per second total capacity for Ojai Valley; 2 of 8.2 cubic feet per second total capacity for Upper Ojai and 2 of 6.4 cubic feet per second total capacity for Rincon. North of Ventura.
Do	Furnishing and installing a complete automatic control and telemetering system for a municipal water district. System shall provide automatic control for starting and stopping pumps in 5 pumping plants based on water levels in tank-type reservoirs. Continuous transmission of telemetering signals to a dispatch office in Oak View from 5 reservoirs, 3 chlorination stations, and 5 pumping plants will be required as will continuous transmission or supervision of alarms. Information will be transmitted over leased telephone lines. Work will include constructing 10,000 feet of 2-wire telephone lines. Vicinity of Oak View and Ojai.
Do	One fabricated steel bulkhead gate, track, and screens for the Casitas Dam. Estimated weight: 182,000 pounds.
Wapinitia, Oreg	Constructing the 42-foot-high earthfill Wasco Dam, containing about 45,000 cubic yards of material and having a crest length of 390 feet, appurtenant structures, and about 1 mile of gravel access road. On Clear Creek, about 35 miles west of Maupin.
Washita Basin, Okla.	Constructing a field office, laboratory and pump house, and installing domestic water and sewerage disposal systems, and liquefied petroleum gas system. North of Foss.
Weber Basin, Utah	Constructing 4 pumping plants consisting of 2 outdoor, sump-type plants of 8 and 13 cubic feet per second capacities, an outdoor, flat-slab-type plant of 4 cubic feet per second capacity; and an indoor-type plant of 5-cubic feet per second capacity. Work will also include constructing about 4 miles of 15- to 36-inch reinforced concrete, pretensioned reinforcement (steel cylinder type) pipe, discharge lines, and trunklines. Sand Ridge, East Layton and Val Verde Pumping Plants, between Salt Lake City and Ogden.
Do	Earthwork and structures for about 15 miles of Uintah bench laterals of precast concrete pipe, modified prestressed steel cylinder pipe, mortar-lined and coated steel pipe and cast iron pipe or asbestos-cement pipe; 2 small reservoirs; and one pumping plant with 4 outdoor, horizontal booster units. South of Ogden.
Do	Constructing recreational facilities including access roads, culinary water system, irrigation ditch, boat ramp, fireplaces, shelters, restrooms and landscaping. At the Wanship Reservoir, 38 miles east of Salt Lake City.
Do	Constructing two 6-room brick veneer residences with floor spaces of about 1,180 square feet, full basements and a double garage, southeast of Ogden.
Yakima, Wash	Furnishing and installing traveling trashracks and conveyor in the forebay of the Chandler powerplant consisting of about 100,000 pounds of machinery parts and structural steel and some concrete work. Near Prosser.

*Subject to change.

MAJOR RECENT CONTRACT AWARDS

pec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
C-4914	Colorado River Storage, N. Mex.	Oct. 24	Construction of fifteen 3-bedroom residences and washhouse building; streets, driveways, and trailer park area; water, sewer, and electrical distribution systems; and power facilities for Navajo Dam government community.	Oehring Construction Co., Farmington, N. Mex.	$260, 190
C-4947	Rogue River Basin, Oreg.	Oct. 11	Construction of earthwork, concrete canal lining, and structures for Howard Prairie delivery canal, station 539+00 to 986+75; and Little Beaver Creek feeder canal.	Cherf Brothers, Inc., Sandkay Contractors, Inc., Cheney Construction Co., and S. Birch & Sons Construction Co., Ephrata, Wash.	1, 285, 057
C-4948	do	Oct. 11	Construction of Keene Creek Dam and Green Springs power conduit, station 1+47.77 to 118+31.75, utilizing concrete cylinder pipe (pretensioned reinforced) or welded plate steel pipe in power conduit, schedules 1 and 4.	Cheney Construction Co., Cherf Brothers, Inc., Sandkay Contractors, Inc., Green Construction Co., and S. Birch & Sons Construction Co., Seattle, Wash.	2, 894, 330
C-4951	Middle Rio Grande, N. Mex.	Oct. 17	Channelization of the Rio Grande, station 1400+00 to 1908+00, Socorro Area.	Reeder Construction Co., Albuquerque, N. Mex.	728, 648
C-4954	do	Nov. 6	Channelization of the Rio Grande, station 1908+00 to 1973+10, Socorro Area.	Boswell Construction Co., Albuquerque, N. Mex.	421, 547
C-4956	Ventura River, Calif	Nov. 20	Construction of earthwork, structures, concrete or steel pipe lines, and access roads for Casitas Gravity, Oak View, Ojai Valley, Rincon, and other mains.	E. A. Irish, Los Angeles, Calif	5, 263, 542
C-4960	Eklutna, Alaska	Oct. 23	Relocation of Eklutna-Palmer 115-kilovolt transmission line using new materials, schedule 1.	Montgomery Electric Co., Portland, Oreg.	230, 978
C-4961	Yakima, Wash	Nov. 1	Completion of Roza powerplant and switchyard	Power Line Erectors, Inc., Spokane, Wash.	121, 531
C-4962	Missouri River Basin, Wyo.	Nov. 29	Furnishing and installing two 25,263-kilovolt-ampere vertical-shaft generators for Fremont Canyon powerplant.	General Electric Co., Denver, Colo.	916, 771
C-4963	Columbia Basin, Wash	Oct. 25	Construction of earthwork, concrete lining, and structures for Block 20 laterals, wasteways, and drains, Wahluke Branch canal laterals.	Donald M. Drake Co., Portland, Oreg.	1, 320, 620
S-4968	Central Valley, Calif	Nov. 8	One 16-foot diameter spherical intake bulkhead and one lot of embedded metalwork for outlet works at Trinity Dam, schedule 1.	Treadwell Construction Co., Midland, Pa.	112, 368
C-4972	Missouri River Basin, Nebr.	Dec. 11	Construction of earthwork and structures for Meeker extension canal, station 1563+15 to 2122+17.6; and laterals, wasteways, and drains.	M. & A. Construction Co., Superior, Nebr.	584, 066
C-4982	Middle Rio Grande, N. Mex.	Dec. 18	Construction of earthwork and structures for Atrisco feeder canal, north reach extension.	Boswell Construction Co., Albuquerque, N. Mex.	133, 548
C-4983	Gila, Ariz.	Nov. 27	Construction of a reinforced-concrete overchute over Wellton-Mohawk Canal, station 661+16; and repair of existing overchute, station 660+00.	Arrow Construction Co., Inc., Yuma, Ariz.	161, 497
S-4984	Ventura River, Calif	Dec. 20	Three 2,400-volt and two 480-volt motor control equipment assemblies for Ventura Avenue Nos. 1 and 2, Rincon, Ojai Valley, and Upper Ojai pumping plants.	Electric Machinery Manufacturing Co., Minneapolis, Minn.	144, 700
C-4989	Colorado River Storage, Ariz.-Utah.	Dec. 10	Construction of two hundred 3-bedroom residences for Page, Ariz.	Page City Constructors (Mobilhome Corp., et al), Bakersfield, Calif.	3, 157, 580
DS-314	Minidoka, Idaho	Nov. 26	Eleven deep well pumping units for 11 wells in North Side Pumping Division.	Layne & Bowler Pump Co., Los Angeles, Calif.	140, 308
DC-369	Ventura River, Calif	Dec. 11	Clearing Casitas Reservoir site	V. J. Nielsen Construction Co., Parlier, Calif.	150, 000
DC-96	Provo River, Utah	Nov. 21	Construction of earthwork and structures for Provo River channel improvement above Deer Creek Reservoir, mile 4.1 to 26.7.	The Contracting Corp., Salt Lake City, Utah.	177, 620

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in this issue . . .

J. J. McCARTHY, Editor

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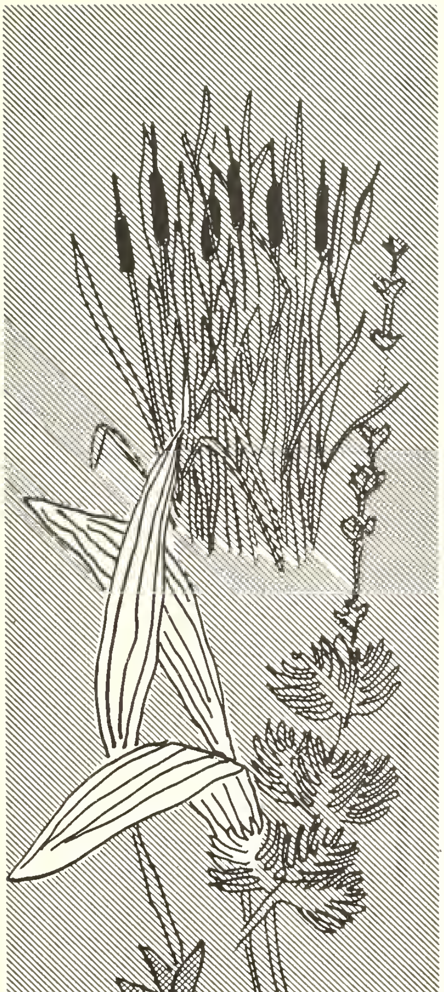


by ROBERT K. HUCKINS
Chipman Chemical Co., Bound Brook, N. J.

Aquatic Weed Control in Lakes and Ponds

The problem of controlling overabundant aquatic plant growths is of major concern to many people; pond owners, fishermen, swimmers, boaters, farmers, water supply managers, industrialists, in fact, all users of water. Such growths, when abundant, may interfere seriously with the use of water for recreational purposes, for irrigation, for drinking, and for industrial manufacturing.

Aquatic plant growths may be classified for purposes of their control, into several main groupings:

1. EMERGENT: Water weeds usually rooted in shallow water, but most of the plant grows above the surface of the water. Examples of this group are the cattail, tule, water lily, alligator weed and pickerel weed. The water hyacinth is a floating emergent plant.

2. SUBMERSED: Rooted water weeds which grow for the most part under water from the bottom of a pond or river. This group includes sago and bushy pond weed, horned pond weed, bladderwort, fanwort and water milfoil. A considerable portion of the water milfoil known as parrot-feather grows above the water. Coontail is a submersed waterweed but is not rooted.

3. ALGAE: Free floating plants of small size appearing as scum or attached to objects in the water. Nuisance algae are generally of two types, pond scums or filamntous types, and single celled algae or water blooms.

Those confronted with aquatic weed problems have tried many ways of controlling these pests. The principal methods developed for lakes and ponds can be classed as biological, chemical or mechanical.

1. BIOLOGICAL: The use of plant eating animals as agents of aquatic weed control has been tried out without any real success except perhaps in specialized areas. While ducks and

Above Left: BEFORE TREATMENT: Pond is covered with scum algae. Above Right: AFTER TREATMENT: With Atlas "A"—a clean surface indicates complete control. ***All Photos in this Article Courtesy of the Chipman Chemical Co.***

muskrats do eat large quantities of plants, they do not eat enough to give good weed control.

The use of commercial fertilizers to stimulate the growth of single celled plants and animals called plankton, which in turn, because of their density, shade out underwater aquatic plants, is widely used for submersed weed control in small farm ponds. To be successful the plankton "blooms" must be maintained at a density heavy enough to shade out the other vegetation. Under this condition the water resembles "pea soup" in color, and as such, is not generally considered to be suitable for recreational use. The amount of fertilizer needed is about 100 pounds per acre and treatments may have to be repeated as often as every 2 weeks from spring to fall. The cost of material and labor involved is too great for the use of this method in larger bodies of water.

2. MECHANICAL: Mechanical methods include mowing, dredging, raking, burning, and crushing of the weeds. For limited areas, in private situations, such methods may be effective but are costly in labor. The treatment of larger areas by mechanical means is very expensive, both in terms of labor and equipment. The "harvesting" of the cut weeds is a major problem and if not done thoroughly, the cut fragments of the plants, having the ability to produce new roots, will serve to spread the nuisance.

3. CHEMICAL: The use of chemicals for the control of undesirable aquatic plant growths is by far the most satisfactory method. Considerable research and development work over a number of years has made several chemicals available that will serve to control aquatic plants in most situations.

Submersed Aquatic Plant Control

The old "tried and true" chemical for the con trol of submersed aquatic plants in lakes anc ponds is sodium arsenite solution (See Editor's note.) It has been widely used for many year with consistently favorable results. As sodium arsenite is relatively nonselective in its effects o submersed aquatic plants it can be used for th control of almost all troublesome plant growths It is usually applied as as pray mixed with wate to the surface of the water area or it may some times be applied directly in diluted form to th exposed pond or lake bottom after draining.

To be most effective there should be almost n flow of water through the treated area for 2 to days after water surface area application is made In artificial ponds or impoundments it is ofte possible to lower the water levels prior to treat ment so that no chemical will be lost over th spillway for this 2 to 3 day period after treatmen while the pond is filling up.

The rate of application of Sodium Arsenit needed for the control of submersed aquatic plant in water treatments is from 4 to 10 ppm, de pending on the size and exposure of the are treated. The term "ppm" (parts per million), a used here, is a weight definition meaning pound of active chemical per million pounds of wate In this case, 4 to 10 ppm of arsenious oxid (AS_2O_3).

There are other new chemicals being develope for the control of submersed aquatic plants tha hold some promise for the future. Until such time that these become available, sodium arsenit remains the most effective and most reasonable i cost of any chemical available today.

ALGAE: There are four chemicals available to date that are specifically recommended for the control of algae.

Copper sulphate has been used for years for this purpose and is effective on many types. A rate of 0.3 to 1.0 ppm is generally used. The amount will vary directly with the hardness of the water.

Sodium arsenite is effective as an algicide as well as a herbicide and is relatively nonselective in its actions. It is used principally for the control of pond scums or filamentous types. The recommended rate for algae is 2.5 ppm.

Among the newer materials are rosin amine D acetate and dichlone (2,3-dichloronaphthoquinone). These two compounds are more selective than copper sulphate and in many instances, more effective. Another advantage of these materials is that they are generally less harmful to fish food organism than is copper sulphate. Rosin amine D acetate is to be recommended especially for the filamentous, scum and mat-forming algae while dichlone is more effective on the single celled "bloom" types.

Rosin amine D acetate is used at rates of 0.3 to 1.0 ppm, depending on water temperatures; the warmer the water the lower the rate needed.

Dichlone is effective against algae at the rates of 0.05 to 0.15 ppm.

Emergent Aquatic Plants

Control of most of the plants found in the emergent group is best achieved with 2,4–D. The low volatile esters or the amine formulations are to be preferred, for with these, there is less danger to adjacent valuable plants.

The recommended rate of 2,4–D for *emergent aquatic* plant control is a 0.5 percent solution using 100 to 200 gallons per acre. For small ap-

AQUATIC WEED PROBLEMS in fresh water lakes—Water lilies, Parrot feather, and Algae.

Typical power spray equipment.

plications, 8 fluid ounces of a 4-pound formulation mixed with 5 gallons of water gives about a 0.5 percent mixture. To make this solution, use 1 gallon of 2,4–D formulation (containing 4 pounds of 2,4–D acid per gallon) to each 100 gallons of water.

Shoreline brush and woody plants can also be controlled with the 2,4–D, 2,4,5–T type Brush Killers. These are used at the same rates and in the same manner as is 2,4–D when used for emergent aquatics.

Recently two newer compounds have come into use for the control of cattail (Typha) and reed grass (Phragmites).

Both dalapon (2,2–dichloropropionic acid) used at 25 to 40 pounds per acre and amino triazole at 5 to 10 pounds per acre are effective in controlling these weeds. A combination of these two has shown real promise in test work.

Application of Chemicals and Equipment Needed

The equipment needed for the application of the chemicals mentioned may be quite simple, e. g., a closely woven bag or a high pressure power sprayer. Copper sulphate is often broadcast over the water in the form of fine crystals. Dichlone is available as a wettable powder and rosin amine D acetate as a heavy thick paste or as a liquid. The first two materials, and also copper sulphate may be placed in a closely woven bag and dragged through the water in the area to be treated. Dichlone and rosin amine D acetate may also be applied as a spray over the surface in the same way as sodium arsenite. For small area spray applications, say up to 3 acres or so, a 5-gallon tank type sprayer may be large enough. The chemicals are diluted with enough water to give adequate coverage of the treated area. More time will be required to do the work with small equipment but the savings over heavy equipment costs may justify the extra time required.

For larger areas power equipment is desirable. Most satisfactory is a centrifugal pump powered with a gasoline engine. Pumps of 1 to 1½ inch size are adequate. The intake line is divided so that dilution water may be drawn from the pond or lake at the same time the chemical is being taken from the shipping drum or spray tank. The output side of the pump is connected via a hose equipped with regulatory valves to a spray boom extended past the stern of the spray boat. A branch "takeoff" hose line to a spray nozzle for reaching shallow and hard to reach areas is helpful.

The boat used for such work should be of rugged construction and powered with an outboard motor for ease in maneuverability.

The agricultural chemical industry is well aware of this national and international problem of overabundant aquatic plant growth. The search for new and more potent and less expensive chemicals is going on steadily. State and Federal Fish and Game Agencies and Experiment Stations are continually testing these new chemicals as they are being developed by industry. The public faced with waterweed problems will surely benefit from these research programs. Pictures of "BEFORE" and "AFTER" treatment, courtesy of E. F. Kennamer, Fish and Wildlife Specialist, Agricultural Extension Service, Auburn, Ala.

For the control of cattails the Bureau of Reclamation uses the Department of Agriculture's suggested recommendation of: 4 to 6 pounds of a low volatile ester of 2,4–D and a 1 to 20 oil-water emulsion (1 gallon diesel oil to 20 gallons of water) using a total volume of 150 to 300 gallons of the emulsion per acre of cattail plants. The first spraying should be done just before the cattail heads form and repeated as necessary, usually about 3 applications over a 2-year period for complete elimination. # # #

Editor's Note: As a safeguard to themselves, to others and to livestock, only persons experienced in the use of arsenic compounds and who thoroughly realize their poisonous nature should undertake to apply them. It is the policy of the Bureau of Reclamation not to use arsenicals in irrigation water.

DOMINY NAMED ASSOCIATE COMMISSIONER

Secretary of the Interior Fred A. Seaton recently announced the appointment of Floyd E. Dominy as Associate Commissioner for the Bureau of Reclamation.

Mr. Dominy, who has been with the Bureau of Reclamation for 11 years, served as Chief of that agency's Division of Irrigation from 1953 until August 1957 when he was named Assistant Commissioner.

Secretary Seaton said that Mr. Dominy, in the new position, will be second in authority to W. A. Dexheimer, Commissioner of Reclamation. He will also have overall charge of policy and program execution pertaining to the functions of the irrigation, power, project investigations, and budget considerations, in addition to his present responsibility for Bureau legislative affairs.

"The creation of the new Office of Associate Commissioner and the selection of Mr. Dominy to fill that position will greatly assist the Bureau of Reclamation in carrying forward its important program," Secretary Seaton said.

Mr. Dominy joined the Bureau of Reclamation in April 1946, as chief of the Allocation and Repayment Branch of the Operation and Maintenance Division. He became assistant director of the Division in 1950 and director in 1953. Under the Bureau's reorganization in December 1953, he became chief of the Division of Irrigation. #

"Ample Water Everywhere but Never Too Much Anywhere"

KINGSLEY DAM AND LAKE McCONAUGHY. *All photos in this article courtesy The Central Nebraska Public Power and Irrigation District.*

Having at all times enough water everywhere nd never too much anywhere is the secret of oprating an irrigation system without wasteways. nd when the system is as extensive as that of he Central Nebraska Public Power and Irrigaion District it takes a lot of planning and close ttention to the details of operation and water anagement to accomplish that end. But here semi-arid Central Nebraska limited water suplies make close scheduling imperative—and hence asteways unnecessary.

The Central Nebraska District brings water to 12,000 acres of land in Gosper, Phelps and earney counties in south central Nebraska, by eans of three canal systems: The Phelps County anal, 56.7 miles in length with 284 miles of disibution laterals, irrigating 72,786 acres; the –65 Canal, 54.7 miles in length with 199 miles distribution laterals, irrigating 33,484 acres, and the E–67 Canal, 9.34 miles in length with 15 miles of distribution laterals, irrigating 5,731 acres.

On these 120.74 miles of main canals and 498 miles of distribution laterals there are no wasteways and only five emergency spillways, which in 17 years of operation have been used only four times and then only because of heavy local rainfall. Even such flood conditions can be usually guarded against. Weather bureau reports, together with the districts own weather station at Holdrege, and readings by patrolmen made on 46 rain gages on the canals are used to anticipate heavy precipitation and excess accumulations, and the 120.74 miles of main canals are blocked into sections by structures making these sections, by careful scheduling, available to store excess flood water. Good water management and careful scheduling, even on a system as extensive and

by STANLEY A. MATZKE, Assistant to the Manager
The Central Nebraska Public Power and Irrigation District, Hastings, Nebr.

OVER 600 MILES OF CANALS AND DISTRIBUTION LATERALS comprise the irrigation system of the Central Nebraska Public Power and Irrigation District which irrigates 112,000 acres.

complicated as this, can eliminate the necessity of dumping water except in rare unforeseen emergencies.

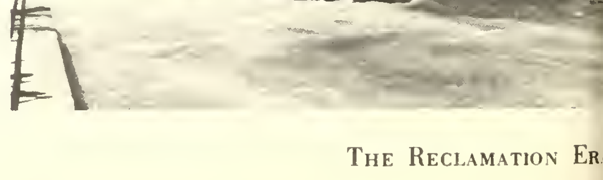
Operation of the system is supervised out of the Central Nebraska District's Holdrege Irrigation headquarters with area supervision offices at Holdrege, Minden, and Bertrand. During the irrigation season 21 patrolmen handle the deliveries, 7 on the 38,982 acres handled out of Holdrege, 8 on the 39,215 acres handled out of Bertrand, and 6 on the 33,804 acres handled out of Minden. Patrolmen travel in pickup trucks equipped with two-way short wave radio by which they can talk to each other, to the base stations at Holdrege, Minden, and Bertrand, and to the maintenance crews. An irrigation superintendent and a water clerk are permanently maintained at each of these three offices and are responsible to the irrigation engineer at the Holdrege headquarters. Employees, including all patrolmen, are on a full time, year around work basis, and are kept busy during the nonirrigation season with maintenance, repairs, shop work and making out water schedules.

But to get the picture of the setup by which approximately a quarter million acre-feet of water is handled each year without wasteways it is necessary to go back several months before the patrolmen begin opening the turnouts at the irrigators' farms; that is back to the first week in February prior to the beginning of the irrigation season in the first part of April.

It is then that the 12-member board of directors makes an official determination of the amount of water available for the coming season. The Central Nebraska District is not obligated by its contracts with its irrigators to deliver any specific amount of water, but only the pro rata share to each acre of the total available each year as determined by the board of directors. This can vary from year to year and in years of ample storage in The Central Nebraska Districts 2 million acre-feet capacity reservoir Lake McConaughy extra water is delivered with the approval of the board, especially in the spring and fall when stream flow is heavy and can be utilized in place of storage water.

After the determination of the amount of water available the board approves a scheduling of water rate deliveries for the approaching irrigation season. Until 1955 the schedule was on the basis of a minimum of 1 acre-foot per acre at the farm turnout divided into seven runs—21 days apart. Enlargements on the canal system completed that year make it possible for water users who desire it to obtain 1½ acre-feet per acre on the Phelps County Canal and on the E–67 Canal. Where 1½ acre-feet per acre is available the scheduling is on the basis of 11 runs 14 days apart, except on E–67 where the irrigators prefer 7 runs 21 days apart. The rate charged is $3.75 per acre for the 1½ acre-feet delivery and $2.50 per acre for the 1 acre-foot per acre delivery. The 1957 delivery was 1½ acre-feet, delivered at

Water being released from Lake McConaughy for use through three hydroelectric powerplants for irrigation on approximately 250,000 acres of Platte River watershed lands from Keystone to Kearney.



the water users turnout, to 73,649 acres and 1 acre-foot to 38,095 acres. Following is a typical water rate delivery schedule as approved by the board:

Runs	Phelps Canal	$3.75	$2.50	E–65 Canal	$2.50	E–67 Canal $3.75
1	4/16–6/4	0. 25 af	0. 25 af	4/16–6/11	0. 25 af	0. 25 af
2	6/4–6/18	. 18	. 09	6/11–7/2	. 18	. 30
3	6/18–7/2	. 18	. 11	7/2–7/23	. 18	. 30
4	7/2–7/16	. 18	. 11	7/23–8/13	. 18	. 30
5	7/16–7/30	. 18	. 11	8/13–9/3	. 18	. 30
6	7/30–8/13	. 18	. 11	9/3–9/24	. 18	30
7	8/13–8/27	. 18	. 11	9/24–10/15	. 18	. 30
8	8/27–9/10	. 18	. 11			
9	9/10–9/24	. 18	. 11	Total af per acre.	1. 33	2. 05
10	9/24–10/8	. 18	. 11			
11	10/8–10/22	. 18	. 11			
	Total af per acre.	2. 05	1. 33			

ord showing the name of the water user, a description of the land, the number of acres to be served, the acre feet of water to be available for each run and the date thereof. Each water user is mailed a card listing this information with the admonition, "Keep this card to remind you of your water delivery dates for this year." Most water users hang the card near the telephone where it serves as a daily reminder and his work and social calendar are geared to its demands.

Each patrolman gets a complete copy of the Water Record so far as it concerns his patrol and also a Route Card for each account on his patrol. These are size 4½ by 7 inches and carried in a loose leaf binder and thereon he keeps

Left: HEADGATE of Phelps County Canal. Center: Board of Directors of Agriculture Committee (from left) Frank Cole, a pump irrigation well driller, Winford Bossung, a farmer, Morits Aabel, an insurance agency manager, J. R. McBride, a feed manufacturer and alfalfa dehydrator operator, and Ben H. Bracken, a lawyer. Right: PATROLMEN CHANGING DIVERSION.

After the adoption of the delivery schedule by the board of directors each of the three area offices begins making up schedules for the patrols under its supervision, and each superintendent with his water clerk and patrolmen makes up the schedule for each water user on each patrol. The acreage entitled to water on each farm and on each patrol has been predetermined by the irrigation superintendent and water clerk and the total amount of each run on each patrol is determined by multiplying the amount of each run as shown by the delivery schedule by the number of acres in the patrol. This then divided by the 14 or 21 days gives the amount of water needed on the patrol each day. The patrolman and water clerk then figure from past experience the amount of water which will be lost by seepage and evaporation and add this to obtain the amount of water needed each day at the patrol diversion. Variations in weather conditions make these estimates subject to day to day changes which it is the patrolman's duty to anticipate and report.

Each area water clerk makes up a Water Record showing the name of the water user, a record of each delivery throughout the season. This looseleaf book also carries his Water Delivery Report blanks of the same size to report each individual delivery to the area office. These are posted on the Water Record and on a Daily Summary Report which is sent each day to the Holdrege headquarters where an overall daily summary is kept from which diversions at all points can be totaled.

A water user can turn down any run by giving sufficient notice to the patrolman or the area office. It is standard procedure that the patrolman contact each water user 2 days prior to the date set for each run and in case he desires no water he signs a Water Shut Off Notice. In case the water user is a tenant the landowner is notified of the water refusal by post card.

The overall water management of the Central Nebraska District is under the supervision of its Hydraulic Engineer at its Hastings headquarters who supervises the release of water from Lake McConaughy which gets 80 percent of the inflow from return flow from irrigation from Bureau of

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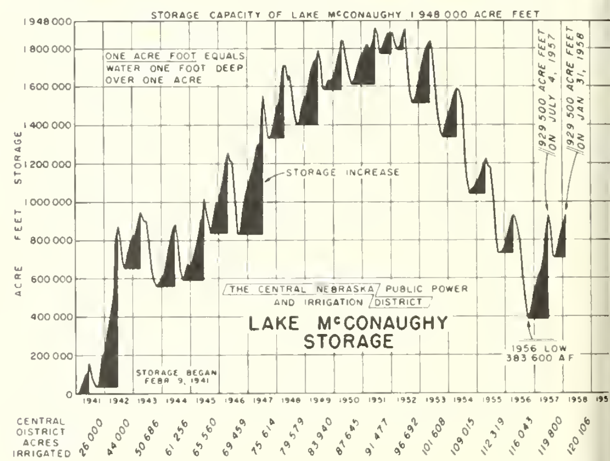
SCHEDULING OF ANNUAL WATER DELIVERIES. Meeting at Holdrege Irrigation headquarters are (standing from left) Assistant General Manager Jack W. Boyd and Irrigation Engineer L. G. Mathieu, and (seated from left) Irrigation Superintendents, Orvin Marquardt of the Bertrand office, William Cronin of the Minden office and Martin Waller of the Holdredge office.

Reclamation reservoirs up the North Platte River in Wyoming; its diversion at the Keystone diversion dam to the supply canal of the Platte Valley Public Power and Irrigation District for operation of its 26,000 kw. hydroplant, from where it is returned to the South Platte River; its diversion at the North Platte diversion dam to the Central Nebraska District's 75-mile-long supply canal on which 8,105 additional acres are irrigated by pumping from the canal and three 18,000 kw. capacity hydroplants are operated, and finally its diversion to the head gates of the irrigation system's three canals as herein described.

This management includes the bypassing down the river at the Keystone diversion of natural flow and supplemental storage water for 6 on-river canals between there and North Platte, the return to the river of natural flow and supplemental storage water at the upper (Jeffrey) hydroelectric plant for the 6 on-river canals between there and Lexington and the return to the river at the Johnson No. 2 hydroelectric plant of natural flow and supplemental storage water for the 2 on-river canals below Lexington.

The Central Nebraska District furnished these on-river canals supplemental storage water up to 125,000 acre-feet each year. The irrigation division management must be closely coordinated with this overall management to the end that full beneficial use is made of every drop of water—so that, like the irrigation division, there is ample water everywhere but never too much anywhere.

Management within the framework of the irrigation division's more or less rigid system still allows room for considerable flexibility as water users with the cooperation of the patrolman change run dates and often, as in the early part of the season, are given considerable leeway as to when they take their early runs. But when the chips are down in the heat and drouth of July and August rigid adherence to the system assures that there will always be enough water everywhere and never too much anywhere. And if there is never too much anywhere you just don't need wasteways, although sometimes when the patrolmen are fighting accumulations from local rains they have to do some mighty fast water juggling.



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WOMEN VOLUNTEERS WANTED FOR ERA

The Secretary or some other officer of each and every organization of women on our projects is requested to take her pen or typewriter in hand and write to J. J. McCarthy, Editor of Reclamation Era, *and outline her views as to how the* Era *may best serve the interests of our project women. The same invitation is extended to every woman not connected with a women's organization.*

The Era *wishes to be of service to everyone on the projects—men, women, boys, and girls. Just now the call is for women volunteers; without whose cooperation this proposed feature of the* Era *cannot be a complete success. Write today!*

Zinc Deficiency in the Irrigated West

Do you have stunted corn with broad white stripes on the lower leaves? Or do you have yellowish-brown patches of stunted beans showing severe chlorosis on the lower leaves soon after they come up? If you do, then chances are that your crop may need zinc.

Zinc deficiency is being noted in more and more areas in the irrigated West. Back in the 1920's, "mottle leaf" on citrus and "rosette" or "little leaf" on deciduous fruits were observed in many areas where these crops were grown. It was particularly bad on old corral areas. Research showed that it could be corrected by the application of sprays containing zinc and that zinc was an essential element for growth. Use of zinc sprays in orchards and groves became a common practice in most fruit-growing areas. Then, in 1950, the author showed that a deficiency in corn and beans in the Columbia Basin and Yakima projects in Washington could be corrected by the application of zinc sulfate sprays. Later research showed that a large number of crops including grain sorghums, onions, alfalfa, hops, grapes, lime and field beans, Sudan grass, soybeans, and castor beans were susceptible to the deficiency.

At about the same time, growers in the Salinas Valley, Calif., started applying zinc sulfate sprays to improve the foliage color and hasten maturity of beans. Later work in California by Dr. John C. Lingle has shown that a number of vegetable and field crops are affected by zinc deficiency in the valleys of California. In North Dakota, severe symptoms of zinc deficiency on corn have been noted where surface soil is removed in the leveling of land for irrigation. In 1954, zinc deficiency on beans and corn was found to be rather widespread in the North Platte valley irrigated areas and in other parts of western Nebraska. In 1957, severe zinc deficiency and stunting of corn was noted in the Prospect Valley of eastern Colorado. The available evidence indicates that areas showing zinc deficiency in crops are rapidly spreading in the irrigated West and that farmers must be prepared to cope with the situation.

Not very much is known about the soil conditions which produce zinc deficiency. A 3,000-pound dry bean crop contains only about one-tenth pound of zinc, yet beans are unable to get this amount of zinc from a soil that often contains as much as 300 pounds of zinc in the surface foot of an acre. Available zinc is generally higher in the surface soil where the organic matter is lo-

by F. G. VIETS, JR., Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, Fort Collins, Colo.

cated and declines rapidly with depth. Hence, removal of surface soil by erosion or by leveling for irrigation will frequently induce zinc deficiency. Both the availability of the native and applied zinc is affected by the soil reaction or acidity. The more acid the soil, the more available the zinc becomes. Zinc can be made more available by the use of sulfur or acid-forming fertilizers like ammonium sulfate. However, changing the soil acidity is not a practical method of increasing the available zinc supply.

In Washington, where zinc deficiency has been particularly severe on hops, corn, Netted Gem (Idaho Russet) potatoes, and onions, application of 10 pounds of zinc per acre broadcast or sidedressed every 3 or 4 years is now recommended. Hops need 20 to 30 pounds per acre. Though other crops are sensitive to zinc deficiency, zinc

gested, but rates above 100 pounds zinc per acre have been required to achieve correction. Therefore, foliage applications are recommended.

Research in Washington has shown that any material which contains zinc in a form soluble in acid is a satisfactory source for soil application. Zinc sulfate and a byproduct of the smelting industry have been cheap and effective sources. The rates suggested here are for elemental zinc and should be corrected for the zinc content of the material used.

There are many puzzling problems yet to be solved. In California, sugar beets have been one of the most responsive crops to foliage applications of zinc spray. However, in Washington sugar beets have rarely shown evidence of zinc deficiency or response to zinc sprays or fertilizers. In both Washington and Nebraska, zinc deficiency

At Left: Zinc deficient onions. At Right: Zinc deficiency on beans. All Photos in this article courtesy of the Author.

remains available in the soil over a considerable period and so this periodic application is sufficient to take care of the zinc needs of all crops in the rotation. Zinc cannot be leached from the soil by rain or over-irrigation. In Nebraska, the same recommendation is now made for control of the deficiency in beans and corn. In Washington, sprays of zinc sulfate were used before soil applications were recommended, but now it appears that sprays should be used only as an emergency method of control. For spraying, a solution of about one-half percent zinc sulfate is used and foliage of the entire plant is wetted. Because 50 to 100 gallons of spray per acre are required, aerial application has not proven feasible.

In California, soil applications have been sug-

on crops is much more severe following sugar beets than any other crop. The reason for this is not known, but some have suggested that it may be due to the fact that phosphate is generally applied to beets. On tree fruits there have been many instances where phosphate application induced zinc deficiency, but with Washington soils application of phosphate had no affect on availability of native or applied zinc for corn or beans.

There are other puzzling problems. In Washington, the Netted Gem variety of potatoes (called Idaho Russet or Russet Burbank in other places) will often show a peculiar stunting and twisting of the terminal growth. Sidedressing zinc fertilizers or spraying zinc sulfate on the foliage

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L. N. McClellan

Grant Bloodgood

Alfred R. Golzé

E. G. Nielsen

William I. Palmer

Donald S. Mitchell

KEY PERSONNEL CHANGES

Changes in top administrative posts in the Bureau of Reclamation's Washington and Denver offices as the result of the retirement of Assistant Commissioner and Chief Engineer L. N. McClellan and Assistant Commissioner S. W. Crosthwait have been approved by Secretary of the Interior Seaton on the recommendation of Reclamation Commissioner Dexheimer.

The changes are:

Grant Bloodgood, formerly Associate Chief Engineer, to Assistant Commissioner and Chief Engineer in Denver.

Alfred R. Golzé, formerly Chief of the Division of Program Coordination and Finance, to Assistant Commissioner in Washington, with primary responsibilities for administrative functions.

E. G. Nielsen, formerly Assistant Commissioner in Washington, to Associate Chief Engineer in Denver.

These, with Commissioner Dexheimer and Associate Commissioner Dominy, complete the top Executive Staff of the Bureau.

William I. Palmer has been named Chief of the Division of Irrigation, succeeding Mr. Dominy, and Donald S. Mitchell has been named Assistant Chief, succeeding Mr. Palmer.

MR. McCLELLAN, a native of Middletown, Iowa, is a veteran in years of service with the Bureau of Reclamation. Upon receiving his B. S. degree in electrical engineering from the University of Southern California in 1911, he joined the Bureau of Reclamation as Superintendent of Power on the Salt River project.

He served as a first lieutenant in the United States Army during World War I, returning to the Bureau, after his discharge, as assistant electrical engineer at Denver. He has worked for the Bureau continuously, with the exception of a brief term with the Southern California Edison Co., holding many top ranking positions. He has served as Chief Electrical Engineer, Assistant Chief Engineer, Chief Engineer, and Director of the Branch of Design and Construction. He held this latter post when appointed to his present position.

Mr. McClellan is a member of the American Institute of Electrical Engineering and the American Society of Civil Engineers. He has also been very active in international professional affairs and is a committee member of the International Conference on Large Electric High Tension Systems. He has received many honors in recognition of his work. The Department of the Interior bestowed its highest award, the Gold Medal Award for Distinguished Service, on him in September 1952. In 1951 he was presented the Gold Medal Award for Distinguished Service by the Colorado Engineering Council to become the fifth recipient of the award in the 25 years of its existence. The honorary degree of Doctor of Engineering was conferred upon him in 1949 by the University of Colorado. This year he was presented the Golden Beaver Award by the Beavers, an organization of construction and equipment companies and men who have built dams and other large structures in the western United States.

Mr. McClellan is a member of Sigma Xi, honorary scientific fraternity, and Tau Beta Pi, honorary engineering fraternity. He is a Fellow and Life Member of the American Institute of Electrical Engineers; member of the American Society of Civil Engineers; member and past vice president of the Colorado Society of Engineers; member of the International Conference on Large Electric High Tension Systems (C. I. G. R. E.); member of the United States National Committee of the International Commission on Irrigation and Drainage; and member of the United States Committee of the International Commission on Large Dams.

MR. BLOODGOOD was first employed by the Bureau in 1920. He received his degree in engineering from the University of Nebraska in that year and immediately went to work for the Bureau of Reclamation on the North Platte and Riverton projects in Nebraska and Wyoming. He was in private engineering work from 1925 to 1929, including the location and construction of a canal and lateral system for a 40,000-acre irrigation project in Mexico. He returned to the Bureau of Reclamation in 1929, working on the Riverton project and later going to the Boulder Canyon project where he was in charge of layout and estimates during construction of Hoover Dam and Powerplant. He was, successively, Resident Engineer for construction of the All-American Canal, Calif., the Gila Project, Ariz., and the Central Valley project, Calif.

He saw military service with the Corps of Engineers in both World Wars I and II.

Returning to the Bureau of Reclamation as Chief of the Construction Engineering Division in Denver in 1946, he later became Assistant Chief and then Chief Construction Engineer. He has been Associate Chief Engineer since January 1954.

He is a member of the American Society of Civil Engineers, Society of American Military Engineers, American Concrete Institute, and United States Committee on Large Dams. He was awarded the Interior Department Gold Medal for Distinguished Service.

MR. GOLZÉ is a career Federal employee with 28 years of service, including 23 with the Bureau of Reclamation. He will be responsible for general administrative detail, including contract administration, programs, finance, personnel, and management. He had previously been Chief of the Division of Program Coordination and Finance.

Mr. Golzé is a native of Washington, D. C., and a graduate in civil engineering from the University of Pennsylvania. He is presently vice president of the National Capital Section of the American Society of Civil Engineers and a member of the National Committee on Engineering Education of ASCE.

He began his public career as a Junior Civil Engineer in the Interstate Commerce Commission in 1930, and transferred to the Bureau of Reclamation as a Design Engineer in the Denver Office in 1933. He was responsible for all Civilian Conservation Corps activities in the Bureau in the late 1930's, and in 1943 went to the Bureau of the Budget in San Francisco.

In 1945, he returned to the Bureau of Reclamation as Assistant Director of the Branch of Operation and Maintenance. He was made Director of the Program and Finance Division in 1947.

MR. NIELSEN, first employed by the Bureau in 1934, obtained his B. S. degree in engineering from the University of Iowa in 1926. After working with private utilities and the Public Service Commission of Missouri, he joined the Bureau of Reclamation as Assistant Engineer in Denver in February 1934. In May 1936 he was promoted to Associate Engineer and in June 1938 became Planning Engineer at Salt Lake City, Utah.

He returned to the Denver office in 1942, and in January 1945 became head of the Hydrology Division. Subsequently, in 1945 he became Regional Planning Engineer at Boulder City, Nev., for the Lower Colorado River area. He became Assistant Regional Director at Boulder City in 1950, and in 1952 he was promoted to Regional Director. He has been Assistant Commissioner of the Bureau of Reclamation since 1955.

Mr. Nielsen is a member of the American Society of Civil Engineers and of Theta Tau fraternity.

MR. PALMER, Chief of the Division of Irrigation, has been with the Bureau of Reclamation since November 1944. He has been Assistant Chief of the Division of Irrigation since January 1956—while serving at the same time as Chief of the Contracts and Repayment Branch of that Division, following his appointment in October 1953. Prior to coming to Washington, Mr. Palmer served in the Bureau's Salt Lake City and Sacramento offices. He has also served with the Soil Conservation Service and other Department of Agriculture agencies in Utah, New Mexico, Arizona, Colorado, and California. He received his B. S. degree in agricultural economics from Utah State Agricultural College at Logan.

MR. MITCHELL has been Chief of the Land and Water Branch of the Division of Irrigation, since September 1950. He is a native of Colorado, and has been with the Bureau since June 1936. His experience covers several years with the Bureau as Irrigation Manager of the South Platte River District in Colorado and a tenure in administration in the Washington Office since 1950. As Irrigation Manager he was responsible for all agricultural activities, such as land classification, economics, and repayment determinations.

Mr. Mitchell received his B. S. degree in agriculture from the University of California.

As this issue went to press, Secretary of the Interior Fred A. Seaton announced the appointment of BRUCE G. DAVIS as Chief of the Bureau's Division of Program Coordination and Finance.

Mr. Davis, a career employee with the Bureau, was Chief of the Programs Branch of the Division at the time of his appointment.

Adventure in the Glen Canyon of the Colorado

The trip through Glen Canyon was not an adventure in the normal sense of the word. There was no physical risk involved in the boat trip that was made from Hite to Lees Ferry. Rather, it was an adventure into an awesome land where geologic turmoil and serene beauty join in close harmony, a rugged country that still conceals much of the history of a prehistoric Indian existence, and a sometimes turbulent, sometimes placid river that twists and turns in directions prescribed by high and sheer canyon walls. It was an adventure into the past. Except for modern equipment and utensils that were taken along on the trip, it was an almost complete, though temporary, retreat from civilization.

The Colorado is a river of many moods. In some places it is angry and tempestuous. In others, it is cool and placid. Sometimes it races along as if on a mission. Then again it will subside to a lazy lapping. It can make man fear or it can soothe him with a monotonous swish. It can stir excitement and then again the deafening roar of the water in the deep canyons will breed a peculiar melancholia. It is unpredictable. It is beautiful.

The Glen Canyon reach of the Colorado River has rugged beauty in the canyon walls that reach 2,000 feet into the sky to forbid passage except in one direction—down the river. It has mysterious beauty—of hidden canyons and passages, caves and grottos, of red sandstone spires and arches and fantastic shapes that change with the moving sun. It has beauty beyond comprehension. Man cannot adequately copy or portray it. But he can absorb it. We did.

We pushed our two rubber rafts in at Hite, an old mining settlement approximately 145 miles upstream from the Glen Canyon Damsite. There were ten in the party which included engineers, zoologists and botanists, a mammalogist, a photographer and two expert river-runners. The red mud was knee-deep and gooey as we climbed aboard and shoved off on our trek down the river. Flash floods and cloud bursts during the previous

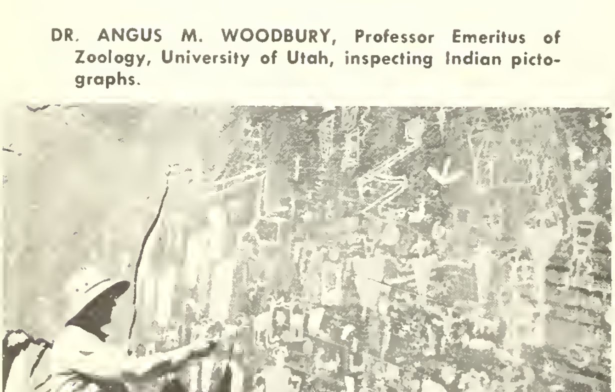
by STAN RASMUSSEN, Regional Photographer, Region 4, Bureau of Reclamation, Salt Lake City, Utah

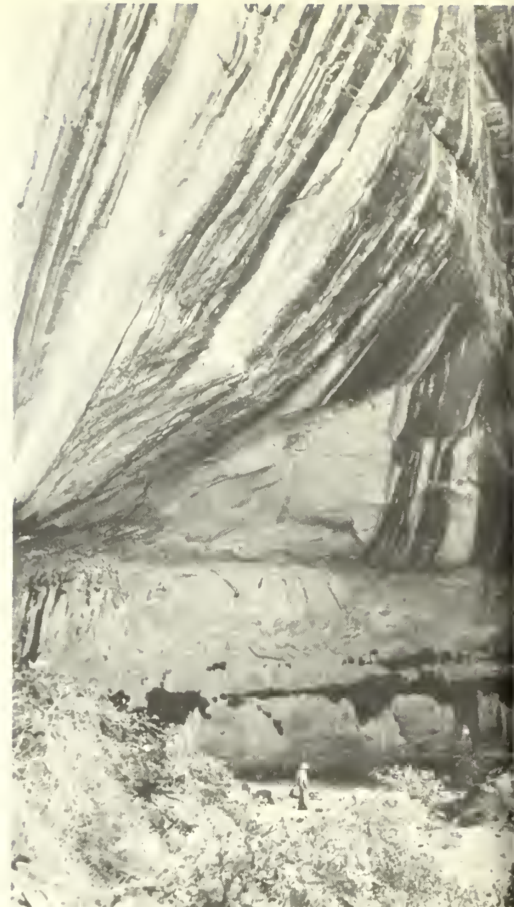
This Canyon appropriately called "Hidden Passage" is one of the many deep and narrow alleyways leading off the Colorado River.

week had left the river extremely muddy and the banks so soft that almost every landing was like walking off into quicksand. It was the only inconvenience to spoil the perfection of the ride down the Colorado.

The purpose of the trip was to plan a scientific

DR. ANGUS M. WOODBURY, Professor Emeritus of Zoology, University of Utah, inspecting Indian pictographs.





study of the area to be inundated by the reservoir of the Bureau of Reclamation's Glen Canyon Dam. Many experts in the field of natural science are in the area working on this project and will complete their studies before the rising waters fill the Glen Canyon. This particular group from the University of Utah included Drs. Woodbury, Durrant, Flowers, Cottam, and Grundman. Representing the Bureau of Reclamation were engineers Herb Riesbol, Denver, and Don Barnett, Salt Lake City, and the author. The river runners were Jack Brennan and Reed Jensen. There is much that must be learned about the reservoir area before it is flooded. These men were contributing their efforts to that end.

It required many stops each day. They were all the same. One or two of the men would take off in a zig-zag course following the tracks of rodents or muskrat or some other animal. Others would wander off in pursuit of plants and vegetation that they would preserve between pieces of

CROSSING OF THE FATHERS. At this point in 1776 Fathers Silvestre Valez de Escalante and Francisco Dominguez carved steps in the Navajo sandstone to aid their horses in the descent to the Colorado River. Reed Jensen of Salt Lake City is shown at the top of the steps.

cardboard and cushions of news print for future analysis in the laboratory. Then another would set about capturing little bugs and insects and stuffing them into small bottles containing alcohol or formaldehyde.

Someone would spot a chuckawalla lizard, which would be pursued with a long strip of rubber cut from an innertube. Curiosity would be the end of Mr. Lizard's freedom as the taut rubber band was released to whop him in the belly, stunning him long enough for the hand of an agile zoologist to close around him. A rattlesnake sleeping under a bush didn't wake up soon enough and was introduced to a white cloth bag as another specimen. And so it went. It was exhausting work slogging through the mud, or up the side of steep canyon walls and warily working back down again, or up sloppy creek beds and through underbrush.

But there were compensations. When the boats had been turned into the banks for the last time after the day's run, it wasn't long until the aroma of coffee would waft through the balmy night air and magnetically pull the party close to the roaring campfire. The stew and dutch-oven biscuits

REED JENSEN and JACK BRENNAN, river runners, walking up Bull Frog Creek in about a foot of mud.

were as tasty as steak and gravy. Then in the light of the full harvest moon there was the conviviality which attends every campfire. And when the talk was done, there came sleep that was deep and satisfying.

The next day would begin with a renewed vigor as the party set out to learn more of this fabulous canyon. History had been here. It was written on the canyon walls.

There are the steps that had been cut in the sandstone by the small party lead by Fathers Escalante and Dominguez in 1776 to assist their animals to the bottom of the canyon. They were returning to Santa Fe, N. Mex., after an unsuccessful attempt to find a direct route to the Presidio of Monterey in California.

And there is a gaping cleft high on the canyon rim where courageous Mormons had blasted an access for their wagons and sent them rumbling in a perilous descent down the canyon to the Colorado River. Today, this is known as the "Hole-in-the-Rock." They crossed the river and headed on into southeastern Utah to found a new settlement near what is now Bluff, Utah.

Then, too, there were the signs left by Major John Wesley Powell. This one-armed ex-artillery officer had led two expeditions (1869–72) down the river—the first expedition for 1,000 miles through many seething, boiling rapids, from Green River, Wyo., to the mouth of the Virgin River. When Powell made his trips the Colorado was virtually unknown except for Indian legend and fabulous stories that had been told by the Spanish after they discovered the Colorado in 1540. Some of his men had carved their names into the walls at the "Music Temple," an enormous cave that was so named by Powell because of the tinkling reverberations that were set off when his men threw rocks into the pool of water inside.

There are signs that are much older. These are picture writings and stone houses that hang high in crevices on the canyon walls. The archeologists and anthropologists are studying the remaining evidences of the prehistoric people who inhabited this now barren region. They are discovering dwelling sites of the "Moki Indians" and already have collected samples of clothing and implements

A company of Mormon pioneers with 83 wagons crossed the Colorado River at this point on their way to settle in southeastern Utah near present community of Bluff, Utah. Twenty-six of the 83 wagons were driven down through the "Hole" and ferried across the river on the first day, January 26, 1880. The road and this crossing were used for one year as the main wagon route to southeastern Utah, and many wagons went both ways through the "Hole-in-the-Rock." This cleft in the canyon wall—the "Hole-in-the-Rock"—will not be flooded by the Glen Canyon Reservoir.

DR. STEPHEN DURRANT, mammalogist, displays a striped-whip snake he captured during the trip.

and remains of farm products that were a part of early man's existence.

But there are new signs too, where modern man has been working. They are the scars at the Glen Canyon Damsite where drill crews have left their mark, and in the huge holes near the bottom where the water of the Colorado River will be diverted from its channel so that a huge concrete dam can be constructed.

A large and beautiful lake will soon fill the area that we traveled on our ride down the river. The advent of clear, placid blue reservoir water into the Glen Canyon will present great recreational opportunities. Places now practically, if not completely, unknown and inaccessible will be reached by the smooth reservoir waters. And overland routes will be opened to the reservoir shore at many suitable locations.

The National Park Service is working on plans for recreational development of the 186-mile long reservoir. Some day—or rather some year—soon, citizens from all parts of the Nation will come to the Glen Canyon and its new reservoir to re-create themselves both spiritually and physically.

Our final landing at Lees Ferry was at muddy as our launching had been at Hite. But it went unnoticed. We were happy. We had spent a week viewing and exploring one of the multitude of canyon areas in the Colorado river basin. We had been privileged to delve a little into the past. We had seen the splendor of the Glen Canyon of the Colorado River, soon to be made available to all. It has whetted our appetite for further exploration of the deep and almost inaccessible canyons of the basin.

Regional Photographer Stan Rasmussen, who took all photos in this article, accompanied a group of University of Utah scientists making a biological reconnaissance of the Colorado River from Hite, Utah, to the Glen Canyon Damsite, 15 miles upstream from Lee Ferry, Ariz. This article presents his description of the boat trip and his reactions to this beautiful and placid 145-mile reach of the Colorado which was appropriately named "Glen Canyon" by Maj. John Wesley Powell in 1869.

DR. WOODBURY displaying two chuckwalla lizards he caught in the reservoir area behind Glen Canyon Dam site.

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

75th Anniversary of Civil Service Act

Over 10,000 civil servants in the employ of the Bureau of Reclamation in the 17 Western States are joining other civil service workers in observance of the 75th Anniversary of the Civil Service Act recently proclaimed by President Dwight D. Eisenhower.

Many of these employees work closely with water users living on 134,000 Reclamation farms which encompass 7,600,000 acres constituting 77 Federal irrigation projects throughout the West. They cooperate with the water users in developing their farms and giving them technical aid which insures better crop returns and a better livelihood. They are also extensively engaged in the field of engineering building dams, canals, laterals, tunnels, etc., all a part of new Reclamation projects under construction.

All of the Bureau's top administrators, including the Commissioner, Assistant Commissioners, Regional Directors, and Division Chiefs, are career civil service employees.

The Bureau of Reclamation is primarily concerned with the development of land and water resources in the arid and semiarid areas.

President Eisenhower in proclaiming the 75th Anniversary of the Civil Service Act stated, in part, "* * * That the anniversary is an appropriate time to salute the Civil Service of the United States and to increase public knowledge and understanding of its importance in our system of self-government."

The Civil Service Act, signed into law on January 16, 1883, has stood for 75 years as the cornerstone of the American civil service system. It established the framework for a personnel system under which today over 2,000,000 employees work for the American people. In general, our earliest Presidents made appointments to public office on the basis of qualifications. But for approximately a half century prior to 1883, the slogan "To the victor belong the spoils" was the accepted principle in filling Government jobs. The spoils system reached such proportions that in 1841 when William Henry Harrison took office as President 30,000 to 40,000 office seekers swarmed into the capital city to claim the 23,700 jobs that made up the Federal executive service of that day.

The remedial climax to this situation came with the passage of the Civil Service Act which provided for the appointment of qualified workers to conduct the business of the Government in an orderly continuing manner. #

COOPERATION IN CANAL SAFETY

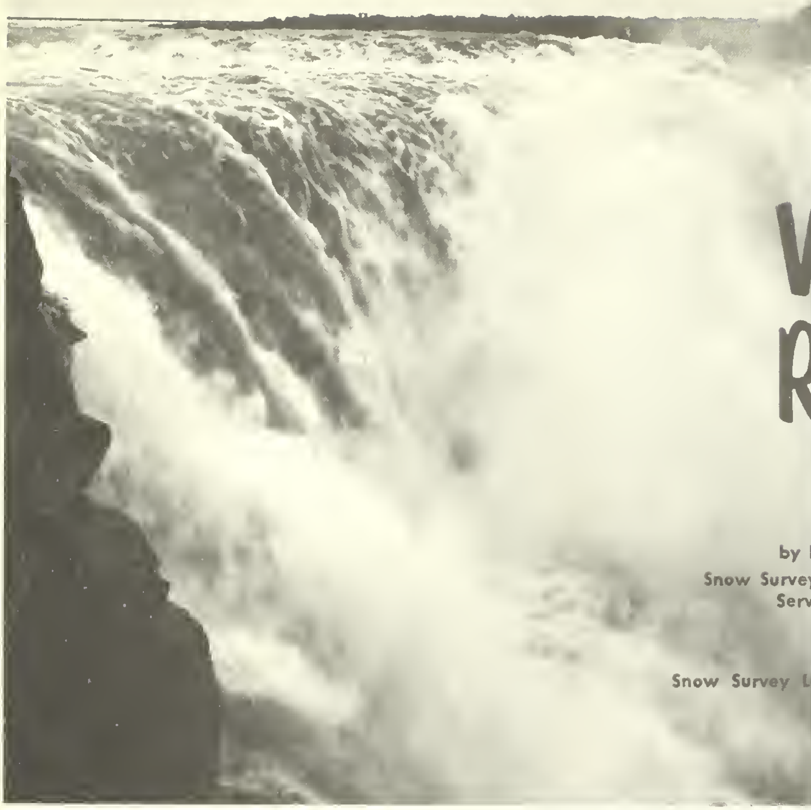
Assistant Secretary of the Interior Fred G. Aandahl recently announced that a cooperative safety campaign with the American National Red Cross has been launched to prevent drownings in canals and reservoirs on Western Reclamation projects. General Alfred M. Gruenther, president of the Red Cross, has pledged the full support of his great organization to Secretary Aandahl and Reclamation Commissioner W. A. Dexheimer in this program. It is intended to be an educational water safety campaign primarily directed toward conditions which now prevail in Western States where many reservoirs and canals have been constructed.

Mr. Richard L. Brown, Assistant Director, Safety Services, Water Safety Division of the National Red Cross and Mr. Ottis Peterson, Assistant to the Commissioner—Information, of the Bureau of Reclamation have been developing details for executing the program.

A pilot program will be undertaken during 1958 to be confined to Reclamation areas within the Bureau's Regional offices in Boise, Idaho, Sacramento, Calif., Boulder City, Nev., and Salt Lake City, Utah.

Messrs. William Blau and Ralph E. Carlson of the San Francisco Regional office of the Red Cross will work directly with Reclamation officials in these four Regions. The geographical sphere of this Red Cross Office is confined to the area west of the Continental Divide.

Continued on page 50



Water Report

by HOMER J. STOCKWELL
Snow Survey Supervisor, Soil Conservation Service, Fort Collins, Colo.
and
NORMAN S. HALL
Snow Survey Leader, Soil Conservation Service, Reno, Nev.

WATER SUPPLIES for almost all irrigated areas of western states ARE EXPECTED TO BE GOOD TO EXCELLENT IN 1958. Only in a few small areas of the western mountains is the snowpack less than normal for April 1. In a large area of California and the Southwest the snowpack approaches a maximum of record. Violent storms at the end of March and in early April resulted in a record increase in snowpack for such a short period. Forecasts range from 150 to 180 percent of normal of streamflows in the Central Valley. Elsewhere in Nevada, southern Utah, Arizona and southwestern Colorado, forecasts of seasonal streamflow of 125 to 150 percent of normal are typical.

On the Columbia Basin and in the northern Rocky Mountains snowfall during the winter has been near average. Unless there are extreme deviations from normal in precipitation or snowmelt during late spring there should be little concern for water shortage in this general area. In a few instances, reservoirs are being lowered as a precaution against the possibility of heavy storms with full assurance that water supplies will still be adequate.

Forecasts of 1958 irrigation water supplies and general water supply conditions in the West, prepared for RECLAMATION ERA, are based on April 1 measurements by the United States Department of Agriculture, Soil Conservation Service and many cooperating organizations[1] on about 1300 snow courses and 100 soil moisture stations, the latter both on the watershed and in irrigated areas. The amount of storage in nearly 250 reservoirs also is considered in appraising the water supply outlook.

Reviewing water supply conditions since the late spring of 1957, it is noted that precipitation has generally exceeded normal for the last 10 months. Streamflow from snowmelt in 1957 exceeded demands. This encouraged substantial reservoir storage holdover, thus adding to the 1958 water supply. Winter rainfall has left irrigated soils wet which will reduce the demands for early irrigation water.

The adequate water supply in sight for this season should not be allowed to result in careless use of water. As of now, the long-term water de-

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several states, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that state, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that province and likewise contributed the information here for British Columbia.

mands in many areas of the West exceed the supply. Demands are increasing. Every effort must be made to use this season's water supply as beneficially as if shortages were expected. Adequate water use for maximum production is desirable, but waste will erode the lands, aggravate drainage problems, deplete soil fertility and result in other long-term damages. Next winter's snowpack might be less plentiful. Carryover storage from this irrigation season in such case might well mean the difference between satisfactory water supplies or extensive shortages in 1959.

In the Pacific Northwest the water supply outlook is generally good. Some local shortage may occur in the Okanogan Valley of Washington. Snowpack is near normal. Soils in both irrigated and mountain areas are wet. Storage in irrigation reservoirs varies, being much above normal in Idaho and Oregon to slightly less than normal on the Columbia River tributaries in Washington. Storage in power reservoirs follows a similar pattern. Winter streamflow has been well above normal, especially on smaller tributary streams.

On the watershed of the Upper Missouri in Montana and Wyoming, snowpack is near normal. Soils under the snow are wet. Soil moisture conditions in irrigated areas are reported as good. Streamflow is expected to be near normal in 1958, except for the Wind River tributaries in Wyoming. Total water supplies are expected to be adequate except for late season shortages on small tributary streams.

The water supply outlook for irrigated areas of the North and South Platte rivers in Wyoming and Colorado is excellent. Streamflow from the mountain watershed probably will be near the average. Excess streamflow from the 1957 snowmelt season allowed for an unusually good carryover of water supplies in both government and privately operated reservoirs. Soil moisture conditions in irrigated areas are relatively good in contrast to recent years. A similar outlook prevails for the Arkansas River in Colorado and western Kansas.

For the first time since 1949, the water supply for the Rio Grande in Colorado, New Mexico and Texas is expected to be reasonably adequate. Streamflow will range near normal. Reservoir storage is well above average in Colorado and near average in New Mexico.

The water supply outlook for Arizona improved materially during March. Snowpack on the Salt and Gila watershed on April 1 was 300 percent of normal, and on the Verde 75 percent of normal. There will be an adequate water supply for irrigation with some carryover storage for next year.

Streamflow in Nevada and Utah will also be adequate to meet the needs. Irrigation water storage in both states is about 125 percent of normal. In some areas of the two states runoff will exceed demand, enhancing the prospects for holdover storage into 1959.

Snowpack in California is far above average, and will cause high flows from snowmelt. Soils in valley areas are wet. Storage in conservation reservoirs is 122 percent of normal.

Runoff forecasts for the major streams of the West for the April–September 1958 period as compared to normal include:

Columbia at The Dalles, Oregon.	92,000,000 ac. ft. or 96 percent
Missouri River at Fort Benton, Montana.	3,258,000 ac. ft. or 96 percent
Colorado River at Grand Canyon, Arizona.	11,300,000 ac. ft. or 112 percent
Sacramento River inflow to Shasta Reservoir, California.	3,650,000 ac. ft. or 150 percent
San Joaquin below Friant Reservoir, California.	2,270,000 ac. ft. or 163 percent

This analysis is again presented in the *Reclamation Era* through the courtesy of the authors, and *Mr. R. A. WORK, Head, Water Supply Forecasting Section.* In the following paragraphs the water supply outlook by states is briefly reviewed.

ARIZONA The snowpack as of April 1 is about 300 percent of normal in the Salt and Gila river watersheds and 75 percent in the Verde River watershed. Runoff during January through March has been above average, and with runoff for April through May forecast from average to much above, total January through May runoff will be about 200 percent of average for the Upper Gila, 130 percent for the Salt River, and 120 percent for the Verde River.

Heavy February and March precipitation changed the water supply outlook in Arizona from poor to the best since 1952. There will be adequate water for the normal irrigation and some carryover storage for next year. Groundwater overdraft will not be relieved, however.

CALIFORNIA The California Department of Water Resources reports that the water supply outlook for the coming season is markedly above normal for the entire state. Runoff during the snowmelt period should be among the highest on record.

This outlook comes as a result of one of the wettest winters in recent years. Precipitation over the entire state since last July averages almost 160 percent of normal. Record-breaking storms occurred in February, March, and early April. Runoff during the first six months of the water year has been about 190 percent of average. In fact, runoff in most of the streams in southern California is above normal for the first time in several years. Late March and early April storms brought substantial increase to the state's snowpack and it is estimated that snow-stored water is about 140 percent of normal.

Water stored in surface reservoirs on April 1 was about 120 percent of average.

Consequently, runoff during the remainder of the 1957–58 water year on major snow-fed streams is expected to average about 160 percent of normal.

COLORADO Water supplies will be adequate for most of the irrigated areas in Colorado this season. Snowfall has been average or above in the mountains except for two small areas on South Platte tributaries north of Denver. Well above normal snowfall has been measured in southwest Colorado. Soils under the snow are wetter than usual in the southern half of the state, but about average in the north.

Contributing to the favorable water supply outlook is the large carryover storage in irrigation reservoirs from the heavy streamflow year of 1957. Excluding the larger conservation and flood control reservoirs, storage is now 70 percent of capacity as compared to only 21 percent a year ago. In contrast to recent drouth years, soil moisture conditions in irrigated areas are good.

The excess snowfall on the San Juan Mountains in southwestern Colorado gives cause for concern lest damage from high streamflow occurs. Snowpack is approaching the recorded maximum measured on May 1 and June 1, 1957. Since mountain soils are wet, very little snow water will be required to prime these soils. Flows equal to or exceeding the high flows of 1957 are definitely possible.

IDAHO The water supply outlook for northern Idaho is for normal streamflow during 1958. In the southern half of the state, the snowpack is well above normal and forecasts of good streamflow are general.

The Blackfoot and Portneuf rivers in eastern Idaho still have a heavy snowpack, but melt conditions have been favorable for reducing the snowmelt flood potential. The snow on the south slopes of these drainages has been melted at the lower elevations and significantly reduced at high altitudes. Heavy rains on these rivers would produce extremely high water, but the chances of a maximum snowmelt coinciding with rainfall are rather small.

Reservoirs in Idaho are above normal, and the new Palisades Reservoir on the Snake River will fill for the first time in 1958. This reservoir alone adds more than one million acre feet of stored water that has not been available in the past.

The Upper Columbia and Kootenai rivers are forecast to flow a little below normal for 1958. The water supply for these rivers is adequate, but they do not pose the high water potential which has occurred several times in the recent years.

KANSAS Moisture conditions are good along the Arkansas River in western Kansas. Precipitation, mostly in the form of snow, has been well above normal during the winter. High storage in John Martin Reservoir in Colorado, along with good prospective inflow, assures an adequate water supply for this season.

MONTANA Water supply outlook along the major streams in Montana is good for 1958. Streamflow east of the Continental Divide is expected to be about 90 percent of average and equal to a year ago. In the Columbia Basin streamflow will be a little above normal and slightly more than in 1957. Streamflow during the winter has been below average in the mountains and extremely deficient in prairie streams. Reservoir storage is near average. Soils in irrigated areas are wetter than in recent years.

NEBRASKA Water supplies along the Platte River in western Nebraska will be adequate this year. Storage in the major reservoirs on the North Platte in Wyoming now totals about 1,625,000 acre feet, or almost twice normal. Of this amount, about 900,000 acre feet are available for use on the older North Platte Project in eastern Wyoming and western Nebraska. In addition, inflow to Seminoe Reservoir is expected to be about 120 percent of normal. Soil moisture conditions in the irrigated areas are good in contrast to recent years. Storage in Kingsley Reservoir is about 1,000,000 acre feet and near normal. This storage is adequate for needs of the tri-county area.

NEVADA This will be the best irrigation water year since 1952. Forecasts on the Owyhee River in northern Elko County are for about 177 percent of normal, 132 percent on the main Humboldt at Palisade, 125 percent on the Walker watershed, and 148 percent on the Carson River system.

Early April storms have increased the mountain snowpack, especially in the Sierras. Water content of the snow courses are below those measured in the record-breaking year of 1952. Most reservoirs are being lowered in anticipation of the high expected flows.

The Truckee Basin Water Committee reports that all of its reservoirs will be filled to capacity. On April 1, the elevation of Lake Tahoe was at 6228.25 feet, storing 630,000 acre feet. Controlled releases are being made to keep the lake below the legal maximum.

April 1 storage in seven important reservoirs was 78 percent of capacity or 120 percent of the 15-year 1938–52 normal. During March, Rye Patch Reservoir storage increased about 19,000 acre feet. It now stores 100,000 acre feet, normal for this time of year.

NEW MEXICO The water supply outlook for New Mexico is the best in about 10 years. The flow of the Rio Grande through New Mexico is expected to be near normal for the first time since 1952. Snowpack in northern New Mexico, although not excessive, is 140 percent of normal. Mountain soils are wet. Storage in Elephant Butte Reservoir is about 85 percent of normal as compared to 10 percent of normal a year ago. Water supply for the Tucumcari and Carlsbad projects is also favorable with relatively high reservoir storage. There is good soil moisture in irrigated areas, and at least average runoff is expected from snowmelt.

OKLAHOMA The water supply outlook for this season for the Altus Project in Oklahoma is good. Winter precipitation has been above normal. Storage in the W. C. Austin Reservoir is adequate for this year's demands providing there is average precipitation during the summer.

OREGON Oregon will have average to abundant water supplies for irrigation this year. Even though the winter has been unusually warm the mountain snowpack is 114 percent of average and 85 percent of a year ago. The streamflow forecasts vary from a low of 90 percent of average on the Clackamas River to a high of 164 percent on the Owyhee River. Watershed soils under the snowpack are well wetted throughout the state—a factor which will favor an adequate runoff from snowmelt. However, lack of low elevation snow may cause late season shortages on streams with low elevation watersheds.

Reservoired water supplies are 129 percent of average and 81 percent of capacity in 23 important reservoirs.

TEXAS With near average storage in Elephant Butte Reservoir in New Mexico and a normal snowmelt inflow in prospect, the water supply outlook for the irrigated area along the Rio Grande in west Texas is the best for several years. Soil moisture conditions in irrigated areas are relatively good. In contrast, the Pecos area has poor prospects at this time. Soil moisture conditions there are good, but the storage in Red Bluff Reservoir is extremely inadequate.

UTAH Water supply outlook for Utah is the best for several years. Storms during March increased the snowpack from 100 to 1000 percent of the normal increment for the month. All streams in the state are now forecast at above normal flows except for the eastern part of the Uinta Basin where the range is 90 percent to 100 percent of normal. For the state as a whole, the snow cover is 117 percent of normal for April 1. The effects of March storms extended over into the Colorado River drainage and resulted in substantial improvements in the water supply outlook in Colorado River tributaries. Forecasts on the Price and San Rafael basins are now from 125 to 150 percent of average. The Sevier River Basin, which has had deficient water supplies for several years will

Continued on page 54

ZINC DEFICIENCY

Continued from page 38

Three rows of beans on right were sprayed with zinc sulphate 21 days before photo was taken.

after the symptoms appear will not correct the condition, but it can be corrected by applying zinc to the soil before the potatoes are planted. On the other hand, the White Rose variety of potatoes, also extensively grown, will not show zinc deficiency.

Why is zinc deficiency spreading? For one thing we may be becoming more aware of it because we know better what symptoms to look for. On the other hand, there have been many changes in soil management which may be conducive to cropping the available zinc from our soils. Crop yields are higher and, hence, more zinc is removed. We use less barnyard manure. We use more nitrogen fertilizers in growing crops and there is considerable evidence to indicate that high-nitrogen programs induce the luxury consumption of available zinc by plants.

As mentioned, land leveling often induces zinc deficiency. However, we should not let this stand in our way of developing efficient irrigation systems. Rather, we should correct zinc deficiency.

In a short article it is impossible to discuss in detail all of the symptoms of zinc deficiency or methods of correcting it. However, if you have stunted plants with greatly shortened internodes, chlorosis of the leaves or very small leaves, be suspicious of zinc deficiency and consult your county extension agent or other reputable specialist. # # #

CANAL SAFETY

Continued from page 46

It is proposed to confine the safety program on a concentrated effort to keep people out of canals and ditches rather than teaching them to swim. The latter, of course, is desirable in any safety program. Efforts to impress upon the parents of young children the necessity of constant watchfulness in canal areas will also be a feature of the program.

The tentative plan is to concentrate on the following areas this year:

- Salt River project in Arizona—to be handled by the Maricopa County Chapter of the Red Cross
- Friant Dam and associated canal projects—to be handled by the Fresno County Chapter
- Folsom Dam area— to be handled by the Sacramento Chapter
- Contra Costa Canal area—to be handled by an as yet undesignated Red Cross Chapter
- Klamath project—to be handled by an as yet undesignated Red Cross Chapter
- Ogden River project area—to be handled by the Salt Lake County Chapter
- Yakima project area—to be handled by an as yet undesignated Red Cross Chapter
- Boise, Idaho, area—to be handled by an as yet undesignated Red Cross Chapter

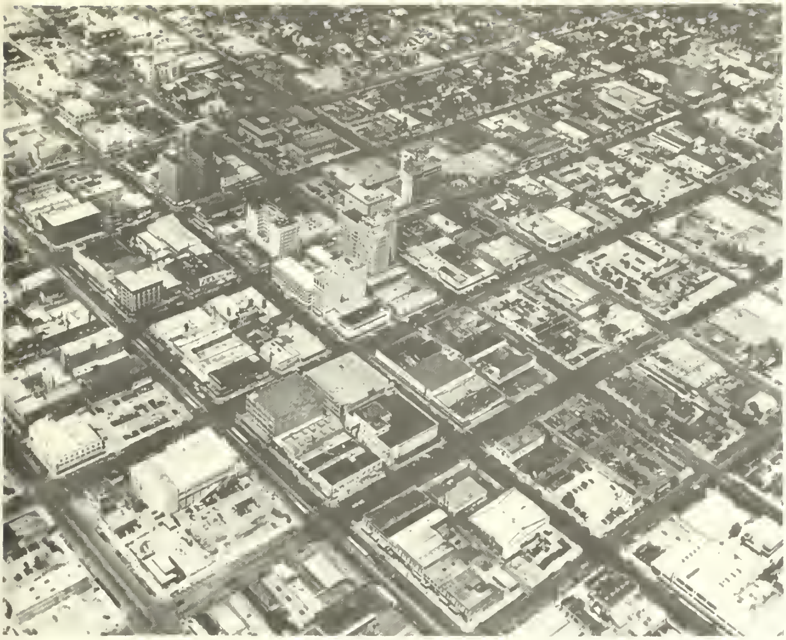
A similar safety public educational program has been launched in cooperation with the Governors of the 17 Western States, the Bureau of Reclamation, law enforcement agencies, school groups, and civic organizations. All have assured us of their cooperation and interest. #

Fifty-five Farm Units To Be Sold During the Year

Twelve full-time farm units on the Eden project in Wyoming will be available for purchase, approximately June 1, from the Soil Conservation Service at Rock Springs, Wyo., Reclamation Commissioner Dexheimer recently announced. These units will embrace 2,735 acres of land.

On the Wellton-Mohawk Division of the Gila project in Arizona, 33 farm units will be available for purchase from the Bureau of Reclamation about November 1. These units embrace 7,050 acres of land.

In the case of the Gila project, veterans will have the preference to purchase.



PHOENIX, ARIZ. *Army Air Corps photo.*

FRONTIER WITH A FUTURE

PART TWO

This is the concluding part of this article on the Power System Dispatching Organization of the Parker-Davis Power System.

The Central Dispatching Office of this System is located in Phoenix, Ariz., where you can walk down any busy street and point to every other person you see and say, statistically speaking, he wasn't here 10 years ago—yes, the population of Phoenix has approximately doubled since 1947. According to the City Manager's Office, people have been moving to the Phoenix area at the rate of approximately 25,000 per year.

Phoenix is both the political and economic capital of the Grand Canyon State, as well as being its largest city. It is also the county seat of Maricopa County, and the hub of the "Valley of the Sun."

Factors in the booming economy include a lucrative winter tourist business, agriculture, and industry.

What is the reason for this rapid expansion? Well, the climate is fabulous, and the growth of industry is providing the jobs needed to enable people to settle down in Phoenix, rather than just limit their presence to vacation periods.

Through the use of irrigation during the past many years, this Valley of the Sun, which is basically composed of arid lands, has been turned into an area of rich farms and attractive communities. In fact, irrigation has always been a prerequisite to intensive crop production in the Valley. Archaeological evidence indicates that farming by irrigation, as now practiced, is a modern revival of an ancient agricultural development in the Gila and Salt River Valleys, where present canals are found to closely follow the route of an ancient canal system.

Partly due to the availability of low-cost power produced at Hoover, Davis, and Parker Powerplants, irrigation and industrial development in the area has been greatly expanded since World War II. These accomplishments, however impressive at the moment, will be quite insignificant when compared to the accomplishments that will take place in the next 10 years.

In shouldering its share of the Power System's responsibilities in the area, the Parker-Davis project, which generates and transmits electric power to the various distributors throughout the area, has equipped its System Dispatchers with the most modern devices in use in the industry today. One of the more important of these devices is telemetering (tele-distance—distance metering).

Keeping track of 19 interconnections with associated power-factor problems and nearly 2,000

by WILLIAM M. DOAK, Chief, Systems Operation Division, Parker-Davis Project Office, Phoenix, Ariz.

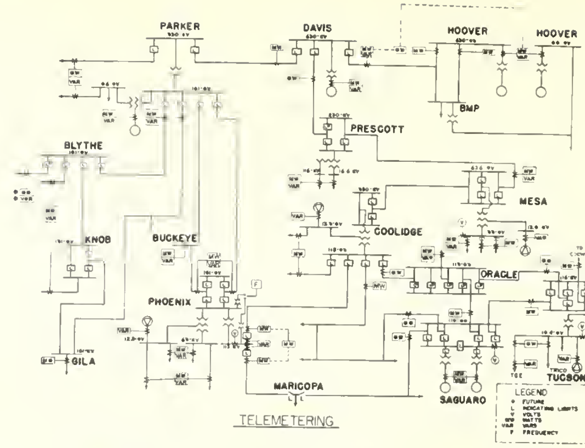
miles of high-voltage transmission circuits would become a chronic headache to the Parker-Davis System Dispatchers if it were not for the modern telemetering and automatic breaker-position indications which are provided in the System's Central Dispatching Office in Phoenix, Ariz.

Telemetering has experienced a steady development for approximately 40 years. In its beginning, it consisted simply of measuring an electrical quantity at one point and transmitting it over metallic circuits to a remote point for indication. It saved many steps and telephone calls by placing continuous indications of magnitude of current, voltage, and power in front of the power station operating engineer. From this simple beginning, it has expanded to encompass entire power systems and interconnections to adjoining power systems. The data that are gathered in this manner are so accurate, and the methods that are used to totalize that information are so reliable, that the telemetering equipment and the associated automatic load control apparatus are now performing many functions that directly aid the Power System Dispatcher. The value of the telemetering system and the automatic load-control apparatus installed on the Parker-Davis System has been amply demonstrated many times.

Although we, who are engaged in electric utility system operations, are inclined to think of telemetering in connection with centralized dispatching systems only, we find the principles of telemetering present in our every day life. As an example—we use localized remote metering systems every time we drive our car. The oil pressure gage, temperature gage, and fuel indicator are examples of a remote reading of quantitative metering. In modern cars, these meet the essential requirements of telemetering in that they have a telemetering unit, a channel of some type, and a read-out device.

Waterworks' systems use telemetering to bring in information concerning flow rate, pressure, and other values. The military also use telemetering to bring back information concerning missile flights and performance of manned aircraft.

Complete surveillance of the Parker-Davis Power System is provided for its System Dispatchers through the eyes of 62 telemetering instruments installed in the System's Central Dispatching Office in Phoenix, Ariz. Available are: instantaneous recordings of systemwide power flows; power interchange with principal



PRESENT and PLANNED telemetering received at Phoenix.

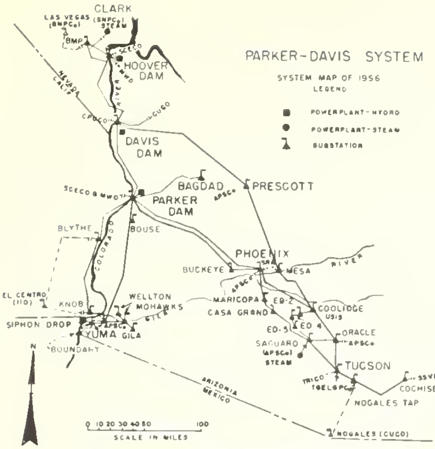
interconnected systems; kilowatt and kilovar loadings on generating plants; loadings on major transmission circuits and synchronous condensers; system voltage and frequency; oil circuit breaker positions on major transmission circuits; and other information essential to good dispatching practice.

Telemetering information is conveyed via carrier current over the System's 230-, 161-, and 115-kv. transmission lines, with all quantities recorded at both transmitting and receiving terminals.

The telemeter channels are both tone modulated and frequency-shift carrier. The frequency-shift carrier-current apparatus uses quartz crystals to control transmitter frequencies.

Each transmitter and each receiver is an independent unit, complete with its own 115-volt, 60-cycle, single-phase power supply.

Aside from measuring routine quantities efficiently, the telemetering system is a strong trouble shooter. Not long ago one of the major 230-kv. transmission circuits became permanently disabled during a severe summer storm. With this important circuit out of service, the System Dispatcher was immediately confronted with the necessity of drastically curtailing service to the numerous customers affected. However, with the invaluable aid of the telemeters available, he was able to carefully load all other circuits, fully and minute-to-minute, up to the established emergency-loading limits. Under conditions such as this, system voltages are increased at different points on the system in order to permit it to transmit additional power, and, at the same time, not exceed stability limits. This function was accu-



Area served by Parker-Davis system.

rately controlled by the System Dispatcher through the effective use of the telemetering facilities provided. Thus, in this particular instance, the net benefits derived were:

(1) A very minimum of load had to be dropped.

(2) The remaining system was enabled to carry much more load, and still maintain good service.

(3) All utility distribution systems served by the Parker-Davis Transmission System were enabled to serve all of their cities and towns.

(4) The public interests, in general, were very much better taken care of than would have been possible without the availability of telemetering facilities.

From the standpoint of system operations, without the application of telemetering equipment in instances such as this, conventional communication channels would have quickly become overburdened and bogged down, and it would have also required considerable time for the System Dispatcher to call the different substations and powerplants to determine plant loading, line loading, and voltage values on the many sections of the system involved. As a matter of fact, during periods of normal operations, the regular communication system is relieved to a great extent of the need for routine calls to the Central Dispatching Office, and is available for other traffic.

Indications of opening and closing of certain pertinent oil circuit breakers are transmitted automatically to the Central Dispatching Office. These breaker indications are superimposed upon supervisory control channels at various substations and powerplants. Each breaker operation will light a lamp on the System Dispatchers' diagram board, as well as sounding a short alarm. Since the board is normally dark, dispatching personnel can easily distinguish where the breaker position change has occurred. The execution of prearranged breaker changes can be observed in the same manner.

Time and space will not permit a more detailed explanation of this important function.

One of the most essential responsibilities of the supervisors and foremen on the Parker-Davis Project is to train each employee in his Division, Branch, or Section to become fully aware of his personal responsibility to assist the System Dispatchers, as representatives of management, in attaining an enviable record in regard to:

(1) reliability of service

(2) quality of service

(3) economy of production

(4) maximum safety to personnel and equipment

Although reliability is placed ahead of the others, one depends upon the other, and the System Dispatchers consider them all collectively. # # #

This Is the Bees' Knees!

To prevent orchard pollinating bees from spreading fireblight to apple and pear blossoms, plant pathologists have come up with the novel idea of making the bees carry the cure instead of the disease. They powder them with a fire-blight-killing antibiotic, streptomycin, by means of a simple wooden trap inserted at the beehive entrance. The bees can't get in or out without walking through the streptomycin, which clings to their bodies ready to kill or inactivate any fireblight-producing bacteria they might pick up as they gather nectar. In controlled greenhouse tests, fireblight infection of pear blossoms has been reduced from about 40 to less than 1 percent. The method is to be tested this year in field orchards.

Wilt Is Less in Thick Cotton Fields

New Mexico A. & M. College reports that when upland cotton is planted on land infested with Verticillium wilt, closer spacing of plants in the row will result in less wilt damage and higher yields per acre. Stands averaging four plants per foot a row had 15 percent fewer wilt-infested plants and up to 70 percent more cotton per acre. Thick spacing also increases the efficiency of mechanical cotton pickers.

Continued from page 49

have above normal runoff this year. The flow of the Virgin River will be slightly above normal. Streamflow in northern Utah is expected to be about average.

Storage in 15 principal reservoirs is now 3,759,000 acre feet, which is 61 percent of capacity and 124 percent of average.

WASHINGTON Water supplies for the areas of Washington east of the Cascade Range are expected to be generally adequate. Possibility of water shortage is not likely in the central areas of Washington, but limited flows can be expected on the Okanogan. Forecasts of streamflow range from 86 to 104 percent of normal. In the state as a whole the snowpack has below normal amounts of water for this time of year. Irrigation reservoir storage is generally below average as of April 1, although there are above normal amounts of water in storage in Conconully and Salmon lakes. Power reservoirs also have less water in storage than the average for this time of year.

WYOMING Prospective streamflow from the high mountain watersheds varies from 60 percent of normal on the Popo Agie tributary of the Wind River to 120 percent of average on the North Platte at Seminoe Reservoir. Flow of the Green River in the Colorado River Basin will be near normal and adequate for all needs this year. The outlook is similar for the Snake River and its tributaries in western Wyoming. Storage in the Seminoe, Pathfinder, Alcova, and Guernsey reservoirs on the North Platte totals about 1,625,000 acre feet, twice normal for this date. Soil moisture in irrigated areas of eastern Wyoming is good. With more than 1,000,000 acre feet inflow expected in these reservoirs during the April–September period, good water supplies for the year are assured. The outlook is favorable for two or three years even if future snowfall is deficient. More than 75,000 acre feet is in storage in the Wheatland Reservoir, and above normal flow is forecast for Laramie River. The water supply outlook for the Wheatland district is the best of recent years except for last year. # # #

Water Stored in Western Reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active Storage (in acre-feet)		
			Active capacity	Mar. 31, 1957	Mar. 31, 1958
Region 1	Baker	Thief Valley	17,400	17,400	17,800
	Bitter Root	Lake Como	34,800	11,800	8,300
	Boise	Anderson Ranch	423,200	208,300	165,700
		Arrowrock	286,600	276,300	123,700
		Cascade	654,100	358,800	291,400
		Deadwood	161,900	73,500	50,400
		Lake Lowell	169,000	143,100	152,100
		Lucky Peak	278,200	186,100	194,900
	Burnt River	Unity	25,200	22,000	12,300
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	2,102,000	2,034,000
		Grand Coulee Equalizing	761,800	528,900	751,100
		Potholes	470,000	307,500	231,800
	Deschutes	Crane Prairie	55,300	55,000	55,000
		Wickiup	187,300	[1] 200,000	195,000
	Hungry Horse	Hungry Horse	2,982,000	1,364,400	1,669,100
	Minidoka	American Falls	1,700,000	1,672,000	1,691,600
		Grassy Lake	15,200	13,900	12,900
		Island Park	127,200	122,900	127,400
		Jackson Lake	847,000	149,400	490,400
		Lake Walcott	95,200	[1] 102,400	80,600
	Ochoco	Ochoco	47,500	44,700	38,300
	Okanogan	Conconully	13,000	9,800	8,300
		Salmon Lake	10,500	9,500	9,700
	Owyhee	Owyhee	715,000	696,700	637,500
	Palisades	Palisades	1,202,000	307,900	758,600
	Umatilla	Cold Springs	50,000	45,200	50,000
		McKay	73,800	52,400	66,100
	Vale	Agency Valley	60,000	58,700	57,200
		Warm Springs	191,000	[1] 192,800	180,000
	Yakima	Bumping Lake	33,700	27,100	27,200
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	367,000	170,600
		Kachess	239,000	206,700	139,900
		Keechelus	157,800	131,600	87,200
		Tieton	198,000	160,400	114,600
Region 2	Cachuma	Cachuma	201,800	37,800	107,200
	Central Valley	Folsom [2]	920,300	556,600	[2] 569,900
		Jenkinson Lake	40,600	[1] 40,800	41,200
		Keswick	20,000	17,300	18,300
		Lake Natoma	2,800	900	1,900
		Millerton Lake	427,800	238,400	386,200
		Shasta Lake	3,998,000	3,561,900	3,740,200
	Klamath	Clear Lake	513,300	396,000	414,100
		Gerber	94,300	87,300	86,700
		Upper Klamath Lake	524,800	465,200	471,400
	Orland	East Park	50,600	49,900	49,200
		Stony Gorge	50,000	[1] 50,800	45,700
Region 3	Boulder Canyon	Lake Mead	27,207,000	11,502,000	19,092,000
	Parker-Davis	Havasu Lake	216,500	166,700	72,200
		Lake Mohave	1,809,800	1,689,700	1,737,900
	Salt River	Apache Lake	245,100	162,000	239,000
		Bartlett	179,500	123,000	145,000
		Canyon Lake	57,900	50,000	54,000
		Horseshoe	142,800	68,000	106,000
		Roosevelt	1,381,600	159,000	264,000
		Sahuaro Lake	69,800	63,000	64,000

[1] Includes some super storage above active capacity.
[2] Corps of Engineers Reservoir.

Water Stored in Western Reservoirs—Continued

Location	Project	Reservoir	Active Storage (in acre-feet)		
			Active capacity	Mar. 31, 1957	Mar. 31, 1958
Region 4	Eden	Big Sandy	38,300	11,100	[3]
	Fruitgrowers Dam	Fruitgrowers	4,500	1,800	4,500
	Humboldt	Rye Patch	190,000	63,100	100,300
	Hyrum	Hyrum	15,300	12,000	12,200
	Mancos	Jackson Gulch	9,800	900	7,800
	Moon Lake	Midview	5,800	4,800	5,400
		Moon Lake	35,800	9,300	[3]
	Newlands	Lahontan	290,900	251,900	234,000
		Lake Tahoe	732,000	597,600	625,200
	Newton	Newton	5,400	2,500	3,800
	Ogden River	Pineview	110,200	15,400	4,700
	Pine River	Vallecito	126,300	22,600	66,200
	Provo River	Deer Creek	149,700	82,700	95,800
	Scofield	Scofield	65,800	6,000	41,500
	Strawberry Valley	Strawberry	270,000	141,800	159,800
	Truckee Storage	Boca	40,900	22,100	9,000
	Uncompahgre	Taylor Park	106,200	25,300	83,100
	Weber River	Echo	73,900	36,700	43,500
Region 5	W. C. Austin	Altus	162,000	8,900	92,200
	Balmorhea	Lower Parks	6,500	5,800	6,200
	Carlsbad	Alamogordo	122,100	4,600	100,000
		Avalon	6,000	2,500	1,600
		McMillan	32,300	17,400	25,600
	Colorado River	Marshall Ford	1,837,100	603,400	840,300
	Middle Rio Grande	El Vado	194,500	800	38,200
	Rio Grande	Caballo	340,900	4,200	123,000
		Elephant Butte	2,185,400	63,500	705,000
	San Luis Valley	Platoro	60,000	1,000	30,400
	Tucumcari	Conchas [2]	467,300	55,400	153,600
	Vermejo	Reservoir No. 2	2,900	0	1,800
		Reservoir No. 13	5,000	1,600	3,200
		Stubblefield	16,100	0	8,300
Region 6	Missouri River Basin	Angostura	92,000	33,500	58,100
		Boysen	710,000	192,600	212,600
		Canyon Ferry	1,615,000	1,012,400	1,169,900
		Dickinson	13,500	3,900	6,100
		Fort Randall [2]	4,900,000	1,752,200	2,289,600
		Garrison [2]	18,100,000	1,002,800	4,565,000
		Heart Butte	218,700	46,900	72,100
		Jamestown	39,200	4,900	13,000
		Keyhole	190,300	2,600	2,800
		Lewis & Clark Lake [2]	385,000	278,600	288,700
		Pactola	55,000	1,200	14,600
		Shadehill	300,000	76,400	80,900
		Tiber	762,000	57,100	87,300
	Belle Fourche	Belle Fourche	185,200	49,900	78,200
	Fort Peck	Fort Peck [2]	14,839,000	1,743,700	3,399,700
	Milk River	Fresno	127,200	110,200	63,500
		Nelson	66,800	49,400	47,900
		Sherburne Lake	66,100	21,100	23,700
	Rapid Valley	Deerfield	15,100	8,600	11,600
	Riverton	Bull Lake	152,000	63,200	60,600
		Pilot Butte	31,600	21,800	20,700
	Shoshone	Buffalo Bill	380,300	116,400	130,000
	Sun River	Gibson	105,000	41,900	31,200
		Pishkun	30,100	16,200	12,100
		Willow Creek	32,400	24,000	20,600
Region 7	Colorado-Big Thompson	Carter Lake	108,900	71,900	100,500
		Granby	465,600	37,800	286,300
		Green Mountain	146,900	50,200	70,900
		Horsetooth	141,800	91,400	116,200
		Shadow Mountain	1,800	1,500	1,200
		Willow Creek	9,100	2,000	3,000
	Missouri River Basin	Bonny	167,200	38,400	43,100
		Cedar Bluff	363,200	68,700	185,400
		Enders	66,000	34,100	36,000
		Harlan County [2]	752,800	66,100	274,000
		Harry Strunk Lake	85,600	27,700	33,600
		Kirwin	304,800	1,600	81,500
		Swanson Lake	249,800	88,400	116,300
		Webster	257,400	0	54,600
	Kendrick	Alcova	24,500	11,500	27,900
		Seminoe	957,000	240,100	561,400
	Mirage Flats	Box Butte	30,400	16,700	25,700
	North Platte	Guernsey	39,800	900	30,000
		Lake Alice	11,200	10,900	1,900
		Lake Minatare	59,200	18,600	31,800
		Pathfinder	1,010,900	313,100	797,000
Alaska District	Eklutna	Eklutna Lake	160,000	81,400	94,900

[2] Corps of Engineers Reservoir.
[3] Not reported.

LAND RECLAMATION

A CENTURY AGO landowners of the Atlantic Coast States were making serious objection to development of the Ohio and Mississippi Valleys under the homestead law. They feared that the competition of new lands would create a surplus of agricultural products and thus force prices down and ruin their market. In subsequent years every reclamation project in the West aroused the same fears and protests. It is easy today to criticize the lack of vision displayed by these early opponents of immigration, and yet the same cry, in slightly modified form, is now being raised in connection with reclamation projects in the West.

Because agriculture is faced with a serious problem of overproduction, there is a general belief that the reclamation program should be halted until consumption catches up with agricultural output. Such a view is a hasty conclusion that is in no way based on the facts.

While it is true that the United States is producing more wheat, corn, and cotton than it can sell at a profit and that the planting of additional acres in these staples would be unwise, it does not necessarily follow that there is a surplus of arable land. Each year the United States imports enough food to put many thousands of acres to work, and with proper irrigation waste lands proposed for reclamation would be suitable for raising these crops.

America's land problem is not that there are too many acres under cultivation but that too many acres are planted in the same crops and too much poor land is producing poor crops when there are unclaimed acres which, through irrigation, could be made to produce better crops at less cost.

—LEBANON (PA.) NEWS.

[Reprinted from the New Reclamation Era, September 1931.]

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DS-4973	Missouri River Basin, Wyo.	Jan. 16	Six 7,750/9,687-kva power transformers for Fremont Canyon powerplant.	Crompton Parkinson, Ltd., Hayes, Middlesex, England.	$206,403
DC-4986	Solano, Calif	Jan. 2	Construction of earthwork, concrete canal lining, and structures for Putah South canal, Green Valley conduit and subconduit; and two earth dams.	Darkenwald Construction Co., Inc. and Vinson Construction Co., Sacramento, Calif.	1,537,474
DC-4988	Washita Basin, Okla	Feb. 3	Construction of Fort Cobb Dam	Hyde Construction Co. and Cook Construction Co., Jackson, Miss.	3,318,432
DC-4993	Missouri River Basin, S. Dak.	Jan. 6	Stringing conductors and overhead ground wires for 67 miles of Utica Junction-Sioux Falls 230-kv transmission line; and installing 230-kv air-break switches for Utica Junction tap switching station.	Hallett Construction Co., Crosby, Minn.	754,780
DS-4995	Missouri River Basin, N. Dak.	Feb. 10	Three 20,000/26,667/33,333-kva autotransformers for Fargo substation.	Legnano Electric Corp., New York, N. Y.	330,820
DC-4999	Missouri River Basin, Kans.	Feb. 20	Construction of earthwork and structures for Osborne canal	Bushman Construction Co., St. Joseph, Mo.	324,750
DC-5000	Columbia Basin, Wash	Jan. 8	Construction of earthwork, concrete canal lining, and structures for Esquatzel diversion canal.	Donald M. Drake Co., Portland, Oreg.	2,681,004
DC-5002	Missouri River Basin, Colo.	Feb. 10	Reconductoring 53 miles of Greeley-Fort Morgan section of the Greeley-Beaver Creek 115-kv transmission line.	Crawford Electric Co., North Platte, Nebr.	239,887
DC-5004	Central Valley, Calif	Mar. 11	Construction of earthwork, pipe lines, and structures, including pumping plants, for laterals 119.6 and 122.5 and sublaterals, Unit 1 extensions, Southern San Joaquin Municipal Utility District, Friant-Kern canal distribution system.	Cen-Vi-Ro Pipe Corp., South Gate, Calif.	698,165
DS-5006	Missouri River, Basin Wyo.	Mar. 19	Two 144-inch butterfly valves for Fremont Canyon powerplant (of Government design), Schedule 1.	Yuba Consolidated Industries, Inc., Yuba Mfg. Division, Benicia, Calif.	231,950
300C-102	Colorado River Front Work and Levee System, Ariz.-Calif.-Nev.	Jan. 27	Stockpiling rock material for river bank protection	Sierra Construction Co., Merced, Calif.	146,270
400S-97	Colorado River Storage, Ariz.-Utah.	Feb. 19	Furnishing electric service in Government areas for Page, Ariz	Arizona Public Service Co., Phoenix, Ariz.	213,389 (total annual estimated cost)
701C-456	Missouri River Basin, Nebr.-Kans.	Jan. 3	Construction of turnouts and wasteway structures, drains and relocation of lateral.	Bushman Construction Co., St. Joseph, Mo.	139,195
700C-459	Missouri River Basin, Nebr.-Kans.	Feb. 10	Construction of earthwork and structures for Franklin floodway drains and lateral extensions.	Bushman Construction Co., St. Joseph, Mo.	189,991

Construction and Materials for Which Bids Will Be Requested Through June 1958*

Project	Description of work or material
Central Valley, Calif.	Replacing 5 wood bridges with 5 bridges of treated timber. On the Contra Costa Canal, near Antioch.
Do	One 84-inch jet flow gate for the Trinity Dam auxiliary outlet works gate chamber. Estimated weight: 80,000 pounds.
Collbran, Colo	Clearing the Vega Reservoir area, about 10 miles east of Collbran.
Columbia Basin, Wash.	Earthwork and structures for about 19 miles of open ditch drains and wasteways, extending a drain about 2 miles and deepening about 2,200 feet of drain. Southeast of Moses Lake; southwest and northwest of Othello and southeast of Quincy.
Do	Constructing about 7,600 feet of tile underdrain, Weber Wasteway, and about 7,600 feet of open outlet drain. East of Moses Lake.
Do	Installing about 350 feet of 12-inch buried concrete cylinder pipe at Soap Lake.
Do	Constructing shop, residences, and service building for Wahluke Watermaster Headquarters, south of Othello.
Crooked River, Oreg.	Constructing the 186-foot-high earth and rockfill Prineville Dam, containing about 1,350,000 cubic yards of material and having a crest length of 780 feet, and appurtenant structures. On the Crooked River, about 21 miles southeast of Prineville.
Gila, Ariz	Constructing one 40- by 60-foot office building of block-type construction and furnishing and erecting one 40- by 60-foot prefabricated steel shop building. At Yuma.
Little Wood River, Idaho.	Clearing about 73 acres in the Little Wood River Reservoir area, northwest of Carey.
Do	Raising the earthfill Little Wood River Dam 42 feet and constructing a spillway and an addition to the outlet works. On the Little Wood River, northwest of Carey.
Middle Rio Grande, N. Mex.	Clearing, cleaning, and shaping about 31 miles of open ditch laterals, removing existing structures and constructing new structures. Near Belen.
Missouri River Basin, Colo.	Additions to the Loveland, Longmont, Erie, and Prospect Valley Substations.
MRB, Kansas	Earthwork and structures for about 19.5 miles of canal and laterals with capacities varying from 140 to 6 cfs. Courtland Canal, Section B5, near Scandia.
MRB, Nebraska-Kansas.	Furnishing and installing 5 fixed radio stations and 25 mobile sets. No houses will be required. At Courtland, Kansas, and Franklin, Red Cloud, Superior and Cambridge, Nebraska.
MRB, Minnesota	Additions to the Granite Falls Substation.
Do	One 3-phase, 110/69/13.2-kv, 25,000-kva transformer, for the Granite Falls Substation.
MRB, North Dakota.	Additions to the Jamestown and Fargo Substations.
MRB, Montana	Earthwork and structures for about 5 miles of open ditch laterals with bottom widths varying from 6 to 4 feet in the Spokane Bench and North Side areas of the Helena Valley Unit, near Helena.
MRB, Wyoming	Hydraulic control systems for 144-inch butterfly valves and 14- by 18-foot fixed-wheel gate at Fremont Canyon Powerplant.
Rogue River Basin, Oreg.	Constructing an earthfill dam structure over and around the existing concrete arch Emigrant Dam to a height of about 79 feet above the existing crest, constructing 3 earth dikes, concrete emergency spillway and concrete outlet works. On Emigrant Creek, southeast of Ashland.
Do	Constructing the concrete Ashland Diversion Dam, 8.5 feet high with uncontrolled overflow crest 65 feet long, and an earthfill dike extension, constructing a canal headworks structure and constructing about 3 miles of open ditch lateral, and three 48-inch-diameter siphons and other appurtenant reinforced concrete structures. Near Ashland.
Do	Constructing the 115- to 85-cfs-capacity Dead Indian Collection Canal, about 3,000 feet long, a rockfill-type diversion dam about 5 feet high and 100 feet long and headworks structure; constructing the 25-cfs-capacity Conde Creek Collection Canal, about 2.5 miles long, a rockfill-type diversion dam 5 feet high and 75 feet long and headworks structure; and constructing improvements to the Grizzly Creek Channel, about 1.5 miles long. About 15 miles northeast of Ashland.
Do	Constructing about 3 miles of 6-foot bottom width unlined canal. Work will include constructing about 700 feet of 6-foot width rectangular concrete bench flume, and two 42-inch-diameter concrete pipe siphons totaling about 2,700 linear feet long. South Fork Collection Canal, about 25 miles east of Medford.
Do	Constructing an access road to the Howard Prairie Dam site, about 27 miles east of Ashland.
Do	Clearing the remaining scattered areas of the Howard Prairie Reservoir site, about 27 miles east of Ashland.
Wapinitia, Oregon.	Clearing about 298 acres in the Wasco Reservoir area, about 35 miles west of Maupin.
Washita Basin, Oklahoma.	Constructing the 136-foot-high earthfill Foss Dam, about 18,000 feet long, including spillway and multipurpose outlet works. On the Washita River, about 18 miles northwest of Clinton.
Do	Constructing a field office, laboratory, pump house including domestic water, sewage disposal and liquified petroleum gas systems. At the Foss Dam site, about 18 miles northwest of Clinton.
Weber Basin, Utah.	Constructing 8 rectangular, earthlined reservoirs; 6 having 20 acre-feet capacities and 2 having 12 acre-feet capacities. Bountiful Subdistrict, near Salt Lake City.
Do	Constructing 4 pumping plants consisting of 2 outdoor, sump-type plants of 8- and 13-cfs capacities, an outdoor, flat-slab-type plant of 4-cfs capacity, and an indoor-type plant of 5-cfs capacity. Work will also include constructing about 4 miles of 16- to 36-inch-diameter reinforced concrete, pretensioned reinforcement (steel cylinder type) and steel pipe discharge lines and trunklines. Sand Ridge, East Layton and Val Verda Pumping Plants, between Salt Lake City and Ogden.

*Subject to change.

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The Reclamation Era

AUGUST 1958

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Access Roads to Glen Canyon
Reservoir Evaporation Reduced

Official Publication of the Bureau of Reclamation

The Reclamation Era

AUGUST 1958 **Volume 44, No. 3**

COVER SKETCH: FLAMING GORGE DAM

J. J. McCARTHY, Editor

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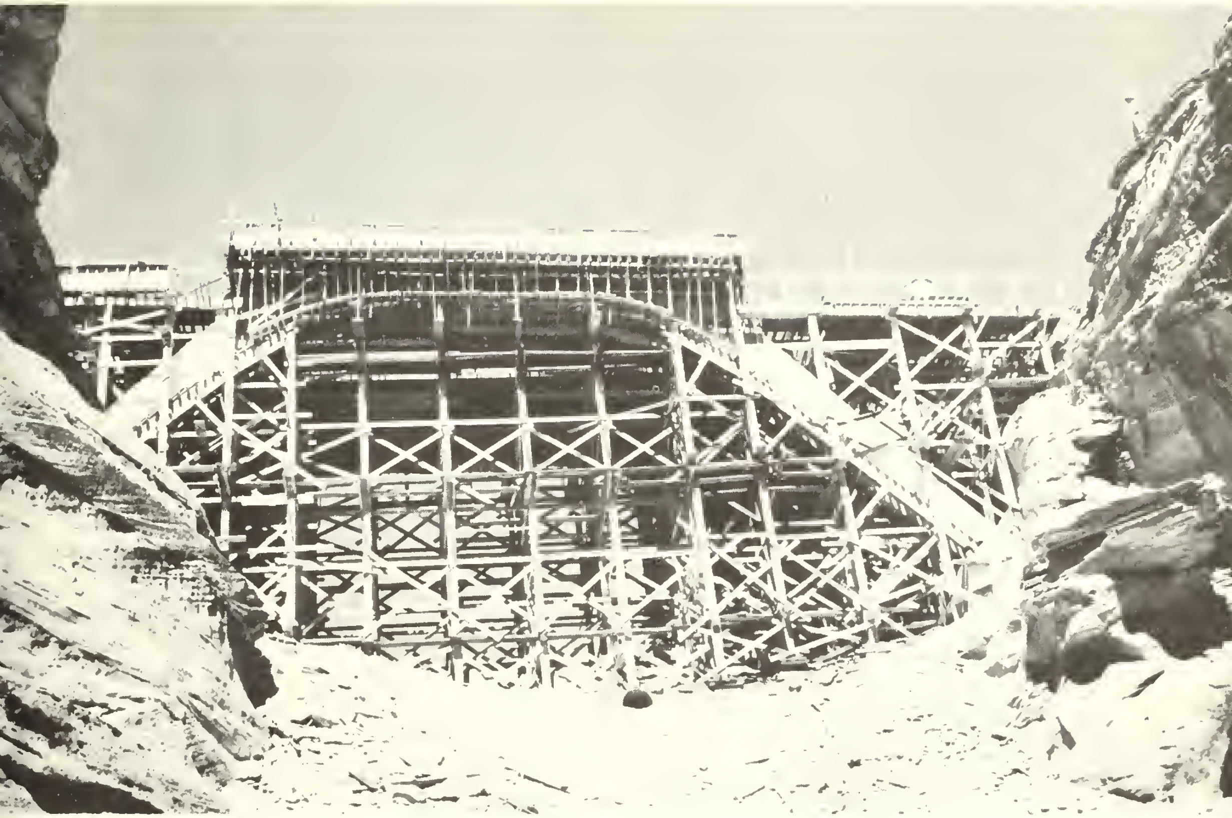

Roads To Scenic Treasures

Located at the hub of Utah's spectacular Monu-
ient Valley, Arizona's Painted Desert, Bryce
'anyon National Park, and Grand Canyon
[ational Park, the 700-foot-high Glen Canyon
)am will harness the flow of the Colorado River
nd unlock a treasurehouse of resources in the cen-
er of an area unmatched for pure scenic beauty by
lmost any other part of America.

The long geologic evolution of the Colorado
'lateau has produced colorful valleys punctuated
y towering monoliths, craggy-toothed edges of
oded monoclinal folds, domes, and uplifts—all
casionally shattered open by gorges gouged
undreds of feet deep into the earth.

Nature's paintpot has splashed the panorama
ith colors ranging the spectrum from Vermillion
liffs to chalk-white Castle Rocks, with changing
olors each hour of the day—at night turning into a weird, spectral goblinland under moonlight.

While Mother Nature was providing the American scene this vast panorama of scenic splendor she, perhaps thoughtlessly, provided Reclamation engineers their best site for the key structure of the Upper Colorado River development at the hub of this rugged area.

Five years ago only the chosen few, willing to spend extra dollars, ventured into the center of this color kingdom by riverboat or packhorse train. Now, a hundred diesel-powered trucks roll to and from the dam site area every day via newly completed access roads. Future travelers will be availed of the spectacular beauty of this wonderland via modern new routes. Based on recreational usage of Lake Mead and other Reclamation reservoirs, tourist visitations will skyrocket the area's public usage.

by L. F. WYLIE, Project Construction Engineer, Glen Canyon Storage Unit

The logistics involved in the construction of Glen Canyon Dam are comparable to those of any army fighting on two fronts—these fronts being separated by only 1,200 feet of Colorado River gorge. Men and materials must move to the dam site from two directions—Flagstaff, Ariz., 135 miles to the south, and Kanab, Utah, 76 miles west. Railheads are located at Flagstaff and at Marysvale, Utah, 190 miles to the north. Because of the high cost of construction and maintenance of branch railways, access roads to the existing arterial highways were the only answer to the logistics problem.

In an all-out cooperative effort to quickly provide access to this inaccessible dam site, the first major Bureau dam not serviced by rail connections, the States of Utah and Arizona, the Bureau of Reclamation and the Bureau of Public Roads will have spent some $12.8 million on roads by the end of this calendar year. During the construction period of the dam and powerplant more than three quarters of a million tons of materials will be trucked into the dam site over these access roads.

Early in the planning of the project the Reclamation engineers saw that the cost of the dam and associated works would be substantially reduced if, during the construction period, a bridge spanned the gorge to tie the two access roads to-

Installing curbing on Bitter Springs—Page access road.

gether and permit easy crossing of the canyo for men and materials.

The proposal for a high steel bridge and high way access created much interest in the highwa departments of Arizona and Utah, as well as i the Bureau of Public Roads. Long-range plan ning was essential, they felt, if the public interes was to be best served before, during and after th construction of the dam and powerplant.

Negotiations by these agencies produced a three way financial plan whereby Arizona and th Bureau of Public Roads would participate i the construction of a highway bridge over th Colorado River. Arizona would bear a por tion of the cost of a 25-mile access highway fro U. S. Highway 89 at Bitter Springs to the da site, and would build 9 miles of permanent high way from the Utah-Arizona line to the dam sit on the opposite side of the canyon.

Seventeen miles of Glen Canyon—Kanab road through Cockscomb Mountains will cost almost $2 million.

Glen Canyon site shows marks of construction progress. Note suspension footbridge in foreground.

With these proposals in writing, the State of Jtah made plans for a 56-mile highway from the lam site west to Kanab, Utah, to link the road vith Highway 89.

The cooperative agreement on the Colorado River Bridge and the 25-mile access highway rom Bitter Springs to Page, Ariz., left the engiıeering and invitations to bid to the Bureau of Reclamation.

In the meantime, work at the dam site could ot be delayed waiting for a highway. Early n 1956 Utah laid out the road from Knab to the Jtah-Arizona line, and the Bureau built a tempoary road the remaining 9 miles to the site. At he same time, Arizona graded a 50-mile road rom "The Gap" on U. S. Highway 89, providing ccess to both sides of the Colorado River.

By the time the first contracts for exploratory rilling and one water diversion tunnel were warded, speed in road construction had become sential. Heavy equipment moved to the dam te over roads still under construction, and both en and machines were often marooned by deructive flash floods.

The contract administered by the Bureau of eclamation covering construction of a 25-mile ghway from Bitter Springs to Page, was sepated into three parts. Construction of the adbed to subgrade of the first 5 miles, which icluded a 300 foot deep cut through the Echo iffs, was awarded to Strong Construction Co. Springville, Utah. The contract for construcon to subgrade of the remaining 20 miles, which icluded a highway bridge over Waterholes Canyon, was awarded to W. W. Clyde & Co., also of Springville. Surfacing and application of seal coat and chips was done by Alexander Construction Co. of Minneapolis, Minn. This firm is also required to furnish a stockpile of crushed rock and chips for the surfacing of the streets of Page. This Bitter Springs highway was opened to traffic last January.

On the opposite side of the Colorado River, the State of Utah pressed for early completion of the 56-mile highway to Kanab. Bridges over the Blue Pools Wash, Paria River, and the Buckskin Wash are now completed. Excavation has begun for the roadbed through an upturned and eroded monoclinal fold known as the Cockscomb. Utah Highway Department officials expect the entire highway to be completed by early fall of this year. To tie Utah's highway to the dam site, the Bureau of Reclamation built a temporary 9-mile oiled road from the State line to the construction area, which will later be brought up to Federal highway standards by the State of Arizona.

Roadbuilding in the Colorado Plateau country is no easy task in any language, and is costly. Averaged out over the 101 miles from Bitter Springs, Ariz., to Kanab, Utah, the highway will cost almost $127,000 a mile. Most expensive, of course, is the one-quarter mile of bridge over the Colorado River, which will cost in excess of $4 million. The usefulness of these facilities will live far beyond the project's construction period, however, and will remain to serve future travelers.

By February 1959, the Kiewit-Judson Pacific Murphy Co., builders of the Colorado River Bridge, will have completed the concrete deck over the Glen Canyon gorge. The Utah State Highway Department will have completed the west leg of the access highway from the dam site to Kanab by the end of this year. Then the men and materials required for Glen Canyon Dam will move swiftly and directly to their destination, in the center of what was once an impenetrable desert.

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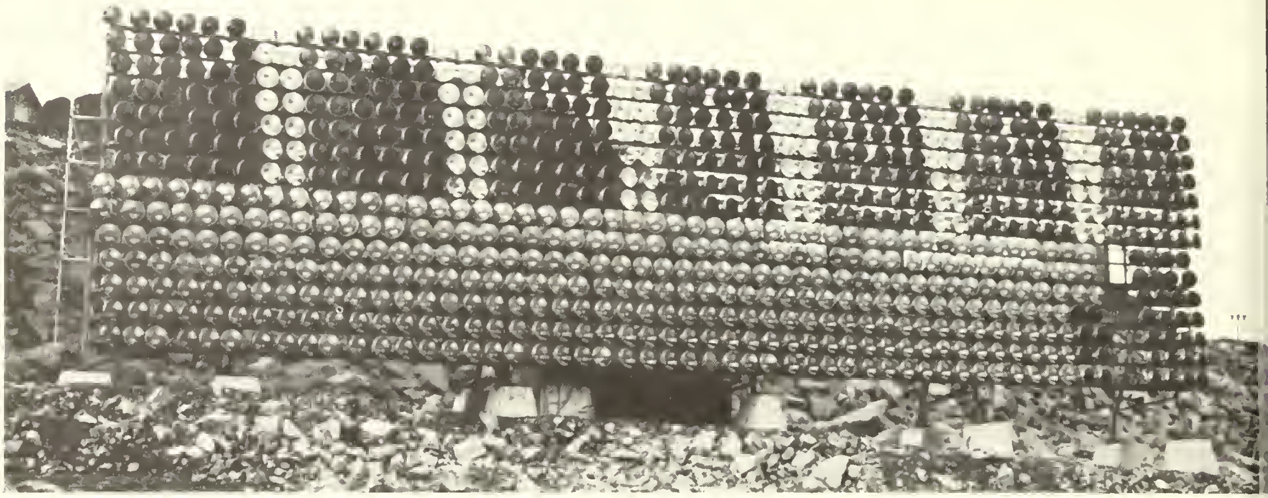
L. F. (Lem) Wylie, Project Construction Engineer, Glen Canyon Storage Unit.

Columbia Basin Colorama



These varicolored lights play on Grand Coulee spillway.

The 3-day Colorama Festival opened on May 30 with a note of solemnity at a Memorial Day ceremony on the roadway atop Grand Coulee Dam. Gayer festivities got underway about 2 hours later with a rodeo parade signaling the start of the first day's activities. The highlight of the first day of the celebration was the official lighting ceremony at the new Coulee Dam tour center. A crowd of approximately 25,000 people gathered to witness the turning on of the new floodlights designed to bathe the spillway of Grand Coulee Dam in colorful hues.

Columbia Basin Project Manager Phil Nalder, acting as master of ceremonies, introduced more than 65 prominent persons associated with the Columbia Basin project. Harold T. Nelson, Bureau of Reclamation Regional Director from Boise, Idaho, gave a brief history of the project to start the speaking portion of the program. The junior senator from the State of Washington, Henry M. Jackson, also spoke, remarking that he hoped that the ceremony would make more people conscious of Grand Coulee Dam and the need for more power developments.

Secretary of the Interior Fred A. Seaton, as emissary of President Eisenhower, delivered the principal address. The highlights of Secretary Seaton's remarks were that the ceremony of color floodlighting the dam for the first time served to emphasize the many benefits coming from this triumph of civilization, and a monument to th ingenuity of American technologists. Secretary Seaton promised the people that the Grand Coulee Dam area would have more recreational develop ments in the near future along the 600-mile shoreline of Lake Roosevelt.

With the words, "I now have the honor and pleasure by this act of formally floodlighting th Grand Coulee spillway," Secretary Seaton pressed the button to start the floodlights through thei 30-minute cycle. The lighting system which Sec retary Seaton formally placed in operation i composed of 742 1,500-watt globes, each about 2 inches in diameter. The 90-foot long, 20-foo high, bank of lights contains 112 red, 336 blue, 9 green, 112 amber, and 84 white lights. The light are so aimed that the entire spillway is lit with

Spectacular view of Grand Coulee from Douglas Memorial Park

the same intensity at all times, no matter how many of the lights are on.

Later in the evening, Secretary Seaton crowned Miss Peggy Brown of Grand Coulee as the 1958 Queen of Lights.

The second day of festivities started with a Colorama Parade which took 1 hour to pass any given point and was viewed by over 10,000 enthusiastic onlookers, even though a hard rain fell during the parade and the rest of the day.

The Colorama Festival was the result of a community-spirited idea. Late in 1957 several civic and fraternal organizations comprised of members from Electric City, Grand Coulee, Coulee Dam, and Elmer City decided that inasmuch as the lights had been installed as a result of community agitation there should be a celebration. The Coulee Dam Lions Club assumed the responsibility for arranging for such a celebration and appointed Bill Gould of Grand Coulee as their Colorama Festival chairman. With the active support of the majority of the people, the festival became overnight a medium by which the communities of the Coulee Dam area could be brought together for a single purpose. Because of the success of this year's festival, plans are already underway for next year's event and it is hoped that the festival will become an annual attraction, signaling the start of the summer tourist season in the State of Washington.

Colorama princesses pose with Grand Coulee power supervisor Al Darland.

The Crow Creek Pump Unit is coming of age. Facilities to serve 5,000 acres were completed in 1954. Today, water has been contracted for 4,247 acres and a strong demand for the small balance of the water available under the present designed capacity. There is little doubt that the acreage could be expanded considerably beyond the 5,000 acres the unit is now prepared to serve.

The unit is located on the main stem of the Missouri River near Toston, Mont. Water is pumped 175 feet above the river, tunneled 2,164 feet through high ground bordering the river, and distributed to the unit through gravity canals.

Peggy Brown of Grand Coulee crowned Queen of Lights by Secretary of the Interior Fred A. Seaton.

CROW CREEK IS GROWING UP

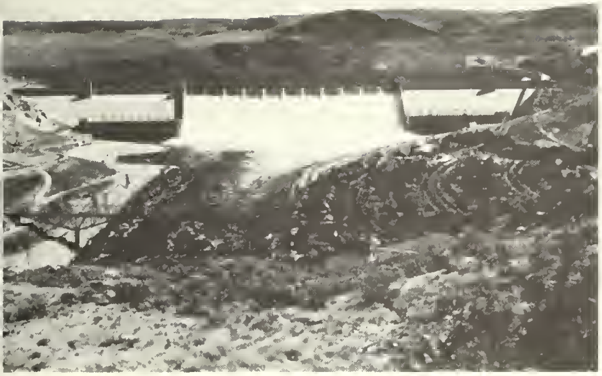
When Congress authorized the construction of a high dam at the Canyon Ferry site and its operation at the 3,800-foot level, a stipulation provided that an acreage equal to that inundated by the additional storage would be irrigated in Broadwater County, Mont. Crow Creek Unit was constructed because of that provision; thus, the usual preconstruction requirements of an organized irrigation district and an executed repayment contract was waived. Public Law 374 (84th Cong., 1st sess.), approved August 12, 1955, authorized the Secretary of the Interior to execute a temporary water service contract for a period of not to exceed 10 years with the Toston Irrigation District. This legislation and the temporary contract subsequently executed with the district contemplate the ultimate negotiation of a long term contract under which the district will assum its proper repayment obligation under the re lamation laws. The first water was available i 1955.

When the Toston Irrigation District was forme in July of 1955, it included only 1,543 acres. I April 1957, additional landowners petitioned th district court for admission into the district. Th petition was granted and the total of lands i the district was increased to 4,247 acres.

Although the lands petitioning for eventua admission into the district brought the total t 4,247, the landowners requested that certain c

Continued on page 80

by C. L. CONAWAY, Publications Officer, Interior Missouri Basin Field Committee, Billings, Mont.



Grand Coulee Dam (above) and Hoover Dam (right) are tabbed outstanding achievements in field of civil engineering.

Two Reclamation Structures Receive ASCE Plaques

In 1955 the American Society of Civil Engineers selected two Bureau of Reclamation projects as being among the "Seven Modern Civil Engineering Wonders of the United States." The structures were Hoover Dam in Arizona and Nevada, and Grand Coulee Dam of the Columbia Basin project in Washington (see p. 6, *Reclamation Era*, February 1956).

This spring President Louis R. Howson of the ASCE honored both of these structures by presenting bronze plaques to Reclamation Commissioner Dexheimer for Hoover Dam and Project Manager Phil Nalder for Grand Coulee Dam and the Columbia Basin project. The following is an account of the presentations:

HOOVER DAM

A bright new bronze plaque glistens in the desert sunlight from its concrete pedestal on the Arizona-Nevada boundary line atop Hoover Dam.

The plaque records the fact that this first of Reclamation's great multipurpose dams was selected by the American Society of Civil Engineers as one of the "Seven Modern Civil Engineering Wonders of the United States."

Louis R. Howson, president of the ASCE, formally unveiled the plaque last April 16 and presented it to Reclamation Commissioner W. A. Dexheimer, who accepted it for the Bureau.

Some 400 people, including engineers and "construction stiffs" who helped build the dam, gathered on the roadway in the bright morning sunshine to witness the unveiling. Some of these men had not been back to the dam site since the project was completed. It was a homecoming for all. Millions of other Americans saw the unveiling on television and in newsreels or read about it in magazines and newspapers throughout the Nation.

Commissioner Dexheimer described the Seven Wonders Award as "the highest single honor bestowed upon Hoover Dam since its dedication September 30, 1935."

"We of the Bureau of Reclamation share this honor with the American people," he declared. "We should all remember and honor men like Walker R. "Brig" Young, the Bureau's construction engineer on the job; the late Frank T. Crowe, construction superintendent for Six Companies, Inc., and other engineers. Many others and particularly the workers, the "construction stiffs," are honored for the blood and sweat that went into the building of Hoover Dam."

Commissioner Dexheimer noted that the

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ASCE plaque atop parapet of Hoover Dam.

workers in the steel mills of Pennsylvania, the cement plants of California, and in hundreds of other industrial plants and factories throughout the Nation joined with those at the dam site to build the world's highest dam.

"This truly was one of the finest examples of cooperation between the Federal Government and private enterprise," he said. "To those planners and builders of Hoover Dam we dedicate this Seven Wonders Plaque."

Commissioner Dexheimer said that 6 million people in the Southwest depend on Hoover Dam to control floods, protecting their lives and property; to store water for their homes, factories, and crops.

"They look to Lake Mead and downstream reservoirs for recreation and as habitats for fish and wildlife. They welcome the power generated at Hoover and other Colorado River dams to light their homes, offices, and factories; pump their water and operate their many electrical appliances," he said.

Commissioner Dexheimer called attention to the current construction by the Bureau of Glen Canyon Dam, 370 miles up the Colorado River from Hoover Dam.

"Within a few years Glen Canyon will join with Hoover in harnessing the floodwaters and the power of the mighty Colorado," he commented. "Between Glen Canyon Dam and Hoover Dam, man someday will build other great dams in Marble and Bridge Canyons to complete the stairway of dams from Glen Canyon to the Gulf of California."

President Howson paid high tribute to the vi sion and technical skill of both Reclamation anc Six Companies, Inc., engineers. He pointed ou that Hoover Dam was selected because it was the first of the great multipurpose dams. Clarence Whalin, Phoenix, Ariz., president of the Arizona section of ASCE presided, and Samuel B. Morris, vice president of ASCE, Los Angeles, Calif. was master of ceremonies. Walter H. Cates, Los Angeles, president of the Los Angeles ASCE section, explained the local ASCE participation ii the ceremony.

Mr. Morris introduced honored guests which in addition to those on the program, includec Reclamation's Associate Chief Engineer, E. G Nielsen, who represented Assistant Commissioner and Chief Engineer Grant Bloodgood; W. H Taylor, Director of the Bureau's Region 3; L. J Hudlow, Boulder Canyon Project Manager; E. A Moritz, formerly Director of Region 3; L. R Douglass, formerly Boulder Canyon Project Di rector of Power; Burton S. Grant, Assistant Gen eral Manager of the City of Los Angeles' Depart ment of Water and Power; William H. Wisely executive secretary, ASCE; R. Robinson Rowe and Finley B. Laverty, directors of district 11 ASCE; and A. E. Cahlan, editor of the Las Vegas Review-Journal. Also acknowledged were A. E Hamilton, superintendent of the Department of

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Reclamation Commissioner Dexheimer accepts Hoover Dam plaque unveiled by ASCE President Howson.

RESERVOIRS BRING BIG RECREATION GAINS

Becoming an Admiral in the "Nebraska Navy" ›ed to be a pretty fair joke in a State boasting › sizable body of water.

The irony no longer fits southwestern Nebraska, here watercraft now number in the thousands, nd it's a man's own fault if he isn't an admiral, least in his own household.

Southwestern Nebraska has gone boat-mad, like e rest of the United States. And what makes e mania practical, in the 19-inch rainfall belt, the existence of 3 new reservoirs.

The 3 would be encompassed by a 60-mile circle rawn around McCook—Harry Strunk Lake, ›vering 1,768 acres behind Medicine Creek Dam › Medicine Creek; Enders Reservoir, covering 1,707 acres behind Enders Dam on Frenchman Creek; and Swanson Lake covering 4,974 acres behind Trenton Dam on the Republican River.

These Bureau of Reclamation reservoirs, constructed for irrigation, flood control, and other multiple uses, were completed between 1949 and 1953. Sufficient time having passed for filling, and for stocking and growth of 2.5 million game fish, the lakes are now gathering spots for thousands who had always thought of water recreation as being somewhere else.

Nature has provided the wherewithal for recreation in many parts of the United States—seashores, mountains, and big lakes or rivers. In the corn and cattle country of western Nebraska,

by ROBERT J. STEINBRUNER, Field Liaison Officer, Region 7, Bureau of Reclamation, Denver, Colo.

Good fishing at inlet to Swanson Lake.

recreation facilities have to be manmade. The lakes are no exception.

Through the Republican Valley Conservation Association, the people crusaded for control of their limited water resources, to convert hazardous dry farming areas into stabilized irrigation farming and to stop the repeated ravaging by floods.

Farmers and townfolk know the main purposes of the reservoirs; they know the lakes' importance to economic living.

But there's also just plain living—direct, unqualified enjoyment of the new water areas.

There's a big gap between existence of bodies of water, and facilities to enjoy them—such as adequate roads, drinking water, picnic tables, boat ramps, sanitary facilities, etc.

That a reasonable amount of recreation facilities exist to meet the public need at Swanson, Enders, and Harry Strunk Lakes, in so short a time, is a tribute to the agencies and individuals who, with the best of good will, have worked their way through many delays and frustrations.

The starting point of fulfillment was a "reservoir management plan" for each reservoir and the willingness of the Nebraska Game, Forestation, and Parks Commission to accept the responsibility for administration of the areas for wildlife and recreation.

The agencies carefully studied the pattern and cover of the shores to determine the most suitable locations for day use, cabin sites, organized group camps, and wildlife areas.

The National Park Service planned the recreation phase of development including such thing as interior access roads, boat ramps, picnic table fire grates, sanitary facilities, swimming, beache cabin and club sites, and shade-tree plantings.

Minimum facilities for the protection of publi health and safety and Government property wer provided as part of the reservoir construction an located to tie in with the overall plan of recrea tional development.

The Fish and Wildlife Service counseled abou the variety and location of vegetative planting for wildlife, beautifying shores that in natura state would be nearly barren. The Soil Conserva tion Service was concerned with basic land-us capabilities and recommended needed soil erosion control measures, such as terracing, revegetation proper grazing, and agricultural practices.

Agricultural and grazing permits, and als cabin leases and concessions, yield revenues whicl the Nebraska Commission plows back into th areas. The commission maintains a three-mar crew headed by Melvin Grim for year-round ad ministration, and in addition hires seasonal labor

Working arrangements between the agencie concerned are most amicable at the local level be tween headquarters offices of the agencies.

All officials would be quick to affirm that many additional improvements are in order.

Organizations in nearby communities are doing what they can to add to the facilities. The most notable contribution is a fine picnic shelter at Swanson Lake, constructed jointly by the Trenton Chamber of Commerce and the parks commission

Hunters land in stubble field by Harry Strunk Lake.

Northern Pike and Bluegill fill creels at Swanson Lake.

An Izaac Walton League chapter has erected
ı attractive clubhouse at Enders, and a number
f good-quality cabins have been built by private
ıdividuals, especially at Swanson and Enders.

Off for a spin around Swanson Lake.

Fortunately, one reservoir benefit requires little no investment—duck hunting. The new bodies water attract vast flocks of ducks for shooting the reservoir marshes or along the rivers where v ducks formerly came. Quail, deer, and other me love the wildlife habitat plantings.

Melvin Steen, Director of the Nebraska Game, restation, and Parks Commission at Lincoln, d R. J. Walter, Jr., Director of the Bureau of clamation at Denver, believe a wonderful job s been done for the public.

The Nebraska admirals and their families—the 350,000 people who used the reservoirs for recreation each of the last 2 years—know best of all that recreation is an additional dividend resulting from construction of irrigation and flood control reservoirs in the arid west. ###

"Rx JELLY BALLS"

"Two cups, three times a day." Would you prescribe "Jelly Balls" as a reducing diet?

The name, courtesy of Mr. Frank McDonald of Southern Okanogan Lands project, Oliver, British Columbia, aptly describes the green pea, green grape, green olive shaped balls which move freely in the water of irrigation projects. "Jelly Balls" are common but are seldom recognized as the alga: *Nostoc*. They are probably never harvested for human food. They are better known for their capabilities of plugging such small openings as siphon tubes, spiles, screens, and sprinkler systems.

"Jelly Balls" are free floating forms of blue-green algae. Their skins are tough and their insides are of the consistency of sun-ripened grapes. With a certain amount of drying to further toughen the skin, "jelly balls" present a dietary amendment high in protein—low in carbohydrates super-charged with chlorophyll and wrapped in its own discrete package. Here is a crop already processed ready for national advertising. The flavor leaves something to be desired, but then it's simply a matter of taste. Consider the adherents to the distinctive flavors of broccoli, okra, and spinach, not to mention lutfisk or boiled cabbage.

On the Columbia Basin project, Washington, "Jelly Balls" have not been harvested. Tons of the little green spheres lie in the waterways drying to the consistency of raisins. Their nitrogen fixing skills serve only to enrich the bottom silts and to further encourage the invasion of the submersed pondweeds.

In Washington as in British Columbia, copper sulfate at one-third pound per cubic foot of water per second controls "Jelly Balls" and the filamentous green algae.

The foregoing item was made available to the Era through the courtesy of Mr. Delbert D. Suggs, Weed Specialist, Columbia Basin project, Washington. #

FIRST SMALL PROJECT LOAN O. K.'d

Secretary of the Interior Fred A. Seaton recently approved the first contract for repayment of a construction loan under the Small Reclamation Projects Act.

The contract is between the Bureau of Reclamation and the Cameron County Water Control and Improvement District in Harlingen, Tex.

The work contemplated by the Cameron County District in the rehabilitation and betterment of the existing nonfederally constructed system serving some 39,000 acres of land from a pumping plant on the Rio Grande River, about 12 miles southwest of Harlingen. No new irrigation is planned.

Witnessing the signing was a bipartisan group of Senators and Congressmen from among those who had sponsored the Small Reclamation Projects Act of 1956. Standing (L. to R.) Hon. Wayne N. Aspinall, Colorado; Dr. A. L. Miller, Nebraska; Senator Frank A. Barrett, Wyoming; Senator Arthur V. Watkins, Utah; Senator Clinton P. Anderson, New Mexico; and seated on Secretary Seaton's right is Hon. Joe M. Kilgore of Texas.

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If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

CORROSION, A FORMIDABLE ENEMY

The economic and material loss through the corrosion of metals is a tremendous amount each year. These losses may be divided into two groups, direct and indirect costs.

The direct costs consist largely of the protection and replacement of corroded equipment or structures. The amount has been estimated as more than $6 billion annually for the United States alone.

The indirect costs have never been satisfactorily estimated. It is known that the amount is tremendous. Indirect costs include such items as conservative design when the rate of corrosion is unknown, replacement and duplication of equipment such as pumps, pipelines and numerous kinds and types of installations in order to insure continuous service when failures occur. To the above can be added the loss of life and limb, resulting from unpredicted failures, explosions, wrecks and many other costly catastrophes.

There are many ways open for combatting corrosion and one is the proper choice of metals. The selection of the proper metal for reducing corrosion to the minimum under specific conditions requires careful study. The first cost of stainless steel may be 4 times that of other steel but under proper conditions can increase the life of a piece of equipment 20 times. The same can be said of other metals such as silver, copper, brass and aluminum under chosen conditions. For instance aluminum may last indefinitely under particular atmospheric conditions but under certain soil conditions corrodes very rapidly. The combining of metals with different rates of corrosion should be done with care. As for example a copper service pipe from a steel main into a building may produce a condition ideal for electrolytic action and cause portions of the main to corrode rapidly. A brass valve seat may remain in good condition at the expense of some other portion of the valve. The same may be true of stainless steel in combination with other types of steel.

The most popular and in many instances, the most economical way of preventing corrosion is by the proper selection and application of protective coatings. There seems to be no end to the types and varieties of these coatings. Some of

Continued on page 79

THE LID'S ON **EVAPORATION**

"The tun (head cavity) of the whale contains by far the most precious of all his oily vintages, the highly prized spermaceti," wrote Herman Melville in his classic 19th century whaling story, *Moby Dick*. Melville's words have particular meaning today, as research by Reclamation scientists indicates that the spermaceti, or sperm oil, of the whale may influence the control of evaporation from reservoirs. If this research is successful, the results will add significantly to the available water supplies in the West and elsewhere.

From spermaceti comes the compound cetyl alcohol, which research shows forms on the water surface a film, or monomolecular layer—an invisible shield between the water and the surrounding air, 1 molecule or about 6 ten-millionths of an inch thick. Cetyl alcohol, also known as hexadecanol, thus has the ability to reduce evaporation from a water surface.

The monomolecular layer is formed by long molecules alining themselves side by side with the water-loving, or hydrophilic ends of the molecules dipped into the water and the water-fearing, or hydrophobic, ends out of the water. When a small amount of hexadecanol is placed on a water surface the molecules stream off onto the surface, alining themselves similar to paper matches in a matchbook and forming an invisible but tough and pliable "lid" on the water surface.

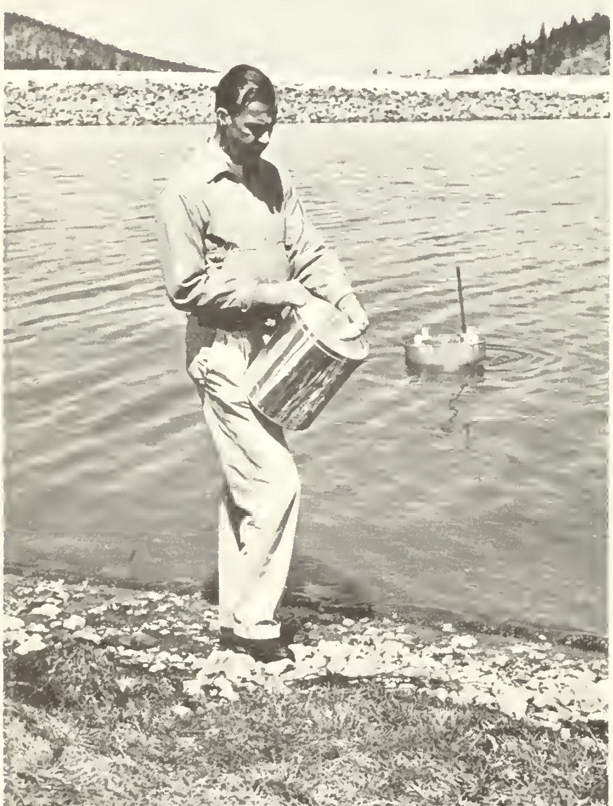
In the arid West, reservoir evaporation reduction is vitally important. One western city alone loses each year approximately 11,000 acre-feet

Photo above—Research in evaporation-preventing chemical films reveals promising results.

by Q. L. FLOREY, Physicist, Bureau of Reclamation, Denver, Colo.

Reclamation research team of Timblin and Florey check results at Rattlesnake Reservoir.

Smooth water surface in foregr



Reclamation physicist Florey examines flake hexadeconal refill for the dispenser in water.

or 3.6 billion gallons of water through evaporation—enough water to supply, on the average, the full municipal needs of 44,000 persons for a year. In the Western States, losses due to evaporation from water surfaces average 11.5 million acre-feet a year—which is underscored by the fact that prices of irrigation water in the West range from $1 to $40 an acre-foot, and that the cost of municipal reservoir water varies from $10 to $80 an acre-foot.

The study of monomolecular layers is not new. For more than 30 years it has been known that layers of certain compounds retard evaporation from water surfaces under laboratory controlled conditions. The "how to do it" is the most difficult part of the development, and has occupied the Bureau researchers' attention since the spring of 1952.

Why is hexadecanol high on the researcher's list of evaporation suppressors? Bureau studies of 125 materials tested show that as much as 65 percent of evaporation can be eliminated under controlled laboratory conditions by placing and maintaining a film of hexadecanol. The chemical is also desirable because it will not react with hardness chemicals in water to form a solid layer which is easily fractured by wave action and quickly loses its ability to reduce evaporation.

sence of monomolecular layer.

Compression of monolayer is determined by the spreading of calibrated oils.

Most important, hexadecanol does not affect the quality of water treated nor the biological elements in water. The Food and Drug Administration of the Department of Health, Education, and Welfare has given full clearance from the standpoint of nontoxicity to human beings for use of hexadecanol in the quantities that would be used in reservoir studies. Reclamation studies have also indicated that hexadecanol is not harmful to fish, fowl, or aquatic plants. These biological investigations are continuing at the Colorado State University.

The Bureau early recognized that to evaluate the effect of monomolecular layers in large scale application to water surfaces, tests would have to be made on a large reservoir where the inflow and outflow of water are acurately known. Such a reservoir is the 2,500-acre Lake Hefner of the Oklahoma City municipal water supply system. A committee was subsequently formed to examine the effects of hexadecanol on water quality of the city's reservoir. On the committee are representatives of the Bureau of Reclamation, United States Geological Survey, City of Oklahoma City, Oklahoma State Department of Health, and the United States Public Health Service and its Robert A. Taft Sanitary Engineering Center.

The committee decided that the effect of hexadecanol treatment upon water quality should be tested first at Kids Lake, a 6-acre body of water adjacent to Lake Hefner. The Kids Lake studies, carried out during the summer of 1956, indicated that water quality was not affected, insofar as taste, odor, color, and toxicity were concerned, and that the Lake Hefner large-scale evaporation studies should proceed.

The Kids Lake investigations also demonstrated that there was need for improving the techniques

Hexadeconal covered this shining area of water within 15 minutes.

Almost entire surface area of Denver's Ralston Creek Reservoir is covered by the water-saving layer.

of applying hexadecanol, maintaining the monomolecular layer, and detecting its presence. This need led Reclamation researchers in the Bureau's Denver Engineering Laboratories to develop a set of calibrated indicator oils which contain a mixture of mineral oil and an alcohol. Using these oils they can determine not only the presence of the monomolecular layer of hexadecanol but also whether it is sufficiently compressed to exert an evaporation retardation effect.

For field confirmation of the laboratory tests the laboratory scientists in the spring of 1957 went to the 100-acre Rattlesnake Reservoir on the Colorado-Big Thompson project near Loveland, Colo. Here, the studies of application techniques included shoreline dispensers in which particles of hexadecanol were confined in brass screening, floating cakes of hexadecanol, and broadcast application of powdered hexadecanol. The researchers concluded that a broadcast application of the powdered hexadecanol gave best results. The oils for detecting the monolayer and its compression were tested and proved satisfactory for further use.

Approval was given in the late summer of 1957 by the Denver Water Board to allow the Bureau to carry out additional studies at the 150-acre Ralston Creek Reservoir, a part of the Denver water system about 10 miles from Denver. At this reservoir, application of powdered hexadecanol has been further investigated, as well as the action of the monomolecular layer under the influence of wind, waves, and sunlight. From these studies together with further laboratory investigations now underway will come definite recommendations on the most effective hexadecanol dispenser, how many dispensers are needed, and where they should be placed to maintain the film of the chemical on the reservoir's surface.

Tests are now in progress to evaluate the feasibility of treatment of large reservoirs with hexadecanol or similar materials. Before a reservoir can be treated, it will be necessary to make a study of the costs and methods for treatment, benefits to be derived from the water saved, etc., to determine the praticability of the treatment.

In the months to come, hexadecanol may have great significance to western water resource developments which will rely on this chemical to reduce evaporation. If only a small percentage of the evaporation can be reduced from the West's many reservoirs, potentially millions upon millions of gallons of precious water can be conserved. Substantial contribution to saving the West's precious water supplies may be realized.

# # #

Hexadeconal dispenser is simple device and easily recharged with chemical.

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

Heart Butte Scout Reservation—

A Resource Development for Youth

by G. A. FREEMAN, Irrigation Division, Missouri-Souris Projects Office, Bismarck, N. Dak.

The Bureau of Reclamation constructed Heart Butte Dam in southwestern North Dakota, and it is one of the components of the Missouri River Basin project. It has already proven itself as a flood control structure, is furnishing a water supply for irrigation, and the recreational values have far exceeded original expectations. Working in cooperation with the Fish and Wildlife Service, the National Park Service, and the North Dakota Game and Fish Department, plans are well underway to develop and encourage public use of the area. A big boost was given to this area when the Missouri Valley Council of the Boy Scouts announced its plans for a scout reservation in this area. It plans to invest $110,000 to develop it.

"Look Over This Wonderful Project—

"You'll be as excited as we are" is the front page caption of the scouts' eye-catching brochure announcing their development plans for the Heart Butte Scout Reservation. The Missouri Valley Council represents the Scout movement in 20 counties in southwestern North Dakota and 2 counties in northwestern South Dakota. Seeking a better and permanent summer encampment area, the council reviewed several possibilities and decided that Heart Butte Reservoir afforded the best opportunities for a number of important reasons. Heart Butte Dam, completed in 1950, is located approximately 60 miles southwest of Bismarck, N. Dak. The lake, created by the dam, varies in width up to 2 miles, and is from 6 to 8 miles in length. The rolling terrain adjacent to the lake, plus a number of well-sheltered bay areas, have created an ideal group camping site for this Boy Scout organization. Three hundred and sixty acres of acquired lands, providing approximately 3 miles of reservoir shoreline, has been leased.

Local Scout officials and leaders, quick to realize the potential of this excellent site and its importance to scouting youth in their council area, set forth an ambitious program of development. Mr. A. W. Klick, veteran scouter and vice president of the council, was selected as campaign manager. He outlined detailed plans for a brick constructed central service lodge, 20 patrol shelters, a water-supply system, roads and trails, council area, archery ranges, beaches, docks, and other details to accommodate up to 1,500 Boy Scouts.

Amid these plans for improved physical fa-

Scouts learn practical rules of boat handling and safety.

Troop 10 Scouts receive instruction at Heart Butte outing.

cilities a unique conservation phase of reservation development also came forward. Two prominent men in tree culture for the Great Plains and scout enthusiasts Elmer Worthington and George Will, Jr., of Bismarck, developed a tree-planting program called "Operation Tree Lift." Thousands of trees were planted during 2 weekends in May 1957, and awards were made to scouts participating. Tree seedlings, furnished by the North Dakota Game and Fish Commission and the Soil Conservation Service, were machine planted during the operation. Planting success has been excellent and many larger trees brought from home and nearby areas were also transplanted on the reservation. In 1958, "Operation Tree Care," in addition to another program of planting, assures the success of the program. Scouts participating in the conservation phase were awarded a "patch" emblem to identify and recognize their important contribution in the development of the area. The central service lodge is also to be constructed next year. This will be a fine brick building to house service facilities for patrol groups encamped in outlying areas.

The year 1957 was one of considerable progress in the Scout council's activities. Under the leadership of Charles Conrad, Great Plains Council President, and Rudy G. Peterson, Scout executive, the summer encampment at the Heart Butte Scout Reservation and development of the site were highly successful.

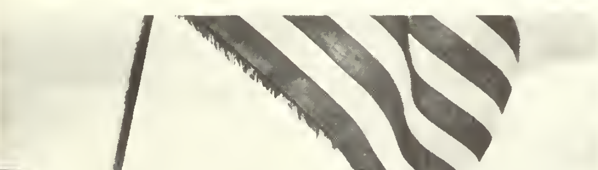
Boy Scouts and their leaders are enthused about their new summer encampment program. In the sheltered bay areas water-safety programs go forward under ideal conditions. It is ideal for canoes, and shallow beach areas provide an excellent location for swimming lessons. Heart Butte, being one of the best fishing lakes in the State, gives the Scout a chance to prove he is "smarter than the fish." Hiking, nature trails, the council fire, and many other forms of recreation and relaxation in the "open air of the country" are well afforded here. This is typical short-grass country—occasionally, scouts find arrowheads, bone knives, or other remains of the American Indians in their treks over the adjacent prairies.

Each troop at summer encampment will have its own shelter area where cookouts and meetings can be held. Scouts bring their own tents and camping gear, and spend a week at "home on the range"—a pleasant excursion in outdoor living with partners and leaders of the Great Plains Council Scout movement.

Life in Scout camp is a busy one for these youngsters. Counselers meet each night to develop the following day's program for their individual troop and to coordinate their plans. Each troop usually plans 3 hours activity for each morning and afternoon. Troop plans and activities are coordinated to include swimming, canoeing, hiking, archery, compass work, boating, rope tying, learning the use of tools, games, fishing, as well as cleanup, sanitation, and varied ac-

Missouri Valley Boy Scout encampment at Heart Butte offers archery practice.

tivities of the camp. Prizes are awarded for troopwork, and each troop tries to win honors on camp inspection. In twilight hours the entire camp assembles to sing, put on skits, get a good campfire going, and enjoy the fellowship afforded by the summer encampment. Once each week an honorary ceremonial "Order of the Arrow" is staged where tribute is paid to a member selected from each troop. The ceremony begins by a flaming arrow shot from behind a hill near the council grounds, and is an impressive moment for each Scout in his tour of encampment. As the Scout leaves, he has learned many things about outdoor living, and in the association of others of his age. Probably he has learned to swim, how to handle a canoe, use a bow and arrow, the importance of conservation of our resources, and many things



General assembly of Boy Scouts of Missouri Valley Council.

that only scouting and camp life bring out. A week at camp has provided him invaluable lessons in good citizenship.

These splendid opportunities provided to the youth of the council area for summer encampment are well founded. The leaders of this council look forward to the continued growth in summer encampment.

As Heart Butte Scout Reservation Camp continues to grow, these fine facilities and enjoyable moments of camping and outdoor living for the boys will contribute much to the time-honored motto of every Scout: "Be prepared." The dividends from their investment will accrue manyfold, and they are to be commended for their work in this important task of building and molding youth—our leaders of the future. ###

HOW ABOUT CASTORBEANS?

Experience has shown that castorbeans can be grown successfully on a commercial basis and can compete effectively for land with other crops, when yields and price relationships are favorable.

Domestic bean prices have been relatively high, and worldwide demand for castor oil is rising to fill industrial and defense needs.

Demand in the United States has been generally strong in recent years, and imports of castorbeans and castor oil are large. A large United States crop, therefore, would make this country less dependent upon imports of crops particularly important in times of international tension.

In the first place, castor oil and its derivatives are used as a raw material in the manufacture of many materials needed for military and defense production, as well as for other products in everyday use.

It is the starting material in the manufacture of sebacic acid, used in making synthetic lubricants for jet aircraft, plastics, and nylon bristle. It is also used in the manufacture of all-purpose greases, hydraulic fluids, artificial leather, pharmaceuticals, soap, printing ink, special low-temperature lubricants, and flexible coatings, as well as plasticizers which are used in the manufacture of explosives and fabrics.

Largest single consumer is the protective-coating industry. Dehydrated castor oil is used as a quick-drying base for paints, lacquers, and varnishes.

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Sesame—AN ANCIENT CROP WITH A FUTURE

by G. W. RIVERS and M. L. KINMAN [1]

Available literature on sesame, *Sesamum indicum* L., indicates that this plant is one of the oldest of the cultivated annual oil seed crops grown by man. Sesame was first grown by small farmers in Asia and Africa. It was brought from Africa by Negro slaves to the Southeastern United States in the 17th century. Since these early importations, sesame has slowly established itself as a crop in the South. In the last 4 or 5 years sesame has become a valuable cash crop in Texas and to some extent in other Southern States and in California and New Mexico. In recent years a rather large commercial acreage has developed in South America. The acceptance of sesame as a crop has been brought about by the research and educational programs of Federal and State agencies working jointly on this planned project. If normal progress is made in this joint endeavor, it would seem reasonable to assume that sesame will become an important cash crop in the South.

Adaptability

Sesame is best adapted to the southern half of the United States where high temperature prevails during the growing season. Sesame is not adapted to soils of low fertility and this is borne out by the fact that best yields are obtained on fertile, well-drained soils. Sesame appears well adapted to most of the more fertile soils of Texas, with the possible exception of the northern part of the Panhandle where early frosts occur, and the high rainfall areas of east Texas where leaf diseases may hinder production. Soils with neutral reaction are preferred, but good results have been obtained on either slightly acid or slightly alkaline soils. Moderate applications of commercial fertilizers are required for satisfactory production on soils of low to moderate fertility.

The plant is somewhat drought resistant and has been grown for centuries in the Middle East with little or no rainfall during the growing season, depending solely upon stored moisture from the rainy season. Areas receiving adequate rainfall for the production of dryland cotton or sorghum have enough moisture for the production of sesame. The highest yields of sesame reported in the United States have been from experiments ground under irrigation in desert areas, with slightly less irrigation water than is required for maximum yields of cotton. Excellent yields have been obtained from as little as 18 inches of irrigation water in the Salt River Valley of Arizona.

Cultural Practices

Sesame should not be planted until the danger of low temperatures is past. Planting dates may be as early as March 20 in the southern limit of the area of adaptation, and as late as June at the northern limit. Generally, sesame would be planted shortly after cotton or sorghum in areas where these crops are grown. June plantings have proved satisfactory in areas with long growing seasons and adequate moisture.

One pound of sesame containing about 150,000 seeds is normally adequate to plant an acre. However, if thinning is practiced, up to 4 pounds per acre may be used. Seed should be planted three-fourths to 1½ inches deep in a well-prepared seedbed that is weed free, mellow, and moist. The depth of planting will depend on the soil texture and available moisture at planting time. It is usually necessary to plant slightly deeper in a fast drying clay textured soil than in a sandy soil.

In humid areas and in irrigated sections, satisfactory results have been obtained by planting on

[1] *Research Agronomists, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.*

Sesame growing at breeding nursery at College Station, Tex., where hundreds of strains, selections, and hybrids are tested.

slightly raised beds. In drier areas, planting on level beds or in shallow furrows has been satisfactory. Presently most of the sesame is grown in rows 36 or 40 inches apart. Double rows 12 to 16 inches apart on 36- to 40-inch vegetable beds have proved satisfactory under irrigation.

Experiments have shown that increased yields of seed have been obtained with 20-inch as compared to 40-inch rows. Thinning is not recommended if the plants are not closer than 1 inch apart in the drill. Available information indicates that stand tolerance is high, under some conditions at least, and a uniform stand of about 40,000 plants per acre may produce as great a yield as approximately four times this number of plants per acre. Methods of seedbed preparation, row spacing, and the stand required for highest production will depend on local environmental conditions, growth habit of the variety and the equipment available. With minor adjustments, farm machinery used for cotton and sorghum can be adapted to planting and cultivating sesame. The major adjustment in machinery used for planting sesame is in the planter box. Sesame seeds are small and easily crushed and will clog the planter plates. The most satisfactory means of overcoming this difficulty is to replace the regular planter hoppers with vegetable planting equipment, such as "Planet Junior" hoppers.

Planting in a weed-free seedbed and early cultivation close to the plants is recommended. Early cultivation causes the seedlings to grow faster, possibly because of the improved soil aeration. When the seedlings become established and reach a height of 3 or 4 inches, they grow rapidly and very little additional cultivation is required to control weeds.

With current shattering varieties such as the K–10 types, much of the hand labor in harvesting can be eliminated. A row binder, such as that used in harvesting corn or sorghum, may be used for cutting and binding the taller type of sesame. A small grain binder, like that used for harvesting wheat and oats, works very satisfactorily for the shorter varieties. Plants are cut and tied in small bundles. The seed ripens and the leaves fall from the plant while the stems are still green and appear immature to the inexperienced grower. Harvesting immediately after the leaves fall prevents some loss from shattering. The bundles are shocked in small shocks consisting of 8 to 10 bundles, and a string is tied around the top of the shock to prevent it from blowing over in the event of a rain or wind storm. In about 2 weeks, under sunny conditions, the bundles are dry enough to thresh.

A grain combine is preferred to the stationary thresher since the only handwork required is to pick up the bundles and throw them into the combine. The combine is pulled from shock to shock. With careful handling of the bundles, 95 percent or more of the seed may be saved.

The cultural practices mentioned above for the shattering varieties of sesame apply to the nonshattering varieties, with the exception of harvesting. When the nonshattering varieties reach physiological maturity, the plants are cut and windrowed. When the plants are dry, they can be threshed with presently available combines. In order to prevent excessive cracking of the seed the cylinder speed of the combine must not exceed 500, 580, and 700 r. p. m. for cylinder diameters of 21, 18, and 15 inches, respectively. To compensate for the slower cylinder speed, the threshing sur-

Nonshattering-type sesame capsule on left, shattering type and exposed seed on right.

face must be increased to approximately double that used for small grains by increasing the number of cylinder or concave bars or both in order to obtain high threshing efficiency.

Non-Shattering Sesame

Indehiscent or nonshattering sesame, that does not lose its seed upon drying, occupies only a small part of the present commercial acreage being grown in the United States. An important phase of the cooperative Federal-State breeding program is devoted to the development of nonshattering varieties. The increase of sesame acreage in the United States depends on the development of nonshattering varieties adapted to complete mechanization, which will produce comparable yields with the present shattering varieties. Indehiscent varieties are now available and the mechanization problems have been worked out reasonably well. When better nonshattering varieties are obtained and properly modified harvest machinery is generally available, it is believed that domestically produced sesame will be competitive with other oilseeds. This problem is a joint one involving plant breeding and agricultural engineering.

Desirable Delco—large strain of sesame capsule on left and Rio-short strain on right.

Uses

The baking industry is the principal market for whole sesame seed in the United States. A large percentage of the seed is used as a topping for bread and rolls and is the form most familiar to the American public. The whole seed is also used in a wide variety of confections. The oil, which is pressed from the seed, is used for shortenings, cooking oils, margarine, and in soaps, drugs, cosmetics, and insecticides.

Experimental field of nonshattering sesame.

Sesame oil possesses a mild pleasant flavor and is easily processed and refined. In Latin America, it is considered the "Queen" of all vegetable oils. Perhaps the outstanding characteristic of sesame oil is its stability or keeping quality, which is a result of its resistance to oxidative rancidity. Sesame meal, the residue remaining after oil extraction, is a valuable protein supplement for livestock and has possibilities as human food.

Market

The specialty uses to which sesame seed are essential in the United States are gradually increasing and imports appear less reliable than previously. This should allow some expansion of production of shattering-type varieties best suited

Combining from windrow with pickup attachment.

to these uses. However, if large acreages of sesame are grown in the United States, the seed must enter the oilseed processing trade. Industrial acceptance of the oil seems assured whenever sufficient quantities are regularly available at prices comparable with competing vegetable oils. Complete mechanization (of nonshattering varieties) is probably required for such a price structure to exist.

Commercial concerns interested in sesame marketing or processing sesame seed contract for the desired acreage before the planting season; supervise the growing of the crop, and either purchase or arrange for sale of the seed at harvest time.

Shattering-type sesame harvested with special rig. Yield was 780 pounds seed per acre.

The Future

Sesame is still a young commercial crop in this country, no regular grain trade channels have been established. Before a farmer plants a crop, he should make sure he has a market for his crop. Although some sesame is sold on the open market at harvest time, much more is contracted before the crop is planted.

Farmers who have grown sesame and given it equal care with their other cash crops have made money. With new nonshattering varieties, the future appears even brighter. It should be pointed out again, as has been done in the past, that sesame is not a wonder crop, but requires careful, intelligent production methods. With increased research and grower experience, sesame should become a stable crop in the South. ###

Corrosion

Continued from page 68

them may prove to be the finest and cheapest type of maintenance but the choice of the proper coating requires careful study.

There is another method of controlling the corrosion due to electrolysis of buried and submerged metal known as cathodic protection, which is coming rapidly into use both in this country and in many foreign countries. Such corrosion is caused by minute electric currents carrying metal from one area called the anode toward another area known as the cathode. Cathodic protection is a process in which very low induced currents are caused to flow toward all parts of the surface to be protected. The process known as galvanizing whereby a metal surface is coated with zinc is an example of cathodic action.

The induced current is produced by an external source, such as a rectifier, or by using such metal anodes as magnesium, zinc, or aluminum to form a galvanic cell with the metal to be protected.

Under ordinary conditions one ampere will protect more than 1,000 square feet of bare metal at an annual cost of $10 to $20.

The Bureau of Reclamation has been doing some pioneer work toward applying cathodic protection to irrigation structures such as radial gates in checks and wasteways, steel pipe siphons and the silt clarifiers at Imperial Dam. The results secured have been quite satisfactory and in some instances the savings made have been unusually high.

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Land leveling prior to irrigation.

Crow Creek

Continued from page 62

the lands be brought under assessment for water immediately and that others be withheld until development work could be completed. The Irrigation District Commission granted these requests. As a result, in 1957, 2,833 acres received water and were assessed; and, in 1958, 3,300 will receive water and be assessed. By 1961, the full 4,247 acres now in the district will receive water and be assessed water charges. It is anticipated that an additional 260 acres will petition this year for admission into the district.

The Crow Creek Unit has sold itself to the landowners in the area, tripling its acreage in about 3 years' time.

Various reasons have been advanced for the increased interest in irrigation, but the most obvious one is that in the face of recent dryland crop failure and near failures, irrigated unit lands have produced crops of up to 5 tons of alfalfa hay per acre and up to 30 bushels of peas to the acre.

Crow Creek farm operators are spending up to $130 per acre in some cases for land leveling and irrigation development. Such expenditures have proved economically sound, for 1 man can irrigate about 25 such acres in a day, 3 times the usual rate in Montana.

In general, the land on the unit has an adequate phosphate content but is low in nitrogen and organic matter. In places where heavy cuts have

Grain crop almost hides Bill Thompson.

Attractive homesite on Crow Creek Unit.

Bill Thompson and Harry Stanley, watermaster, speculate on yield.

Plowing in contour ditches preparatory to harvest.

been made to level the land, applications of up to 300 pounds of nitrogen and phosphate mixed appear to be necessary. Experience has shown that if such fields are planted to alfalfa hay, the leveling is apparent the first year but not the second year. Farmers feel that after the third year of cropping to alfalfa, the land will be suitable for any type of irrigated agriculture.

One of the extremely favorably signs on the Crow Creek Unit is the manner in which farm operators are handling the transition from dry to irrigated farming methods. For the most part, operators are placing their acreages under the agricultural conservation program. They are applying engineering and sound land treatment practices and, in general recognizing that irrigated agriculture demands techniques different from those practiced on dryland farms. This trend is being assisted considerably by the fact that in several instances successful irrigation farmers from other parts of the West have been attracted to and purchased land on the unit.

Alfalfa on Hunsacker Farm yields up to 5 tons per acre.

Alfalfa ready for second cutting.

ASCE Plaques

Continued from page 64

Water and Power, Hoover Dam, and D. D. Dutter, resident engineer for Southern California Edison Co.

L. F. Wylie, construction engineer for the Bureau of Reclamation at Glen Canyon Dam and Al Bacon, construction superintendent for Merritt-Chapman & Scott, prime contractor on Glen Canyon Dam, flew down from Kanab, Utah, to witness the unveiling.

The bronze plaque, mounted on the upstream parapet wall, reads "A Modern Civil Engineering Wonder of the United States—One of the Seven Selected by the American Society of Civil Engineers—1955." The lettering surrounds a miniature blue and gold ASCE shield.

The other "Wonders" include the Colorado River Aqueduct, the Panama Canal, the San Francisco-Oakland Bay Bridge, the Empire State Building, and Chicago's Sewage Disposal System. The seven were selected from among several hundred other civil engineering works nominated by ASCE members.

GRAND COULEE DAM AND THE COLUMBIA BASIN PROJECT

"Grand Coulee Dam and the Columbia Basin Project—an Engineering Marvel!"

That is the citation made by the American Society of Civil Engineers in naming the Columbia Basin project as one of the "Seven Modern Civil Engineering Wonders of the United States."

Against backdrop of Grand Coulee Dam, plaque awaits unveiling.

P. R. Nalder, CBP Manager, presents ASCE President Howson picture album of project.

President Howson, of the society, presented a plaque to Columbia Basin Project Manager Phil Nalder, formally dedicating the citation at a special ceremony at Grand Coulee Dam on March 11, 1958.

In presenting the plaque, Mr. Howson paid particular tribute to the many engineers who had worked and who are still working on the project when he told the audience, "The project is a monument to the creative imagination of the modern civil engineer who first had the constructive vision to recognize the potentialities of such a project and the planning abilities to draw together the tremendous resources and power exercised in the development.

"This project has now been in operation long enough to demonstrate many of its contributions toward human welfare. It has materially affected the economic life and development of the entire Pacific Northwest to such an extent that it has been the forerunner of additional great power expansion, both public and private.

"The Columbia Basin project harnessed nature to meet man's needs on a scale so tremendous that it was long considered completely visionary and impossible. The execution of the project was largely the result of the application of civil engineering principles with broad vision and ingenuity.

"This selection of Grand Coulee Dam and the Columbia Basin project as "One of the Seven Modern Civil Engineering Wonders of the United States and the presentation of this plaque are concrete indications of the workings of the civil engineering profession for the benefit of mankind."

In accepting the plaque on behalf of the Bureau of Reclamation, Phil Nalder, Columbia Basin project manager, honored all who have worked to make the Columbia Basin project a success when he said, "To us this plaque is more than a recognition of the engineering accomplishments on the project. It is a tribute to the thousands of employees who have worked and those employees who are now working to make it a success. It is also a memorial to those who were associated with this project but did not live to witness this honor."

Work was started on this irrigation project over 24 years ago when the late Frank A. Banks drove the stakes for the axis of Grand Coulee Dam. Construction has been going on continuously since that time. The last 108,000-kilowatt generator was placed in the powerplant in late 1951 and the plant has maintained maximum production since. Last year 2½ percent of the Nation's electrical energy and approximately 40 percent of the energy in the Pacific Northwest was generated here. A part of the energy produced is used to operate the world's largest irrigation pumps necessary to lift the water from Franklin D. Roosevelt Lake 280 feet into the grand coulee where it flows by gravity to the irrigation project some 60 miles south. Crops worth $24½ million were grown on 203,000 acres in 1957.

To June of last year, approximately $517 million was spent on the project. To complete it, at today's prices, it is estimated it will cost $250 million. Regardless of the cost of the project, hovewer, the entire amount expended will be repaid to the United States Treasury with income from the sale of power and the portion of construction costs assessed the water users. In addition, a 3-percent interest payment is being made on expenditures for power facilities. It is interesting to note that through last June, $139 million had been returned from project operations to the Treasury.

To completely describe the many engineering features to be found on the project would take pages, but, as can be attested by the number of persons who visit with us from all walks of life each year, it may well be stated that it is one of the most interesting developments of its kind in the world.

CBP Design Chief Davidson looks on as Project Manager Nalder accepts plaque from ASCE President Howson on behalf of Bureau of Reclamation. Louis Rydell, ASCE Director, and Edwin Nasburg, CBP Hydrology Chief, to the right.

Do You Know . . . Irrigation Water Isn't All Wet

Are the ditches that bring water to your farm free of weeds? If they are not, when you irrigate you will be adding something more than water to your fields. A curious research worker in Colorado took the trouble to count the weed seeds carried in the water by a weedy ditch. His finding was startling—an application of 6 inches of water per acre carried with it 170,800 weed seeds! This is one reason why crops must be cultivated, or sprays like 2, 4D used, to keep yields up.

Subscriptions

Subscription rates for the quarterly publication are 50 cents per year, with 15 cents additional required for foreign mailing. Separate copies may be purchased for 15 cents each.

All subscriptions should be sent direct to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Requests for changes in mailing address, renewals, and separate copies should also be sent direct to that agency. #

Castorbeans

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An estimated 135 million pounds of castor oil were utilized in manufacturing processes in 1957, while only about 9.5 million pounds were produced from domestic beans. This meant that United States industry met its needs chiefly from imports.

This country, in fact, takes about 50 percent of the total world trade in castorbeans and oil. This year, prospects are that domestic castorbean acreage will be larger than in 1957, but even the larger output will represent only a relatively small portion of the United States industry's requirements.

In 1957, domestic growers harvested about 15,500 acres, according to trade estimates. These produced about 21 million pounds of beans, compared with 4 million in 1956. Practically all the beans were grown under irrigation, with California accounting for over half of the United States output.

The sharp increase reflects mainly the availability of acceptable harvesters and favorable prices. The average per-acre yield in 1957 was 1,360 pounds, compared with 780 pounds a year earlier. Yields in individual States varied from 1,825 pounds per acre in California, to 300 pounds in the dryland areas of Oklahoma and Arkansas. increase. Also, castorbeans are poisonous and must not be fed to animals or consumed by humans.

Castorbeans store well. Some varieties can be held as long as 5 years without significant loss of oil content. This could go a long way toward giving the market some stability in supply and in moderating the sharp price fluctuations.

[Reprinted from the Agricultural Situation, February 1958, Vol. 42, No. 2.]

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-4978	Ventura River, Calif.	June 11	Construction of steel tanks for Oak View, Villanova, Ojai East, Upper Ojai, and Rincon reservoirs.	Chicago Bridge and Iron Co., South Pasadena, Calif.	$884,576
DC-4979	do	May 9	Construction of Ventura Ave., Ojai Valley, Upper Ojai, and Rincon pumping plants.	Robert E. Ziebarth and Sylvester B. Alper, Torrance, Calif.	546,213
DS-5001	Missouri River Basin, N. Dak.	Apr. 28	One 25,000-kva synchronous condenser with control equipment for Fargo substation.	Allis-Chalmers Mfg. Co., Denver, Colo.	372,577
DC-5021	Fort Peck and Missouri River Basin, Mont.-N. Dak.	May 14	Constructing foundations and furnishing and erecting steel towers for 310 miles of Fort Peck-Dawson County-Bismarck 230-kv transmission line.	Lipsett, Inc., Sioux Falls, S. Dak.	5,275,510
DC-5022	Wapinitia, Oreg.	May 26	Construction of Wasco Dam	C. H. Strong Engineering & Construction, Eugene, Oreg.	231,270
DS-5023	Colorado River Storage, Ariz.-Utah.	Apr. 3	3 million barrels of bulk portland cement for construction of Glen Canyon Dam and powerplant.	American Cement Corp., Los Angeles, Calif.	9,741,900
DS-5024	Missouri River Basin, N. Dak.	Apr. 24	Two 230-kv power circuit breakers for Fargo substation	Brown Boveri Corp., New York, N. Y.	131,825
DC-5028	Weber Basin, Utah	May 8	Construction of earthwork, pipelines, and structures for Uintah Bench laterals, Weber aqueduct lateral system.	Hilton and Carr Construction Co., Ogden, Utah.	983,662
DC-5032	do	June 12	Construction of first stage earthwork, extension of drainage in borrow area A, and placing excavated material in dam embankment, Wiliard Dam.	M. H. Hasler Construction Co. and H. C. Smith Construction Co., Los Angeles, Calif.	1,101,140
DC-5039	Missouri River Basin, Kans.	do	Construction of earthwork and structures for Courtland canal laterals, wasteway, and drains.	Bushman Construction Co., St. Joseph, Mo.	391,801
DC-5045	Colorado River Storage, Utah-Wyo.	June 18	Construction of Flaming Gorge Dam, powerplant, and access roads.	The Arch Dam Constructors (Joint venture of Peter Kiewit Sons' Co., Morrison-Knudsen Co., Inc., Mid-Valley Utility Constructors, Inc., Coker Construction, Inc.) Omaha, Nebr.	29,602,497
117C-512	Columbia Basin, Wash.	June 16	Construction of five 2-bedroom residences with attached garages, office, and 5 service buildings; and roads and utility systems for Wahluke headquarters site.	Basin Builders, Ephrata, Wash.	163,400
200C-369 Supp.	Ventura River, Calif.	do	Clearing Casitas reservoir site	Union Construction Co. and R. A. Bianchi Construction Co., Ventura, Calif.	348,488
400S-100	Colorado River Storage, Ariz.-Utah.	May 19	Power for construction of Flaming Gorge Dam and powerplant.	Moon Lake Electric Association, Vernal, Utah.	1,213,800
400C-107	Weber Basin, Utah	Apr. 29	Construction of 2.3 miles of access roads, parking areas, concrete boat ramp, recreational facilities, and water supply system for Wanship reservoir recreation area.	Nelson Brothers Construction Co., Salt Lake City, Utah.	134,244

MAJOR RECENT CONTRACT AWARDS—Continued

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5044	Rogue River Basin, Oreg.	June 25	Enlargement of Emigrant Dam	R. A. Heintz Construction Co., Portland, Oreg.	$2,635,493
DS-5049	Central Valley, Calif.	June 30	Penstock header and outlet pipe for Trinity Dam	Southwest Welding and Mfg. Co., Alhambra, Calif.	2,313,953
DS-5053	Colorado River Storage, Ariz.-Utah.	June 30	220,000 tons of pozzolan for Glen Canyon Dam and powerplant	J. G. Shotwell, Mercer Island, Wash.	2,508,000
DC-5056	Colorado River Storage, Colo.-N. Mex.	June 25	Construction of Navajo Dam and access roads	Morrison-Knudsen Co., Inc., Henry J. Kaiser Co., F and S Contracting Co., Los Angeles, Calif.	22,822,624
DC-5061	Rogue River Basin, Oreg.	June 30	Construction of earthwork and structures for Conde Creek and Dead Indian collection canals; and two diversion dams.	Cherf Brothers, Inc., Sandkay Contractors, Inc., Cheney Construction Co., S. Birch and Sons Construction Co., Ephrata, Wash.	165,579

Construction and Materials for Which Bids Will Be Requested Through September 1958*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	One 115,000-hp, 180-rpm, 480-foot-head, vertical-shaft, Francis-type turbine for Unit N-8, Hoover powerplant.
Central Valley, Calif.	Clearing timber and brush from Stuarts Fork of the Trinity Reservoir area, near Lewiston.
Do	Relocating 9 miles of county road from Rush Creek to Mule Creek, about 60 miles northwest of Redding.
Colorado River Storage, Ariz.	Constructing a 48- by 256-foot administration building, a 96- by 48-foot, 1-story police building, a 40- by 100-foot steel frame fire station, and a 40- by 100-foot steel frame garage building. At Page, about 135 miles north of Flagstaff.
Do	Embedded metalwork for four 40-foot 0-inch by 52-foot 6-inch radial gates at Glen Canyon Dam. Estimated weight: 95,500 pounds.
Columbia Basin, Wash.	Earthwork and structures for about 2.8 miles of 36-foot bottom unlined canal and about 1.1 miles of 12-foot bottom width concrete-lined canal. Wahluke Canal, near Othello.
Do	Earthwork and structures for about 60 miles of unlined laterals, wasteways, and drains with bottom widths varying from 14 to 2 feet near Vantage.
Do	Earthwork and structures for about 23 miles of open and closed drains near Othello, Moses Lake, and Quincy.
Do	Gravel surfacing about 10.3 miles of operating roads west of Mesa.
Do	Four synchronous, motor-driven, horizontal, centrifugal-type pumping units, 3 with a capacity of 51 cfs at a total head of 65 feet, and one with a capacity of 25 cfs at a total head of 65 feet for the Sand Hollow pumping plant.
Crooked River, Oreg.	Constructing the 188-foot-high earth and rockfill Prineville Dam, containing about 1,400,000 cubic yards of material and having a crest length of 790 feet. On the Crooked River, about 21 miles southeast of Prineville.
Eden, Wyo.	Earthwork and structures for about 10.5 miles of surface drains, 0.5 mile of deep drain, and rehabilitating 1 mile of existing lateral, about 42 miles north of Rock Springs.
Fort Peck, Mont.	Three single-phase, 220-115-13.2-kv, 20,000/20,000/10,000-kva autotransformers with provisions for 2 stages of future forced air cooling, and 3 each 97- and 15-kv tank-mounted lightning arresters for the Dawson County substation.
Do	Two 3-phase, 230-kv, 1,200-ampere, 5,000-mva interrupting rating power circuit breakers and two 3-phase, 115-kv, 800-ampere, 1,500-mva interrupting rating power circuit breakers for the Dawson County substation.
Little Wood River, Idaho.	Clearing trees, brush, and other floatable debris from about 73 acres of the Little Wood River Reservoir area, about 12 miles northwest of Carey.
Middle Rio Grande, N. Mex.	Clearing, cleaning, and shaping about 35 miles of open ditch laterals, removing existing structures, and constructing new structures near Belen and Albuquerque.
Do	Clearing and excavating about 1.1 miles of pilot channel in the Rio Grande to a 150-foot bottom width, and furnishing and erecting a jetty field. Hot Springs area, near Truth or Consequences.
Middle Rio Grande, N. Mex.—Con.	Constructing about 5 miles of 14-foot bottom width canal, excavating about 1 mile of 150-foot-wide pilot channel, removing a brush diversion weir, installing metal jetty units, and constructing structures. San Juan Feeder Canal, near Belen.
MRB, Minn.	Granite Falls substation additions including concrete foundations, furnishing and erecting steel structures, and installing a 115/69-kv, 25,000-kva transformer, associated circuit breakers, and other electrical equipment.
MRB, Mont.	Earthwork and structures for about 11.5 miles of unlined laterals with bottom widths of from 5 to 3 feet. Spokane Bench Laterals, near Helena.
MRB, Nebr.	Constructing a 38- by 40 foot concrete block headquarters and office building complete with water supply, sewerage, heating, and electrical systems. At Red Cloud.
Do	Constructing a 43- by 120-foot concrete block headquarters and shop building complete with water supply, sewerage, heating, and electrical systems. At Cambridge.
MRB, Wyo.	Grading and gravel surfacing about 5 miles of county road, grading and bituminous surfacing, with a crushed rock base, about 1 mile of access road and a parking area at Glendo Dam, about 5 miles southeast of Glendo.
Do	Clearing about 52 acres of timber and brush from the Anchor Reservoir area, about 39 miles west of Thermopolis.
Provo River, Utah.	Constructing the riprap faced Stewart Park Dike, about 4,355 feet long, on the Provo River, about 21 miles northeast of Heber.
Do	Installing a radial gate in intake structure to Duchesne Tunnel, constructing a telephone line from outlet to inlet of tunnel, and 4 miles of gravel surface access road, near Kamas.
Rogue River Basin, Oreg.	Constructing the concrete Ashland Diversion Dam, 8.5 feet high with overflow crest 65 feet long, an earthfill dike extension, concrete canal headworks structure, and about 3 miles of open ditch lateral, 1.5 miles of which are to be concrete lined, near Ashland.
Do	Constructing a 2-bedroom frame residence and garage at Green Springs powerplant, about 11 miles southeast of Ashland.
Weber Basin, Utah.	Constructing 8 rectangular, earthlined reservoirs each to be 22 feet from bottom of reservoir to top of banks, 6 of which are to have 20 acre-feet capacities and 2 which are to have 12 acre-feet capacities. Work will also include construction of reinforced concrete control structures and pipeline connections to the Davis Aqueduct, near Salt Lake City.
Do	Earthwork and structures for about 3.9 miles of 15- to 21-inch precast concrete pipelines and 9.8 miles of unlined open ditch laterals with bottom widths of from 4 to 2 feet. West Farmington area, near Salt Lake City.

*Subject to change.

United States Department of the Interior
Fred A. Seaton, Secretary

Bureau of Reclamation, W. A. Dexheimer, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington 25, D. C.

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The *Reclamation* Era

NOVEMBER 1958

IN THIS ISSUE:

SALINE WATER, by Fred G. Aandahl, Assistant Secretary of the Interior

Official Publication of the Bureau of Reclamation

The Reclamation Era

NOVEMBER 1958 Volume 44 No. 4

In this issue . . .

J. J. McCARTHY, Editor

T. R. McCANN, Art Director

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Beef Cattle On The Strawberry Valley Project

Roundup time on the Strawberry Valley summer range.

Production of beef cattle is an important item and is closely integrated with the farming practices and the total economy of the Strawberry Valley Project. Raising beef cattle requires an understanding of physical and economic conditions as they affect each individual's enterprise including the many contributing factors which are beyond the control of each operator. Market trends are studied to determine how many cattle it will be desirable to hold or to purchase. The amount of feed raised, the amount of feed available on pastures, and the amount of feed that can be purchased in relation to anticipated profits from sales also influence the number to be fed. Project farmers who raise or feed cattle plan farming operations to coordinate the needed forage crops with cash crops. Alfalfa and other hay, field corn, and grains are the crops raised principally for feeding. Such crops as sugar beets, peas, and sweet corn are raised as needed cash crops as well as feed to supplement forage crops.

Crops raised on the Strawberry Valley Project are conducive to the raising and feeding of livestock. Of approximately 37,000 acres of irrigated lands, about 18,300 are used to raise alfalfa and other hay, pastures, and corn ansilage principally for the feeding of livestock; 12,300 acres are used to raise barley, oats, wheat, and grain corn, much of which is fed to livestock; and 4,000 acres of sugar beets, sweet corn, and peas which also provide some forage. There are only about 2,400 acres of orchards and other canning crops which do not contribute to the livestock industry.

by W. HAROLD HIRST, Conservationist, Region 4, Bureau of Reclamation

In addition to crops raised on the irrigated farm lands, the cattle enterprise of the project is materially benefitted by 57,000 acres in Strawberry Valley, of which all but 8,400 acres occupied by the Strawberry Reservoir, where project water is stored, are grazed during the summer by sheep and cattle owned by project farmers. This range does not provide summer grazing for all project livestock, but it has a great influence on the number raised and fed on farms or utilizing forage from those farms. As an indication of the numbers of livestock on the project, the crop census for 1951, the last year that a livestock inventory was taken, showed there were approximately 11,000 beef cattle; 39,000 sheep; 4,000 dairy cattle; 3,000 hogs; and 140,000 chickens.

Beef cattle operations vary from farm to farm. Some farmers maintain breeding herds and raise calves for sale as feeders or as fat cattle. Others purchase feeders entirely while still others maintain small breeding herds and purchase extra feeders.

During the summer, cattle are grazed on the Strawberry Valley range, on irrigated pastures, or on other available summer pasture. After cattle are returned to the farms, they are usually grazed on crop aftermath or pastures as long as feed is available, until bad weather precludes further grazing, or until a desirable price is obtained.

At the end of the grazing season, cattle to be fattened are placed in corrals or feed lots while those to be maintained over the winter are either placed in corrals or fed in the fields. Adequately constructed corrals and sheds are important to fattening cattle since exposure to cold and windy weather may make it impossible to obtain maximum gains. In fact, some feeders prefer to place cattle to be fattened on maintenance rations until the end of February when satisfactory gains are possible. Feed lots or corrals vary considerably, as can be noted in the accompanying photographs, but have the common qualities of well-drained or surfaced yards, an accessible manger, and protection from winds and inclement weather.

Once cattle are in the feed lot for fattening or in the corrals or fields for maintenance throughout the winter months, producers begin the utilization of the harvested crops and purchased supplements. Feeding practices vary considerably between farmers according to feeds available or through rations found to give the best results.

Feed lot where George Chaffin fattens cattle. A few are kept on feed year long.

Feed yard of Arlo Larson and baled alfalfa hay ready for larger feeding operations after harvesting season.

There is also considerable difference in rations for the maintainance or for the fattening of livestock. The following examples illustrate the differences in rations and show the general feeding practices followed on the Strawberry Valley project.

George Chaffin raises some cattle but purchases most of them as feeders. He uses alfalfa and corn ensilage in his feeding operations. The ensilage, which he raises, consists principally of alfalfa and corn. This is placed next to an excavated hillside by dumping from trucks from above. The ensilage consists of about four-fifths alfalfa and one-fifth corn. He also harvests some of his alfalfa nd grass as dry baled hay. Maintenance rations sually consist of 30 pounds of dry hay per day er head with about two pounds of cottonseed cake r meal added when inferior hay is being fed. During the fattening process two rations are used, ne is a starting ration and the other a finishing ation. The daily starting ration, which is fed nly from about 10 to 16 days, consists of 4 to 5 ounds of rolled barley, 2 pounds of dry beet pulp, pounds of cottonseed cake or meal, 4 to 5 pounds f dry hay, and as much ensilage as they will eat. The fattening ration is the same except for increasing rolled barley to 15 to 18 pounds per day. ncreasing the barley reduces the amount of ensilage that the cattle will eat. The average gain n weight of the cattle on the fattening rations is bout 2½ pounds per day except during January nd February when it is difficult to make gains unless better than average weather prevails. The attening process takes from 120 to 150 days.

Glen Cowan raises about all the livestock he eeds. His maintenance ration consists of about pounds of dry alfalfa hay, 20 pounds of grass ay, and one pound of cottonseed cake. The hay s harvested dry and put in stacks loose. Starting ations for fattening feeders consist of 5 pounds f rolled barley, ½ pound of cottonseed meal, 20 ounds of corn ensilage, and 8 pounds of chopped ry alfalfa. Fattening rations consist of 12 to 5 pounds of rolled barley, one pound of cottonseed meal, 8 pounds of chopped alfalfa, and 10 pounds of corn ensilage. Average gain for the full period on feed is about 2.3 pounds per day. Feeding for fattening starts about October 1 and is completed in from 120 to 150 days.

Grover Johns feeds starting rations for about 60 days which consist of 5 pounds of rolled barley, 2 pounds of dry beet pulp, and all the dry alfalfa hay the cattle will eat. Fattening rations consist of 15 pounds of rolled barley, 2 pounds of cotttonseed meal, up to 2 pounds of dry beet pulp, and all the dry chopped alfalfa the cattle will eat which does not exceed 10 pounds per day. The rate of gain is from 1½ to 2 pounds per day. The feeding period lasts from 150 to 180 days.

Arlo Larson feeds all year, although he feeds less cattle during the harvesting season. Because of the poor gains during the months of January, February, and March, he frequently holds fall purchased feeder cattle on maintenance rations until after that time. Maintenance rations consist of 10 pounds of dry alfalfa hay, and all the pea silage they will eat which is about 20 pounds. Fattening rations consist of 3 to 4 pounds of dry alfalfa hay, 30 to 35 pounds of corn ensilage, and about 15 pounds of rolled barley in the winter and about 12 in the summer. Fattening rations are fed for about 150 days. The daily rate of gain is less than 2 pounds during the winter and slightly more than 2 pounds during the spring, summer, and fall months.

Irrigated valley below Echo dam along Weber River. Scattered alfalfa hay stacks.

Feed lot and alfalfa hay ready for the feeding operations of Grover Johns.

Earl Levanger and Paul Lambert buy all their cattle as feeders. They are put directly on fattening rations which consist of 15 pounds of rolled barley, 4½ pounds of alfalfa hay, and 2 pounds of dried beet pulp. The feeding period is from 150 to 160 days and the rate of gain is from 1½ to 2 pounds per day.

Cattle raising and feeding, like any other business undertaking, is a matter of individual choice and, as in any other industry, the extent of profits varies among individual operators and depend on economic factors and individual enterprise. One common advantage in raising cattle, however, is being able to dispose of feed crops through the sale of fed cattle for which there is always a ready market. There is also the advantage of keeping fertility on the farm. Also the pride of ownership and watching efforts result in better herds and fattened beef is often satisfying and provides some compensation in addition to cash received from their sale. The exact magnitude of the benefits derived from cattle raising and feeding on the Strawberry Valley Project are not available but profits derived from this enterprise as a part of the farm activities add materially to project well-being, local economy, and American Agriculture. # # #

Ensilage harvested and ready for the feeding operations of George Chaffin.

ELMER F. BENNETT

New Under Secretary

Elmer F. Bennett of Longmont, Colorado, was nominated as Under Secretary of the Interior on September 21, 1958.

He came to the Department in 1953 as a Special Assistant to the Solicitor and Legislative Counsel. In these capacities he frequently appeared before Congressional Committees as a witness and technical adviser.

He became Assistant to the Secretary of the Interior in June 1956 and in this capacity he had assignments to assist in the formulation and development of policies and procedures throughout the complete range of Department activities. His duties also required that he maintain liaison with the several bureaus and offices of the Department, with the Congress, and other Government agencies.

He was promoted to the office of the Solicitor for the Department in May 1957. Prior to joining the Department he served as a trial attorney in the antimonopoly field for the Federal Trade Commission. He also served as legislative and legal adviser to the late Senator Eugene D. Millikin of Colorado.

Mr. Bennett was educated at Colorado State College of Education at Greeley, and Stanford University Law School at Palo Alto, California.

He is married to the former Gertrude Turner of Golden, Colorado. They have two children and reside in Bethesda, Maryland.

George W. Abbott, Assistant to the Secretary, of Grand Island, Nebraska, succeeds Mr. Bennett as Solicitor. # # #

CROP REPORT

Acreage and Gross Crop Value, 1957

Crop group	Irrigated crops		Gross crop value	
	Acres	Percent of total	Dollars	Percent of total
Cereals	1, 710, 143	26. 08	112, 404, 817	12. 11
Forage	2, 987, 263	45. 56	115, 517, 940	16. 76
Field crops, miscellaneous	1, 151, 674	17. 56	278, 901, 066	30. 05
Seeds	263, 977	4. 03	29, 114, 720	3. 14
Vegetables	474, 088	7. 23	171, 003, 383	18. 42
Fruits and nuts and miscellaneous	317, 033	4. 83	155, 220, 221	16. 72
Other [1]			25, 994, 771	2. 80
Total reported	6, 904, 178	105. 29	928, 156, 918	100. 00
Less: Multiple cropped	486, 754	7. 42		
Plus: Soil-building crops	20, 845	. 32		
Cropland not harvested	118, 997	1. 81		
Total	6, 557, 266	100. 00	928, 156, 918	100. 00

[1] Additional revenues from Federal and commercial agencies.

The value of crop production on 77 Reclama-ion projects amounted to $928,156,918, and aver-ged $141.55 per acre in 1957. The cumulative alue of crops grown stands at $13,277,660,991.

More than 150 important crops were grown on Reclamation projects. Specialty crops occupied nly 16 percent of the acreage but produced 40 ercent of the total crop value. For example, he grape harvest totaled $42.3 million, lettuce 30 million, and fresh market tomatoes $15.1 nillion. Melons added $18.7 million, carrots 10.4 million, and hops $15.9 million. Seeds, int, and nuts accounted for $29.1, $3.6, and $5.5 illion, respectively. Other specialty crops ac-ounted for $201.1 million.

Irrigated lands on Reclamation projects did not ntribute significantly to national crop sur-luses. Tobacco, corn, wheat, and cotton ac-unted for about 86 percent of the value of all mmodities under loan and in inventory of the ommodity Credit Corporation. None of the bacco, less than one-third of 1 percent of the rn, 1.8 percent of wheat, and 2.4 percent of the tton involved in the surplus program was rown on Reclamation projects.

Irrigated land provided full irrigation service taled 3,319,425 acres. Supplemental water serv-e was provided to 3,188,597 irrigated acres. emporary water service was furnished for ,244 irrigated acres.

The irrigated farms number 126,890, of which percent are full-time operating units. These ll-time farms provide support for 392,239 farm people. There are 94,136 people on part-time farms served by the Bureau.

Four new units of the Missouri River Basin Project and 168,797 acres were added to the irrigation service area of Federal Reclamation projects in 1957, bringing the total area subject to irrigation service to 7,827,598 acres. The new units were Hanover-Bluff and Owl Creek in Wyoming, Sargent in Nebraska, and Kirwin in Kansas.

The area irrigated in 1957 was 6,577,266 acres, an increase of 157,123 acres over 1956.

Other major additions to irrigated acreage occurred on the following projects: Boulder Canyon, Colorado-Big Thompson, Columbia Basin, Gila, Minidoka and Rogue River Basin. The upward revision of the Colorado-Big Thompson project acreage is based on results of a complete survey of irrigated land under the project.

States gaining 5,000 or more acres of irrigated area in Reclamation projects were California, Colorado, Idaho, Nebraska, Washington, and Wyoming.

Grain and Forage Crops

Almost three-fourths of the irrigated acreage in Reclamation projects is devoted to the production of grain and forage, chiefly livestock feed crops. The livestock enterprises of these farms are of great significance to the rapidly growing population of the western states which heavily rely on this prime beef and lamb production. The center of the meat packing industry has been moving constantly westward. The hypothetical breaking point between eastbound and westbound livestock shipments is now near the eastern base of the Rocky Mountains. The intensified demand from coastal population centers will move this breaking point farther east as time goes on, adding emphasis to the need for finished meat production in the West. The grain and forage production on the irrigated lands of the West complements the grazing value of 700,000 acres of rangeland, making each more valuable to the cause of providing meat for the Nation's dinner tables. The acreage and production of these crops were slightly greater than in 1956. Their value amounted to $267,922,757, in 1957, approximately 29 percent of the value of all crop production.

Miscellaneous Field Crops

Miscellaneous field crops rank third in acreage but first in value among the several classes of crops. Their culture is less intensive and on a broader scale than that of vegetables. These crops include dry beans, cotton, sugar beets and other cash crops which are usually the pivot-point of a farmer's cropping rotation. Upon these is hinged a sequence of specialty and forage and feed grain crops. Western irrigated lands have natural production advantages for growing these crops, as evidenced by national acreage and production trends.

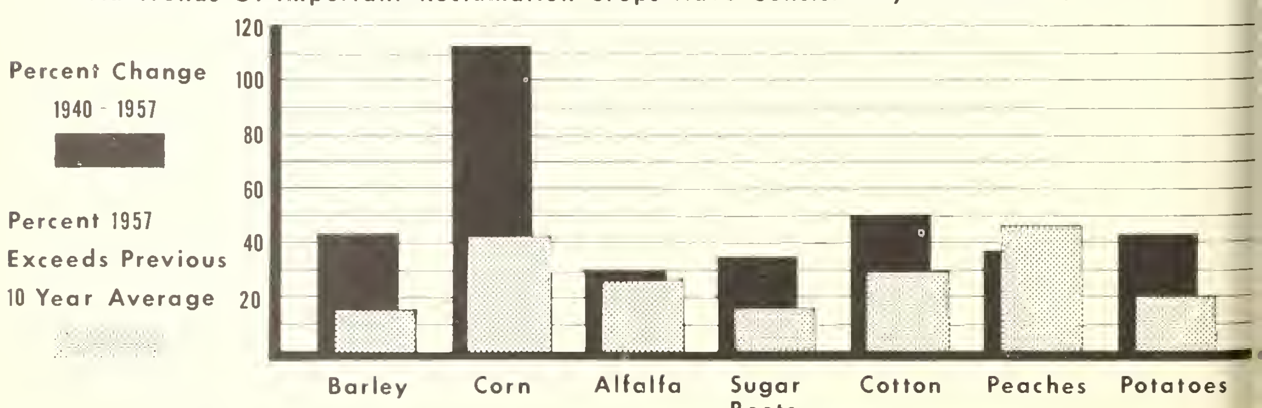
Probably the most universally grown cash crop on western irrigation projects is the sugar beet. Reclamation projects supply a little more than one-third of the sugar produced on the United States mainland. The average per acre yield of sugar beets exceeded the 1956 figure by 6 percent and was greater than the previous 10-year average by 16 percent. Since 1940 the per-acre yield on Reclamation projects has increased by 35 percent. The project-wide average yield on the Columbia Basin project was 25.2 tons per acre. Ten projects had sugar beet yields exceeding 20 tons per acre. Total returns for the crop, including the value of beet tops and additional factory and Federal payments was $91,312,122. Sugar beets on the Colorado-Big Thompson project alone had a total value of nearly $25 million.

Some of the specialty type crops in this category had significant changes in 1957. Castor bean acreage increased 10 times, broomcorn acreage increased 63 percent, and increases were also made in hops and mint acreage. Extra-long staple cotton, grown only in the Southwest under irrigation, more than doubled its acreage due to market demands and relaxation of acreage controls for this scarce, premium fiber crop. # # #

CREDIT

All photographs in the article entitled "Crow Creek is Growing Up," in the August issue of the Era were taken by Charles A. Knell, Region 6.

Yield Trends Of Important Reclamation Crops Have Consistently Increased Since 1940



New Cropping Methods On New Reclamation Projects

Lewis DeFillips irrigating sugar beets near Idaho Falls.

Photo by Stan Rasmussen, Region 1.

One of the outstanding and most significant agricultural developments in the United States during the post-World War II period has been the rapidly increased efficiency and productivity of our farms. Among those who are contributing to the new records being established almost every year are the new homesteaders and farmers developing new private farms on recently constructed western Reclamation projects, such as the Northside Pumping Division of the Bureau of Reclamation in south central Idaho.

Here is a stellar example of what the mechanical revolution on the farm has done in comparatively recent years. While our basic interest lies in the production of sugar beets throughout this entire section of Idaho, it must be noted that numerous other crops are doing very, very well on lands that until only a year or two ago were sagebrush-covered wastelands.

Not long ago, producing a good sugar beet crop on this new land would have been an impossibility for at least several years. There would first be the period of building the soil with legume crops and adding humus through production of straw crops.

Today, with new cultural practices, our new Idaho farmers obtain high yields of beets soon after clearing the land and treating it in accordance with modern fertilization methods.

Before World War II, getting new land ready for production was a long and arduous task. Once the water was made available for the land, then came the laborious clearing—by hand, with horse-drawn equipment or with small tractors. And in Idaho, sagebrush resists clearing with stubborn determination to remain rooted in the soil.

After clearing, the next struggle was leveling the land so that it could be irrigated without having dry high spots and water-logged low spots. The result, during the years before modern methods were adopted, usually was a piece of land with light, dusty soil devoid of humus, subject to wind and water erosion and prey to rodent depredation. Livestock feeding was essential in those days to provide the fertilizer so desperately needed to put the land in production. Thus it was that long years of painstaking work were required to build the soil to its productive potential.

by H. A. ELCOCK, General Agriculturalist, The Amalgamated Sugar Company, Ogden, Utah

479605 O - 58 - 2

This Excellent field of SUGAR BEETS was grown on third crop year.

The contrast between the old methods and the plan of attack employed by our present-day sugar beet growers and new Idaho farmers is amazing, even to many of us who have lived through both eras and have observed the giant strides made since the last war. On the Northside Pumping Division water is obtained either from wells or by pumping from the Snake River.

The new farm developers move in with large specialized sagebrush cutters and windrowers powered by huge crawler tractors and frequently erase the brush from as much as 40 acres a day. While the average land in the area requires a relatively small amount of levelling to prepare it for irrigating and cropping, large and efficient land levellers are now employed and the job requires but a fraction of the time and labor once devoted to this phase of the development work.

Because cash outlays are required to develop the land and pay maintenance, operation and capital costs of the irrigation project, little time can be wasted by the new farmer in producing cash crops. Wind erosion is another factor which requires planning and clearing and levelling to be finished just in time to get a crop planted.

Along with the famed sugar beet, the new south central Idaho farmer usually turns to potatoes, grains, peas, beans and alfalfa for his cropping rotation. Grain land can be prepared early in the spring using a liberal amount of commercial fertilizer—about 100 units of nitrogen per acre—and will result in a crop of from 60 to 75 bushels per acre. The grain often is used as a nurse crop for alfalfa, or is grown for the straw to be plowed under for humus and prevention of wind erosion on the light soils.

Potatoes have proven to be an excellent first cash crop on this new land. By addition of 250 to 300 units of nitrogen and 100 to 150 units of P_2O_5 per acre, excellent quality and quantity potatoes can be obtained in the first year. This generally can be repeated successfully for a second year, if desired.

After one or two crops of potatoes, sugar beets, peas or beans can be grown with great success. Sugar beet crops exceeding 25 tons per acre are not unusual on this new land within a year or two of its clearing. It has been demonstrated that the tough and valuable sugar beet is an ideal crop following potatoes or peas, since the land is then well settled for irrigation and good cultural practices can be carried out to assure large yields. With the addition of 200 units of nitrogen and 100 units of phosphoric acid per acre, excellent sugar beet crops are obtained on this new project land.

The new methods of commercial fertilization and the correct use of irrigation water on Idaho's new Reclamation farms have enabled these lands to compete successfully with older established farms in the area. Cash crops are now a part of the first year's farming and the old established method once employed of spending seven to ten years building up the generally low nitrogenous western soils is a thing of the past.

It is commonplace in southern Idaho and on new lands to produce in the first year 200 cwt. of excellent quality potatoes per acre, 60 to 75 bushels of wheat, 30 to 35 bushels of seed peas or 3,000 pounds of process peas. The second and third year bring the excellent sugar beet yields common

(Continued on page 111)

First cutting of alfalfa on a Palisades Project irrigated farm east of Ririe, Idaho.

Photo by Phil Merritt, Region 1.

Guy C. Jackson

W. A. Dexheimer

Floyd E. Dominy

N R A MEETS IN HOUSTON

As this issue went to press the 27th Annual Convention of the National Reclamation Association was scheduled to be held at the Rice Hotel, Houston, Texas, on Wednesday, November 19, continuing through November 20 and 21.

Secretary-Manager William E. Welsh arranged the preliminary plans for the convention after conferring with President Guy C. Jackson and other officials of the Association from the various Western States. Indications were that the meeting would be well attended and the speakers would include nationally known authorities in the field of water resource development.

The theme of the convention will be "RECLAMATION—Development of the West and Food for our Rapidly Increasing Population."

Under Secretary of the Interior Elmer F. Bennett was scheduled to deliver a principal address entitled "The Case for Reclamation."

ONE OF THE HIGHLIGHTS of the convention will be a boat trip down the Houston Ship Channel and a tour of San Jacinto Monument and grounds.

In addition to Under Secretary Bennett and President Jackson, others scheduled to address the convention included leading members of the House and Senate Interior and Insular Affairs Committees; Governor Price Daniel of Texas; General E. C. Itschner, Chief, United States Army Corps of Engineers; Donald A. Williams, Administrator, Soil Conservation Service; and Reclamation Commissioner W. A. Dexheimer.

In addition to the foregoing it was also hoped to have Governor George D. Clyde of Utah, Dr. Luna B. Leopold, Chief Hydraulic Engineer of the Geological Survey and J. W. Grimes, President of the Association of Western State Engineers as speakers.

Other Interior and Reclamation officials selected to attend the 27th Annual Convention of the N. R. A. were Solicitor George W. Abbot; Associate Commissioner of Reclamation, Floyd E. Dominy Associate Solicitor, Water and Power Edward W. Fisher; Assistant to the Commissioner-Information, Ottis Peterson; Chief, Division of Irrigation, William I. Palmer; and Chief, Division of Project Development, N. B. Bennett.

# # #

National Employ the Physically Handicapped Week has been designated as October 5–11 by President Dwight D. Eisenhower. This is the fourteenth year in which the "Week," which only points up the problem, will be observed. The program for employing the physically handicapped includes every week in the year. There can never be any relaxation in the continuing programs that are carried out at the national, State and community levels in the interest of these people. The following is an account of a few handicapped persons employed in Reclamation areas.

Beatrice P. Salisbury

Hire The Handicapped—It's Good Business

MRS. BEATRICE PRICE SALISBURY, who works as a general clerk in the Bureau's Palisades Project office, in Idaho, dislocated her right hip at the age of ten. She received various treatments but these proved unsuccessful and eventually resulted in tuberculosis.

This necessitated her spending a long period of time in a sanitarium.

However her determination to live and learn eventually saw her teaching shorthand and typing in the Gem State Business College in Idaho Falls, Idaho, by the time she was 20. The following year she married an Iowa farmer and they now have four children. It is necessary for Bea to have a brace on her leg while working and use crutches for long walks. However, in 16½ years of Government service she has lost only one day of work as a result of this original handicap.

Earle E. Harrison

It is her philosophy that being handicapped makes a person more determined to succeed, develop other skills for lacking ones, and makes her children more self-reliant by doing for themselves instead of depending on her.

EARLE E. HARRISON lost his right hand as a result of a childhood riding accident. His excellent adjustment to this handicap is reflected in his record of long and successful Government service.

Before his transfer to the Bureau of Reclamation in 1947, Mr. Harrison had been employed by several other Government agencies as an Engineering Aid and as an Electronic Engineer Instructor. His experience in the Bureau of Reclamation has included work in inspection, materials, and office engineering. Although much of his work had involved surveying and other field assignments, he has never permitted this handicap to interfere with the efficient performance of his duties, as is evidenced by his advancement to the position of Construction Management Engineer.

Mr. Harrison's cheerful personality and professional ability have earned him the friendship and respect of his fellow employees on the Washita Basin Project.

JOE G. BARNES is employed as a student Trainee (Engineering) in the Grand Junction Projects Office of the Bureau of Reclamation and is working on routine laboratory tests of concrete materials and earth materials. He is qualified and has in the past held a full-time job on a survey party. He has a very pleasant personality and he performs his work well even though he lost practically all the use of his left arm as a result of polio when he was one year old. Although the polio left him with some grip in his hand, he is unable to move his arm freely.

Mr. Barnes has overcome his handicap to an amazing degree. He swims, plays tennis and baseball, and can drive a farm tractor and operate other farm equipment.

Joe was born in Santa Anna, Texas, and was reared on a farm near there. He is a senior at Colorado University at Boulder, Colorado, where he is majoring in Geology.

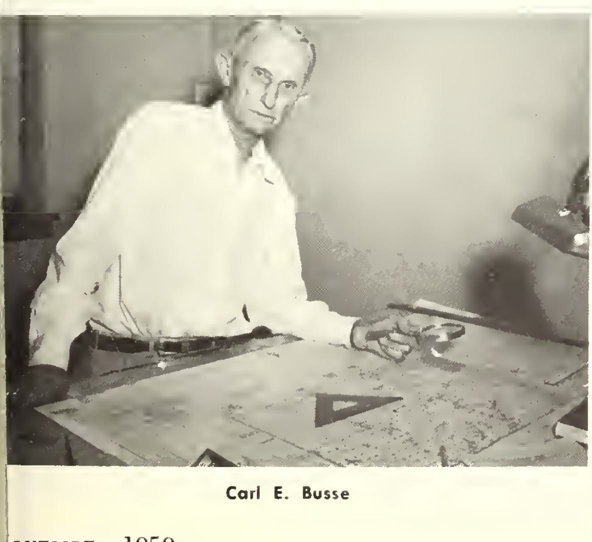
Joe G. Barnes

CARL E. BUSSE, draftsman in the Missouri-Oahe Projects Office at Huron, South Dakota, has been with the Bureau of Reclamation since 1943, working first on the Buffalo Rapids Project at Terry, Montana, and since 1948 at Huron. Carl is very nearly deaf, his handicap resulting from an ear infection suffered when he was 9 years old. Nevertheless, he spent about 7 months in the Army during the latter part of the First World War, and then served as County Engineer at Big Timber in Sweetgrass County, Montana, from 1922 to 1943. He has about three years training in Civil Engineering at Montana State College. He is very capable and efficient in his work. He misses the comradeship of conversing with his fellow workers and friends but mostly he misses music and shows. Carl reads and studies, does his own housekeeping and cooking, and every year makes a trip back to Big Timber to visit his old friends.

He will retire on November 30, 1958, and plans to go back to Big Timber and "run out a ditch or two" for some of the irrigators in Sweetgrass County.

HARVEY E. BENDER is employed as Supervisor of the Bureau of Reclamation's Soils Laboratory at Huron, South Dakota. Mr. Bender is an excellent example of a well qualified physically handicapped person doing fine work in the field of his choice.

A veteran of World War II, he was stricken with a severe case of polio in November 1948, 2 years after discharge from the service. He spent one year in the hospital suffering from general paralysis of the body, especially the legs. As a result of good hospital care and faithful effort on his part, he recovered use of all faculties except his legs; which requires that he use a cane much of the time.



Carl E. Busse

In 1949, he entered Huron College, Huron, South Dakota, and attended 2 years. During the Spring of 1950, he was employed part time at the Bureau of Reclamation soils lab, Huron, South Dakota. In the Fall of 1950, he was transferred to the Bureau of Reclamation soils laboratory at South Dakota State College. Continuing part-time work for the Bureau, he graduated in June of 1953. In September of 1953, all soil and water testing was transferred to a fully equipped laboratory in Huron, South Dakota, where Mr. Bender has been in charge since that time.

He holds a B. S. degree from South Dakota State College majoring in the field of soils.

Harvey E. Bender

MELVIN L. MEDIGER is Chief, Personnel and Office Services Branch in the Missouri-Oahe Projects Office, Huron, South Dakota. He is responsible for all office service functions and that portion of the personnel function as delegated to that office. He is an outstanding example of a physically handicapped employee putting out highly satisfactory work.

A veteran of World War II, 34th Division, European Theater, he lost his right leg by shrapnel at San Peatro, Italy, in January 1944. Upon his discharge from the service, Mr. Mediger was fitted with an artificial limb which is not apparent except for a slight limp and the cane that he carries.

Normally an active outdoorsman, he had to temper his activities to this new handicap. However, with a wife and three active sons ranging in age from 6 to 13, he has overcome this physical restriction and sets a fine example in his community in boy scout work and in his office for his enthusiasm for employee participating parties, picnics, welfare and benefit programs.

IRVIN I. SIMMONS served with the 47th Infantry Regiment, 9th Infantry Division during the campaigns in North Africa and Sicily and in Normandy until injured. His right leg is paralyzed below the knee from shell fragments received in this injury and he walks with a slight limp which is not apparent to many people.

He was honorably discharged from the service in 1947 after several unsuccessful operations to repair the damaged nerve. Subsequently, he attended South Dakota State College in Brookings and completed the Electrical Engineering course, gaining his B. S. degree in June 1951.

In June 1951, he entered on duty as an Electrical Engineer with the Bureau's Missouri-Oahe Projects Office at

(Continued on page 108)

STATUS OF SALINE WATER CONVERSION

by HON. FRED G. AANDAHL
Assistant Secretary of the Interior

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Assistant Secretary of the Interior

Under the provisions of the Saline Water Conversion Act of 1952 (P. L. 448, 82d Congress, 2d Session, as amended), the Department of the Interior was given the responsibility of carrying forward the Saline Water Conversion program. David S. Jenkins, Director, Office of Saline Water Conversion Studies, has been in direct charge of the program. It has been carried forward under the supervision of the Assistant Secretary of the Interior, Hon. Fred G. Aandahl.

The intriguing possibilities of using converted sea water to support life in plants and animals have engaged the interest of men for many years. The first successful use of sea water for drinking water is lost in antiquity, but probably antedates by 200 years or more the Rhyme of the Ancient Mariner:

> Water, Water everywhere
> Nor any drop to drink.

Evidence of the use of distillation appears as early as 1593 when Sir Richard Hawkins is said to have used a still for fresh water supply while en route to the South Seas. Other references trace the development of the simple still for shipboard use down through the eighteenth century.

Some 167 years ago, Thomas Jefferson, then Secretary of State, wrote a treatise on the subject of distillation. To determine the merit of the process by experimentation, he asked the help of the American Philosophical Society, the College of Philadelphia, and the University of Pennsylvania. A certain Mr. Isaacks, as the story goes, "fixed the pot, a small caboose, with a tin cap and straight tube of tin passing obliquely through a cask of cold water; he made use of a mixture, the composition of which he did not explain, and from 24 pints of sea water, taken up about 3 miles out of the Capes of Delaware, at floodtide, he distilled 22 pints of fresh water in 4 hours, with 20 pounds of seasoned pine, which was a little wetted by having lain in the rain."

Such scholarly and historical interest in salt water conversion was abruptly put to the test of urgent practicability by the onslaught of World War II. The many cases of persons afloat in small boats brought about by the aircraft and surface-ship casualties resulted in a surge of experimental work in this field. British and American investigations explored a number of possibilities and the armed forces adopted the use of cans of fresh water and plastic bags for chemical freshening of sea water.

Meanwhile, the exploitation of mineral deposits in arid areas such as Chile, the concentration of population in semi-arid regions such as Palestine and our southern California, and the heavy pollution of our rivers have at various times further stimulated the consideration of demineralizing saline waters.

In 1929, for example, we find mentioned the use of condensate from a coal mine power plant in Kentucky. This installation is reported to have produced about 40,000 gallons per day of distilled water. A triple-effect plan for Kuwait on the Persian Gulf was fabricated in 1949 with a capacity of about 700,000 gallons per day. Recent additions to the Kuwait plant have increased the daily capacity to 5-million gallons per day making the tiny Skiekdom the world's largest producer of converted water.

An extended drought in California aggravated the water problem in that semi-arid state during the 1930's and 1940's and resulted in the introduction of proposals to the Congress for appropriations of funds to study the various methods of demineralizing sea water.

Thus, we find scattered instances of man's earlier endeavors in this field.

Reflect for a moment on some of the published statistics on our water uses in this modern age. Eighteen thousand gallons of water to make a ton of ingot iron; 65,000 gallons to convert this ton of iron into steel; 7,000 gallons for a barrel of gasoline; 160 gallons for a pound of aluminum or a pound of synthetic rubber; 3,600 gallons for a ton of coke. On the farm, a pound of beef on the hoof has required 3,750 gallons of water for the steer and the grass he eats; and a slice of bread including the growing of the grain has used 37 gallons of water. In our homes and farms and factories, the use of water amounts to 1,500 gallons a day for each man, woman, and child.

By 1975, with a population of 220 million, we may be withdrawing for use as much as 440 billion gallons a day of this precious resource—almost double our present use. The present upper limit of our water supply is the average runoff, nearly 1,200 billion gallons a day.

On the whole, then, the water supply of the country is adequate. But because the supply is variable in time, in place, and in quality, national and yearly averages do not reveal the cold fact that many localities and regions have serious supply problems. The recent drought in the Southwest made it dramatically clear that water shortages may have a devastating effect upon the people and the economy of a region. The social and economic distress caused by failing public supplies is another painful reminder that our people must maintain an alert interest in their local water supplies, present and future.

The consumption of natural resources has increased out of all proportion to our increase in population. From 1900 to 1950 the population of the United States doubled, but the consumption of power increased 11 times, the production of all minerals increased 8 times, and the consumption of electrical energy about 60 times.

In addition to the growing deficiencies in the quantity of readily available water, the natural salinity of many of our inland streams and underground waters together with the effects of expanded irrigation, industry, and population have created a national problem of water quality. While acute localized shortages had been suffered in certain locations, it was not until the need for improvement of the many brackish inland waters arose in addition to the possibility of converting ocean water that the problem was viewed as a national one.

In 1952, the 82nd Congress enacted Public Law 448. This Act authorized the Secretary of the Interior to provide for the development of low cost processes for converting saline water to fresh water for agricultural, industrial, municipal and other uses. This program is under the Office of the Assistant Secretary of the Interior for Water and Power Development and is administered through a small administrative and scientific staff in the Office of Saline Water. The information being presented here is derived from the reports and publications of that Office.

The authorized program was designed to encourage private research and development in this general area and to assist such private effort by means of a program of Federally financed research and development contracts where private activity alone did not seem to be making sufficient progress. Public effort both local and Federal was to be coordinated for the purpose of accelerated research and development.

In 1955 by amendments to the 1952 Act, the original small program was extended in time to a total of 14 years from the date of the original act and expanded in scope through increasing of the authorization from $2 million to $10 million over that period, 1952–1966. So far, just over $4 million has been appropriated. It is evident that this program, which has cost about one-half million dollars annually for 6 years, cannot be compared with large Federal programs that the Congress has authorized on a basis of urgency. Moreover, the present program is restricted to serving needs within the United States.

With a view to obtaining the greatest practicable participation of private knowledge and skill, an active campaign was developed at the outset of the program to bring together all existing and new ideas on conversion methods for research and development, and to enlist the cooperation of engineers, scientists, and organizations in exploring these ideas and methods. A brochure, "Demineralization of Saline Waters," was compiled and distributed, outlining all known phenomena or processes that might be considered for saline water conversion. Interest so developed was further stimulated by publications, addresses and other contacts with scientific groups.

Some results of this stimulation of technical interest became apparent. At the recent International Symposium on Saline Water Conversion, held in Washington in November 1957, more than

300 scientists and engineers working in this field, from 16 countries in addition to the United States, took part, presenting 39 scientific papers, which brought out a large number of scientific ideas and views.

Experience has shown the need for a proper perspective on the costs of conversion of saline waters. At the outset of our program, we analyzed the cost estimates made by advocates of the various processes. It was found that few of these early estimates, if any, included all actual costs. Further, many such estimates of 5 or 6 years ago represented optimistic extension of laboratory results to future large-scale application. Thus, for example, it was estimated that projected large-size distillation plants utilizing processes then in commercial production could convert sea water to fresh water at a cost of $1.25 to $1.50 per thousand gallons of product. Overlooked by some was the fact that such large scale operation had not been actually accomplished. The actual cost of large output conversion of sea water today by conventional processes is about $2 to $3 per thousand gallons. Even in recent months, optimistic announcements of conversion costs running as low as 20 cents per thousand gallons have been made, but these also have been carefully investigated by the Department and have been found to represent only a minor portion of the total costs.

The most promising of the conversion methods now under development include several distallation and membrane separation processes, and one form of salt water separation by freezing. For these, pilot plant work is needed and in part is already in progress to explore their economic feasibility and potential fields of application. Other processes, still in the laboratory, are recognized as justifying further investigation. Still other approaches to conversion have on investigation been found to lack sufficient promise of practical value.

Laboratory and economic study to date has narrowed the field from some twenty phenomena or processes to five broad groups: (1) distillation through artificial heat; (2) solar heat distillation; (3) separation of salt water by membrane processes, of two or possibly three kinds; (4) freezing; and (5) other chemical or electrical means of separation, including solvent extraction.

It has been ascertained that the various potential processes are suited to different conditions, as they offer partial answers to the complex overall problem of providing fresh water from different saline sources, in different locations, for different uses, and in different quantities. Some processes may be best adapted to supply of an individual farmstead or home, others to furnishing millions of gallons per day to a city or an industry.

As one result of the work under the Saline Water Conversion Act, three new or improved distillation methods are under pilot plant development or ready therefor, and several leading industrial companies are taking part in further development.

Electrodialysis using ion-exchange membranes, which five years ago was little more than a laboratory phenomenon, is now a commercial reality, and other membrane processes are about to enter the pilot plant phase. The possibilities of separation by freezing had received some attention at the beginning of the program, but entrapment of brine in the ice crystals was an unsolved difficulty; since then, research has developed a successful ice-washing process, and a composite freeze-evaporation cycle has been sufficiently tested for pilot plant design. One of the attractive features of this process is the smaller quantity of energy required for freezing as compared to that for evaporation.

Two modified distillation processes, one based on vapor-compression, the other on multiple-effect evaporation, progressed to initial field testing in December 1957. The former is represented by the Hickman rotary still as designed to produce 25,000 gallons of distilled water per day. The other test is directed toward scale prevention, for application to a distillation cycle proposed by W. L. Badger utilizing long tube vertical evaporators. Test units have been installed at a seashore location at the test station of the International Nickel Company, Harbor Island, North Carolina.

Membrane processes became increasingly important, particularly for conversion of brackish waters, with the availability of improved membranes at lower cost for electrodialysis. Field tests in Arizona and South Dakota had shown a year ago that electrodialysis equipment can be operated satisfactorily on several types of brackish water, but it is now clear that it will be necessary to develop lower cost equipment. Work to this end is being undertaken at the Bureau of Reclamation laboratories in Denver, where evaluation tests of membranes, including types newly developed by the Dutch, are also under way.

Solar heat distillation, which has demonstrated its feasibility and its usefulness as a conversion process under appropriate conditions, is also circumscribed by high costs of installation and maintenance, and will depend for extension of use on reduction of these costs. Under contract with Battelle Memorial Institute, small solar distillation pilot plants are being erected in Florida.

Separation of salt water by freezing has been found most promising when embodied in a conversion process which uses vacuum evaporation in combination with ice formation. Results so far obtained are sufficiently promising to warrant pilot plant development. Several other potential conversion processes are still in the laboratory state.

Private industrial firms have been developing and improving distillation equipment for a considerable period without Government assistance. Many such conversion units are in use on shipboard and several much larger land-based installations are supplying potable water to industry and populations in over a dozen locations throughout the world.

Private industry has furthered the conversion of saline water more recently by improving distillation processess, developing electrodialysis equipment, and in producing greatly improved ion-selective membranes. Many firms have also contributed advice, cost information, new ideas, data on fabrication costs, and similar aid to the Department in its evaluation of equipment and practical application of new processes and devices.

A number of manufacturers have announced their intentions of developing processes in the future that might produce potable water for about $1 to $1.50 per thousand gallons, although present costs of the most recent commercial conversion plants using sea water range from about $2 to $3 per thousand gallons.

As we view the broad field of salt water conversion, we question whether any radical or sudden advances in technology can be expected that would bring about a drastic reduction in the cost of conversion. We look instead for a gradual reduction in costs—through the development of new or improved processes by way of the pilot plant stage, and through much more basic and exploratory research.

Progress so far has been most encouraging. The next step in our work, in addition to the continuation of basic research and small pilot plant experimentation, is the construction of experimental demonstration plants for the more promising processes. We are confident that with the continuing support of the saline water conversion program by the Congress and the continuing activity of the numerous non-Federal interests in the field, the age-old objective of obtaining fresh water from salt water will surely be attained on a large scale for irrigation, industrial, and municipal use. # # #

WATER

IS THE PRICE TOO HIGH?

The dollar cost of providing increased water supplies under current conditions will be high. Will it be too high?

It might appear to be more economical to wait for a downward curve in the whole structure of prices and wages before undertaking the kind of construction programs required to meet our needs. But where are the signs that such a curve is in the making? And how long can we wait?

Every hot, dry summer imperils the water supply of many millions of people. Suppose next year—or the year after—brings similar conditions? Picture a shortage that goes beyond the critical stage. A few years ago New York was only days away from such a crisis. Some smaller places have gone through it.

Picture a water supply inadequate to handle a serious fire. Picture a water supply insufficient to maintain proper sanitation. Picture a water supply no longer able to keep industrial processes functioning.

The price of keeping pace with the need for water may seem high, but what about the price of failure? One uncontrolled fire, one epidemic, a group of major industries lost to the community—any of these could involve an expense beside which the price of improved water supplies—even with costs what they are—would hardly be noticeable.

Water is essential to life—the life of a city as well as the life of a human being. Without water, a man dies. Without water, a community faces the same fate.

In the face of a crisis, no price can be too high. High prices paid to prevent a crisis are low prices! And the community concerned with getting the most for its money doesn't just keep pace with water needs, but stays five or ten years ahead of them, for water works aren't built in a day—especially a day of emergency!

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WOMEN VOLUNTEERS WANTED FOR ERA

The Secretary or some other officer of each and every organization of women on our projects is requested to take her pen or typewriter in hand and write to J. J. McCarthy, Editor of RECLAMATION ERA, *and outline her views as to how the* ERA *may best serve the interests of our project women. The same invitation is extended to every woman not connected with a women's organization.*

The ERA *wishes to be of service to everyone on the projects—men, women, boys, and girls. Just now the call is for women volunteers without whose cooperation this proposed feature of the* ERA *cannot be a complete success.*

Write today!

VEGA DAM—*Reclamation's Newest in Western Colorado*

by H. E. SIMISON, Special Services Officer, Region 4

Vega Dam will store the water of Plateau, Leon, and Park Creeks. Feeder canals will deliver flows from Leon and Park Creeks into the 32,700 acre-foot reservoir. Vega Reservoir will supply urgently needed water to supplement deliveries to 18,340 acres of presently irrigated land in the Collbran Project area. A full water supply will also be provided to 2,310 acres in new irrigated farms.

Weather is the big problem faced in building Vega Dam. Located at about 8,000 feet elevation on the north flank of the famous 10,000-foot high Grand Mesa (the largest flat-topped mountain in the United States), the winters are snowy and the springs are rainy. Placing of earth in the dam proceeds from about May 1 to November 1 with brief interruptions by summer showers.

In winter, snowfall ranges up to 135 inches or more, and snow piles up to 4½ feet deep on the level. Spring rains often make the earth in the borrow areas too wet to place in the dam, and the haul roads too slippery to use. At such times, there is nothing to be done but to shut down work and wait until everything dries out.

Even so, Vega Dam will be completed by September 1959, ahead of the time allowed under the $1,707,000 contract with the C. F. Lytle Co. of Sioux City, Iowa.

The 29-mile long Southside Canal, with initial capacity of 240 cfs, will thread its way from the Vega Reservoir down through the Collbran Project lands on the several "mesas" (benchlands) along the south side of Plateau Creek. Water will be delivered from the Southside Canal to existing ditches of the Collbran Project.

Two powerplants—the Upper and Lower Molina Powerplants—will be built with total installed capacity of 13,000 kilowatts. New pipelines will carry water from existing small reservoirs on Big and Cottonwood Creeks to the powerplants. In addition to increasing the water supply for all irrigable lands on the Collbran Project water from the Southside Canal also will be delivered to replace the water diverted for the powerplants.

Construction of the Southside Canal will start with the award late in 1958 of a contract for excavation and lining of a 6-foot, 3-inch, horseshoe-shaped tunnel, 2,300 feet long.

The storage to be provided by construction of Vega Dam is the key to a reliable water supply for the Collbran Project. In August 1958, Vega Dam was about two-thirds completed. The spillway and outlet works were largely completed, and the embankment of the dam had risen 40 feet above the bed of Plateau Creek.

In a year or two, Vega Reservoir will be a favorite fishing spot for many people from the surrounding countryside, since it will be accessible for fishing earlier than the many lakes high on Grand Mesa. #

VEGA DAM, at right: Vehicles and work stations were in operation when this aerial photo was taken over Vega Dam site near Collbran, Colo., east of Grand Junction. Broken line across the photo shows where the top of the 145 foot high dam will be. Four X's in center area are at floodlight towers mounted on skids used by night shift workers. Project engineer Edward H. Jeffries of the Bureau of Reclamation looked at the photo and explained some of the other objects, which are numbered as follows: 1—The concrete plant; 2—Heavy equipment repair shop; 3—Trashrack intake structure which will release reservoir water to canal; 4—Bottom-dump trucks which are hauling clay to the dam bed; 5—Caterpillar tractor pulling a scarifier which loosens packed surface so it will bond with the next layer of clay; 6—Sheepfoot packing roller being pulled by tractor; 7—Crane pouring concrete from a massive bucket through "elephant trunk" to gutter alongside the curving spillway structure; 8—Truck which hauled the concrete; 9—Canal which carries the water of Plateau Creek under the dam bed while work is in progress, and 10—Air compressor for jack hammers, tampers and other pneumatic equipment. The dam, being built at a cost of $1.7 million, will be 2,100 feet long at the crest, 700 feet thick at the bottom, and 30 feet wide at the top. The reservoir it backs up will hold 33,000 acre-feet of water and will be 2½ miles long and a half-mile wide. The construction firm building the dam is the C. F. Lytle Co. of Sioux City, Iowa. Completion of project is slated for 1963. ***We are indebted to Mr. Monk Tyson and the Denver Post for this photograph and the caption information.***

Highway in the Sky

In the high plateau desert near the Arizona-Utah border, men and machines matched their skills and energies against the forces of nature to build the world's highest bridge. Over the muddy streak of the Colorado River far below, two half arches of steel project out from the 700-foot vertical cliffs of pink sandstone. This was the start of the Glen Canyon Bridge which will someday be a crossing point of Highway 89, a major thoroughfare spanning the southwestern part of the United States.

Against the vastness of this canyon, the spider webs of steel slowly arched toward their closure point midway between the 1,028-foot gap. When that closure was made on August 6, 1958, it was a day of great rejoicing for the bridge workers of Kiewit-Judson Pacific-Murphy, contractors for the bridge. It was also a day of rejoicing for Bill Choate, project superintendent for Kiewit-Judson Pacific-Murphy, and for Al Tokola, the project engineer. These men were chiefly responsible for laying out the method of erection for this arch span.

Some 4,000 tons of structural steel will eventually go into this bridge which, when completed, will provide a 30-foot roadway across the canyon.

Although under separate contract, the bridge is an integral part of the multimillion-dollar dam which will be located upstream from the bridge.

Before any steel work could be accomplished on the bridge, the contractor had the task of setting up a camp site and building access roads into a wilderness area. After constructing the barracks and mess hall on the west side of the canyon, Kiewit-Judson Pacific-Murphy took on the problem of transporting men and equipment across the 1,028-foot chasm that separated the east and west sides of the river. They soon had a 1,500-foot cableway in operation across the canyon. Running from a 100-foot tower on the right bank to a 110-foot tower on the left bank, the 2-inch track strand had a load capacity of 12½ tons. A second and heavier 25-ton capacity highline cableway was erected to aid the steel erection of the arch span. The head tower of this highline, which is located on the left bank or west side,

by FRANCIS J. MURPHY, Project Manager, Kiewit-Judson Pacific-Murphy

ABOVE, final adjustment of key chord.

is 165 feet high and the tail tower on the right bank or east side is 150 feet high.

The towers were capable of luffing horizontally 21 feet in either direction, allowing them to cover the bridge from any point.

After some 4 months of cliffhanging, the survey crews obtained their prime controls which were checked out by the Bureau of Reclamation, and the abutments and skewbacks for the bridge were surveyed in.

The erection of the bridge was a carefully planned step-by-step arrangement to bring the two half arches together midway across the gorge. With the closure point reached and the two half arches converted into a continuous arch span, the bridge was transformed from a three-hinged arch to its design condition as a 2-hinged arch.

Tiebacks were necessary to hold the panels of the arch sections as they progressed to the closure point. Seventy-two of these tieback lines were used.

The tiebacks consist of Bethlehem 1½ inch bridge strand and were supplied in special lengths through Bethlehem Pacific Coast Steel Corporation. The rope is prestressed and has an ultimate breaking strength of 138 tons per strand. The strands are connected to the tops of 100-foot towers at each side of the canyon. These towers are composed mostly from secondary steel members—the post and floor beams which will eventually be used in the bridge when the arch span is completed. The towers are anchored by back guys, also composed of bridge strand. Sixteen of these back guys were tied into the tops of each side of the two towers. They are fastened to deadmen with flat link bars inbedded in the reinforced concrete of the deadmen. Each deadman fills an ex-

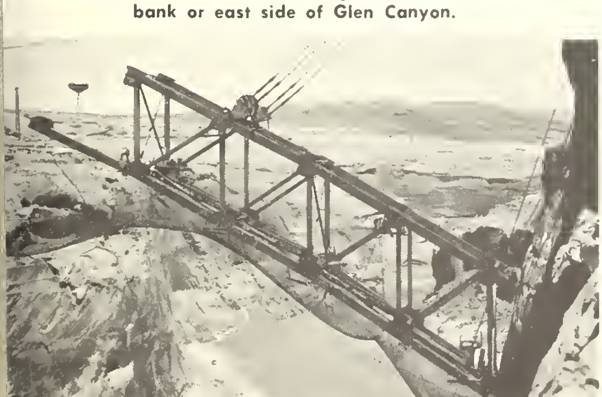
L. to R.: Truck crane servicing job, head tower of 12½-ton cableway, tail tower of 25-ton cableway, and tieback tower.

cavation 22 x 25 feet wide and 15 feet deep in the solid sandstone.

In the erection sequence, the first lower chords of each of the half arches are anchored to the skewbacks with 16-inch diameter pins which become the permanent anchorages for the bridge. The upper chords of the arch panels do not connect the skewbacks but are held up by normal truss construction aided by tieback lines which are anchored to their half arches by strongbacks.

The point of closure is 21 panels out from both sides of the canyon. When reached, 18 tiebacks were in use on each of the four upper chords. Ten strands were tied off at the 15th panel point of each chord. Hydraulic jacks were positioned at each strongback. Simultaneously taking tension off two strands at each of the upper chords, the two half arches were lowered. 20-inch diameter pins were then inserted in the final upper chord

First 4 panels of steel being set on the right bank or east side of Glen Canyon.



Key chord being lowered into position. Photo by J. L. Digby, Region 4.

members, closing the arch into a 3-hinged structure. The two lower chords coming together at the 21st panel were designed so that they telescoped into each other. Five-hundred ton hydraulic jacks were positioned between each of the opposing lower chords. A precise loading depending on the temperature was supplied at each jack. When this was accomplished and it was determined that the arch was aligned, the interleafing plates in the lower chords were field drilled, aligned with drift pins and then riveted.

When the load was relieved on the jacks, the bridge was transformed into a 2-hinged arch. The crown of the lower chord members of the arch is 165 feet above the point where the lower chords pin into the skewbacks.

The roadway deck, at an elevation some 700 feet above the canyon floor and 113 feet higher than the dam crest, will provide motorists with an excellent view of the dam and reservoir.

Structural steel members for the bridge were fabricated at the Judson Pacific-Murphy Corporation plant in Emeryville, California, and shipped by rail to Flagstaff, Arizona. They were then trucked to the town of Page, which the Bureau of Reclamation is building, on the east or right bank of the canyon.

Bridge building is at best a difficult work, for bridges seem to find their reason for existence in hazardous and inaccessible regions. However,

Completed arch. Billow of smoke resulted from blast set off to signal the closure of the two half arches.

Picture shows detail of the tiebacks with the sections for distributing tension in place.

the compensation for this work comes in the thrill of the acceptance of the challenge and the ultimate conquest of the obstacles invariably presented by nature.

This bridge was no exception. The challenge was accepted! # # #

AVOID FERTILIZER INJURY

Nitrogen and potassium salts in fertilizers are soluble. If large amounts are placed with or very close to the seed of young plants, delay in growth or loss of stand may result. The salts dissolve in the soil water and the plant may suffer from reduced moisture availability. Water with salts dissolved in it has an increased "osmotic pressure" and plants cannot absorb the water readily. Too, a high salt content actually may be toxic to the roots.

The solution of salts will move upward when the soil dries out. If fertilizers high in soluble salts are placed directly below the seed, upward movement of the salt will bring heavy concentrations into the area where the seed is germinating or the young plant is developing. Likewise, if fertilizer is placed above the seed, light rains will wash the salts down around the germinating seed. Of course with plenty of rainfall after planting, little difficulty will be experienced.

WATER REPORT

by HOMER J. STOCKWELL, Snow Survey Supervisor, Soil Conservation Service, Fort Collins, Colo., and NORMAN S. HALL, Snow Survey Leader, Soil Conservation Service, Reno, Nev.

Another good year was experienced by water isers in the western United States in 1958. Folowing heavy runoff in 1957, high streamflow and good carryover storage provided an adequate vater supply. Isolated local water shortages ocurred along streams where little or no storage vas available.

As with most water supply situations, the one his year was unusual. Concurrent with the excelent irrigation water supply, a severe short-term lrouth was recorded, particularly west of the Continental Divide. From midsummer through arly fall, precipitation was only a small fraction f normal. Another unusual characteristic of vater management was bank full streamflow in everal areas where regulated flows are normally naintained. This year, reservoirs for local storge were full and there was little or no demand or water during the peak of snowmelt. In some f these areas, due to lack of rainfall, late season ow was deficient. It was necessary to draw eavily on stored water. In a few areas, water sers were faced with a late season shortage after arly season uncontrolled losses.

The heavy snowpacks on the Sierra Nevada and limited areas of Utah, Colorado, and New Mexico caused little damage. The lack of late spring precipitation along with definite advance plans for use of available reservoir storage averted serious damage.

With recent drouth years still a vivid memory, plentiful water years such as 1957 and 1958 serve as a reminder that additional storage is needed, not only to better distribute water through the irrigation season, but also over the years of drouth and plenty.

In Arizona and New Mexico, surface water supplies were the best since 1952. A long trend of drouth was reversed. Reservoir storage generally increased during the irrigation season. Runoff into the Central Valley of California was over 150 percent of normal following a good winter snowpack increased by severe storms the first week of April. Practically all major reservoirs were filled. The Columbia Basin States of the Northwest also had plentiful water supplies. With a normal runoff there was some depletion of reservoir storage reserves from a year ago. A similar situation exists in the Rocky Mountain area.

(Continued from page 105)

Water supplies were at least adequate. Storage in smaller irrigation reservoirs is down some 10 to 25 percent from a year ago, but still range near 150 percent of normal. Storage in larger reservoirs has tended to increase. Summer rainfall was near normal east of the Continental Divide. The west slope of the Rockies shared in the general midsummer and early fall drouth.

Outside of the Central Valley of California and adjacent areas in Nevada mentioned previously, seasonal runoff was rather nominal. The flows for the April 1–September 30 period of the major streams of the West are indicated by the following provisional records in approximate percent of normal: Colorado River at Grand Canyon, 105 percent; Rio Grande at Otowi Bridge, 125 percent; Columbia River at The Dalles, 100 percent; and the Missouri River at Fort Benton, Mont., 85 percent. The flow on the Sacramento River above Shasta Reservoir was the greatest ever recorded.

The outlook for 1959 irrigation water supplies is relatively good. On the favorable side of the picture is above normal reservoir storage on major streams. On some watersheds, this is substantial with next year's water requirements already on hand. On the deficit side, there is a large area of the Columbia, Colorado, and Great Basin watersheds where soils are extremely dry. Heavy fall rains or above normal winter snowpack will be required to produce average runoff for the 1959 snowmelt season. Where reservoir storage is not available, next year's water supplies will be directly related to mountain snowpack and soil moisture, and rainfall during the next growing season.

This report on water supply conditions is presented in RECLAMATION ERA through the courtesy of the authors under the direction of *R. A. Work*, Head, Water Supply Forecast Section, Soil Conservation Service.[1]

(Continued on page 109)

[1] THE SOIL CONSERVATION SERVICE coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal bureaus, various departments of the several States, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that State, contributed the California figures appearing in this article.

WATER STORED IN WESTERN RESERVOIRS

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1957	Aug. 31, 1958
Region 1	Baker	Thief Valley	17,400	[1]	6,400
	Bitter Root	Lake Como	34,800	6,700	6,500
	Boise	Anderson Ranch	423,200	312,900	313,300
		Arrowrock	286,600	22,700	21,500
		Cascade	654,100	458,500	466,000
		Deadwood	161,900	121,800	107,600
		Lake Lowell	169,000	18,800	67,600
		Lucky Peak	278,200	242,800	261,400
	Burnt River	Unity	25,200	5,000	10,600
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	4,914,000	5,225,000
		Banks Lake	761,800	649,600	759,100
		Potholes	470,000	146,200	102,100
	Deschutes	Crane Prairie	55,300	[1]	31,000
		Wickiup	187,300	69,000	89,000
	Hungry Horse	Hungry Horse	2,982,000	[1]	2,978,800
	Minidoka	American Falls	1,700,000	553,500	404,500
		Grassy Lake	15,200	11,900	9,200
		Island Park	127,200	65,400	39,500
		Jackson Lake	847,000	663,400	635,700
		Lake Walcott	95,200	95,400	90,900
	Ochoco	Ochoco	47,500	20,500	[1]
	Okanogan	Conconully	13,000	6,300	6,700
		Salmon Lake	10,500	[1]	10,300
	Owyhee	Owyhee	715,000	484,500	505,200
	Palisades	Palisades	1,202,000	548,600	548,600
	Umatilla	Cold Springs	50,000	6,400	6,500
		McKay	73,800	15,000	14,900
	Vale	Agency Valley	60,000	15,200	22,800
		Warm Springs	191,000	97,300	118,000
	Yakima	Bumping Lake	33,700	14,800	13,400
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	153,200	128,900
		Kachess	239,000	131,900	139,000
		Keechelus	157,800	35,400	35,600
		Tieton	198,000	71,900	62,100
Region 2	Cachuma	Cachuma	201,800	34,200	196,000
	Central Valley	Folsom [2]	920,300	580,900	621,500
		Jenkinson Lake	40,600	[1]	34,200
		Keswick	20,000	19,300	18,000
		Lake Natoma	8,800	8,100	8,700
		Millerton Lake	427,800	153,300	145,300
		Shasta Lake	3,998,000	3,167,200	3,282,600
		Lake Thomas A. Edison	125,100	[1]	119,200
	Klamath	Clear Lake	513,300	299,100	338,500
		Gerber	94,300	52,300	54,900
		Upper Klamath Lake	524,800	268,100	394,100
	Orland	East Park	50,600	15,500	35,000
		Stony Gorge	50,000	21,700	20,100

WATER STORED IN WESTERN RESERVOIRS—Continued

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1957	Aug. 31, 1958
Region 3	Boulder Canyon	Lake Mead	27, 207, 000	21, 498, 000	23, 814, 000
	Parker-Davis	Havasu Lake	216, 500	634, 600	573, 400
		Lake Mohave	1, 809, 800	1, 387, 400	1, 511, 700
	Salt River	Apache Lake	245, 100	216, 000	243, 000
		Bartlett	179, 500	66, 000	54, 000
		Canyon Lake	57, 900	46, 000	53, 000
		Horseshoe	142, 800	7, 000	20, 000
		Roosevelt	1, 381, 600	30, 000	396, 000
		Sahuaro Lake	69, 800	55, 000	56, 000
Region 4	Eden	Big Sandy	38, 300	30, 600	3, 500
	Fruitgrowers Dam	Fruitgrowers	4, 500	2, 100	1, 300
	Humboldt	Rye Patch	190, 000	62, 900	131, 100
	Hyrum	Hyrum	15, 300	5, 500	4, 700
	Mancos	Jackson Gulch	9, 800	9, 400	4, 700
	Moon Lake	Midview	5, 800	4, 400	600
		Moon Lake	35, 800	21, 000	7, 200
	Newlands	Lahontan	290, 900	159, 400	202, 500
		Lake Tahoe	732, 000	632, 400	698, 400
	Newton	Newton	5, 400	600	900
	Ogden River	Pineview	110, 200	28, 200	21, 300
	Pine River	Vallecito	126, 300	107, 900	62, 400
	Provo River	Deer Creek	149, 700	118, 100	101, 900
	Scofield	Scofield	65, 800	41, 700	39, 700
	Strawberry Valley	Strawberry Valley	270, 000	156, 000	155, 300
	Truckee Storage	Boca	40, 900	4, 600	11, 700
	Uncompahgre	Taylor Park	106, 200	108, 000	75, 200
	Weber River	Echo	73, 900	29, 300	8, 200
Region 5	W. C. Austin	Altus	162, 000	104, 000	107, 500
	Balmorhea	Lower Parks	6, 500	1, 900	2, 000
	Carlsbad	Alamogordo	122, 100	60, 600	123, 400
		Avalon	6, 000	(1)	4, 700
		McMillan	32, 300	(1)	35, 800
	Colorado River	Marshall Ford	1, 837, 100	703, 500	608, 000
	Middle Rio Grande	El Vado	194, 500	55, 500	128, 100
	Rio Grande	Caballo	340, 900	22, 300	50, 400
		Elephant Butte	2, 185, 400	516, 500	975, 900
	San Luis Valley	Platoro	60, 000	49, 500	34, 000
	Tucumcari	Conchas [2]	467, 300	75, 800	274, 000
	Vermejo	Reservoir No. 2	2, 900	1, 800	2, 200
		Reservoir No. 13	5, 000	1, 000	4, 700
		Stubblefield	16, 100	5, 500	12, 000
Region 6	Missouri River	Angostura	92, 000	69, 400	73, 700
		Boysen	710, 000	543, 000	475, 600
		Canyon Ferry	1, 615, 000	1, 375, 800	1, 387, 000
		Dickinson	13, 500	5, 000	4, 500
		Fort Randall [2]	4, 900, 000	1, 830, 400	1, 534, 000
		Garrison [2]	18, 100, 000	4, 728, 800	4, 786, 000
		Lake Taschida	218, 700	65, 700	63, 500
		Jamestown	39, 200	3, 900	14, 400
		Keyhole	190, 300	1, 700	0
		Lewis and Clark Lake [2]	385, 000	290, 500	332, 100
		Pactola	55, 000	12, 300	18, 300
		Shadehill	300, 000	82, 500	79, 100
		Tiber	762, 000	170, 200	196, 800
	Belle Fourche	Belle Fourche	185, 200	37, 600	34, 000
	Fort Peck	Fort Peck [2]	14, 839, 000	2, 840, 200	4, 655, 100
	Milk River	Fresno	127, 200	65, 700	43, 000
		Nelson	66, 800	49, 800	41, 000
		Sherburne Lake	66, 100	17, 200	16, 000
	Rapid Valley	Deerfield	15, 100	10, 200	9, 700
	Riverton	Bull Lake	152, 000	137, 100	97, 700
		Pilot Butte	31, 600	11, 000	6, 900
	Shoshone	Buffalo Bill	380, 300	322, 300	152, 400
	Sun River	Gibson	105, 000	31, 400	40, 000
		Pishkun	30, 100	7, 700	25, 500
		Willow Creek	32, 400	18, 200	29, 500
Region 7	Colo.-Big Thompson	Carter Lake	108, 900	77, 400	25, 400
		Granby	465, 600	395, 300	432, 800
		Green Mountain	146, 900	146, 300	137, 300
		Horsetooth	141, 800	94, 200	46, 700
		Shadow Mountain	1, 800	1, 300	600
		Willow Creek	9, 100	1, 300	4, 000
	Missouri River Basin	Bonny	167, 200	40, 300	34, 700
		Cedar Bluff	363, 200	198, 100	178, 500
		Enders	66, 000	30, 500	35, 000
		Harlan County [2]	752, 800	247, 800	236, 200
		Harry Strunk Lake	85, 600	34, 100	30, 000
		Kirwin	304, 800	80, 300	80, 600
		Swanson Lake	249, 800	111, 700	121, 600
		Webster	257, 400	70, 200	84, 100
	Kendrick	Alcova	24, 500	27, 500	27, 900
		Seminoe	957, 000	[3] 977, 400	928, 300
	Mirage Flats	Box Butte	30, 400	13, 200	16, 800
	North Platte	Guernsey	39, 800	26, 800	27, 000
		Lake Alice	11, 200	3, 400	1, 900
		Lake Minatare	59, 200	31, 200	29, 800
		Pathfinder	1, 010, 900	224, 300	900
Alaska Dist	Eklutna	Eklutna Lake	160, 000	160, 000	165, 900

[1] Not reported.
[2] Corps of Engineers Reservoir.
[3] Includes some superstorage above active capacity.

HANDICAPPED

(Continued from page 95)

Melvin L. Mediger

Huron, South Dakota, where he is presently employed as Acting Chief, Resources and Development Branch, Power Division.

Mr. Simmons is married and has three children, ranging in ages from 6 months to 5 years. He owns his own home and leads a full life in keeping up with his hobbies of amateur radio and gardening.

GILBERT S. ANDERSON of the Salt River Project in Phoenix, Arizona, suffers from arthritis believed induced by a back injury sustained in a fall from a platform in North Dakota.

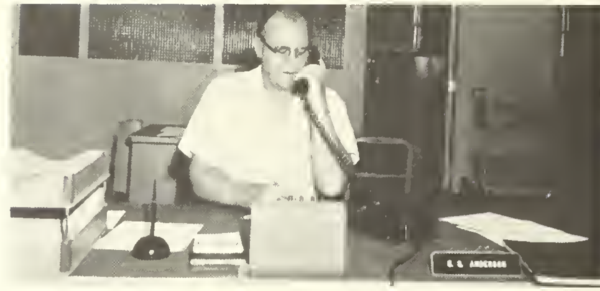
He was born and reared in Donnybrook, North Dakota, and after completing his education at Donnybrook high school assisted his mother on their grain and cattle farm. He spent six months with the old Civilian Conservation Corps, working at the International Peace Gardens near the Canadian Border.

Anderson, customer service clerk in the Project's Power Billing department, blames all of his back trouble on the North Dakota fall and a cold train ride across the Rockies to California. He spent several years in various types of work before his doctor advised him to come to Phoenix.

A talented trumpet player, Anderson has operated his own dance orchestra and has played in a number of others. He still spends some of his free time on the band stand to supplement the family larder and he is affiliated with the Phoenix Musicians' local.

Irvin I. Simmons

Gilbert S. Anderson



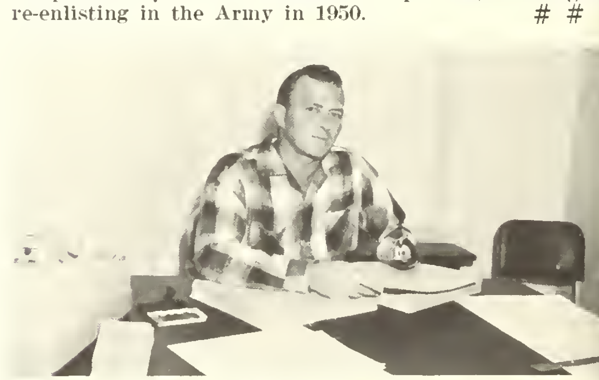
In order to enable him to perform his duties in the power business more efficiently, Anderson has taken courses in refrigeration and electricity. He is also an amateur carpenter and has built an addition to his house.

KEITH L. MASON, a native of Gypsum, Kansas, lost his left arm in an automobile accident near Williams Air Force Base while serving a second hitch with the Air Force. Mason's handicap has not prevented him from participating in sports despite the fact that he was a natural left hander. He developed a good right hand curve on the bowling alleys and is now president of the Thursday Night Bowling League at Chandler, Arizona.

He is now a general clerk in the Salt River Project Irrigation Service department and is currently assisting in setting up transfer journals. His fellow workers are the first to admit that Mason is a good, conscientious worker and asks no quarter because of his handicap.

During his first hitch with the Air Force, Mason graduated from Officers' Candidate School with a second lieutenant's commission. He spent some time in England during World War II with a Quartermaster Truck Company handling supplies and bombs.

Separated from the service in 1945 as a first lieutenant, he spent four years as a salesman in Spokane, Washington, re-enlisting in the Army in 1950. # # #



Keith L. Mason

PRESIDENT EISENHOWER in the conclusion of his proclamation stated in part "I particularly urge all employers to give the physically handicapped equal consideration for retention in their jobs as well as for employment, and I request our citizens to remember, throughout the year, that by their interest and assistance many handicapped persons can achieve economic independence and active participation in the total life of the national community."

(Continued from page 106)

In the following paragraphs, water conditions by States are briefly reviewed along with a statement of conditions affecting the 1959 water supply as of October 1.

ARIZONA. 1958 has been the best water year in Arizona since 1952. The carryover storage in the reservoirs assures the main agricultural areas of adequate water for the coming year. Storage in the eight major reservoirs in the State, excluding those on the Colorado River, is 121 percent of average and 28 percent of capacity. Soil moisture conditions in the mountain forest lands are good to excellent due to late summer rains.

CALIFORNIA. The California Department of Water Resources reports that water conditions during the spring and summer months were satisfactory throughout the State.

Winter precipitation was about 150 percent of average in most portions of the State. Storms during the first week in April brought large increases in snowpack in mountainous areas, further increasing runoff prospects for an already above-average year. Runoff in the North Coastal Area and Sacramento River above Shasta Dam exceeded that for any year since accurate records began on these streams. The unimpaired April–July runoff of major Central Valley streams was 22,800,000 acre-feet, as compared with an average runoff of 13,700,000 acre-feet.

All major reservoirs serving the Central Valley, with the exception of Isabella on the Kern River and Monticello on Putah Creek, were filled during the runoff period. As of October 1, 1958, there were 8,800,000 acre-feet of water stored in 43 major reservoirs serving the Central Valley. This was about 120 percent of the 10-year average, 65 percent of the usable capacity, and about 1,800,000 acre-feet more than the water in storage on October 1, 1957.

COLORADO. Irrigation water supplies were generally adequate for all areas of Colorado this year. Streamflow was near average. Reservoir storage carried over from 1957 and stored during the peak of snowmelt provided a good supply for late season irrigation. East of the mountains a lot of water was lost that normally would have been used or stored during May and early June. There was little demand and storage reservoirs were full. Rainfall was near normal in midsummer, but deficient in August and September. During this latter period there was a heavy demand on storage reserves which fortunately were available.

On the Colorado River early streamflow was high, particularly in southwestern Colorado. However, rainfall from May through August was near the lowest of record. Late streamflow was extremely deficient. Water shortages occurred where adequate storage was not available. Because of the drouth, total seasonal streamflow was 10 to 20 percent less than expected.

Mountain soils are relatively dry. Reservoir storage varies, being more than normal but less than for the fall of 1957. The outlook is much better than during the drouth period of 3 to 7 years ago, but normal or better mountain snowfall will be required to meet demands for irrigation next year. Large storage reservoirs of the city of Denver are still near capacity.

IDAHO. Late spring precipitation was responsible for giving Idaho a normal water supply this year. Streamflow was slightly greater than expected in early spring.

Reservoir storage at the end of the 1958 irrigation season is near that of a year ago in the older reservoirs. The new larger reservoirs, such as Lucky Peak and Palisades, contain slightly more water than on October 1, 1957, reflecting a greater proportion of storage in the new reservoirs. Carryover storage for 1959 is considered good.

Soil moisture conditions on all watersheds in Idaho are poor. A dry late summer and fall has depleted soil moisture far more than usual for this time of year.

Heavy rains during the fall will be necessary to ensure a normal runoff for 1959 from an average snowpack.

KANSAS. The irrigated area along the Arkansas River in western Kansas received more than an average water supply this year. Crops were good. Storage in John Martin and other reservoirs in eastern Colorado indicate a favorable outlook for 1959.

MONTANA. Water supplies for irrigation during the 1958 growing season were adequate. Forewarning of possible shortages in isolated areas required good water management. Although May rains were practically nonexistent, crops on dryland were saved by good rains in June, July and August. Storms were well spaced. Upland hay and grain production were in the bumper crop category for 1958. Irrigation reservoirs are slightly below average with above average storage in larger power reservoirs.

Carryover storage is satisfactory. Streamflow has been close to average in the Columbia Basin and about 75 percent of average in the Missouri Basin. Plains streams runoff was far below average during this season.

NEBRASKA. Surface soil moisture conditions are slightly below normal for most of the State. However, subsoil moisture is a little above normal. Storage in Nebraska is excellent, with most of the reservoirs close to the top of the irrigation pool. In percent, reservoir storage is better than 200 percent of normal and around 95 percent of usable irrigation capacity. With the large reservoirs on the North Platte in Wyoming holding 125 percent of the normal carryover, the 1959 water outlook for Nebraska is excellent.

NEW MEXICO. For the first time in several years irrigation water supply in all areas served directly from streams in New Mexico has been adequate. Streamflow has been normal or above throughout the season. April and May flow of the Rio Grande was very high, but damage was averted through skillful use of available storage capacity. Storage measured in all major irrigation reservoirs in New Mexico is above normal. Alamogordo and Conchas in eastern New Mexico are near capacity.

Soil moisture in the mountains is not as favorable as in the fall of 1957, but is better than average. With a normal snowfall next winter, water supply for the 1959 season will be at least average.

NEVADA. Farmers and ranchers have just completed one of the best agricultural seasons in recent years. All water users had adequate supplies. A cool, dry spring allowed the heavy snowpack to decrease with minimum flood damage.

All major reservoirs, except Rye Patch on the Humboldt River, filled to capacity during the spring runoff. Lovelock Valley, served by Rye Patch, also had adequate water supplies. Even nonreservoir users experienced good late season water.

On October 1, Nevada reservoir storage was 72 percent of capacity or 130 percent of the average October 1 storage. This excellent carryover storage will provide a good start on next year's water needs.

OKLAHOMA. Water supply conditions were good for the W. C. Austin Project in Oklahoma for 1958. Streamflow was below normal, but so was irrigation water demand. There was a net increase in storage during the irrigation season. Outlook for next year is better than average for this early date.

OREGON. Irrigation water supplies in Oregon were adequate or better in the 1958 season. Only in a very few small scattered areas were "shortages" experienced and these represented areas where the lack of summer precipitation allowed streamflow to "fall off" earlier than had been expected.

Actual water supplies were similar to the outlook as forecast in the spring. The South Fork of the Walla Walla River near Milton produced within 4 percent of the forecast. Inflow to Upper Klamath Lake was 20 percent greater than forecast. Inflow to Owyhee Reservoir was 19 percent less than forecast. No other comparisons are available at this time.

Carryover storage is excellent with 25 reservoirs now holding 133 percent of the 1938–52 average. Mountain watersheds are very dry throughout the State, and fall rains have been absent or only very light thus far.

SOUTH DAKOTA. Reservoir storage in western South Dakota is 86 percent of normal as of October 1. Surface soils are relatively dry, but subsoil moisture is well above normal due to heavy rains in June and July. The outlook for next year, based on present conditions, is considered fair.

TEXAS. In contrast to recent years, water supplies along the Rio Grande in West Texas have been greater than average. Crop conditions are good and no reductions had to be made for prospective or actual water storage. A substantial part of next year's supply is stored in Elephant Butte Reservoir in New Mexico. On the Pecos River, water supplies were about average. Carryover in Red Bluff reservoir is near normal.

UTAH. Irrigation water supplies have been good throughout most of the State this summer. As was anticipated last May (when the final water supply forecast was issued) the only area where noticeable shortage occurred was in the eastern part of the Uinta Basin. Here, water users having natural flow rights had a short, late season supply, while those having reservoir storage rights had adequate water.

One of the driest summers of record caused streamflow to drop much faster than normally. Fortunately, the heavy high elevation snowpack kept streamflow up sufficiently so few natural flow rights were adversely affected.

The dry, hot summer has left the soil moisture in both the mountains and the valleys severely depleted. This means that unless heavy rains occur this fall before the winter snow begins to collect, an above average snowpack will be needed if streamflow next summer is to be adequate. This is particularly true for those who are dependent on the natural flow of the streams and those who are served by the smaller reservoirs.

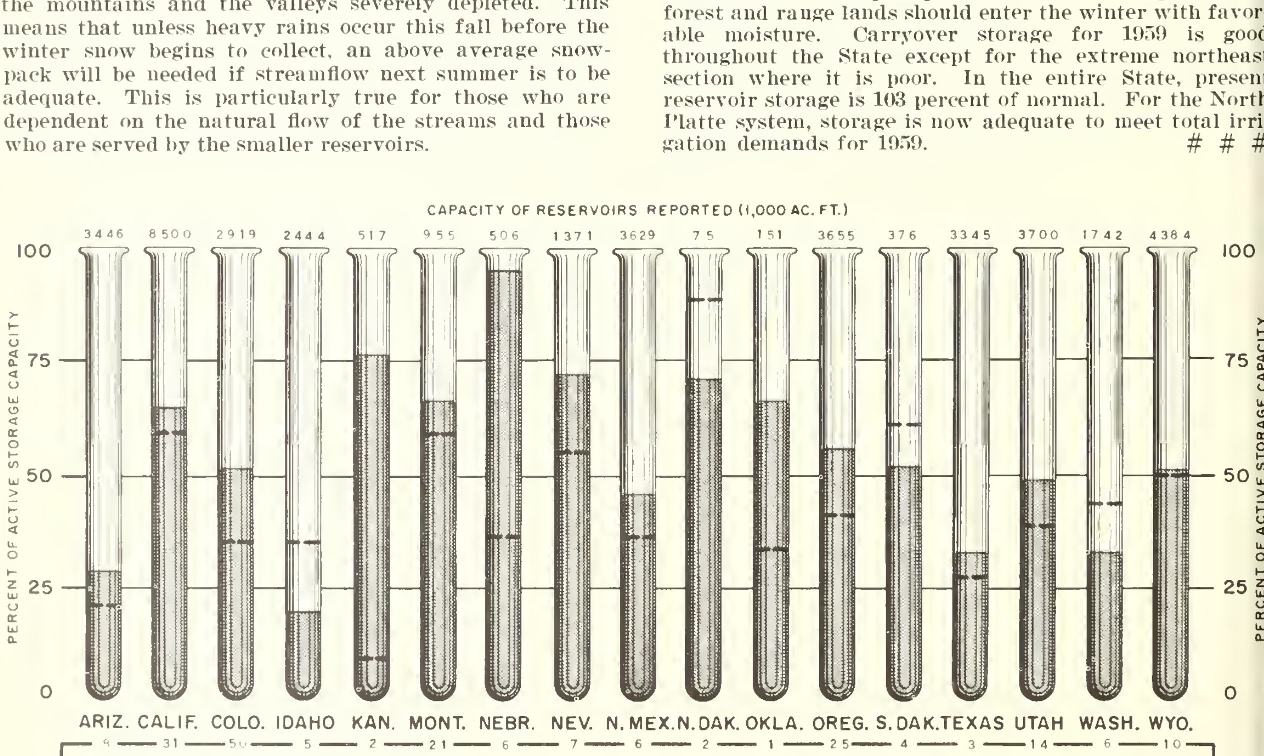
The combined storage in 14 reported reservoirs is 49 percent of capacity as compared to the average of 38 percent capacity. It is noted that relatively more water is stored in the larger reservoirs, since storage in some of the smaller reservoirs is as much as 20 percent below average.

WASHINGTON. The water supply for irrigation in the State of Washington has been adequate over most of the State. In the Columbia Basin and Yakima and Okanogan Rivers, water users who had storage rights had sufficient water, but those who relied on natural flow for their water supply were forced to curtail their normal irrigation operations.

Precipitation during the spring and summer was very erratic. A few stations reported above normal rainfall during a generally dry season. The forests have been tinder dry this summer with practically no rainfall at the high elevations. The drouth was partially relieved by rains in September. Rainfall in the Yakima Valley, as recorded at the reservoirs, was 91 percent of normal during the season. However, September rainfall averaged 172 percent of normal. The Okanogan Irrigation District reported that at Conconully only two of the six months during the irrigation season had below normal rainfall. The soil moisture condition of the watersheds as of October 1 is poor, which will adversely affect to some extent the water supply outlook for next year.

Reservoir storage is slightly less than normal and less than a year ago. If precipitation and snowfall are average this winter, the 1959 water supply should be reasonably adequate.

WYOMING. Water supplies were adequate in Wyoming for 1958. Subsurface soil moisture conditions at high elevations are above normal except in the Snake River watershed. If fall precipitation is near average, soils of forest and range lands should enter the winter with favorable moisture. Carryover storage for 1959 is good throughout the State except for the extreme northeast section where it is poor. In the entire State, present reservoir storage is 103 percent of normal. For the North Platte system, storage is now adequate to meet total irrigation demands for 1959. # # #



RESERVOIR STORAGE on Oct. 1, 1958

BUREAU WATER PLAYGROUNDS POPULAR

Bureau of Reclamation water playgrounds at Lake Mead, Coulee Dam, and Shadow Mountain, Colorado, were hosts to 11 percent of the 38,396,000 visitors during 1957 to 32 historic and recreation areas administered by the National Park Service. The National Park Service year-end report shows 4,318,713 visitors at the Reclamation areas, an increase of 317,325 over the previous year.

Lake Mead National Recreation Area at Hoover Dam ranked second in the Nation with 2,955,257 visitors; the Blue Ridge Parkway, Virginia, and North Carolina was first with 5,048,236.

The attendance record of the three Reclamation areas:

	1957	*1956*
Lake Mead	2,955,257	2,672,774
Shadow Mountain, Colo	1,110,824	1,075,982
Coulee Dam National Recreational Area	266,863	252,632

Lake Mead's visitors exceeded by 51,525 the 2,943,732 travelers to the most popular of the 29 National Parks, the Great Smoky Mountains, N. C.-Tenn.

WATER

WHAT IS WATER WORTH?

Water is a commodity so precious that no tyrant has ever dared deny it to his people. The earliest records of our civilization are linked to the spring and the waterhole, the river, and the well. The Children of Israel faltered in the wasteland and were ready to revolt until Moses struck the rock and brought forth a spring.

Wars have been fought over water rights and once mighty nations have vanished because their water resources failed. Men have battled to the death over the last few drops in a canteen. Formidable fortresses, impregnable in other respects, have fallen because of an insufficient water supply.

Ships' masters have had to risk the destruction of their vessels and the slaughter of their crews because water shortages forced landings on savage isles. Families have given up their homes and deserted their properties because of failing wells and dried-up water courses. London was virtually destroyed by fire in the seventeenth century and Chicago reduced to ashes in 1871 because sufficient water could not be delivered to the right place at the right time.

What is water worth?

Water is beyond price—so far beyond price that water is free of all price.

Reprinted from What Price Water? by permission of American Water Works Assoc., Inc., New York 16, New York.

NEW CROPPING METHODS

(Continued from page 92)

Irrigating potatoes on the Palisades Project in Idaho.
Photo by Phil Merritt, Region 1.

to the whole southern Idaho area, alfalfa hay running from 4 to 5 tons per acre and, in the lower elevations, 28 to 32 bushels of commercial beans.

Along with the lessons of early development, the Idaho farmer is also profiting by the knowledge that as the farm becomes an established unit, then proper rotation programs must be followed to retain the land's fertility and to maintain the full production potential. Thus it is that livestock feeding soon becomes a part of the farm program, along with the crop rotation designed to produce feed crops and cash crops.

It is indeed a wonderful sight to see the sagebrush giving way to beautiful new productive farmlands in southern Idaho and to observe each year at harvest time the bounteous yields of the soil which had lain unused and scorned as a desert for many, many years. The key to unlocking this new treasureland has been water, combined with man's ability and determination to find and make for himself and his family a home where each can contribute to earning the family living and where each may be a part of the dignity and strength of producing the food and fiber for our national requirements. # # #

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If you have friends or associates, who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5042	Little Wood River, Idaho.	Aug. 22	Enlargement of Little Wood River Dam	Lewis Hopkins Co. and Arthur R. Sime, Pasco, Wash.	$1,093,94
DC-5051	Missouri River Basin, N. Dak.	July 29	Construction of Stage 03 and 04 additions to Fargo substation	William Collins & Sons, Inc., and Northolt Electric Co., Fargo, N. Dak.	236,34
DS-5052	Colorado River Storage, Ariz.-Utah.	July 1	Penstocks and outlet pipes for Glen Canyon Dam	Vinnell Steel, Irwindale, Calif	3,778,00
DC-5058	Middle Rio Grande, N. Mex.	July 16	Construction of earthwork, clearing, and structures for irrigation rehabilitation, Belen Unit 9.	Shufflebarger & Associates, Inc., Albuquerque, N. Mex.	149,18
DC-5060	do	July 16	Construction of earthwork, clearing, and structures for irrigation rehabilitation, Belen Unit 11.	do	145,58
DC-5064	Rogue River Basin, Oreg.	Aug. 22	Construction of earthwork and structures for South Fork collection canal, Sta. 291+10.3 to 450+28.1; and Deadwood Creek siphon for Daley Creek collection canal.	Floyd R. Grubb, Salem, Oreg	236,69
DC-5067	Ventura River, Calif	Aug. 25	Construction of Casitas Nos. 1 and 2, Matilija No. 2, and Rincon chlorination stations.	Young & Anderson Co., Brea, Calif.	215,43
DC-5068	Columbia Basin, Wash	Aug. 28	Construction of earthwork and structures for Potholes East canal enlargement, Sta. 172+00 to 251+00 and 510+00 to 770+00.	George W. Lewis and Thompson Construction Co., Kennewick, Wash.	693,11
DC-5069	Colorado River Storage, Utah-Wyo.	Aug. 19	Construction of administration building, garage and fire station, and field laboratory for Flaming Gorge community facilities.	Witt Construction Co., Provo, Utah.	161,05
DC-5076	Missouri River Basin, Mont.	Sept. 10	Construction of earthwork and structures for completion of Spokane Bench laterals.	Contractors and Excavators, Inc., and Zuber Brothers Contractors, Warden, Wash.	185,91
DC-5078	Missouri River Basin, N. Dak.	Sept. 8	Relocation of 1.9 miles of Devils Lake-Carrington 115-kv. transmission line.	Main Electric, Inc., Minot, N. Dak.	126,18
DC-5079	Weber Basin, Utah	Sept. 19	Construction of 8 reservoirs and Bountiful Subdistrict laterals, Davis aqueduct lateral system.	Nelson Brothers Construction Co., Salt Lake City, Utah.	446,07
DC-5080	Central Valley, Calif	Sept. 4	Furnishing and installing armature winding for one of generator units 1, 2, or 3 at Shasta powerplant.	General Electric Co., Denver, Colo.	205,00
DC-5084	Rogue River Basin, Oreg.	Sept. 18	Construction of earthwork, concrete lining, and structures for Ashland lateral diversion dam and lateral extension, Schedules 1 and 3.	Cherf Brothers, Inc., Sandkay Contractors, Inc., and Cheney Construction Co., Ephrata, Wash.	305,85
DC-5085	Weber Basin, Utah	Sept. 5	Construction of earthwork, concrete canal lining, and structures for Gateway canal revision, Sta. 387+65 to 400+50 BK.	Mac Construction Co., Salt Lake City, Utah.	119,38
117C-514	Columbia Basin, Wash	July 15	Constructing DE236 and DE236A drains and underdrain for Weber wasteway chute.	Lewis Construction Co., Inc., and S. L. Boutelle, Kennewick, Wash.	194,49

U. S. GOVERNMENT PRINTING OFFICE : 1958 O - 479605

Construction and Materials for Which Bids Will Be Requested Through December 1958*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	One 115,000-hp, 180-rpm, 480-foot-head, vertical-shaft, Francis-type turbine with pressure regulator for Hoover powerplant, Unit N-8.
Do	One 168-inch butterfly valve for Hoover powerplant.
Do	One 100,000-kva, 16,500-volt, 3-phase, 180-rpm, vertical-shaft, hydraulic-driven generator for Hoover powerplant, Unit N-8.
Central Valley, Calif.	Constructing a 102-inch precast concrete pipe siphon under railroad and highway on the Corning canal.
Do	Constructing about 5 miles of bituminous-surface road from Stoney Creek to Ridgevill , and reinforced concrete bridge over Mule Creek.
Collbran, Colo	Earthwork and structures for about 22 miles of earth-lined and unlined canal and constructing 6 precast concrete pipe siphons.
Colorado River Storage, Ariz.	Constructing a 48- by 256-foot administration building and a combination garage, fire station, and police building.
Columbia Basin, Wash.	Constructing the indoor-type Radar pumping plant will include constructing a reinforced concrete substructure, a superstructure of structural steel frame with uninsulated metal panel siding, and a crane runway for a 15-ton traveling crane, installing 5 electrically driven, horizontal pumping units of 146-cfs total capacity.
Do	Constructing the Sand Hollow pumping plant will include an 81.5- by 27-foot building with concrete substructure and structural steel superstructure, installing 4 motor-driven pumping units, 3 with 51-cfs capacities and one with 25-cfs capacity with total heads of 65 feet, electrical control equipment.
Do	Relocating about 560 feet of the EL18 siphon and constructing structures. North of Moses Lake.
Do	Earthwork and structures for about 1 mile of 3-foot bottom width concrete-lined lateral and about 8 miles of unlined laterals with bottom widths varying from 6 to 2 feet, and one 36-inch precast concrete pipe siphon about 2,300 feet long.
Do	Earthwork and structures for about 18 miles of open-ditch drain and about 1 mile of closed pipe drain.
Do	Two motor-driven, horizontal, centrifugal-type pumping units each with a capacity of 20 cfs at a total head of 106 feet.
Do	Gravel surfacing about 50 miles of operating roads in Blocks 85 and 20, near Royal and Mesa.
Do	Furnishing and installing 8 automatic slide gates on the West canal, fifth section, northwest of Othello.
Fort Peck, Mont	Additions to the Dawson County substation will include grading and fencing a major extension to the area, constructing concrete foundations, furnishing and erecting steel structures, installing 3 single-phase, 230/115/13.2-kv, 20,000-kva autotransformers and associated electrical equipment, major items of which will be Government furnished. Near Glendive.
Milk River, Mont.	Two 4- by 5-foot, high-pressure gate valves and hydraulic hoists for Sherburne Lake dam.
Minidoka, Idaho	Modifying laterals and constructing drains for the North Side Pumping Division, near Rupert.
MRB, Colorado	Reconductoring about 30 miles of 115-kv wood-pole transmission line from Flatiron switchyard, near Loveland, to Greeley substation.
MRB, Kansas	Earthwork and structures for about 14 miles of canal, and about 17 miles of laterals, including precast concrete pipe siphons, highway and railroad crossings, and 3 small pumping plants. Osborne canal and laterals, near Alton.
MRB, Montana	Earthwork and structures for about 45 miles of open ditch laterals and about 20 miles of open and closed drains. Helena Valley Unit, near Helena.
MRB, Nebraska	Earthwork and structures for about 15 miles of 18- and 20-foot bottom width Culbertson canal, near Culbertson.
MRB, North Dakota.	Furnishing and stringing 795,000 CM ACSR conductors and 0.5-inch steel overhead ground wires for the 165-mile, single-circuit, steel Fargo-Granite Falls 230-kv transmission line.
MRB, Wyoming	Constructing about 35 miles of 115-kv, wood-pole transmission line from Boysen switchyard to Pilot Butte switchyard.
Do	Completion of the Fremont Canyon powerplant and switchyard will include placing second stage concrete for a 2-unit powerplant, installing embedded and nonembedded parts for two 24,000-kw generators and two 33,500-hp turbines and other hydraulic, mechanical and electrical machinery.
Do	One 10,000-kva, 115- to 69-kv power transformer for Pilot Butte switchyard.
Provo River, Utah.	Constructing about 8,355 feet of riprap-faced dikes on the Provo River.
Riverton, Wyo	Furnishing and applying about 1,200 tons of catalytically-blown asphalt membrane lining to Wyoming and Pilot canals and laterals.
Washita Basin, Okla.	Clearing timber and brush, and clean-up work in the Fort Cobb reservoir area.
Do	Earthwork and structures for about 21 miles of 15-, 18-, 21-, 27-, 30-, and 33-inch precast reinforced concrete pipelines for the Anadarko aqueduct.
Weber Basin, Utah.	Constructing about 800 linear feet of 12-inch and 2,800 linear feet of 27-inch precast concrete pipeline, both of which are to be connected to the existing Davis aqueduct.
Yakima, Wash	Supplemental construction and lining portions of Kennewick Main canal, near Kennewick.

*Subject to change.

United States Department of the Interior
Fred A. Seaton, Secretary

Bureau of Reclamation, W. A. Dexheimer, Commissioner

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The Reclamation Era

FEBRUARY 1959

IN THIS ISSUE:

Plastic Canal Linings
How to Choose the Right Fertilizer

Official Publication of the Bureau of Reclamation

The Reclamation Era

FEBRUARY 1959 Volume 45 No. 1

In this issue . . .

J. J. McCARTHY, Editor

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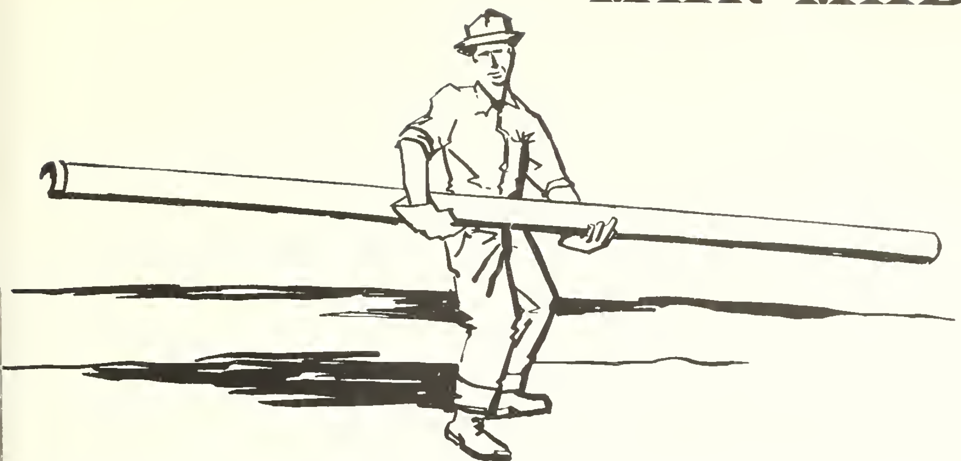
MAN-MADE RAIN



For hundreds of years the American farmer has planted his corn, cotton and spinach and depended on a bountiful nature to keep them watered. All too often nature has let him down. He has been left with scorched fields, withered crops and a note to be renewed at the bank. But the time is approaching when drought-ridden growers will no longer have to depend on rain clouds to spill out their moisture on a thirsty vegetation.

Thousands already are turning on their own rain when they need it and turning it off when they have had enough. It's a new development called portable irrigation, made possible by the invention of aluminum pipe. All the land owner needs in order to get this pushbutton rain when he wants it is a good supply of water, a pump, motor and enough aluminum pipe.

The source of water may be a river, lake, creek, spring or well. Just hook up the pumping system and the aluminum pipe will carry this water to where it ought to be. A set of sprinkler heads will distribute it in a rain-like shower over 1 to 4 acres at a time. Sprinkler heads and pipe are moved as additional acreage is to be refreshed. This form of irrigation is available to every farmer, regardless of how hilly or rough his land may be, if he has a sufficient supply of water around.

"Snooky" Uhlian has a farm bordering the Cumberland River near Nashville. His 90 acres of bottom land has been in the Uhlian family for a half century or more. Snooky is the third generation to sell roasting ears and turnip greens from it. Up to 6 or 7 years ago there were dry years in which the crops were almost a total failure. There have been three successive years of disastrous droughts since then, but not disastrous to Snooky. During those 3 dry years he sold around $20,000 worth of crops a year when most other farmers around him had practically nothing of any kind to offer. The $12,000 he invested in his man-made rainpower 7 years ago more than paid for itself in each of the dry years since. It consists of a pump and motor on the bank of the Cumberland, a few hundred feet of 8-inch main line aluminum pipe, a few more hundred feet of 6-inch lateral pipe, and a volume gun that slings water in a complete 2-acre circle at a setting. He waters about 10 acres each day through the late afternoon and night. His corn retains that healthy dark green color when unirrigated crops roundabout are drying to a crisp.

Someone may ask, why didn't somebody think of this method of watering crops before? Answer: There was no aluminum pipe. The conventional steel pipe was simply too heavy and too expensive to move around over a large acreage for watering an acre or so at a setting. One man easily can pick up a 20-foot length of 6-inch aluminum pipe and walk off with it.

The limiting factor in the use of man-motivated rain is the amount of water available.

One farmer I knew had 200 acres through which a creek flowed. The irrigation dealer who engineered his farm told him he could depend on only enough water to adequately cover 10 acres. So he bought a $2,500 system, put that 10 acres in tobacco, kept it well watered, and made $1,000 an acre. Tobacco, being his chief money crop, always had been about two-thirds his gross income.

by ROSS L. HOLMAN

Another 100-acre farmer who grew 5 acres of tomatoes, cantaloupes, and greens, used the remainder of his 100 acres for dairying. He built an irrigation reservoir. It was replenished by runoff rainy season water from surrounding high ground. He watered only the 5-acre truck patch. He sold $12,000 worth of irrigated tomatoes and cantaloupes the first year at a high price.

The first cost of a portable irrigation system usually runs from $1,000 to $20,000 or more, depending on the amount of acreage to be watered and other factors. These portable outfits are making such a big difference on the farms where they are installed that their use is spreading like measles.

In nearly every State on farms where there is enough water to farm at all, the idea is taking hold. State extension departments are promoting it. In many places it is easier for a farmer to get money from a bank to install portable irrigation than for any other short-term need.

Until recently the only kind of irrigation used to any extent was the flood type. The watered land has to be level and water carried through it by means of canals, furrows, and dikes. It is used on only 3 percent of America's tillable ground. Yet this 3 percent has produced one-fourth of the Nation's products. Many of our best authorities say that 20 times that much land can be sprinkler-irrigated. It will remove forever the biggest gamble that the farmer faces and save him many whole years of almost total crop loss.

Many farmers already have enough available water to put their entire farms under portable irrigation, if necessary. One farmer who specializes in hybrid seed corn at $10 a bushel lost his entire 1953 crop as a result of a drought. Although the 1954 drought was more severe he produced $75,000 worth of corn from 100 acres. He had installed an irrigation outfit tied to an adjoining river.

It is well to emphasize that no farmer anywhere should buy an irrigation system until his farm is engineered for it by a trained technician. This determines the kind of system he needs and how it should be set up. Without this technical assistance he may lose his shirt.

Continued on page 16

Levi Burton of Bartley, Nebraska, irrigates his alfalfa field by sprinkler near his new home, a result of good irrigated crops. ***Photo by L. C. Axthelm, Region 7.***

PLASTIC CANAL LININGS

As a part of the continuing search for satisfac-
ory and low-cost linings for irrigation canals hat can be installed by project forces, using a inimum of equipment normally available on an rigation project, an experimental test section of uried plastic membrane lining was constructed n a lateral of the Heart Mountain Division, Shoone Project, Wyo. The work was accomplished the fall of 1957 and a prefabricated, black, inyl plastic material 8 mils in thickness was sed for the 400-foot long experimental installaon.

Preparation of the lateral subgrade and inallation of the plastic lining were performed by roject forces, using project equipment. The ling material was donated by the Bakelite Co. of ew York. The black, 8-mil thick vinyl film was irnished in one piece 17 feet wide and 400 feet ng. The weight of the plastic lining material as approximately 350 pounds. The film was ackaged at the factory, accordion-folded into a rdboard box about 4-feet long by 1-foot thick. he Bakelite Company is currently wholesaling is material at about 40 cents per square yard, cording to R. H. Kennedy, Chief, Operation and Maintenance Branch and W. H. Swenson, Head, Materials Section, who reported the installation work.

The lateral was overexcavated to provide for 9 inches of combined earth and gravel cover over the lining after placement. The slopes were flattened to 2½:1, and where sandstone was encountered, the subgrade was excavated slightly below grade and refilled with earth material to provide a cushion to prevent possible puncture of the film. The rough excavation was made with a dragline and fine-grading was accomplished with hand shovels, rakes and a lightweight lawn roller. Trenches were cut into the slope at the elevation of the top of the lining, as shown, to anchor the film and to prevent surface water from seeping under the lining. Cutoff trenches 18 inches in depth were excavated at both inlet and outlet transitions to prevent water from getting under and displacing the lining.

Placing of the lining was easily accomplished by using a two-wheel trailer in the bottom of the lateral to carry the box containing the plastic. The lining was first unfolded again toward each side slope.

Preparation of the subgrade for lining.

Gravel cover is hauled to site and removed from truck with clam shell bucket and placed in the canal section in one operation.

A minimum amount of earth material was placed in the trench at the top of the lining by hand methods to hold the plastic in place while the cover was being placed by the dragline. Placement of the lining for the entire 400-foot reach was completed without difficulty in about 1 hour. The plastic remained soft and pliable even though the temperature was only slightly above freezing during placement.

The earth cover was silty sand material obtained from over-excavating the canal section. A template was constructed and pulled along the bottom and side slopes of the canal to level the earth cover prior to placing the gravel cover. No particular difficulty was experienced in placing the earth cover. The plastic apparently withstood the impact of the material dropping from the dragline bucket without any noticeable tearing of the lining. No doubt the excellent condition of the canal subgrade contributed to the successful application of the cover without damage to the membrane.

The gravel cover was hauled to the site in dump trucks and picked out directly from the truck with a clam shell bucket and placed in the canal section in one operation.

In order to secure comparative costs which could be used for estimating the cost of similar work on other projects, labor and equipment costs were kept on the installation. These are given below. A minimum of supervision normally would be required for installation of this type of lining and the costs would be reduced materially on a larger installation using experienced personnel. Accordingly, costs somewhat lower than shown would normally result.

Dragline, excavation	$216.00
Dragline, placing earth and gravel cover	204.00
Loader, loading gravel trucks	36.00
Patrol, cleanup work	88.00
Labor, fine grading subgrade	168.55
Labor, smoothing earth cover	164.80
Labor, smoothing gravel cover	69.01
Transportation	43.74
Engineering and supervision (field costs)	206.17
Total installation cost	1,196.27
Installation cost per square yard (756 square yards)	1.58

Approximately the same amount of subgrade preparation would be required for any type of membrane lining. The ease and time required to install this plastic membrane was a large factor in reducing the costs.

Where the canal prism is more than 20 feet and the length to be lined more than 400 feet, additional lengths of the plastic could be joined in the field to reduce the weight for handling conveniently. The Bakelite Co. advises, however, that practically any width and length of film can be supplied and handling in the field will be the controlling factor on the size of sheet to be used. The ease in making field splices between two sheets of the vinyl plastic film was illustrated during the installation where it became necessary to patch a tear in the film which occurred during the unfold-

Continued on page 16

HAVASU LAKE NATIONAL WILDLIFE REFUGE

Havasu Lake National Wildlife Refuge, established in 1941 to protect and manage the wildlife resources on the reservoir back of Parker Dam, is situated on the reservoir formed by Parker Dam on the Colorado River, 17 miles north of Parker, Ariz. It extends north from the dam nearly 55 miles to the upper end of the swampy backwaters between Needles, Calif. and Topock, Ariz. The dam was constructed by the Bureau of Reclamation in 1938 to provide a desilting basin and foreway for the aqueduct of the Metropolitan Water District of Southern California.

The refuge may be divided into four distinct sections: Havasu Lake, Mohave Canyon, the Topock area, and the Bill Williams Delta. Havasu Lake is the open body of water behind Parker Dam. It is approximately 40 miles long, and varies in width from one-fourth mile to more than 3 miles. The shoreline of the southern half of the lake is characterized by precipitous, rocky cliffs of volcanic origin. The upper half of the lake is margined by desert areas. There are a few stretches that are low and sandy. Waterfowl food plants, such as sego pondweed, grow profusely in many sections. Although it is an artificial reservoir, Havasu Lake's shoreline fluctuates not more than 4 or 5 feet per year. This guarantee of moisture has resulted in a fringe of brush and trees, particularly in the upper part of the lake, where screwbeans, black willow, cottonwoods, and salt cedars form a backdrop to coves and bays.

In Mohave Canyon the lake becomes a river, restricted much of the way by towering red cliffs, with many secluded backwaters margined by bulrush and cattail. The canyon extends for about 10 miles. Scenic features of the canyon include Mohave Rock, which splits the river at the lower end of the canyon; Devil's Elbow, where the river

ABOVE, HARRIS HAWKS

by LOUIS D. HATCH, Refuge Manager, Havasu National Wildlife Refuge

Two marbled godwits and a willet on sandbar at north entrance to Gun's hole in Topock area.

Photograph by Gale Monson, U. S. Fish and Wildlife Service.

makes two 90° bends in less than half a mile; and Picture Rocks, where Indian petroglyphs, or rock-writings, are viewable from the water.

The Topock Area consists of about 28 square miles inundated by the river since the completion of Parker Dam. The channel of the Colorado River is confined to the west edge of the area by a large levee constructed by the Bureau of Reclamation. The bulk of the area is a network of channels and ponds set in low ground. Its east side, where the refuge extends for nearly 10 miles above Topock, is a deep lake. There is much flooded brushland, and the stands of cattail and bulrush are the most extensive in Arizona.

The fourth and southernmost section of the refuge, the Bill Williams Delta, is a small area of less than two square miles, formed by the deposition of silt from the Bill Williams River. This area is located in the midst of towering cliffs of volcanic rock, some of which are 2,000 feet in height. Underground water seeps to the surface to form a few small streams, which often are converted into a series of ponds by beaver dams. The delta area provides a wide range of wildlife habitats, and many of the rarest plants and animals of Arizona are found here. Permission to visit this area must be obtained from the Refuge Manager at Parker, since the area is inaccessible except by vehicles with four-wheel drive.

Slightly less than half of the 45,761-acre area lies in California; the remainder in Arizona. Wintering populations of ducks and geese find their way through the mountainous or eastern section of the Pacific flyway into the Colorado River drainage, making extensive use of the refuge. The development of waterfowl habitat on the refuge is still in progress. Habitat improvement by brush control for the encouragement of Bermuda grass and other browse is expected to prove attractive to geese and other waterfowl.

The fall migration usually begins in August with the arrival of large numbers of pintails and green-winged teal. In October, the wintering Canada and snow geese, mallards, American widgeons, and gadwalls begin arriving. The re-

MOHAVE CANYON above Mohave Rock.

turn flight northward reaches its peak in February and March. Coots are present by the thousands from September through March. Many species of ducks, including the common goldeneye and the hooded merganser, are present during the winter months. During migrations, loons, grebes, glossy ibises, long-billed curlews, willets, marbled godwits, ring-billed gulls, and Forester's and black terns are commonplace. Among the brush and trees of the shoreline the Gambel's quail, great horned owl, roadrunner, white-winged dove, ladderbacked woodpecker, blade phoebe, verdin, crissal thrasher, black-tailed gnatcatcher, yellow warbler, yellow-breasted chat, and blue grosbeak may be observed.

Mohave Canyon, with its sequestered backwaters, is home to a variety of birds. A limited number of ducks and other water birds nest on the Havasu Lake Refuge. Nesting colonies of herons, cormorants, and both common and snowy egrets can be found in April and May. The Harris' hawk, one of America's rarest birds of prey, nests commonly in the Topock Area. Prairie and peregrine falcons, white-throated swifts, and canon and rock wrens should be watched for along the cliffs. The Topock Area is notable for its large winter concentrations of waterfowl. Among the smaller birds, vermillion flycatchers, marsh wrens, yellow warblers, yellowthroats, red-winged blackbirds, and song sparrows breed commonly. Tree swallows gather in incredible numbers during migration, and hundreds spend the winter. Beaver are numerous on the refuge. These valuable fur animals prefer willows, which grow profusely in some sections, but utilize the extensive stands of cattail for food and for the construction of their lodges. Muskrats are also present in considerable numbers. A few bighorn sheep and wild burros inhabit the rugged, mountainous terrain which extends to the lake margins in a number of places. The bighorns are found only on the Arizona side.

Fish abound in the refuge waters, including large-mouth bass, channel catfish, bluegill, crappie, and carp. A year-long season is permitted, subject to the joint regulations of California and Arizona, except at such times and in such places where closing of an area to fishermen is advisable to give better protection to birds. Bullfrogs inhabit the Topock Area and many parts of the lake, and soft-shelled turtles are common.

Bighorn sheep, 2 ewes, Mohave Canyon, looking north. ***Photograph by Gale Monson, U. S. Fish and Wildlife Service.***

Portions of the refuge area are open to public shooting during the waterfowl season. It has been learned through banding that many of the birds taken by hunting are the ducks and geese which nest in the Mountain States of Utah, Wyoming, Idaho, and Montana.

Firearms are prohibited at all times, except shotguns, during the open waterfowl season in those areas open to hunting. Molesting wildlife or damaging plants is prohibited. Visitors are especially cautioned against disturbing resting or feeding flocks of birds, and are expected to stay away from nesting colonies.

Havasu Lake is popular for swimming, boating, camping, and water skiing. The lake attracts large numbers of visitors throughout the year and, situated as it is in a desert section of the country, provides one of the few recreational areas in the region available to the public.

While public use is secondary in function to a wildlife refuge, public use on Havasu Lake has increased 600 percent in the past 10 years. Lake

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Havasu provided 250,000 visitor's-days-use last year, and it is anticipated that by 1975 it will receive more than one million visitor's-days-use. As an example of the increased use, two 12-hour counts taken during the Memorial Day holiday reflected these interesting results:

Young brown Pelican.

	Cars	*Boats*	*People*
1957	335	210	1,532
1958	864	705	3,360

Some 3,000 visitors took the self-guided tour at the Parker Dam Powerplant last Memorial Day weekend.

To accommodate fishermen, water sports enthusiasts, picnickers, campers, sightseers, and naturalists, 8 concessions have been established, 5 on the lake and 3 near Topock. A wide range of facilities is available at these concessions, among them rental boats and outboard motors, motels, housetrailer parks, cabins, and camping space. Due to the extent of the area, it is best for visitors to make local inquiry at such places as Kingman, Parker, and Topock in Arizona, and Needles and Vidal Junction (on U. S. Highway 95) in California. One or more concessions are accessible from any one of these points. The concessions are, respectively, Shorty's Camp, Gunn's Camp (Catfisherman's Paradise), and Five-Mile Landing at Topock, accessible from U. S. Highway 66; Site Six, on the Arizona side of the lake, reached by turning south off Highway 66 about 10 miles east of Topock (this concession has an excellent 6,000-foot landing field); Havasu Landing, on the California side of the lake, to which an all-paved road extends from U. S. Highway 95 about 21 miles south of Needles; Roads End Camp and Black Meadow Landing, on the California side of the lake, accessible by road from Parker Dam; and Havasu Springs, on the Bill Williams arm of the lake, reached by driving across Parker Dam from the California side.

Camping is permitted for not more than 72 hours (3 days) at any place along the shore of Havasu Lake except Mohave Canyon, provided that the camper maintains a neat camp and removes all traces of same upon leaving. Camping facilities are provided at most concession sites for a nominal fee. Camping is not permitted along the Bill Williams arm of the lake, and only in designated areas in the Topock Area.

A 10-year recreational development program has been prepared to cope with the advancing tide of the recreational seeking populace of Southern California. Campground development has been initiated along both the Arizona and California shores of Havasu Lake. These sites will contain picnic tables, fireplaces, and toilet facilities. Wood for campfires must be provided by campers and picnickers. Use of campstoves is desirable.

Water skiing has increased at a fantastic rate, making it necessary to establish definite ski areas on the lake. The ski zones provide the most compatibility among the interests of a wildlife refuge, water storage, and the varied recreational uses of skiing, fishing, hunting, swimming, and sightseeing. # # #

CANAL LININGS

Two publications that may be of interest to you on the subject of canal-linings are: (1) Lining Irrigation Canals, and (2) USBR's Lower-cost Canal Lining Program.

The Portland Cement Association's illustrated, 32 page booklet "Lining Irrigation Canals," discusses the need for canal linings, the economics of lining, general design considerations and describes the types of linings that can be constructed with portland cement. Included are concrete, plastic soil-cement, compacted soil-cement, and shot-crete linings; precast lining units and pipe; and cast-in-place concrete pipe. Copies of the Portland Cement Association booklet can be obtained by writing the Association at 33 West Grand Avenue, Chicago 10, Ill.

Steel storage building 60' x 32' with sections painted white to test the effect of the paint. *Photograph by T. E. Bond, U. S. D. A., Univ. of Calif.*

WHITE PAINT FOR FARM BUILDINGS

Characteristics of White Paint Prevent Excessive Heating of Metal Farm Structures by Radiation from Sun, Sky, Environs

PART OF A GALVANIZED STEEL storage building in the Imperial Valley was painted—to study the influence of white paint on the thermal environment within a steel building and under metal animal shades—as part of a research project concerning the modification of the environment to improve animal gains.

The long dimension of the storage building was oriented north and south. The exterior of the south end—and the south 20′ section—were painted with standard white house paint. The center 20′ section was painted with bone-white paint. The north section and north wall were left unpainted.

Temperatures of the different sections were measured with thermocouples attached to the inside surfaces. The temperatures of the painted surfaces were greatly reduced. At 1 p. m., when outdoor air temperature was 100° F., and the temperature inside the building was 102.5° F. surface temperature reductions were: 25.0° F., west wall; 42.6° F., west roof; and 41.0° F., east roof. There was little difference in the temperatures of the unpainted north end and the painted south end even though the south end was in the sun all day. In effect, the white paint put the south end in the shade. There was little difference in the effect of the two types of white paint.

With only one building available for study, it was not possible to compare directly the air temperatures in painted and unpainted buildings. However, it was possible to calculate from the test data what the air temperatures within two such unventilated buildings would be, based upon actual surface temperatures of the painted and unpainted sections. These calculations were made for three different sets of data. The air temperature in the white painted building was taken as the air temperature inside the test building, and the temperature inside the unpainted building was calculated on the basis that the amount of heat transferred to the air in both buildings was the same. Such considerations indicated air temperature differences as great as 28° F. within the two buildings.

Calculated temperature differences within unpainted and white painted galvanized steel buildings based on actual surface temperature measurements of painted and unpainted sections.

Date 1955	Time p. m.	Inside air temperatures, ° F.		
		White	Unpainted (calculated)	Temperature difference
June 25	1:00	102.5	130.5	28.0
June 25	2:00	100.0	116.8	16.8
June 26	2:00	102.5	119.8	17.3

Radiation from the surfaces was measured with a directional radiometer. At 2:30 p. m. the white surfaces in shade—east side—gave off 184 B. t. u.—British thermal units—per hour per square foot compared to 172 B. t. u. per hour per square foot from the unpainted surfaces, indicating a more rapid emission of energy from the white surfaces. In the sun—west side—315 B. t. u. per hour per square foot came from the white surfaces and 231

by T. E. BOND, C. F. KELLY, and N. R. ITTNER from the unpainted surfaces. The greater amount of energy from the white surfaces indicated they had both greater reflectivity and greater emissivity than the unpainted surfaces—very desirable characteristics in building heat load consideration.

PAINTED ANIMAL SHADES

Shades are important for protecting livestock from radiation from the sun and sky and, indirectly, from the surroundings. Because the shade material is generally hotter than the surface of a shaded animal, the animal receives radiation from it.

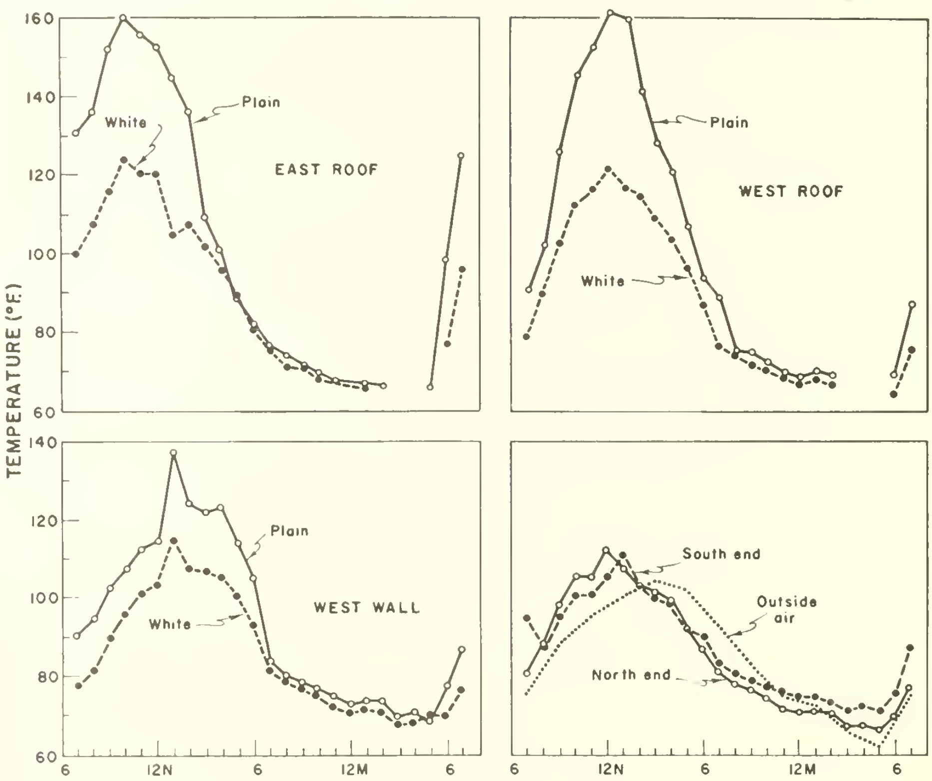
The radiation characteristics of both surfaces of the shade material influence the radiation heat load on the animal. The characteristics of the top surface have a major influence on the temperature of the shade material; the emissivity of the bottom surface greatly affects the quantity of energy that will be emitted to the animal. In addition, the reflectivity of the bottom surface determines the quantity of incident energy from the ground that will be reflected back down to the animal.

White paint was tested as a means of reducing the temperature of metal shades to reduce the heat load on animals under them.

Three flat, portable shade frames 8′ x 8′ x 4′ high were covered with corrugated embossed aluminum roofing. One shade was left unpainted. White paint was applied to the top surface of the remaining two and the bottom of one of these was painted with black paint. White paint and the unpainted aluminum sheet reflect about the same amount of solar energy but the emission of white paint, at ordinary shade material temperatures, is much greater. Because of this the temperature of the white painted aluminum was as much as 15° F. lower than the unpainted aluminum. The radiant heat load—as indicated by black globe thermometers—was as much as 13 B. t. u. per hour per square foot less under the white surfaced aluminum.

The third shade with the white top and black underside remained at about the same temperature as the shade with only the white top surface. However, because the black underside did not reflect energy from the ground back down to the animal, the radiant heat load under the white and

Continued on page 12



Above—24-hour comparison of surface temperatures of painted and unpainted sections of steel storage building.

NEW AGRICULTURAL DEVELOPMENT

The following are excerpts from recent releases of the Climax Molybdenum Co., and are published for the consideration of and evaluation by the Irrigation Farmer. Additional information should be obtained from County Extension Agent or State Agriculture College. Ed.

An agricultural advance designed to help farm-rs increase the productivity of their land was nveiled in Portland, Oregon, by Climax Molyb-lenum Co., a division of American Metal Climax, nc., before a special meeting of County Agents nd agronomists from Oregon and Washington. t is a new, easy-to-apply form of Molybdenum, n element which is essential to the growth and ealth of crops, especially legumes.

The new formulation, a seed treatment com-ound known as Moly-Gro, can effect harvest increases as high as 50 percent on peas, alfalfa, peanuts, soybeans, clover, and many other crops. According to William M. Stilwell, manager of agricultural sales and development for Climax, this development opens the door for the first time to practical commercial application of molybdenum to crops and ultimately to greater income per acre for farmers.

Molybdenum is a micronutrient required by plants in only minute quantities—but it serves vital functions in the fixation and utilization of nitrogen. It enables the root nodule bacteria of legumes to fix nitrogen from the atmosphere. Further, in building protein nitrogen, plants first must convert nitrogen into a simpler form. Molybdenum plays an important role in the plant enzyme system, making this conversion possible.

Molybdenum has been put to work on Australian and New Zealand soils with excellent results. Soils which once yielded just a sparse scattering of native legumes were able to produce luxuriant

\bove, Dr. H. M. Reisenauer, Washington State College, exhibits the increase possible. Peas were picked from test plots of same size. Molybdenum treated peas on right.

Preparation of seed. Moly-Gro is mixed with water and passed over the seed before planting.

Treated seed is spread out on canvas to dry before being planted.

carpets of clover. Since the early Australian successes with molybdenum, a number of research programs have been conducted in the United States. These studies have indicated that although not as dramatic as the responses in Australia, many crops and soils in this country show a significant yield increase with molybdenum—as high as 50 percent in some cases.

The Pacific Northwest has already witnessed considerable success in commercial use of molybdenum, particularly on pear crops. New Jersey truck farmers, too, have found that a common disease known as whiptail can be readily controlled in cauliflower when treated with the element, and citrus growers have adopted it to control a troublesome leaf disease called yellow spot.

Both sides of this field were treated and contain thriving green stands. Center area untreated, crop is pale yellow.

Moly-Gro is used to treat seed before planting, rather than added to the soil as a top dressing. Readily soluble, it can be applied to seed while inoculating or slurry-treating with other compounds, for unlike the simple forms of molybdenum, such as sodium molybdate or molybdic oxide, it is completely compatible with inoculants—won't harm the essential bacteria. # # #

White Paint for Farm Buildings

Continued from page 10

black was lower than under the white shade and as much as 18 B. t. u. per hour per square foot lower than under the unpainted shade.

The same advantages were found in painting galvanized steel shades—the surface temperature was reduced as much as 50° F. by painting the upper surface white. In the tests, white painted galvanized steel shades showed an advantage over the unpainted aluminum shades.

These investigations are being continued with other building materials in order to evaluate their usefulness in protecting livestock and farm products from heat.

(T. E. Bond is Agricultural Engineer, U. S. D. A., University of California, Davis.)

(C. F. Kelly is Professor of Agricultural Engineering, University of California, Davis.)

(N. R. Ittner is Specialist in Animal Husbandry, University of California, Imperial Valley Field Station, El Centro.)

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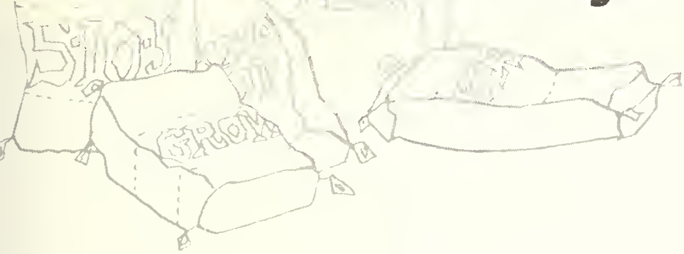
How to Choose the Right Fertilizer



Farmers generally accept the fact that the proper use of fertilizers is the key to profitable crop production. Yet, a nationwide survey made for the National Plant Food Institute showed that only 40 percent of the farmers were able to choose the proper kinds of fertilizers to correct plant food deficiencies on their crops. With farmers caught between the cost-price squeeze that's frequently aggravated by acreage restrictions, they must turn more and more toward increasing their per acre yield if they are to stay in business.

Fertilizer, alone, doesn't give the answer because the best fertilizer in the world won't be effective unless the soil is in good physical condition, is free of harmful salts, and insects, weeds, and diseases are controlled. If other growing conditions are favorable, then fertilizers can provide the extra yield that can spell the difference between profit and loss.

Fertilizers To Use

How can a farmer find out what fertilizers to use? There are several ways to do so, from talking with his neighbors to getting chemical tests made of his soils and crops. Checking with your neighbor to see what he does to get big yields can be helpful if you follow the same cropping system he does and if your soils are the same. On the other hand, it isn't a good idea to follow another farmer's practices blindly because you seldom find two farmers who do everything exactly the same.

Other sources of information are county extension agents, local Soil Conservation Service Technicians, fertilizer dealers, and the state Agricultural College. These are the people who know what has been found out about fertilizer use in their areas.

Determining the need for a particular fertilizer calls for some knowledge of the plant food content of soils and crops. There are five common ways to do that, each of which helps to pin down the particular plant nutrient that is needed. They are: (1) Crop requirement for plant food, (2) Soil type, (3) Deficiency symptoms, (4) Soil tests and (5) plant tests.

Crops differ widely in the amount of plant food they must have to give maximum yields. The accompanying table shows the plant food removed in harvesting several crops that are grown under irrigation. Knowing how much plant food a particular crop takes out of the soil, however, doesn't give all the information a farmer must have when he applies fertilizer. Soils differ in their ability to supply plant food. A soil developed from granite, for example, frequently contains more available phosphorus than one developed from limestone or sandstone. Similarly, sandy soils have less storage capacity for nutrients than do clay soils, which is why clay soils are usually "stronger" than sandy soils. Soil surveys have been made in most irrigated areas by federal and state agencies and they offer a guide to the nutrient level as well as to other limitations that are likely to be found.

Continued on page 21

by **H. E. DREGNE** *New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico.*

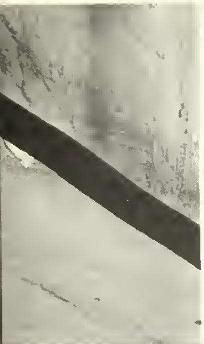
Norris Brodbury, left, Director of Los Alomos Scientific Laboratory ond Lloyd Pierson, Supervisoy Range and Archeologist ot Arches National Monument, Moab, Utah, are shown inspecting a Pueblo-type dwelling.

Many pictographs w ground. *All pho*

Exploring

Members of on orcheologicol expedition under the direction of the University of Utah are shown opprooching o cave once inhobited by Pueblo Indions.

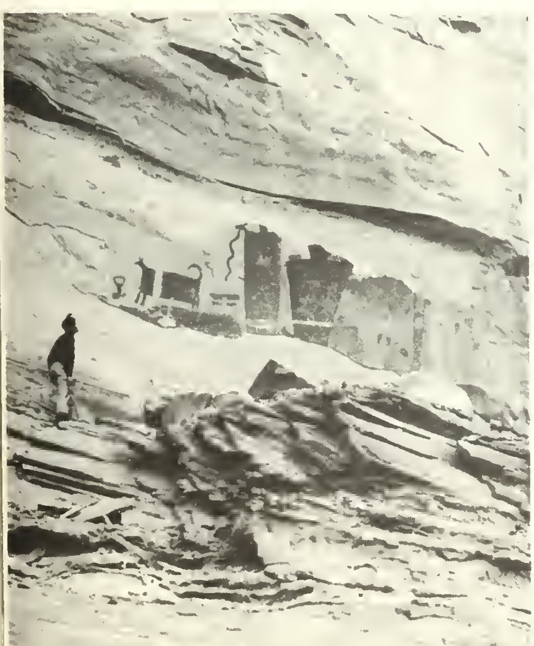
These petroglyphs ore some of the evidences of the prehistoric Indions who once inhobited the Glen Canyon oreo.



their historical back-
B. Slote, Region 4.

Typical of many of the Puebloan houses found in the Glen Canyon stretch of the Colorado River are these partial walls made of sandstone cemented with clay.

en Canyon



Shown are paintings that would probably have reached a height of fifteen feet before their partial destruction.

An entrance to one of the many side canyons off the Colorado River in the Glen Canyon stretch.

MAN-MADE RAIN

Continued from page 2

Even in normal rainfall years there are nearly always enough short dry spells in which crop production can be boosted by artificial rain at the right time. Authorities tell us that in Mississippi, a State which averages 50 inches of natural rain a year, drought has had a retarding effect on crop production in 39 out of 41 years.

Department of Interior officials say we have a lot more water resources than we realize. We get a superabundance of sky water in frequent heavy rain and flood seasons, but it runs off to sea. We are learning ways to store this moisture and ration it out through the growing season as needed. Small creeks are being dammed and lakes created so that a farmer can accumulate the water both during flood and normal flow season. Irrigation authorities say that, on the average, a farm needs a replenishing flow of 7½ gallons per minute per acre to maintain a supply at the same level.

D. S. Mitchell, Assistant Chief of the Division of Irrigation, Bureau of Reclamation, says that every section of the country can now use irrigation some time during almost every year. John Bird, former Associate Editor of Better Farming Magazine, says that over 50 million acres could be watered from existing or easily developed sources, as compared with 3 million acres already being artificially watered in humid areas.

Engineers say that water from the Mississippi, Ohio, Missouri and other large rivers could be pumped into large reservoirs spotted at strategic spots, even long distances away. Think how much water these huge streams carry off to the sea during flood seasons.

Many scientists are dreaming of a cheap process of desalting ocean water and piping its superabundance to vast areas of our country. They have already reduced the cost of desalting to an unbelievably low mark. They believe it is only a question of time when they can make it virtually as cheap as fresh water for irrigation.

In the meantime, seven times as much of our fresh water supply is going to waste as is being used. Our most immediate need is to salvage this great asset.

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# # #

Completed lining installation.

Plastic Canal Linings

Continued from page 3

ing process. The repair was made without difficulty and without delay to the work using solvents and materials furnished by the manufacturer. The manufacturer reports that field splices made in this manner can be expected to develop at least 80 percent of the tensile strength of the material.

The ease in making field splices between two sheets of the vinyl plastic film when it became necessary to patch a tear is illustrated below.

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the ERA that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

AQUATIC AND BANK WEEDS
cause concern, research, and action

ABOVE. Willows on Strawberry Highline Canal sprayed with Weedone.

Aquatic weeds which grow submerged in, floating on, or emergent from water are causing tremendous losses in irrigation and drainage canals, in ponds, lakes, and marsh lands. A closely related part of the problem is that of bank weeds which grow at the waterline or on the banks above or on wet lands in marshes. The demands of our increasing population for more water for irrigation, for potable and industrial uses, recreation, game and fish have made the problem more acute and have made us aware of its growing importance. The increasing awareness of the aquatic and bank weed problem along with the recent spectacular advances in herbicides available for evaluation have caused renewed hope that these weeds can be economically controlled and have stimulated increased research and action programs in that direction. Research has already developed a number of improved methods now in use in action programs on control of aquatic and bank weeds, and there is reason to believe that many more problems can be solved through research.

Aquatic and bank weeds cause losses of at least eight types: (1) Aquatic weeds reduce the flow of water as much as 97 percent in more extreme cases. Reduce flow causes high water levels in canals and streams resulting in (*a*) flooding, (*b*) seepage into adjoining areas or poor drainage, (*c*) breaks in canal banks, (*d*) greater water losses from evaporation, and (*e*) inadequate delivery of irrigation water to farms or inadequate drainage of water from farms. In addition, reduced velocity of flow causes increased sedimentation which reduces carrying capacity and makes more frequent mechanical cleaning necessary. (2) Floating weeds and other aquatic weeds that break loose obstruct weirs, gates, and other structures and often create flood hazards during storms. Also, algae and fragments of other submersed aquatic weeds clog sprinklers in sprinkle irrigation systems. (3) Aquatic and bank weeds provide breeding grounds for obnoxious insects such as mosquitoes. (4) They prevent economic uses of farm ponds and reduce recreational values of lakes and ponds by interfering with fishing, swimming, boating, and hunting. (5) Aquatic weeds interfere with navigation of otherwise navigable streams. (6) Decaying organic matter produced by aquatic weeds cause objectionable odors and flavors in potable water. (7) Emergent aquatic weeds and bank weeds transpire tremendous quantities of water into the air causing serious losses in areas of water shortage. (8) Bank weeds prevent the proper inspection and maintenance of irrigation and drainage canals and shorelines of reservoirs.

No overall cost figures are available on the total value of losses caused by aquatic and bank weeds or on the total costs of controlling these weeds in the United States. However, a few examples of such costs and of the extent of the problem may be sufficient to give an indication of the economic importance of waterweeds and bank weeds. Annual losses from aquatic and bank weeds on the 130,000 miles of irrigation canals and laterals in

by F. L. TIMMONS AND D. L. KLINGMAN

17 Western States totalled $25,500,000 according to a survey conducted in 1947 and 1948 by the Bureau of Reclamation. This figure probably would be considerably higher now because of increased prices for farm products and the addition of at least one million acres of new land under irrigation in the last 10 years.

Figures supplied by the United States Army Corps of Engineers show that since 1939 over $500,000 has been spent on the Potomac and Mohawk-Hudson Rivers in attempts to control water chestnut, and over $5 million has been spent in controlling water hyacinth in Florida, Alabama, and Louisiana since 1905. These figures represent only small areas, and in spite of these expenditures we still have both water chestnut and water hyacinth with us. In Arkansas, Drainage District No. 16 is spending $5,000 to $8,000 annually for mechanical control of water stargrass in about 20 miles of drainage channel. This is $250 to $400 per mile for underwater cutting, which is the method used.

The Central and Southern Florida Flood Control District, supported by Federal, State, and county funds, has a network of 500 miles of major drainage canals in which the annual operating costs for aquatic weed control exceed $50,000. In addition, about $30,000 is spent on aquatic weed control in the smaller drainage and irrigation ditches serving 15,570 square miles of agricultural land in southeastern Florida.

The Los Angeles Department of Water and Power reported the use of 135 tons of copper sulfate during the 1955 season for control of aquatic weeds in potable water supplies at a total cost of $30,000. Using their figure of $30,000 and multiplying it by the large number of cities in the United States which have aquatic weed problems in their potable water supplies would give a sizeable figure.

In 1951 there were an estimated 1,666,000 farm ponds in the United States, and the annual rate of increase was 38,000. Of these, 627,000 have been built with Soil Conservation Service technical assistance. According to Philip F. Allan, Biologist, Soil Conservation Service, Ithaca, N. Y., "Nature abhors a farm pond and sets about destroying it. Through an orderly succession of various kinds of plants—beginning with bacteria and extending through the algae, the rooted submerged aquatics, the floating plants, marsh plants, bog shrubs and swamp trees—Nature sets about converting ponds to dry land. It is man's very difficult job to prevent this occurrence or at least to slow it down."

Dead morning glory (bindweed) overhanging irrigating system.

The traditional methods of controlling aquatic and bank weeds include handcutting or pulling, and mechanical mowing, chaining, dragging, or crushing. These methods are still in use in many areas and in many situations but, with the present high labor costs of extensive weed infestations, they are too slow and expensive for extensive use. In most instances the hand and mechanical methods give only partial or temporary control. With these methods the best that irrigation or drainage districts, farmers, and others can do is fight a defensive battle against aquatic and bank weeds.

Research on control of aquatic and bank weeds has lagged considerably behind research on control of weeds on crop lands and range lands and is still only a small fraction of the research being conducted on land weeds. However, some research on aquatic and bank weeds has been under way for about 10 years and has resulted in the development of several improved control methods. Research on control of aquatic and bank weeds was begun in 1947 and 1948 by the Agricultural Research Service and the Bureau of Reclamation working cooperatively. Some research had been done before that time by a few state experiment stations.

The first improved method developed by the cooperative research was the discovery and development of aromatic solvents for the control of submersed aquatic weeds in irrigation channels. The use of these aromatic solvents or methylated hydrocarbons, consisting largely of xylene, has been increasing rapidly in the West since 1952 and totaled approximately 580,000 gallons in 1957. Based upon comparative cost figures compiled by Manager Carroll F. Wilcomb of the North Side Canal Co., Jerome, Idaho, the use of this improved chemical method throughout the Western States in 1957 resulted in a saving of $1,084,600 as compared to the cost of controlling submersed aquatic weeds by the previously used mechanical methods. Also, the weed control provided by aromatic solvents was much superior to that by mechanical methods and resulted in reduced crop losses from inadequate irrigation, water losses, and other causes. Directions for using aromatic solvents for controlling submersed aquatic weeds in irrigation systems are given in USDA Circular 971.

Aromatic solvents in mixture with gasoline and heavy chlorinated benzenes are also being used successfully for control of submersed aquatic weeds in water control canals in Florida. The recommendations for this use are given in Florida Agricultural Experiment Station Circular S–97.

effective in controlling cattail. While these herbicides are more expensive than 2,4-D ester in oil-water emulsion, this disadvantage is offset, at least in part, by three distinct advantages: (1) dalapon and amitrol are effective in low volumes of 12 to as low as 5 gallons of water per acre and therefore may be applied by airplane, whereas 2,4-D is effective only when applied in high volumes of 150 gallons per acre or more by ground equipment. (2) Dalapon and amitrol involve less hazard of spray drift and volatile fumes onto sensitive crops, and (3) one spray application per growing season usually will give as good control of cattail as two repeated applications of 2,4-D in oil-water emulsion.

One of the best examples of the benefits from improved methods to a total program of controlling aquatic and ditchbank weeds is provided by the Imperial Irrigation District of Southern Cali-

Left, Sego Pond Weed infestation in the Irish-American Canal, Humboldt project. Center, water treated with blanket of Beneclor. Right, Sego Pond Weed has disappeared to some extent and remaining weed is lifeless.

Another improved method developed by the cooperative research between the Agricultural Research Service and the Bureau of Reclamation is the control of cattail by spraying with 4 to 6 pounds per acre of a low volatile ester of 2,4-D and a 1 to 20 oil-water emulsion (1 gallon of diesel oil to 20 gallons of water) using a total volume of 150 to 300 gallons of emulsion per acre of cattail. The first spraying should be done just before cattail heads appear and retreatments made as necessary, usually about three applications over a 2-year period for complete elimination. Cost figures reported by Bureau of Reclamation irrigation projects show that the costs of eliminating cattail by this method range from $24.12 to $43.42 per mile of canal as compared to costs of $407 to $418 per mile for draglining, the most common mechanical method of controlling cattail.

More recently, research has shown that dalapon (2,2-Dichloropropionic acid) and amitrol (3-amino-1,2,4-triazole), alone or in combination, are

fornia. This District has 3,100 miles of canals and drain channels which irrigate and drain approximately 400,000 acres of land. During the 5-year period, 1945–49, inclusive, when burning with oil burners was the only available method of control, the Imperial District spent $1,318,000 on weed control. The operation was confined to the inside channels, but it was still necessary to burn an average total of 22,000 acre-miles of ditchbanks each year, because of the frequency of burning required, and to chain or hand clean submersed aquatic weeds in many hundreds of miles of channel. During the next 5-year period, the Imperial Irrigation District gradually adopted improved chemical methods which consisted of spraying with 2,4-D, with contact oils, TCA (sodium trichloroacetate), and dalapon for control of bank weeds and treating with aromatic solvents for control of submersed water weeds. During 1955–57, the District was able to extend its improved chemical methods to begin the successful eradication of several serious weed problems that had resisted all control efforts before. The District sprayed an average of 4,920 acre-miles of cattail and woody growth with 2,4-D-TCA mixture and sprayed 3,729 miles of phragmites with dalapon. In 1957 only 602 acre-miles of ditchbank were burned as compared with 6,500 acre-miles in 1955 and 22,000 acre-miles per year during 1945–49. Mr. Oscar L. Fudge, superintendent of the Imperial Irrigation District, stated that the improved chemical methods made it possible for the District to change from a defensive program to an offensive control program and to make important gains in eliminating aquatic and ditchbank weeds at very little increase in cost despite rising prices.

Copper sulfate has long been used as an algicide for the control of algae. Recent research and experience by the Bureau of Reclamation and the Los Angeles Water and Power Department show that a continuous feed application or frequently repeated applications of copper sulfate for control of algae also controlled or inhibited the growth of rooted submersed species. The chief disadvantage of copper sulfate is that it is toxic to most species of fish at concentrations above 1 p. p. m. The maximum tolerance limit of fish and the minimum concentration necessary for control of algae are too close together for extensive use of copper sulfate in ponds and lakes where saving the fish has top priority.

Treatment with sodium arsenite solution at 4–10 p. p. m. concentration of arsenious oxide (As_2O_3) has been widely used for many years to control submersed weeds in lakes and ponds. Most species of fish will tolerate up to 11 or 12 p. p. m. of arsenious oxide without injury, which permits the removal of aquatic weeds from ponds and lakes without serious loss of fish. The chief disadvantage of sodium arsenite is its toxicity to humans and warm blooded animals and the consequent necessity for extreme care in applying and handling this chemical. Publications giving directions for the use of sodium arsenite in the control of aquatic weeds are available and should be closely followed.

In recent years the research departments of several manufacturers of herbicides have diverted part of their attention from herbicides for land weeds to the development and screening of chemical compounds for aquatic weed control. Because of this shift in interest, more than 20 new herbicides now show definite promise for control of aquatic weeds, and many more compounds are being evaluated by commercial and public research agencies.

Treating aquatic weeds by admitting a commercial weed killer within a Parshall flume.

The development of promising new aquatic herbicides and the increased public awareness of the serious aquatic weed problem in lakes and ponds has resulted in expanded action and research programs on control of these weeds by State departments of conservation and fish and game. Some of the States that have been most active in this field are New Jersey, Wisconsin, New York, Oregon, Massachusetts, and California. State experiment stations in Alabama, Michigan, Oregon, California, and other States have active research programs under way. The United States Fish and Wildlife Service and the Soil Conservation Service also have extensive action programs and are conducting research on the control of aquatic and bank weeds.

In 1957, Congress made funds available for a considerable expansion in research on control of aquatic and ditchbank weeds by the United States Department of Agriculture, Agricultural Research Service. Existing research programs in Montana, Washington, and Wyoming were enlarged. New research projects were begun in Arkansas and Florida in cooperation with the State experiment stations, the Central and Southern Florida Flood Control District, and other agencies. The cooperative research program between the Agricultural Research Service and the Bureau of Reclamation at Denver, Colo., was reactivated and enlarged to comprise four research

Continued on page 27

V. H. Gledhill, New Mexico A & M College, is using a photoelectric colorimeter to determine phosphorus in soils.

How to Choose the Right Fertilizer

Continued from page 13

Deficiency Symptoms

Deficiency symptoms, such as yellowing of leaves (nitrogen deficiency) and purpling in corn blades (phosphorus deficiency), show that a crop is suffering from a lack of adequate nutrients. Unfortunately, fertilizing on the basis of deficiency symptoms is like locking the barn door after the horse is stolen: by the time the deficiency symptoms show up, yields are already hurt. In most cases, fertilizing then won't bring the yields back up to where they would have been if the crop had been adequately fertilized all along. The symptoms do prove, though, that the kind or amount of fertilizer used wasn't right for that crop and soil, and a change will have to be made.

Soil tests are the best method we have to determine, before a crop is planted, what nutrients are likely to be deficient. They also tell whether the soil contains excess salt, which is a major problem in irrigated areas. If there is too much salt, fertilizers won't be effective no matter how much is applied. Helpful though they may be, soil tests are not perfect for predicting probable response to fertilizer because climatic conditions, for one thing, vary from year to year and have a direct effect on crop yields. They can be, however, a good tool in deciding what fertilizer to use and how much to apply, if the soil samples are taken carefully.

Plant tests tell what a plant is actually getting from the soil, in contrast to soil tests, which tell what the soil is capable of supplying. The plant, itself, is the best indicator of whether the present fertilizer program is adequate or inadequate. There is sometimes a big difference between the amount of plant food in the soil and the amount a crop takes out. This is especially true with nitrogen, whose availability depends heavily on climatic conditions during the growing season. Plant testing, if properly done, has the big advantage of letting the farmer know of a nutrient deficiency or excess before symptoms show up, while there's still time to do something about it.

Testing Plants

Taking a plant sample for testing is much more difficult than taking a soil sample. One reason is

Effect of nitrogen and phosphorus on growth of cotton.

Effect of nitrogen on size of heads of sorghum.

that it's important to know what part of the plant is the best indicator of its nutrient status. With sugar beets, the petiole is preferred for nutrient tests; for alfalfa, the entire top growth is taken; in cotton, the first mature leaf is the best part of the plant to sample. Another reason is that time of sampling is important if maximum benefit is to be gotten from the plant test. Nutrient deficiencies are most likely to occur when the crop is growing rapidly and needs large amounts of plant food. Soils may be able to supply enough nutrients when the crop is growing slowly but may be unable to keep us with a fast growing crop. Plant tests can show whether a deficiency is likely to appear.

After talking things over with his neighbors and agricultural advisors, and after having soil and plant tests made, the farmer decides what fertilizer to buy. Then he wants to know how much good it does, if any. That brings us to the final step: applying the fertilizer to all but a small strip through the middle of the field. Comparing yields on the fertilized part of the field with the unfertilized part will prove whether the fertilizer was effective. Don't think that the fertilizer wasn't any good just because you can't see any obvious difference between the two parts of the field. Most people can't pick out yield differences in cotton, for example, unless one crop is at least 25 percent better than another. And a 25 percent yield increase can make fertilizing a highly profitable practice.

Effect of nitrogen and phosphorus on growth of tomatoes.

*Plant food composition of crops**

Crop	Yield	Plant food, pounds per acre—		
		Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Alfalfa	3 tons	140	35	135
Corn	60 bushels	95	35	70
Cotton	1 bale (lint)	65	25	50
Potatoes (Irish)	180 sacks	125	35	170
Sugar beets	15 tons	115	45	145
Wheat	30 bushels	50	20	30

*Table shows pounds of plant food in entire plant when acre yield is as listed in column 2.

Painting "Cyclone" Type Fencing

The Consumers Power Co., Saginaw, Mich., has developed a new technique in the maintenance of "cyclone" type fencing used to protect many structures, including substations, pumping plants, material yards and other facilities.

Periodic painting and maintenance of this type of fencing material is often neglected because ordinary methods using hand brushes or spray equipment are time consuming and costly. The power company uses ordinary sweeper's brooms as applicators and report the method to be fast and thorough and economical.

The Columbia Basin Project

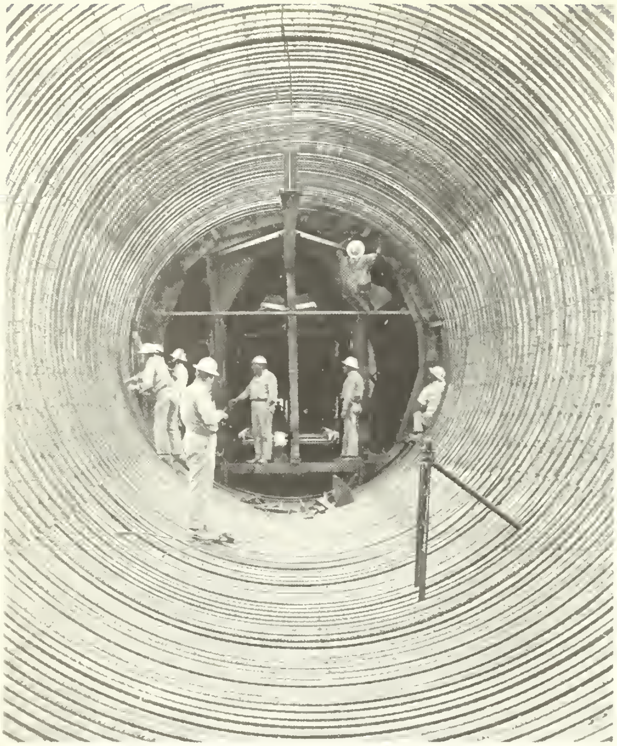
Grand Coulee Dam viewed from the north bank of the Columbia River.

The Columbia Basin Project in Eastern Washington, began in 1933 when work got under way on Grand Coulee Dam on the Columbia River. By 1942 the dam was completed and still stands as the largest man-made concrete structure in the western hemisphere. From its 18 gigantic generators power now flows to farm and city homes, to businesses, and to industrial plants within a radius of 700 miles. Development of this natural resource has broadened the economy of the whole Pacific Northwest.

After World War II, work started on the canals and laterals that will eventually carry water to a million acres of arable land in Central Washington. In 1948, irrigation water was made available to 5,400 acres in the south end of the project near Pasco, Wash. However, it was not until 1952 that the project's irrigation program got into full swing. In 1952, and in each succeeding year, water has been made available to areas varying from 34,000 to 66,000 acres in size. All the lands involved were previously used for grazing or dry-land farming. By 1958 water was available for over 380,000 acres.

The first boost in the economy of the area came from construction activity. This stimulus is being replaced by one based on expansion of the irrigated farming area. A part of the project's contribution to local, regional, and national economies is in the form of returns from processing and sale of commodities produced in the irrigated area.

Usually the initial processing functions are carried on in the local area where farm commodities are produced. They promote community growth, account for increased local earnings and add to the wealth of the area. The importance of this



Workman inside the Wahluke Siphon now under construction.

trade creating aspect of Reclamation development is frequently overlooked.

Rising out of a semi-arid range and wheat country, the Columbia Basin project brought a need for services and facilities that the scattered grain elevators and livestock market outlets could not provide.

To better understand just how much of a change there has been in the Basin, one should go back about 60 years in the history of the area. Until the rush of homesteaders started at the turn of the century, there had been few settlers in the Basin and most of the land was used for grazing. The homesteaders flocked in and established dryland farms which were successful for a short time. However, intensive cultivation soon lowered the water level in the soil and farmers were forced to rely on rainfall to grow their crops. This source proved to be too scant and most of it came at the wrong time of the year.

Many who stood and watched the first trickle of irrigation water flow to the south could remember the early days when they fought what seemed to be an almost hopeless fight. They thought of the disappointments and the bitterness, of the small elations, and of the constant and exacting hard work required to win this victory.

The project was planned as a family-type development, designed to provide a farm which would yield a living for one family.

The average farm unit on the project is just under 80 acres but there is variation in the individual units. The size depends on the class of land. Those with the best land are smaller than those which have poorer land. This way of laying out the units was adopted so that with all things equal the potential income of each farm would be relatively equal.

When the first modern day settlers came to the Columbia Basin Irrigation project, the land was a raw, desert waste. Sagebrush and rocks and cheat grass, bisected by the raw earth of new canals, was the picture confronting the settler.

Most of the settlers came from the Northwest and West to settle on the project. More than half of them lived in Washington and two-thirds of these in South Central Washington. Almost a third came from Idaho, Oregon, and Montana, and the remaining western states account for another 10 percent. The remainer of about 10 percent came from other parts of the nation and from foreign countries.

About half of the settlers are United States Service veterans but only one in four bought his farm under veteran's preference. There is a requirement under veterans' preference that a settler must have minimum assets of $5,500 but most of them arrived on the project with more than that—the medium figure is about $14,000.

And why did the settler come to the Basin? There are many reasons. Most of those who came from a nonfarm job said they preferred farm work and rural living. Those who had been farming

Grain sorghum production is increasing in the project area.

elsewhere said they felt the project offered them more opportunity. A great many of them came because it gave them a chance to develop a better farm.

A new and enlarging base of irrigated agriculture induces investments and employment. Producers goods and services are needed by farmers to grow crops and livestock as it is by those who process products sold by a farmer. Additional consumer goods and services are needed by the farmers and the processors as well as those who supply them. The mutual interdependence of those supplying the needs of one group and in turn demanding the supplies and services of another have put in motion an economic cycle that reflects itself in increased employment. Such has been the pattern in the Columbia Basin project area.

An upward surge in industrial employment has been experienced in the Columbia Basin project area since the start of irrigation.

Since 1950, local marketing facilities have changed considerably. Dryland grains no longer dominate the project area, having been replaced by other crops and livestock produced on the rapidly expanding irrigated acreage. Nowhere has this change been expressed more clearly than in the expansion of marketing facilities in the area. From 1952 to 1957 about 17 million dollars were invested in 64 processing and marketing plants to handle farm products of the Columbia Basin project. Moreover, four score livestock feeders have

Processing plant handling onion crop from new lands.

found this area a desirable place to finish cattle and sheep.

While the network of primary and secondary roads is very necessary in development of the area as part of our economic life, it represents only part of the transportation picture. All types of commercial transportation serve the area.

Livestock promises to be an outlet for a large percentage of the cereal and forage crops grown on the project. It is expected that eventually these crops will occupy about 70 percent of the total croped acreage. During the first few years under irrigation of their farms, farmers have leaned heavily on cash crop production, but a trend toward forage and cereal production for livestock is underway.

Air and water transportation meet on Lake Roosevelt.

This church is typical of the many new churches in the Columbia Basin Project.

Postal receipts correlate highly with general business conditions. Increase in economic activity resulting from the growth of basic industries has reflected itself in a rapid rise in retail sales in the Columbia Basin project area.

Irrigation development has established a new and broader economic foundation and in so doing has enticed people into the area. This means increased investments.

The Columbia Basin project has received attention from private investors during the last decade. Some have started small construction and manufacturing firms; some opened local real estate and insurance businesses; others established specialty shops, motels, or law offices. For every 10 establishments in existence in 1948 in the Columbia Basin project area, there are now 18. This figure does not include the many new businesses which are operated by owners without paid employees.

Fishing, hunting, camping, and all types of water sports are rapidly becoming an important part of the life and economy of the Columbia Basin.

As an example, on opening day of the lake fishing season, April 22, 1956, there were 23,750 fishermen trying their luck in lakes of the Columbia Basin project area. They took 190,000 fish that day.

However, fishing and water sports are not the only forms of recreation benefiting from introduction of water to the area. Family camping has also taken a big upswing in the area. Vacationers who once saw the Basin only when passing through are now spending all or part of their vacations in the area.

The hunter finds more game here each year and the area produces some of the best waterfowl shooting in the Northwest. # # #

4,000 miles of canals and laterals will be necessary to deliver irrigation water to a million acres of arid land.

Aquatic Weeds

Continued from page 20

scientists working on greenhouse and laboratory evaluation of aquatic herbicides, on physiological and ecological factors affecting aquatic weeds and on the improvement of research and application techniques. The Agricultural Research Service has made contract research funds available to the Alabama Agricultural Experiment Station for screening of a large number of chemical compounds for effectiveness on aquatic weeds and for tolerance of fish. All aspects of this expanded program are coordinated and integrated with research being done by other agencies to provide the most effective total program in developing improved methods of control.

Many problems on control of aquatic and bank weeds remain to be solved. We need more effective and less expensive methods for controlling submersed aquatic weeds in irrigation canals, especially in large canals with capacities above 100 c. f. s., including those up to 1,000 and even 4,500 c. f. s. in California and Washington where serious aquatic weed problems have developed recently. We need safer and more lasting methods of controlling algae and other submersed aquatic weeds in ponds and lakes. We need less expensive and more effective chemical methods for control of cattail, sedges, rushes, and other rank-growing emergent aquatic and bank weeds. We have promising leads for answering many of these needs, and it seems logical to predict that many improved methods of controlling aquatic and bank weeds will be developed by research in the next few years. # # #

Reprinted from Soil Conservation, Dec. 1958

BOOKS

U. S. D. A. Yearbook Published

The 1958 yearbook of Agriculture en-tled *Land* is now off the press. The earbook gives comprehensive coverage the land resources of the Nation th an intent to engender better un-rstanding and appreciation of our ritage of productive lands and to fos-r serious consideration as to the land quirements of coming generations.

The yearbook's many stimulating ticles were prepared by recognized thorities in the land resource field. e consensus is universally expressed the yearbook's contributors on the ed for improved land resource plan-ng and utilization to ensure adequate ace for food and fiber supplies before r rapidly expanding requirements lipse the foreseeable capacity of our atively fixed supply of land.

Chief of the Bureau's Irrigation Di-vion, William I. Palmer, coauthored e of the yearbook articles, *Some new s for irrigation*. John B. Bennett, rector of the Technical Review Staff, partment of Interior, was a member the yearbook committee and collabo-ted in the preparation of two articles rarding public land. Other contrib-ng authors from the Department of terior were H. R. Hochmuth and Karl L. Landstrom, Bureau of Land nagement, and Robert K. Coote and W. Goding, Technical Review Staff.

The publication is for sale by the perintendent of Documents, Wash-ton 25, D. C., at $2.25 per copy.

SOIL-PLANT RELATIONSHIPS by C. A. Black

JOHN WILEY & SONS, INC., NEW YORK

In this book will be found a thorough analysis of some of the major soil-plant relationships. It has been designed to give an overall understanding of these relationships which can be applied in analyzing and interpreting specific situations. To minimize geographical limitations, general principles and concepts have been stressed and applications are referred to only in the form of examples.

Throughout, the author has emphasized soils as a substrate for plant growth. He sets forth the pertinent facts and ideas about soil properties and behavior but minimizes technical details. Using soils as the point of departure, Dr. Black has been remarkably successful in integrating the properties of soils with the responses of plants—establishing a stronger link between these factors than can be found in any other work of this kind.

LETTERS

Reprint Request

Dear Sirs: We think the article on handicapped employees of your bureau and how they are leading productive lives is most stimulating. We think it is an excellent example that all governmental agencies might well emulate.

We maintain constant liaison with Governor's Committees on the employment of the handicapped in all the States and Territories. We would like very much to make a national distribution of the article in the November issue of your magazine. Would it be possible for you to supply us with reprints as you did last year?

Your continuing cooperation is deeply appreciated by our committee.

Cordially,

Melvin J. Maas,
Chairman, the President's Committee on Employment of the Physically Handicapped, Washington 25, D. C.

We were pleased to make the reprints available.—Ed.

Highway in the Sky

Dear Sirs: I am editor of the Las Vegas Scene, a weekly tabloid supplement to the Sunday Sun newspaper. I have had the pleasure of reading one of your feature stories—"Highway in the Sky," in the Reclamation Era. It would make excellent general reading material for residents of Southern Nevada, who are quite interested in the progress of the new Glen Canyon Dam.

Whenever you have features of interest to Nevadans, I would be pleased to reprint them in the Scene magazine.

Looking forward to future cooperation with your department, I remain,

Cordially yours,

Bob Warren,
Editor of Scene.

Reprint permission gladly granted.—Ed.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5047	Crooked River, Oreg	Oct. 14	Construction of Prineville Dam	Keystone Construction Co., Inc., and Associates, Prineville, Oreg.	$2,614,944
DC-5086	Columbia Basin, Wash	Oct. 10	Construction of earthwork, concrete canal lining, and structures for Wahluke Branch canal.	George W. Lewis and Thompson Construction Co., Kennewick, Wash.	234,316
DC-5089	Missouri River Basin, Nebr.	Nov. 10	Construction of earthwork and structures for Culvertson canal, laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	427,450
DS-5092	Fort Peck, Mont	Oct. 29	Three 20,000-kilovolt-ampere autotransformers for Dawson County substation.	American Elin Corporation, New York, N. Y.	289,515
DC-5093	Columbia Basin, Wash	Nov. 6	Construction of earthwork and structures for Block 82 laterals, wasteways, and drains, Royal Branch canal laterals.	Cherf Brothers, Inc., Sandkay Contractors, Inc., and Pheiffer & Pontius, Ephrata, Wash.	1,215,273
DC-5097	Central Valley, Calif	Oct. 21	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County road, Rush Creek to Stoney Creek.	O. K. Mittry & Sons, Gardena, Calif.	1,321,341
DC-5100	Washita Basin, Okla	Oct. 17	Construction of Foss Dam	Wunderlich Contracting Co., Palo Alto, Calif.	7,351,557
DC-5101	Missouri River Basin, Nebr.	Nov. 10	Construction of spillways, wasteways, and siphons for Culbertson canal.	Doolittle Construction, Inc., Wichita, Kans.	447,98
DC-5102	Middle Rio Grande, N. Mex.	Oct. 14	Channelization of the Rio Grande, Albuquerque Area	Jackson Construction Co., Rocky Ford, Colo.	204,397
DS-5103	Washita Basin, Okla	Oct. 21	Four 6-foot by 7-foot 6-inch high-pressure gate valves for river outlet works at Foss Dam.	Hardie-Tynes Mfg. Co., Birmingham, Ala.	103,500
DC-5104	Collbran, Colo	Nov. 7	Construction of Southside tunnel with 6-foot 3-inch diameter horseshoe section, schedule 1.	Theo Wood Construction Co., Salt Lake City, Utah.	344,468
DC-5113	Missouri River Basin, Nebr.-Kans.	Nov. 18	Construction of earthwork and structures for White Rock canal, and laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	273,270
DC-5114	Central Valley, Calif	Nov. 26	Construction of railroad and highway siphon for Corning canal	E-W Construction Co., Eugene, Oreg.	133,507
DC-5115	Colorado River Storage, Ariz.-Utah.	Dec. 4	Construction of administration building; and garage, fire station, and police building for Page, Ariz.	Sierra Construction Corporation, Las Vegas, Nev.	334,546
100C-350	Yakima, Wash	Nov. 26	Supplemental construction for Kennewick Main canal	L. D. Shilling Co., Inc., Moses Lake, Wash.	118,802
200C-392	Central Valley, Calif	Oct. 2	Clearing 4,855 acres of Trinity Reservoir site, Stuart Fork area and downstream to Trinity Dam.	Union Construction Co., Inc., Missoula, Mont.	906,915

Water is Wealth

U. S. GOVERNMENT PRINTING OFFICE: 1959 O—491307

Construction and Materials for Which Bids Will Be Requested Through March 1959*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	One 115,000-hp., 180-r. p. m., 480-foot-head, vertical-shaft, Francis-type turbine with pressure regulator, for Hoover powerplant, Unit N-8.
Do	One 100,000-kv.-a., 16,500-volt, 3-phase, 180-r. p. m., vertical-shaft, hydraulic-driven generator for Hoover powerplant, Unit N-8.
Do	One 168-inch butterfly valve for Hoover powerplant. Estimated weight: 450,000 pounds.
Central Valley, Calif.	Constructing indoor-type Corning canal pumping plant, intake channel, outlet structure, and switchyard, and furnishing and placing 750 feet each of 36- and 60-inch concrete discharge pipe, southeast of Red Bluff.
Do	Constructing about 6 miles of bituminous surface treatment road from Ridgeville to Covington Mill, about 55 miles northwest of Redding.
Central Utah, Utah.	Constructing the 140-foot-high Stanaker Dam, containing about 1,900,000 cubic yards of material, with a crest length of 1,900 feet, and appurtenant structures. On Stanaker Draw, north of Vernal.
Collbran, Colo.	Constructing about 22 miles of earth lined and unlined canal with bottom widths varying from 16 to 10 feet, and 6 precast concrete pipe siphons, near Collbran.
Do	One 11,700-hp., 600-r. p. m., 2,430-foot-head, horizontal-shaft, impulse-type hydraulic turbine with governor, shut-off valve, and separate bypass valve for Upper Molina powerplant; and one 6,400-hp., 450-r. p. m., 1,328-foot-head, horizontal-shaft, impulse-type hydraulic turbine with governor and shutoff valve for Lower Molina powerplant.
Do	Constructing 2 powerplants with switchyards, 7 miles of plate-steel pipe penstocks, and an equalizing reservoir, about 40 miles east of Grand Junction.
Colorado River Front Work and Levee System, Ariz.	Constructing about 3 miles of open ditch drain and about 2 miles of 24-inch-diameter precast concrete pipe closed drain, near Yuma.
Columbia Basin, Wash.	Constructing the indoor-type Sand Hollow pumping plant, and concrete outlet transition, and furnishing and placing about 700 feet of 66-inch inside-diameter concrete discharge pipe, northeast of Beverly.
Do	Constructing about 1 mile of concrete-lined lateral, 8 miles of unlined laterals, a concrete pipe siphon and 2 small outdoor-type pumping plants, Block 201, near Mesa.
Do	Gravel surfacing about 42 miles of operating roads, Blocks 85 and 86, near Royal City.
Do	Constructing about 11.5 miles of concrete-lined laterals with bottom widths varying from 8 to 2 feet, in Blocks 21 and 48, near Taunton.
Fort Peck, Mont.	Constructing radio relay stations at Makoshika, near Glendive; Sioux Pass, northwest of Sidney; and Sentinel Butte, east of Glendive.
Little Wood River, Idaho, and Crooked River, Oreg.	Six 4- by 6-foot high-pressure gate valves with hydraulic hoists, two for Little Wood River Dam and 4 for Prineville Dam. Total estimated weight: 216,000 pounds.
MRB, Colo.	Reconductoring about 24 miles of the Flatiron-Greeley, 115-kv., wood-pile transmission line, from Flatiron switchyard near Loveland to a point about 6 miles west of Greeley.
MRB, Kans.	Constructing about 9 miles of 8- and 6-foot bottom width White Rock Extension Canal, including a 2-mile-long, 42-inch pipe siphon crossing the Republican River, and about 7 miles of 3-foot bottom width laterals, near Republic.
MRB, Minn.	Constructing radio relay stations near Erhard and Morris.
MRB, Mont.	Constructing about 45 miles of open ditch laterals and about 20 miles of open and closed drains. Helena Valley Unit, near Helena.
MRB, Nebr.	Constructing the Merritt Dam, an earthfill structure 120 feet high, 3,100 feet long, and containing about 1,500,000 cubic yards of material, and appurtenant structures, about 25 miles southwest of Valentine.
Do	Constructing about 15 miles of 20-foot bottom width Culbertson Canal, near Culbertson.
Do	Constructing about 25 miles of bituminous surface soil cement access road to Merritt Dam site, southwest of Valentine.
Do	One 5-foot by 6-foot, two 4-foot by 4-foot, and two 2-foot 9-inch by 2-foot 9-inch high-pressure gate valves each with a hydraulic hoist for Merritt Dam. Total estimated weight: 183,000 pounds.
MRB, N. Dak.	Furnishing and stringing three 795,000 CM ACSR conductors and two 0.5-inch-diameter steel overhead ground wires for the 165-mile, single-circuit, steel-tower Fargo-Granite Falls 230-kv. transmission line.
MRB, S. Dak.	Modifying the Shadehill Dam outlet works stilling basin and constructing a concrete drop structure. On the Grand River about 15 miles south of Lemmon.
MRB, Wyo.	Constructing the Gray Reef Dam, an earthfill structure 30 feet high and 800 feet long at the crest, and a concrete-gated spillway. About 2.5 miles downstream from Alcova Dam.
Do	Constructing about 142 miles of 115-kv. wood-pole transmission line from Kortes switchyard, about 35 miles northeast of Rawlins, to Cheyenne substation.
Do	Constructing about 35 miles of 115-kv. wood-pole transmission line from Boysen switchyard to Pilot Butte switchyard, within 40 miles of Riverton.
Do	Completing the Fremont Canyon powerplant and switchyard and extending the Alcova-Fremont 115-kv. transmission line. Forty miles southwest of Casper.
Do	Constructing the Guernsey Rural substation, south of Guernsey.
Paonia, Colo.; Rogue River Basin, Oreg.; Washita Basin, Okla.	Twelve high-pressure gate valves with hydraulic hoists as follows: four 2-foot 9-inch by 2-foot 9-inch for Foss Dam; one 3-foot 6-inch by 3-foot 6-inch, two 2-foot 9-inch by 2-foot 9-inch, and one 2-foot 3-inch by 2-foot 3-inch for Emigrant Dam enlargement; four 2-foot 9-inch by 2-foot 9-inch for Paonia Dam. Total estimated weight: 198,500 pounds.
Weber Basin, Utah.	Constructing the second phase of Willard Dam, an earthfill structure 20 feet high, 15 miles long, and containing about 10,000,000 cubic yards of material. At Willard Bay 11 miles northwest of Ogden.
Do	Constructing 980 linear feet of 12-inch and 2,500 linear feet of 27-inch precast concrete pipelines connecting to the Davis Aqueduct and 2 reinforced concrete stream inlet structures, near Salt Lake City.
Do	Constructing about 1.1 miles of road and 0.6 mile of irrigation ditch, clearing the reservoir area, and fencing about 2 miles. Willard reservoir, about 11 miles northwest of Ogden.

*Subject to change

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The Reclamation Era

MAY 1959

IN THIS ISSUE:

New Commissioner of Reclamation

Recreation at Canyon Ferry

Official Publication of the Bureau of Reclamation

The Reclamation Era

MAY 1959 Volume 45 No. 2

In this issue . . .

J. J. McCARTHY, Editor

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington 25, D. C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, March 3, 1958.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents (single copy). Subscription Price. 50 cents per year; 25 cents additional for foreign mailing.

W. A. DEXHEIMER

FLOYD E. DOMINY

NEW COMMISSIONER OF RECLAMATION

Appointment of Floyd E. Dominy as Commis-oner of Reclamation, effective May 1, was nounced by the White House on April 3. Presi-nt Dwight D. Eisenhower appointed Mr. ominy to succeed W. A. Dexheimer, whose resig-tion as Commissioner the President accepted th regret.

Mr. Dexheimer, who had served as Commis-ner since 1953, had completed 30 years of Fed-l service—chiefly with the Bureau of Reclama-n.

Mr. Dominy, who has been with the Bureau 13 rs, had served as Associate Commissioner of clamation since March 1958. Prior to that he d been an Assistant Commissioner primarily ponsible for Bureau legislative affairs and ief of the Bureau's Division of Irrigation.

The President, in accepting Mr. Dexheimer's ignation, wrote:

ear Commissioner Dexheimer:

As you have requested, I am accepting your gnation as Commissioner of Reclamation, effec- May first. I regret, however, that personal siderations cause you to leave government serv- at this time, particularly in view of how well you have carried forward the traditions of the Reclamation program.

"The care and development of our natural resources require, on the part of responsible officials, a high dedication such as yours to principles of wise use and prevention of waste. Through your participation in the planning and construction of water resource projects over the past thirty years, you have made a significant contribution to the public good, of which you should be very proud. Your tenure as Commissioner of Reclamation has been the climax of a truly noteworthy career in public service.

"With best wishes for your continued success and happiness."

With his resignation, Mr. Dexheimer submitted to the President a summary statement of the accomplishments of the Bureau since 1953—when Mr. Dexheimer was appointed Commissioner by President Eisenhower. This summary showed that 53 projects or units had been authorized since July 1, 1953, at a total estimated cost of $1,434,151,773. Combined, these features will have storage capacity of 41,533,400 acre-feet, will irri-

Continued on page 38

economical drop structures halt canal erosion

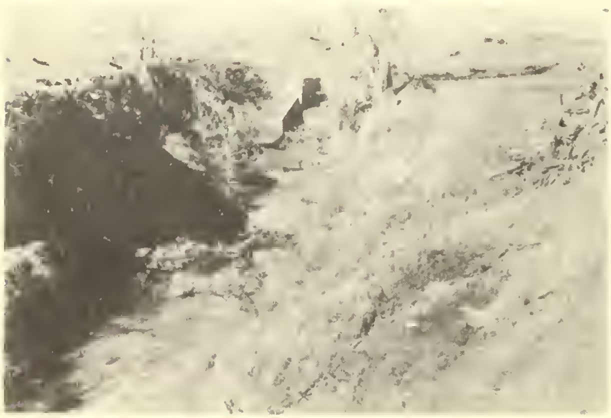
by
THEODORE T. WILLIAMS [1]
DEAN F. PETERSON, JR. [2]

Prevention of further scour and the rehabilitation of a badly eroded irrigation channel was the subject of an investigation completed recently at Colorado State University. Results of the study indicate that bed erosion has been halted in this canal at relatively low cost by the installation of concrete drop structures.

The three-mile-long outlet channel from Thompson Storage Reservoir east of Fort Collins, Colo., having a maximum discharge of 250 cfs, was put in use 60 years ago. Excessive erosion occurred since the channel, which was constructed in alluvial material, had a drop in elevation of 75 feet. The result, by the spring of 1955, was an impressive canyon having a width ranging up to 100 feet, and depth up to 30 feet.

In 1955, although the downstream part of the channel had become fairly stable, the first mile still had a fall of 15 feet. Another 15 feet of fall was absorbed by an old drop structure which had been installed many years ago to protect the reservoir outlet works. This structure, which h been extended and repaired many times, h fallen into a serious state of disrepair, was be undermined, and had reached the point of im nent failure. Erosion of the channel, which w responsible for the loss of considerable irriga crop land, was aggravated by runoff from s rounding fields, and by a high water table wh kept the steep banks saturated to a considera height. The extent of erosion in the upper re of the channel is indicated in figure 1, which i view looking upstream at the old drop structu and figure 2, taken from the same point, look downstream. For comparison, figure 3 is a v of the stable lower reach.

Figure 1.—View of Thompson Lake Outlet Channel, looking upstream at the old drop structure, before 1955 construction program. Channel at this location is 30 feet deep and 100 feet wide.



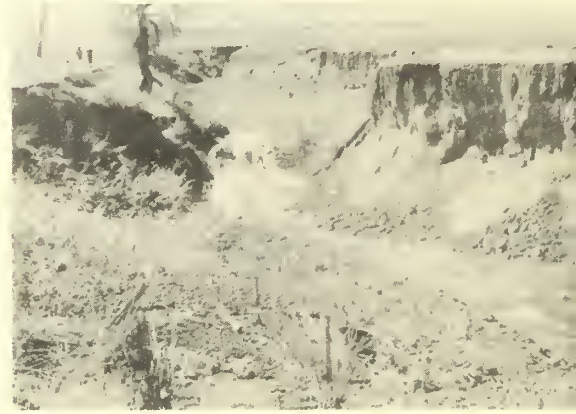


Figure 2.—View of Outlet Channel before 1955 construction gram. This view was taken from the same point as photog on left.

To reduce further erosion of valuable fa land, as well as to protect the reservoir ou works against undermining, an extensive constr tion program was instituted in the spring of 19 The existing drop structure was replaced b reinforced concrete chute, equipped with a 10-f ogee crest and modified Saint Anthony Fa stilling basin. This structure, which drops

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igure 3.—View of lower reach of Outlet Channel. A series of rop structures installed many years ago has maintained this reach a stable condition.

Figure 4.—View of new concrete chute installed spring of 1955. This structure replaced the old drop. The discharge of 125 cfs is one-half the design discharge.

vater 13½ feet, is shown in operation in figure 4.

Three vertical overfall drop structures, spaced bout 1,300 feet apart, were installed downstream rom the chute. Each of these structures consists f a breast wall with 20-foot crest. Vertical, parllel sidewalls extend downstream from the crest a distance of eight feet, and terminate in downstream wingwalls placed at an angle of 45° with the axis of the structure.

Utilizing results of laboratory research investigations at Colorado State University, the overfall drop structures were designed to be equipped with gravel-riprapped or "armorplated" scour holes, rather than with the conventional concrete stilling

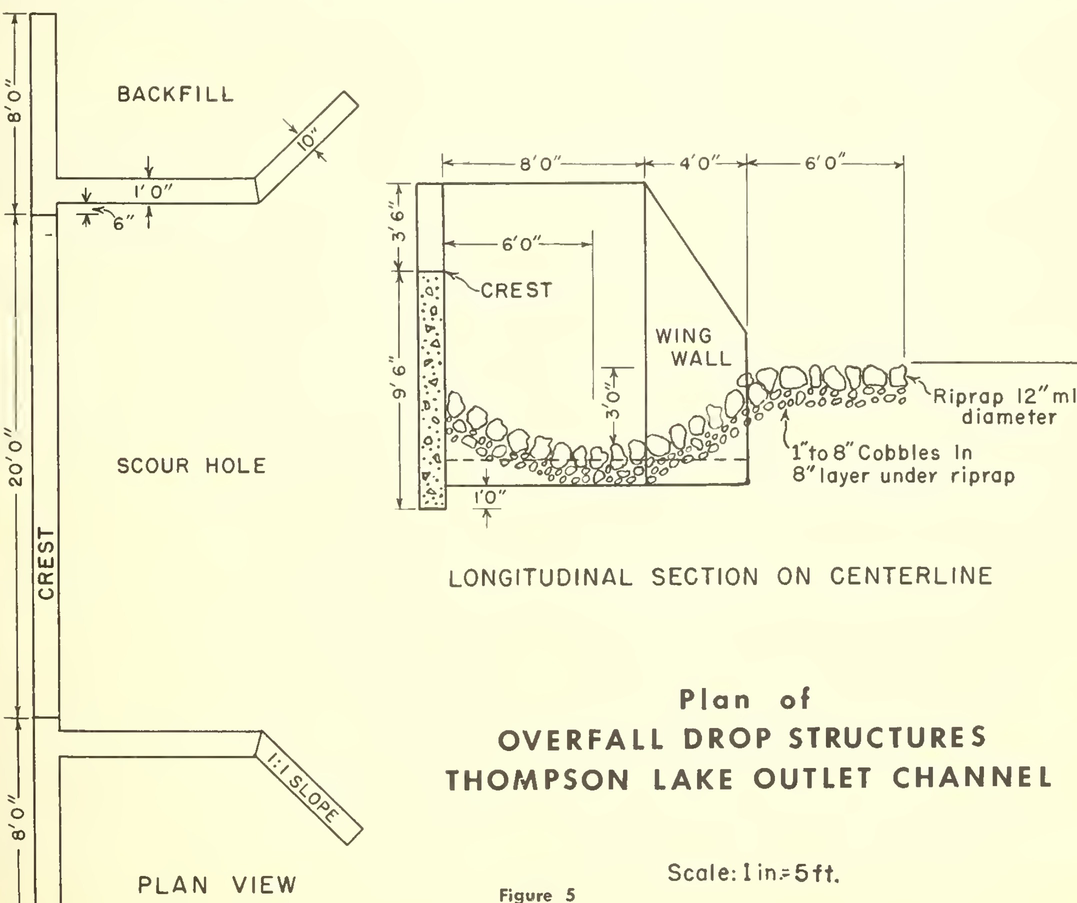


Figure 5

Figure 6.—View of Overall Drop Structure No. 2 shortly after construction in 1955. Energy is dissipated by the pre-formed gravel-armor-plated scour hole. Notice, however, that the coarse portion of the specified armorplating material was not installed.

basins. The laboratory findings indicated that the rate of scour in alluvial material can be significantly decreased if the scour hole is lined with well-graded gravel having a mean diameter larger than that of the natural bed material. It was found that gradation of the armorplating material is more important than absolute size of the particles. Scour hole evolution and protection is currently undergoing further investigation at Colorado State University. Additional information on this work may be obtained from the Colorado State University Research Foundation, Fort Collins, Colo.

The design of the drop structures is indicated in figure 5. Unfortunately, the canal company failed to install the coarse portion of the specified armorplate, so that present armorplating consists only of the light gravel and such gravel materials as have scoured from the natural material. Even so, it has furnished considerable protection against scour. However, the stilling basin performance cannot be adequately judged on the basis of these installations. Figure 6 shows one of the drop structures shortly after its installation, while figure 7 shows the same structure in operation two years later.

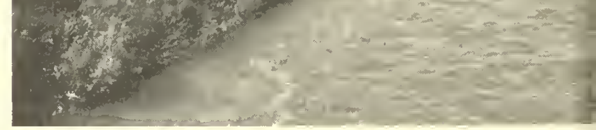
Each of the vertical drop structures lowers the water elevation by about 5 feet. There is, therefore, virtually no net drop in elevation between structures, and consequently, no opportunity for bed erosion. In fact, considerable sediment storage capacity is provided upstream from each of the structures.

The rate of bank erosion has not been significantly decreased by the new construction, owing to the factors already mentioned: first, the stee canyon walls adjusting to the angle of repose the material; second, the entry of drainage wate from adjoining lands; and third, the high wat table. The eroded bank material has largely bee deposited upstream from the drop structures, a very little has been lost from the channel. Car ful measurements of the rate of deposition, ho ever, indicate that the sediment storage capaci will be exhausted in about 1965. After that dat sediment will be transported the full length the channel, unless a new series of drops at high elevations, should be constructed to provide mo sediment capacity.

Installation of the structures was performed crews of the Larimer and Weld Irrigation Sy tem, owners of the channel, at an estimated co of $13,000. ##

Editor's Note: All the structures were designed by Pr fessor Peterson. Study of the channel behavior befo and after installation was performed by Mr. Williams a research investigation for a Master's thesis.

Figure 7.—View of Drop No. 2 in operation two years after construction. The discharge shown is 184 cfs. Notice the ro plastered spillway for discharging wastewater into the chan from adjacent fields.



CANAL SAFETY BOOKLET

A new booklet, Canal Safety, has been pu lished by the Bureau of Reclamation as an add tional measure to protect the public, operati personnel, and animal life from the hazards canals and other water-carrying structures.

Copies of the booklet may be obtained by wri ing to any Bureau of Reclamation field office. R gional offices are located in Boise, Idaho; Sacr mento, Calif.; Boulder City, Nev.; Salt La City, Utah; Amarillo, Tex.; Billings, Mont. a Denver, Colo.

Soil Sterilant Control of Grass Type Weeds

by NAT TOLMAN
Chief, Irrigation Operations Division
Bureau of Reclamation, McCook, Nebraska

Men who operate irrigation systems in the higher rainfall belts of the more humid states generally agree that grass type weeds are one of their more troublesome operation problems. Generally, grass weeds are not as serious in the arid States where irrigation first became important. In Nebraska and Kansas, the grass type weeds are very expensive to control but if allowed to grow are very troublesome. There are several different ways operation and maintenance people have tried to handle the grass type weeds: Some irrigation districts try to control them by drowning them with irrigation water. In our area, this is an unsatisfactory procedure because we do not have a crop distribution system or a water supply adequate to keep water in all laterals throughout the irrigation system. Sometimes the grasses are kept in control by mowing, but ordinarily you can only mow the patrol roads and the tops of the laterals and you cannot get the mower down in the bottom of the ditch where the weeds cause the most trouble. Sometimes, attempts are made to get water through weed infested laterals by using shovels and pulling weeds by hand. This is the most expensive method used. The grasses are sometimes controlled by reditching laterals or by using draglines to clean out the choked area. Either of these methods is very expensive. The use of weed burners is sometimes recommended, but again it has been found propane burners are very expensive to operate.

For the last 3½ years, we have been testing and experimenting with grass weed control by use of soil sterilants. There are several different soil sterilants on the market, but our experience has been almost entirely with the DuPont compound, commercially sold as Telvar–W. It was known experimentally as CMU. The first test application of soil sterilant was started in the fall of 1954 and followed with a spring application in 1955. The results were very satisfactory, so a limited field trial application was made in 1956. Sterilant was applied to 20 miles of lateral that year. The results again were very satisfactory, so in 1957 the sterilant was applied to 123 miles of lateral.

It was found that the spring application is the most satisfactory in our area. Sterilant should be applied to a freshly cleaned or burned lateral as soon as the frost is out of the ground in the spring. The results are poor if sterilant is applied to frozen ground or laterals filled with trash and debris. Fall application seems to require

Wm. J. O'Donnell applying soil sterilant to the wetted perimeter of irrigation ditches. Note the new type single jet nozzle which is used for applying the sterilant. The single broad jet nozzle is light weight and does not clog up as often as do the smaller jets. *Photo by L. C. Axthelm.*

Left, view of an irrigation lateral in the Bostwick Irrigation District near Superior, Nebr., which is choked up with grass type weeds. Right, view of an irrigation lateral in the Bostwick Irrigation District near Superior, Nebr., taken at the end of the season to show effects of the wetted perimeter having been treated with soil sterilant. ***Photo by G. C. Lynn.***

about one-third more chemical to get the same results.

As to the rate of application, we have tried a number of different rates and have decided that in the silty soils of the Republican and Kansas River Valley of Nebraska and Kansas, control of grass weeds can be obtained with 12 pounds per acre. On the sandy soils, more sterilant is required and about 15 pounds per acre seems to be right. On clay soils, an application of 10 pounds seems to be sufficient. The sterilant is applied with a rather low quantity of water, one pound to 4 or 5 gallons of water makes a satisfactory mix. We try not to apply more than 30 to 50 gallons of water per acre.

As to machinery, the ordinary truck or jeep-mounted sprayer handles the sterilant mixture satisfactorily provided the sprayer has a *good agitator*. Soil sterilant does not dissolve in water, therefore, it must be kept in suspension by continuous operation of the agitator. To get a uniform distribution, the screens and nozzles should be cleaned after every hour or hour and a half of use. Sterilants are expensive, and, therefore, should be applied with a hand boom and should not be allowed to spread out over areas where a good cover of grass is needed. After the sterilant has been applied to the clean lateral, water should be put into the ditch and allowed to soak the sterilant into the soil, rather than wash it through the lateral.

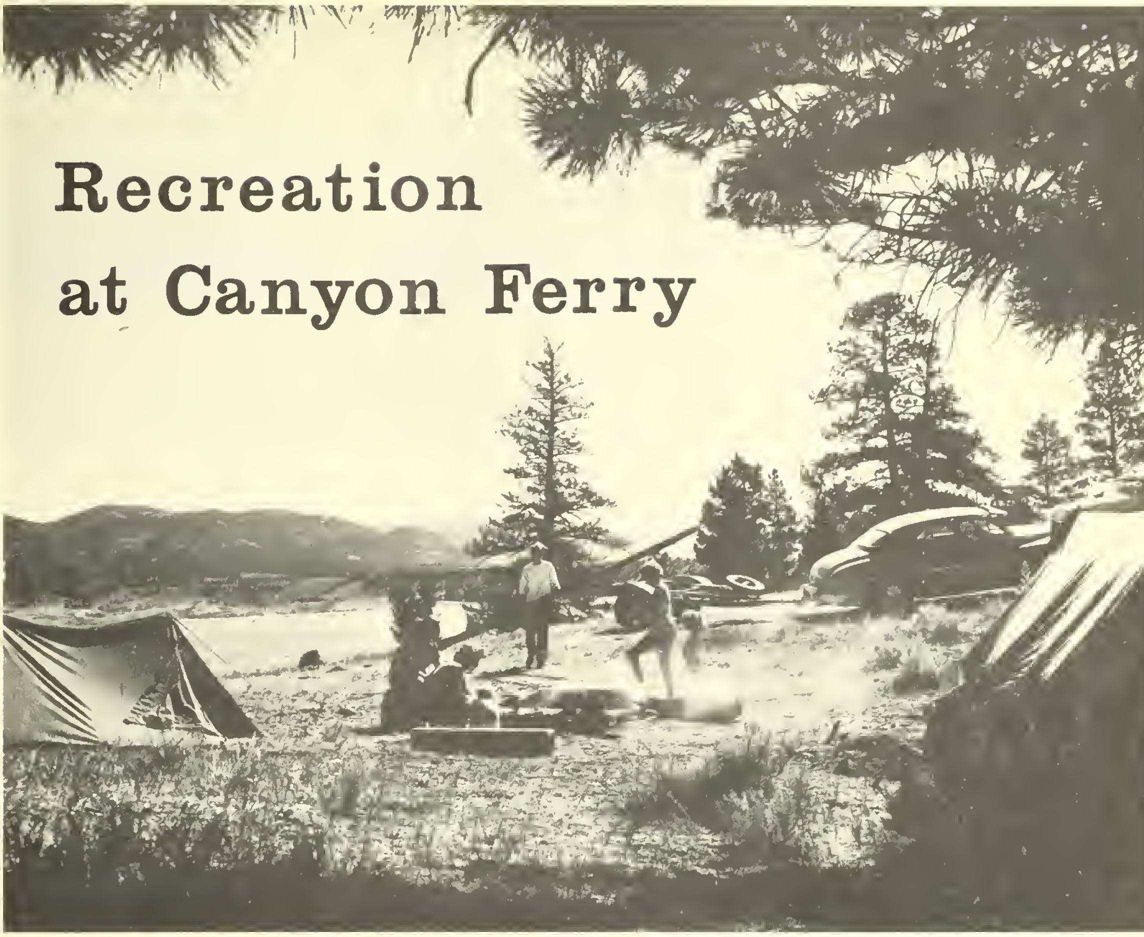
As to the cost, it is our experience that if you treat 100 or more miles per year, the cost will run about $45 to $50 per mile. The chemical is expensive. In large quantity orders, it costs $3 a pound. Last year in the Bostwick Irrigation Districts, our Superintendent, Gordon Lynn, kept good cost records on treating 123 miles of lateral. His record of costs is as follows:

Chemical–1485# @ $3.00	$4,440.00
Labor	1,036.00
Mileage and equipment	207.00
Per mile	46.20

One of the questions we have tried to answer is how long does the sterilant provide protective control of gasses. Some carry-over effects were obtained but not enough to get along on an every other year basis. I believe that if sterilant is applied 3 years, perhaps we might get along without any application the fourth year or with a one-half strength treatment. It was found that the soil sterilant method of controlling grass weeds is about in line with the cost of 2,4–D on broad leaf weeds or is comparative to cleaning a ditch with machinery but the results obtained through sterilant are more lasting than with burning or the usual cleaning methods. After sterilant has been applied, the laterals do not "choke up" with grass after each little rain shower. We are particularly pleased with the sterilant in that we have had no claims for crop damage by the sterilant washing out on farm lands, nor have we had any personal injuries.

The sterilant has effectively controlled some of our most aggravating grass weeds such as foxtail, fireweed and barnyard grass. ###

Recreation at Canyon Ferry



Canyon Ferry Unit of the Missouri River Basin Project, located on the Missouri River near Helena, Mont., is a multiple purpose dam and reservoir development. Irrigation, the generation of electric power, flood control, municipal water, the creation of recreational opportunities and fish and wildlife conservation activities are the benefits of this multiplepurpose unit. These benefits are all important in varying degree, but on any summer week end there is little doubt in the minds of many Canyon Ferry visitors that recreation is the dominant use of the water surface, shoreline, and the other adjoining lands of Canyon Ferry Reservoir. Fishing, picnicking, swimming, camping, hiking, sightseeing, water skiing—these are the activities that bring thousands of visitors to this scenic mountain lake each year.

Canyon Ferry Dam, 17 miles northeast from Helena, was completed in 1953; the powerplant in 1954. The lake, extending 25 miles from the dam to near Townsend, Mont., has a surface area of 35,200 acres, at elevation 3,800 feet above mean sea level, and is about 4½ miles across at its widest point. The lake has a shoreline of about 200 miles. At the lower end of the reservoir the terrain is rough and rocky, particularly the west shore, contrasting with the placid shoreline at the upper end of the lake where the water spreads out over the valley.

It is about 58 air miles from Canyon Ferry Dam to Three Forks, where the Jefferson, the Madison, and the Gallatin Rivers converge to form the Missouri, a stream that is better known as the Big Muddy for the greatest part of its 2,473-mile-long

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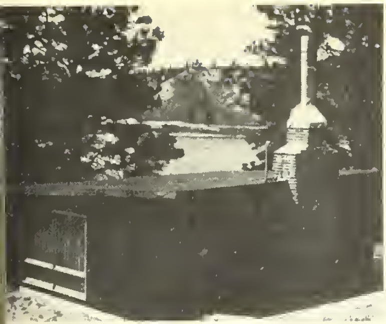
course. At the Three Forks, though, the Missouri is a cold, clear stream whose hurried waters, coming from the nearby slopes of the Rocky Mountain Range along the Continental Divide, soon become a part of the 2,051,000-acre-foot Canyon Ferry Reservoir.

The lands and waters of the reservoir area are divided into three general classes: tracts required for operation and maintenance of the dam and reservoir, recreation areas administered by the Parks Division of the Montana State Highway Commission and the wildlife areas administered by the Montana Fish and Game Department. Under terms of memoranda of understanding, the two agencies agreed to administer, operate, and maintain certain lands and waters for recreation and wildlife. A management plan implements the memoranda of understanding and presents the policies and procedures to be followed by the two State agencies in developing and administering the areas. The management plan was compiled by the Bureau of Reclamation and incorporates plans and information furnished by the two Montana agencies, the National Park Service, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Land Management.

Mr. Ashley Roberts, Director of the Parks Division, has observed Canyon Ferry's recreational growth since the reservoir began to fill. Before even simple facilities could be constructed, hundreds of visitors arrived at the new lake when fishing was first opened in 1955. Scores of tents and trailers dotted the shoreline during that first spring and summer when fishermen sought and found rainbow and Loch Leven trout of such eager, enthusiastic traits that fishermen could only announce loudly and often that it was "phenomenal." While fishing may have since declined somewhat, as compared with that astonishing initial period, other recreation potentials at Canyon Ferry have increased measurably. More than 50,000 persons visited Canyon Ferry in 1958. The reconstructed hard-surfaced highway from Clasoil, a siding on the Northern Pacific Railway which also parallels U.S. Highway No. 10N, to Canyon Ferry, a distance of 9 miles, will bring

Cave Bay on the east shore of the lake, near the dam. Scene of the annual Shrine Fish Derby. Four such derbies have been held since 1955. *Photo by C. A. Knell*, Region 6.



Three of the many summer homes on the east shore of the lake. These homes are located on Magpi Bay, about 4 miles from the dam. *Photos by Edwin O. Wilson.* Right, one of the many pleasure craft seen on a summer week end at Canyon Ferry Lake. Some of these boats are "traveling" boats. A Billings resident will tow his launch to Canyon Ferry Lake. However, most of the craft are owned by residents from Helena, East Helena, Townsend and nearby towns. *Photo by C. A. Knell.*

nany more people to the lake during the coming ummer, and it is anticipated that about 100,000 isitors will admire and enjoy the lake during 959. The 9-mile-long section, a part of the Lewis nd Clark county road system, was constructed y the Montana Highway Commission.

The county road utilizes the crest of Canyon 'erry Dam to reach the ranches, located on the othills above the Big Belt Mountains, and also rovides access to the many summer cabins and le public day-use areas along the east shore of le lake. The east shore is gentle compared with le west shore where the Spokane Hills approach le lake abruptly. Personnel of the Montana 'ational Guard have a site at the lower end of le west shore and in 1955 they built a short secon of the west access road. During the past ummer and fall, employees of the Montana Highay Commission bulldozed another 3 miles or so f the new road. The more timid motorist may el that it is a trail rather than a road but the rovisions of an access road to the rugged west hore quickly created a desire for many new cabin tes. Even before the road was built some of the ger potential cabin owners transported material y boat so that construction could begin at once. here are now more than 60 summer cabins at anyon Ferry, and others are under construction. 'he Parks Division leases the sites annually at 25 per year. Potential cabin owners must conruct the proposed summer homes within 2 years, herwise the lease is cancelled and the site is ade available to someone else. All cabins must constructed in conformity with established regations included in the management plan.

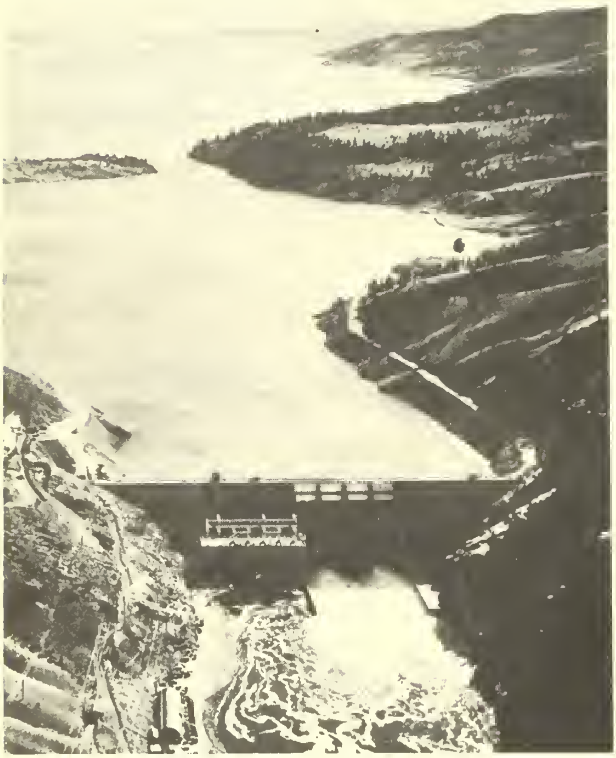
Canyon Ferry visitors have enjoyed the use of facilities—tables, fire grates, refuse cans, wells—at four day use areas and one camping area during the three past years and the continuing interest in these areas will require fabrication and placement of new similar equipment before summer's visitation begins. The Parks Division is planning to establish three other camping areas on the west shore.

As provided for in the memoranda of understanding, the two Montana agencies may derive revenues from licenses, permits, leases, or contracts, which they issue, and use such revenue for the administration, development, and maintenance of the areas. Exclusive of the tracts required by the Bureau for the operation and maintenance of the unit, 20 percent of the land is under the administration of the Parks Division, and 80 percent of the land and the water surface is under the administration of the State Fish and Game Department.

There are two places on the lake where boats and docks are available for rent—at Cove Bay on the east shore and Yacht Basin on the west shore. Members of the Broadwater Boat Club have taken over an area near Townsend for development. Other than the site selected and used by personnel of the Montana National Guard, no other organized camps or club sites have been established yet, although several groups have shown interest.

The Canyon Ferry Recreation Association is an alert organization whose members are promoting and developing many activities such as fishing, boating, campsites, access roads, safety regulations and enforcement, and information signs.

Canyon Ferry Dam and Powerplant on the Missouri River near Helena, Mont. Cemetery Island, where some 30 pioneers are buried, once was a hill overlooking the Canyon Ferry community. The island is visible in the left of the photograph. *Photo by C. A. Knell.*



The greater number of the members are from Helena, East Helena, Townsend, and Canyon Ferry, although the membership also includes enthusiasts from Butte, Billings, and Great Falls. It is an enthusiatic association and the activities will do much to assist the Parks Division of the Montana Highway Commission and the Montana Fish and Game Department in carrying forward the recreational potentials of this scenic lake.

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New Commissioner of Reclamation

Continued from page 29

gate 855,875 acres, provide 200,970 acre-feet of municipal and industrial water, and have a generating capacity of 1,380,500 kilowatts.

New starts have been made during the same period on 37 projects or units, with a total estimated cost of $874,985,763. Of this, about $290 million had been obligated.

Recent laws provide for loans to irrigation districts for construction of small projects and distribution systems. To date, 6 loans totaling $23,600,000 have been made. Ten loans totaling $26,200,000 are awaiting funds.

Mr. Dexheimer worked on the construction of the Yakima project in Washington, Hoover Dam on the Colorado River 1929–36, the Bartlett Dam in Arizona, and on Shasta Dam in California from 1938 to 1942.

He had been a career employee of the Bureau of Reclamation since 1928, with the exception of service with the Corps of Engineers in World War II and private foreign work for a year thereafter.

He served from 1942 to 1946 in India and China as Assistant Theater Engineer on the staff of Gen. Joseph Stilwell.

On leaving the military service as a lieutenant colonel, Mr. Dexheimer returned to China as a consulting engineer with the Morrison-Knudsen International Co.

In 1947, he returned to the Bureau of Reclamation at Denver, where he served as Assistant Chief Construction Engineer until his appointment as Commissioner.

A native of Denver, Colo., he was born in 1901. He attended the University of Denver in 1921 and 1922 and was graduated from Colorado State University in 1926 with a degree in civil and irrigation engineering.

Mr. Dominy joined the Bureau in April 1946 as chief of the Allocation and Repayment Branch of the Operation and Maintenance Division. He became Assistant Director of the Division in 1950 and Director in 1953. Under the Bureau's reorganization in December 1953, he became Chief of the Division of Irrigation. In 1957, he was named Assistant Commissioner.

Beginning his professional career as a teacher of vocational agriculture in Hillsdale, Wyo., Mr. Dominy became county agricultural agent in Campbell County in 1934 and continued in that job until the fall of 1938. He became field agent for the Western Division of the Agricultural Adjustment Administration in 1938 and served until 1942, when he became Assistant Director of the Food Supply Division, Office of the Coordinator of Inter-American Affairs. In this position, he was responsible for developing and directing an emergency food supply program in cooperation with various South and Central American countries.

Continued on page 56

Ogden Valley's 3 layer water system

Under the Weber Basin project, a unique three-ayer water system has been created by the nlargement of Pineview Reservoir in Ogden alley.

Ogden Valley is located in Weber County, Jtah, about 10 miles east of Odgen on the east ide of the most westerly range of the Wasatch Mountains. The valley has an area of about 23 quare miles and is completely surrounded by nountains. This valley is a fault trough bounded n the east and west by faults and filled to a depth f more than 600 feet with unconsolidated de-osits of clay, sand, and gravel. These deposits re of both lake and stream origin. The stream sediments were brought in principally by the three main tributaries entering the valley, the south, middle, and north forks which converge near the west side of the valley. Below this point of convergence, the river enters the steep, narrow and rocky Odgen Canyon. The lake sediments were laid in a small lake that once occupied Ogden Valley and was connected with glacial Lake Bonneville by an arm of water that occupied Ogden Canyon.

The sediments in the valley include about 70 feet of clay, sand, and gravel in alternating layers and is underlain by a bed of varved clay with a maximum thickness of about 70 feet. This clay

pstream view of Pineview Dam showing spillway and outlet works
Photo by Paul F. Norine.

by JAMES N. OKA, Hydraulic Engineer
Weber Basin Project Office, Ogden, Utah

The Ogden Artesian Wells area prior to inundation by Pineview Reservoir.

layer extends out across the lower parts of the Ogden Valley. Silts and gravels of unknown depths are found under this clay bed. As the aquifer formed by the silts and gravels fill with water, an artesian condition is produced. The recharge area for this artesian basin is the upper part of Ogden Valley where the confining clay layer is absent.

In 1914 Ogden City started drilling wells in the artesian system in the lower Ogden Valley to obtain municipal water. The drilling of these wells continued at irregular intervals until 1933. A total of 51 wells were drilled in what was called Artesian Park. At the present time only 47 of these are in use. They consist of thirteen 4-inch, thirty 6-inch, two 8-inch, and two 12-inch wells with an average depth of about 135 feet. Approximately 15,000 acre-feet of water is obtained annually from these wells with a maximum recorded combined flow of 32 second-feet. By decree, Ogden City has prior rights to the total flow from these wells except that from July 1 to September 30 of each year the withdrawal cannot exceed a daily average flow of 22 second-feet.

In 1935 and 1936 as a part of the Ogden River project, the Bureau of Reclamation constructed the Pineview Dam at the lower end of Ogden Valley in the head of Ogden Canyon. The 41,000 acre-foot reservoir, later enlarged to 44,000 acre-feet, completely inundated the Ogden City artesian wells with about 30 to 400 feet of water.

Before proceeding with the construction o Pineview Dam, a contract was negotiated betweer the United States and Ogden City. This contrac required the United States to cut off the wells cap them underground, and construct a new col lection system. The project included the installa tion of tees attached to the well casings above which were 2-inch air vent pipes. The water wa conveyed through the tees and horizontal pipes t a large collection chamber. From there it wa conveyed to the city mains. The contract also gave Ogden City right to drain the reservoir wheneve there was trouble or evidence of failure of the col lecting system or wells. The reservoir was firs drained in 1944 for these purposes. This inspec tion showed that a number of pipes near the tee close to the well casings had developed leaks Some of the air vent pipes had developed crack and one was practically sheared off. It appeare that the damage was caused by vertical movemen of the earth over the confined aquifer. Delicate instruments were installed to determine any move ment of the earth. The instruments showed a ver tical up and down movement which in some case amounted to three-quarters of an inch.

The filling of Pineview Reservoir created a situation in which the additional load of the weight of the water impounded was super-impose upon the clay layer. The surface reservoir wa

Continued on page 51

HISTORY in Glen Canyon

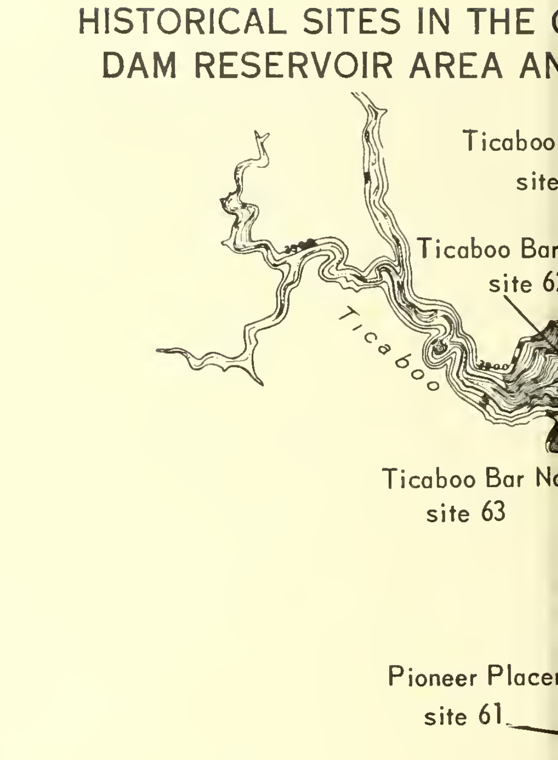
The opening last February of a highway bridge across the Colorado River at the Glen Canyon damsite might be called the end of a book: the end of a long record of man's dealing with Glen Canyon on an individual basis. The introduction of the book would tell of the discovery of the canyon by the Spanish explorers Dominguez and Escalante in the historic year 1776. These men and their small company were on their way back to Santa Fe after having made the first comprehensive traverse of Utah and the Arizona strip, when they discovered a difficult ford 24½ miles above Glen Canyon Dam. This, the Crossing of the Fathers, was used intermittently afterwards by Mexican traders, American fur men, and later by Jacob Hamblin, Mormon scout and missionary on his first trips to the Hopi villages which began in 1895. After 1872, when John D. Lee put a ferry in operation at Lee's Ferry, 15 miles below Glen Canyon Dam, the Crossing of the Fathers was little used—except by the Indians.

When the United States determined to round up the Navajo Indians in 1863 and place them in the concentration camp at Bosque Redondo, a good many of them eluded Kit Carson and the Army by moving in with the Paiutes living in the canyon lands bordering the Colorado River in Utah. From there the Navajos crossed the river to raid the Mormon settlements from time to time until peace was negotiated with them by Jacob Hamblin in 1874. To the Navajos and the Paiutes, like the ancient Pueblos who preceded them by centuries, Glen Canyon and its many tributaries, together with San Juan Canyon, offered a secure home which they came to know intimately. The deep canyon was scarcely a barrier. The Indians reached the river bottom lands at many places and they forded the river at many places, including the Crossing of the Fathers, during low water or on the ice in cold weather. These were the beginnings.

The exploratory expeditions undertaken by John Wesley Powell, 1869–1872, focused interest on the canyons of the Colorado and it is from that time that the intensive history of Glen Canyon begins. Powell demonstrated that the canyons of the Colorado were passable, and the Wheeler and Hayden surveys publicized the adjacent country.

Government explorers were followed by settlers and miners. During the 1870's Mormon frontiersmen worked their way around the base of the High Plateaus where they established small farming communities like Kanab, Paria, Cannonville, Escalante, and Hanksville. This at the same time that discoveries of gold and silver on the headwaters of the San Juan River brought thousands of miners into southwestern Colorado where they promptly disturbed the Ute Indians. In order to forestall another Indian outbreak on the southern border and also to expand the frontier of settlement, the Church of Jesus Christ of Latter-Day Saints sent a colonizing mission to the San Juan country. This was the famous expedition which crossed Glen Canyon at Hole-in-the-Rock. These courageous Mormon trekkers spent altogether 6 months on the trail before they arrived at Bluff on the San Juan River in April, 1880. They had crossed some of the most difficult terrain for wag-

by C. GREGORY CRAMPTON, Professor of History and Director of Historical Research, Upper Colorado River Project, University of Utah.

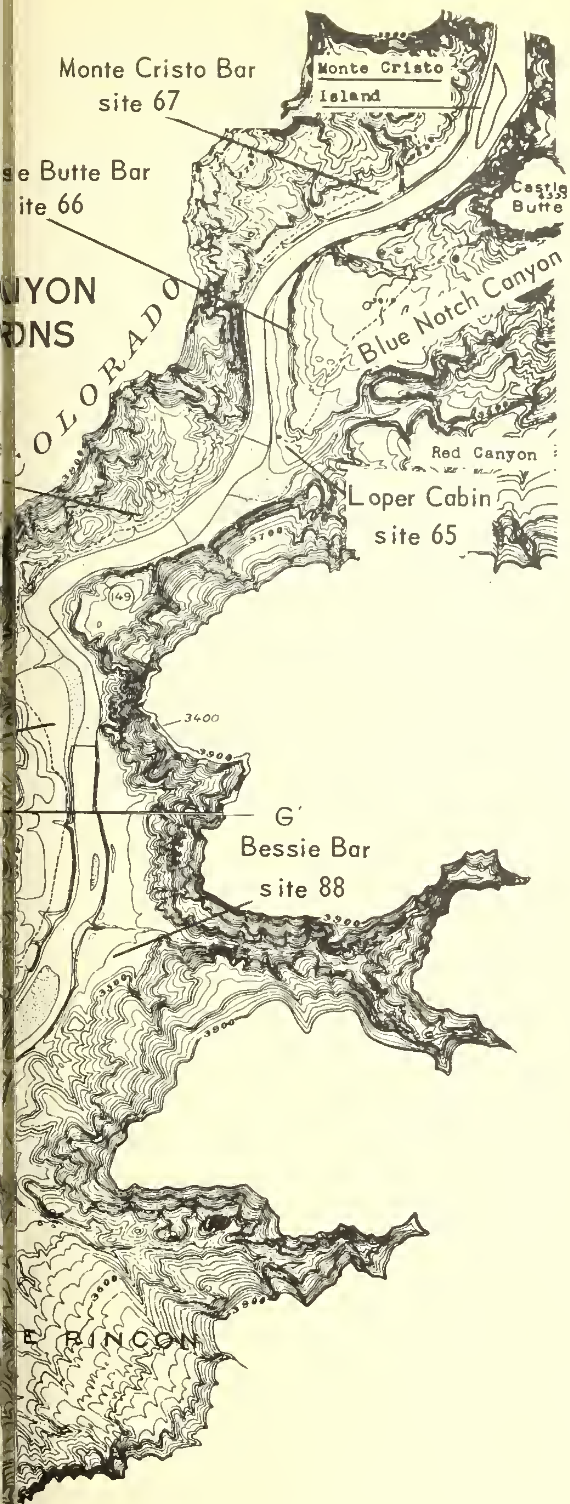


Map showing the location of historical sites along an 11-mile stretch of the Colorado River in Glen Canyon. This area was intensively worked during the gold rush in the canyon from 1883 to about 1910.

ons anywhere in the United States and the road they built may still be seen in many places. The most spectacular construction is at the Hole-in-the-Rock through which wagons were driven to reach the river a thousand feet almost directly below.

The discovery of gold opens another—and the longest—chapter in the history of Glen Canyon. About 1883, Cass Hite, a prospector from the San Juan Country in Colorado, was told by the Navajo Chief Hoskinnini that there was gold in the sands of the banks along the Colorado River. Hite found pay dirt at Dandy Crossing where the settlement of Hite is located and later at the mouth of Ticaboo Creek downstream a few miles where he built a cabin. Hite's placer gold mining operations attracted others to the Canyon, including the officers of the Denver, Colorado Canyon, and the Pacific Railway Co., organized in 1889 to build a railroad from Colorado to the coast. The company planned to avoid the expense of moun-

Professor David E. Miller examines an engine built along the river at New Year Bar to pump water for mining purposes.



tain construction by using the natural grade of the canyons of the Colorado River!

The idea of a canyon railroad was abandoned after two surveys were made. However, when gold was discovered in the early 1890's in the Abajo Mountains, La Sal Mountains, Henry Mountains, and the San Juan River, and considerable numbers of men rushed into these regions adjacent to Glen Canyon, another company was organized by the Chief Engineer, Robert B. Stanton, for the purpose of mining in the canyon. Stanton in 1898 staked out nearly all of the river bars in Glen Canyon not already claimed by others and then he assembled an 80-bucket gold dredge on the Colorado above Bullfrog Creek. The company went bankrupt after 6 months' operations in 1900.

Stanton was not alone in the canyon. Hundreds, perhaps thousands, of men prospected the whole length of Glen, the canyons above and all the tributaries in the decade between 1890 and 1910. They found gold all of the way through Glen Canyon from the mouth of the Dirty Devil to Lee's Ferry but practically nothing was found in the tributary streams. The exception was the canyon of the San Juan where diggings were located at several places below Mexican Hat.

Gold hunting in Glen Canyon was difficult

Don R. Mathis climbs steep roadway blasted from sandstone cliff by R. B. Stanton to haul in heavy machinery for a gold dredge installed in Glen Canyon in 1900.

Part of the cabin occupied by Bert Loper, miner and river runner, who lived in Glen Canyon many years.

All photos by the author.

business. The gold, seldom found in pockets, was extremely fine and difficult to extract from the sand and gravel. The canyon with its precipitous walls and deeply-incised tributaries was difficult to traverse. Roads were blasted in sandstone cliffs to haul in heavy machinery. Steps were cut in steep slick rock slopes to make horse trails, and various kinds of craft from barges to skiffs were used to navigate the river. Cabins were built, small plots of land were irrigated to raise food, and a post office was established at Hite to keep the canyon miners in touch with the world. When World War I opened, gold operations virtually ceased only to be revived briefly during the depression of the 1930's.

The later history of Glen Canyon is varied. An oil boom in the 1920's led to considerable prospecting and at least four wildcats were drilled in the canyon floor at the Waterpocket Ford. Oil prospecting continues today in upland regions of Glen Canyon. There was a flurry of uranium prospecting after World War II especially in the upper part of the canyon but the profitable working mines have been found on the tributary streams some distance above the level of the future reservoir in Glen Canyon. Other diverse activities in the canyon include trapping, trade with Indians, farming, stock raising, and flights from justice.

The scenic beauty of Glen Canyon has attracted a large number of tourists every year until it is now one of the most well-traveled streams in the United States. The gold miners of the earlier years became thoroughly familiar with the natural features of the canyon lands but they were not very articulate about them—moreover, scenery got in their way'—so they were all rediscovered by later travelers. The first approaches were mainly by land and on the eastern bank where guides like

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WATER REPORT

The irrigation water supply outlook in the western United States is fair to good in the north, poor in the south and southwest. There are a few areas of very heavy snowpack near the Canadian border in northern Idaho and western Montana. At the other extreme, there is a widespread deficiency of seasonal snow accumulation over southern Colorado, Oregon, Utah, and California as well as all of New Mexico, Arizona, and Nevada. For intervening areas snowpack is near normal.

Relatively high runoff during the 1957 and 1958 water years provided substantial carryover storage, particularly in larger reservoirs. Water supply outlook in many areas includes the effect of storage. Where snowpack is normal, storage will provide supplemental and late season water supply. Where snowpack is low, stored water will tend to alleviate a disastrous shortage during the 1959 season. Again this year, the need for storage facilities to carry water from good to poor seasons, particularly on tributary streams, is apparent.

With average or less snowpack in the mountains, it follows that very little probability exists for damage from high streamflows resulting from snowmelt. The only reference to this possibility is made for the Blackfoot and Clark Fork rivers in western Montana.

Forecasts of 1959 irrigation water supply and general water supply conditions in the West are based on April 1 measurements by the U.S. Department of Agriculture, Soil Conservation Service and many cooperating organizations [1] on about 1,300 snow courses and 100 soil moisture stations. The amount of storage in nearly 250 reservoirs also is considered in appraising the water supply outlook. The relative demand for water in an area is recognized as an integral part of the general water supply situation.

The purpose of water supply forecasts is to provide advance information on prospective water supplies in order that plans may be made for the best use of water by individual as well as group users. In this report only general areas and major tributaries are considered.

In the Missouri River Basin streamflow will range near normal with 120 percent of normal in

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several States, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that State, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that Province and likewise contributed the information here for British Columbia.

by HOMER J. STOCKWELL, Snow Survey Supervisor, Soil Conservation Service, Fort Collins, Colo., and NORMAN S. HALL, Snow Survey Leader, Soil Conservation Service, Reno, Nev.

some upper Missouri tributaries, and down to 60 percent of normal in the Wind River drainage in Wyoming. Water supplies along both large and small streams should be adequate, but not plentiful. The headwaters of the North and South Platte rivers in Colorado and Wyoming have a normal or better snowpack. Soil moisture in irrigated areas is good. Carryover storage is well in excess of normal in both public and privately owned reservoirs for agricultural and municipal use. A similar outlook prevails for the Arkansas River Valley. The irrigated area of eastern Colorado and Wyoming and western Nebraska and Kansas has a reasonably good water supply outlook, almost comparable to the 1957 and 1958 water years.

Water supply outlook for the Rio Grande is poor in both Colorado and New Mexico. April 1 snowpack is near a minimum of record and mountain soils remain dry. Storage in Elephant Butte is near average, but the outlook remains poor because of minimum prospective inflow. In the eastern New Mexico projects at Tucumcari and Carlsbad, the water supply outlook is good with well above normal carryover storage.

Surface runoff prospects are poor in Arizona with no snow remaining as of April 1. Carryover storage is near normal, which will provide an average surface water supply on the Salt River and its tributaries. Storage is not sufficient to meet normal demands for the Gila and Little Colorado Rivers.

The general shortage of winter snow extends into the San Juan Basin in Colorado and the southern two-thirds of Utah. Streamflow in this general area of the Colorado River and Great Basin will range from about 30 to 60 percent of normal. Heavy demand areas without storage will be critically short. Water supply outlook in northern Utah is somewhat better. Streamflow there is forecast from 75 to 100 percent of normal with above average carryover storage.

Streamflow in Nevada will be extremely low, near 10 percent of normal on the Humboldt and 50 percent of normal for streams from the east slope of the Sierras. Central, eastern, and southern Nevada have a short water season in prospect.

In the Columbia Basin water supplies are generally adequate for Washington, northern Idaho, and western Montana. Tributaries in western Montana have a near record snowpack. In southern Idaho snowpack is light. Reservoir storage can make up the shortage of natural streamflow, but rivers without storage are faced with a serious shortage of water.

Snowpack on Columbia River tributaries in Oregon has been less than normal. Streamflow forecasts range from a low of 17 percent on the Owyhee to near 100 percent on some smaller streams in southwest Oregon. Most streamflow forecasts are in the range of 60 to 90 percent of normal.

In California, the winter snowpack has been deficient. Water supply outlook varies from fair in the north, where near normal runoff is expected, to poor in the south, as indicated by forecasts of less than one-half of normal. Reservoir storage will provide the difference between poor and fair supplies in many areas.

Forecasts for the the major streams of the West for the April–September 1959 period as compared to normal, are as follows:

Columbia River at The Dallas, Oregon
96,500,000 ac. ft. or 99 percent of normal

Missouri River at Fort Benton, Montana
3,341,000 ac. ft. or 99 percent

Colorado River at Grand Canyon, Arizona
7,300,000 ac. ft. or 73 percent

Sacramento River inflow to Shasta Reservoir, California
2,000,000 ac. ft. or 85 percent

San Joaquin River below Friant Reservoir, California
745,000 ac. ft. or 55 percent

Rio Grande at Otowi Bridge, New Mexico
280,000 ac. ft. or 33 percent

This analysis is again presented in the *Reclamation Era* through the courtesy of the authors, and Mr. R. A. WORK, *Head, Water Supply Forecasting Section.* In the following paragraphs the water supply outlook by States is briefly reviewed.

ARIZONA—An exceptionally dry March has been added to an already deficient moisture year. As a result, the January through May runoff in the State will average only 20 percent of normal. However, reservoir storage is 84 percent of average. The water supply for the land served by reservoirs on the Salt and Verde Rivers is adequate for this year. The available water in the San Carlos and Carl Pleasant Reservoirs will be short of a full supply, but will not require drastic curtailment of normal cropping operations. In the limited areas where only direct diversion of spring runoff is available, the water supply will be short.

CALIFORNIA—The California Department of Water Resources reports that the water supply outlook is for below average runoff in all areas of the State. Snowmelt runoff from mountainous areas will vary from near minimum of record in the southern San Joaquin Valley, where extensive agricultural development exists, to near average in the extreme northwest portion of the State where most of the water must be wasted to the sea because of geographical limitations of the region.

Precipitation was below average in all but portions of the extreme northern section of the State where near or slightly above average amounts were recorded. Snowpack was also below average in all but the same areas. A very dry, warm March contributed little to the snowpack and in many cases caused premature snowmelt with resultant depletion of the lower elevation snowpack. It is estimated that the snow-stored water is about 60 percent of average for the State as a whole. Water stored in surface reservoirs is about 105 percent of average for April 1.

Water supply conditions in the area south of Sacramento will limit agricultural use where carryover or importations are not adequate. Water will be available for municipal and industrial use in virtually all areas of the State.

COLORADO—The water supply outlook is relatively good for the Platte and Arkansas Rivers east of the front range in Colorado. Mountain snow accumulation to April

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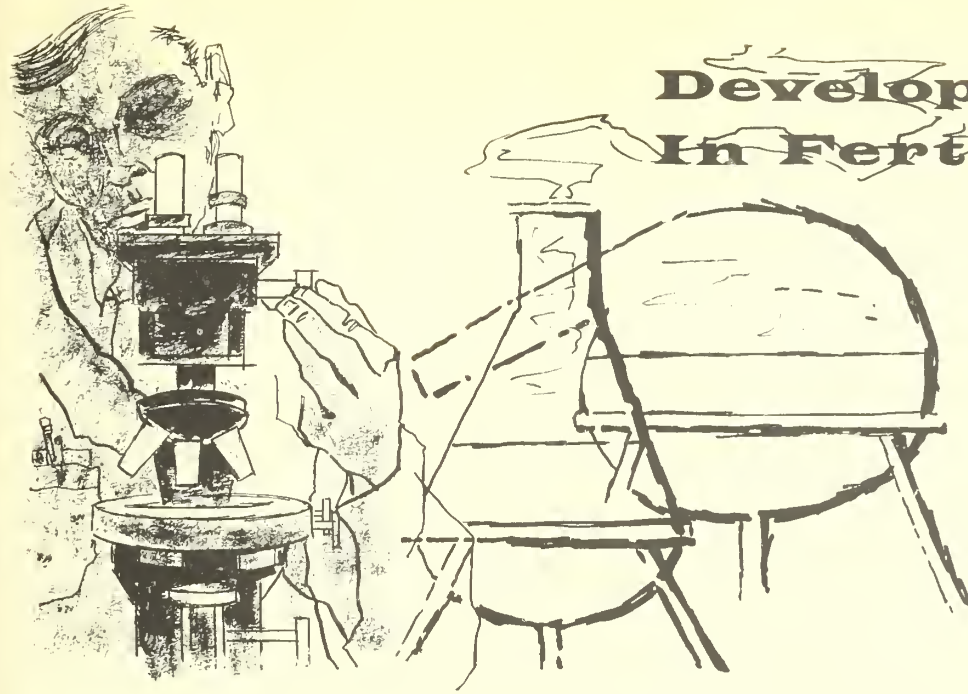
New Developments In Fertilizers



by

VINCENT SAUCHELLI
Chemical Technologist
National Plant Food Institute

Like so many other industries in our economy, the fertilizer industry, since the late 1930's has experienced the urge for new plans and activities to meet the requirements of greater consumer demand and lower unit cost of production. The tempo of change received new impulses during and immediately after the recent war period and the fertilizer industry has remarkably met the pace set by our new mechanized powered agriculture which it serves. The farmer was required to step up his production of food, feed and fiber crops for war exigencies. He discovered he could use fertilizer as a new hired hand and by its use boost his crop yields and net profit.

The stepped-up demand for commercial fertilizer coupled with urgings from Federal Government agencies stimulated the fertilizer industry to build new productive capacity. As a consequence capacity has outstripped demand. This will be better understood by referring to some supporting statistical data.

Synthetic ammonia has become the chief source of nitrogen. In 1939 the total United States production was 245,000 tons and rated capacity was about 380,000 tons per annum. By the first of 1958 the total United States capacity was about 4,190,000 tons and production upward of 3,000,000 tons. This is a spectacular growth, perhaps more spectacular than the tonnage of any other product of the chemical industry.

Ammoniation

One of the important new developments in the manufacture of compound or mixed fertilizers is the use of ammonia and the ammoniating solutions in the production of the granulated type of fertilizer. Granulation and ammoniation seem to have developed side-by-side and represent a radical change in the technology of fertilizer. These developments have altered the character of the industry by changing it from a more or less blending or dry-mixing operation to a chemically-engineered, quality controlled industry requiring highly skilled personnel in production, sales and management.

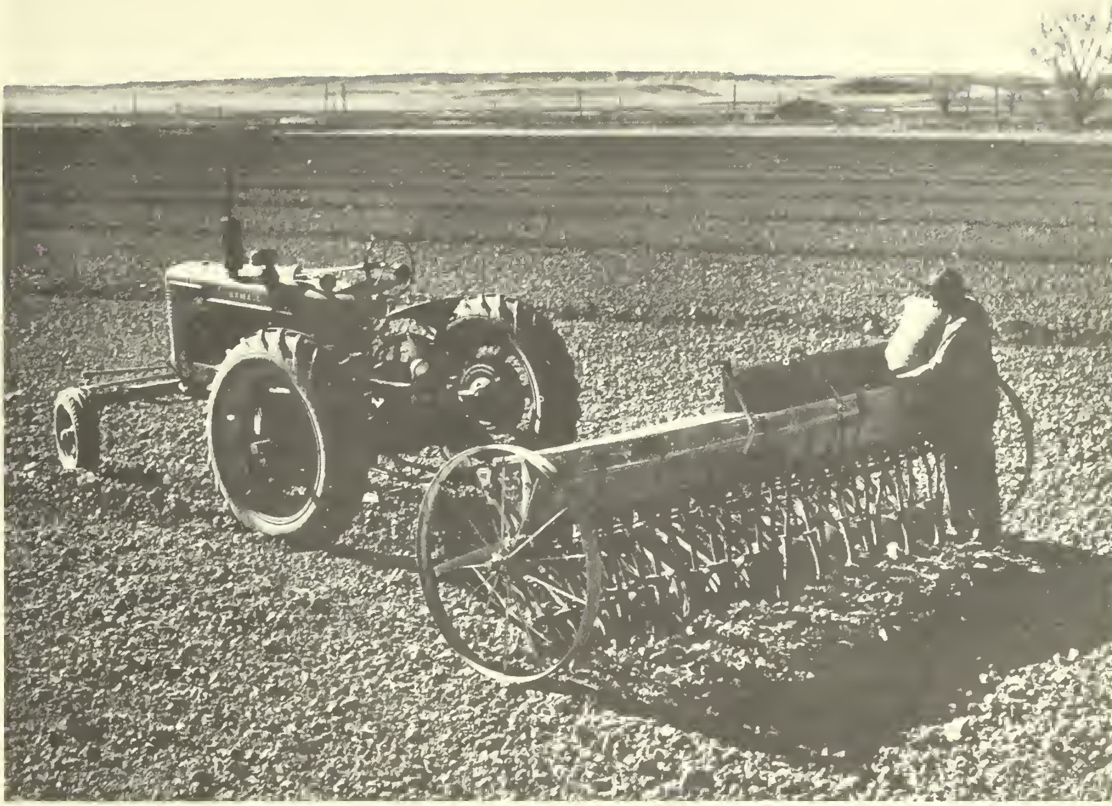
Ammoniation of fertilizer mixtures began in earnest about 1937. The ammoniating solutions consist of varying percentages of ammonium nitrate, or urea or both in a solution of ammonia. The free ammonia in these solutions reacts with the superphosphate and free acid present in the mixture. The result is an ammoniated phosphate and the effect on the physical condition of the product is very favorable.

The usual method of producing a mixed fertilizer to furnish two or more major plant nutrients is by the so-called batch method; that is, weighed amounts of the solid, raw materials supplying nitrogen, phosphorus and potassium plus other desired nutrients, are put into a rotary drum mixing unit and thoroughly blended. To make many mixtures of relatively higher nitrogen content it is now customary to introduce a specified volume of one of the ammoniating solutions. The phosphorus is furnished by normal or triple superphosphate and, in some grades, by added phosphoric acid. Solid nitrogen carriers commonly used are ammonium sulfate, ammonium nitrate, ammonium phosphate and urea. These raw ingredients are carefully selected for compatability and mixed in the drum mixer after which the blended material is conveyed to storage bins. Each mix is a batch. The free ammonia in the nitrogen solution reacts with the superphosphate and free acid. Heat is generated by this reaction and advantage is taken of this for drying the mass.

Granulation

The method of granulating a fertilizer to make a free-flowing, homogeneous product is a modification of the batch mixing system. The current, favored system utilizes selected raw materials which will granulate easily. The operator finds and uses certain soluble salts in the mixtures which will develop under high temperatures the proper volume of liquid phase with the minimum use of water. In all modern granulating plants the ammoniating and granulating operations proceed in a continuous manner and not in batches. Great

Drilling winter barley and banding fertilizer in one operation on land irrigated under south half S–4 sprinkler system. *Photo by S. B. Watkins.*



W. J. Walters loads seeding machine with oats for seeding on land irrigated under the border dike method of irrigation. The border dikes can be seen in the background.

skill is required to devise formulations of raw materials which will provide the correct combination of liquid phase and generate the right amount of heat of chemical reaction. This really constitutes the fundamental control in the process.

The first commercial production of granulated mixed fertilizer and of superphosphate took place in the fall of 1935. It was not until 1950, however, that granulation became established in the United States. Since then new granulating plants have been built at a rapid rate and at the beginning of 1958 the number had increased to 171. Of the total number, 162 granulating installations are located in the Middle West. The total annual production of granulated fertilizers is currently about 3 to 4 million tons. The trend is definitely toward the production and use of granulated mixed fertilizers and materials.

Phosphates

Reference was made to the spectacular growth of the synthetic ammonia industry. No less remarkable has been the expansion of production facilities for making superphosphates. Capacity far outstrips demand. At present the estimated total capacity of this country is 4,600,000 tons, basis P_2O_5, and consumption a little over half this amount.

The same story holds good for the American potash industry. The present estimated total productive capacity is about 2,500,000 tons, basis K_2O, per annum. This represents a surplus capacity of about 25 percent over actual consumption.

Test plots operated by the State Experiment Station on the Huntley Reclamation project.

The fertilizer industry serves a fundamental need in our economy. Its primary objective is to help the farmer get a reasonable profit from his operations. It is an established fact that commercial fertilizers are an indispensable tool in modern agriculture. They serve, when properly employed, to make poor soils fertile and fertile soils more fit to grow the newly developed high-producing crops varieties profitably. Industralized farming must constantly strive to reduce the crop unit cost of production. In this objective commercial fertilizers are the key factor. ###

Ogden Valley

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alternately filled and emptied each year causing an alternate increase and decrease of pressure on the clay bed. As this clay bed is essentially impervious the alternating pressure change causes a slight alternating movement in the clay bed. With the added weight, there is also a certain amount of compressibility of the aquifer which contracts when water is withdrawn from it and expands when water is added.

Beginning in 1955 as a part of the Weber Basin project, the Bureau of Reclamation started construction work to raise Pineview Dam an additional 29 feet. The reservoir capacity was to be enlarged from 44,000 acre-feet to 110,000 acre-feet. Before the impoundment of water by the enlarged reservoir, it was considered necessary to correct the problem of future breaks in the pipes tapping the artesian water.

It was believed that the additional head on the reservoir and greater drawdowns due to the enlargement would increase the magnitude of fluctuations in the artesian pressures of the underground aquifer and cause further movement of the impervious clay bed.

To remedy future breaks in pipes it was necessary to make flexible connections to compensate for the ground movement. A 25 foot by 25 foot by 10 foot deep excavation was made around each well; the well casing being near one edge of the hole. About 12 to 16 well points were driven into the ground around the excavation to a depth below the bottom of the hole. These well points were connected to an 8-inch line laid on top of the ground. By means of a vacuum pump, water was pumped through the well points and delivered to the stream bed which carried it away. By this method, the excavation was kept free of water while the job of modifying the wells was in process.

Ogden City Artesian Well No. 36 after excavation, with modification and repair about to begin.

Ogden City Artesian Well No. 36 showing water gushing from break at tee.

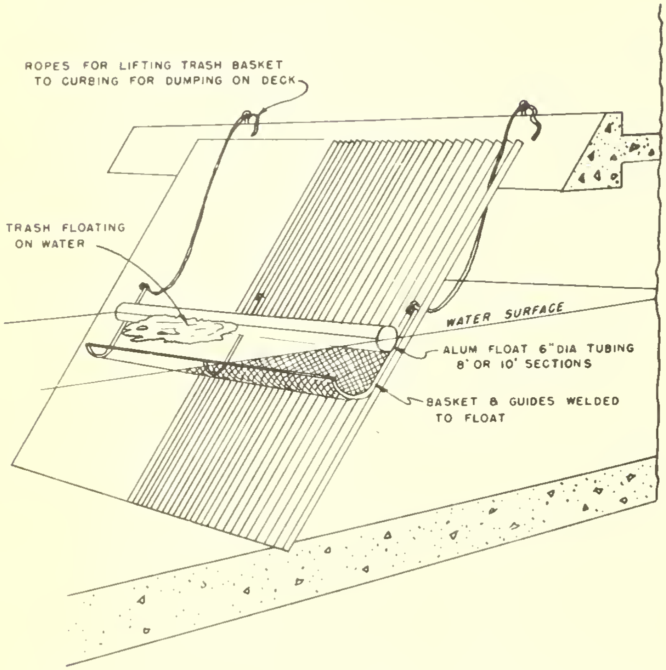
The horizontal pipeline attached to the well casing was then cut in two places, one near the vertical well casing and the other, 10 to 15 feet away. Two dresser couplings were used to reconnect the lines, making them flexible.

To make the air vent lines flexible, lead connections were inserted near the well head. In all, 24 wells required repairs but 45 were modified as described. This program of modification was completed in December 1956.

It is believed that this modification of the wells will solve the problem of the breaks in the pipes. This, however, will be determined after the enlarged reservoir is filled and emptied several times under actual operation.

With completion of all construction required in raising of the dam and modifications of the artesian wells, the three layer system is now ready to begin operations. ###

Floating Trash Basket



This all aluminum floating trash rack is light in weight and may be altered to fit the structure it is to be used on. The baskets are built in short lengths to facilitate the lifting of sections containing the most trash, leaving the others to be cleared at a later date. Designed by Lester F. Beal, Engineering Draftsman, Bureau of Indian Affairs, Portland, Oregon.

Your Magazine

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

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If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

History at Glen Canyon

Continued from page 44

John Wetherill and Zeke Johnson packed tourists in with horses and mules. Now the canyon rims may be reached by four wheel driven vehicles at many points, but most tourists prefer to see the canyon by water. Their numbers will increase as the waters of the reservoir bring new and enchanting areas into view.

This brief review will indicate that, far from being an isolated region remote from the currents of human activity, Glen Canyon has been the very center of a historical panorama including Spanish Padres, Mormon scouts, Government explorers, prospectors, outlaws, trappers, and tourists. And now a new era begins as the Nation through reclamation adapts the power generated in Glen Canyon to wide public use.

The building of this dam means that a good many historical values will be lost as the waters of the Colorado are gradually impounded. A program of historical research by the University of Utah, sponsored by the National Park Service, is under way to see that an adequate record is made of the canyon's history and to prevent the loss of valuable relics. Field studies in combination with library research have enabled us so far to locate and identify over a hundred historical sites in the reservoir area of Glen Canyon alone. It is expected that the work will continue until we have written the complete history of Glen Canyon.

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Glen Canyon from the trail to Klondike Bar—one of the placer mining operations along the river.

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1 is normal or better, soils in irrigated areas are moist, and surplus storage carried over from the past two heavy streamflow years will help to provide a supplemental supply should the summer months be dry. A substantial amount of water is stored in the larger reservoirs, including John Martin on the Arkansas, in the Colorado-Big Thompson, and in Denver municipal reservoirs on the South Platte. Streamflow on the Lower Platte was above normal during the winter, so reservoirs will fill by the start of the irrigation season.

For northwestern Colorado, including the Upper Colorado River, streamflow will be slightly less than normal, but adequate to meet all but late season demands. Some shortage probably will occur on Gunnison River tributaries.

Seasonal snowfall has been light on the San Juan, Dolores, and Rio Grande drainages. Streamflow for 1959 on all of these streams will range near one-half of normal. Severe shortages, comparable to the 1954–56 period, are in prospect. The only favorable item is higher groundwater levels in San Luis Valley as compared to these drouth years. The use of groundwater again will be extensive. The shortage will be most severe on the Dolores River.

IDAHO—The Kootenai River in northern Idaho frequently poses a serious high water threat to all interests along its flood plain, but is forecast to flow normally this year. Streams originating in Montana and flowing into Idaho are predicted to have excellent water supplies for 1959.

The snowpack is light along rivers in southern Idaho so the outlook is for a low water supply. Reservoir-stored water can make up for deficiencies in natural streamflow, but on those rivers without adequate storage, a serious water supply shortage is in prospect. Dry soils beneath the light snowpack indicate an early recession in streamflow during the irrigation season. Carryover storage from 1958, however, is excellent on all rivers, and will give major southern rivers, such as the main stem Snake, Boise, and Payette, a normal supply when considering the reservoirs involved.

KANSAS—The prospects for irrigation water along the Arkansas River are relatively good. Soils are in good condition. Storage in John Martin and the Great Plains reservoirs in eastern Colorado, along with prospective streamflow indicates a good water supply in this area for 1959.

MONTANA—The water supply outlook for Montana is fair to excellent for the 1959 irrigation season. Missouri River Basin streams are expected to flow from 80 to 114 percent of average with Columbia River tributaries forecast at 109 to 166 percent of average. An exceptionally heavy snowpack covers the headwaters of the Swan and Blackfoot rivers and Mission Range with measurements all above previous records covering 20 years. This is likely to cause high water on the Blackfoot and Clark Fork rivers above Missoula and also in the Swan River to Big Fork.

Soil moisture conditions under the snowpack and in irrigation areas are relatively good. Irrigation and power production reservoirs contain slightly more than average carryover storage this April 1.

NEBRASKA—Water supplies along the North Platte in Nebraska are expected to be very favorable in 1959. Storage in the channel reservoirs in Wyoming serving the North Platte project contain a normal amount of water credited to the western Nebraska irrigated area. Snowpack in the mountains of Colorado and Wyoming is above normal and inflow to the reservoirs is forecast at near average. Soil moisture in the irrigated areas is very good as a result of recent storms. Reservoir storage in the state serving the main Platte Valley is also much above normal. Streamflow last year was high in this area.

NEVADA—Water users who do not hold reservoir storage rights are faced with critically short supplies. Fortunately, reservoir storage is above normal, and those who do have storage rights can expect adequate, but limited supplies.

Forecasts on the Owyhee River in northern Elko County are for about 20 percent of normal streamflow, 12 percent on the Humboldt River at Palisade, and about 50 percent on the Walker, Carson, and Truckee-Tahoe. Central, eastern, and southern Nevada, with no reservoir storage, face a short-water season.

April 1 storage in seven important reservoirs was 78 percent of capacity or 120 percent of the 1938–52 normal. Lake Tahoe stores 563,000 acre-feet at elevation 6227.63 above sea level, and is not expected to approach the legal maximum. Rye Patch Reservoir on the Lower Humboldt is 123 percent of the April 1 normal. Bridgeport and Topaz reservoirs on the Walker River system are full.

NEW MEXICO—Following two good water years, a severe shortage of irrigation water is in prospect for the Rio Grande through New Mexico. Snowpack is less than 50 percent of normal on the watershed in Colorado and New Mexico. Above Elephant Butte, water shortage will be similar to that experienced in the 1953–56 period. The outlook below Elephant Butte in New Mexico and Texas is improved because of over 1,000,000 acre-feet in storage. However, with minimum inflow forecast to Elephant Butte the outlook is considered fair to poor in this area.

Although streamflow from snowmelt will be negligible into Conchas Reservoir on the Canadian River and Alamogordo Reservoir on the Pecos River, the water supply outlook is relatively good. Storage in these reservoirs is well above average and will provide a reasonably adequate water supply.

OKLAHOMA—With practically no precipitation on the Altus project in Oklahoma since the fall of 1958, the water supply outlook is poor. Soils are very dry. Storage in Altus is about 150 percent of normal, but unless spring precipitation is normal or better, the water supply will not be adequate.

OREGON—Water content of the mountain snowpack in Oregon averages only 61 percent of the April 1 normal. The soil mantle under the mountain snowpack is still only partially wet except on the main Cascades and in the northeastern Oregon counties where moisture penetration is satisfactory. Soils in southeastern Oregon are exceptionally dry.

Stored water in 22 irrigation reservoirs is 110 percent of the average April 1 amount. Good carryover supplies from last year help to make the outlook this year more favorable. Reservoired water will literally "save the day" for many areas this season.

Forecasts of April–September runoff range from lows of 17 and 26 percent normal on Owyhee and Silvies Rivers to near 100 percent on the Applegate, Illinois, and Wallowa Rivers. Other forecasts for the April–September runoff (in percentages of normal) are as follows: Malheur River, 55; Burnt, 60; Powder, 68; Grande Ronde, 68; Umatilla, 86; Walla Walla, 77; John Day, 76; Crooked, 48; Deschutes, 74; Willamette, 85; North Umpqua, 85; Rogue, 69; Klamath Lake, 90; Chewaucan, 55; Blitzen, 56.

SOUTH DAKOTA—Water supply outlook for irrigation areas near the Black Hills is fair. Storage is below normal. Soil moisture conditions in irrigated areas are reported as fair to poor.

TEXAS—The water supply outlook for West Texas along the Pecos and Rio Grande is fair to poor. Storage is above normal in Elephant Butte on the Rio Grande and Red Bluff Reservoir on the Pecos, but inflow to these reservoirs from snowmelt will be negligible. Soil moisture conditions in irrigated areas are poor.

UTAH—A fair water supply is in prospect for the area bounded on the north by the tributaries of Bear River in Idaho and Wyoming, and on the south by the Upper

Duchesne River and the streams draining into Utah Lake. Most streams here will yield from about 70 to 95 percent of average flow. South of this area to the Arizona State line and in the Uintah Basin, other than the Upper Duchesne, the outlook is for only fair to critically short water supplies. In this area forecasts vary between 16 and 76 percent, with most forecasts in the 30 to 60 percent range. Reservoir storage in the State generally is above average and will prove to be a vital factor for those having rights to its use.

WASHINGTON—Snowpack in the State of Washington varies from 75 percent to 145 percent of normal. Forecasts of streamflow vary from 75 percent to 121 percent of normal. Snowfall has been very good in the northern part of the State and in the tributary basins of the Okanogan, Similkameen and Pend Oreille Rivers. Snowpacks are below normal in those watersheds which lie south of the Wenatchee River along the east slope of the Cascades and south of the Skykomish River west of the Cascades.

The soil mantle beneath the snowpack is wet, as indicated by soil moisture measurements. Reservoirs used for irrigation and power show above normal storage for this time of year.

Substantial gains have been made in the snowpack during the late winter months. The water supply picture, then only fair, has improved to its present state of good over most of the State.

WYOMING—The water supply outlook for Wyoming irrigated areas is relatively good. Streamflow will generally be near to or only slightly below normal. There is, however, an area of snowpack deficiency on the Popo Agie watershed. The snowpack on a small area of the northern slope of the Bighorn Mountain is at a record high, but the record period is short.

With near normal inflow and carryover storage the water supply along the North Platte is good, although there may be some deficiency on the Laramie and smaller tributaries. Soil moisture in irrigated lands is good.

The flow of the Bighorn River will be below normal. Storage in Boysen Reservoir as well as in smaller irrigation storage reservoirs on the Wind River is very low. Inflow to Buffalo Bill Reservoir on the Shoshone River is expected to be near average but storage is very low.

The flow of the Green River will be generally less than average, but will be adequate to meet local water demands.

WATER STORED IN WESTERN RESERVOIRS

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1958	Mar. 31, 1959
Region 1	Baker	Thief Valley	17,400	17,800	17,400
	Bitter Root	Lake Como	34,800	8,300	21,800
	Boise	Anderson Ranch	423,200	165,700	290,700
		Arrowrock	286,600	123,700	275,100
		Cascade	654,100	291,400	407,100
		Deadwood	161,900	50,400	70,500
		Lake Lowell	169,000	152,100	154,300
		Lucky Peak	278,200	194,900	180,800
	Burnt River	Unity	25,200	12,300	19,200
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	2,034,000	2,672,000
		Banks Lake	761,800	751,100	764,500
		Potholes	470,000	231,800	277,800
	Deschutes	Crane Prairie	55,300	55,000	54,000
		Wickiup	187,300	195,000	200,000
	Hungry Horse	Hungry Horse	2,982,000	1,669,100	1,839,600
	Minidoka	American Falls	1,700,000	1,691,600	1,603,100
		Grassy Lake	15,200	12,900	11,900
		Island Park	127,200	127,400	126,900
		Jackson Lake	847,000	490,400	484,900
		Lake Walcott	95,200	80,600	93,400
	Ochoco	Ochoco	47,500	38,300	31,800
	Okanogan	Conconully	13,000	8,300	9,700
		Salmon Lake	10,500	9,700	8,900
	Owyhee	Owyhee	715,000	637,500	523,800
	Palisades	Palisades	1,202,000	758,600	724,000
	Umatilla	Cold Springs	50,000	50,000	50,000
		McKay	73,800	66,100	68,500
	Vale	Agency Valley	60,000	57,200	34,500
		Warm Springs	191,000	180,000	133,800
	Yakima	Bumping Lake	33,700	27,200	8,100
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	170,600	341,800
		Kachess	239,000	139,900	190,700
		Keechelus	157,800	87,200	118,700
		Tieton	198,000	114,600	140,400
Region 2	Cachuma	Cachuma	201,800	107,200	200,200
	Central Valley	Folsom [2]	920,300	[2] 569,900	472,200
		Jenkinson Lake	40,600	41,200	40,800
		Keswick	20,000	18,300	17,200
		Lake Natoma	8,800	1,900	8,500
		Millerton Lake	427,800	386,200	243,100
		Shasta Lake	3,998,000	3,740,200	3,280,000
		Lake Thomas A. Edison	125,100	(1)	61,700
	Klamath	Clear Lake	513,300	414,100	287,400
		Gerber	94,300	86,700	55,100
		Upper Klamath Lake	524,800	471,400	406,300
	Orland	East Park	50,600	49,200	50,900
		Stony Gorge	50,000	45,700	51,200

[1] Not reported.
[2] Corps of Engineers Reservoir.

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1958	Mar. 31, 1959
Region 3	Boulder Canyon	Lake Mead	27, 207, 000	19, 092, 000	20, 735, 000
	Parker-Davis	Havasu Lake	216, 500	72, 200	565, 800
		Lake Mohave	1, 809, 800	1, 737, 900	1, 702, 800
	Salt River	Apache Lake	245, 100	239, 000	242, 000
		Bartlett	179, 500	145, 000	71, 000
		Canyon Lake	57, 900	54, 000	53, 000
		Horseshoe	142, 800	106, 000	43, 000
		Roosevelt	1, 381, 600	264, 000	405, 000
		Sahuaro Lake	69, 800	64, 000	48, 000
Region 4	Eden	Big Sandy	38, 300	([3])	5, 100
	Fruitgrowers Dam	Fruitgrowers	4, 500	4, 500	4, 000
	Humboldt	Rye Patch	190, 000	100, 300	123, 200
	Hyrum	Hyrum	15, 300	12, 200	12, 900
	Mancos	Jackson Gulch	9, 800	7, 800	4, 000
	Moon Lake	Midview	5, 800	5, 400	6, 200
		Moon Lake	35, 800	([3])	10, 500
	Newlands	Lahontan	290, 900	234, 000	254, 000
		Lake Tahoe	732, 000	625, 200	554, 400
	Newton	Newton	5, 400	3, 800	2, 300
	Ogden River	Pineview	110, 200	4, 700	22, 000
	Pine River	Vallecito	126, 300	66, 200	47, 000
	Provo River	Deer Creek	149, 700	95, 800	86, 100
	Scofield	Scofield	65, 800	41, 500	35, 700
	Strawberry Valley	Strawberry Valley	270, 000	159, 800	157, 700
	Truckee Storage	Boca	40, 900	9, 000	2, 100
	Uncompahgre	Taylor Park	106, 200	83, 100	56, 700
	Weber River	Echo	73, 900	43, 500	38, 600
Region 5	W. C. Austin	Altus	162, 000	92, 200	86, 500
	Balmorhea	Lower Parks	6, 500	6, 200	5, 700
	Carlshad	Alamogordo	122, 100	100, 000	124, 400
		Avalon	6, 000	1, 600	1, 900
		McMillan	32, 300	25, 600	29, 900
	Colorado River	Marshall Ford	1, 837, 100	840, 300	746, 500
	Middle Rio Grande	El Vado	194, 500	38, 200	2, 800
	Rio Grande	Caballo	340, 900	123, 000	185, 200
		Elephant Butte	2, 185, 400	705, 000	889, 100
	San Luis Valley	Platoro	60, 000	30, 400	34, 000
	Tucumcari	Conchas [2]	467, 300	153, 600	254, 800
	Vermejo	Reservoir No. 2	2, 900	1, 800	2, 500
		Reservoir No. 13	5, 000	3, 200	4, 200
		Stubblefield	16, 100	8, 300	8, 900
Region 6	Missouri River	Angostura	92, 000	58, 100	50, 600
		Boysen	710, 000	212, 600	100, 100
		Canyon Ferry	1, 615, 000	1, 169, 900	1, 346, 200
		Dickinson	13, 500	6, 100	5, 800
		Fort Randall [2]	4, 900, 000	2, 289, 600	2, 979, 000
		Garrison [2]	18, 100, 000	4, 565, 000	3, 965, 900
		Lake Taschida	218, 700	72, 100	78, 300
		Jamestown	39, 200	13, 000	11, 400
		Keyhole	190, 300	2, 800	4, 700
		Lewis and Clark Lake [2]	385, 000	288, 700	306, 400
		Pactola	55, 000	14, 600	19, 400
		Shadehill	300, 000	80, 900	86, 000
		Tiber	762, 000	87, 300	145, 500
	Belle Fourche	Belle Fourche	185, 200	78, 200	58, 200
	Fort Peck	Fort Peck [2]	14, 839, 000	3, 399, 700	5, 136, 900
	Milk River	Fresno	127, 200	63, 500	86, 800
		Nelson	66, 800	47, 900	42, 500
		Sherburne Lake	66, 100	23, 700	36, 900
	Rapid Valley	Deerfield	15, 100	11, 600	9, 300
	Riverton	Bull Lake	152, 000	60, 600	45, 500
		Pilot Butte	31, 600	20, 700	12, 100
	Shoshone	Buffalo Bill	380, 300	130, 000	13, 600
	Sun River	Gibson	105, 000	31, 200	61, 900
		Pishkun	30, 100	12, 100	19, 400
		Willow Creek	32, 400	20, 600	28, 700
Region 7	Colo.-Big Thompson	Carter Lake	108, 900	100, 500	81, 500
		Granby	465, 600	286, 300	246, 000
		Green Mountain	146, 900	70, 900	49, 100
		Horsetooth	141, 800	116, 200	95, 400
		Shadow Mountain	1, 800	1, 200	600
		Willow Creek	9, 100	3, 000	2, 000
	Missouri River Basin	Bonny	167, 200	43, 100	40, 900
		Cedar Bluff	363, 200	185, 400	171, 900
		Enders	66, 000	36, 000	32, 100
		Harlan County [2]	752, 800	274, 000	247, 200
		Harry Strunk Lake	85, 600	33, 600	35, 800
		Kirwin	304, 800	81, 500	80, 900
		Swanson Lake	249, 800	116, 300	118, 000
		Webster	257, 400	54, 600	69, 500
	Kendrick	Alcova	24, 500	27, 900	27, 100
		Seminoe	957, 000	561, 400	597, 200
	Mirage Flats	Box Butte	30, 400	25, 700	24, 400
	North Platte	Guernsey	39, 800	30, 000	8, 300
		Lake Alice	11, 200	1, 900	4, 400
		Lake Minatare	59, 200	31, 800	37, 600
		Pathfinder	1, 010, 900	797, 000	186, 400
Alaska Dist	Eklutna	Eklutna Lake	160, 000	94, 900	60, 400

[2] Corps of Engineers Reservoir.

[3] Includes some superstorage above active capacity.

New Commissioner of Reclamation

Continued from page 38

During World War II, from 1944 to 1946, he served as a lieutenant in the U.S. Naval Reserve. As a military government staff officer on islands of the Pacific reoccupied by Allied forces, he was responsible for the development and administration of agricultural programs.

Mr. Dominy was born in Hastings, Nebr., in 1909 and was educated in the Hastings public schools and Hastings College. He obtained his B.A. degree in agriculture from the University of Wyoming in 1932 and did postgraduate work at the University of Wyoming and Columbia University.

He married Alice Criswell of Adams County, Nebr., December 23, 1929. They have three children and one grandchild: Mrs. Janice Elaine DeBolt and daughter, Jancey Lynn, of Torrington, Wyo.; Charles E. Dominy, a cadet at the U.S. Military Academy at West Point; and Ruth Ellen Dominy, 12, who lives at home with the Dominys at Oakton, Va. ##

SODIUM CHLORATE AND SAFETY

The use of sodium chlorate as a weed control material is not generally recommended because of its dermatitis and fire hazard problems. If used, sodium chlorate and other chlorate weed-killing compounds should be handled with extreme caution. The following precautions should be rigidly observed:

1. Sodium chlorate should not be permitted to come into contact with the skin or the eyes. If it gets on the skin or in the eyes, the chemical must be removed immediately by thoroughly flushing the surfaces with water.

2. Sodium chlorate should be stored in tightly covered metal containers. The containers should never be opened in buildings; or placed in fields where there is any livestock.

3. Should sodium chlorate be spilled on the clothing, such clothing, since it constitutes a dangerous fire hazard when dry, should immediately be removed and thoroughly washed. Rubber boots and gloves should be worn by workmen when spraying with the chemical.

4. A person should not be permitted to walk or ride, or to move equipment of any kind through treated areas, and livestock should be kept out of such areas until after a heavy rain, as even slight friction is likely to ignite the vegetation and cause serious fire damage. Areas near buildings where fires might result in loss of life or property should not be sprayed. Smoking should be prohibited while applying sodium chlorate or while working around sodium chlorate containers, equipment, or treated areas. #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5048	Weber Basin, Utah	Jan. 28	Construction of earthwork, pipelines, and structures for trunklines 1.9, P-3.7, and P-20.5; and East Layton, East Sand Ridge, West Sand Ridge, and Val Verda pumping plants.	Olsen Construction & Engineering Co., Ogden, Utah.	$561, 236
DC-5116	Fort Peck, Mont	Jan. 15	Construction of stage 01 additions to Dawson County substation.	Electrical Builders Associated, Valley City, N. Dak.	212, 942
DC-5117	Colorado River Storage, Paonia Participating Project, Colorado.	Jan. 7	Construction of Paonia Dam and relocation of State Highway No. 133.	Bud King Construction Co., Missoula, Mont.	3, 167, 176
DC-5119	Central Valley, Calif	Jan. 12	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County Road, Stoney Creek to Ridgeville.	Sierra Construction Co., Inc., Merced, Calif.	815, 238
DC-5126	Washita Basin, Okla	Feb. 9	Construction of earthwork, structures, and concrete pipelines for Anadarko aqueduct, Western Farmers Electric Cooperative lateral, and Fort Cobb lateral.	B and M Construction Corp., Oklahoma City, Okla.	1, 372, 551
DC-5129	Missouri River Basin, Kans.	Mar. 11	Construction of earthwork and structures for Osborne canal, Sta. 335+54.1 to 1069+64.4; and laterals and drains. Schedules 1 and 2.	Bushman Construction Co., St. Joseph, Mo.	1, 434, 548
DC-5136	Boulder Canyon, Ariz.-Calif.-Nev.	Mar 18	One 115,000-hp vertical-shaft, hydraulic turbine for Unit N-8, Hoover powerplant.	Baldwin-Lima-Hamilton Corp., Eddystone Division, Philadelphia, Pa.	1, 422, 800
DS-5138	Boulder Canyon, Ariz.-Calif.-Nev.	Mar. 20	One 168-inch butterfly valve for Unit N-8, Hoover power plant.	Todd Shipyards Corp., Seattle Division, Seattle, Wash.	418, 006
DC-5140	Columbia Basin, Wash	Mar. 18	Construction of Sand Hollow pumping plant and discharge line, Block 83.	Lewis Hopkins Co., Pasco, Wash.	216, 631
DC-5154	Missouri River Basin, Colo.	Mar. 23	Reconductoring 29.34 miles of Flatiron-Greeley 115-kv transmission line.	Crawford Electric Co., North Platte, Nebr.	179, 966

Construction and Materials for Which Bids Will Be Requested Through June 1959*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	1 100,000-kva, 16,500-volt, 3-phase, 180-rpm, vertical shaft, hydraulic-driven generator for Hoover powerplant, Unit N-8.
Central Valley, Calif.	Constructing the indoor-type Corning canal pumping plant, an intake channel, an outlet structure, a switchyard, and discharge lines. Southeast of Red Bluff.
Do	1 3 phase, 3,750 kva, class OA, 60-kv delta to 2.4/4.16-kv wye power transformer with lightning arresters for Corning canal pumping plant switchyard.
Collbran, Colo.	Constructing 58,300 linear feet of the Bonham-Cottonwood pipelines of either precast concrete cylinder pipe (pretensioned) or steel pipe, including gate valves, air valves, and linemeters. Near Collbran.
Do	Constructing about 11.5 miles of 8- to 10-foot bottom width unlined canal and about 0.1 mile of 10-foot bottom width earth-lined canal. Southside canal, near Collbran.
Colorado River Storage, Ariz.	4 40- by 52.5-foot radial gates for Glen Canyon dam. Estimated weight: 1,416,000 pounds.
Do	6 7- by 10.5-foot outlet gates, liners, and anchor bolts for Glen Canyon dam. Estimated weight: 1,343,000 pounds.
Do	4 100,000-pound-capacity double-drum electric hoists for Glen Canyon dam. Estimated weight: 178,800 pounds.
Colorado River Storage, Utah.	1st phase clearing, about 6,400 acres, of the Flaming Gorge reservoir site. About 17 miles east of Linwood.
Columbia Basin, Wash.	Constructing about 13.9 miles of open ditch drains and about 4,250 feet of closed drains. Near Mesa, Othello, Quincy, and Moses Lake.
Klamath, Calif.	Constructing an outdoor-type pumping plant with a wood superstructure set on wood piling, 3 25-efs pump units, and 30-inch steel discharge pipes for each pump terminating in a concrete outlet structure. Tule Lake Division, southwest of Tule Lake.
Middle Rio Grande, N. Mex.	Constructing about 5 miles of the 14-foot bottom San Juan Feeder canal, excavating about 1 mile of 150-foot-wide pilot channel, and installing metal jetty units. Near Belen.
Milk River, Mont.	Rehabilitating the Sherburne Lake dam outlet works by installing new high-pressure slide gates, placing additional concrete in the outlet works intake tower and in wingwalls at downstream portal of the outlet works conduit, and placing riprap at the downstream portal of the outlet works conduit. On Swiftcurrent Creek, southwest of Babb.
MRB, Minn.	Granite Falls (Stage 04) substation additions will consist of constructing concrete foundations, furnishing and erecting an extension to the existing steel structure and minor new structures, installing 3 230-kv circuit breakers, 1 15,000-kva reactor and associated switches and other electrical equipment, major items of which will be Government furnished.
MRB, Nebr.	Constructing the Merritt dam, an earthfill structure 120 feet high, 3,100 feet long, and containing about 1,500,000 cubic yards of material, appurtenant structures, and an access road. About 25 miles southwest of Valentine.
MRB, S. Dak.	Sioux Falls (Stage 05) substation additions will consist of constructing concrete foundations, furnishing and installing steel structures, and installing a 115-kv circuit breaker and associated electrical equipment, major items of which will be Government furnished.
Do	Modifying the Shadehill dam outlet works stilling basin and constructing a 72-inch steel pipe drop structure. On the Grand River about 15 miles south of Lemmon.
MRB, Wyo.	Constructing the Gray Reef dam, an earthfill structure 30 feet high and 800 feet long, and a concrete-gated spillway. About 2.5 miles downstream from Alcova dam.
Do	Additions to the Pilot Butte switchyard will consist of grading and fencing a new switchyard area, constructing concrete foundations, furnishing and erecting steel structures, installing a 115-kv transformer, circuit breakers, and associated electrical equipment, major items of which will be Government furnished. North of Riverton.
Do	Additions to the Boysen switchyard will consist of minor modifications to the 115-kv bus structure, constructing concrete foundations for and installing 2 115-kv circuit breakers, and installing 115-kv switches and associated electrical equipment, major items of which will be Government furnished. 13 miles south of Thermopolis.
Okanogan, Wash.	Installing 2 54-inch cast-iron slide gates and hoists in Conconully dam outlet works. 14 miles northwest of Omak.
Rogue River Basin, Oreg.	Constructing 9 33- to 51-inch precast concrete pipe (pretensioned) siphons totaling about 2,835 feet long, a reinforced concrete bench flume about 330 feet long, 6 concrete checks, and a check and wasteway on the East lateral, near Ashland.
Do	Constructing about 9 miles of 65-cfs-capacity unlined canal, and about 1.5 miles of 130-cfs-capacity unlined canal, and 3 stream inlet structures. South Fork and Daley Collection canals, east of Medford.
Do	Constructing the Phoenix canal diversion dam, a 150-foot-long concrete structure with uncontrolled crest, earth embankments at each end, a reinforced concrete headworks structure with 12- by 10.5-foot radial gate control, and a reinforced concrete fish screen structure with a 5-foot-diameter by 17-foot-long revolving drum fish screen. Northeast of Talent.
Washoe, Nev.-Calif.	Constructing the Prosser Creek dam, an earthfill structure 139 feet high, 1,850 feet long, and containing about 1,700,000 cubic yards of material, a concrete spillway and outlet works structures, and relocating about 1 mile of county road. On Prosser Creek, northeast of Truckee, Calif.
Weber Basin, Utah.	Constructing the second phase of Willard dam, involving the excavation and placement of 9,500,000 cubic yards of earth material, which will bring the embankment to a maximum height of 20 feet and a length of about 15 miles. At Willard Bay, 11 miles northwest of Ogden.
Do	Constructing about 14,300 linear feet of 12- to 24-inch-diameter precast reinforced concrete pipe for heads of 75 to 125 feet, including pressure reducing valves, gate valves, air valves, blowoffs, linemeters, and turnouts; and earthwork and structures for about 12,400 linear feet of unlined open ditch laterals with bottom widths of 2, 3, and 4 feet. Woods Cross laterals, near Salt Lake City.
Do	Constructing about 9,000 linear feet of 6- to 12-inch pipelines with gate valves, air valves, blowoffs, and linemeters. The pipelines may be constructed of mortar-lined and coated or coal-tar enamel painted steel pipe, precast reinforced concrete pipe, precast concrete cylinder pipe (pretensioned), cast-iron, or cement-asbestos pipe. Ricks Creek laterals, near Salt Lake City.

*Subject to change.

U.S. GOVERNMENT PRINTING OFFICE : 1959 O—500383

United States Department of the Interior
Fred A. Seaton, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington 25, D.C.

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The Reclamation Era

AUGUST 1959

IN THIS ISSUE:

One Ditch System
Flaming Gorge

Official Publication of the Bureau of Reclamation

The Reclamation Era

AUGUST 1959 Volume 45 No. 3

In this issue . . .

J. J. McCARTHY, Editor

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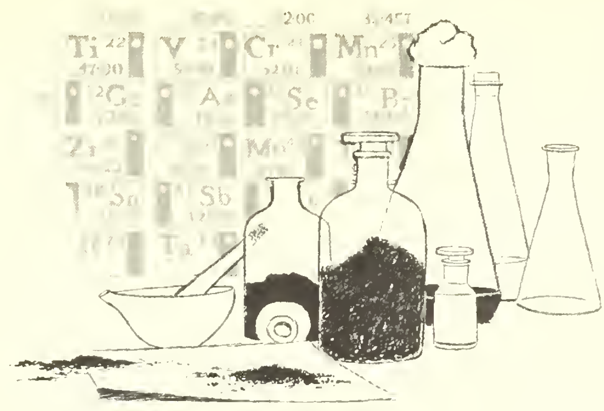


THE IMPORTANCE OF MINOR ELEMENTS

The chemist analyzes the ash of plants to determine its mineral composition. Invariably he finds that the mineral components of plants make up from 5 to 10 percent of the total dry weight and this small quantity may contain 50 or more chemical elements present in concentrations which vary from the minutest trace to as high as 3 to 4 percent. The remainder of the dry weight of the plant, 90 to 95 percent, consists of carbon, hydrogen, and oxygen. That average of 7-percent minerals content, though relatively small, is most vitally important. Without the minerals available to its functions, life as we know it would not be possible.

Of the large number of mineral elements present in trace amounts in the plant ash only a half dozen or so are recognized by plant physiologists as essential. They are iron, copper, zinc, boron, manganese, and molybdenum. Cobalt, sodium, chlorine, fluorine, iodine, and possibly vanadium are essential to animal life but, insofar as is now known, are not needed by plants.

During the last 30 years scientists have gradually learned more and more about the role of trace elements in plant, microbial and animal physiologies. But the surface has only been scratched. The need exists for more precise and complete information regarding the relationship of these trace elements to the proper functioning of the organism. Some of the elements, for example, are known to act as the indispensable unit in organic enzymes. One investigator regards these trace elements as "tools in the process of growth." They probably engage in a chemical reaction as a catalyst to speed it along, then come out of that to repeat the same role in another reaction and so on. Cobalt, for example, occurs in the central atom in a molecule of vitamin B12.

The discovery of the vital role that trace elements play in the life processes of plants and animals about 25 years ago was rather dramatic. In Australia it was demonstrated that a minute supplement of cobalt kept sheep in normal, vigorous health while sheep that were pastured on cobalt-deficient land declined in health and died.

Iron was the first trace element recognized as essential to animal life. Most of the iron in our bodies is found in the red pigment of the blood—the hemoglobin. Experience has shown how certain visual symptoms in plant foliage are associated with deficiencies of trace elements. These symptoms, also popularly called "hunger signs," can be very helpful to farmers and soil scientists if they can be properly interpreted. Very often it may be too late to apply corrective measures when the "hunger signs" show up noticeably.

by VINCENT SAUCHELLI, Chemical Technologist, National Plant Food Institute, Wash., D.C.

These symptoms generally refer to unbalanced plant food sources in the feeding root zone. They may indicate deficiencies of the major elements as well as of trace elements.

It is recognized that trace elements may become deficient in sandy soils or sandy soils containing so-called raw humus much sooner than in loam soils. This is very true when such soils have a high pH value, except perhaps in the case of molybdenum. However, sandy soils which have received applications of farmyard manue tend to maintain a more or less satisfactory content of manganese, copper, and boron.

The occurrence of trace element deficiencies varies from one area to another. Many observers report that deficiencies seem to be associated with soils in which one kind of crop is grown continuously, as say in a vineyard or orchard. Furthermore, it is possible to induce a deficiency of several trace elements by an excessive application of lime. This points up the importance of testing the soil in order to determine the quantity of lime needed to adjust the pH to the proper needs of the crop.

Boron deficiency seems more widespread than that of the other trace elements. Borax is the most common carrier applied to soils to correct boron deficiency. Great care is needed to avoid applying an excess of this element to any particular crop since an overdose may prove toxic. In Florida, for example, celery growers are advised to apply not more than 10 pounds an acre to prevent "crack stem," whereas growers in the Northeast may apply as much as 40 pounds per acre to an alfalfa crop without injurious results.

Iron deficient leaf compared to normal leaf, Redlands Mesa, Mesa County, Colo. ***Photo by A. F. Hoffman.***

Magnesium deficiency as shown on Kieffer pear leaves.

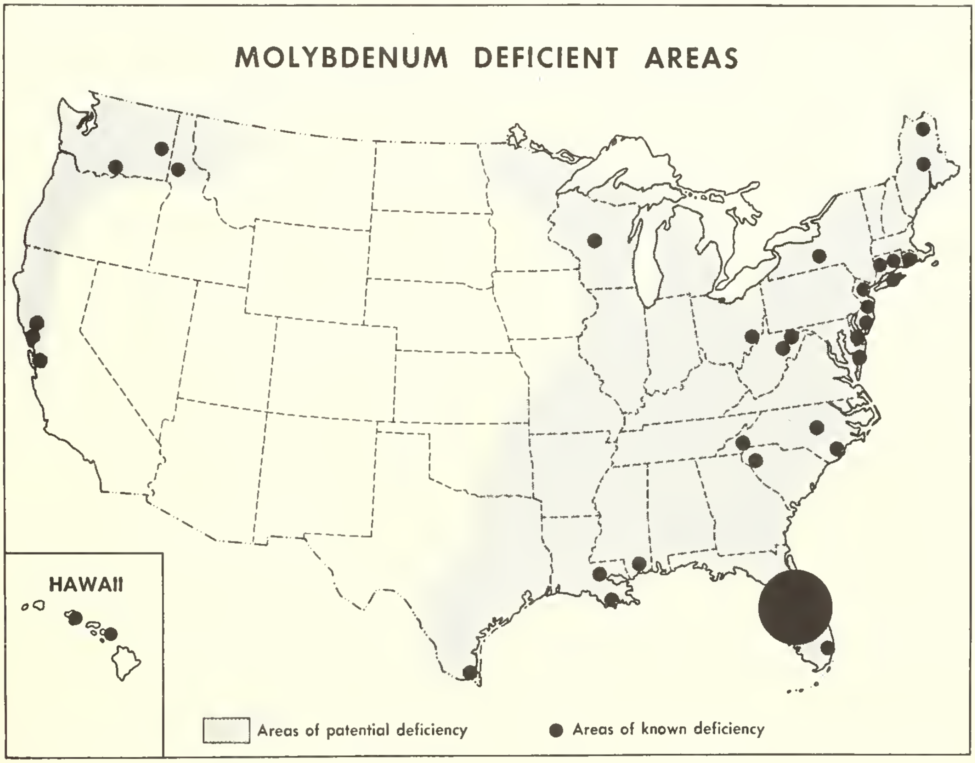
Lettuce grown in nutrient solutions shows effect of molybdenum on growth.

Growers with crops on alkaline marl and muck soils apply 50 pounds per acre of manganese sulfate to maintain the attractive green color in the foliage. Pecan growers apply zinc sulfate to control "pecan rosette," or white-bud of corn. Citrus growers of Florida find it necessary to use magnesium, manganese, copper and zinc according to the symptoms appearing in the foliage.

It was slowly but definitely been forced upon farmers in many parts of the country to appreciate that the elements other than nitrogen, phosphorus, and potassium can be of major importance also in growing a crop of normal, vigorous plants. For, no matter how carefully one plans his fertilizer, cover-crop and soil management practices, he cannot afford to neglect to recognize the importance of providing adequate amounts of the trace elements if he wants maximum, profitable yields.

With the recognition that trace elements are vitally important to plants and animals, scientists are beginning to insist that more precise soil tests should be developed for their detection and determination. It is unsatisfactory to wait for foilar "hunger signs" before doing something corrective: yield response to trace elements have been very often obtained in the entire absence of any visual symptoms of deficiency. # # #

Map showing areas of potential deficiency and areas of known deficiency.



GLENDO DEDICATION

SECRETARY FRED A. SEATON

On the plains of Wyoming, more than 6,000 people assembled on June 9 to celebrate completion of Glendo Dam, Reservoir, and Powerplant, newest units in the harnessing of the North Platte River.

The presence of Secretary of the Interior Fred A. Seaton and Commissioner of Reclamation Floyd E. Dominy, a dedication program of entertainment, a buffalo barbeque, and the huge new lake itself combined to attract the remarkably large crowd.

Secretary Seaton, dedicating the facilities, pointed out that the Glendo Unit will make a major contribution to the prosperity of the North Platte Valley, through supplemental irrigation, production of electric energy, and flood control benefits.

Others participating in the ceremony were REA Administrator David A. Hamil, Wyoming Gov. Joe J. Hickey, Iowa Gov. Herschel Loveless, and Maj. Gen. Keith Barney, Division Engineer of the Corps of Engineers of Omaha and Chairman of the Missouri Basin Inter-Agency Committee.

Commissioner Dominy addressed a banquet attended by 200 persons in nearby Douglas the evening of June 9. The banquet both celebrated the Glendo features and was in connection with an MBIAC meeting in Douglas on June 10.

Miss Jeanie Waters of the town of Glendo was "Miss Glendo." Accompanied by beauty queens representing the State of Wyoming and the cities of Casper and Cheyenne, "Miss Glendo" smashed a bottle of champagne against a rock from the dam as the symbol of completion of the dedication.

Glendo Dam is 190 feet high, of earthfill construction and included an ungated concrete spillway. Glendo Reservoir's capacity is nearly 800,000 acre-feet, including 272,800 acre-feet for flood control. On dedication day, the reservoir contained about 525,000 acre-feet, its normal "full" capacity. The big, new body of water, 80 miles southeast of Casper and 110 miles north of Cheyenne, already is being heavily used for recreation.

#

COMMISSIONER FLOYD E. DOMINY

one ditch system

The one-ditch irrigation drainage system was constructed originally for drainage only. Its purpose was to control high water tables in swamp and overflow land bordering the Sacramento River and in the Sacramento-San Joaquin Delta. The system is just what its name implies—one ditch serves both as an irrigation distribution system and as a drainage collection system. Commonly a central drain 7 to 9 feet deep is constructed down the slope of the land and collectors 6 to 7 feet deep are dug at right angles to the main on a flat grade. The size of the ditches is determined by winter flood runoff requirements as flood runoff is larger than summer irrigation demand. In the larger districts main drains usually have 6- to 10-foot bottoms while the collectors have 4-foot bases.

Here is how the system operates:

During the irrigation season water is introduced into the mains at the upper end of the system. In the Sacramento, San Joaquin Delta area, where the river water level is higher than the ground surface, water is siphoned into the system from the adjacent river or delta tidal channels. The irrigation supply within the system is controlled by a series of gates and checks which serve to back the water into the secondary drains or ditches. The controls, installed primarily at road and field crossings, serve to keep the irrigation supply from piling up in the lower end of the system. Normally the summer irrigation supply occupies the bottom 3 to 4 feet of the combined use ditches. The individual farmer then lifts the water from the ditch onto his land through portable pumps similar to those shown in the accompanying photograph. Water is applied through either sprinkler systems or conventional gravity methods.

From the foregoing it is obvious that the one-ditch system is most advantageous in areas where a drainage system is required. Lands having 2 to 10 feet fall to the mile lying predominantly in one plane such as valley troughs and lake bed areas describe the conditions best suited to a one-ditch system.

The advantages of a one-ditch system are best

by J. A. McKEAG
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Sacramento, Calif.

demonstrated by comparison with a conventional irrigation and drainage system under similar conditions. The first obvious advantage is the elimination of dual rights-of-way with the resulting saving of farm land. A second advantage is savings in cost of construction. The few controls required in the one-ditch system plus savings in rights-of-way and added construction costs, compared to a separate conventional gravity irrigation system, would result in savings of $75 to $100 an acre. In addition, an annual saving of $2 to $3 an acre in the operation and maintenance costs would be realized. These savings more than offset the added costs of pumping required to lift the water from the ditches onto the adjacent land. Costs of pumping vary from 5 to 10 cents per acre-foot per foot of lift depending upon whether water is pumped with a permanent electric-driven pump installation or by a portable gas-driven pump. In the Sacramento, Sacramento-San Joaquin area the water requirements average 2½ to 3½ acre-feet per acre, and the net lift is about 5 feet. In other words to lift 3 acre-feet of water 5 feet at 5 cents per acre-foot would cost 75 cents an acre.

Other advantages are: reduced maintenance in the drain system as the depth of water during the summer season restricts weed growth in the drain to the edges; because of reliance on drains for irrigation supply both the districts and the individual farmer keep the drains in good repair; with a portable pump "turnout," diversions can be made from anyplace along the drain eliminating need for head ditches and adding flexibility to field layout.

In actual practice, the shallow drains probably give as good a net control of water level as a conventional dual system having unlined irrigation ditches. In this system there are no water surfaces above ground surface to create hydrostatic pressures. Canal and distribution system losses are eliminated and irrigation flows return immediately to the drains rather than ponding at the ends of the fields. In addition, because irrigation water is diverted by pumping from the drain ditch supply, and pumping is a direct cost to the farmer, he has an added incentive not to over irrigate or to let the water run.

It might be argued that the shallow depth of effective drainage during the summer months would make such a system ineffective in controlling salinity. It is true that surface and subsurface flows return immediately to the irrigation supply and might be expected to deteriorate the quality of water and, hence, salt up the land especially at the lower portion of the system. The answer lies in what has happened where the system has been in use. After some 30 years of one-ditch irrigation and drainage on 750,000 acres in the Sacramento-San Joaquin Delta no damaging saline condition has been reported at any time or place, nor is there evidence of salt damage to any

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Robert and Chuck Brown checking the operation of their pumping unit. The unit is pumping more than 1,000 gallons per minute. Water delivery is from the Bartley Canal, Missouri River Basin project, Nebraska. *Photo by L. C. Axthelm.*

RECREATION AND THE COLORADO RIVER STORAGE PROJECT

Today, more than ever before, the out-of-doors is providing the recreation opportunities people of this country are seeking for their increasing leisure time. In the past 10 years visits to national parks have almost doubled and visits to State parks have slightly more than doubled.

One of the major attractions is water—a lake for boating, fishing or swimming, or to provide a scenic setting for a picnic or a campsite. More and more, recreationists are looking for water where they may launch their boats. It is estimated that more than 7 million Americans now own recreational boats, about 3 times as many as 10 years ago. Rivers, the seacoasts, and natural lakes help to meet the demand for places to use boats, but in many parts of the country these resources are being supplemented, to an increasing extent, by manmade lakes.

Studies conducted for the National Park Service in various sections of the country have added to our knowledge of preferences affecting the demand for water-connected recreation. In the Southwest, picnicking, swimming and fishing were found to be the three most popular forms of outdoor recreation. In the Northeast, these forms of recreation were included in the four most popular activities. In studies made in river basins in the Plains States and in the Middle Atlantic region, these activities were also found to be among the five top-ranking activities.

Each of the surveys contained questions designed to measure the extent of unmet recreation demand. Two of the studies provided an opportunity for the individuals reporting to indicate the number of persons not taking part in various activities who would do so if the activity were readily avaliable. In both of these studies, boating was found to be the top-ranking activity in terms of the number of additional persons who would like to participate. Fishing was in second place, while other top-ranking activities were picnicking, swimming, hunting, and ice skating. These answers, and the answers to similar questions in the other surveys, show a consistent pattern of high popularity for recreational activities that require water areas.

Recognizing the popularity of water recreation and the public demand to use reservoirs for recreation, Congress authorized recreation as one of the beneficial uses of the Colorado River Storage Project. Here is an opportunity not only to enjoy water-connected recreation but to do so in a region of top recreational appeal.

The scenic and scientific values of the Upper Colorado Basin have been known since the days of the early explorers. In 1941 the National Park Service undertook an extensive study of the recreation resources of the entire river basin. The report of the survey states: "The Colorado River Basin is one of the outstanding recreational regions in the United States because of its great variety of natural scenery, climatic conditions, areas and objects of scientific interest, and abundant evidence of prehistoric occupation. * * * Here one may enjoy a large amount of sunshine and find perfect climates and settings for various

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types of outdoor recreation the year around * * *. The majority of the proposed reservoirs * * * will create new recreational resources benefiting the basin."

The Colorado River Storage Project Act provides the broadest authority relating to recreation at reservoirs ever authorized by Congress to best promote recreational development and operation to serve the public interest. Section 8 of the act states:

"In connection with the development of the Colorado River Storage Project by the Bureau of Reclamation, including participating projects, the Secretary is authorized and directed to investigate, plan, construct, operate, and maintain (1) public recreational facilities on lands withdrawn or acquired for the development of said project or of said participating projects, to conserve the scenery, the natural, historic, and archeologic objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects by such means as are consistent with the primary purposes of said projects * * *."

Following enactment of this legislation, the National Park Service began studies and plans for recreational developments and facilities at those reservoir sites where construction of the dams, by the Bureau of Reclamation, was under way or scheduled at an early date. For a number of the areas, only preliminary general development plans have been prepared, because of limited access to much of the area surrounding the larger reservoir basins.

Aerial view looking almost due north to the site where Stanaker Dam will be constructed. ***Photo by Stan Rasmussen.***

General view of Damsite, Glen Canyon Unit, Colorado River Storage project. ***Photo by J. L. Digby.***

A preliminary general development plan has been completed for the Glen Canyon reservoir area. This reservoir will lie in the heart of the canyon lands of southern Utah and northern Arizona. This area is one of the most rugged, roadless, and inaccessible regions within the continental limits of the United States. Lands on either side of the river canyons present a profusion of greatly eroded winding gorges, ridges and hills. In the background, sheer cliffs and mesa-topped buttes, broken by an occasional mountainous uplift, complete a landscape of vivid color and awesome space. With the reservoir, relatively easy water access will be available to this outstanding canyon country.

The plan for recreation use of the reservoir area shows three major developments. The major sites, when fully developed, will provide facilities for activities directly associated with water and for camping and picnicking, as well as meals, lodging and other services to the public.

First to be developed is the Wahweap site, an area a few miles northeast of the dam, in Arizona and adjacent to a new major highway. Adequate

The completed Wanship Dam shortly before its dedication on May 9, 1957. ***Photo by Stan Rasmussen.***

topographic data has made it possible to prepare a master plan for the area. The plan has been approved, and construction is under way and will continue as rapidly as funds become available.

Other major development areas are proposed in the vicinity of Warm Creek and the Colorado River and where Bull Frog Creek enters the river.

Minor development sites have been chosen at Hole-in-the-Rock and Shock Bar. These sites will serve the boat traveler and fishermen and offer limited accommodations and services.

The Bureau of Reclamation has provided vista houses and parking areas on each side of the river below the dam and has provided uniformed guides who can give information to visitors interested in the construction of the dam.

It is expected that the Glen Canyon reservoir area will be administered by the National Park Service as a National Recreation Area, similar to the Lake Mead National Recreation Area. As a start toward that administration, Mr. James M. Eden was assigned, in May 1959, as project manager of the recreation area, with headquarters at the Wahweap site and residence in Page, Ariz. As funds became available, additional personnel will be assigned for administration, protection, and interpretation.

The Service estimated an expenditure of $10 million as the cost of Federal recreation development at the Glen Canyon area. Concessioners will, no doubt, spend at least $5 million on capital investments. It is expected that the recreational use of the Glen Canyon area will be well over a million visitor-days annually.

An outstanding point of interest for the recreationists who will be attracted to the reservoir is Rainbow Bridge. This unique natural feature, protected for future generations by establishment of Rainbow Bridge National Monument in 1910, is greater than any other known natural bridge in size, color, and in its almost perfect symmetry. The arch of salmon pink sandstone, curving in

Left, artist's conception of Navajo Dam on the San Juan River, east of Farmington, N. Mex. Right, artist's conception of the Flaming Gorge Dam to be constructed on the Green River in Eastern Utah. ***Art work by Harold Gill.***

the form of a rainbow, rises 309 feet above the bottom of the gorge.

Concern over the possibility that the Glen Canyon Reservoir might actually damage the natural bridge has been based on such factors as the effect of a permanent body of water at the base of the abutments of the bridge, or of wave action against the abutments, the change in the water table, and the composition and porosity of the rock. Authority to take action to avoid the danger of gradual disintegration of the rock foundation of the bridge is contained in the Colorado River Storage Project Act. The act provides that as a part of the Glen Canyon Unit the Secretary of the Interior shall take adequate protective measures to preclude impairment of the monument. Under the Secretary's direction, the Bureau of Reclamation and the National Park Service have made joint studies to determine the best means of providing adequate protection.

Among the other areas where general development planning has been undertaken are the Flaming Gorge and Navajo units of the Storage Project.

Flaming Gorge Reservoir will provide a large body of water in a semiarid region enhanced by outstanding scenic surroundings. Located near the Continental Divide, with its north-south belt of national parks, national forests and resorts, the reservoir will be located in a vacation area

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Flaming Gorge Reservoir area. Looking downstream on the Green River.

safety is everybody's business

Everyday in the year

by FORREST E. BYRNS, Commissioner's Office, Washington, D.C.

All illustrations courtesy of the National Safety Council

Each year, it is customary for the President of the United States to issue a proclamation designating the last full week in July as "National Farm Safety Week." In accordance with that custom, President Eisenhower this year so designated the week beginning July 19, 1959.

By the time this issue of the Reclamation Era is distributed to its readers, that week will be past. The principal objective of such designation, however, is to remind all of our farm residents throughout the country that farm safety is a problem that concerns all of us, and not only for 1 week of the year, but every day of every week of every year.

The health, safety, and prosperity of our rural families are vital to the strength of this Nation. Accidents suffered by the rural inhabitants of this country result in thousands of injuries, many deaths, and considerable property loss each year, and constitute a serious problem.

The number of these accidents can be reduced—if we will all join in a continuing campaign, every day in the year, to prevent needless accidents on the farms, in the fields, and on the farm-to-market highways.

There are two basic kinds of accidents. First, those resulting from mechanical causes such as unguarded machinery; worn or otherwise defective rope, tools, and other equipment; holes in platforms and flooring, etc.; and secondly, those resulting from personal causes such as fatigue, ignorance, carelessness, thoughtlessness, recklessness, insubordination, "horseplay," and other such human failings.

All these causes of accidents can be brought under control by the intelligent and conscientious farmer who recognizes it as his duty to study the hazards on his farm, whether they be mechanical or personal, and to take appropriate steps to eliminate or make them harmless.

Past accidents can be valuable guides in preventing similar ones in the future. Above all, the farmer or farm worker must not allow himself to fall into the mistaken attitude that accidents always happen to "the other fellow" and never to himself. He may be that other fellow next time. Vigilance is the necessary price of farm safety.

Unlike the factory worker, the farm worker lives at his place of work and so he is exposed to the hazards of his occupation for longer periods. Safety rules and regulations enforced by systems of inspection and fines for violation help to protect the factory worker. On farms the rules of safety must necessarily be enforced by the farmer himself.

Each farm is a unit in itself and as such is responsible for its own safety. It is the farmer and his helpers who must keep the farm a safe place on which to work and live.

It is probably the every day negligences that cause most farm accidents. They may not be spectacular, but they disable workers, add to labor problems, increase insurance costs, and reduce farm income. Farm safety depends on continuing vigilance, with constant checking, repairing, and maintenance of equipment in good order. A few minutes spent in removing an obvious hazard will save many a hard-earned dollar. The following check lists of common farm hazards may be of assistance in helping our readers to eliminate accidents on the farm. Every farm operator is urged to give thoughtful consideration to each item to determine if there are any suggestions or reminders here which might improve his own operations.

Autos, Trucks, and Tractors

1. Keep trucks and autos in good mechanical condition. Brakes, steering mechanism, tires, and lights should be checked frequently.

2. Make sure your drivers are licensed, and see that they obey State vehicle laws.

11. Don't drive a tractor at over four and one-half miles per hour during off-the-road operation.

12. Do all pulling from the tractor draw bar. Don't hitch anything to the axle.

13. If someone is helping to hitch an implement to the tractor, be careful not to back into him with the tractor.

Machinery

1. Guard V-belts, pulleys, chains, sprockets, power takeoffs, and gears on your farm machinery against accidental contact.

2. Guards removed for repair or other purposes should be put back as soon as possible.

3. Never clean machines with gasoline or liquified petroleum gas. Use a high flash point solvent.

4. Turn off the power before adjusting or cleaning machinery.

3. Warn workmen about the hazards of riding in open and flat bed trucks.

4. Before transporting employees in trucks, enclose the truck bed on all sides and provide fixed seats.

5. Lash a load securely to the truck.

6. Don't overload a truck.

7. Don't allow workmen to ride on top of loads.

8. Don't allow workmen to ride with their legs hanging outside the truck.

9. Before starting a tractor motor, see that it is out of gear and that the brake is set.

10. Don't operate a tractor on dangerous inclines or too near steep banks or irrigation ditches.

5. Keep children away from machinery.

6. Don't step over or under moving belts.

7. Don't wear loose or torn clothing or torn or ragged gloves near moving machinery.

8. Don't climb over or around a combine or thresher that is operating.

9. Don't get in front of a mowing machine to make adjustments while it is in gear.

10. Make sure that your workers know the proper way to use farm equipment for the job they do.

11. Never operate a spray tower or other ele-

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FLAMING GORGE

The Flaming Gorge Unit is one of the four storage reservoirs authorized for construction on the Colorado River Storage Project. The principal features of the unit are the Flaming Gorge Dam, powerplant, and switchyard. The dam is located on the Green River about 6 air miles south of the Utah-Wyoming State line in Daggett County, Utah. The dam, community of Dutch John and about 27 miles of the reservoir are located inside the Ashley National Forest.

Daggett County is located in the extreme northeastern corner of the State of Utah and prior to the start of construction of Flaming Gorge Dam its population was about 350 people. The county is bisected by the Green River which flows through deep colorful canyons. Prior to construction of a bridge across the river by the Bureau of Reclamation the inhabitants of the eastern part of the county were obliged to travel some 100 to 120 miles through Rock Springs and Green River, Wyo., to reach Manila, Utah, the county seat of Daggett County. Daggett County contains some of the most beautiful and the most rugged terrain in the State of Utah and abounds in excellent fishing streams and big game hunting areas.

The dam is to be a thin arch-type concrete structure having a structural height of about 495 feet above its foundation with a crest length of 1,180 feet and containing about 922,000 cubic yards of concrete. The powerplant, located at the downstream toe of the dam, will have 3 generating units, each of 36,000 kilowatt capacity. A 2-lane roadway will cross the crest of the dam and eventually will become a link in the primary highway connecting U.S. 30, near Green River and Rock Springs, Wyo., and U.S. 40 at Vernal, Utah. The

by JEAN R. WALTON, Construction Engineer, Flaming Gorge Unit, Dutch John, Utah

reservoir will have a storage capacity of 3,930,000 acre-feet and will extend upstream some 91 miles to within 4 or 5 miles of Green River, Wyo. The area draining into the reservoir will cover 15,000 square miles in Wyoming and Utah. The normal maximum water surface of the reservoir will be at elevation 6,040 with the crest of the dam at elevation 6,047.

Actual work on the Flaming Gorge Unit was initiated when the Bureau of Reclamation established a temporary project office in Vernal, Utah, in August of 1956. Most of the field engineering crews were required to live in trailers at Manila, Utah, or to commute from Green River, Wyo. This arrangement was necessary until sufficient facilities and housing were constructed at the damsite to permit moving the project headquarters and personnel near to the site of the work.

The first actual construction was started following the award of a contract to the Wangsgaard Construction Co. of Logan, Utah, in January 1957, for construction of the first 7½ miles of access road and a temporary timber pile bridge across the Green River. With completion of a second access road construction contract in June 1958, a road connection was made between Dutch John, on the east side of the river and Manila, Utah, and

Above, Flaming Gorge Unit. Dutch John, Utah, Utah's newest town. Right, looking downstream on the Green River. *Photo by F. B. Slote.*

Green River, Wyo., on the west side of the river.
The area that was selected for the community site was probably one of the most isolated and inaccessible locations in the State of Utah. It was visited very infrequently by a few sheep and cattle men and by numerous hunters during the big game season. The area around the community of Dutch John abounds with deer during the latter part of the hunting season as it has throughout the past been a migratory feeding ground during the

Government campsite at Manila, Utah. Log cabin in foreground is the Bureau's first field office in the Manila area.

winter months for deer from the higher country.

The only semblance of civilization in the Dutch John area was the Pacific Northwest high pressure gas pipeline and a dirt airstrip.

A contract was awarded to the Witt Construction Co. of Provo, Utah, in July 1957, for the construction of the community facilities at Dutch John. The amount of this contract was slightly under two and three quarter million dollars. The contract covered the general grading for the community, construction of streets and sidewalks, construction of a sewer collecting system, a sewage treatment plant and ponding areas, a water distribution system, a power distribution system and the construction of 80 O and M type residences. In January 1958, when it appeared that the prime contract for the construction of the dam and powerplant would be delayed 1 or 2 years, this contract was modified to delete 30 of the 80 residences.

Work was started on the contract in August 1957 and was substantially complete in February 1959.

Other construction required at Dutch John for establishment of the community, consisted of erection of Transa-houses and trailers, construction of two temporary warehouses, construction of temporary metal garages, and construction of a laboratory, administration building, and garage and fire station. These facilities have all been completed and the community is now taking on a finished appearance.

The Daggett County school district with the help of Federal funds, awarded a contract in September 1957 for the construction of a four classroom school building at Dutch John which was completed and ready for classes by September 1958. The grade school at Dutch John accommodates the first six grades and a kindergarten. Children in the seventh and eighth grades and in high school are transported by bus some 20 miles to Manila, Utah.

The first Bureau of Reclamation people were moved into Dutch John in January 1958, and by May 1958, sufficient Transa-homes and trailers and utilties were available to accommodate most of the organization.

Bids for the construction of Flaming Gorge Dam and powerplant ranged from a low of $29½ million to a high of over $50 million. The low and successful bidder was the Arch Dam Constructors of Omaha, Nebr. This company is a joint venture consisting of Peter Kiewit Sons' Co., Omaha, Nebr.; Morrison-Knudsen Co., Boise, Idaho; Midvalley Utility Constructors, Houston, Tex.; and Coker Construction Co. of Omaha, Nebr. Peter Kiewit Sons' Co. is the sponsor and is running the job for the joint venture.

The prime contract was awarded on June 18, 1958, and notice to proceed was issued on July 1, 1958. Since the latter date, the contractor has completed most of its camp construction and most of the construction in its shop and warehouse areas.

The contractor has worked throughout the winter on the construction of the access road from Dutch John to the left abutment of the dam and on the powerplant service road to river level in order to gain access to the damsite for heavy construction equipment. All of this road work has been very heavy construction consisting in the main part of exceptionally deep rock cuts. The construction of these roads is now nearing completion.

The Coker Construction Co., one of the joint venture, excavated the diversion tunnel in the right abutment of the dam. The diversion tunnel

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Administration building, Bureau of Reclamation, Dutch John, Utah.

N. B. BENNETT, Jr.

WILLIAM I. PALMER

KEY PERSONNEL CHANGES

Selection of two new assistant commissioners of the Bureau of Reclamation was announced recently by Secretary of the Interior Fred A. Seaton. They are both from the ranks of the Bureau career service.

They are: N. B. Bennett, Jr., who will be Assistant Commissioner for Engineering and Power, and W. I. Palmer, who will be Assistant Commissioner for Project Development and Irrigation.

The new appointments were made on the recommendation of Commissioner Floyd E. Dominy, head of the Bureau of Reclamation.

The new Assistant Commissioners in addition to the Assistant Commissioner for Administration, A. R. Golze, and the Assistant Commissioner and Chief Engineer, Grant Bloodgood, who headquarters at the Reclamation Engineering Center in Denver, Colo., complete the Bureau's top command.

Mr. Bennett was chief of the Division of Project Development, a position he held since 1953. A native of Sheridan, Wyo., he received a B.S. in civil engineering from the University of Nebraska He first worked for the Bureau of Reclamation in 1933 on construction of Kendrick project in Wyoming. After some private employment and 3 years as assistant State engineer and engineer-secretary for the Wyoming Water Conservation Board, he returned to the Bureau of Reclamation in 1942 as assistant engineer at the Salem, Oreg., field office.

A year later he transferred to the office of the Chief Hydraulic Engineer at Denver. In July 1945 he transferred to Washington, D.C., as Assistant Chief of the newly created Division of Engineering Surveys in the Branch of Project Planning. He became Assistant Director of the Branch in 1946 and Director in 1953.

Mr. Bennett also serves as Chairman of the U.S. section of the International Engineering Board with Canada on water problems of the Souris-Red and the Wateron-Belly Rivers.

Mr. Palmer, who was Chief of the Irrigation Division, is a native of Cedar City, Utah, and received a B.S. degree in agricultural economics at Utah State Agricultural College, Logan, Utah. After a period of private employment he entered the Federal service in 1935 as manager of the Widtsoe land-use adjustment project of the Department of Agriculture in southern Utah.

He served in various other capacities in the Department of Agriculture, particularly in the

Resettlement Administration and Soil Conservation Service, before transferring to the Bureau of Reclamation in 1944. He has worked in Bureau of Reclamation Regional offices in Salt Lake City, Utah, and Sacramento, Calif., as well as in Washington, D.C.

Prior to being named Assistant Chief of the Irrigation Division in 1956, Mr. Palmer was Chief of the Contracts and Economics Branch where he administered a billion dollar repayment program. He was named Chief of the Irrigation Division in January 1958.

LEON W. HILL

Another key personnel appointment was announced by Interior Secretary Fred A. Seaton. This was the promotion of Regional Irrigation Supervisor LEON W. HILL to the position of Regional Director at the Bureau's Region 5 Office in Amarillo, Tex. This appointment was also made upon Commissioner Dominy's recommendation.

Mr. Hill was born in Winters, Tex., and holds a BA from New Mexico A & M and a masters degree from the University of Texas. He first taught at Las Cruces Union high school, New Mexico, and, in 1936, began his Federal career with the Department of Agriculture.

He remained with the Department of Agriculture until the war when he served with the Army Corps of Engineers in the Pacific. He was discharged as a lieutenant colonel in March 1946.

He then worked briefly with the Department of Agriculture in Washington until appointment as an agricultural economist in the Irrigation Division of the Amarillo office of the Bureau of Reclamation in July 1946. He was named chief of the allocations and repayment branch in 1948, assistant regional irrigation supervisor in 1950 and regional supervisor in 1952. As Regional Director he will have general supervisory responsibility for Bureau of Reclamation affairs in Texas, Oklahoma, New Mexico and the Rio Grande basin area in southern Colorado. #

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the RECLAMATION ERA, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

Sound-Slide Film on Molybdenum in Agriculture Produced by Climax

The story of the trace element molybdenum—an essential nutrient in the growth and development of crops—is portrayed in a new sound-slide film produced by Climax Molybdenum Co. and available for presentation before agricultural and farm groups.

Presented in a combination of photographs and lively cartoon art, the film points out how molybdenum can spell the difference between crops of high yield and quality and those of low or average harvest and health. The film highlights an important new method of application whereby seed is treated before planting. Also featured is a newly developed form of molybdenum, known as Moly-Grow.

Called "Moly-Gro Means Money," the film is in color, runs some 15 minutes in length, and can be used on either automatic or manually operated sound-slide film projectors. It can be obtained on loan from: Climax Molybdenum Co.; Division of American Metal Climax, Inc., 500 Fifth Avenue, New York 36, N.Y. #

Safety Is Everybody's Business

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vated equipment within 6 feet of high voltage lines.

Hand Tools

1. See that portable electric hand tools have a 3-pronged plug for automatic grounding.
2. Replace broken or splintered handles on axes, sledges, hammers, picks, and other hand tools. Handles should fit tight and should be free from splinters.
3. Dress and round off mushroomed heads of "shock" tools, such as wedges, chisels, and sledge hammers.
4. Keep edged tools such as knives, axes, and chisels sharp and at the proper cutting angle.
5. Provide storage space for hand tools in a proper place, such as a tool house, bin, rack, or box. Keep them there when not in use (leaving hand tools scattered around may cause injury).
6. See that workers know how to use hand tools correctly.
7. Use the proper tool for the job.

Ladders

1. Always inspect a ladder before using it.
2. Store your ladders, under cover, horizontally, with sufficient supports to prevent sagging.
3. Check all ladders and repair them before harvesting or pruning begins.
4. Don't paint ladders, for paint hides defects. Use oil or clear varnish.
5. Never stand higher than the second rung from the top.
6. Don't overreach when on a ladder.
7. Don't carry heavy or unwieldy loads on a ladder.
8. If a portable straight ladder is used on a smooth surface, prevent slipping by nailing cleats against the feet of the ladder or use safety shoes on the ladder.
9. If possible, use stepladders less than 10 feet high. Never use stepladders more than 20 feet high.
10. Use orchard or single pole ladders on soft ground only.
11. Use the right ladder for the job. Don't use makeshift ladders.
12. Don't leave ladders where children may climb them or run into them.

13. Don't place a metal ladder where it can come within 6 feet of a high voltage line.
14. Face the ladder when climbing or descending it.

Work Areas

1. Keep floors, ramps, and runways clear of slippery material.
2. Place standard handrails around ladder openings and stairways.
3. Place standard guard rails on all platforms and working surfaces that are more than 4 feet above the ground.
4. Keep walks and passageways clearly lighted and free from obstructions.
5. Repair broken flooring.
6. Place a standard guard around open holes in the floor.

7. Provide trapdoors over floor openings and keep the trapdoors closed. When it is necessary to have trapdoors open, keep floor openings guarded.

8. Keep floors and working areas free of debris and other obstructions.

9. Secure men against slipping or falling before they begin to repair roofs or clean gutters.

10. Don't store loose materials above shoulder height.

11. Remove nails from loose boards without delay.

12. Keep farmyards clear of garden tools, forks, rubbish, and waste.

13. Make sure that staging and scaffolds are well constructed, well braced, and well guarded.

Animals

1. Approach an animal from the side or front, and speak to it as you approach.

2. Keep children away from pens and barns.

3. Use a staff when handling bulls.

4. Keep a bull in a strong pen having emergency exits.

5. Don't clean a bull pen while a bull is in it.

6. Use special care in handling animals with newborn young.

7. Don't antagonize or teas animals.

In the Home

1. Keep stairways free from any obstructions.

2. Keep stairways and hallways properly lighted.

3. Provide a strong handrail on all stairways.

4. To reach things above you, use a ladder. Don't use chairs or makeshift devices.

5. Don't let the electrical parts of an appliance become wet.

6. Don't use a lamp cord to supply current for equipment or appliances.

7. Never turn on a light, or touch electrical equipment, while you are in a bathtub.

8. If you are standing on a wet floor, don't plug in electrical equipment.

9. Don't touch any grounded metal, such as radiators or water faucets, while handling an electrical appliance.

10. Don't run extension cords through door openings or under rugs.

11. From time to time, inspect electrical toys and other appliances for defective or worn cords.

12. If you think that an electrical appliance may be faulty, check it at once, and repair it if necessary.

13. Store matches, poisonous materials, acids, and flammable substances out of reach of children.

14. Be sure that poisons are clearly labeled.

15. Don't allow paper, rags, or other combustible rubbish to accumulate in attics, basements, or closets.

16. Don't use gasoline or kerosene to start a fire.

17. Don't use gasoline or naphtha as a cleaning solvent.

18. For ashes, use only metal containers.

19. Don't use coins to repair burned out fuses.

20. Provide a metal or asbestos stand for your iron.

21. Don't let handles of cooking utensils extend beyond the stove.

22. Make sure that all firearms are unloaded. Keep ammunition locked up.

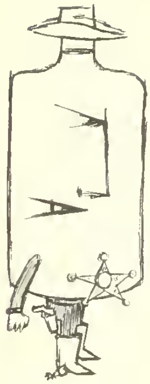
23. Keep stair carpeting securely fastened, and all small rugs anchored.

24. Don't light a gas stove or furnace if you think gas is escaping.

25. Be sure you know the location of gas, water and electricity shutoffs, in case of emergency.

26. Be sure that firefighting apparatus is in good condition and ready for use.

The true wealth of our Nation lies not only in its natural resources, but in its human resources. The safeguarding of these priceless human resources, therefore, is the soundest possible investment for the farmer, for his family, and for his community. # # #



a new western HERO

There is a new law man at work in the irrigated West. Like many famous enforcers of law and order in the old West, he is known by a variety of names. To Dr. René Blondeau (technologist for the Shell Development Co. which has been conducting experiments with the new product) he is known as F–98. He is a member of the growing family of herbicides. His chemical identity is C3 H4 O, and his real name is Acrolein. A potential protector of the public's interest in canals and laterals, he can make it tough on public enemies of the irrigation world—namely, pond weeds.

Last summer, this public hero made short work of such desperadoes as Sago, Giant Sago, Richardson, and other pond weeds, and all the algae. His activities, so far on an experimental basis, ranged from Arizona to Washington, and from Idaho to Florida. He worked in irrigation canals, large and small, drain ditches, and ponds.

Sometimes he was strong; sometimes he was weak; but always astoundingly effective for almost unbelievable distances. Not only did he kill his victims, but he caused them to disappear. The weeds became flaccid almost immediately, gradually disintegrated, and floated away. In a week or 10 days, they simply could not be found in the channels they formerly choked.

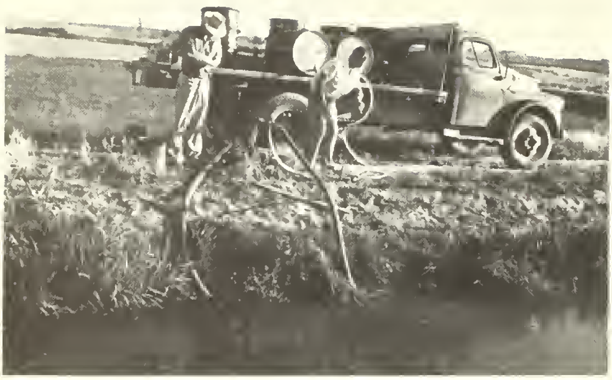
This public protector's method of operation is simply to break down plant cells by reacting with various of their vital enzyme systems. This destroys all plant tissue above ground. Since the tissues slough off gradually, there is no clogging of canal structures by debris. Contrast this to the old mechanical method of ditch digging with chains which merely breaks aquatic weeds loose and often requires removal by hand or machine of loose weeds as they pile up farther downstream.

One of the irrigation canals in which this new herbicide operated in Idaho last summer was the Notus Canal in the Boise Valley. This canal has an infamous reputation for its ability to grow pond weeds. Its water supply comes primarily from drains and therefore, has all the help it needs for continuing infestation. It is a small canal having a capacity of 150 second feet at its heading, and decreasing until at Mile 28, it runs only about 5 cubic feet per second. Laterals leading from the canal start at Mile 10 and come in at intervals downstream.

Experimental wholesale raids on the pond weeds in this system started on the night of July 7, 1958, at 10 p.m., when the writer began pumping F–98 into the head of the Notus Canal. The material was applied in a reduced canal flow of 100 second feet at the rate of 250 gallons over a period of 1 hour.

Passage of this water-loving hero through the body of the canal dealt speedy death to the pond weeds. Not even densely matted weeds growing

by JOHN WALKER, Manager, Black Canyon Irrigation District, Notus, Idaho



Left, application of experimental herbicide, F98, for pond-weed control, Notus Canal, Black Canyon irrigation district, Notus, Idaho. Right, cutting and removal of pond-weeds by hand.

along the waterline could escape, for this killer penetrated into hidden places that other weed killers (such as aromatic solvents) would pass by.

What did this chemical do? It destroyed the pond weeds for over 25 miles in a single application, and eliminated many other undesirable inhabitants of the canal, including snails and hosts of liver flukes which are harmful to farm animals. It lowered the water surface and made possible the delivery of more water to farms.

It was not difficult to follow its path. F–98 is strong, so strong, that one-fourth part per million in the atmosphere can be detected by anyone. Five parts per million in the air will drive a man away. The effect is like that of tear gas.

In strong solutions, F–98 is dangerous to crops, so it must ultimately be diluted or destroyed. In the Notus Canal experiment, all laterals were closed off and the water was confined to the canal and drains until the "slug" of F–98 had passed through. In conjunction with the weed killing experiment, crop tolerance tests were run on a variety of crops grown on the Black Canyon project. To summarize—what are the good and bad traits of F–98? The advantages:

(1) High efficiency for great distances.
(2) Excellent solubility in water.
(3) Speedy and positive action.
(4) Easy detection.

The disadvantages:

(1) Need for exceptionally careful handling (shipping in heavy drums, proper storage, careful application).

(2) In high concentrations, hazardous to crops and fish.

Will this product find a place in keeping canals and drains clean? Those of us who have experimented so far think so. Like the aromatic solvents which have been replacing the old inefficient and time-consuming systems of dragging with chains, this new weed killer is a time and labor saver. Two or three applications per year will keep canals weed-free. It has some definite advantages over aromatic solvents. It is a deadly killer, but one that can be controlled, and 1959 will see continued experiments to improve its effectiveness at concentrations which will not damage crops. Some progress on this has already been reported since the Notus tests. # # #

Mosquito Control

An interesting but little known aspect of Reclamation's work in California is mosquito abatement. At present the Bureau has contracts with six abatement districts for cooperative mosquito control on Government rights-of-way for Central Valley project canals and reservoirs. Through these contracts the Bureau reimburses abatement districts the moderate costs of the work they perform. In addition, field forces do considerable draining and filling of low spots to prevent mosquito development. The joint program has also reduced mosquito-borne diseases.

One Ditch System

Continued from page 62

of the crops although some 40 commercial crops varying from truck to alfalfa are produced in the area. In fact, many of the operators, when asked about the effect of the relatively shallow water table during the irrigation season, claim advantages from subirrigation rather than any ill effects. It may be that the success of the system results from good quality water diverted from the Sacramento River, thus preventing a deleterious concentration from building up in any one season. Further, the average annual winter rainfall is about 15 inches. This quantity of water is probably sufficient to flush out any seasonal accumulation. In any case, if a concentration should build up in the lower part of the system, some fresh water could be shoved through the system or the system drained, thereby flushing out any accumulated salts.

While the one-ditch system is applicable only for special terrain and water supply situations it merits consideration for many locations where a two-ditch system is now in use. # # #

Typical farm pumping unit lifting water from one-ditch system. Note weed restricted to sides because of depth of water.

It takes only 50 years to wash down 7 inches of topsoil that has taken thousands of years to build up—*Twentieth Century Fund.*

CROP REPORT

The Bureau's annual crop summary reveals that a record high crop value of over $987 million was produced in 1958. The Reclamation crop amounted to about 5 percent of that of the U.S. as a whole in terms of value but was produced on only 2 percent of its cropland.

The Chief Joseph Dam and Michaud Flats Projects and the Glendo Unit of the Missouri River Basin Project initiated irrigation operations in 1958, bringing to 79 the number of operating projects.

The addition of 222 thousand acres to the irrigable service area of Reclamation projects brought the total to 8,049,642 acres. Of this, 6,756,737 acres were irrigated; the remainder being taken up in rights-of-way, farmsteads and other farm uses or awaiting leveling, ditching and other land development needs on the farms.

Full irrigation service lands comprised 4,256,301 acres of the irrigable area and were distributed among 57 projects. Supplemented irrigation service was provided to 35 projects. Thirteen of the projects included in each of the service categories included land areas which received both full and supplemental irrigation service.

The farms and cities which are provided water from Reclamation facilities represent homes and livelihoods for 9.7 million persons in the 17 Western States. Population on the 103 thousand full-time farms and 26 thousand part-time farms exceeds 490,000 persons. Urban encroachments on Reclamation projects have removed from farming use about 2 percent of the irrigable area. About 791,000 persons reside in these suburban fringe areas. Thirty-two projects provide municipal and industrial water service to some 106 municipalities and 68 industrial entities, benefitting directly about 8.4 million persons.

Visitors flocked to Reclamation reservoirs in greater numbers in 1958 than ever before. A total of 164 reservoirs received an estimated 19.5 million visitor days of recreational use. Peak day use exceeded one-half million persons. #

Flaming Gorge

Continued from p. 72

with an inside diameter of 26 feet and will be concrete lined to an inside diameter of 23 feet. It is 1,100 feet long. Open cut excavation at the inlet portal was started in the fall of 1958 and actual tunneling operations got underway about the first of January 1959. The diversion tunnel was holed through on March 2, 1959. Since then the subcontractor has completed the removal of the 5-foot invert segment of the circular tunnel, which was left in for a roadway, and the removal of tight projections of the rock. The excavation is now complete.

Arch Dam Constructors started the concrete lining of the diversion tunnel in May 1959 and expect to have this completed and be able to divert the flow of the Green River through the single diversion tunnel in August or September. Cofferdams will be constructed upstream and downstream of the dam and powerplant foundation areas in order to permit the unwatering of this portion of the river channel for construction of the dam and powerplant.

Concrete will be placed in the dam in 7½ foot lifts. The full length of the dam consists of 24 blocks, each block being about 50 feet in length. Placement of concrete will be by cableways 1,900 feet long extending from the left to the right abutment of the dam using 8 cubic yard buckets. The fixed headtower of the cableways will be located above the left end of the dam and the movable tailtowers, moving in an arc of 190 feet radius, will be located on the right side of the river. Two cableways will be used in placing the mass concrete in the dam.

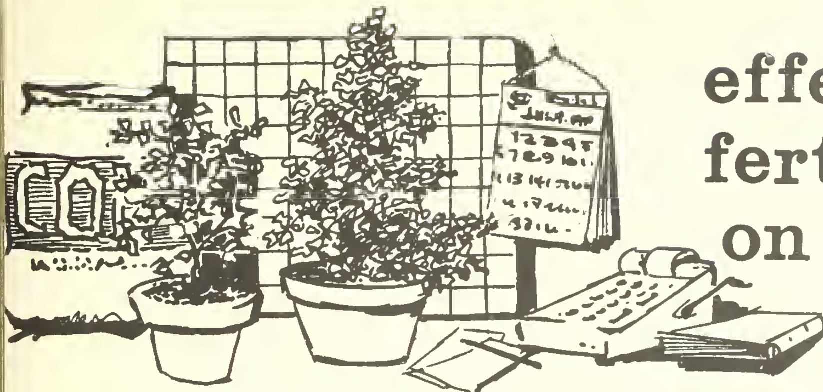
The contractor's construction program calls for starting excavation of the spillway tunnel, located in the left abutment, in August. This work will continue throughout the remainder of the summer and through the winter. Placing of concrete in the dam is expected to start in June of 1960 and be completed in the late fall of 1962. Concrete placement will be restricted to the months of April through October of each construction season due to the freezing weather during the winter months. All work under the Arch Dam Constructors contract is scheduled for completion in July of 1963.

It is anticipated that reservoir storage will start in the fall of 1962. The first generating unit is scheduled to go into operation about the middle of the summer of 1963 with the remaining two units to follow at intervals of 3 to 4 months. All construction and installation of equipment for Flaming Gorge Unit is scheduled to be completed by the middle of the summer of 1964.

Many changes have been made in this isolated area in the northeast corner of Utah during the past 2 years. There are now nearly three times as many people living in Dutch John as previously inhabited the entire county of Daggett. By the middle of this summer good roads will be available to Dutch John and to the Flaming Gorge Dam from both Vernal, Utah and Green River, Wyo. Construction is in progress to provide visitors with easy access and excellent facilities from which to view the construction work in progress.

Aerial view of Dutch John, Utah, and surrounding area. ***Photo by F. B. Slote.***

Diversion tunnel outlet, Flaming Gorge Dam. Outline is sketched on picture.



effect of fertilization on crop yields

by CARL W. CARLSON [1]

When land is placed under irrigation it is important that farm operators adjust crop production practices to take full advantage of irrigation water. If irrigation water is properly used, one of the biggest production variables, namely moisture, will be under control. Two other production factors which the farmer may control are fertilization of the soil and plant population. Both have a marked influence on yield.

Most of the information available on the effects of these two crop production variables has been obtained by studying these variables individually. In order to make recommendations to the farmer, the simultaneous effects of varying both fertilization and plant population should be known. For example, many experiments have been conducted to determine the value of commercial fertilizer on the production of corn. If the trial was conducted at a single plant population, the effect of nitrogen added was undoubtedly greatly affected by the plant population chosen.

As plant population increases the average yield of an individual plant decreases. Undoubtedly this is caused by a decrease in the supply of those production factors that each plant has to share with its competing neighbors. It has been found that when the number of plants growing on an acre of land is increased, the plant food requirement per acre is also increased. If maximum returns from high rates of fertilizer application are to be obtained, it is necessary to have a sufficient number of plants to efficiently utilize the fertilizer applied. However, there is a limit to the number of plants that can be grown on an acre even though the fertility level of the soil may be high. This limitation is brought about by factors other than soil fertility, such as light, becoming important.

A 3-year study with corn in North Dakota has shown that when no nitrogen fertilizer was applied, an increase in plant population resulted in an increase in silage yield but a decrease in grain yield. Similar work done in South Dakota showed a decrease in grain yield and no consistent effect on silage yield when plant populations were increased and no nitrogen was applied. At both locations this decrease in corn grain yields was apparently brought about by a deficiency of soil nitrogen.

When a medium application of nitrogen was used, an increase in the plant population resulted in some increase in both silage and grain yields. Applications of high amounts of nitrogen resulted in still larger silage and grain yield increases. High plant populations were necessary for maximum yields. There were no visual nitrogen deficiency symptoms at the higher nitrogen rate but some were evident at the medium nitrogen rate.

In all studies the weight of individual corn ears decreased as the plant population increased. Workers in Nebraska have shown that as the population increased over 14,500 plants per acre, ear weight decreased. One-half pound ears were produced with stands between 19,000 and 20,000 plants per acre. Barren stalks became a problem at high plant populations.

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[1] Soil Scientist, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Mandan, N. Dak.

Sugar beet roots harvested at Mandan. Both nitrogen and phosphorus were needed for maximum yields.

In Nebraska when large amounts of nitrogen were used, together with high plant populations, weak, slender stalks were produced. This resulted in lodging, which increased with increasing planting rates. On many of the plots with high plant populations, approximately half of the plants were lodged at harvest time.

According to the results reported here, irrigation farmers should plan for a minimum corn stand of 14,000 mature plants per acre. Kernels planted 11 inches apart in 40-inch rows result in such a spacing. Because it is generally assumed that about 85 percent of the kernels planted will produce mature plants, it is necessary to plant kernels about an inch closer than the desired spacing. Plantings made for silage or forage production should be spaced at 8 inches within the row (20,000 plants per acre).

Several workers have studied the fertility and spacing interactions with grain sorghums. In general the findings have been similar to those obtained with corn. Lodging and small head size became a problem when high plant populations were used. Maxium yield response of sorghum to high rates of fertilizer will require a minimum plant population of 45,000 plants per acre. Some workers have used populations up to 200,000 plants per acre without encountering too much difficulty.

Workers in Nebraska, studying the interaction of plant population and fertility with potatoes, found that the yield was increased by increasing the plant population. Nitrogen fertilizer gave yield increases only in plots having the highest plant populations. The highest yields and best quality potatoes were produced on treatments having 21,780 plants per acre.

Workers in North Dakota reported that a minimum of 20,000 plants per acre was necessary to obtain maximum benefit from fertilizer application.

Potato response to nitrogen fertilizer at Upham, N. Dak. Plant population was approximately 20,000 plants per acre.

Corn grain from sampled plot, Upham, N. Dak. Left to right: O nitrogen rate with 14,000 plants per acre. O nitrogen rate with 23,000 plants per acre. 120 pounds nitrogen per acre with 14,000 plants per acre and 120 pounds nitrogen per acre with 23,000 plants per acre.

Plant populations are important in sugar beet production also. In most cases maximum benefits have been measured only when populations above 20,000 plants per acre have been used. In many cases 25,000 to 30,000 plants per acre were required to obtain the highest yields.

Several workers have reported that crop varieties respond differently to nitrogen fertilization and variable plant populations. Studies with corn have shown that some hybrids do not respond to high rates of nitrogen fertilization, at high planting rates, while others do. Apparently the ability of individual corn plants to grow despite competition is partly governed by genetic factors.

With most crops, as the plant population was increased the maturity date was delayed. In an experiment in North Dakota with corn, as the population rate increased silking was delayed 1 day for each additional 4,000 plants.

For most crops studied, increasing the rates of nitron fertilization increased the number of plants required for maximum yield. In some cases the number of plants needed for maximum yield was doubled by nitrogen applications.

In summary it appears that under irrigation both fertilization and spacing must be at an optimum in order to obtain maximum yields. #

Plant population of 15,000 plants per acre and nitrogen fertilizer applied at a rate of about 100 pounds per acre as necessary for maximum corn yields under irrigation. *Photographs courtesy Department of Agriculture.*

Recreation

Continued from page 66

long of national interest. Existing recreation facilities in the reservoir area are limited, and recreation facilities will be needed on the shores of the reservoir to accommodate the many thousands of visitors to whom this outstanding scenic area will become accessible.

The Flaming Gorge unit is considered to be of national significance, and recreation planning includes two major development sites north of the national forest, on each side of the reservoir near the Utah-Wyoming State line.

Recreation development along the shores of the Navajo Reservoir will help meet the rapidly increasing needs for outdoor recreation in the San Juan River basin, an area long known for outstanding recreational appeal. The dam is being constructed in a deep canyon on the San Juan shortly below the mouth of its tributary, Los Pinos, and the reservoir located primarily in northwestern New Mexico will extend into Colorado. Major recreation development are proposed on each side of the reservoir a short distance from the dam. Among these is the Currecanti, a main unit of the development located in Colorado, which will consist of two or three principal dams creating reservoirs for additional recreation.

The recreational opportunities to be afforded by Reclamation reservoirs are discussed at only three such sites in this article. However, it is anticipated that the Colorado River Storage Project will provide similar opportunities at an estimated total of 15 reservoirs ultimately. These will be located in the States of Arizona, Colorado, New Mexico, Utah, and Wyoming.

The phenomenal recreational use of reservoirs indicates that these recreation developments will result in significant monetary benefits to the surrounding area, as well as providing substantial recreation opportunities. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5133	Middle Rio Grande, N.M.	May 6	Channelization of the Rio Grande, Albuquerque Area, Unit 3	Boswell Construction Co. Albuquerque, N.M.	$284,845
DC-5135	Columbia Basin, Wash.	April 10	Construction of earthwork and structures for Block 83 laterals, Royal Branch canal laterals.	Otis Williams and Co. Kennewick, Wash.	478,811
DC-5139	Colorado River Front Work and Levee System, Ariz.	April 6	Construction of earthwork, pipe lines, and structures for South Gila Drain No. 2.	Vega Engineering and Grading Co. Berkeley, Calif.	188,11
DS-5141	Missouri River Basin, Minn.	April 13	Three 230-kv power circuit breakers for Granite Falls substation, Schedule 1.	Brown Boveri Corp. New York, N.Y.	212,22
DC-5144	Missouri River Basin, Wyo.	May 11	Completion of Fremont Canyon powerplant	Flora Construction Co. and Argus Construction Co. Denver, Colorado.	575,77
DC-5155	Collbran, Colo	April 17	Construction of earthwork and structures for Southside canal, Sta. 18+95.46 to 1146+49, Schedules 1 and 4.	Vitro Corp. of America, Refinery Engineering Company Division, Farmington, N.M.	1,598,34
DC-5156	Missouri River Basin, N. Dak.-Minn.	April 28	Stringing conductors and overhead ground wires for 165 miles of Fargo-Granite Falls 230-kv transmission line.	Midland Constructors, Inc. Chicago, Ill.	1,524,64
DC-5160	Central Utah, Utah	May 4	Construction of Stanaker Dam	Morrison-Knudsen Co., Inc. Salt Lake City, Utah.	1,658,83
DC-5148	Missouri River Basin, Neb.	April 15	Construction of earthwork and structures for Culbertson canal.	Bushman Construction Co. St. Joseph, Mo.	751,46
DC-5150	Central Valley, Calif	April 7	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County road.	Ray Kizer Construction Co. Portland, Ore.	613,73
DC-5161	Collbran, Colo	May 22	Construction of Upper and Lower Molina powerplants, penstocks, and equalizing reservoir.	Vitro Corp. of America, Refinery Engineering Company Division, Farmington, N.M.	2,425,24
DC-5166	Missouri River Basin, Mont.	May 15	Construction of earthwork and structures for North Side and East Side laterals, sublaterals, and drains.	A and B Construction Co. Helena, Mont.	1,242,44
DC-5167	Columbia Basin, Wash.	May 4	Construction of earthwork, concrete lining, and structures on Wahluke Branch canal laterals.	Triangle Construction Co. and George L. Thompson Kennewick, Wash.	589,26
DC-5169	Missouri River Basin, Wyo.	June 10	Construction of 140 miles of Kortes-Cheyenne 115-kv transmission line.	Hoak Construction Co. West Des Moines, Iowa.	1,513,36
DC-5171	Missouri River Basin, Wyo.	May 26	Construction of 37.3 miles of Boysen-Pilot Butte 115-kv transmission line.	Pacific Electrical and Mechanical Co., Inc., Los Angeles, Calif.	386,95
DC-5172	Central Valley, Calif	May 25	Furnishing and installing trash removal equipment for fish collecting facilities at Delta-Mendota intake canal.	Hart and Hynding, Inc., San Francisco, Calif.	206,85
DC-5177	Missouri River Basin, N. Dak.	June 12	Constructing foundations and furnishing and erecting steel towers for 100 miles of Bismarck-Jamestown 230-kv transmission line No. 2.	Midland Constructors, Inc., Chicago, Ill.	1,447,70
DC-5178	Middle Rio Grande, N. Mex.	June 1	Channelization of the Rio Grande	Boswell Construction Co., Albuquerque, N. Mex.	345,31
DC-5181	Central Valley, Calif	June 19	Construction of Corning canal pumping plant, etc	Hood Construction Co. and F. W. Case Corp., Whittier, Calif.	824,08
DS-5184	Lower Rio Grande Rehabilitation, Texas.	June 17	Three natural gas engines for pumping plant on the Rio Grande.	Worthington Corp. Harrison, N.J.	223,43
DC-5185	Weber Basin, Utah	June 5	Construction of the second stage of Willard Dam.	George M. Brewster and Son, Inc., Bogota, N.J.	4,606,26
DC-5186	Collbran, Colo	June 8	Construction of earthwork, pipe lines, and structures for Bonham and Cottonwood pipe lines.	Davis and Butler Construction Co., Salt Lake City, Utah.	1,669,35
DC-5191	Milk River, Mont.	June 26	Rehabilitation of Sherburne Lake Dam outlet works	Winslow-Huckaba Co., Whitehall, Mont.	168,67
DC-5198	Rogue River Basin, Oreg.	June 19	Construction of earthwork and structures for South Fork and Daley Creek collection canals.	H. Barnhart and Leonard R. Ward, Medford, Oreg.	499,43
DC-5199	Central Valley, Calif	June 24	Furnishing and installing armature windings at Shasta powerplant.	General Electric Co. Denver, Colo.	462,66
117S-551	Columbia Basin, Wash	Apr. 23	Aerial photographs and topographic maps for 151,000 acres of East High canal.	Land and Air Maps, Inc., Maumee, Ohio.	149,37
200C-407	Central Valley, Calif	Mar. 31	Clearing 1,655 acres of Trinity reservoir site	Hubner and Michner, Inc., Denver, Colo.	350,00
200C-407	Central Valley, Calif	Mar. 31	Clearing 3,310 acres of Trinity reservoir site	J. H. Trisdale, Inc., Redding, Calif.	553,35
200C-411	Central Valley, Calif	May 28	Construction of earthwork, structures, and bituminous surfacing for Whiskeytown dam access road.	H. Earl Parker, Inc., Marysville, Calif.	350,35
400C-133	Colorado River Storage, Utah-Wyo.	June 17	Clearing 6,800 acres of first phase of Flaming Gorge reservoir site.	Herman H. West and Co. and Phillips and Jordan, Robbinsville, N.C.	2,385,00

Construction and Materials for Which Bids Will Be Requested Through September 1959*

Project	Description of work or material
Central Valley, California.	Constructing about 13.7 miles of lines for hydrostatic heads. Tea Pot Dome laterals, near Porterville.
Do	Earthwork, structures, and bituminous surface treatment for about 6 miles of county road from Swift Creek to Carrville.
Do	One hoist, stems, and support beams for fixed-wheel penstock gate for Trinity dam.
Collbran, Colo	Earthwork and structures for about 11.5 miles of bottom width unlined canal and about 0.1 mile of earth-lined canal. Southside canal, near Collbran.
Do	One 9,600-kva, 600-rpm, 0.9 power factor, 4,160-volt, horizontal-shaft generator for Upper Molina powerplant; and one 5,400-kva, 450-rpm, 0.9 power factor, 4,160-volt, horizontal-shaft generator for Lower Molina powerplant.
Colorado River Storage, Arizona.	Six 7- by 10.5-foot outlet gates, liners, and anchor bolts for Glen Canyon dam.
Do	Eight 155,500-hp, Francis-type hydraulic turbines for Glen Canyon powerplant.
Columbia Basin, Washington.	Earthwork and structures for about 6.7 miles of concrete-lined laterals, about 12 miles of compacted earth-lined laterals, about 1.5 miles of unlined laterals, about 16.5 miles of open-ditch drains and wasteways, about 5,000 feet of closed drains, 1,000 feet of pipe chute, and a small outdoor-type pumping plant.
Do	Compacted blended earth lining about 7.5 miles of Royal Branch canal and laterals.
Do	Constructing eight 2-bedroom frame residences.
Crooked River, Oregon.	Earthwork, structures, and crushed-rock surfacing for about 7 miles of highway from Prineville dam to Bear Creek.
Gila, Ariz	Constructing 1,350 feet of precast concrete pipe bypass lines with open flow meters and slide gates for Wellton-Mohawk pumping plants.
Fort Peck, Mont. and MRB, North Dakota.	Furnishing and stringing 954,000 circular mil, ACSR conductors and 0.5-inch steel overhead ground wires for the 304 miles of Fort Peck-Dawson County and Dawson County-Bismarck 230-kv transmission lines.
Lower Rio Grande Rehabilitation, Texas.	Rehabilitating about 5.2 miles of lateral will include reshaping the prism and banks and constructing unreinforced concrete lining with bottom widths of 5 and 3 feet in the new section.
Middle Rio Grande, New Mexico	Constructing 13 structures including culverts, siphons, checks, drops, wasteways, and turnouts south of Belen.
Minidoka, Idaho	Constructing Unit A relift pumping plant, discharge line, and a small reservoir. Ten miles southwest of Paul.
MRB, Kansas	Earthwork and structures for about 12 miles of 10- to 3-foot bottom width canal, and about 12.5 miles of 3-foot bottom width laterals. Osborne canal, near Osborne.
Do	Earthwork and structures for about 6.4 miles of canal and about 6.9 miles of laterals, including the 2-mile-long, 42-inch-diameter Republican River siphon. White Rock extension, near Republic.
MRB, Minnesota	Stage 04 additions to the Granite Falls substation will consist of constructing concrete foundations, furnishing and erecting an extension to the existing steel structure and minor new structures, installing three 230-kv circuit breakers, one 15,000-kva reactor and associated switches and other electrical equipment, major items of which will be Government-furnished.
MRB, Nebraska	Earthwork and structures for about 9 miles of 16- to 12-foot bottom width Culbertson extension canal. Work will include siphons with alternate schedules of monolithic or precast concrete pipe. Near Culbertson.
MRB, South Dakota	Stages 03 and 04 additions to the Huron substation will consist of regrading and fencing the existing area, constructing concrete foundations, furnishing and erecting steel structures, and installing a 60,000-kva bank of single-phase, 230/115-kv autotransformers.
MRB, Wyoming	Constructing the Gray Reef dam, about 2.5 miles downstream from Alcova dam.
Do	Constructing one mile of tile for closed drain and about 2 miles of open drains, Hanover-Bluff Unit, south of Worland. (Readvertisement of Specifications No. 601C-59).
North Platte, Wyoming	Constructing a rock-lined inclined drop structure about 60 feet wide by 115 feet long on Cherry Creek drain.
Rogue River Basin, Oregon	Constructing a 30-inch-diameter siphon on West lateral. Billings siphon, near Ashland.
Do	Constructing the Phoenix diversion dam will consist of a reinforced concrete floor slab with piers for a flashboard controlled crest and appurtenant training and retaining walls, on Bear Creek, near Talent.
Do	Constructing 12 siphons with a combined length of about 2,750 feet. Work will include constructing turnouts and wasteways, near Ashland.
Weber Basin, Utah	Earthwork and structures for about 2.4 miles of unlined open-ditch laterals and about 2.8 miles of pipe laterals. Wood Cross laterals, near Salt Lake City.

*Subject to change.

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The Reclamation Era

NOVEMBER 1959

IN THIS ISSUE:

Phreatophytes—Water Wasters
Key Changes in Bureau Offices

Official Publication of the Bureau of Reclamation

The Reclamation Era

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In this issue . . .

J. J. McCARTHY, Editor

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PHREATOPHYTES—water wasters —*a menace in the arid west*[1]

PHREATOPHYTES—plants that habitually obtain their water supply from the ground water table (zone of saturation) or the capillary fringe above it—are causing great concern in irrigated areas of Western United States, especially in the Southwest. In many places these plants constitute the principal vegetation along irrigation and drain canals, around reservoirs, along streams and on flood plains in the arid West. They interfere with water flow and canal maintenance, clog stream channels, create flood hazards, and "pump" enormous quantities of precious water from the ground water reservoir into the dry air.

The U.S. Geological Survey estimated in 1957 that undesirable phreatophytes cover 15 million acres of bottomlands in 17 Western States and use nearly 25 million acre-feet of water annually. The Geological Survey and the U.S. Soil Conservation Service estimated that it would be practicable to save 25 percent of this wasted water for beneficial uses by stream channelization and effective control of phreatophytes. This would provide an additional 6¼ million acre-feet of water for irrigation, power development, and industrial and potable uses. Allowing 25-percent loss between the reservoirs or diversion dams and the irrigated farms this would leave over 4⅔ million acre-feet of salvaged water that could be delivered to cropland. [This was more water than was delivered in 1957 to all of the land that was irrigated on the Imperial, Calif.; Salt River, Ariz.; Boise, Idaho; and Columbia Basin, Wash.; projects combined, which had a total of 1¼ million acres of land under irrigation. The total gross value of crops on these projects for 1957 was nearly $228 million. Ed.]

Federal and State agencies concerned with conservation of water, maintenance of irrigation and drainage systems, and prevention of floods in the West have been making a concerted effort to find means for combating the rapidly spreading phreatophyte menace.

by F. L. TIMMONS [2]

[1] Investigations conducted cooperatively by the U.S. Department of Agriculture, Research Service, Crops Research Division and the Wyoming Agricultural Experiment Station.

[2] Research Agronomist, Crops Research Division, ARS, U.S. Department of Agriculture.

Kinds of Phreatophytes

Undesirable phreatophytes are found in all parts of the United States, but the problems they cause are most critical in the West. The plants most commonly classified as undesirable phreatophytes are salt cedar (*Tamarix pentandra*), willow (*Salix spp.*), baccharis (*Baccharis glutinosa*) velvet mesquite (*Prosopis juliflora*), and greasewood (*Sarcobatus vermiculatus*). All of these are trees or shrubs.

The phreatophytes are a group of plants containing genera or species from a number of different plant families. The most varied genus is willow (*Salix*), which contains more than 100 different species ranging from the black willow, a tree reaching heights up to 60 or 70 feet, to small shrubs such as button willow, which grows along mountain streams or lakes at elevations above 8,000 feet. Willows are found in all parts of the United States. The closely related genus, *Populus* (cottonwood, aspen, and poplars), contains many species of trees, which occur in various parts of the United States. Many species of *Tamarix* are found in southern Asia, northern Africa, and southern Europe but only a few species have been introduced into North America. Only the *Tamarix* species known as salt cedar has escaped to become a serious problem. Other plant families are represented among the phreatophytes by only one or two species.

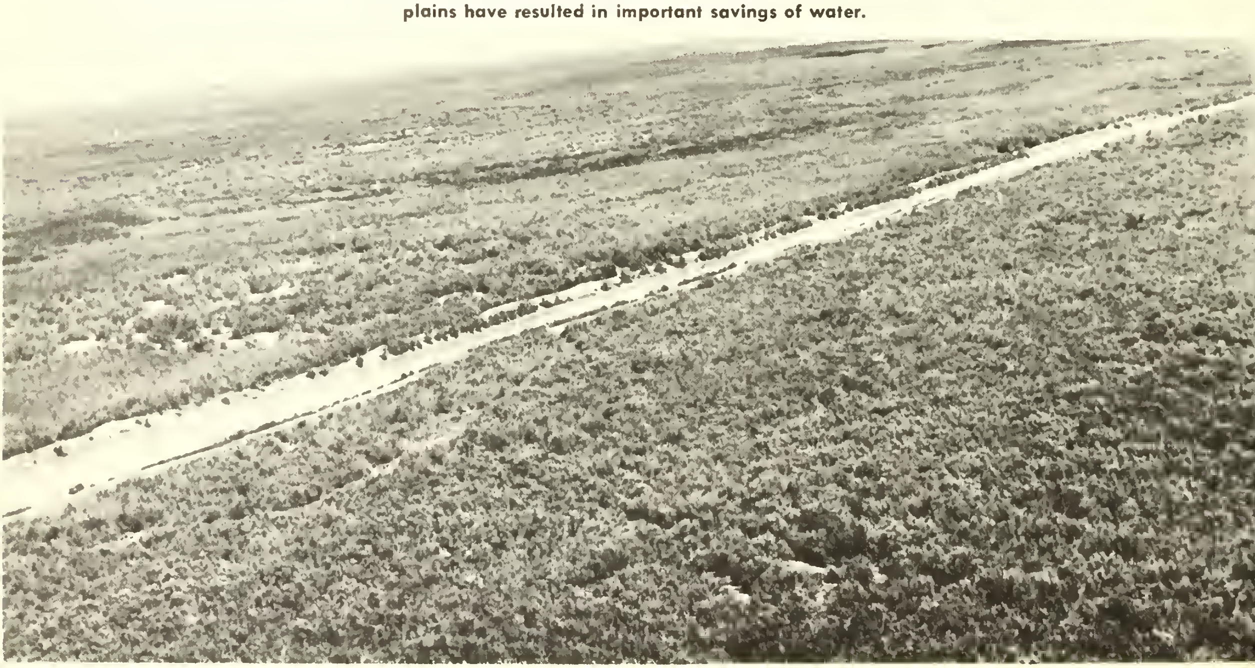
While most phreatophytes are undesirable, a few are valuable crops or ornamentals. One notable example of a beneficial phreatophyte is alfalfa, the most valuable hay-crop plant in the United States. Other beneficial phreatophytes are certain species of willow, cottonwood, poplar, and tamarisk, which are shade trees or ornamentals.

Heavy Users of Water

Most of the phreatophytes grow best when the ground water table or capillary fringe above it is only 6 to 10 feet below the surface. However, salt cedar, willow, cottonwood, and greasewood will extend their roots 15 to 20 feet deep and mesquite has been known to send its roots 40, 50, or even 100 feet to water. On the other hand, willow and salt cedar grow luxuriantly at or just above the waterline along canals and reservoirs. They have been observed to survive several months with up to 50 percent of the above-ground growth submerged by water.

Phreatophytes are notoriously heavy users of water. The ground water level in some localities declines during the day and rises at night with clocklike regularity because of the high water requirements of these plants. In a study by the U.S. Geological Survey, water consumption by phreatophytes during a 12-month period from 9,303 acres

Excavating deep and narrow conveyance channels through dense thickets of phreatophytes on river flood plains have resulted in important savings of water.



A truck-mounted high-pressure sprayer and spray gun are suitable equipment for making high volume spray applications of 2,4-D on willows and other phreatophytes along canals with access roads (Bureau of Reclamation, Region 6).

along a 46-mile stretch of the Gila River flood plain in Arizona amounted to 28,000 acre-feet, an average of about 3.0 acre-feet an acre. The density of the vegetation over the area studied was about 52 percent. If the density had approached 100 percent, which occurs in some infestations, the annual consumption would have been much higher. Tank experiments at Saffard, Ariz., showed a total water use of 7¾ acre-feet per acre of salt cedar with the depth of water table 6 feet below the surface. From studies made by the U.S. Department of Agriculture, the National Resources Planning Board concluded that the average annual consumption of ground water on the Pecos River Delta above McMillan Reservoir, occupied by a dense growth of salt cedar, was about 5.0 acre-feet per acre.

Salt Cedar Spreading Rapidly

Salt cedar is the most aggressive and notorious of the undesirable phreatophytes. This species, which is indigenous to north Africa, southwest Asia, and India, probably was brought to America by the early Spanish explorers. It has been distributed throughout the United States for ornamental planting in parks and around homes. Since about 1930 it has spread rapidly along streams and canals in Arizona, New Mexico, Texas, Oklahoma, and the southern parts of Colorado, Utah, Nevada, and California. Recently, salt cedar has been reported growing in nearly every natural watercourse in these areas at elevations below 5,000 to 6,000 feet. At higher elevations and in colder climates the plant occasionally occurs but does not spread as rapidly, and does not dominate a plant community as at lower elevations and in warmer climates. However, during the past 5 years, rapidly spreading infestations have been observed in Oregon, Wyoming, western Nebraska, and west-central Kansas. Ecological studies are underway in north-central Wyoming and west-central Kansas to determine if possible whether salt cedar is potentially a serious problem on tributaries of the Missouri River and perhaps on the entire Missouri River System.

Control by Mechanical Methods

Most woody phreatophytes are "root sprouters" and are difficult to control by mechanical means alone. Root and crown sprouts which develop following mowing, bulldozing, discing, sawing off, grubbing and/or burning, usually grow to a height of 6 to 8 feet the first year after mechanical clearance. The mechanical treatment must be repeated one to three times each year to maintain control and such repetition is expensive. The cost may be $25 or more per acre for mechanical clearing of mature phreatophyte growth. The cost of mechanically controlling regrowth usually ranges from $3 to $6 per acre annually, depending upon the method used. Where the land is leveled for irrigating and growing crops after clearing off phreatophyte growth, the cost of clearing and leveling may total as much as $80 per acre. Despite the high cost, mechanical methods are being used on thousands of acres by the Bureau of Reclamation, the New Mexico State Engineer's Office, the U.S. Boundary Commission in New Mexico and Texas, and the U.S. Fish and Wildlife Service to control phreatophyte growth in strategic conveyance channels and floodways, on levees and canal banks and on critical feed-producing areas in wildlife refuges.

Channelization Saves Water

Excavating deep and narrow conveyance channels through dense stands of phreatophytes and mechanically clearing phreatophytes from broad floodway channels have resulted in important savings of water. A conveyance channel 6.2 miles long through dense salt cedar on the Pecos River flood plain above McMillan Reservoir near Carlsbad, N. Mex., at a cost of $64,697 prevented much of the earlier losses of water released from the upstream Alomagordo Reservior into the downstream McMillan Reservior for irrigating purposes.

Dense mature "jungles" of salt cedar are accessible for spraying with 2,4-D only by airplane (Bureau of Reclamation Region 3).

Channelization and floodway clearing through dense phreatophyte growth on a 35-mile stretch of the Rio Grande above Elephant Butte Reservoir at a cost of $1,463,000 salvaged an estimated 200,000 acre-feet of water from 1951 to 1956. The future annual salvage is estimated as 45,000 acre-feet. In another 40-mile reach of the river the annual salvage resulting from channelization is about 40,000 acre-feet. Keeping these conveyance channels and floodways free from obstructive phreatophyte growth is a continuing problem requiring mechanical or chemical treatment one or more times each year.

Control by Chemicals

Some phreatophytes can be controlled effectively by spray applications of 2,4-D at rates of 1 to 3 pounds per acre. Most species of willow can be eradicated by 1 or 2 foliage spray applications of 2,4-D in high volumes (100 or more gallons of water per acre) applied by ground spray equipment or in low volumes (5 to 10 gallons per acre of water or oil-water emulsion) applied by airplane or helicopter. Dormant sprays with 2,4-D applied in oil or oil-water emulsion in late fall or early spring are also effective on willows. Cottonwood is somewhat more resistant than willows to 2,4-D, but it usually yields to repeated treatments. Velvet mesquite is resistant to 2,4-D but can be controlled by high- or low-volume foliage spray applications of 2,4,5-T.

Where tall phreatophytes on canal banks or levees are killed by chemical treatment, a problem of clearing off the dead brush and tree growth usually remains. Some agencies, for example, the Bureau of Reclamation Region 5, which comprises New Mexico, western Texas, and western Oklahoma, and Region 6, which includes Montana, the western Dakotas, and north central Wyoming, have found it more convenient and less expensive to clear off the live growth before spraying with 2,4-D. In Region 6, willows, cottonwood, and wild rose are bulldozed off during the winter when the ground is frozen and the plants are easily broken off at the surface. The luxuriant sprout growth which develops the following year is then easily killed by 2,4-D applied in late summer. Where wild rose is present, a mixture of 2,4,5-T and 2,4-D is used.

Salt Cedar More Difficult

Salt cedar has been successfully eliminated from irrigation ditchbanks and similar areas by two or three repeated spray applications of 2,4-D at 2 to

Continued on Page 107

GUY C. JACKSON

FLOYD E. DOMINY

NRA CONVENES IN DENVER

As this issue went to press the 28th Annual Convention of the National Reclamation Association was scheduled to be held at the Shirley Savoy Hotel, Denver, Colo., on Wednesday, October 28, continuing through October 29 and 30.

Secretary-Manager William E. Welsh arranged the preliminary plans for the convention after conferring with President Guy C. Jackson and other officials of the Association from the various Western States. Indications were that the meeting would include nationally known authorities in the field of water resource development.

National Reclamation Association President Jackson was scheduled to deliver the principal address.

One of the highlights of the convention was to be a tour to the new $150 million Air Force Academy at Colorado Springs, which was officially dedicated and held its first commencement earlier this summer.

In addition to President Jackson, others scheduled to address the convention included leading members of the House and Senate Interior and Insular Affairs Committees; Gov. Steve McNichols of Colorado; Wm. E. Richards, President of the National Association of Soil Conservation Districts; and Reclamation Commissioner Floyd E. Dominy.

Other Interior and Reclamation officials in attendance at the annual convention of the N.R.A. were Assistant Secretary—Water and Power Development, Fred G. Aandahl; Assistant Commissioners N. B. Bennett and W. I. Palmer of Reclamation; Associate Solicitor, Water and Power, Edward W. Fisher; assistant to the Commissioner-Information, Ottis Peterson; Chief Division of Irrigation and Land Use, Gilbert G. Stamm; and Chief, Division of Project Development, D. R. Burnett.

A discussion on Federal-State relations in the field of water rights between Assistant Attorney General Perry W. Morton of the Justice Department, representing Attorney General Rogers, and former Under Secretary of the Interior Hatfield Chilson promised to be another key feature of the convention.

Last minute developments indicated such top speakers as Senators Gordon Allott and John A. Carroll of Colorado; Marshall N. Dana, charter member of the NRA and the Association's first president (1932–35); Dr. Cecil H. Wadleigh, member of the Agricultural Research Service, Soil and Water Conservation Research Division of the U.S. Department of Agriculture; and Richard W. Batterton, mayor of Denver, were anticipated at the meeting.

will chemistry reduce seepage losses

The milky appearance of the irrigation water is caused by SS–13 which is being applied to a plot of sandy soil on the Yuma Mesa Unit of the Gila Project in Arizona. In this instance the SS–13 is being tried experimentally to see if it will (1) reduce infiltration rate and thereby permit a more uniform spread of the water over the sandy surface, or (2) increase water-holding capacity thererby inceasing the period between irrigations. *(Photo by Maurice N. Langley, formerly of Region 3.)*

October 29, 1957, may prove to be a historic date for irrigation in the West. As the sun's early rays shone across the desert and sand dunes of the Imperial East Mesa in California, pumps were started, a valve turned and a flow of a gray-green substance about the consistency of diesel fuel was released into 400 c.f.s. of water flowing in the Coachella Canal of the All-American Canal System. What was this peculiar substance, where did it come from, and what was it supposed to do were questions in the minds and on the lips of observers to this unique performance in the desert wastes of Southern California.

The whole story is a long one and is filled with many discouraging pages, but the villian of the plot is an insidious robber called seepage. In past years a certain amount of seepage has been an accepted fact, but as more people and industries come West the water losses that previously could be tolerated will be of prime importance to the very existence of man in the Far West.

When water was plentiful great canals were built in the natural earth formation without impervious linings and seepage took its toll becaus lining cost more than water. Several years ag the Imperial Irrigation District, the Coachell Valley County Water District, and the Bureau o Reclamation recognized that seepage losses o large magnitude from the Coachella and All American Canals could not continue indefinitely Study was given to corrective measures tha would not require a positive lining since the cana system is in use the year round. Bentonite an montmorillonite clays were investigated an found unsuitable because of the large amount o calcium sulphate or gypsum in Colorado Rive water.

During this search for a sealant a chemist fo the Brown Mud Co., Torrance, Calif., who spe cialized in the chemistry of drilling muds for oi wells, requested and was given permission to wor with the soils of the Coachella Canal to see if certain chemical preparation might be used t reduce seepage. For the next 6 to 8 months ther were stories about men taking soil samples an carrying them away, and of the installation o peculiar gadgets in the sides of the canal.

Finally came October and letters of invitatio to observe a trial canal treatment on October 29 Irrigation engineers from Arizona, Nevada, Colo

by C. L. SWEET, Bureau of Reclamation, Region 3, Boulder City Nev.

rado, and California were present, and as the valves were turned and the greenish-gray material flowed into the water and formed a river of milk, there was but one question, "What is it?" The answer, "SS–13." "What is it supposed to do?" The answer, "Reduce seepage losses."

Time passed. It developed that inflow-outflow measurements of a canal carrying up to 1,500 c.f.s. could not be made precise enough to determine seepage changes in an 8-mile section of an 82-mile-long canal. For this reason it became apparent that no conclusions could be drawn as to how much, if any, water was saved. However, there were two significant indications. An observation well in the bank of the canal with a continuous recorder showed a water level difference between the water level in the recorder well and the level of the canal of about 0.2 foot before treatment. After treatment the difference in water levels varied from 1.5 to 3.2 feet, depending upon the elevation of the water in the canal. The second significant indication was the fact that operating records showed a larger percentage of water reaching the Coachella Valley distribution system than in previous years.

These indications were sufficient to interest the Salt River Valley Water Users' Association, Phoenix, Ariz., in a test to determine exactly how much water an application of SS–13 would save. An agreement was made among the association, Arizona State University, Tempe, Ariz., and the Bureau of Reclamation to make such a test.

The South Canal of the Salt River project has a design capacity of 1,200 c.f.s. and was lined with pneumatically applied concrete about 30 years ago. The only value of the lining at present is for erosion control as extensive cracking has destroyed any significant value against seepage losses. This canal was chosen for several reasons, one of which was that it represented a canal comparable in size to the Coachella Canal and some data for comparison might be obtained.

In November 1958, a 4,000-foot section of the South Canal was cleaned of all sand and a retention dam faced with polyethelyne plastic was constructed at each end of the test section. The section was ponded between November 22 and 24. Seepage losses were found to be 0.928 cubic foot per square foot per day for a total loss of 7.11 acre-feet per day. The ponded water was released and the section filled with water containing 670 p.p.m. of SS–13 which was ponded for a period of 72 hours. The seepage losses after treatment were found to be 0.382 cubic foot per square foot per day for a total loss of 3.08 acre-feet, or a reduction of about 59 percent in seepage losses. The ponded water was released, the dams removed, and the canal placed in normal service.

During the first week in February 1959, the canal was again emptied and the dams reconstructed as in November. The test section was refilled and ponded between February 8 and 11. The results showed seepage reduction of approximately 60 percent, as compared to 59 percent in November. This difference is within the limits of accuracy of the test and it is concluded there was no change. It is planned to again duplicate this ponding test this month to obtain factual data as to the length of time the treatment is effective.

What is SS–13, what do we know about it, and what does it cost to treat a canal? It consists of resinous polymers and heavy atoms mixed in a carrier of common diesel fuel. Its function is to increase the ionic attraction of the soil particles for water, thus increasing the thickness of the hygroscopic envelope of water around each particle. This decreases the voids or passage through which water can move and reduces the flow through the soil. We know it is no more pleasant to drink than a mixture of diesel oil and water. It is harmful to fish, few animals like it, and people shouldn't. Cost of treatment will vary with every installation, but was about $0.07 per square yard on the Coachella Canal test and $0.217 per square yard at Phoenix. However, it should be recognized that the Phoenix test was a research project in which 90 percent of the material was wasted with deliberate intent and the construction of retention dams is not required for normal application. Therefore, normal cost of application should be much lower than experienced in these research projects.

Will chemistry reduce seepage? It has been proved that chemistry will reduce seepage by about 60 percent in a large canal at Phoenix, Ariz., of the canal there was no change. The feeling of the cooperators on the Phoenix tests is one of cautious optimism. Will October 29, 1957, be a date of historical significance to the irrigated West? Data being obtained should produce rather definite conclusions within the next year. Are we at last about to back the seepage villain into a corner? The next episode should provide the answer. # # #

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Commercial Fertilizers in Neutral and Alkaline Soils of the West [1]

Drilling winter barley and banding fertilizer in one operation on land irrigated under sprinkler system.

Misconceptions and lack of information about fertilizer application cost American farmers thousands of dollars each year. Fertilizers commonly are broadcast or banded on the plow sole during land preparation; broadcast on the soil surface before or during seedbed preparation; band placed at various depths before or at planting; sidedressed after plant emergence; topdressed on pastures, cereals, or other densely populated crops; applied in irrigation water; or sprayed upon foliage of growing plants.

Commercial fertilizers are available as liquids, solids, or gases. The use of a given type depends upon method of application, availability, price, effectiveness, ease and cost of storage.

Liquid fertilizers usually are corrosive requiring special storage facilities. Dilution of solid material with water lowers their analysis. This may increase cost of transportation, storage, etc. The extra weight may compact soils if tanks ar[e]
hauled through fields for fertilizer distribution
Solid or dry materials are easily and cheapl[y]
stored in paper or waterproof bags, but may ten[d]
to solidify with time when stacked too high, o[r]
if material becomes moist. Anhydrous ammonia
the principal gaseous fertilizer used, is of ver[y]
high analysis, but storage tanks must be heavy t[o]
withstand pressures involved. Fertilizer dealer[s]
often supply equipment for distributing thei[r]
product, whether liquid, solid, or gas.

Fertilizer materials in various forms may sup-
ply one or more nutrients needed by plants. Fo[r]
instance calcium nitrate, sodium nitrate, ammo-
nium sulfate, ammonium nitrate, urea, anhydrou[s]
ammonia and other forms supply supplementa[l]
commercial nitrogen. Ammonium phosphate, 11-
48-0, provides 11 percent nitrogen and 48 percen[t]
phosphate, whereas 10-10-5 furnishes 10 percen[t]

by DR. CHAUNCY O. STANBERRY [2]

[1] Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Arizona Agricultural Experiment Station cooperating.

[2] Soil Scientist, Western Soil and Water Conservation Researc[h]
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Tucson, Ariz.

nitrogen, 10 percent phosphate, and 5 percent potash. Costs of a needed nutrient source for a given method of application, cost of application itself, and effectiveness vary among the different available materials and methods of application. Total cost per unit of required nutrient is commonly accepted for deciding which material to purchase. Total cost per effective unit of required nutrient applied should be the most efficient basis for deciding which source to utilize.

Two nutrients most commonly need in irrigated soils of the West are nitrogen and phosphorus. Sometimes micronutrients such as boron, zinc, and molybdenum are needed also, but usually only in minute quantities. The Agricultural Extension Service and Agricultural Experiment Station usually can supply information on rates and methods of application, when to fertilize, etc.

Nitrate nitrogen moves vertically with the water applied, though ammonium nitrogen, phosphorous and most other nutrients move little or none with water. Even on the soil surface nitrate nitrogen moves little laterally unless water flow moves soil particles. Rapid surface evaporation in sandy soils, and retardation of root activity where soil temperatures become excessive, may leave surface-applied ammonium, phosphate, and other less mobile nutrients, positionally unavailable to plants. Ammonium sources may oxidize to nitrates before a subsequent irrigation and then be carried into the root area in solution. Phosphates are immobilized quickly, but remain available if in contact with plant roots, for at least several years in many neutral and alkaline soils of the West.

BROADCASTING OR BANDING ON THE PLOW SOLE DURING LAND PREPARATION usually places the fertilizer sufficiently deep in moist soils to be positionally available to many plant roots despite surface evaporation. However, a disadvantage is the increase in necessary work and time for plowing. Smaller fertilizer equipment available for use with plows requires repeated filling, and area covered per unit of time is much less than with conventional broadcasting equipment. Some fertilizer applied may not be positionally available since application is made without reference to future plant positions. To insure an adequate supply for crops, a higher rate may be necessary than for fertilizer sidedressed only along each plant row. Since all fertilizer is at the plow depth, in very infertile soils plants may grow slowly and be stunted before their roots reach needed nutrients.

Fertilizer Placement and Planting Equipment—Belt applicator on each side of tractor will apply one, two, or three bands of dry fertilizer each to depths of 7 inches. Planting equipment immediately behind fertilizing equipment will plant a maximum of eight raws (four on each side of tractor) of seed (*Agricultural Research Service, Yuma, Ariz.*).

BROADCASTING FERTILIZERS ON SOIL SURFACES BEFORE OR DURING SEEDBED PREPARATION with adequate incorporation is one of the cheapest and most effective methods of application. Good broadcasting equipment satisfactorily and inexpensively distributes fertilizer on soil surfaces for incorporation. With the large capacity of wide broadcasting now available, fillings are infrequent and much land may be fertilized in a short while. Plowing to 6 inches or more following broadcasting places much of the fertilizer near the plow depth available to plant roots. Smaller amounts are scattered through the soil to the surface giving young shallow rooted plants an early supply. If the soil is bedded for planting or transplanting, broadcasting needed nutrients just before the bedding operation often is more effective than banding within the bed.

Disadvantages include an additional operation for application, only partial positional availability with incomplete root distribution, and only solid or liquid fertilizers may be utilized, though gaseous ammonia may be less expensive. Also, drying of calcareous soils which have received ammonium fertilizers may result in considerable nitrogen loss by volatilization.

BAND PLACEMENT AT VARIOUS DEPTHS BEFORE OR AT PLANTING leaves water-mobile fertilizers less subject to leaching than broadcast applications because less water contacts each unit of fertilizer. Band placement of immobile nutrients at appropriate depths permits them to remain in moist soil and be accessible to roots. Sometimes banding fertilizers gives superior results in dense fine-textured soils where inadequate fertility, aeration, mechanical impedance, or plant rooting habit limit root distribution. Even in friable fertile soils short season crops or very young plants at first may respond better to band applications because of limited root distribution. Response for the entire season, however, usually is not superior to broadcast applications.

Band placement of phosphates became popular in acid soils of the eastern United States because some of the banded material remained available to plants. Broadcast applications giving greater fertilizer surface contact per unit of soil were entirely precipitated as iron and aluminum phosphates which are less available to plants.

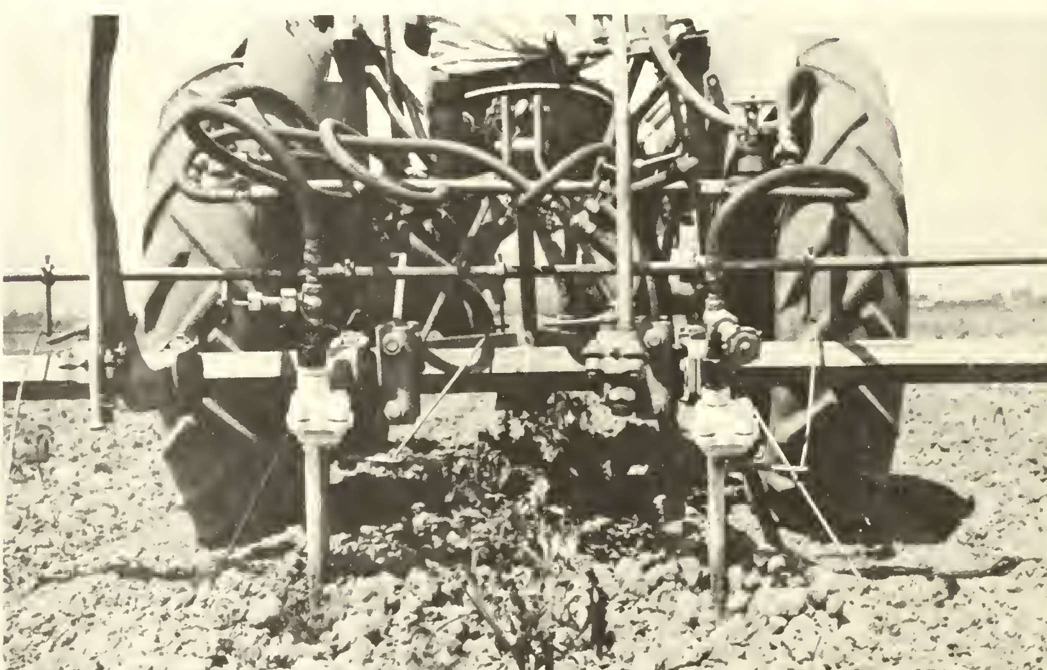
Banding in neutral and alkaline soils often is less effective than broadcasting and incorporating the same nutrients. For instance, broadcasted water-soluble phosphates in calcareous soils may be dissolved in water and moved a short distance in solution before reprecipitating to give a large surface area of sparingly water-soluble calcium phosphates. Though of low water solubility, however, these phosphates may be adsorbed by plant roots if surface contact is great between root and phosphate.

SIDEDRESSING GROWING PLANTS may be accomplished during cultivation operations It is a type of banding, and may be especially beneficial for short season crops, those with limited root distribution, or in compact fine-textured soils. Since applications are close to plants, less fertilizer may be required than when broadcast over the soil surface or banded before seeding and plant establishment. Caution must be exercised to prevent root pruning with the sidedressing equipment, or "burning" of tender rootlets by fertilizer applied too closely.

Fertilizer application by topdressing on pastures, cereals, and other densely populated crops, or in irrigation water is relatively inexpensive. Also, liquid, solid, or gaseous types of fertilizers may be used. Unless feeder roots are active very near the soil surface, however, ammonium and phosphate sources topdressed or applied in irrigation water are not fully utilized during the year because of positional unavailability. In coarse unstratified soils the minimum practical irrigation often more than refills the effective root zone with water. This results in loss by deep percolation and decreases efficiency where a nitrate source

Continued on Page 109

Fertilizer equipment for banding cheap ammonia gas is useable on the same tractor used to apply dry materials (University of Arizona, Tucson).



EDWARD T. BRADFORD

The Handicapped Are Teamworkers

Edward T. Bradford suffered a mishap on his ninth working day after graduating from college which made a desk engineer out of him, but it didn't keep him from becoming a successful one.

When "Brad" got his civil and irrigation engineering degree from Colorado State University in 1934, his whole bent was toward construction work—an outdoorsman and athlete, he wanted to spend as much of his life as possible in the open air. Accordingly, he was happy to report on June 23 to the General Land Office (now Bureau of Land Management) for duty as a cadastral survey chainman.

On July 5, on Tennessee Pass in Colorado, the 500-pound rock on which Brad was standing gave way, tumbling him to the bottom of a 30-foot highway cut and thudding down on top of him. His left leg was crushed.

The injured man lay virtually unattended for hours in a mountain hospital. Gas gangrene set in. The fateful decision was automatic: amputate above the knee or die.

Brad returned to duty 6 months later, and in October 1935 became a draftsman for the Bureau of Reclamation. He rose through the engineering ranks to become Head of the Design Unit in the Kansas River Projects Office in 1947, and in 1955, to Chief of the Design Branch in the Region 7 Office, his present position.

Mr. Bradford would still rather be a construction engineer. But as a wise realist, he has adapted and developed his abilities with considerable success in the design field. Except for the change of direction in his career, and necessary denial of sports activities, his artificial leg lets him live a completely normal life.

JAMES C. NELSON

When James C. Nelson of Greeley, Colorado, volunteered for the Royal Air Force in 1940, he fully realized the risks he was courageously inviting. As courageously, he bears up under the injuries that resulted from his war service and that bother him to this day, without, however, letting them influence the quality of his work as auditor for the Northern Colorado Water Conservancy District at Loveland.

Squadron Leader Nelson crashed on takeoff while test flying a Mosquito bomber in 1944. He

The 15th National Employ the Physically Handicapped Week has been designated as October 4–10 by President Dwight D. Eisenhower. This is the 15th year in which the "Week," which only emphasizes the problem, has been observed. The President in his proclamation stated partially: " * * The expanding national program to develop maximum employment opportunities for the physically handicapped is continuing to attract the interest of additional thousands of dedicated volunteers in national, State, and community committees who are working wholeheartedly with public and private agencies for the rehabilitation and employment of handicapped persons * * *." This is an account of a few persons working in the Reclamation area.*

JAMES G. NELSON

lost his right leg below the knee and suffered a compound fracture of the left ankle. The lower portion of the left tibia was shattered and could not be set properly.

In spite of the injuries, Jim continued a career of flying after his discharge from the Royal Air Force. For 4 years he was chief demonstration pilot for a London aircraft firm, and for the 6 years following he served as senior experimental test pilot for an English company doing development work on supersonic delta-wing bombers.

He returned to the United States in 1953 and accepted the position he now holds. He lives in Loveland, Colo., with his English-born wife and two sons and a daughter aged 13, 14, and 15. He takes part in many community affairs and enjoys numerous sports. He indulges his enthusiasm for skiing every chance he gets despite the artificial leg and a stiff ankle. He is fond also of swimming.

The damage to his left ankle continues to trouble him, but he has overcome all the difficulties arising from loss of the right leg.

MELVIN M. SHYROCK AND DENVER B. GIMLIN

Two employees of the South Platte River District Office engage in responsible electrical operation work without being impaired by physical disabilities—Melvin M. Shyrock who is a power system dispatcher at Loveland, Colo., and Denver B. Gimlin, pumping plant operator at the Granby Pumping Plant near Granby, Colo.

Melvin Shyrock has a severe congenital deformation of the left forearm and hand. He was a War Department line electrician before entering the Bureau of Reclamation in March 1946 as a third-class lineman. He has served the Colorado-Big Thompson project diligently and efficiently as a lineman, maintenance electrician, construction electrician, powerplant operator, and substation operator at various locations. He has held his present position for 2 years.

With his wife and two children, 4 and 9 years old, he enjoys many activities. Fishing and camping are tops on his list of extra-curricular activities. He is a fine baseball pitcher and batter.

Denver G. Gimlin wears an artificial limb for his right leg below the knee, amputated after an accident in 1940 suffered while he was working on a high-voltage transmission pole for a utility in eastern Colorado.

MELVIN M. SHYROCK

He entered the Bureau in 1951. In his maintenance work, he moves about without impairment doing a wide variety of tasks in switchyards and with electric motors, generators, pumps and convertors and electronic equipment switchboards. He formerly was an ardent golfer, and continues to swim at every opportunity.

JOHN R. GRIM

John R. Grim is serving as a general supply clerk in the Sacramento Valley Canals Project Office, Central Valley Project, Red Bluff, Calif. He is a veteran of World War II, having enlisted in the Navy in 1942, and served until September 1944. Grim lost his right leg, with severance above the knee, in a train accident at the Ship Docks in San Francisco, Calif., in September of 1943. Disability was rated at 85 percent. He wears an artificial limb.

Following his discharge from the Navy in 1944,

DENVER B. GIMLIN

Grim worked for a few months in a sugar factory at Crocket, Calif., but his health could not stand the intense heat. He next worked as a cab driver, despite his handicap, and was obliged to find another job when his company sold out and was taken over by another firm with its own drivers.

He returned to South Dakota to visit relatives and to look for work. Early in 1948, upon hearing of Bureau of Reclamation project openings in that State, under developments proposed by the Missouri River Basin Project, he applied for a job at Faith, S. Dak., where hiring was taking place to staff a construction office for a proposed reclamation dam in the locality. Grim was interviewed and subsequently hired as a clerk-typist and went to work for the Bureau on February 3, 1948.

His adjustment to his handicap and his determination not to let his disability interfere with

JOHN R. GRIM

his work have made him not only a capable and enthusiastic employee but also one who merited advancement. He received various assignments through the period of years, including tool checker, procurement agent, truck driver, caterpillar tractor and traction swing-crane operator, caretaker of Government construction-camp houses, recorder of weather readings, and checker of river water samples, storekeeper of power operation and maintenance stores at the Pierre, S. Dak., and presently general supply clerk in the Red Bluff, Calif. construction office.

John Grim is now 36 years of age. He was married in April of 1944. The Grims have three children, Bobby 14 years old, Nancy 11 years old, and Craig 4 years old.

PAUL CULLEY

To those familiar with classifications, the job descriptions of rigger and plant mechanic bring to mind hazardous occupation wherein the knowledge required for moving heavy equipment is basic. The work calls for physical stamina, agility, and the dexterity to meet, and overcome obstacles which are found to be inherent in this type of position. Paul Culley meets the requirements in the rigger and plant mechanic positions even though he carries with him a memento of his war service in World War II.

While serving as sergeant in the 345th Infantry Regiment, 87th Division, Third Army, and following campaigns in Rhineland and the Ardennes, Culley was wounded in action on March 4, 1945, while on the front lines near Nuestein, Germany. An exploding land mine caused him to suffer multiple wounds of the right leg, compound fracture and complete paralysis of the deep peroneal nerve, (drop foot, which necessitates the wearing of a spring steel brace attached to his right leg). Hospitalized from March 5, 1945, to October 4, 1946, and later going through a period of extended leave and adjustment, becoming familiar with the use of prosthesis, Culley eventually returned to his work at Hoover Dam. Paul does not have much to say about the days immediately following his return to work at Hoover Dam, and although he did not complain, we suspect that it was then that he was fighting the hardest fought battle of his life. Suffice to say that he won that battle, and today he remains in the forefront of those workmen who consistently win the praises of their supervisors.

Continued on Page 106

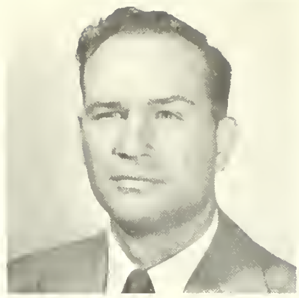
LEST WE FORGET Without

Instead of Like This

And This

igation—It Can Be Like This

BERNARD P. BELLPORT



H. P. DUGAN

EDWIN F. SULLIVAN

KEY CHANGES IN BUREAU OFFICES

COMMISSIONER FLOYD E. DOMINY recently announced several key appointments in the Reclamation headquarters at Washington, D.C., the Denver, Colo.; Sacramento, Calif.; Boise, Idaho; and Amarillo, Tex., offices.

The new appointments are as follows: Associate Chief Engineer, Barnard P. Bellport, Regional Director, at Sacramento, Calif., Hugh P. Dugan; Assistant Regional Director, Sacramento, Calif., Edwin F. Sullivan; Regional Director at Denver, Colo., John N. Spencer; Assistant Regional Director, Denver, Colo., James L. Ogilvie; and Assistant Regional Director, Boise, Idaho, M. Boyd Austin.

Other changes include the appointments of Assistant Regional Director, John C. Thompson, at Amarillo, Tex.; and Donald R. Burnett, Chief of the Division of Project Development; Daniel V. McCarthy, Assistant Chief of the Division of Project Development; Gilbert G. Stamm, Chief of the Division of Irrigation and Land Use; Fred W. Gilbert, Chief, Division of Property Management; and F. W. Jones, Chief, Division of Organization and Personnel, all in the Washington, D.C., office.

"BERNARD P. 'BARNEY' BELLPORT—a veteran of 23 years with Reclamation—is eminently qualified for his new job by reason of his diversified construction experience, outstanding engineering competence, and managerial ability," said Commissioner Dominy at the time of his appointment. Mr. Dominy continued—"next in line to the vitally important job of Chief Engineer of one of the world's leading engineering centers, he is unusually well qualified for the position and the Bureau is fortunate to have him."

Mr. Bellport has been Regional Director at Sacramento since September 1957. A 52-year-old native of LaCrosse, Kans., he holds a B.S. degree in mining engineering, and has been with the Bureau of Reclamation since 1936. His entire Bureau career has been devoted to work in the Central Valley of California. In 1952 he became construction engineer in charge of the Solano Project which is also located in the Central Valley. He received a superior accomplishment award in 1951 for his work on the Central Valley Project. His earlier experience included work for mining companies, a utility company, and the Montana Highway Commission.

H. P. DUGAN "PAT," following his graduation in 1936 from Colorado State University, Fort Collins, Colo., with a bachelor of science degree in civil engineering and irrigation, entered Federal service with the U.S. Soil Conservation Service at Colorado Springs, Colo. After a period of a few months as an engineer-trainee for this organization, he transferred to the Bureau of Reclamation.

From September 1936 to September 1942 he was employed as an engineer on the investigation of potential irrigation projects at Yampa, Colo.; Yuma, Ariz.; La Grande, Oreg.; Pinedale and Green River, Wyo., and Denver, Colo. His experience during this period covered all phases of the investigations of water resource development projects.

Upon his return to the Bureau of Reclamation in January 1946, after the war, he was assigned to the Hydrology Branch of the Project Investigations Division. In September 1946 he was appointed as Head, Water Resources and Utilization Section of the Hydrology Branch, with technical responsibility for the adequacy of the hydrologic studies being made for potential projects in the 17 Western States. In August 1952 Dugan became Head of the River Regulation Section and was responsible for sponsoring and coordinating the hydrologic aspects of the Bureau of Reclamation in planning its river regulation function. In January 1954 he was appointed Assistant Chief Development Engineer of the Project Investigations Division—the position from which he was promoted to Regional Director.

He has prepared and participated in the preparation of reports and studies on innumerable proposed potential water resource development projects throughout the West and has been called upon to advise on potential developments and water resources in many parts of the world.

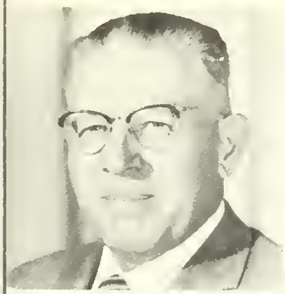
Dugan is a registered professional engineer in the State of Colorado.

EDWIN F. SULLIVAN, a civil engineer, has had 20 years experience on the Central Valley Project.

The region comprises the Central Valley of California, some contiguous coastal areas and the Klamath River Basin of northern California and southern Oregon.

Sullivan, who has been Chief of the Bureau's Fresno, Calif., office as supervisory general engineer, succeeds A. N. Murray who resigned recently to become general manager and chief engineer of the California State Reclamation Board. Sullivan will be assistant to Hugh P. Dugan, who was named regional director effective September 1 when Bernard P. Bellport moved to Denver, Colo., as associate chief engineer at the Bureau of Reclamation Engineering Center.

Sullivan is a native of Red Bluff, Calif., received a bachelor of science degree in engineering from the California Institute of Technology in 1939, and went to work



JOHN N. SPENCER

JOHN C. THOMPSON

DONALD R. BURNETT

GILBERT G. STAMM

for the Bureau of Reclamation in December of the same year.

He first worked in the Central Valley Project offices at Sacramento on investigations and planning for the development of the giant project. He went to Fresno in 1951 and has headed the field office there since 1954.

Sullivan is a registered civil engineer in California, a fellow of the American Society of Civil Engineers and a member of the California Society of Professional Engineers and the American Geophysical Union.

JOHN NEWELL SPENCER, Acting Director of Region 7 at Denver, is a career Government employee in the fields of land and water conservation. His Federal service began in November 1933 in the office of the Secretary of Agriculture, continued for 9 years in other agricultural work, commencing with the Bureau of Reclamation in December 1945. He is a dedicated conservationist, whose free-time activities are consonant with his background and present assignments.

During the entire period of his Bureau of Reclamation service prior to his appointment as Regional Director, Spencer was Supervisor of Irrigation in the Denver Regional Office.

Promotion of Spencer to the topmost regional position was due in part to the improvement of irrigation systems on existing projects and progress of new irrigation development in Region 7 during his tenure as Supervisor of Irrigation. During this period, 157,400 acres in portions of Colorado, Wyoming, Nebraska, and Kansas have been brought under irrigation and supplemental water has been brought to 759,400 acres.

Spencer was born in Hayden, Colo., and received his bachelor of science degree from Colorado State University.

He is a member of the American Society of Agricultural Engineers, American Association for Advancement of Science, and Wilderness Society.

JOHN C. THOMPSON fills the position vacated by Donald R. Burnett who transferred to the Bureau's office in Washington, D.C. to head the Div. of Project Development.

Thompson comes from Albuquerque, N. Mex., where he has managed the Middle Rio Grande Project for the Bureau of Reclamation since 1951, having been with the Bureau since 1935.

He is a native of Jackson, Miss. He attended the University of Mississippi and was graduated from the University of New Mexico in 1931 with a degree in civil engineering. His first position with the Bureau of Reclamation was as the Office Engineer on the Marshall Ford Dam in Texas. Subsequently, he spent 8 years on planning major irrigation, drainage, and dam projects, including the Bridge Canyon Dam and powerplant in Arizona and the Valley Gravity Canal on the Lower Rio Grande in Texas.

In 1949 Thompson was appointed special assistant to the Regional Director as the representative of the Bureau of Reclamation on the Interior Department's Southwest Field Committee, and in 1951 was selected to head the Middle Rio Grande Project, N. Mex.

Region 5 of the Bureau of Reclamation includes the States of Texas, New Mexico, and Oklahoma, and parts of Colorado and Kansas. The Gulf Basins Project, extending along the Gulf coast in Texas, now being investigated by Region 5 engineers, is one of the largest in the Bureau's history of developments accomplished in the 17 Western States in which it is authorized to operate. Another Bureau project with which Texas, and especially Amarillo, is concerned is the Canadian River Project which would supply the Texas Panhandle with much of its water needs.

DONALD R. BURNETT was named Chief of the Division of Project Development on July 19 and previously had been Assistant Director of Region 5 of the Bureau with headquarters in Amarillo, Tex. The Division is responsible for the advance investigation and planning of Reclamation projects.

He is a native of Madison, S. Dak., and attended the engineering schools of the University of Nebraska and Utah, graduating from the latter in 1931 with a B.S. degree in engineering. He has been with the Bureau of Reclamation since 1934, with the exception of war service with the Air Force as an ordnance officer.

GILBERT G. STAMM was Assistant Director of Region 1 of the Bureau with headquarters at Boise, Idaho. He has had about 24 years of Federal service, over 13 of which have been with the Bureau of Reclamation. A native of Denver, Colo., he is a graduate of Colorado State University with a B.S. degree in agricultural economics. His first 10 years of Federal service, almost all of which was related to irrigation research and development, operation and maintenance, were spent with various agencies of the U.S. Department of Agriculture (covering 17 Western States).

He was formerly superintendent of Reclamation's Central Snake River Projects in southwestern Idaho and eastern Oregon and regional supervisor for irrigation of the Pacific Northwest. # # #

CANAL SAFETY BOOKLET

A new booklet, Canal Safety, has been published by the Bureau of Reclamation as an additional measure to protect the public, operating personnel, and animal life from the hazards of canals and other water-carrying structures.

Copies of the booklet may be obtained by writing to any Bureau of Reclamation field office. Regional offices are located in Boise, Idaho; Sacramento, Calif.; Boulder City, Nev.; Salt Lake City, Utah; Amarillo, Tex.; Billings, Mont. and Denver, Colo.

THE 10 COMMANDMENTS OF SAFETY

1. Treat every gun with the respect due a loaded gun. This is the first rule of safety.

2. Guns carried into camp or home, or when otherwise not in use, must always be unloaded, and taken down or have actions open; guns always should be carried in cases to the shooting area.

3. Always be sure barrel and action are clear of obstructions, and that you have only ammunition of the proper size for the gun you are carrying. Remove oil and grease from chamber before firing.

4. Always carry your gun so that you can control the direction of the muzzle, even if you stumble; keep the safety on until you are ready to shoot.

5. Be sure of your target before you pull the trigger, know the identifying features of the game you intend to hunt.

6. Never point a gun at anything you do not want to shoot; avoid all horseplay while handling a gun.

7. Unattended guns should be unloaded; guns and ammunition should be stored separately beyond reach of children and careless adults.

8. Never climb a tree or fence or jump a ditch with a loaded gun; never pull a gun toward you by the muzzle.

9. Never shoot a bullet at a flat, hard surface or the surface of water; when at target practice, be sure your backstop is adequate.

10. Avoid alcoholic drinks before or during shooting. #

Reprinted from a leaflet supplied free in quantities to anyone interested in advancing the cause of hunting and shooting safety. Send requests to Sportsmen's Service Bureau, 250 East 43d Street, New York 17, N.Y.

CARR HEADS WATER COMMISSION FOR CALIFORNIA

JAMES K. CARR, former official of the Bureau of Reclamation both in California and Washington, D.C., has been elected chairman of the California Water Commission.

The Commission is an advisory agency on water development policy and also has responsibilities in water rights administration and Federal appropriations of interest to California.

Mr. Carr is a registered civil engineer in California and Washington, D.C., and is a graduate of Santa Clara University. He was assistant to the Regional Director in the Bureau's Sacramento, Calif., office for several years, later moving to District Manager of the Sacramento Valley District in Region 2. In 1952 he was transferred to the Washington office, and later became engineering consultant to the House Interior Committee.

He has been assistant General Manager of the Sacramento, Calif., Municipal Utility District since 1953.

Mr. Carr has been closely identified with the Central Valley Project for many years, having worked on construction of Shasta Dam as a young engineer just graduated from Santa Clara University.

CLINTON REPORTS

Region 6 Director F. M. Clinton, who attended the 26th Executive Committee Meeting of the International Commission on Large Dams in Helsinki, Finland, recently and then toured water projects in Finland and Sweden stopped in Washington en route home.

Mr. Clinton was impressed with the igenuity of the Finns and Swedes in using locally available materials (such as evenly hewed logs) in form work and support. (The logs, incidentally, are floated downstream to pulp mills after use in construction.) The Scandinavians also lean heavily toward rockfill dams, he said. They employ deep tailrace excavation to gain head at their underground powerplants, as being more economical than raising the height of their dams. In addition, they balance tunnel and powerplant excavation with rock requirement for dam construction. The Finns have a 400-kilovolt transmission system—and the Swedes a 380-kv.—as compared with the Bureau's highest voltage of 220 kv.

Water Report

WATER SUPPLIES WERE ADEQUATE for most irrigated areas of the North Pacific and northern Rocky Mountain states. With streamflows among the minimum of record, WATER for irrigation WAS SHORT over a wide area of the Southwest and especially in the southern half of California.

Snowmelt season streamflow was above normal in only a few isolated areas, mostly on Columbia River tributaries in western Montana. The adequate water supplies of 1959 were possible only through depletion of reservoir storage carried over from the good water years of 1957 and 1958. Irrigated lands with no carryover storage suffered some shortages this year, almost without exception.

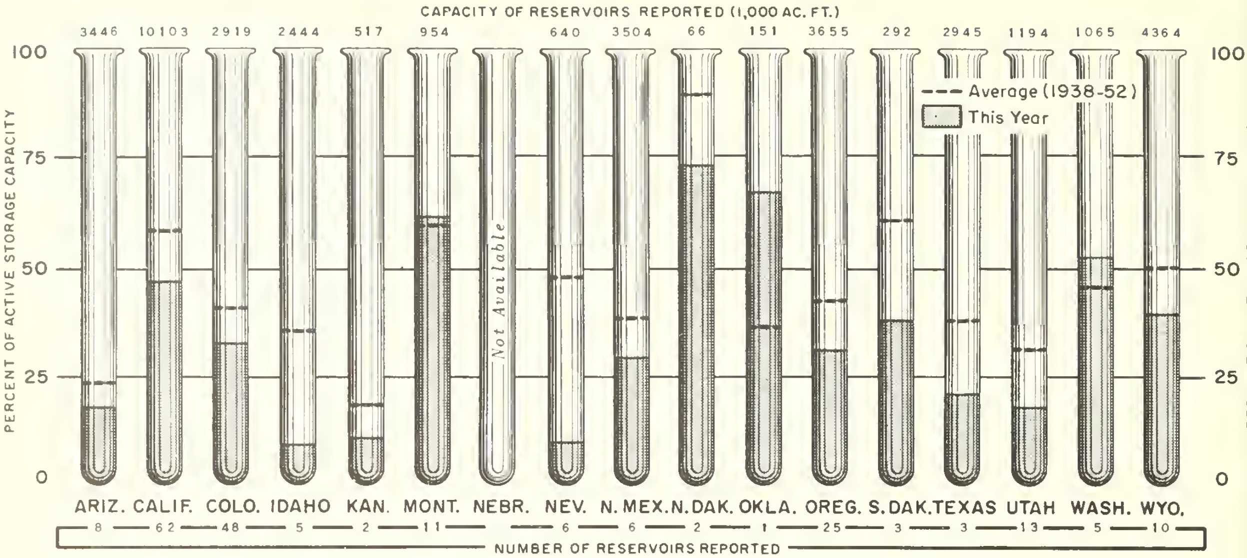
With storage depleted, the snowpack during the winter of 1959–60 will have to be normal or better to provide a good water supply next year. Although the depletion of reservoirs is not as severe as at the end of the 1953–56 drouth period, the stored water is no longer available as a reserve, as was the situation for the past two water years.

The summer of 1959 was dry, but freakish September weather has already given some boost to the prospects for 1960. Heavy rainfall was gen-

The Soil Conservation Service coordinates snow surveys during the winter and spring months conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal agencies, various departments of the several states, irrigation districts, power companies, and others. The California Department of Water Resources, which conducts snow surveys in that state, contributed information on California water supply as a part of this report. The Water Rights Branch, British Columbia, Department of Lands and Forests has charge of the snow surveys in that province.

by HOMER J. STOCKWELL, Water Supply Forecast Section, Snow Survey Supervisor, Soil Conservation Service, Portland, Oreg., and Gregory L. Pearson, Snow Survey Supervisor, Soil Conservation Service, Salt Lake City, Utah

Reservoir Storage on October 1, 1959



eral over all western states the past three weeks with an extremely unseasonal snowfall in Colorado and areas of states adjoining. Dry mountain soils have become wet. This will reduce the amount of water required from any given snowpack to wet up the soils, making more available for runoff.

Summer flows of the major streams are indicated by only incomplete provisional records, but the flow of major streams was approximately as follows in percent of normal: Colorado at Grand Canyon, 65 percent; Rio Grande at Otowi Bridge, 35 percent; Columbia at The Dalles, 115 percent; Missouri at Fort Benton, 85 percent; and the Sacramento at Red Bluff, 70 percent.

This article is prepared for RECLAMATION ERA from information supplied by the Snow Survey and Water Supply Forecast Section, Soil Conservation Service, United States Department of Agriculture.

Water supplies for Washington, western Montana and northern Idaho were good. The season ended with some improvement in reservoir storage over a year ago. The flow of the Flathead River was 150 percent of normal. The flow of all streams in Wyoming was below normal. Reservoirs were drawn down to meet irrigation water demands. The North Platte project now has a relatively small amount of water in storage. Eastern Colorado had adequate supplies at the expense of carryover storage. All of the carryover water in John Martin Reservoir was used. In the Colorado River basin, runoff was much lower than expected. Summer precipitation was extremely deficient.

An extremely low runoff occurred in the Rio Grande. Water supply was supplemented by pumps in Colorado. Below Elephant Butte over a half million acre-feet of stored water was used for top crop production. The Tucumcari and Carlsbad projects in eastern New Mexico had a good season using carryover storage and with summer rains. These projects have a good carryover for next year.

A combination of an extremely low April 1 snowpack and a dry summer resulted in a widespread water shortage over Arizona, Nevada, the southern half of Utah and California, and extending into central Oregon. On streams without carryover storage water supplies were very poor. California reports streamflow the fourth or fifth lowest of record. All streamflow was less than 50 percent of normal, except in one Salt River tributary in Arizona. In the Salt River Valley late summer rains and carryover storage provided a near normal surface water supply.

Reservoirs in California were depleted, but with a normal spring runoff they can be expected to have the usual amount in storage at the beginning of next summer.

In Oregon, southern Idaho and central Utah the adequacy of water supply was directly related to the availability of storage. Irrigated areas along streams without storage had a poor year.

As compared to a year ago, storage is seriously depleted but mountain and valley soil moisture is much improved over October 1, 1958. The importance of having adequate reservoir storage on tributary streams was demonstrated this year in areas where direct streamflow was short.

A heavy snowpack will be necessary this next winter if we are to have a good year in 1960.

In the following paragraphs 1959 water conditions by states are briefly reviewed, with a summary of conditions affecting the 1960 water supply as of October 1, 1959.

This report was prepared under the supervision of *R. A. WORK*, Head, Water Supply Forecasting Section, Soil Conservation Service, Portland, Oregon, from data and reports from agencies mentioned above, and from snow survey supervisors of the Soil Conservation Service: Arizona, George Watt; Colorado and New Mexico, Jack N. Washichek; Idaho and Columbia Basin, M. W. Nelson; Montana and Missouri Basin, A. R. Codd; Nevada, Manes Barton; Oregon, W. T. Frost; Utah and Colorado Basin, Gregory L. Pearson; Washington, Robert T. Davis; Wyoming, George W. Peak.

ARIZONA—Following the very poor winter and spring runoff, irrigation supplies for 1959 depended on well water and carryover storage supplies from the previous year. In almost all cases there was adequate water available for this year's crops. Good July and August precipitation also added to the irrigation supply, along with replenishing the stock water supply and improving forage on the range. However, storage is low and another dry season such as last winter will cause a serious water shortage for next year in many areas.

BRITISH COLUMBIA—The Department of Lands and Forests of British Columbia reports that spring and summer water supply has been excellent during 1959. Generally streamflows were close to average in April and May and above average in June, July, August and September, with the exception of the Okanagan region. April through September accumulated precipitation was above normal. In the Okanagan Valley, meteorological stations recorded normal to below normal rainfall.

Runoff from mountain snow was greater than usual in June and July with well above normal rainfall in August

Continued on page 111

Water stored in western reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1958	Aug. 31, 1959
Region 1	Baker	Thief Valley	17, 400	6, 400	9, 500
	Bitter Root	Lake Como	34, 800	6, 500	12, 000
	Boise	Anderson Ranch	423, 200	313, 300	341, 900
		Arrowrock	286, 600	21, 500	5, 800
		Cascade	654, 100	466, 000	488, 400
		Deadwood	161, 900	107, 600	49, 800
		Lake Lowell	169, 000	67, 600	32, 000
		Lucky Peak	278, 200	261, 400	187, 500
	Burnt River	Unity	25, 200	10, 600	4, 400
	Columbia Basin	F. D. Roosevelt Lake	5, 072, 000	5, 225, 000	5, 225, 000
		Banks Lake	761, 800	759, 100	625, 700
		Potholes	470, 000	102, 100	135, 000
	Deschutes	Crane Prairie	55, 300	31, 000	20, 000
		Wickiup	187, 300	89, 000	29, 000
	Hungry Horse	Hungry Horse	2, 982, 000	2, 978, 800	3, 004, 600
	Minidoka	American Falls	1, 700, 000	404, 500	112, 500
		Grassy Lake	15, 200	9, 200	6, 300
		Island Park	127, 200	39, 500	38, 600
		Jackson Lake	847, 000	635, 700	641, 700
		Lake Walcott	95, 200	90, 900	83, 400
	Ochoco	Ochoco	47, 500	(1)	4, 800
	Okanogan	Conconully	13, 000	6, 700	7, 100
		Salmon Lake	10, 500	10, 300	10, 300
	Owyhee	Owyhee	715, 000	505, 200	191, 700
	Palisades	Palisades	1, 202, 000	548, 600	686, 900
	Umatilla	Cold Springs	50, 000	6, 500	6, 900
		McKay	73, 800	14, 900	12, 900
	Vale	Agency Valley	60, 000	22, 800	10, 400
		Warm Springs	191, 000	118, 000	24, 600
	Yakima	Bumping Lake	33, 700	13, 400	12, 700
		Clear Creek	5, 300	5, 300	5, 300
		Cle Elum	436, 900	128, 900	249, 600
		Kachess	239, 000	139, 000	173, 100
		Keechelus	157, 800	35, 600	94, 300
		Tieton	198, 000	62, 100	104, 900
Region 2	Cachuma	Cachuma	201, 800	196, 000	186, 800
	Central Valley	Folsom [2]	920, 300	621, 500	284, 200
		Jenkinson Lake	40, 600	34, 200	29, 200
		Keswick	20, 000	18, 000	19, 800
		Lake Natoma	8, 800	8, 700	8, 500
		Millerton Lake	427, 800	145, 300	59, 100
		Shasta Lake	3, 998, 000	3, 282, 600	2, 157, 300
		Lake Thomas A. Edison	125, 100	119, 200	74, 700
	Klamath	Clear Lake	513, 300	338, 500	186, 100
		Gerber	94, 300	54, 900	8, 900
		Upper Klamath Lake	524, 800	394, 100	189, 600
	Orland	East Park	50, 600	35, 000	1, 600
		Stony Gorge	50, 000	20, 100	24, 200

Continued on P. 110

PAUL CULLEY

HANDICAPPED

Continued from Page 97

Paul, who lives in Las Vegas, Nev., is very active in civic affairs. He has served as deputy coroner of Las Vegas, is a member of the Clark County School Board, the draft board, adviser to the Nevada State Welfare Board, Director of the Veteran's Coordinating Council, past Vice President of the Nevada State Federation of Labor, officer in the Stationary Engineer's Union (Local 54), member of the Central Labor Council and Building Construction Trades Council, past Commander of the Veterans of Foreign Wars, and he absent-mindedly admits to being a member of the Disabled American Veterans. # # #

Concrete for Glen Canyon Dam

The magnitude of the concrete production and placement program at Glen Canyon Dam and Powerplant, Colorado River Storage Project major features in northern Arizona, requires an unusually large and complex construction plant. Approximately 5 million cubic yards of concrete will be produced and placed in the dam and powerplant. Concrete processing for these structures is scheduled to start in November of this year.

Concrete placement is tentatively scheduled at the rate of approximately 9,000 cubic yards per day. To achieve this goal, the contractor will employ a mix plant having six 4-cubic yard tilting mixers. The plant will have a 3,000-ton aggregate storage bin divided into eight compartments. Mixers will discharge into compartmented hoppers totaling 28-cubic yard capacity. The hoppers in turn will discharge into 12-cubic yard capacity railroad transfer cars which will deliver the concrete to 12-cubic yard buckets at either of two 50-ton capacity cableways for depositing in the dam. The 12-cubic yard buckets are the largest buckets to be used on a Bureau of Reclamation construction undertaking.

The cableways will be situated so that one can pass above the other; both will have traveling head and tail towers and either line will be able to service all areas of the dam and powerplant. Working together, the two cableways will be able to handle a 100-ton load. The upper, main cableway spans 2,050 feet between towers on opposite sides of Glen Canyon. The line, largest ever built, is 4 inches in diameter, weighs 38 pounds per foot, has a strength of 880 tons, and will operate at a tension of 320 tons.

A concrete aggregate processing plant, including heavy media processing features, will be installed at the lower end of the Wahweap Creek aggregate deposit about 6 miles northwest of the damsite. At Clarksdale, Ariz., a new cement mill is being constructed to supply about 3 million barrels of cement. A plant for processing some 1,170,000 barrels of natural pozzolanic materials is being erected north of Flagstaff.

* * *

Cement and pozzolan for the dam will be furnished by the Government on contracts, separate from the prime construction contract. Commercial sources of pozzolan located several hundred miles distant and material deposits in the general vicinity of the dam were investigated. Altogether some 97 samples from 74 sources (9 from commercial sources) including volcanic materials, shales and clays, diatomite and diatomaceous earth, and fly ash were tested. Approximately 3 million barrels of portland cement at an estimated peak rate of production of 120,000 barrels per month will be required to build the dam. Because of the long haul from the nearest existing cement plant, and the large quantity of cement required, it was indicated that some savings might be realized by constructing a plant nearer the damsite.

A helicopter is ideal for applying low-volume chemical sprays on phreatophyte growth along irrigation and drain canals, especially where there are no ditchbank roads (Bureau of Reclamation Region 6).

PHREATOPHYTES

Continued from Page 88

4 pounds in high volume of water applied by ground-spray equipment. On the other hand, low-volume sprays applied by airplane have consistently failed to give more than a temporary kill of salt cedar topgrowth, even when repeated as many as four to five times during periods of 3 to 5 years. This conclusion is based upon 4 small-scale airplane test applications in Arizona and 20 medium-to-large scale airplane applications in New Mexico by the Bureau of Reclamation and New Mexico State Engineer's Office from 1948 through 1956. A total of 51,746 acres was airplane-sprayed on the Pecos River and Rio Grande flood plains at an average cost of $3.18 per acre. Some of this acreage included areas resprayed two to five times. These spray treatments gave good kills of topgrowth and temporarily reduced the nonbeneficial consumptive use of water but with one exception, gave very little permanent reduction in the stand of salt cedar. Because of the hazard to cotton, no airplane applications of 2,4-D are made on that crop during its growing season. The spraying of the 10,000 acres of floodway along the Rio Grande is being done with a ground-spraying unit consisting of a large-capacity centrifugal pump, a 1,750-gallon tank, and a 32-foot hydraulic boom on each side, mounted on a 4-wheel trailer equipped with trunnion axle and four 18- x 24-inch tires. Extension booms and boom-jet nozzles at the end of each boom provide for spraying a swath approximately 100 feet wide.

Research on Phreatophytes

Considerable research on water use by phreatophytes has been done in Southwestern States by the Geological Survey, the Agricultural Research Service, and the Soil Conservation Service. The ecology and physiology of salt cedar is being stud-

Two airplane-spray applications of 2,4-D killed 85 percent of the salt cedar in this 100-acre area. Airplane spraying of more than 51,000 acres of salt cedar in 18 other areas gave good kills of top-growth but low percentage plant kills (Bureau of Reclamation Region 5).

ied at Tempe, Ariz., by the U.S. Forest Service.

Research on control of phreatophytes has been limited mostly to a few experiments on control of willows in Utah, Montana, and Washington, and to a series of experiments on salt cedar near Phoenix, Ariz., by the Agricultural Research Service and the Bureau of Reclamation. Conclusions from this latter research begun in 1951 may be summarized as follows:

1. Clearing off mature salt cedar growth by mechanical methods and burning the crushed down debris followed by spraying regrowth when 4 to 6 months old with a 50–50 mixture of the esters of 2,4-D and 2,4,5-T at 3 pounds per acre or more is the most effective and least expensive method of control now known.

2. Recent research indicates that 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) is more effective than 2,4-D or 2,4,5-T but more research is needed on this question.

3. Rapid regrowth of salt cedar from crowns and roots after mechanical clearance and burning usually reached a maximum height of 6 to 8 feet the first growing season.

4. Single spray applications of 2,4-D or mixtures of 2,4-D and 2,4,5-T on mature salt cedar or regrowth following mechanical clearance usually cause defoliation and kill a high percentage of topgrowth but seldom will reduce the stand appreciably.

5. Ester forms of 2,4-D and 2,4,5-T alone or in mixture are much more effective than the amine of 2,4-D. Application rates of less than 2 pounds per acre usually give poor results.

6. Young salt cedar regrowth or seedlings (6 months or less) is much more easily killed by 2,4-D and mixtures of 2,4-D and 2,4,5-T than is growth a year or more old. A single spray application at 2 pounds or more per acre will kill young salt cedar seedlings. However, mature salt cedar or regrowth after mechanical clearance requires repeated applications, usually 3 or more, over a period of 2 or more years.

7. Dormant applications of 2,4-D and 2,4,5-T esters in oil or oil-water emulsion as basal or cut-stub treatments at concentrations of 0.5 percent or more are effective but expensive methods suitable only for small or widely scattered infestations of salt cedar.

A more effective chemical method than those now known is urgently needed for controlling the large-area infestations along rivers in the Southwest. Such an effective and inexpensive chemical treatment must not be hazardous to cotton, the region's most important cash crop. # # #

Bulldozing is the most common mechanical method of clearing off tall mature salt cedar and other phreatophyte growth. Usually the debris is bunched and burned and followup discing, mowing, or spraying with 2,4-D is used to maintain control of regrowth and seedlings (Bureau of Reclamation Region 3).

Your Magazine

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

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If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

COMMERCIAL FERTILIZERS

Continued from Page 94

is used. Also, fertilizer distribution and amount of intake, often is not uniform.

Fertilizer sprayed upon the foliage of growing plants may give fast response in plants with nutrient deficiencies or incipient deficiencies. However uptake of nutrients from foliage sprays is limited and depends upon crop, leaf maturity, relative humidity, temperature, source of material, and other factors. Also the nutrient source and concentration must not harm plant tissue appreciably. If the crop requires 100 pounds of nitrogen per acre, use of foliar sprays of either urea nitrogen or urea plus ammonium nitrate should require several applications and a large amount of cost and work. The best use for foliar sprays is probably in orchards where spraying equipment is available, where an incipient or actual shortage demands immediate attention, or as an experimental tool to control nutrient levels within plants.

There is no best method of application for all situations. Choice will depend upon crop, soil type and condition, fertilizer source and rate, cost, operator preference, type of application, etc. Biological response to various methods and rates of application is far more complex than commonly believed. Dr. C. T. DeWit, a skilled scientist in Holland, has given an extensive mathematical and comparative consideration of various methods and rates of application. Even though fertilizer placement is complex, and oversimplification is hazardous, it appears that broadcasting needed nutrients and incorporation into the soil is a "good bet" for general conditions until better information is available. # # #

WATER
WHAT IS WATER WORTH?

Water is a commodity so precious that no tyrant has ever dared deny it to his people. The earliest records of our civilization are linked to the spring and the waterhole, the river, and the well. The Children of Israel faltered in the wasteland and were ready to revolt until Moses struck the rock and brought forth a spring.

Wars have been fought over water rights and once mighty nations have vanished because their water resources failed. Men have battled to the death over the last few drops in a canteen. Formidable fortresses, impregnable in other respects, have fallen because of an insufficient water supply.

Ships' masters have had to risk the destruction of their vessels and the slaughter of their crews because water shortages forced landings on savage isles. Families have given up their homes and deserted their properties because of failing wells and dried-up water courses. London was virtually destroyed by fire in the seventeenth century and Chicago reduced to ashes in 1871 because sufficient water could not be delivered to the right place at the right time.

What is water worth?

Water is beyond price—so far beyond price that water is free of all price.

Reprinted from What Price Water? by permission of American Water Works Assoc., Inc., New York 16, New York.

O. C. HEDGEPATH, North Unit, Deschutes Project, in Oregon, drilling his farm to ladino clover (*Photo by Stanley Rasmussen, formerly of Region 1*).

Water stored in western reservoirs—Continued

Continued from p. 105

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1958	Aug. 31, 1959
Region 3	Boulder Canyon	Lake Mead	27,207,000	23,814,000	20,617,00
	Parker-Davis	Havasu Lake	216,500	573,400	108,70
		Lake Mohave	1,809,800	1,511,700	1,388,70
	Salt River	Apache Lake	245,100	243,000	242,00
		Bartlett	179,500	54,000	39,00
		Canyon Lake	57,900	53,000	54,00
		Horseshoe	142,800	20,000	14,00
		Theodore Roosevelt Lake	1,381,600	396,000	223,00
		Sahuaro Lake	69,800	56,000	43,00
Region 4	Eden	Big Sandy	38,300	3,500	50
	Fruitgrowers Dam	Fruitgrowers	4,500	1,300	80
	Humboldt	Rye Patch	190,000	131,100	25,90
	Hyrum	Hyrum	15,300	4,700	3,70
	Mancos	Jackson Gulch	9,800	4,700	80
	Moon Lake	Midview	5,800	600	3,00
		Moon Lake	35,800	7,200	2,10
	Newlands	Lahontan	290,900	202,500	44,50
		Lake Tahoe	732,000	698,400	469,20
	Newton	Newton	5,400	900	40
	Ogden River	Pineview	110,200	21,300	9,10
	Pine River	Vallecito	126,300	62,400	30,40
	Provo River	Deer Creek	149,700	101,900	67,00
	Scofield	Scofield	65,800	39,700	13,70
	Strawberry Valley	Strawberry Valley	270,000	155,300	108,50
	Truckee Storage	Boca	40,900	11,700	1,00
	Uncompahgre	Taylor Park	106,200	75,200	61,70
	Weber River	Echo	73,900	8,200	15,70
Region 5	W. C. Austin	Altus	162,000	107,500	103,10
	Balmorhea	Lower Parks	6,500	2,000	20
	Carlsbad	Alamogordo	122,100	123,400	104,50
		Avalon	6,000	4,700	1,40
		McMillan	32,300	35,800	22,20
	Colorado River	Marshall Ford	1,837,100	608,000	724,70
	Middle Rio Grande	El Vado	194,500	128,100	20,20
	Rio Grande	Caballo	340,900	50,400	55,40
		Elephant Butte	2,185,400	975,900	575,30
	San Luis Valley	Platoro	60,000	34,000	4,00
	Tucumcari	Conchas [2]	467,300	274,000	245,50
	Vermejo	Reservoir No. 2	2,900	2,200	2,00
		Reservoir No. 13	5,000	4,700	3,20
		Stubblefield	16,100	12,000	6,40
Region 6	Missouri River	Angostura	92,000	73,700	20,00
		Boysen	710,000	475,600	211,80
		Canyon Ferry	1,615,000	1,387,000	1,516,40
		Dickinson	13,500	4,500	3,40
		Fort Randall [2]	4,900,000	1,534,000	2,394,90
		Garrison [2]	18,100,000	4,786,000	4,746,00
		Lake Taschida	218,700	63,500	55,30
		Jamestown	39,200	14,400	9,30
		Keyhole	190,300	0	50
		Lewis and Clark Lake [2]	385,000	332,100	247,70
		Pactola	55,000	18,300	20,90
		Shadehill	300,000	79,100	75,60
		Tiber	762,000	196,800	107,20
	Belle Fourche	Belle Fourche	185,200	34,000	1,50
	Fort Peck	Fort Peck [2]	14,839,000	4,655,100	6,446,40
	Milk River	Fresno	127,200	43,000	74,30
		Nelson	66,800	41,000	40,30
		Sherburne Lake	66,100	16,000	34,80
	Rapid Valley	Deerfield	15,100	9,700	3,30
	Riverton	Bull Lake	152,000	97,700	77,70
		Pilot Butte	31,600	6,900	5,20
	Shoshone	Buffalo Bill	380,300	152,400	294,50
	Sun River	Gibson	105,000	40,000	65,20
		Pishkun	30,100	25,500	25,80
		Willow Creek	32,400	29,500	6,20
Region 7	Colo.-Big Thompson	Carter Lake	108,900	25,400	41,80
		Granby	465,600	432,800	348,60
		Green Mountain	146,900	137,300	141,10
		Horsetooth	141,800	46,700	52,70
		Shadow Mountain	1,800	600	80
		Willow Creek	9,100	4,000	1,80
	Missouri River Basin	Bonny	167,200	34,700	33,30
		Cedar Bluff	363,200	178,500	174,10
		Enders	66,000	35,000	25,00
		Harlan County [2]	752,800	236,200	168,00
		Harry Strunk Lake	85,600	30,000	17,40
		Kirwin	304,800	80,600	71,50
		Swanson Lake	249,800	121,600	71,00
		Webster	257,400	84,100	61,70
	Kendrick	Alcova	24,500	27,900	26,80
		Seminole	957,000	928,300	591,40
	Mirage Flats	Box Butte	30,400	16,800	9,80
	North Platte	Guernsey	39,800	27,000	23,70
		Lake Alice	11,200	1,900	3,80
		Lake Minatare	59,200	29,800	9,50
		Pathfinder	1,010,900	900	129,30
Alaska Dist	Eklutna	Eklutna Lake	160,000	165,900	(1)

[1] Not reported. [2] Corps of Engineers Reservoir. [3] Includes some superstorage above active capacity.

Continued from P. 105

and September contributing to the high streamflows in these two months. Because of this above average fall precipitation watershed soils appear to be well primed so that a normal winter snowpack should provide British Columbia with a good water supply next year.

CALIFORNIA—The Department of Water Resources reports that the water year ending September 30, 1959, must be considered one of the driest of record with respect to conditions influencing the supply in California. The North Coastal area was the only significant part of the state receiving normal precipitation. Throughout the rest of the state precipitation averaged about 60 percent of normal, with the parched South Coastal area averaging less than 40 percent of normal.

Above normal spring temperatures produced early snowmelt, which caused peak flows on snowmelt streams to occur one to two months before such flows are normally expected. With this early melting and an already deficient early season snowpack, April 1 snow water content was ranked the lowest of record in most areas.

The major area of irrigation use in California is the Central Valley. The April-July runoff of major Central Valley streams was 6,625,000 acre-feet as compared to an average runoff of 13,719,000 acre-feet. The April-July runoff of Sacramento River at Red Bluff was the 10th lowest in 59 years of record, and about 70 percent of normal. However, the Sacramento River was the only snowmelt stream of the Central Valley area to exceed a 50 percent of normal April-July runoff. Runoff with respect to normal on other major streams in this area ranged from 10 percent for the Tule River near Porterville (4th lowest of record) to above 50 percent for the Feather River near Oroville (7th lowest of record).

In general, April-July runoffs of the remaining snowmelt streams in the Central Valley were the 4th lowest of record for streams south of latitude of Stockton, and the 5th lowest of record for streams between this latitude and the Feather River Basin.

On October 1, 1959, there were 5,949,000 acre-feet of water stored in the 43 major reservoirs serving the Central Valley. This was 2,851,000 acre-feet less than that of October 1, 1958, about 80 percent of the 10-year average, and 45 percent of the usable capacity.

Although reservoir storage at present is somewhat below average, normal spring runoff during the 1960 season would result in average storage amounts in almost all reservoirs in this area.

COLORADO—Streamflow throughout the state was somewhat less than expected this summer. Since carryover storage in most areas was normal or better, farmers having access to this supplemental supply had only limited shortages. Areas in the central and southern part of the state that depended on streamflow alone experienced more severe shortages.

To date, the Colorado Big-Thompson Project has supplied 211,000 acre-feet to water users along the South Platte. The John Martin Reservoir was emptied to supply enough water to mature crops on the Lower Arkansas in Colorado and Kansas. As was anticipated, shortages occurred in the southern part of the state. Pumping helped to supplement surface supplies.

Present reservoir storage is the lowest since 1956. Summer precipitation for the state as a whole was about 90 percent of normal.

An unseasonable snowstorm hit practically all of the state late in September and deposited up to 70 inches of snow at mountain elevations. Soil moisture in both mountains and valleys should be excellent. Prior to this storm, most areas were reporting poor to fair soil moisture.

Unless the coming snow season is better than normal, water shortages may exist in many parts of Colorado next summer.

IDAHO—The water supply forecast made on April 1 this year has proven to be slightly high in southern Idaho, where a poor water supply was forecast, and slightly low in northern Idaho, where an above average water supply was forecast.

In the irrigated areas of Idaho, reservoir storage on the main rivers made up for deficiencies in streamflow and a normal water supply was available. On the smaller streams, where there is inadequate storage facilities, the low water supply reduced crop production significantly. In general, farm and ranch operators, with low water supply outlook, were forewarned and made efficient use of the water supplies available.

The heavy rains throughout Idaho in the latter part of September have definitely broken the drought which has prevailed over the southern areas during last winter and this summer. Precipitation has brought soil moisture up to near normal for this time of the year. The continuation of the present weather trend will result in well primed soils for the 1960 season.

KANSAS—There was no material reduction in crops in irrigated areas along the Arkansas River. This was primarily due to the carryover storage in John Martin Reservoir in Colorado. Summer precipitation was about 80 percent of normal. With no carryover storage in John Martin, a high snowpack will be necessary to insure adequate water next year.

MONTANA—Irrigation water supplies for the 1959 growing season were generally adequate. Below normal spring temperatures resulted in a delayed runoff from mountain streams. Runoff from plains streams was low due to hot, dry weather with July being one of the driest on record. Precipitation in late September has greatly improved soil moisture conditions throughout the state.

The severe earthquake which rocked northwestern Montana in mid-August and created Quake Lake on the Madison River increased the flow of springs and streams in the Upper Madison, Gallatin and Red Rock river basins.

Storage in both irrigation and power reservoirs is above average.

Streamflow has been much above average on most of the Columbia River Basin with the South Fork of the Flathead River flowing about 150 percent of the 1938–52 average during the April-September period. With the exception of the plains streams, which have produced much below average runoff, streamflow of the Missouri River Basin has been 80 to 100 percent of average.

NEBRASKA—Water supply along the North Platte was adequate for irrigation use this year. Summer rainfall was slightly less than normal. Runoff in the North Platte and its tributaries from Colorado and Wyoming mountains was about three-quarters of normal and somewhat less than expected. Depletion of storage in the major reservoirs on the North Platte in Wyoming provided more than the usual percentages of water available. Normal or better snowpack will be required to provide assured supplies for next year.

NEW MEXICO—Streamflow along the Rio Grande and its tributaries was only about 40 percent of normal. Better than normal carryover storage tended to relieve the deficiency in runoff. Areas without storage had a poor water supply. Soils were dry prior to the start of the irrigation season and in most cases remained dry. Pumping was heavy. Carryover storage in Elephant Butte and Caballo reservoirs is 575,000 as compared to 1,080,000 acre-feet at this time last year.

Water supply on the Carlsbad Project was good due to excellent carryover storage and average precipitation. Carryover storage is now better than normal.

The Arch Hurley Conservancy District started the season with a nearly full reservoir and ended the season in the same position. Prospects for next year's water supply are good in this area.

Along the Rio Grande a heavy snowfall in the mountains will be necessary to insure good water supply for next year.

NEVADA—As was forecast, extremely low streamflow was experienced throughout Nevada during 1959. Dry

Construction and Materials for Which Bids Will Be Requested Through December 1959*

Project	Description of work or material
Boulder Canyon Project, Nev.	Installing cement mortar lining in about 10,000 linear feet of 6- and 8-inch cast-iron water mains in Boulder City.
Central Utah, Utah.	Clearing about 240 acres of trees and brush, 11 miles of fencing, and 3 farm sites in the Stanaker reservoir site, north of Vernal.
Central Valley, Calif.	Constructing 16 miles of 6- to 33-inch pipelines for hydrostatic heads varying from 25 to 200 feet. The specifications will include alternate bids for the pipelines of concrete pressure pipe, mortar-lined and coated-steel pipe, cement-asbestos pipe, pretensioned concrete cylinder pipe and noncylinder prestressed pipe within acceptable limits of sizes and heads. Work will also include constructing 4 small pumping plants. Tea Pot Dome laterals, near Porterville.
Do	1 hoist, stems, and support beams for 10- by 20-foot fixed-wheel penstock gate for Trinity Dam.
Colorado River Storage, Ariz.	2 300-ton overhead traveling cranes and one set of lifting beams for Glen Canyon powerplant.
Do	1 75-ton overhead traveling crane for machine shop at Glen Canyon powerplant.
Colorado River Storage, Utah.	3 50,000-hp., 240-r.p.m., 365-foot-head, vertical-shaft, Francis-type hydraulic turbines for Flaming Gorge powerplant.
Columbia Basin, Wash.	Earthwork and structures for about 7.7 miles of concrete-lined laterals, 54.5 miles of unlined laterals, 23.4 miles of compacted earth-lined laterals, and 9 miles of wasteways and drains in Blocks 18, 19, 20, 42, 45, 46, 47, 74, 80, 88, and 89 in vicinities of Othello, Connell, Moses Lake, Mesa, Warden, and Quincy.
Do	Constructing 8 2-bedroom frame residences with full basements and attached garages, a 28- by 112-foot concrete-block garage and a 36- by 52-foot concrete-block shop building, both with truss roofs, and complete water and sewerage facilities.
Klamath, Calif.	Earthwork and structures for about 10 miles of earth-lined canals, laterals, and drains, about 10 miles southwest of Tule Lake.
Lower Rio Grande Rehabilitation, Tex.	Rehabilitating about 9 miles of lateral consisting of reshaping the prism and banks and constructing unreinforced concrete lining with bottom widths of 5 and 3 feet in the new section. Work will also include constructing timber slide-gate checks, concrete bridge, turnouts, drainage culverts, and road crossings.
MRB, Kans.	Earthwork and structures for 6.9 miles of canal, 4.8 miles of open laterals, and 1 51-c.f.s. pumping plant. Courtland No. 1.
MRB, Nebr.	Earthwork and structures for about 15 miles of 12- to 5-foot bottom width canal, about 21.5 miles of 6- to 3-foot bottom width laterals and wasteways, and about 1.7 miles of 15- to 8-foot bottom width drains. Culbertson extension canal.
MRB, N. Dak.	Stage 03 additions at Devils Lake substation will consist of constructing concrete foundations, furnishing and erecting steel structures, installing a 10-mvar-46-kv. capacitor bank and associated electrical equipment, major items of which will be Government-furnished.
Do	Stage 04 additions at Jamestown substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 2 230-kv. circuit breakers, a 5,000-kv.-a. reactor and associated electrical equipment, major items of which will be Government-furnished. Stage 05 additions at Fargo substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing a 5,000-kv.-a. reactor and associated electrical equipment, major items of which will be Government-furnished.
Do	Stages 03 and 04 additions at Bismarck substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 2 230-kv. circuit breakers and associated electrical equipment, major items of which will be Government furnished.
MRB, S. Dak.	Earthwork and furnishing and applying asphaltic membrane material covering for impervious membrane lining for 8,600 linear feet of canal. Angostura canal, near Oral.
Do	Stage 03 additions at Tyndall substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 1 15-kv. circuit breaker and associated electrical equipment, major items of which will be Government-furnished.
Do	Stage 03 additions at Huron substation will consist of regrading the existing area, constructing concrete foundations, furnishing and erecting steel structures, and installing a 60,000-kv.-a. bank of single-phase 230/115-kv. autotransformers, 1 115-kv. and 2 230-kv. circuit breakers, and associated electrical equipment, major items of which will be Government-furnished.
MRB, Wyo.	Additions at Cheyenne substation will consist of grading and fencing an extension to the existing area, constructing concrete foundations, furnishing and erecting a steel structure, and installing 3 115-kv. circuit breakers and associated electrical equipment, major items of which will be Government-furnished.
Parker-Davis, Ariz.	Constructing 5 or 6 3-bedroom frame or frame stucco residences at Davis Dam Government camp.
Washita Basin, Okla.	Constructing a chlorination station at Fort Cobb dam will consist of constructing a 37- by 17-foot reinforced concrete block building, and installing Government-furnished chlorination equipment.

*Subject to change.

soils under the below normal mountain snowpack deducted a large percentage of last spring's snowmelt runoff. Abnormally cold spring temperatures delayed early runoff and in some cases snowmelt peak flows never occurred. The Humboldt River at Palisade had an 8 percent of normal (1938–52) April–July flow; the Carson River near Carson City had a 29 percent of normal April–July flow; and Lake Tahoe inflow during April–July was 31 percent of normal.

Water users served from reservoirs had a fairly adequate supply due largely to last year's reservoir carryover. Water users served from natural flow had a poor year.

Heavy reservoir drawdowns have been used to augment the low streamflow. Carryover storage is very low except for Lake Tahoe, which now has about 425,000 acre-feet in storage, or 95 percent of normal.

OKLAHOMA—Water supply for the W. C. Austin Project was slightly better than normal. Crop production was near average. Lake Altus has nearly the same amount of water as a year ago. Fall precipitation has been good, and soil moisture conditions are good to excellent.

OREGON—Irrigation water supplies during 1959 were extremely short in south-central, central, and southeastern Oregon, except where large storage facilities were available. Reports indicate that crop production was relatively good in most areas of the state, even if streamflow was low. Actual water supplies were very close to that indicated by the April 1 snowpack.

Outlook for next irrigation season is poor in terms of stored water, but mountain soils are well primed as a result of recent storms. Fall rains have been three to five times normal in eastern Oregon, and near normal in the southeastern part of the state. Carryover storage in 25 reservoirs is only 42 percent of normal.

SOUTH DAKOTA—Irrigation water supply for the Black Hills area of South Dakota was deficient this year. Runoff was much below normal. There was a long period of drouth in late summer. Reservoir storage has been depleted to near the lowest point of record.

TEXAS—There was no reduction in crop production in western Texas due primarily to the carryover storage in Elephant Butte. No material reduction in crops occurred along the Pecos even though the runoff was extremely light. Heavy pumping helped make up the shortage of streamflow.

UTAH—Water supplies in Utah this summer were about as anticipated last spring. They varied from generally adequate to limited shortages in the northern part of the state, with limited to severe shortages in central areas. In the south, shortages have been severe except for those users who pump from ground water or who had good water supplies stored in reservoirs as a carryover from 1958. Frequent showers the last of July, the first of August and during September materially helped the water supply situation in many areas.

If water supplies for 1960 are to be adequate, an above average snowpack will be needed next winter. The poor

Continued on P. 4 of Cover

U.S. GOVERNMENT PRINTING OFFICE: 1959 O—524938

MAJOR RECENT CONTRACT AWARDS*

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5192	Colorado River Storage, Ariz.-Utah.	July 16	4 40-foot by 52.5-foot radial gates for Glen Canyon dam spillways.	Vereinigte Osterreichische Eisen—und Stahlwerke Aktlengesellschaft, Linz/Donau, Austria.	$309,850
DS-5196	Missouri River Basin, N. Dak.	July 17	2 230-kv. power circuit breakers for Jamestown substation, Schedule 1.	Brown Boveri Corp., New York, N.Y.	142,225
DS-5200	do.	July 21	2 230-kv. power circuit breakers for Bismarck substation	do.	142,225
DC-5202	Central Valley, Calif.	July 10	Construction of earthwork, structures, and gravel surfacing for relocation of Trinity County road, Cedar Creek to Nelson Creek Gap.	Floyd R. Grubh, Salem, Oreg.	574,959
DS-5208	Missouri River Basin, S. Dak.	Sept 10	12 230-kv. power circuit breakers for Fort Thompson substation. Schedule 1.	American Elin Corp., New York, N.Y.	808,900
DS-5213	Colorado River Storage, Ariz.-Utah.	Aug. 14	4 100,000-pound radial-gate hoists for spillways at Glen Canyon Dam.	Moffett Engineering, Inc., Berkeley, Calif.	104,000
DC-5214	Missouri River Basin, Nebr.	Aug. 7	Construction of Sherman Dam	J. A. Tobin, Construction Co., Kansas City, Kans.	2,149,380
DC-5215	Rogue River Basin, Oreg.	Aug. 31	Construction of major structures for East lateral rehabilitation.	Pegram Construction Co., Othello, Wash.	268,016
DS-5216	Colorado River Storage, Ariz.-Utah.	Aug. 27	6 7-foot by 10.5-foot outlet gate valves, conduit liners, anchor bolts, and piezometer piping for left diversion tunnel outlet works at Glen Canyon Dam.	Yuba Consolidated Industries, Inc., Yuba Manufacturing Division, Benicia, Calif.	509,655
DC-5219	Rogue River Basin, Oreg.	Sept. 4	Construction of Billings siphon, West lateral rehabilitation, utilizing pretensioned concrete siphon pipe, Schedule 1.	C. H. Strong, Engineering and Construction, Eugene, Oreg.	156,481
DC-5220	Missouri River Basin, Wyo.	Sept. 18	Construction of Gray Reef Dam	Davis Construction Co., Inc., Grand Junction, Colo.	593,237
DC-5221	Missouri River Basin, Nebr.	Sept. 24	Construction of earthwork and structures, including 5 canal siphons, for Culbertson extension canal, Station 1126+00 to 1719+00; and laterals, wasteways, and drains, utilizing monolithic concrete in 81- and 87-inch diameter siphon barrels. Schedules 1, 2, and 4.	Bushman Construction Co., St. Joseph, Mo.	1,539,106
00C-419A	Central Valley, Calif.	Sept. 17	Clearing 5,595 acres of Trinity reservoir site, Trinity Center, East Fork, and Trinity River areas.	R. W. Byers, Redding, Calif.	511,100
00C-499	Missouri River Basin, Kans.	Aug. 7	Construction of earthwork and structures for Pump No. 4 canal, Pump No. 4 West Canal, pumping plant, discharge lines, and Pump No. 4 West laterals P4W-0.2 and P4W-0.8.	Bushman Construction Co., St. Joseph, Mo.	112,391

WATER
NOT FOR WATER ALONE

Look at your water bill; then look behind it. Consider some items which might well appear, but don't.

There's no reference to medical service, yet the health of your community, of your family, and of yourself is protected by the vigilance of the men who check and treat and recheck water to make sure it's safe for you.

There's no fee for securing reduced fire insurance rates, yet the whole schedule of these rates is substantially reduced if an adequate public water supply—so necessary to an effective defense against fire—is available.

There's no contribution levied for community development, yet key industries can produce goods and provide employment only because a dependable water supply is available.

Without a continuing flow of water, sewers could not be properly flushed or streets kept clean.

You could conceivably obtain enough water through your own efforts to satisfy your thirst, clean your body, and water your garden. But only through an organized system of collection, storage, distribution, and treatment can water resources be mobilized to produce the broader benefits which you, as a citizen, enjoy.

The price which you and all consumers pay for water you use helps to meet the costs of making these benefits available to all.

Without a water works system, the cost of urban living would be prohibitive!

WATER
IT TOOK A LOT OF MONEY

Your water system serves you by securing water, by storing water, by testing and purifying water to make it safe for use, and by delivering water into your home or place of business.

These things it is able to do because substantial sums of money have been expended on equipment and installations which perform these functions.

Fortunately, most of us benefit by expenditures made over a period of years, including periods when prices were much lower than they are now. Yet even in terms of 1940 prices, when most commodities cost less than half what they do now, water works facilities cost real money.

A 2-billion gallon reservoir, then big enough to provide a 200-day supply for a city of 100,000, cost $2,500,000 in 1940.

The pumping station required to move this water through the city's mains cost $100,000 to build and equip.

A mile of 8-inch cast iron pipe, of the type used for water mains in residential areas, cost $6,500, and under normal conditions cost another $4,500 to install.

An elevated storage tank of 125,000-gallon capacity, of the type you'll see serving small towns and villages cost $18,000.

A filtration plant for a fairly large city cost $1,850,000.

Whether financed by private capital or a municipal authority, a water works has always represented a major investment, ranging from $50 to $100 per person served.

Regardless of prevailing prices, it has always taken a lot of money to bring you safe, usable water.

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summer just ending will have a major influence on next year's water supply since reservoir storage has been so severely depleted. Of 15 reporting reservoirs, only the three largest have above average carryover supplies. Of the remaining 12 reservoirs, seven have a carryover which averages only 6 percent of capacity.

Unless October and November prove to be dry months, soil moisture conditions will not be detrimental to next year's water supply. At present, principally as a result of September storms, soil moisture is average or above in northern watersheds, about average in the center of the state, and slightly below average (about 15%) in the south.

WASHINGTON—Generally adequate water for irrigation and other purposes was available throughout the state during the 1959 season. Runoff was normal or slightly above in April and May and well above normal during June, July and August. An exception was in the south and extreme southeastern part of the state where poor runoff was experienced throughout the summer.

There was very little high water on any of the tributaries in the state. Minor floods were confined to local areas.

Precipitation followed the runoff pattern to a very close degree with below normal precipitation during the earlier part of the summer, followed by above normal during the latter months. September reports from selected precipitation stations indicate rain fell in excess of 200 percent of normal. This precipitation has primed the mountain soils which will tend to increase runoff next year.

Reservoir carryover is excellent for the major irrigation reservoirs in the state and the outlook for the 1960 irrigation season is very good unless there is an extremely poor snowpack this winter.

WYOMING—Streamflow during the summer months was slightly less than normal no Bighorn River tributaries in the northwest part of the state. There was some depletion in storage in major reservoirs for irrigation use in late summer. The flow of the Green River in western Wyoming was about 80 percent of normal.

The flow of the North Platte into Seminoe Reservoir was about 75 percent of normal. Water supplies along the North Platte in eastern Wyoming were adequate at the expense of a decrease in total storage in large reservoirs on the main stem. Some shortage of water occurred along the Laramie River. Northwestern Wyoming was extremely dry. # # #