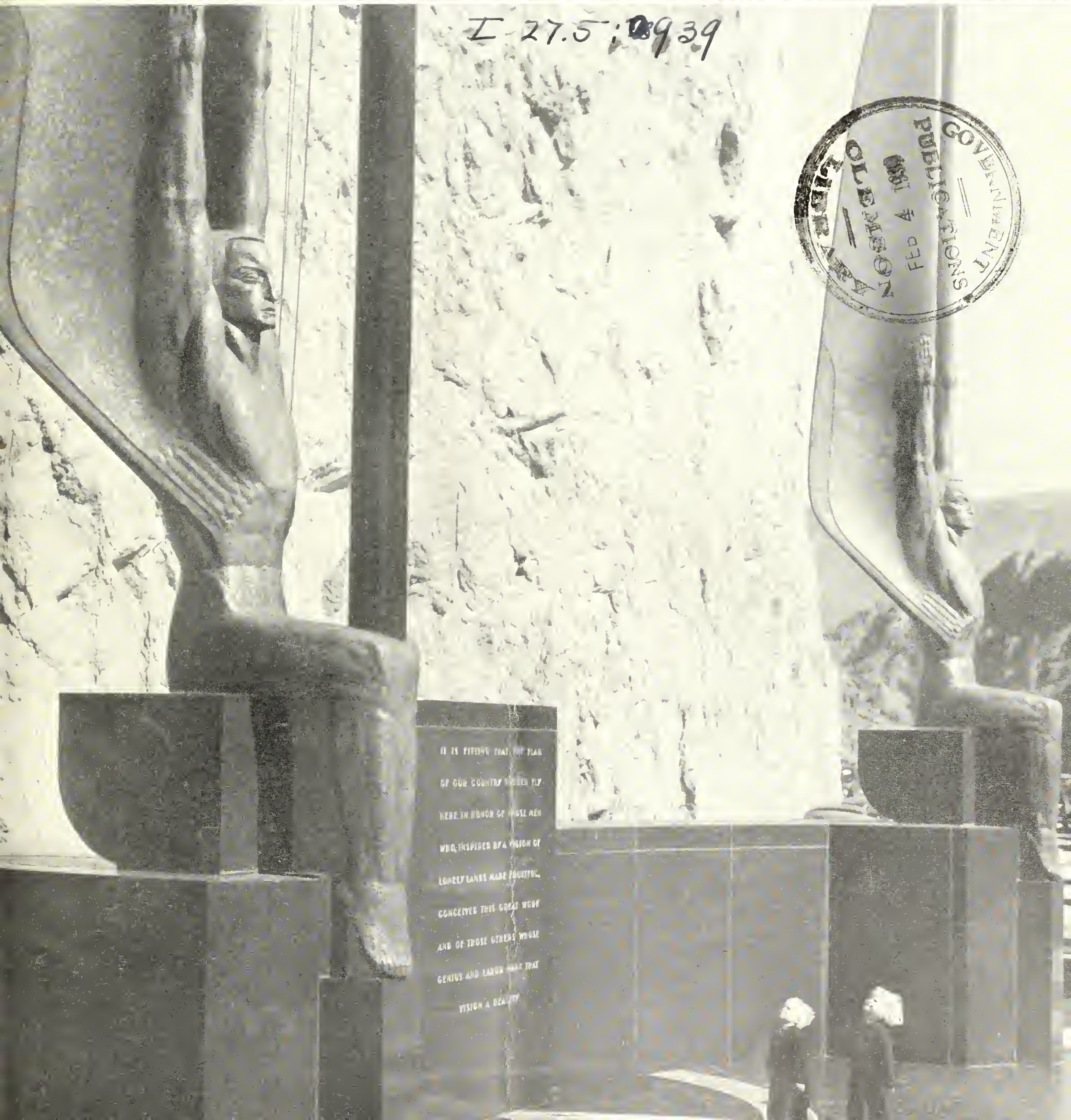
THE RECLAMATION ERA

JANUARY 1939

PRESENT GENERATION REVIEWING SCULPTURE SURROUNDING 125-FOOT FLAGSTAFF AT BOULDER DAM



CONSERVATION

". . . I shall touch briefly on certain facts about your Department over which I am for the moment steward. The function of your Department of the Interior is to conserve the vast store of natural resources of the United States. For long years our American earth and water, our minerals and our forests were used with little thought of tomorrow. It was a matter of grab whatever you can get and the devil take the hindmost.

"In China, a doctor is paid to keep his patient healthy, not to save him when he is dying. The Department of the Interior serves in this manner for our Nation's natural resources. We believe in watching over our land, our forests, our minerals, while they are there to be watched over, and keep them from wasting away because of man's thoughtlessness and greed or the temperament of Nature.

"This is what we mean by Conservation. Conservation is the wise planning for and the prudent use of our natural resources. This principle guides every action of your Department. By right we should not call it the Department of the Interior, but really the Department of Conservation. The day will come when it will be known by that name. I am positive that the citizens of our country are beginning to heed our warnings; to realize that although our resources are bountiful, they are not limitless. To plan their wise use is Conservation, and progress in a democracy. . ."

Hon. Harold L. Ickes,
Secretary of the Interior.

From a radio broadcast on January 8, 1939, Mutual Broadcasting System,
based on his annual report to the President

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

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Gates for Control of Flow Through Spillways

By ROBERT F. HERDMAN, *Engineer, Denver Office*

SPILLWAYS are provided in connection with dams as a safety measure. A storage reservoir is likely to be full or nearly full at the beginning of a flood, and unless a safe escape is provided for excess flood water entering the reservoir, the dam may be destroyed.

The simplest form of spillway is one with a free-flow crest which permits unobstructed flow over a weir whenever the water surface in the reservoir is above the crest. No water can be stored above the crest of such a spillway; nevertheless the dam must be of sufficient height to provide the required freeboard and the head necessary for the escape of flood waters. Such a spillway therefore requires a higher dam for a given length of crest than a spillway controlled by gates; by means of gates a constant water surface elevation can be maintained regardless of the flow through the spillway. The margin between the crest of the spillway and the maximum allowable water surface elevation represents potential storage capacity sacrificed for uncontrolled flow. This loss of storage can be prevented to some extent by a long crest which requires less depth of overflow, but in many cases a long crest is impractical and uneconomical. Maximum storage, therefore, can best be obtained by the use of gates.

Various gates have been developed for this purpose. Those in most general use by the Bureau may be divided into the following types:

Radial or Taintor gates which are the cheapest and are in most general use for crest control. They are most suitable where the top of the gate is at all times above the water surface of the reservoir.

Drum gates, otherwise known as sector gates, which are overflow gates and which are particularly adapted to a dam having sufficient height to provide the necessary recesses for the gates and where a large unobstructed opening is required.

Ring gates, which are a special adaptation of the drum-gate principle, for use only on a circular spillway.

Roller gates, which provide a long and unobstructed opening and are particularly suited to a low dam where the depth of crest is not sufficient to provide recesses for drum gates.

Stoney, caterpillar, and fixed-wheel gates, which are of the same type but are differentiated by the type of rollers provided to reduce the frictional resistance to motion of the gates. These gates are used for higher heads and narrower openings than drum or roller gates and are particularly suited to short spillways requiring large depth of flow.

It is difficult to define exactly the economic field of each type of gate, or all of the conditions affecting the choice of type; each gate has particular characteristics adapting it for use under certain conditions. The question of watertightness needs little consideration in the selection of type as the leakage prevention devices are equally effective in all. Operating mechanisms may be hand- or motor-operated hoists or automatic devices, often a combination of the three.

Radial Gates

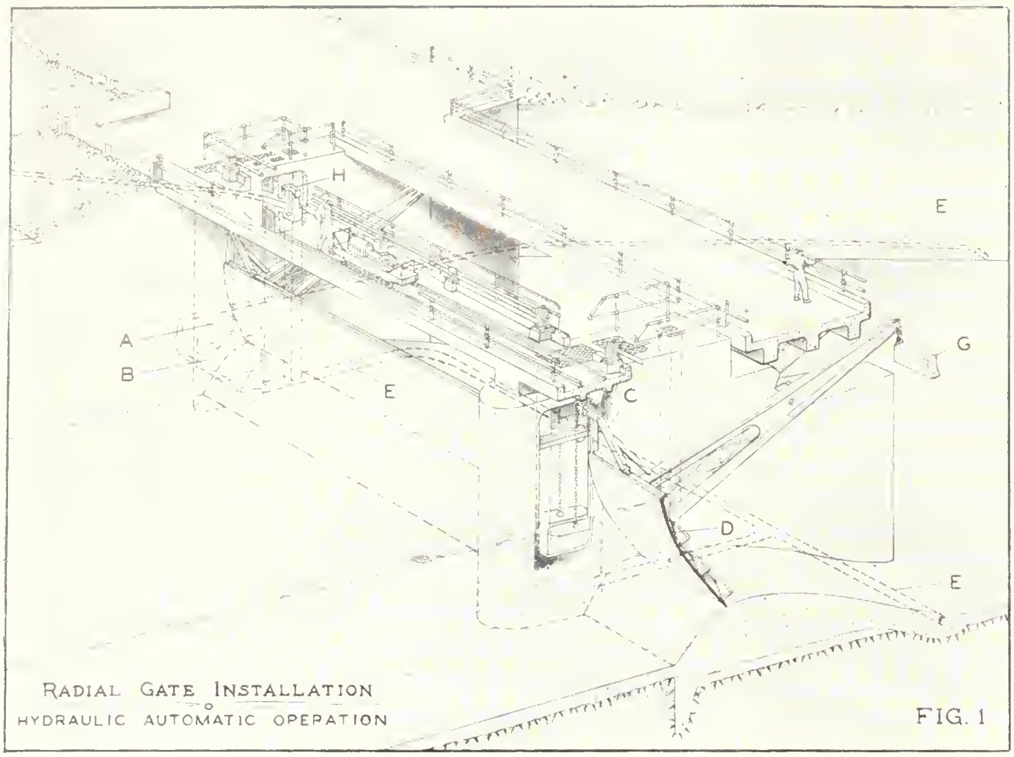
Radial gates consist of a face plate, or leaf, which is a true sector of a circle, connected by arms to pivots at the center of curvature. This arrangement results in the concentration of the resultant water pressure at the pivots. The gates are usually built of structural steel but may be made of steel and wood. Their particular advantages are that they are much easier to raise than slide gates and will close under their own weight because frictional resistances are overcome by the great leverage of the heavy leaf about the pivot. They require less powerful hoists than other types, and they are less likely to leak or to bind on account of unequal settlement of the parts of the supporting structure.

Operating mechanisms vary from the individual hand hoist for the smaller sizes to motor-operated hoisting equipment for large gates. In either case the gate is lifted by ordinary round or flat wire rope wound on drums or by chains passing over sprocket wheels. Hoisting equipment is operated preferably by electric power. Where such power is not available, gasoline engines or gasoline-electric generating units may be used. A gas engine or an electric motor arranged to travel from one gate to another is sometimes used for spillways with a number of gates. This is not economical for installations of two or three gates nor particularly desirable for a large number of gates because of the additional time required to raise the gates and the possibility of failure of the single hoisting unit in the face of a rapidly developing flood.

Automatic control is provided as an auxiliary control for spillways as a safeguard in the event of a sudden rise in the reservoir in the absence of the attendant. The radial gate is well adapted to such control, hydraulic or electric. In either case automatic operation is effected by a float arrangement set to respond to fluctuations of the reservoir water surface. A typical automatic hydraulic radial-gate installation is shown in figure 1. Water from the reservoir is admitted to wells (A) in the piers containing floats (B) suspended from davits (C) attached to the ends of the radial gates (D). The floats are actually weights heavier than water, consisting of a steel shell filled with a bituminous material. Pipe drains (E) extend from the wells to the downstream side of the gate structure.

The automatic operating principle is that of buoyancy, the floats in part and the gate being counterbalanced by a concrete counterweight (G) attached to an extension of the gate arms. The inlet to the wells (H) is adjusted so that when the water in the reservoir is at the normal water surface elevation, the water surface in the wells will stand at the bottom of the floats and the water will pass through the wells only in such quantity as can be discharged by the drains. Any rise in the reservoir above normal will increase the inflow and cause the water in the float wells to rise and submerge the floats. As the suspended weight of the floats decreases by reason of their submergence, the forces are unbalanced and the counterweight causes the gate to rise, raising the floats until they are out of the water an amount sufficient to bring the forces again into balance.

The amount of gate opening is dependent



upon the rise of the reservoir level; the higher the reservoir water surface the larger the inflow, and the higher the water surface in the wells, and consequently the greater the gate opening. The principle involved may be readily demonstrated by running water into a basin with the outlet stopper removed. A definite inflow will cause the water to rise until the head or pressure on the outlet is sufficient to cause an equivalent outflow. Increasing the inflow will cause further rise of the water until the inflow and outflow are again equal.

The principles involved in the automatic control have been used in California and elsewhere for some time, with satisfactory results.

Automatic electrical operation of radial gates is accomplished by means of a float-switch control set to operate when the reservoir water surface rises above the normal level. This switch controls a circuit through a magnetic reversing switch which, in turn, controls a circuit which energizes the hoist motor in the proper direction to raise or lower the gate. This apparatus responds readily to the rise and fall of the water surface.

Electric operation is dependent upon a continuous supply of power. Hydraulic operation has the advantage of being independent of the auxiliary hoisting mechanism and of the power supply. There is no interference between the automatic and mechanical equipment.

Radial gates are made practically watertight by means of seals around the sides and the bottom of the gate. Considerable care is required in setting and adjusting the gate on its bearings to secure the clearances and alinement required to prevent binding and in setting the seals to fit snugly into position. A common type of side seal is a piece of rubber belting bolted to the upstream face of the gate and held against a rubbing surface on the side walls of the gate structure by the pressure of the water. Another type is made of rubber and cord fabric, the construction being similar to that used for the bead on an automobile tire. A typical cross section of a strip of this device shows a bead of approximately 1¾ inches in diameter on one edge of a flat rubber strip approximately 2¼ inches wide. The dimensions vary with the size of the gate to be sealed.

Drum Gates

The drum gate, as used by the Bureau, is hinged on castings anchored along the upstream side of a recess in the spillway crest. In the lowered or open position, the gate rests in the recess with the upstream face forming a continuous curve with the crest of the concrete weir structure. The operating principle is that of buoyancy; the gate is floated to an upright position by water pressure in the recess underneath the gate and is lowered by relieving the pressure. Close regulation can readily be secured by hand, automatic, or remote control.

A typical installation is shown in figure 2, a section through the weir of the Boulder Dam spillways. These spillways consist of four openings 100 feet wide in each of two structures. The gates have a net lift of 16 feet and consist of structural-steel members, the outer surface of ½- and ⅝-inch plate being supported on built-up plate girders on 28-inch centers.

Automatic control by a float mechanism or independent hand control is provided for operating each gate. A float is mounted in a well in each pier (fig. 2). The lower end of a rod attached to the float supports a sheave through which passes a cable attached at one end to a pilot valve inside the main control valve, with a 24-inch differential needle valve which controls the flow of water from the gate recess. The pilot valve, actuated by the rise or fall of the float, controls the movement of the main body of the control valve. The other end of the cable, after being carried through a second sheave, is attached to a quadrant which, in turn, is affixed to and turns with the end hinge pin of the drum gate so that upward movement of the gate exerts a pull on the cable coupled to the pilot valve. The result of this combination is to open the control valve when the float rises; on the escape of water from the gate recess, the gate will lower, unwinding cable from the quadrant, allowing the control valve to close. The quadrant therefore effects a counteracting or restoring action in the control mechanism, causing the gate to come to rest when the reservoir surface becomes stationary.

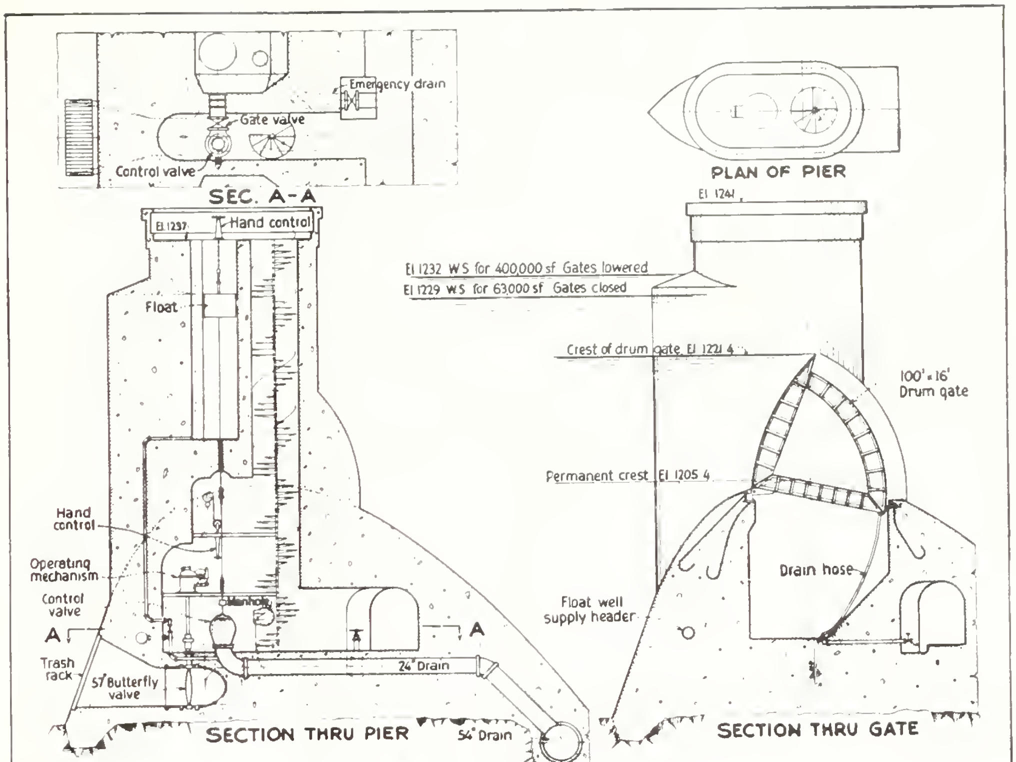
Hand operation is provided from three positions. From a position on top of the pier a hoist may be used to raise or lower the float. From another position in the pier beneath the sheave assembly a mechanism may be used to adjust the position of the lower sheave. The manipulation of either has the same effect as a rise of reservoir water. An emergency drain extending from the gate recess to an outlet downstream from the spillway weir, normally closed by a gate valve, may be operated by hand to control the gate should the hand-control mechanism or automatic apparatus be out of order.

Flow into the gate recess is provided by a 58-inch diameter pipe connecting the recess with the reservoir. A butterfly valve controls the amount of water passing to the recess. As the rising reservoir level reaches the inlet the recess chamber fills, floating the gate up in advance of the rising water surface. When the gate reaches its maximum position, the water against the bottom holds it in position until an additional rise in the reservoir, operating through the control mechanism, opens the control valve and releases water from the chamber, allowing the gate to lower. This additional rise may be selected at will. At Boulder it is intended that the reservoir water surface will be about 7.5 feet above the crest of the gate, corresponding to the discharge of 63,000 second-feet for both spillways. With a slight rise above this elevation, the gates will lower completely, after which an additional rise of approximately 3.5 feet will discharge the total capacity of 400,000 second-feet. As the flood peak decreases the gates automatically rise to their maximum position and remain there until the flood discharge has ceased. As the water surface level recedes the gates automatically return to their lowered position.

Seals are particularly important in connection with automatic control because it is desirable to prevent, as nearly as possible, any leakage from the gate chamber. Spring brass seals are used at the upstream edge of the gate along the hinge casting, at both ends and along the downstream gate seat. Any accumulation of water inside the gates is drained by a flexible hose at each end of each gate, coupled at one end to the gates by ball-and-socket joints and connected at the other end to pipe drains.

Ring Gates

This type of gate was designed especially for the spillway for the Owyhee Dam. The spillway is the circular lip of a funnel formed at the top of a shaft which discharges into a tunnel some 240 feet below the intake (fig. 3). The discharge over the spillway is regulated by a structural-steel ring gate 12 feet high and 60 feet in diameter. In the lowered position, the gate rests in a recess in the concrete crest so that the top of the gate forms part of the curve of the crest of the spillway. The operation of the gate is similar to that of the drum gate described above.



DRUM GATE & CONTROL FIG 2

Roller Gates

The roller gate in its simplest form consists of a hollow cylinder having a diameter corresponding to the height to which it is desired to raise the water above the spillway crest. The principal merits of the gate are simplicity and speed of operation, low operating resistance, small amount of leakage, long and unobstructed opening between piers, great durability, and stability.

The cylinder is built up of steel plate, stiffened by structural steel to withstand the strains to which it is subjected. The hollow cylinder, being a very efficient form of girder for supporting loads in any direction, makes a sturdy and simple closing device. In many designs a steel cylinder of smaller diameter becomes the supporting structural member for an apron which is attached to the upstream side and which consists of a skin plate supported by tangential struts from the cylinder. Figure 4 is a typical cross section of a roller of this type. When the roller is down, the apron bears against a sill in the crest of the spillway and forms the gate.

In general, the cylinder rolls on inclined tracks supported in lateral recesses in masonry piers or abutments. Around each end of the cylinder is a rim consisting of a rack and a smooth track. The track rolls on the track referred to above; the rack engages with a similar rack placed in the recess. Either a guide and counterguide ring assembly is used to prevent the teeth of the rack from becoming disengaged by trash and debris or the rack and track are protected by the end sealing shields hereinafter described. The gate is operated from one end by means of a sprocket chain wound around the end of the cylinder and carried to a hoist mounted on top of the pier. When the cylinder supports an apron, the ends are provided with wheels centered on the axis of the cylinder and attached to it. The wheels are fitted with a smooth track and rack which operate as described above for the large diameter cylinder.

If it is desirable to skim ice or debris from the surface of the reservoir, provision may be made to lower the gate to allow floating matter to pass over the top. The design of figure 4 provides for lowering the gate for this purpose. The roller and apron move into the position shown by broken lines.

The sealing of a roller gate against leakage along the bottom can be secured by bolting a strip of wood to the gate which will bear on the masonry below or preferably upon a machined cast-iron or steel beam embedded in the concrete. End seals consist of large flexible shields lined with wooden strips around the edges, attached to the ends of the roller normal to its axis. The flexibility of these shields permits the water pressure to press the wooden strips against the finished surfaces of the masonry piers.

The roller gate is a European development but has been used to some extent in this country for more than 20 years. Gates as long as 148 feet and as high as 21 feet are in operation, and one 158 feet long and 39 feet high is planned in Europe. One of the earliest American installations was by the Bureau of Reclamation in 1915 on the diversion dam across the Grand River near Grand Junction, Colo. These were the first steel roller gates to be fabricated in this country.

The Grand River installation consists of six rollers supporting aprons, each roller 70 feet long and 10 feet 3 inches high, and a seventh roller with an apron spanning a sluiceway, 60 feet long and 15 feet 4 inches in height. Provisions made for their operation and watertightness follow closely those previously described.

No difficulty has been experienced in the operation of the rollers. One man easily handles all work in connection with the operations. Leakage around the rollers does not exceed one-half cubic foot per second per gate, occurring mostly at the bottom of the end shields where the shields are rigidly attached to the main cylinders. In general, these gates have been very satisfactory and are admirably adapted to serve the purpose for which they were installed. Four gates, each 75 feet long and 23 feet high, have recently been installed by the Bureau in the All-American Canal headworks on the lower Colorado River. Two gates, 110 feet by 17¼ feet high, a cross section of which was used for figure 4, are being installed on the Roza Diversion Dam in Washington.

Stoney Gates

Stoney gates, so called because of their inventor, F. G. M. Stoney, are flat-leaf

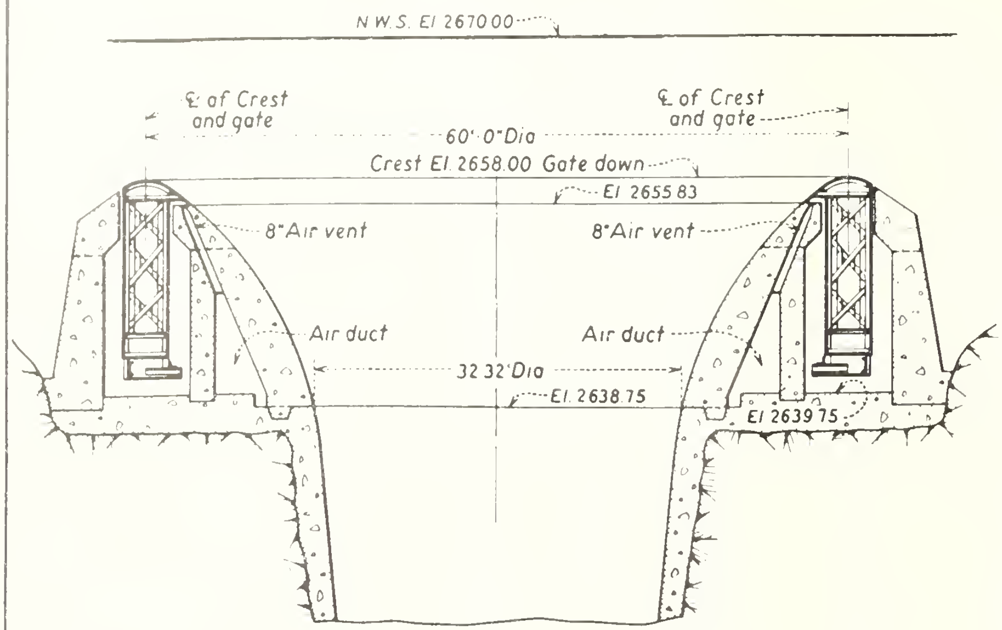


FIG. 3
RING GATE

structural-steel gates. They have been used for depths of water as high as 40 feet and openings as wide as 50 feet, and for lesser depths and for openings as wide as 90 feet. The gate moves in guides cast in concrete piers and on roller trains which are independent of both the gate and the piers. The rollers travel on tracks of castings or structural steel anchored to the masonry of the piers and designed to accommodate the various bearing and guide members of the gate. The roller train consists of rollers from 4 to 6 inches in diameter, supported by side plates with arrangements for maintaining alinement. The water pressure against the gate is carried through the rollers to the track. The gate moves on the diameter of the rollers and therefore moves twice as fast as the roller train. A supporting device for the rollers, which compensates for this relative movement, generally consists of a wire rope running from the top of the gate through a sheave attached to the roller train and to the service bridge. Another type consists of a set of pinions that travel on stationary toothed racks mounted on the gate guides, with corresponding traveling racks attached to the gate.

Rollers or shoes are usually placed on the ends of the gate to prevent lateral movement.

The gate, which will lower by its own weight, is generally suspended by wire rope or chains from drum or geared hoists located on a service bridge. The gate may be operated with or without the aid of counterweights. In some recent installations, the counterweights have been omitted and gantry cranes used.

Sealing along the sides of the Stoney gate may be secured effectively by rubber belting fastened to the face of the gate as described for the radial gate. Brass, bronze, or wood staunching rods are sometimes attached vertically to the gate and forced into their sealing position by the pressure of the water. The bottom may be made tight by attaching a wooden strip to the bottom of the gate and scribing this strip to a smooth steel beam embedded in the crest of the gate structure or by extending the face and side plates of the gate to form a tight seat on a sill.

Stoney gates are not suited for operation under high heads because of the destructive racking of the roller trains by water passing at high velocity under the gate. For some gates, however, protective steel covers have been devised to overcome this trouble.

The principal Stoney gate installation by the Bureau is on the Laguna Dam on the Yuma project, California-Arizona, one of the Bureau's earliest major developments. At the time of their installation in 1908 they were among the largest of their kind in the world. Figure 5, which is a cross section through one of these gates, shows the gate and hoisting mechanism. There are six gates in the spillway of the dam, each 17 feet 11¾ inches high and 34 feet 9½ inches wide. This installation has been very satisfactory.

Caterpillar Gates

These gates are very similar to the Stoney gates previously described. Instead of the independent roller trains provided for the Stoney gates, each side of the caterpillar gate is equipped with one or more continuous chains or belts of "caterpillar rollers" which have traction on a vertical seat in the gate slot of the gate structure and travel with the gate. The links and link pins of the roller chain are of steel bushed with bronze to reduce friction and corrosion. The chain runs on a cast-iron or cast-steel track fastened to the gate.

Watertightness around the sides and bottom of the gate is secured in a similar manner to that described for the Stoney gate.

The principal advantages of the caterpillar gate over the Stoney gate are that the roller trains, being attached to the gate, do not require special handling devices and the roller trains are not subject to racking from water flowing under the gate.

Several gates of this type have been built by the Bureau and are giving satisfactory service. The north spillway of the Guernsey Dam in Wyoming is controlled by a caterpillar gate 50 feet in height closing a clear opening of 50 feet. The gate is mounted on six sets of 8-inch diameter rollers on each side, variably spaced throughout the gate's height to produce an equal load on each set. The rollers travel on H-beam tracks bolted to structural-steel members embedded in the downstream face of the gate structure slots. Lateral movement of the gate is controlled by 8-inch diameter guide rollers on the ends of the gate rolling on the flange face of 8-inch H-beams bolted to the piers.

Ten 50- by 50-foot caterpillar gates have recently been installed, three at Bartlett Dam, two at Mormon Flat Dam, and five at Parker Dam. As an aid to realizing the size of these gates, it may be stated that the height of each 50-foot gate is about equal to the height above ground of a 4½-story building. The structures required for these gates rise some 130 feet above the gate sills, a height about equal to that of an 11-story building. Each gate weighs over 400,000 pounds.

Such gates are raised by chains carried over sprockets on the main shafts of twin hoists, one for each side, with reducing gear and the driving motor located midway between them. A standby gasoline-engine drive is provided for emergency operation. Concrete counterweights are provided in order to reduce the required capacity of the hoisting equipment.

Fixed-Wheel Gates

The fixed-wheel gate is similar to the Stoney or the caterpillar gate except that the gate travels on wheels attached to the gates instead of on trains of rollers. This type of gate is adapted to maximum spans of about

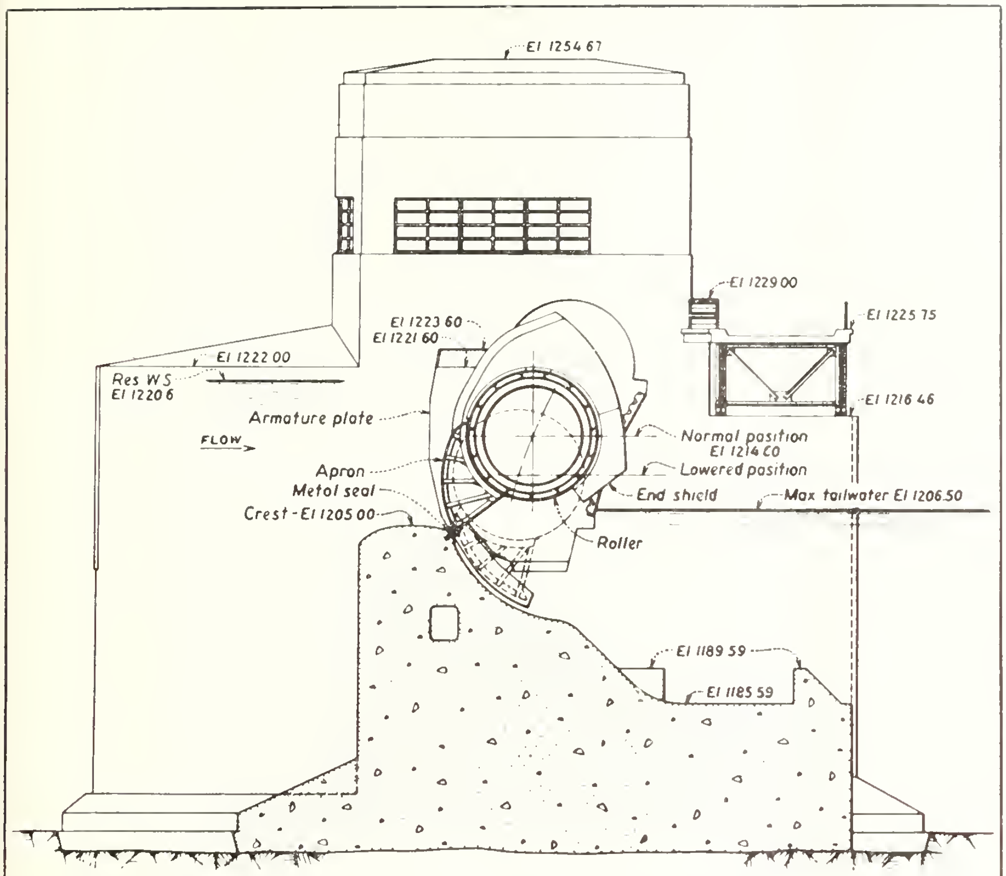


FIG. 4
TYPICAL ROLLER GATE WITH SHIELD

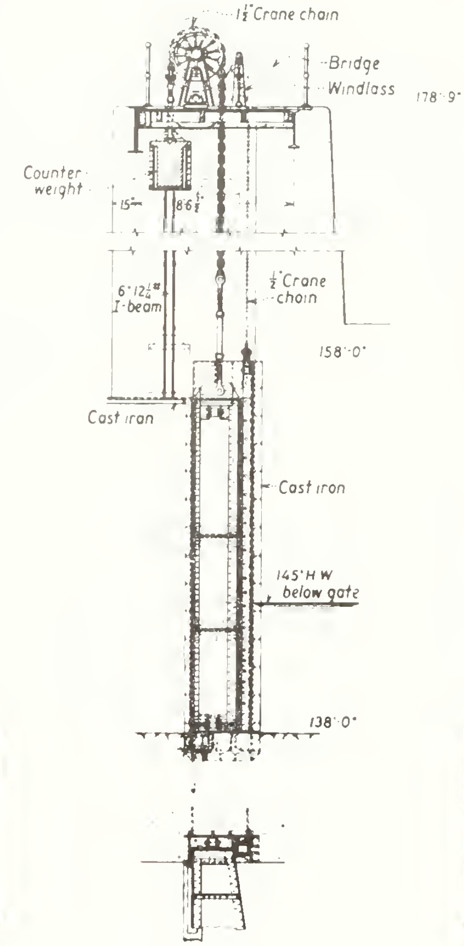


FIG. 5
TYPICAL STONEY GATE INSTALLATION

25 feet and heights not much over 30 feet. Beyond these limits the caterpillar type of gate is more suitable as well as more economical. On the smaller sizes the fixed wheels are carried by bronze bearings. On the larger sizes the wheels are provided with roller bearings and are spaced to produce an equal load on each wheel. For this reason, the frictional resistance to raising the gate under full pressure need not be appreciably greater than that of the caterpillar type of gate. The fixed-wheel gate is raised by means of hoisting machinery similar to that provided for the Stoney or the caterpillar gate.

Operation of any of the foregoing gates of this type may be either mechanical or electrical, automatic control being secured in a similar manner to that described for the radial gate. Sealing against leakage may be accomplished by any of the various methods described for similar types.

Alcova Dam Spillway Typical

A typical installation of this type is the Alcova Dam spillway recently completed by the Bureau on the Kendrick project in Wyoming. Three gates 25 feet 8 inches wide by 40 feet high control the spillway.

Each gate is mounted on nine wheels on each side, spaced to produce an equal load on each wheel. The wheels are double-flanged, rolled-steel, 21 inches in diameter, revolving on steel roller bearings and rolling on railroad rails anchored to the downstream face of the gate slots in the piers. Lateral movement of the gates is controlled by steel gate shoes attached to the ends of the gate and notched to travel on a structural-steel guide anchored to the back face of the pier-gate slot.

Seals for the Alcova Dam gates are similar in principle to those previously described but depart somewhat from the usual design. The bottom edge of the skin plate rests on a sill consisting of babbit metal poured into the trough of a structural-steel channel attached to the top flange of an **I**-beam embedded in the concrete of the spillway crest. The side seals consist of vertical strips of rubber belting with one edge attached to the upstream face of the gate and the other edge bound between a steel rubbing plate and a stiffening angle. The rubber strip is turned through an angle of 90° so that the rubbing plate will be in contact with the flange of a steel tee anchored in the face of the pier upstream from the guides. The stiffening angle is suspended from a clip angle at the top of the gate by means of a turnbuckle which is used to adjust the position of the seal. The water pressure forces the rubbing plate tight against the face of the pier.

Turkey Trade on Klamath Project

KLAMATH project farms sold about 16,000 turkeys for the Thanksgiving market, receiving 22 cents a pound for the birds.

Industrial Development on Grand Valley Project

THE Grand Valley Rural Power Lines, Inc., completed construction of additional transmission lines in the Orchard Mesa district at a cost of $48,000, which will serve 142 additional farms with electricity, with more to come in later.

Owyhee Sugar Beets

THE sugar beet harvest has been completed on the Owyhee project, with a yield that proved better than had been anticipated. The yield was estimated to average about 15 tons per acre on the entire acreage in the Nyssa factory area. Approximately 15,900 acres were grown, more than half of which was in Malheur County.

Federal Reclamation in Nebraska

By JOHN C. PAGE, *Commissioner of Reclamation*[1]

A KEENER and more inquiring interest in the Federal Reclamation program has been the natural result of the growing consciousness on the part of the whole Nation of the problems that make a broad conservation program essential.

Recurring droughts and floods, especially, have served to emphasize the tempering benefits of this work in the arid and semiarid third of our country—this work which was undertaken more than 36 years ago as a major part of the first national drive toward conservation and more intelligent use of our resources.

The record which has been made by Federal Reclamation is clear and the benefits of this work cannot be doubted nor minimized. It provides a good example of what may be expected from a well-planned conservation program, honestly executed.

When, in 1902, President Theodore Roosevelt proposed Federal Reclamation to the Congress, he predicted that it would "enrich every portion of our country just as the settlement of the Ohio and the Mississippi Valleys brought prosperity to the Atlantic States." The record made since June 17 of that year, when the act creating the Bureau of Reclamation was signed, shows accomplishment of what he predicted.

What Reclamation Has Meant to the Nation

If the members of the Nebraska State Irrigation Association, among whom are included many irrigation farmers and others familiar with the program, will indulge me a moment, I should like to review briefly what the program has meant to the United States.

First, it has meant, through the construction and settlement of 34 projects comprising a little more than 3,000,000 acres of land, creation of homes for almost 900,000 persons on irrigated farms and in cities and towns which have grown up among those farms.

Second, it has meant the establishment of substantial, permanent communities in these big Western States, where without irrigation even an approach to close settlement is impossible. In these communities are 850 schools, almost 1,000 churches, and banks which had deposits last year of about $225,000,000. The manner in which a contribution of this sort bolsters State and National Governments does not need to be spelled out syllable by syllable to be understood.

Third, these projects produce each year about $100,000,000 of wealth, most of which goes into the channels of trade, principally those leading to the industrial centers of the East.

These results have been obtained from operating projects which were built at a cost of about $250,000,000 and which have repaid, under contracts that are expected eventually to return the whole investment, nearly $50,000,000 of the total.

This is the record upon which, under the leadership of Franklin D. Roosevelt, another conservation-minded President, and Secretary Ickes, a still greater reclamation program is being carried forward today. Projects, several of them combining multiple conservation purposes, such as aid to navigation, flood control, river regulation and power development with irrigation, are being constructed to provide water for 2,500,000 additional acres and to provide a reliable supplemental water supply for another 2,500,000 acres of western irrigated lands now short of water.

Nebraska, a Beneficiary of Federal Reclamation

Nebraska, one of the 16 States originally embraced by the Reclamation Act, from the outset has been closely associated with the Federal Reclamation program, participating in its benefits and sharing in the hopes and aspirations for the future.

This State is so situated, extending from the arid to the humid belts and across that uncertain zone between, that its associated water and land-use problems are very complicated. Here, in Scotts Bluff in western Nebraska, you live in an area unquestionably arid, where irrigation and farming are Siamese twins. The problem here has been met by the construction of the North Platte Federal Reclamation project and other development privately financed. Uncertainties introduced by variable seasonal rainfall, sometimes sufficient, sometimes insufficient, always unpredictable, a little farther east have served to make the problem there more difficult to meet.

State and local efforts in other sections of the State are attempting to meet the different situations. The University of Nebraska is to be complimented, for example, for the work it has done in gathering data on ground water supplies. Where the streams are so few and their flow so largely appropriated and used, availability of ground water assumes a major importance.

Development of these resources, however, must not proceed blindly or without careful weighing of economic and social considerations. The history of irrigation by pumping from wells in some sections of the West is so tragically eloquent that its lessons must not be overlooked.

The long period of deficient rainfall over the Great Plains, beginning in 1930, has provided a new point for the old argument that water in this area must be used prudently. It has provided for all a new significance for the responsibilities of the individual to his community. Wasteful overirrigation by water users in one locality may deprive others elsewhere of the opportunity to produce crops and maintain homes. Ownership of a prior water right is a simple fact, but possession of water is not an excuse for unnecessary and wasteful use.

History of North Platte Project

Turning to the North Platte project, the only Federal project in the State, I should like for a moment to discuss its significance.

This project was approved by the Secretary of the Interior conditionally in 1903, construction was begun in 1905, and the first water was delivered in 1908. With the completion of the Northport Division in 1923, the area for which the Bureau of Reclamation was prepared to supply water within the project limits was 183,296 acres, while supplemental supplies were provided under contract for an additional 104,779 acres. These areas combined are twice as large as the total of all irrigation projects in Nebraska prior to the enactment of the reclamation law, and at present they represent half of all the lands irrigated in the State.

While farther east than most, the North Platte project is illustrative of the many factors entering the development of projects under the Bureau of Reclamation. With the storage facilities located in another commonwealth, the interstate character of the stream was a factor. Development of water power and utilization of the surplus was another.

On the edge of the drought area, some project lands have felt the effects of conditions that have been disastrous to vast sections less favorably situated.

From both an economic and a social standpoint, Reclamation's contribution to the development of western Nebraska is notable. In Scotts Bluff County in 1909 the assessed value of all types of property was $1,459,000.

[1] Paper prepared by Commissioner Page and presented December 9, at the forty-sixth annual convention of the Nebraska State Irrigation Association held at Scotts Bluff, Nebr., by C. F. Gleason, superintendent of power, North Platte project, Guernsey, Wyo.

In 1936, after 25 years of irrigation, it was $23,936,000—roughly an increase of 16 times.

Irrigated lands in Scotts Bluff County are assessed as high as $80 an acre as compared with maximum assessments of $9 an acre on dry farm lands and $3.60 on pasture lands.

While only 193,000 of the 432,000 acres in this county are irrigated, it is estimated that 80 percent of the population derives its incomes from irrigated agriculture. In Box Butte County where only 1.5 percent is irrigated of an area 50 percent larger than that of Scotts Bluff County, the population is less than half as large and the assessed valuation less than one-third.

The average value of improved land with a paid-up water right in the Pathfinder Irrigation District, for example, is $85 an acre as compared with $3 an acre for land without water. A conservative estimate of the increase in value of lands irrigated in Nebraska as a result of this project is $20,000,000. Related industrial and urban development would greatly increase this remarkable total.

The 2,119 irrigated farms on the project in Nebraska have a population of 7,000, and there are in the area 11 cities and towns with 18,000 inhabitants who are in a large measure dependent on irrigation operation for a livelihood. Including those in the Goshen division in Wyoming, there are 70 schools, 54 churches, and 9 banks with more than $7,000,000 in deposits.

Like other projects in the reclamation States, the North Platte project contributes to the purchasing power of the area with a national distribution of the benefits. In 1937, the value of the crops produced on lands served or dependent on the project works in Nebraska exceeded $5,500,000. The Federal investment in the works serving this area totalled $17,000,000, all of which is repayable.

In any development of this type, with the passage of decades, some adjustments become necessary. The major project works have stood the test of time and years of operation.

Reclamation's Engineering Record

The construction record of the Bureau of Reclamation is good all down the line. The Bureau has never had a dam which failed, for example, and it has built 147 dams, 4 of which were the highest in the world when they were completed. There has been no serious trouble with any major structure on Federal Reclamation projects. Years of engineering experience and research lie back of each.

The Bureau of Reclamation, however, pioneered in the development of irrigation projects in many areas. It is undoubtedly true that some lands were included within project boundaries which, for one reason or another which later became apparent, should not have been classified as irrigable. The Repayment Commission, after an investigation last year, recommended that authority be granted to reclassify project lands. This should be done in justice to the water users and in justice to the reclamation program. I believe that adjustments which result will not be great.

On the North Platte project, two problems are faced. The difficulties of the Northport, division, as the Repayment Commission pointed out, can best be solved by a special plan covered by special legislation.

CCC Aid

Already, with the aid of the Civilian Conservation Corps, we have attacked the other problem, that of straightening and improving the canals and laterals so as to decrease the loss of water in transit. The first Civilian Conservation Corps camp established under the jurisdiction of the Bureau was opened on the North Platte project 5 years ago. Soon a second camp was placed here, and since that time two have operated on the project continuously. The canal improvement program conducted by these camps has been of major importance. In addition, the CCC enrollees have planted more than half a million trees for windbreaks, and also have provided a recreational area at Guernsey Reservoir.

It is my opinion that we can look forward to additional cooperation from the States in anticipating and meeting the special problems of the projects as their settlement and operation bring these new problems into prominence. In some instances the States have not given the attention to the projects which is warranted by their very great importance to the States. On several projects, additional facilities for guidance in the agricultural development, in the control of weeds, in the best use of water on the land, and in marketing are needed and can best be provided by the States and their agricultural colleges.

Organizations such as the Nebraska State Irrigation Association could render outstanding service by developing in their States intelligent and aggressive programs for the cooperative efforts needed.

Secretary Ickes recently said that the people of the country have little conception of what is being done in the way of significant public works through the reclamation program in the West.

The healthy general interest in reclamation springing from an awakening to the importance of broad conservation programs inevitably will lead to a better understanding. This will mean much to the West and to reclamation through broadening the support for a worthwhile program.

State Senator McColl Loses Life in Auto Accident

JOHN B. McCOLL, of Redding, California, State senator representing Shasta and Trinity Counties, one of the organizers and untiring workers of the Central Valley project, died the morning of December 19, 1938, as the result of an automobile accident the day previously. He passed away in a San Bernardino hospital from head injuries which he received when his car collided with another in Cajon Pass during a Sunday rain and sleet storm.

Mr. McColl was driving alone at the time, returning from a trip to Boulder Dam. At first it was thought that he was not seriously injured. Taken to a hospital immediately for a check up, he lapsed into a coma from which he never recovered consciousness. The two occupants of the other car were slightly injured.

In commenting on the loss of this young State senator, who had just passed his forty-fourth birthday, Governor Merriam of California issued the following statment: "In the untimely death of Senator McColl the State loses the services of a man who represented our finest type of American public official. His loss is an irreparable one to the Central Valley project."

The Bureau of Reclamation, at its Washington, D. C., headquarters and in the field offices, will miss Mr. McColl. His assistance and counsel, particularly on matters leading up to the approval of the Central Valley project and since, during the period of construction, have been valued and they were always cheerfully extended. The name of Senator McColl is inseparable from the great project now being built in California.

Power Development in December Federal Reclamation Projects

Project	*Output kilowatt-hours*
Salt River, Ariz	8, 865, 700
Yuma, Ariz	854, 497
Boulder Canyon, Ariz.-Nev	149, 777, 000
Grand Valley, Colo	606, 650
Boise, Idaho	5, 451, 934
Minidoka, Idaho	2, 599, 000
North Platte, Nebr.-Wyo.	1, 849, 560
Newlands, Nev	398, 000
Strawberry Valley, Utah	478, 139
Yakima, Wash	2, 117, 000
Riverton, Wyo	206, 880
Shoshone, Wyo	1, 285, 400
Total	174, 489, 760

Annual Report of the Secretary of the Interior, Fiscal Year 1938

THE illustrated report of the Secretary of the Interior, to the President, for the fiscal year ended June 30, 1938, consisting of 421 pages, with index, is now available. It can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 50 cents.

The report describes the outstanding activities and achievements of the various bureaus and offices having to do with parks, reclamation, power, public lands, geology, mining, Indians, education, territories and island possessions, and four District of Columbia eleemosynary institutions.

The report includes, pages 51–83, the Thirty-seventh Annual Report of the Bureau of Reclamation under Commissioner John C. Page. It discusses briefly the homemaking opportunities on the irrigation projects; construction work, including progress on the Grand Coulee Dam, Boulder Canyon, Central Valley, Colorado-Big Thompson, the All-American Canal, and other projects; power, repayments, economic development, operation and maintenance, crop results and finances with tables and illustrations of irrigation results.

Two Former Bureau Officers Married

FRANK E. WEYMOUTH, former Chief Engineer of the Bureau of Reclamation and now general manager of the Metropolitan Water District of Southern California, is receiving the congratulations of his associates on his marriage on November 10, in Honolulu, to Miss Barbara Turner. The couple returned to Los Angeles on December 7, and are making their home at the Chapman Park Hotel.

Charles A. Bissell, former Chief of the Engineering Division, Washington office of the Bureau of Reclamation, and now connected with the Metropolitan Water District of Southern California, this year surprised his former associates in the Bureau by sending out holiday greetings in the name of Mr. and Mrs. C. A. Bissell. Congratulations! The Bissells are at home at 619 N. Camden Drive, Beverly Hills, Calif.

CONTENTS

THE RECLAMATION ERA • JANUARY 1939

CUT ALONG THIS LINE

COMMISSIONER, (Date)..........

Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check[1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

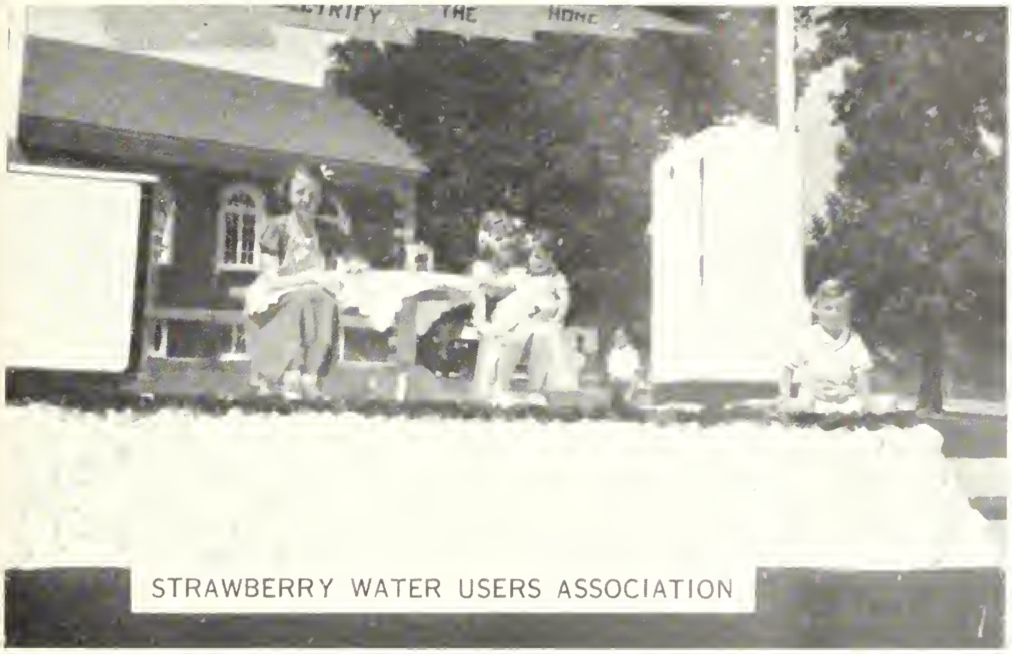
January 1939 (Name)..........

(Address)..........

....

[1] Do not send stamps.

NOTE.—36 cents postal charges should be added for foreign subscriptions.



Onion Days and Home Coming Celebration Strawberry Valley Project

THE Strawberry Valley project, Utah, takes a great deal of pride and interest in the parade feature of the annual Onion Days and Home Coming celebration, the latest of which was held on September 3, 4, and 5, 1938. At this celebration the project manages to organize a parade which takes an hour or more to complete the parade course.

The accompanying snapshot was made of a float that was entered by the Strawberry Water Users Association in the parades featured at the latest celebration.

Reservoir at Parker Dam Fills

RELEASE of water from Lake Mead to fill the 510,000 acre-foot reservoir at Parker Dam, 155 miles below Boulder Dam on the Colorado River, has been completed.

In addition to the regular releases for irrigation needs on the Yuma Federal Reclamation project in Arizona and the Imperial Valley and other areas in California, from October 13 until about December 31, 10,000 to 16,000 acre-feet of water daily were turned through the outlets of Boulder Dam to fill the reservoir at Parker Dam.

The purpose of filling the reservoir at Parker Dam at this time was to make it possible for the Metropolitan Water District of Southern California to test the pumps and reservoirs along its aqueduct line. These tests are now being begun with the aid of power from Boulder Dam power plant.

Parker Dam, recently finished by the Bureau of Reclamation, was built with funds advanced by the Metropolitan Water District. It will serve to reregulate the Colorado River below Boulder Dam and to pond water at the first pumping plant of the Metropolitan Water District at the head of the aqueduct.

The aqueduct of the Metropolitan Water District, composed of 13 cities in the vicinity of Los Angeles on the coast of southern California, is nearing completion. It will carry water from the Colorado River a distance of about 250 miles for domestic supply. The water district is a major purchaser of Boulder power. It also buys its water, paying the Boulder Canyon project fund 25 cents an acre-foot for that used. The ultimate capacity of the aqueduct will be 1,500 second-feet, or a million gallons a day.

Lake Mead on December 31, 1938, contained 22,565,000 acre-feet of water, a reduction from the high point that year of 23,185,000 acre-feet. This reduction in storage represents a drop in the elevation of the water surface of slightly more than 4 feet from the all-time high.

The great floods of the Colorado, which occur in May or June each year with the melting of snow in the Rocky Mountains, cause the lake to rise rapidly for a few weeks. During the remainder of the year the inflow and the outflow of Lake Mead either just about offset each other, or the water surface slowly declines as irrigation demands downstream exceed the natural flow of the river above the headwaters of the lake.

The capacity of Lake Mead is 30,500,000 acre-feet, about equal to 2 years average total flow of the Colorado and sufficient to cover the State of New York to a depth of approximately 12 inches.

Corn Husking Contest

CORN HUSKING is not a fine art in the arid and semiarid States for the reason that little corn is raised on irrigation projects. This fall, however, the first corn-husking contest ever to be held west of Nebraska took place on the H. E. Noah farm near Ontario, Oreg., on the Owyhee Federal Reclamation project. The Owyhee project, a new development, has some acreage planted in corn which later, if it follows the agricultural history of other Federal Reclamation projects, will be devoted to other crops.

The contest, because of its novelty, was attended by the usual fanfare of broadcasting system, traffic officers, and numerous judges and officials and was viewed by a crowd estimated at 3,000 people, many of whom had never seen an ear of corn husked before in their lives.

More contestants applied than could be accommodated and qualification tests had to be held in advance to reduce the field to the 12-man limit. The winner was Walter Oberg of Carlton, Oreg., who was credited with husking 1,512 pounds of corn in the 1-hour period, after the customary deductions for husks left and ears missed.

Men who had seen contests in Iowa remarked that the variety of corn on Mr. Noah's farm, which was the hybrid "Iowealth," is the same that is usually chosen in contests in the Corn Belt, and while the yield was estimated at 100 bushels per acre, the corn was much more difficult to husk than in Iowa, the husks clinging close and the ears breaking off hard. This accounted for the usual maximum rate of husking of 35 ears per minute at the Owyhee contests being far below the peak rate of 70 ears per minute some times reached during national contests.

Record Sugar Beet Harvest on Belle Fourche Project

THE sugar beet harvest on the Belle Fourche project made excellent progress during November under favorable weather conditions, and about 85 percent of the crop had been hauled to dump at the close of the month. Yields reported varied from 8 to 21 tons, with a prospective average of about 13 tons per acre, or the highest of record for the project. Reports of 16 tons per acre were common.

Construction of Bull Lake Dam, Riverton Project, Wyoming

By TOLLIFF R. HANCE, *Inspector*

THE Riverton irrigation project, located in West Central Wyoming on the eastern slope of the Continental Divide, was begun in 1920. Water from the Wind River is diverted into Wyoming Canal by means of a concrete diversion dam, constructed in 1923 and located about 34 miles northwest of Riverton. About 9¼ miles from the point of diversion, water is brought to a power plant which furnishes power to surrounding towns. Waste water from the power plant is discharged into Pilot Butte reservoir for subsequent diversion to Pilot Canal for irrigation purposes.

Extension of the canal system and the irrigation of additional land necessitated supplemental storage of the flood waters of the Wind River above the point of diversion. Prior to the construction of Bull Lake Dam no storage, other than the small amount in Pilot Butte Reservoir, was provided for the project, the natural flow of the Wind River being relied upon throughout the irrigation season. The principal tributary of the Wind River above Diversion Dam is Bull Lake Creek. This creek discharges about 3 miles upstream, and is the outlet of Bull Lake, a natural lake formed by glaciation. This lake was about 6 miles long, had an average width of about one-half mile, and lay in a deep depression formerly occupied by glacial ice and extending from the foothills of the Continental Divide to within 3 miles of the Wind River. The original stream channel was widened and deepened by the glaciers and the material deposited in a series of moraines across the mouth of the depression between the Wind River and the foot of the lake.

Bull Lake Dam is located in the glacial moraine at the outlet of the lake and provides storage by impounding water above the old lake level. The drainage area of approximately 220 square miles extends to the top of the Continental Divide and taps the glaciers lying below the historic Fremont Peak. The run-off is characterized by its rather late maximum, usually occurring in latter part of June and early part of July. The initial run-off, from the low melting snows, usually begins early in May and is supplemented by the melting glaciers later in the season. The annual run-off for the period 1918 to 1935 averaged 223,000 acre-feet, with a maximum of 294,400 in 1923 and a minimum of 130,600 in 1934, thus providing ample water for the reservoir capacity of an estimated 155,000 acre feet.

Early Investigations

Investigations of the dam site were made as far back as 1906 by the Wyoming Central Irrigation Co. Reports on the location were made by the Bureau in 1919 and again in 1935. The construction of the dam was approved and $1,000,000 provided from E. R. A. funds for the work. Bids were opened December 7, 1935, and the contract for the construction awarded to S. J. Groves & Sons Co., of Minneapolis, Minn., who gave a bid price of $653,397.50. The contract was awarded December 21, 1935, and notice to proceed acknowledged February 24, 1936.

Panorama of dow

The contract allowed a total of 700 calendar days for completion of the work, but owing to delays in receiving materials, etc., an extension of 120 days was allowed. The final payment for the contractor gave him $649,414.21 for the work.

The Dam

The dam is of the earthfill and rockfill type and winds its way through the saddles of the glacial moraine at the outlet of the lake. Three horizontal curves on the axis line of the dam take advantage of the formation and permit a maximum of storage with a minimum of material. The whole geological structure rests on a residual blue clay which provides a stable and highly impervious foundation. The largest portion of the embankment in the section between the spillway and the north abutment rests for the most part directly on the blue clay. Two cut-off trenches with a 10-foot bottom and a 6-foot depth with 1 : 1 side slopes are constructed in the foundation through the creek bed. In the lower parts of the embankment these trenches are reduced in width to 4 feet. The upstream face of the dam has a 3 : 1 slope and is faced with a 3-foot layer of riprap, from the crest to a berm at elevation 5,750. The downstream slope of the earthfill was constructed on a 2 : 1 slope. The rockfill is laid against the earthfill and is finished on a 1½ : 1 slope, to elevation 5,750, a 6 : 1 slope to 5,768 and a 2½ : 1 slope to crest of the dam at elevation 5,813. Outlet is provided by two 8-foot diameter horseshoe-shaped conduits located just south of the old creek channel and at the foot of the hill forming the right bank of the creek. The outflow is controlled by four pairs of slide gates, operating in tandem, in the conduit plug just upstream from the axis of the dam. The gates are 5 by 5 feet and provide control of the outlet and diversion discharge furnishing a maximum capacity of 4,500 second-feet.

General view of Bull Lake Dam from north abutment

ace, Bull Lake Dam

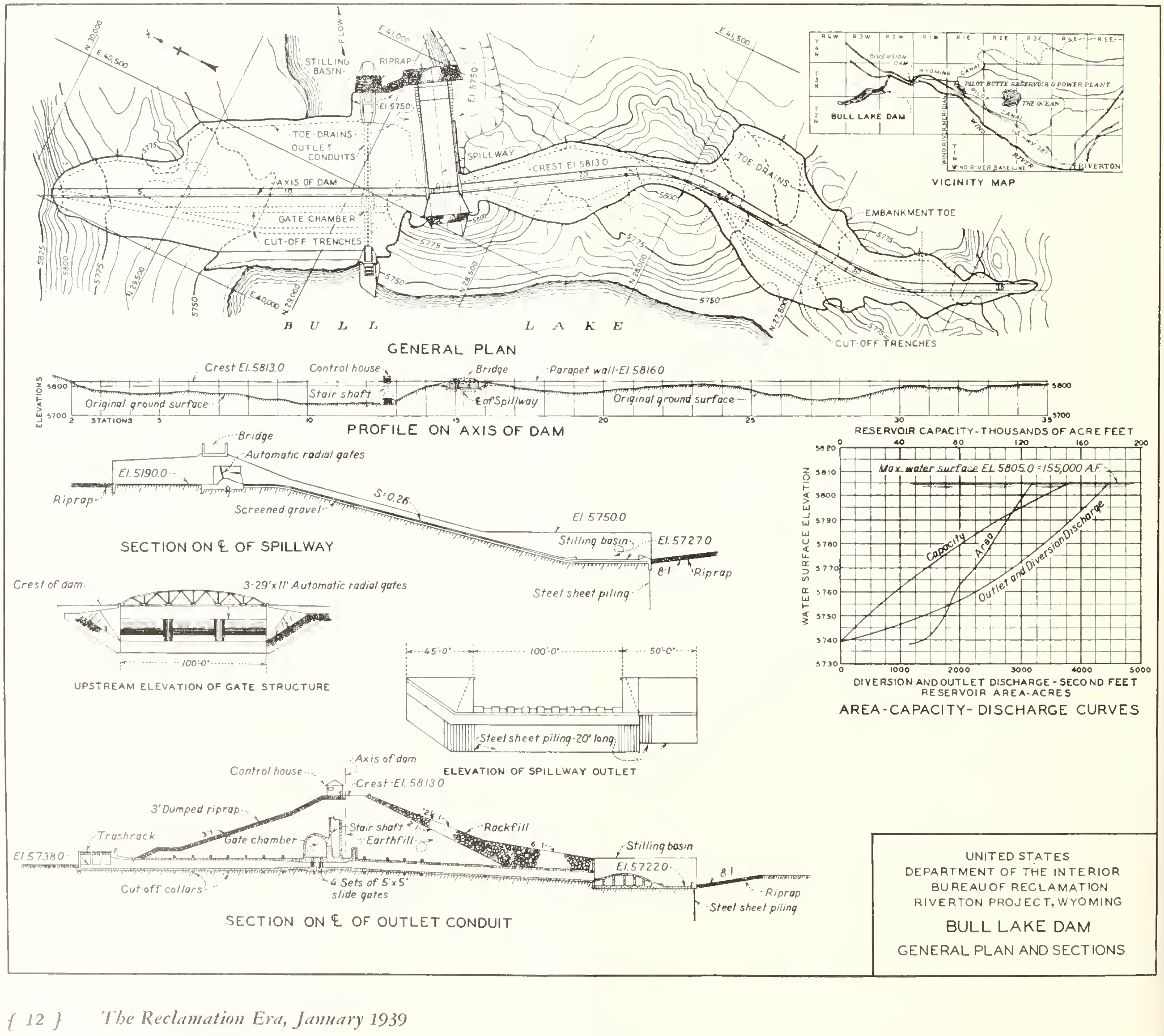
The spillway provides a capacity of 10,000 second feet and is constructed in this hill, which is the largest in the confines of the dam. Control is established by three 29 by 11 feet automatic radial gates.

Construction

Work was started by the contractor March 28, 1936. The embankment south of the spillway was started and completed to the base of the parapet wall November 27, 1936. The construction of the outlet conduit was started July 25, 1936, and was completed December 18, 1936, and diversion of the water through it took place April 8, 1937. One section of the spillway wall was placed in October 1936, and no further work was done until May 6, 1937. The concreting of the spillway was completed November 3, 1937. The roadway was completed July 20, 1938, and final construction was made July 22, 1938.

Borrow pits. The general procedure of construction of the earthfill was to place the tighter materials in the center of the dam and the materials with a higher percolation rate near the upstream and downstream face. Some difficulty was encountered in maintaining a uniform production of these materials and frequent changes in location of pit operations were necessary.

The section of the dam south of the spillway was constructed in 1936 and materials from the two borrow pits at the south abutment were used almost entirely. The major portion of the core material came from the pit located downstream from the axis. Some rock was encountered in this pit and was used in the rockfill and riprap sections. The material was rather dry and was too tight to make flooding previous to excavation feasible. Moisture was added at the pit by maintaining a stream of water on the face of the excavation. During the early part of the season rocks, with a maximum dimension of more than 5 inches, were removed on the fill by hand picking but because of the large amount of rock encountered this method was abandoned and a revolving trommel set up. This trommel was fabricated from steel rails and was about 6 feet in diameter and 14 feet long. It turned at about 5 revolutions per minute and effectually removed the oversize rock. It also served to mix the materials



more thoroughly and gave a more uniform moisture content. The products fell into two hoppers for loading trucks and buggies for transportation to the embankment.

Material for the more pervious section of the embankment was taken from a pit located about 1,000 feet upstream from the dam, south of the abutment. Considerable oversize rock obtained from this pit was used in the rockfill portions of the dam. Some material from the spillway excavation was used in the core. The material for the main section of the dam came from three borrow pits and the balance of the spillway excavation. The pit at the north abutment contained a very large percentage of rock which was not uniformly distributed however, and for the most part the material required trommeling. In some locations there was such a percentage of rock that pit run material was used in the rockfill sections. The chief deficiency of the pit was suitable clay for the core material. The spillway excavation provided a good tight clay comparatively free from rock. Extra material was obtained by borrowing from the sides of the spillway excavation and using the material from a hill at the foot of the spillway. A borrow pit upstream from the dam and below high-water elevation furnished about 158,500 cubic yards, comparatively free from rock.

Rockfill and riprap.—The rock obtained from all the borrow pits was principally granite, syenite, and diorite. Occasionally a limestone was encountered but as a whole the rock is heavy and very durable. The rock was dumped in place and brought to an even plane by means of bulldozers and a dragline. In a few instances large rock hauled to the riprap area were shot to facilitate this placing. The backfill behind the sides of the spillway chute was given a rock blanket to protect it from erosion.

Earthfill.—Materials for the earthfill were hauled from the borrow pits and the trommel with trucks and speedsters. Usually it arrived with the moisture content somewhat below optimum. Additional water added from hoses during dumping and spreading operations was usually sufficient but frequently additional mixing was necessary to establish a uniform moisture condition. This mixing was accomplished on the fill by stirring the material with a rock blade dozer before rolling.

Concrete.—Aggregate for concrete was produced from borrow pits along Wind River and transported about 3 miles to the dam site. The deposit was composed primarily of the harder plutonic rocks and resulted in strong durable concrete. Screening was done at the pit and oversize rock crushed. The material was stockpiled in two locations at the dam site. The batching plant was located at the stock piles and the material discharged from the batcher was transported to the mixer by trucks. The contractor used a paving mixer and moved it to the various parts of the job. Concrete from the mixer was transported to the forms in a bottom dump bucket with a crane.

Outlet Works

A cofferdam for unwatering the outlet works foundation was completed July 2, 1936. It was found necessary to reinforce this cofferdam at the upper end with steel sheet piling. These were temporarily driven and were later pulled and used under the conduit barrels. Settlement and displacement of the conduit structure was minimized by constructing a line of cells of steel sheet piling from the trash-rack structure to a point well below the gate chamber. These were driven to a firm anchorage in the blue clay. Some rock was encountered which made driving difficult. The material lying on top of the blue clay at the upper end of the conduit was deemed unsatisfactory to support the conduit even though it was confined with the sheet piling. Accordingly this material was excavated and replaced with selected material, rolled in place in a manner similar to that used in placing the dam embankment. This amounted to 918 cubic yards. No harmful settlement of the conduit barrels was noted prior to the diversion of water through them.

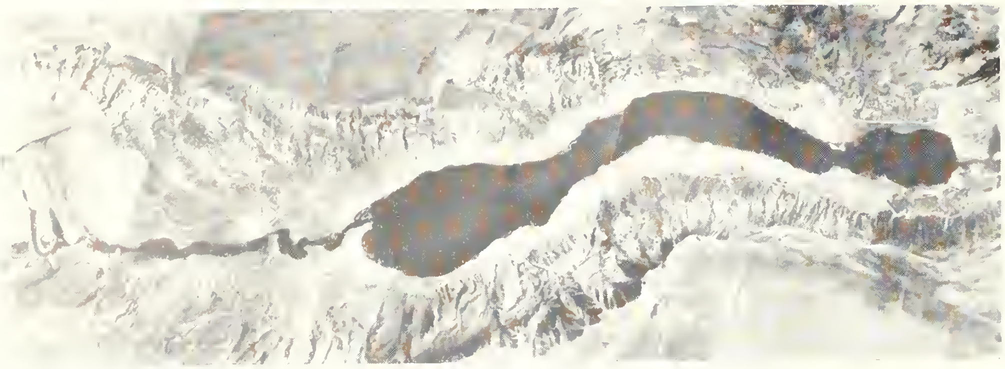
The trash-rack structure is rectangular in all elevations as well as in plan and is 36 feet in length, 24 feet 6 inches in width, and 17 feet 6 inches in height. Two 9-foot 3-inch by 10-foot openings are provided in the front with intake sills at elevation 5,738, three 8-foot 6-inch by 10-foot openings are provided on each side with intake sills at elevation 5,741 and six 8-foot 6-inch by 9-foot 3-inch openings are provided on the top. All openings are protected by trash-rack bars. Stop log slots are provided at the downstream end for emergency control of the water. A transition 10 feet long connects this structure to the normal barrel section.

The normal barrel section is divided into two parts by the plug containing the slide gates. The barrel was constructed in sections 32 feet in length with a 4-foot gap between sections. This method allowed for shrinkage and settlement of the individual sections and the 4-foot contraction sections, placed about 30 days later, insured a watertight structure. The plug containing the gates was constructed with two 5 by 5-foot conduits, lined with castings for supporting the gate, for each of the horseshoe-shaped sections. Satisfactory flow conditions are provided by means of transition sections above and below the gates. By holding to rigid gate operating schedule, the transition from the gates was permitted to be shortened, resulting in an economy in concrete construction. A dome-shaped gate chamber was constructed over the conduit plug and provides a housing for the gate hoists. Access to this chamber is through a 9-foot diameter stair shaft, extending up through the dam to the control house, and containing a spiral stairway. The shaft also contains the control piping for the slide gates, connecting the gate hoists with the control valves in the control house. A 6-foot diameter airshaft parallels the stair shaft to provide air to the downstream side of the gates. A ladder hung on the side of the air shaft provides access to the gates for inspection and maintenance.

The outlet works terminate in a stilling basin which dissipates the energy of the discharging water before it passes on down the creek channel to the Wind River. The design of the stilling basin was the result of considerable model study. The principal features of the design are a hydraulic hump, toothed apron and dentated sill. The hump consists of a curved slab supported on concrete walled cells filled with gravel. It begins at the invert of the outlet conduits and rises 7 feet 6½ inches 30 feet away; it then curves downward and terminates in a toothed step or apron. At the downstream end of the basin the dentated sill terminates the stilling pool. The function of the hump is to prevent the formation of the hydraulic jump in the conduit barrels at relatively low or unbalanced discharges. Steel sheet piling cells were driven under the wing walls and downstream end of the stilling basin.

Spillway

The spillway structure is located on the natural ground of the largest hill of the glacial moraine, nearly at the mid-point of the dam. The intake, chute, and stilling basin have a uniform width of 100 feet. The inlet at elevation 5,790 leads to a crest 4 feet higher, over which are hung three 29- by 11-foot radial gates. These are separated by two piers, which support the gate hinges and provide the actuating wells for the automatic operation of the gates. A 101-foot 6-inch structural steel bridge spans the gate structure and provides a roadway across the spillway as well as an operating platform for the radial gate emergency hoists. The intake and gate structure occupy approximately 110 feet of the length, the chute furnishes 200 feet more and the 142 feet of the stilling basin makes a total length of the spillway of 452 feet. A toothed apron at the bottom of the chute and a dentated sill at the end of the basin constitute the principal features of stilling pool. The entire chute is underlain with a 1-foot layer of screen gravel encasing a grillage of open joint tile to take care of any seepage through the morainic hill. The stilling basin is anchored to the blue clay foundation by a line of steel sheet piling at the downstream end. An unsatisfactory condition of the foundation under the left wingwall of the stilling basin was corrected by driving sheet piling cells, excavating the unsatisfactory material, and backfilling with selected material from the borrow pits. The compacting for this backfill was done by means of the crane and hammer used



Aerial mosaic of Bull Lake taken shortly after beginning of construction
The high water line and Bull Lake Dam are indicated in white

to drive the pile. This method gave a high degree of compaction.

Parapet and Curb Walls

Construction of the parapet and curb walls was started October 11, 1937, on the portion of the fill, south of the spillway, completed the year before. Three hundred and twenty-four feet were constructed by November 3, 1937, when concreting operations were discontinued for the winter. The completion of this wall was the principal construction during 1938. The wall was constructed in two lifts, the first being the base and about 12 inches of the wall and the second, the balance of the wall. The parapet provides an additional 3 feet of free board to the dam. A more uniform and generally smoother finish was obtained on the parapet wall by lining the forms with sheets of masonite. The riprap and rockfill were placed against the parapet and curb walls by stockpiling before the concrete construction and later moving the material against the wall. The latter operation was done by attaching a toothed blade to the bottom of an old shovel dipper and reaching over the wall and raking the material in place. The method proved to be very satisfactory and required a minimum of hand placing to obtain a uniform appearing slope.

A total of 54 hydrostatic pressure indicators for experimental study were installed in two rows of holes drilled into the dam embankment. These were installed by government forces.

Storage of water was begun in the reservoir May 13, 1938, and reached a maximum of about 100,000 acre-feet with the elevation of the reservoir at 5,788.4. Since the canal development on the project is still under construction and has given no opportunity for utilization of the additional water, the reservoir was not filled.

Government Work

In addition to the installation of the test apparatus described above, settlement plugs have been permanently installed on the slopes of the embankment and on the parapet wall, to furnish data for future study. A fence has been erected around the stilling basins and along the sides of the spillway chute for protection of visitors. The weir box for the automatic control of the spillway radial gates was installed in the actuating well in the left abutment section of the spillway gate structure. The painting done by the contractor on the conduit liners and the slide gates proved to be unsatisfactory through no fault of his, and they were repainted by Government forces. A caretaker's house on the north side of the creek about 1,000 feet downstream from the dam completes the work.

Costs

A general summary of quantities and costs, including the work done by the Government, is given in the accompanying table.

Feature	Quantities of materials	Contract	Material furnished by United States	Total cost
Embankment, including rockfill and riprap	809,371 cubic yards	$451, 177. 96	$9, 464. 57	$460, 642. 53
Spillway	4,447 cubic yards concrete	39, 680 95	19, 078. 46	58, 759. 41
	794,579 pounds metalwork	24, 693. 20	37, 648. 10	62, 341. 30
	Other items	35, 441. 78	1, 230. 33	36, 672. 11
Outlet works	4,635.7 cubic yards concrete	52, 771. 58	20, 447. 65	73, 219. 23
	1,874,707 pounds metalwork	35, 143. 43	84, 872. 82	120, 016. 25
	Other items	10, 505. 31	1, 629. 82	12, 135. 13
Right of way including damages				2, 580. 50
Engineering and inspection				108, 111. 56
Clearing lakeshore				15, 620. 00
Government work, etc				51, 808. 11
Total		649, 414. 21	174, 371. 75	1, 001, 906. 13

F. H. Betts Dies

FRED H. BETTS, who for many years was a faithful employee of the Bureau of Reclamation, died on November 30, 1938, at Walla Walla, Wash.

Mr. Betts was born in Indianolo, Iowa, on May 16, 1880, and was graduated from the Simpson College Law Department in that city, entering later the engineering department of the University at Missoula, Mont., from which he graduated. In 1900 he entered the Forest Service of the Department of Agriculture. In January 1917 he went to France in the capacity of civil engineer, returning in 1919 to reenter the Government service as engineer for the Bureau of Reclamation. During his connection with the Bureau he was located in various places, most recently in Washington State.

Final Report Boulder Canyon Project

TWO additional reports of the series of 41 bulletins have been issued as follows:

Part V, Technical Investigations:

Bulletin 1. Trial Load Method of Analyzing Arch Dams, 266 pages. Price, $1.50 paper, $2 cloth bound.

Bulletin 2. Slab analogy experiments. 184 pages. Price, $1 paper, $1.50 cloth bound.

Application can be made for these bulletins to either the Washington or Denver office of the Bureau of Reclamation, accompanied by the remittance in accordance with prices indicated. Postage to foreign countries, 20 cents each, additional.

The completed series, divided into 5 parts, will include 41 bulletins describing general features, hydrology, preparatory investigations, surveys and preliminary construction, design and construction, technical investigations, hydraulic investigations, and cement and concrete investigations.

Power Development Boulder Canyon Power Plant Power Generated in 1938

Month	*Total kilowatt-hours generated*	*Main generators*
January	137, 815, 000	5
February	129, 975, 000	5
March	118, 440, 000	5
April	124, 789, 000	5
May	119, 984, 000	5
June	111, 874, 000	6
July	115, 383, 000	6
August	123, 242, 000	7
September	125, 166, 000	7
October	132, 565, 000	6
November	133, 717, 000	7
December	149, 777, 000	7

CCC Construction of Parapet and Curb Walls Rye Patch Dam, Humboldt Project, Nevada

By THOMAS WILLIAMSON, *Assistant Engineer*

THE PLAN of Rye Patch Dam includes a parapet wall on the upstream side and a curb wall on the downstream side of the roadway top of the earth embankment. Following customary engineering practice, the construction of these items was deferred for a considerable time after the dam was completed to allow for full settlement of the embankment, as any irregularities of settlement would affect their alignment and grade. Construction of the embankment was completed on April 11, 1936, and construction of the parapet wall was begun in March 1938. The maximum observed settlement of the 70-foot fill during this period was approximately 1 inch. Construction of Rye Patch Dam was described in detail in the July 1937 issue of The Reclamation Era.

Construction of the parapet and curb walls was undertaken as a CCC work project by Camp BR-36, Lovelock, Nev., in cooperation with Humboldt project forces. The CCC supplied the labor, supervision, equipment, construction surveys, and part of the materials. The project supplied materials, skilled labor and supervisory inspection. The work was done under the handicap of a 23-mile travel distance from camp to the dam. The principal dimensions and quantities involved in the construction were: Parapet wall, footing width, 3 feet 9 inches; height, 7 feet 9 inches; length, 795 feet; curb wall, 9 inches wide by 2 feet 6 inches high, 780 feet long; concrete, 345 cubic yards; reinforcing steel, 26,000 pounds. The principal items of equipment used were: Two 7-cubic-foot concrete mixers, an air compressor, an air-driven water pump, an engine-driven vibrator, and a variable number of dump and stake trucks.

Construction Procedure

Foundation trenches were excavated by hand with pick and shovel. The solid compaction of the embankment made this operation slow and laborious, but left firm sides and good conditions for handling the forms, steel, and concrete. Screened gravel, previously stock-piled by the contractor who built the dam, was hand-loaded into dump trucks, hauled to the pump and washed, then unloaded into bins at the mixers. Batching of the concrete aggregates was done by box measures before loading into the mixer skips. Clean sand was secured from a nearby pit. The concrete was carried in wheelbarrows from the mixer spout to the forms. The two mixers were used alternately as the wall progressed, one being set up ahead and provided with accessory bins, platforms, and runways while the other was being operated.

Reinforcing steel was cut, shaped, and set in place and the parapet foundation slab, 9 inches thick, was poured for its entire length before the wall proper was started. Removable forms for the wall were built in 30-foot sections and moved ahead and reused as soon as stripped. The usual pour was a 60-foot length of wall, which was always completed in one shift with no breaks or joints, except the designed construction joints at the ends. Contraction spaces above ground were provided at 15-foot intervals by inserting $\frac{3}{16}$-inch plywood forms, or spacers. Forms were stripped 24 hours after the pouring was completed. The freshly exposed surfaces were dressed, washed, and rubbed with carborundum to a smooth ornamental finish. The curb wall, while much smaller than the parapet, was constructed by essentially similar methods.

Curing was done by the water-sprinkling method, water being supplied from the reservoir through hose and pipes from the pump operated by the compressor. Burlap coverings were used to shade the exposed surfaces and the concrete was kept moist for 2 weeks after pouring.

Backfilling around the walls was done by hand, the earth portion being evenly moistened and thoroughly tamped, in part, by a jackhammer fitted with a tamping shoe and

CCC enrollees constructing parapet wall, Rye Patch Dam

operated from the compressor, and in part by hand tampers. The outer faces at the walls were trimmed to a neat line connection with the rock surfacing of the embankment by refilling the top of the excavated trenches with hand-placed rock. The inner or roadway faces were refilled with earth to 1 foot below road grade and with gravel to grade. Excess material was loaded into trucks and removed and the surface then scarified and graded to a smooth roadbed.

Enrollees and Public Benefited

The CCC enrollees engaged in this work were active, alert, interested, and industrious and performed their tasks in a manner highly creditable to any group of workmen. The opportunity to assist in the production of a high-class piece of construction, the variety and novelty of the various operations, the steady and orderly progress of the work from day to day, and the chance to learn from experienced inspectors, foremen, and skilled workmen all contributed to enhance the interest and enlist the cooperation of the enrollees to an unusual degree. The service of training and experience thus rendered to these willing young men was no small part of the public benefits accruing from this work project.

The entire job was done in conformance with the same standard rigid specifications applicable to the Rye Patch construction contract. Project inspectors closely supervised the work and required the same strict adherence to specifications and standards of first-class workmanship as expected of a contractor. The completed structure is an outstanding example of good CCC accomplishment. Simplicity and dignity of design, appropriate choice of material, permanence, utility, carefulness of detail, accuracy of alinement, and honesty of workmanship are all fabricated into a monument that will long remain a worthy record of cooperative public achievement reflecting credit on its builders.

Progress of Investigations of Projects

Arizona-California: *Colorado River surveys.*—Work was continued on the preparation of the aerial mosaic map of the areas along the lower Colorado and Gila Rivers.

California: *Kings River-Pine Flat project.*—Diamond drilling and test pit exploration of Tehipite dam site, and water supply studies and power development of the Kings River and tributaries were continued. Classification and other maps were prepared for report and studies of dams at several sites were in progress.

Colorado: *Blue River transmountain diversion.*—Power studies were continued and report was nearly completed.

Eastern slope surveys.—Preparation of reports on the North Republican River and Trinidad projects was continued. Designs of a flood control dam on Purgatoire River were prepared.

Western slope surveys.—Diamond drilling at State Line dam site, La Plata project, was begun, and drilling was completed at the Harvey Gap dam site on Silt project; economic and water supply studies of the Florida, La Plata, Paonia and Silt projects were continued.

Idaho: *Southwest Idaho.*—Report of flood control on the Boise River was prepared and geologic examination made of Anderson Ranch and Dog Creek dam sites.

Snake River storage—South Fork.—Designs and estimates for dams at Elk Creek and Grand Valley sites were prepared, and flood control studies made.

Montana: *Gallatin Valley project.*—Diamond drilling at Spanish Creek dam site was continued, and test pits dug.

Marias project.—The main canal line was surveyed; topography of Shelby dam site and land classification surveys were completed.

Rock Creek project.—Land classification of 14,000 acres was completed and studies of irrigation possibilities made.

Montana-North Dakota: *Fort Peck pumping project.*—Topography for 37,000 acres was completed; control of an additional 20,000 was made, and land classification begun.

Nebraska: *Mirage Flats project.*—Reconnaissance of the irrigable area was made and a survey of a reservoir on Niobrara River begun.

Oklahoma: *Altus project.*—An economic study of farming possibilities was commenced by the Department of Agriculture, and studies of flood regulation by a dam at Lugert site was made.

Canton and Fort Supply projects.—Reports are in course of preparation of the projects in the North Canadian River Basin. Land classification of the Canton project was completed.

Oregon: *Grande Ronde project.*—Studies of water supply and preparation of report were in progress.

Medford project.—Tests of suitability of earth for dams on Little Butte Creek were made and studies of water requirements were in progress.

South Dakota: *Black Hills.*—Field surveys of the Beaver Creek and Angostura projects were completed.

Utah: *Blue Bench and Ouray Valley projects.*—Preparation of reports was in progress.

Gooseberry.—Topographic survey of Scofield Reservoir and foundation exploration of Gooseberry Dam site were completed. A conference regarding Lawrence Reservoir development was held.

Weber River.—Surveys and water supply studies looking to a comprehensive development of Weber River were in progress.

Utah-Idaho-Wyoming: *Bear River surveys.*—Studies of reservoirs at the Woodruff Creek and Woodruff Narrows sites were continued. Additional surveys for the aerial mosaics were made and printing of final sheets was in progress.

Colorado River Basin.—Surveys were continued of the Dark Canyon Dam site in Utah, Dewey Reservoir site, Utah-Colorado, and in the Green River Basin in both Utah and Wyoming. A reconnaissance was made of Pot Hook Reservoir site in Little Snake River Basin, surveys made of canal lines in San Juan River Basin, Colorado-New Mexico, and water supply studies in the Virgin River Basin, Utah.

Bun B. McCombs, 1879-1938

BUN B. McCOMBS, ditchrider with auto on the Reservation division of the Yuma project, passed away at the Yuma General Hospital on December 21, 1938, his death being attributed to intestinal influenza, with which he was stricken on December 12.

Mr. McCombs was born in Lewisville, Tex., on June 2, 1879 and was employed as ditchrider on the Yuma project on January 16, 1919, in which position he had served continuously until his last illness. The records show that he was a faithful and conscientious employee whose services were at all times satisfactory.

Klamath Potatoes

ABOUT 900 cars of potatoes were shipped from the Klamath project during November, bringing total shipments to about 2,500 cars. The price of potatoes continued to strengthen during the month and at the close, bright U. S. No. 1's were selling at 54 cents per bushel.

Yakima Turkeys

ABOUT 125 tons of dressed turkeys were shipped from the Sunnyside district of the Yakima project to supply the Thanksgiving demand in coast markets. The wide breasted variety of birds developed on valley farms bring a premium on the market.

IMPORTANT LABOR CONTRACTS

State	Project	Description of work	Contractor	Amount of contract	Work started	Probable date of completion	Per-cent com-plete
Arizona	Gila	Construction of Gila River crossing	Metropolitan Construction Co., Pasadena, Calif.	$337,376	February 1938	January 1940	69
Arizona-California	All-American Canal	Concrete drops and powerhouse structure.	Pleasant-Hassler Construction Co., Phoenix, Ariz.	675,390	June 1937	March 1939	81
Do	do	do	Frank J. Kernan and John Klug, North Portland, Oreg.	743,649	do	do	41
Do	do	Construction of Drop No. 1 and Coachella turn-out.	Lewis-Chambers Construction Co., New Orleans, La.	145,119	August 1937	July 1939	10
Do	do	Construction of structures	Atlas Construction Co., Pasadena, Calif.	262,240	July 1938	June 1939	28
Do	do	Earthwork, Coachella Branch Canal	W. E. Callahan Construction Co., Dallas, Tex., and J. P. Shipley, Los Angeles, Calif.	382,872	August 1938	August 1940	18
Do	do	Construction of canal crossings, check, and turn-out.	Atlas Construction Co., Pasadena, Calif.	269,892	September 1938	June 1939	7
California	Central Valley	Diversion tunnel and temporary relocation of S. P. R. R.	Colonial Construction Co., Spokane, Wash.	426,475	July 1938	February 1939	41
Do	do	Earthwork, tunnel, canal lining, and structures, Contra Costa Canal.	Pearson, Minnis, & Moody, and Werner & Webb, Los Angeles, Calif.	340,992	August 1938	October 1939	18
Do	do	Construction of Shasta Dam and power plant.	Pacific Constructors, Inc., Los Angeles, Calif.	35,939,450	September 1938	January 1944	3.6
Do	do	Construction of Sacramento River Bridge.	Clifford A. Dunn, Klamath Falls, Oreg.	173,120	October 1938	September 1939	41
Colorado	Pine River	Construction of Vallecito Dam	Martin Wunderlich Co., Jefferson City, Mo.	2,115,870	May 1938	September 1942	21
Idaho	Boise-Payette	Earthwork, tunnel, canal lining, and structures.	Haas, Doughty & Jones and Marshall & Stacy, San Francisco, Calif.	172,687	June 1938	August 1939	69
Do	do	do	J. A. Terteling & Sons, Boise, Idaho	239,406	do	March 1939	55
Idaho-Wyoming	Upper Snake River storage.	Construction of Grassy Lake Dam	S. J. Groves & Sons Co., Minneapolis, Minn.	429,508	June 1937		61
Montana	Milk River	Construction of Fresno Dam	Wachter, O'Neil & McGarry Bros., Bismarck, N. Dak.	1,117,409	March 1937	February 1940	56
Nevada-California	Truckee storage	Construction of Boca Dam	Geo. W. Condon, Omaha, Nebr.	733,735	April 1937	July 1939	77
Texas	Colorado River	Construction of Marshall Ford Dam	Brown & Root Co., Inc., Austin, Tex., McKenzie Construction Co., San Antonio, Tex.	6,[illegible]67,973	February 1937	December 1939	75
Utah	Provo River	Construction of Deer Creek Dam and appurtenant works.	Rohl-Connolly Co., Los Angeles, Calif.	2,189,096	July 1938	March 1942	20
Do	Sanpete	Construction of Spring City Tunnel	Dan Teters & Co., Inc., Riverside, Calif.	128,235	November 1937	February 1940	89
Washington	Columbia Basin	Completion of Grand Coulee Dam	Consolidated Builders, Inc., Oakland, Calif.	34,442,240	March 1938	February 1942	13
Do	do	Furnishing and erecting penstocks and pump inlet pipes	Western Pipe & Steel Co. of California, San Francisco, Calif.	1,456,624	do	November 1940	17
Do	Yakima-Roza	Earthwork, tunnel, and canal lining	T. E. Connolly Co., Los Angeles, Calif.	316,142	May 1938	April 1939	55
Do	do	Earthwork, canal lining, and structures	Haas, Doughty & Jones and Marshall & Stacy, San Francisco, Calif.	141,291	July 1938	February 1939	57
Do	do	Construction of Roza Diversion Dam, bench flume and railroad bridge	Morrison-Knudsen Co., Inc., Boise, Idaho	527,560	August 1938	March 1940	31
Wyoming	Kendrick	Construction of Seminoe Dam and power plant.	Winston Bros. Co., Minneapolis, Minn.; Morrison-Knudsen Co., Boise, Idaho; Utah Construction Co., Ogden, Utah.	3,631,371	January 1936		94
Do	Shoshone	Earthwork, tunnel, bench flumes, canal linings, and structures.	Barnard-Curtiss Co., Minneapolis, Minn.	304,850	October 1938	April 1940	7
			Total, 27 contracts	94,310,575			

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W. I. Swanton, Engineering Division

Death of Hugh McGonigle

HUGH McGONIGLE, warehouseman at Boulder Dam for the Six Companies Inc., and since 1910 connected either directly or indirectly with the Bureau of Reclamation, died at Redding, Calif., on December 12, 1938.

Mr. McGonigle was employed as storekeeper and foreman on the Yakima project in 1910, and from 1925 to 1931 as costkeeper on the Rio Grande project, from which position he resigned to enter the employ of the Six Companies Inc. at Boulder Dam.

Humboldt Alfalfa

ON THE Humboldt project, Nevada, a movement is on foot to purchase 2,000 tons of second crop alfalfa at $5 per ton to be made into alfalfa meal by a mill to be brought in for that purpose. Hay being fed to cattle is sold at $6 per ton fed.

It is reported that 5,400 tons of alfalfa has thus far been sold for feeding locally, which does not include the 2,000 tons mentioned above. Most of the grain is still in storage.

Beet Harvest Completed on the Minidoka Project

BEET HARVEST on the Minidoka project was completed during November and the sugar factories at Burley and Paul were operated continuously throughout the month. An initial payment of $4.40 per ton was made on November 15 for all beets harvested up to November 1, a total of 128,540 tons. The total yield for the project is 205,665 tons, or an average of 16.43 tons per acre, the largest ever recorded. Of this yield, 88,913 tons were produced in the Burley district, and 116,752 tons in the Rupert-Paul district.

NOTES FOR CONTRACTORS

Specifications No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1938						*1938*
804	Columbia Basin, Wash	Oct. 20	Leavenworth station for migratory fish control.	Nat McDougall Co	Portland, Oreg	$272,718.00		(1)
801	Central Valley, Calif	Sept. 30	Earthwork, canal, lining, and structures, Contra Costa Canal, station 638 to station 1066, and Los Medanos wasteway.	Haas, Doughty & Jones and Marshall & Stacy.	San Francisco, Calif	[2] 316,331.50		Dec. 2
805	Columbia Basin, Wash	Nov. 21	Embedded metalwork for drum-gate anchorages at Grand Coulee Dam.	The Kilby Steel Co., Inc	Anniston, Ala	[3] 66,112.00	Discount ½ percent	Dec. 6
				Stearns-Roger Mfg. Co	Denver, Colo	[4] 36,251.00	F. o. b. Odair, Wash	Do.
				John W. Beam	do	[5] 35,990.00	Discount ½ percent. F. o. b. Peotone, Ill.	Do.
808	Provo River, Utah	Nov. 22	Construction of Olmsted and Alpine-Draper Tunnels.	George K. Thompson & Co.	Los Angeles, Calif	[6] 746,535.50		Dec. 2
809	Riverton, Wyo	Nov. 10	Earthwork and structures, Pilot Canal station 1570 to station 1841, Pilot Canal laterals 31.0 to 34.9 and sublaterals.	Inland Construction Co	Omaha, Nebr	103,081.00		Dec. 6
1134-D	All-American Canal, Ariz.-Calif	do	Four 16-foot 7-inch by 5-foot, two 14- by 5-foot and five 9-foot 6-inch by 10-foot top-seal radial gates. Four 5,000-pound capacity, and one 10,000-pound capacity motor-driven, radial gate hoists.	Stearns-Roger Mfg. Co	Denver, Colo	[7] 5,489.60	F. o. b. Calexico, Calif	Nov. 26
				Enterprise Foundry Co	San Francisco, Calif	[8] 5,100.00		Nov. 25
1135-D	Colorado-Big Thompson, Colo.	Nov. 23	Structural steel and steel castings for highway bridge over Blue River at Green Mountain Dam.	Virginia Bridge Co	Denver, Colo	7,777.00	F. o. b. Kremmling, Colo.	Dec. 1
1133-D	Boise-Payette, Idaho	Nov. 22	Earthwork, Black Canyon Canal, laterals 24.8 to 26.2 and A-line Canal laterals 2.0 to 9.4.	Henry L. Horn	Caldwell, Idaho	12,527.50		Dec. 8
1138-D	Colorado-Big Thompson, Colo.	Nov. 29	Construction of dormitory at Estes Park headquarters.	John A. Bell	Berthoud, Colo	9,035.00		Dec. 3
806	Central Valley, Calif	Nov. 14	Earthwork, tunnels, and structures, Southern Pacific R. R. relocation, milepost 287.81 to milepost 288.725.	United Concrete Pipe Corporation.	Los Angeles, Calif	598,673.50		Dec. 13
807	do	Nov. 17	Superstructures for Sacramento River bridges, third and fourth crossings, Southern Pacific R. R. relocation.	American Bridge Co	Pittsburgh, Pa	[4] 124,377.00	F. o. b. Gary, Ind. (structural steel).	Do.
1115-D	Columbia Basin, Wash	Sept. 15	Structural steel framing for Leavenworth fish hatchery.	American Bridge Co	Denver, Colo	12,426.00	F. o. b. Chicago	(1)
1137-D	Colorado-Big Thompson, Colo.	Nov. 28	Construction of 6 duplex cottages at Estes Park headquarters.	House and Lindley	Estes Park, Colo	20,880.00		Dec. 16
1140-D	do	Nov. 25	Transformers, circuit breakers, disconnecting switches, lightning arresters, etc.	Maloney Electric Co	St. Louis, Mo	20,566.00	F. o. b. Kremmling, Colo.	Dec. 21
				Kelman Electric & Mfg. Co	Los Angeles, Calif	[4] 825.55	do	Dec. 8
				Westinghouse Electric & Mfg. Co.	Denver, Colo	1,917.92	do	Dec. 12
				do	do	[10] 3,391.11	do	Do.
				The High Tension Co. Inc.	Phillipsburg, N. J	[11] 156.00	F. o. b. Kremmling, Colo., discount 1 percent.	Dec. 4
				Johnson Mfg. Co	Atlanta, Ga	[12] 102.60	do	Dec. 7
				Bowie Switch Co	San Francisco, Calif	[13] 219.00	do	Do.
				do	do	[14] 219.00	do	Do.
				do	do	[15] 325.00	do	Do.
				do	do	[16] 142.00	do	Do.
				do	do	[17] 142.00	do	Do.
1141-D	Boulder Canyon, Ariz.-Nev.	Nov. 30	Pipe fittings and valves for units A-6 and A-7, Boulder power plant.	Geo. B. Limbert & Co	Chicago, Ill	[7] 7,850.00	F. o. b. Boulder City	
				Associated Piping & Eng. Co. Ltd.	Los Angeles, Calif	[8] 15,800.00	F. o. b. Los Angeles, discount 2 percent.	Dec. 21
1144-D	All American Canal, Ariz.-Calif.	Dec. 6	28 radial gates and gate hoists	Pacific Iron & Steel Co	do	[7] 12,695.00		Do.
				Commercial Iron Works	Portland, Oreg	[8] 15,590.00	Discount ½ percent	Do.
1145-D	Salt River, Ariz	Dec. 5	Three cylinder heads for 173,000-pound hydraulic hoists and 3 hydraulic gate hangers for high-pressure gates at Bartlett Dam outlet works.	Consolidated Steel Corporation, Ltd.	Los Angeles, Calif	2,622.06		Dec. 12
1148-D	Yakima, Wash	do	One set of liners for lower cylinder gate openings in outlet works at Cle Elum Dam.	Pacific Car & Foundry Co	Seattle, Wash	2,630.00		Dec. 13
30,536-C	Deschutes, Oreg	Nov. 28	Carry-all scrapers and control units	R. G. LeTourneau Inc	Peoria, Ill	12,505.23	Discount 2 percent	Dec. 16
33,016-A	Central Valley, Calif	do	Steel reinforcement bars, 2,707,900 pounds.	Columbia Steel Co	Pittsburg, Calif	67,929.23	Discount ½ percent b. p. v.	Dec. 14
811	Colorado-Big Thompson, Colo.	Nov. 30	Two 102-inch ring-seal gates and 2 sets of conduit units for Green Mountain Dam.	Koppers Co. (Bartlett-Hayward Division).	Baltimore, Md	54,000.00	F. o. b. Baltimore, discount ½ percent.	Dec. 16
812	Deschutes, Oreg	Dec. 1	Two 96-inch ring-follower gates and 2 sets of conduit units for Wickiup Dam outlet works.	do	do	35,000.00	do	Do.
810	Yakima-Roza, Wash	Dec. 5	Two 110-foot roller gates for Roza diversion dam.	Treadwell Construction Co	Midland, Pa	[5] 79,960.00		Dec. 22
1143-D	Sun River, Mont	Dec. 2	Earthwork and structures, extensions of sublaterals of laterals G. M. 31, G. M. 47-11 and G. M. 96, Greenfields division.	Elmer Genger	Fairfield, Mont	[2] 23,669.50		Do.
1142-D	All-American Canal, Calif.	Nov. 30	Preparing and stock piling 95,000 cubic yards of sand and 173,000 cubic yards of gravel.	V. R. Dennis Construction Co.	San Diego, Calif	100,232.00		Dec. 20
								1939
813	Yakima-Roza, Wash	Dec. 8	Earthwork, canal lining and structures, Yakima Ridge Canal, stations 1641+15 to 1952+00.	J. A. Terteling & Sons	Boise, Idaho	[2] 448,335.70		Jan 6
814	Shoshone-Heart Mountain, Wyo.	Dec. 20	Construction of Shoshone River and Buck Springs Creek siphons, Heart Mountain Canal.	Utah Construction Co	San Francisco, Calif	[3] 84,537.50		
				Barnard Curtiss Co	Minneapolis, Minn	[5] 31,864.50		
				Consolidated Steel Corporation, Ltd.	Los Angeles, Calif	[18] 212,100.00	F. o. b. Los Angeles	
818	Boulder Canyon	*1939* Jan. 3	Power transformers for units A-1 and A-2, Boulder power plant.	General Electric Co	Schenectady, N. Y	376,350.00	F. o. b. Boulder City, Nev.	
A-38, 215-A	Columbia Basin, Wash.	*1938* Nov. 30	Steel reinforcement bars, 1,700,000 pounds.	Bethlehem Steel Co.	San Francisco, Calif	44,370.00	F. o. b. Odair, Wash., discount, ½ percent, 47 cents less.	Jan. 4
B-47, 361-A	Central Valley, Calif	Dec. 12	Steel reinforcement bars, 4,920,000 pounds.	do	do	[3] 119,780.80	F. o. b. Coram, Calif., discount, ½ percent, 27 cents less.	Jan. 7
A-38, 239-A	Columbia Basin, Wash.	Dec. 14	Tubing and fittings	Graybar Electric Co., Inc	Denver, Colo	28,948.56	F. o. b. Odair, Wash	Jan. 6
30,550-A	Deschutes, Oreg	Dec. 12	Tractors (3, 95-hp. Diesel-engine powered, crawler type).	Caterpillar Tractor Co	Peoria, Ill	26,345.67	F. o. b. Redmond, Oreg., discount, $150.	Do.

[1] All bids rejected.
[2] Schedules 1 and 2.
[3] Schedule 1.
[4] Schedule 2.
[5] Schedule 3.
[6] Schedules 1 and 3.
[7] Item 1.
[8] Item 2.
[9] Schedule 4.
[10] Schedule 5.
[11] Item 5.
[12] Item 6.
[13] Item 7.
[14] Item 8.
[15] Item 9.
[16] Item 10.
[17] Item 11.
[18] Schedule 2, Item 19, and Schedule 4, Item 32.

Reclamation Organization Activities

Commissioner Page Addresses University Students

ON THE afternoon of December 15, in his office, Commissioner Page addressed the student body of the American University, studying government, on the subject of the activities of the Bureau of Reclamation.

Assistant Commissioner Williams in West

R. B. WILLIAMS, Assistant Commissioner, left Washington January 5 for a period of approximately 2 weeks. Traveling by way of Denver, Mr. Williams' itinerary includes stops at Los Angeles, Yuma, and Sacramento. In California he will consider details of bringing the different interests together in order that a start may be made on the Friant division of the Central Valley project.

W. R. Nelson Addresses Students of Engineering

ON THE evening of January 4, Wesley R. Nelson, Chief of the Engineering Division, addressed the Student Chapter of the American Society of Civil Engineers on the subject of the Central Valley project in California. The lecture was given at George Washington University.

H. A. Parker Now Irrigation Engineer, Columbia Basin Project

SECRETARY of the Interior Harold L. Ickes has announced the appointment of Horace A. Parker, construction engineer of the Upper Snake River Storage project, as irrigation engineer in charge of investigation and development of the irrigation features of the Grand Coulee Dam, Columbia Basin project in Washington.

As explained by John C. Page, Commissioner of Reclamation, Mr. Parker, in his new assignment, will report to and through Frank A. Banks, construction engineer in charge at Coulee Dam, Wash., for the Bureau of Reclamation. He will assume general direction of the surveys, classification, and appraisal of the Columbia Basin lands and be available to assist in the planning and organization of irrigation districts in the area to be watered by the Grand Coulee Dam.

Mr. Parker left his post at Ashton, Idaho, headquarters of the Upper Snake River storage project, on January 1 and immediately took up his new assignment with headquarters at Ephrata, Wash. I. Donald Jerman, resident engineer at Grassy Lake Dam, succeeds Mr. Parker on the Upper Snake River project as acting construction engineer.

The work of completing the surveys, classifying the land, and making the appraisals of the land to be irrigated, as required under the antispeculation act, at present is about 50 percent complete. It had been directed previous to Mr. Parker's appointment by Mr. Banks and through his regular field organization.

Mr. Page further explained: "From the outset, it has been the intention of the Bureau, when the local demand arose for such action, to add a responsible and experienced man from the Bureau's organization to Mr. Banks' staff for the purpose of providing guidance in the organization of irrigation districts, and of acting as a liaison officer between the local landowners and the Bureau during the important period when the project is taking definite form.

"Proper organization of districts to administer the project lands is an important factor in the success of a Federal Reclamation project. Many matters which eventually may assume importance can be anticipated by one who has had experience in the relationships of irrigation districts with the Bureau of Reclamation. In anticipating these details, and suggesting methods to meet and cover them, Mr. Parker should be of great assistance to the future project settlers. Development of troubling difficulties in the future can be obviated by proper organization at the outset."

Mr. Parker has had long and varied experience which especially suits him for the important assignment. He has held responsible positions in the Bureau of Reclamation for more than 25 years, both in the construction field and in the operations field.

Born September 20, 1887, at Livermore Falls, Maine, Mr. Parker graduated in civil engineering at the University of Maine in 1909; following which in 1909 he entered the employ of the Bureau of Reclamation as a rodman on survey work in Montana. From 1910 to 1922 he was office and field engineer of the Milk River project, Montana; from 1923 to 1931 he was superintendent of the lower Yellowstone project; in 1933 and 1934 he was superintendent of the Shoshone project, Wyoming; and from 1935 until his transfer to the Columbia Basin project was construction engineer in charge of the Upper Snake River storage project, which includes the construction of Island Park Dam, Grassy Lake Dam, Cross Cut Dam, and the Cross Cut Canal. In 1932 Mr. Parker left the Bureau for 1 year and served as project manager for the Lower Yellowstone Board of Control. He is married and has one son.

In his new position Mr. Parker will be available for advice, guidance, and consultation in connection with irrigation district organization activities.

"He will be in a position to cooperate with and to help the local people to whatever extent they desire," Mr. Page added. "The Bureau will not attempt to dictate policies to the landowners. On the other hand, it is offering, through Mr. Parker, the resources and experiences of its whole organization in an effort to be helpful, realizing that the success of the project and the success of its settlers will depend, to a large extent, upon a proper start being made at this time."

L. H. Mitchell Addresses Western Groups

L. H. MITCHELL, field supervisor of operation and maintenance, left Washington on January 7 for the West. He will address the annual water users' meetings on the Grand Valley and Strawberry Valley projects on the subject of the "Practical Use of Soil and Water," his address being illustrated with lantern slides.

Mr. Mitchell will also address the various CCC camps in Utah and Colorado while on this trip.

Recent Appointments in the Denver Office

Denver office:

Associate engineers, Frank B. Cook, and Eugene Loux Gallagher.

Junior engineers, Dale H. Rea, George W. Birch, Hermon L. Cooper, Norbert E. Landdeck, Ivan F. Richards, Melvin Lee-Roy Barmettler, George Murray Cunningham, Oscar Schur, Arthur L. Mitchell, Albert Alper, Jesse L. Honnold, Samuel Rifkin, Francis V. Frazier, George L. Barcus, and Perry M. Ford.

Junior electrical engineer, Lawrence R. Schumacher.

Belle Fourche Girls Excel in Culinary Art

TWO GIRLS from the Belle Fourche project—Blanche Lindgren, of Belle Fourche, and Lucia Vorhees, of Arpan, captured national honors in custard making at the 4–H Dairy Show held at Columbus, Ohio.

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

John C. Page, Commissioner — Roy B. Williams, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; D. S. Stuver, Asst. Gen. Supt.; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Chief, Mails and Files Division; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

R. F. Walter, Chief Eng.; S. O. Harper, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts; L. S. Davis, Engineer, C. C. C. Division

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge: Name	Official in charge: Title	Chief clerk	District counsel: Name	District counsel: Address
All American Canal [1]	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr.	Robert P. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of Power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr.	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr.	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Colorado Big Thompson	Denver, Colo.	Porter J. Preston	Supervising engr.	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr.	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Constr. engr.	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr.	James A. Dolphin	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Lovelock, Nev.	Stanley R. Marean	Superintendent	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo.	H. W. Bashore	Constr. engr.	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr.	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	L. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Pine River	Bayfield, Colo.	Charles A. Burns	Constr. engr.	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah
Provo River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr.	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. C. Koppen	Constr. engr.	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr.	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr.	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt.		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr. [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr.	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Nolde O. Anderson	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.
[2] Acting.
[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

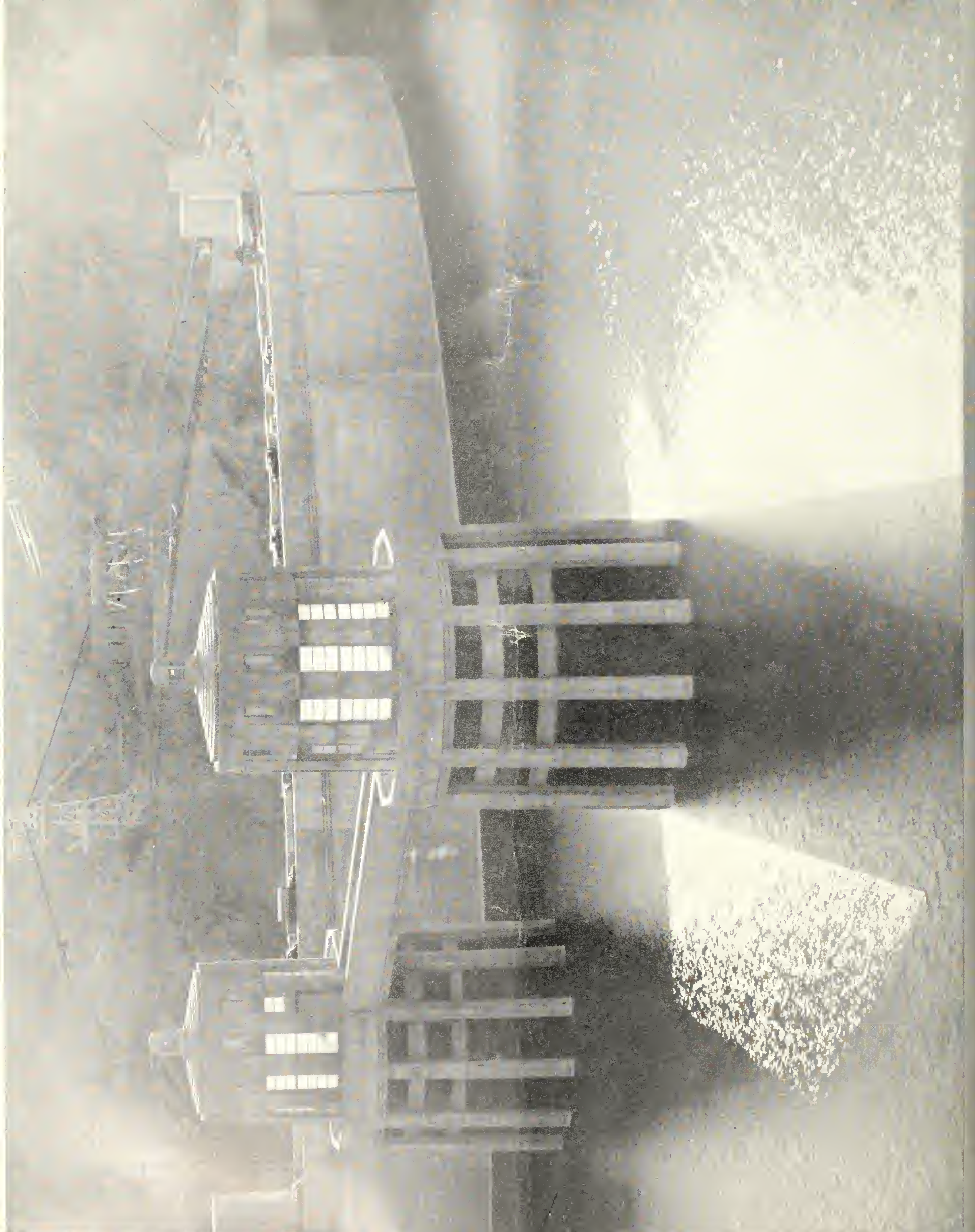
Project	Organization	Office	Operating official: Name	Operating official: Title	Secretary: Name	Secretary: Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	N. W. Blindauer	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping [1]	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River, W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	V. W. Russell	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler and P. J. Preston	Senior engineers
King's River-Pine Flat (Calif.)	Fresno, Calif.	S. P. McCasland	Associate engineer
Fort Peck Pumping (Mont., N. Dak.	Denver, Colo.	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo.	A. N. Thompson	Engineer.
Gallatin Valley (Mont.)	Denver, Colo.	W. G. Sloan	Engineer
Marias (Mont.)	Shelby, Mont.	Fred H. Nichols	Associate engineer
Canton and Fort Supply (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo.	J. R. Iakisch	Senior Engineer
Black Hills (S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate Engineer.
Salt Lake Basin (Utah)	Provo, Utah	E. O. Larson	Construction engineer.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.



THE RECLAMATION ERA

FEBRUARY 1939

SPRINGTIME ON THE DESERT

Secretary Ickes Speaks on Recreation and Irrigation[1]

The circumstances under which I come to Fresno at this time are particularly pleasant. Your Congressman, the Honorable Bertrand W. Gearhart, last week introduced three bills in the House of Representatives at Washington. All of us, the people of the San Joaquin Valley and the State of California, Congressman Gearhart himself, and I are vitally interested in these bills.

The first bill provides for the construction of lateral canals for the Central Valley project in order to extend the benefits of irrigation to additional sections of interior California in the region of Sacramento to Bakersfield. The value of such a project is self-evident.

The second bill authorizes the Bureau of Reclamation to construct the Pine Flat irrigation and flood control reservoir, together with power dams on the Kings River which are found feasible in connection with the Pine Flat project.

The third of Congressman Gearhart's bills is for the establishment of the John Muir-Kings Canyon National Park, a proposal of both local and national importance, and not unrelated to the Pine Flat project. In one important respect they supplement each other, because a national park in the Kings Canyon country would help preserve the watershed and thus increase the value of the Kings River for irrigation and electric power.

The Pine Flat irrigation project and the John Muir-Kings Canyon National Park proposal are closely linked, because they both relate to the use of the same general land area; to the use of public lands under the control of Congress and the President. It is extremely necessary to see that these two projects are properly coordinated. Part of the lands jointly affected by the irrigation project and the national park proposal are essential for economic development. Part of them are primarily important for recreation, which in areas of high scenic value calls for preservation and protection.

If the Federal Government should establish the John Muir-Kings Canyon National Park, without at the same time mapping out a policy for irrigation and power development for this region, there would be danger that the national park might have boundaries conflicting with a sound economic policy.

If, on the other hand, the Government should go ahead with irrigation and power-dam construction before establishing a national park, there would be danger that this commercial development would damage an area primarily important as a scenic and recreation asset.

By mapping out both of these important projects together, it is possible to harmonize them without injury to either. If either of these projects were put forward without regard to the other, there would be uneasiness and apprehension among the friends of the other measure, and where you have apprehension you generally have needless antagonism.

The Department of the Interior is eager to do its share, both in guarding and protecting the land that deserves to be in a national park, and to help the people of the San Joaquin Valley realize the greatest possible benefits from the waters that come down out of the mountains.

Before my term of office expires I hope to return here to help to dedicate the John Muir-Kings Canyon National Park and to stand by the side of your able and efficient Representative, Bertrand W. Gearhart, watching precious water making a garden out of what is now a potentially rich desert.

[1] Address delivered at Fresno, Calif., and broadcast over Station KMJ

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • FEBRUARY 1939 • NUMBER 2

Boca Dam, Truckee Storage Project

NEVADA-CALIFORNIA

By F. M. SPENCER, *Associate Engineer*

THE water problems and related conditions of the Truckee storage project probably are as involved as are those in any other territory of comparable area. Complications are due to many causes, among which are: Unusual geographical and topographical conditions, the chronological order of the establishment of water uses, diverse and opposed industrial interests, and, perhaps of most concern, the limited water resources.

Lake Tahoe, situated in eastern California and west central Nevada with State boundary line dividing the lake between the two States, is the source of the Truckee River, whence the river flows about 100 miles, descending nearly 2,500 feet, to discharge into Pyramid Lake. The outlet at Lake Tahoe is in California and the river remains in California for about the first 35 miles of its course. From Lake Tahoe to the California-Nevada State line the channel is rather deeply cut and is confined throughout most of that distance by steep canyon walls, there being no diversions for agricultural purposes. The first such diversion is made by a low rock dam placed almost at the point where the river enters Nevada, and though this particular diversion is for water use several miles distant, other diversions are made and irrigation begins a short distance downstream. As the valley widens nearer to Reno and Sparks, which are separated by a distance of only 3 miles, irrigation becomes extensive and continues so to a point about 7 miles below or east of Reno, where the river enters a narrow canyon with only occasional points of sufficient width to permit agricultural activities. At Wadsworth the river swings to the north toward Pyramid Lake.

Emerald Bay

Beginning with the irrigation diversion at the California-Nevada boundary line and counting all diversions which are made for the irrigation of lands adjacent to the Truckee River between that point and Wadsworth, Nev., there are 47 separate diversions, 33 of which are made before the river enters the narrow canyon below Reno and Sparks. Between Wadsworth and Pyramid Lake there are a few more scattered diversions, principally for the irrigation of Pyramid Lake Indian Reservation lands, and at Derby, about 20 miles east of Reno, a diversion is made by the Derby Dam for delivery of water, by the 30-mile long Truckee Canal, to the Lahontan Reservoir for use on the Newlands project, now operated by the Truckee-Carson Irrigation District.

Above or west of Reno and principally in the steeper canyon above the State boundary, the rapid fall of the river is utilized at several different points to generate hydroelectric power for the Sierra Pacific Power Co.'s system. Power thus generated is supplemented by power purchased from the Pacific Gas and Electric Co. which is conducted from over the summit of the Sierra Nevada Mountains to help supply demands in Nevada.

The Washoe County Water Conservation District

In 1929, the Washoe County Water Conservation District was organized as a public corporation, organized and operating under the laws of the State of Nevada, with offices at Reno. The district does not yet have an operation and maintenance department, its activities to date being solely of a business nature. District lands are located around Reno and Sparks with two small, separated tracts, one up the river and one downstream from the main body, the total area amounting to about 30,000 acres. Thirty-one of the river diversions mentioned serve district lands and it is worthy of note that this area is served by many small diversions, ranging from ½ to 90 second-feet, instead of one or a small number of main canals and their accompanying laterals, also that the diversion ditches are owned and maintained by corporations, voluntary organizations, unorganized groups and individuals. The first water rights for the local district irrigation diversions date back to about 1860, for a generation to about 1890, and the Derby Dam and Truckee Canal water rights to 1902, the last in the amount of 1,500 cubic feet per second.

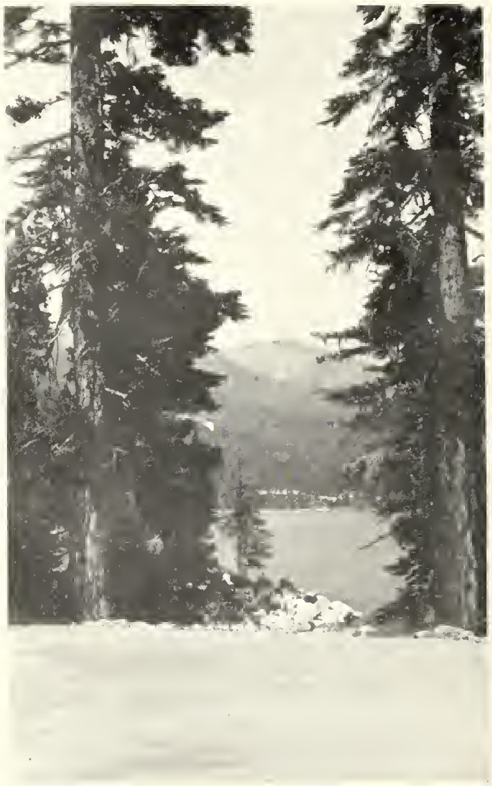
Adverse Interests

Both Lake Tahoe and Pyramid Lake are well-known points of interest and resort centers. The latter, however, is on an Indian reservation, is in more or less of a desert area with little vegetation, and has been only slightly developed as a resort. The Lake Tahoe area has the combination of a beautiful lake, picturesque mountains, heavy timber, and a bracing climate. It has been developed, in recent years, as a popular resort and summer play ground. The value of land around the lake has greatly advanced, expensive homes and resorts and other places of business have been constructed and recreational activities have become profitable and important. Also summer homes and camps have been built along the upper part of the Truckee River and extensive recreational developments have been made at Donner Lake, which is located a few miles from the main stream on a tributary, Donner Creek. The latter development is not greatly affected by water storage in Lake Tahoe, but it can readily be seen that the Tahoe recreational improvements would create a desire for a stabilized lake surface elevation and a uniform river flow, while irrigation interests around Reno seek upstream storage and withdrawals during the irrigation season. The Truckee-Carson Irrigation District desires releases from Lake Tahoe to fill Lahontan Reservoir and upstream storage in Tahoe to supplement reserves in Lahontan Reservoir. The power company needs river flows adjusted to meet its daily and seasonal power demands. The situation is further complicated by the need in the valley areas for flood control during wet periods and for additional water during dry seasons for sanitary and domestic purposes. Sportsmen have added to the problems by asking certain regulations for the protection and increase of fish and other wildlife. These problems are more serious on account of some interests being in one State, some in the other, and some in both, also because the water laws of the two States differ.

Advancement by Agreements

Lake Tahoe has an area of approximately 187.5 square miles and a drainage area of 519 square miles, the run-off from which is partially controlled by the concrete dam at the lake outlet constructed in connection with the Newlands project. Outside of that section, the Truckee River drainage area is extensive but steep and has created, by sudden run-off, flood flows at Reno as high as 16,000 second-feet. The need for combined upstream storage and flood control was recognized many years ago and after years of study, investigation, and controversy, the first step in bringing the various interests together was made by the execution of the Truckee River Agreement. The last signature to this agreement was secured on February 11, 1937, the parties to the agreement being: United States of America, Truckee-Carson Irrigation District, Washoe County Water Conservation District, Sierra Pacific Power Co. and a certain percentage of the water users of the Truckee River within the conservation district. The purpose of this agreement has been stated briefly as "to effect the security of mutual and individual benefits, the clarification and protection of rights, to fix the methods of operation for the entire river, and to establish the long-desired understanding among all parties." The Truckee River Agreement was a prerequisite to and made possible the execution of a repayment contract by and between the United States and the Washoe County Water Conservation District. That repayment contract was authorized by a conservation district election on April 7, 1936, and was executed December 18, 1936, thereby making possible the construction of additional upstream storage facilities.

Although the Truckee Storage project includes the Washoe County Water Conservation District adjacent to Reno and Sparks, Nev., and the Boca Dam and reservoir at Boca, Calif., the only construction contemplated was that of the Boca Dam. The district is an old established area ready to handle releases from the proposed reservoir even though considerable improvement could beneficially be made in the distribution system.



Crystal Bay, Mount Rose in the distance

Sundown at Emerald Bay

Investigations, Conditions, and Progress

Reservoir and damsite surveys were made in the Truckee River drainage area for the purpose of attempting upstream storage as early as 1889 or 1890, but it was not until the investigations by the Bureau of Reclamation which resulted in the report of Truckee River conditions by E. B. Debler in April 1929 that work leading directly to the Boca Dam was done. This work was followed in August 1934 by surveys and testing at a recommended site about 4 miles above Boca but on May 25, 1935, such surveys and testing were abandoned to commence on the finally selected site at Boca.

The Boca site is located on the Little Truckee River, in California, a tributary to the Truckee River which supplies about 40 percent of the total discharge of the latter. The dam is situated at a point about one-half mile upstream from the confluence of the tributary with the main stream. The location is practically on United States Highway 40 and the Southern Pacific R. R. main line, 27 miles from Reno, Nev. The conditions for economical and practical construction at this site generally are favorable except those of a climatic nature. Operations after winter snows begin are impossible and the temperatures usually become too low about the latter part of October to carry on concrete work without costly protection. Winter weather conditions are usually too severe for economical work until about the middle of March and then if the snowfall has been heavy during the winter, construction work may be delayed until late in April. High-water conditions in the spring and possibly in the fall are also serious problems. The record flood flow occurred in December 1937, when a peak of an estimated 4,000 second-feet was reached in the Little Truckee River at Boca and 16,000 second-feet in the main stream at Reno. Construction work was under way at that time and considerable delay, inconvenience, and damage resulted.

Under the repayment contract of December 18, 1936, made in pursuance of the National Industrial Recovery Act, the Emergency Relief Appropriation Act, and the National Reclamation Law, there was to be constructed a reservoir with a capacity of 40,000 acre-feet, for which purpose $1,000,000 was made available from an allocation of $1,500,000. Repayment of costs is to be made by the Washoe County Water Conservation District in the usual manner, over a period of 40 years. An unusual arrangement whereby Washoe County participated in the cost of Boca Dam and Reservoir to the extent of $500,000, by the authorized issuance of noninterest-bearing bonds in that amount, very greatly reduced the district's burden. Subsequent to the execution of the repayment contract agreements were made by the United States, the Sierra Pacific Power Co. and the Washoe County Water Conservation District whereby the capacity of the reservoir was increased to 40,800 acre-feet, the power company agreed to pay a proportionate part of the construction costs amounting to about $20,000, and the joint operation and maintenance of the Boca Dam by the power company and conservation district was provided for. This change was made to provide power company pondage regulation of river flows in connection with power generation as provided for in the Truckee River Agreement.

Bids for the construction of Boca Dam under Specifications No. 696, were opened at the Reno office of the Bureau of Reclamation on September 30, 1936, there being 18 bidders. The contract was awarded to George W. Condon Co., of Omaha, Nebr., as a result of the low bid of $729,435, and was executed February 15, 1937. Construction work was commenced on March 30, 1937. Counting the extensions of time granted the contractor on account of unavoidable delays and orders for changes, the date for completion under the contract is August 26, 1939.

The dam will be the earth-fill type with rock fill and rock riprap facings, 107 feet high above the stream bed with a crest width of 35 feet and a length of 1,650 feet. Its construction will involve about 1,350,000 cubic yards of excavation, the driving and concrete lining of an outlet tunnel 726 feet long, the placing of 8,350 cubic yards of reinforced concrete and the placing of 790,000 cubic yards of zoned embankment and 150,000 cubic yards of rock fill and riprap. The outlet tunnel, driven around the west end of the embankment through the right abutment, is circular, 12 feet in diameter, for 369.54 feet of its length and horseshoe shaped, 10.5 by 14 feet, for the last 315.36 feet. A gate chamber makes up the remaining total length wherein two control slide gates, each 4 by 4 feet, are to be installed. Two 50-inch diameter steel pipes will lead from the gate chamber to two 42-inch needle valves in the valve house at the outlet portal. The spillway with a capacity of 8,000 cubic feet per second is constructed at the left end of the embankment, is of the concrete-lined, open channel type, and will be controlled by two radial gates, each 19 by 16 feet.

During the fall and winter of 1936–37 three wood frame Government buildings, an office, a laboratory, and a garage, were constructed at the dam site. These buildings were well built as permanent structures and will be used as the caretaker's residence, an auxiliary power unit station, and for garage and storage purposes after construction is complete. No Government camp was constructed, the employees being supplied transportation from Reno. A contractor's camp was built at Boca, consisting of the necessary shops, warehouses, cookhouse, bunkhouses, cabins, and residences. The camp was well provided with a water system, sewage disposal facilities, fire protection, and other modern improvements. The main bureau engineering and clerical office has been maintained at Reno, Nev. It was established in the Federal building in April 1934, where work has been handled for the Humboldt project and CCC Regional Office, as well as the Truckee Storage project.

Lake Tahoe from Mount Rose

Construction

Although most of the work done during April, May, and part of June of 1937 was of a preparatory nature, some contracted construction work was kept underway after March 30, 1937. The first concrete pour, which was on the spillway gate structure cut-off wall, was made June 23; outlet tunnel lining concrete pours began September 12; the outlet tunnel excavation driven from both portals was holed through on October 16; and outside concreting was discontinued, because of low temperatures, on October 24, 1937. At the outlet tunnel lower portal, where the work could be housed economically, concreting was continued until a later date. For the winter of 1937–38 all construction operations were discontinued on January 31, 1938, all operations after October being confined to the outlet works.

In the spring of 1938 some work was attempted late in April, but weather, wet ground, and high water conditions prevented much progress until about the middle of June. The river was completely diverted through the outlet tunnel to permit work in the river bottom part of the dam area on June 12, 1938.

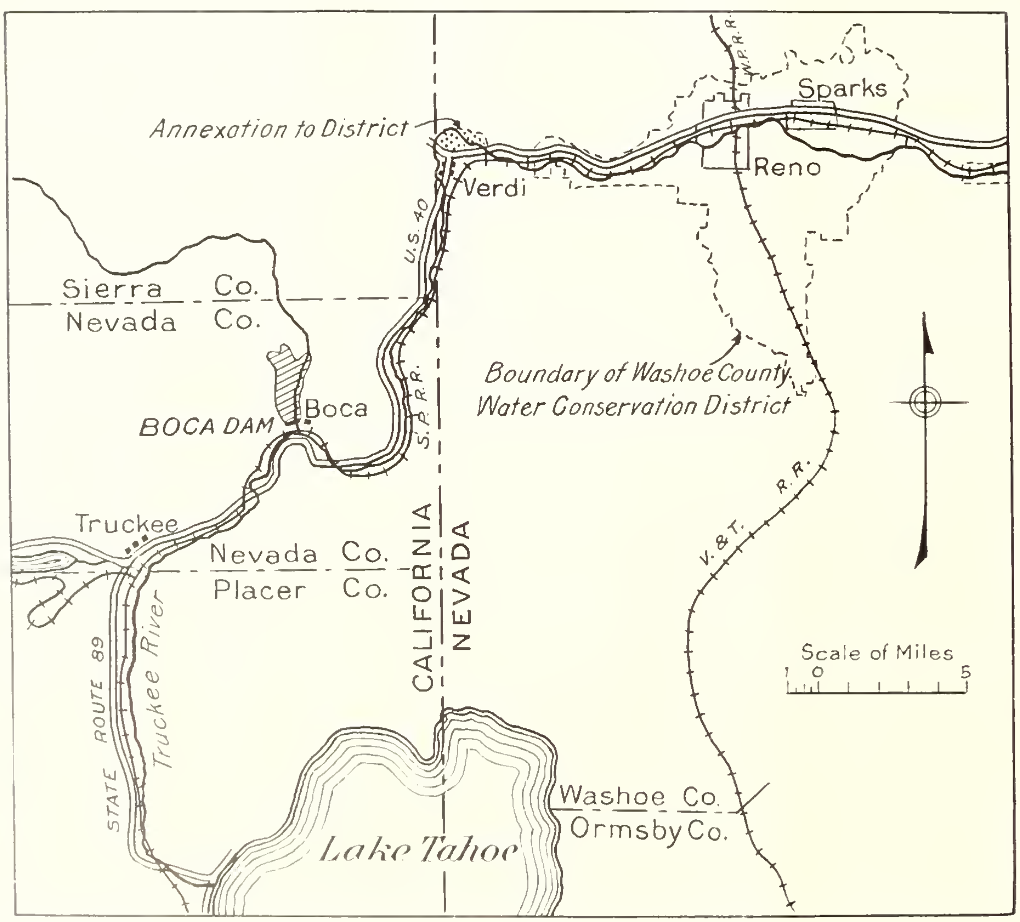
Early in November 1938, the embankment, exclusive of rock fill and riprap, had been placed to elevation 5,602, there remaining only 10 feet of height to reach the contemplated crest elevation of 5,612. Rock placing had not progressed as rapidly as the earth fill, but at that time the speed of such work was being materially increased. Of the outside concrete work there remained only a few spillway pours and part of the outlet control valve house structure, all of which is economically applicable to the use of covering and artificial heat and may be continued to completion even though colder weather begins. Because mechanical and electrical installations, spillway channel excavation, riprapping and any inside concreting or general clean-up work may be accomplished during colder weather, it is believed that the Boca Dam will be brought practically to completion this year.

One of the main hindrances to construction during the work months of 1938, the period of most progress, was the result of the heavy snowfall and severe winter of 1937–38. Unusually high moisture was in evidence during the entire summer, adding to the difficulties of spring floods and bad ground surface conditions by preventing the use of material from borrow pits which were previously considered the main source of such material. The ground was found to be more deeply saturated than for many years, with actual spring conditions at many points.

Concrete aggregates have been supplied by the Government and, due to the lack of suitable local materials, were shipped by railroad from Marysville and Fair Oaks, Calif. In connection with these shipments, as well as with any material shipments, a very marked advantage has been had by having the railroad main line so near the work and by having a spur track in existence by which the material was brought directly to the site. This spur was situated along a side hill with sufficient slope to permit the construction of aggregate unloading bins directly under the track and also to permit withdrawals from the bins into trucks backed under the bins. CCC forces and equipment were used to transport the aggregates from the bins to stockpiles near the concrete mixers.

The contractor is to be commended for the adequate quantity and quality of his equipment. In connection with all parts of the job he has maintained suitable equipment for the work in hand.

Interstate features of the Truckee storage project



Owyhee Livestock in Good Condition

REPORTS from the Owyhee project indicate that cattle and sheep are in better condition than for some years past, and a big calf and lamb crop is expected. Feeder stock are high in price. With an abundance of cheap hay, grain, beet pulp, and other feed on the project, the stockman is in a very favorable position.

Izaak Walton League of America Organizes Chapter in Boulder City

THE Boulder Dam Lake Mead Chapter of the Izaak Walton League of America was organized in Boulder City on December 14. More than 50 enthusiastic sportsmen attended the meeting and signed as charter members.

Belle Fourche Livestock

EARLY fat lambs shipped in December from the Belle Fourche project brought an average of $8.75 at central markets, and feeders were well pleased with the profits. Dressed turkey shipments for the holiday trade were heavier than usual, a total of 480 crates, or about 93,000 pounds, going out from project towns.

Shoshone Livestock

SHEEP and cattle on the Shoshone project are in excellent condition. It is reported that more livestock are being fed on the project than in previous years. Farmers who went out of the sheep business when the prices of agricultural products were good are purchasing a few ewes to start up farm flocks again.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
A-38, 241-A	Columbia Basin, Wash.	*1938* Dec. 14	Thin-wall tubing (410,000 feet)	New England Electric Co.	Denver, Colo.	$39,423.00	F. o. b. Odair, Wash.; discount, 5 percent	*1939* Jan. 9
1146-D	Kendrick, Wyo.	Dec. 12	Switchboards, transformers, disconnecting switches, expulsion fuses, and oil circuit breakers for Greeley and Cheyenne substations.	The Wolfe & Mann Mfg. Co.	Baltimore, Md.	[1] 17,992.00		Jan. 5
				Westinghouse Electric & Mfg. Co.	Denver, Colo.	[2] 8,947.70	F. o. b. Greeley and Cheyenne.	Jan. 9
				The High Tension Co., Inc.	Phillipsburg, N. J.	[3] 755.35	F. o. b. Greeley and Cheyenne; discount, 1 percent.	Jan. 10
				Hi-Voltage Equipment Co.	Cleveland, Ohio	[4] 122.40	F. o. b. Cheyenne	Jan. 11
				Southern States Equipment Corp.	Birmingham, Ala.	[5] 249.50	F. o. b. Greeley	Jan. 13
				Westinghouse Electric & Mfg. Co.	Denver, Colo.	[6] 1,528.00	F. o. b. Cheyenne	Jan. 9
				Do.	do.	[7] 498.96	do.	Do.
				Do.	do.	[8] 15,550.09	F. o. b. Greeley	Do.
				Memco Eng. & Mfg. Co.	Long Island City, N. Y.	[9] 10,150.00	do.	Do.
1150-D	Columbia Basin, Wash.	Dec. 22	1 brail hoists and 3 elevator hoists for installation in fish traps at Rock Island Dam.	Puget Sound Machinery Depot.	Seattle, Wash.	6,915.72	F. o. b. Seattle	Jan. 6
1158-D	do.	Dec. 29	Tank trucks for transporting fish, migratory fish control (8 trucks).	Kenworth Motor Truck Corporation.	do.	[10] 59,041.12	F. o. b. Portland	Jan. 10
1162-D	Colorado-Big Thompson, Colo.	*1939* Jan. 3	Heating system for dormitory at Government camp at Green Mountain Dam.					(11)
1149-D	Columbia Basin, Wash.	*1938* Dec. 29	Elevator towers, tank chutes, brail frames, and trash rack metalwork for installation in fish traps at Rock Island Dam.	Smith Corporation d/b/a General Iron & Steel Works.	Portland, Oreg.	6,738.00	F. o. b. Portland	*1938* Dec. 29
1139-D	Colorado-Big Thompson, Colo.	Nov. 30	Construction of office building at Estes Park headquarters camp.	Christian F. Martin	Adams City, Colo.	13,165.00		*1939* Jan. 12
1151-D	Yakima-Roza, Wash.	Dec. 23	Overflow gate for fish ladder at Roza diversion dam.	Smith Corporation d/b/a General Iron & Steel Works.	Portland, Oreg.	330.00	F. o. b. Portland	*1938* Dec. 30
A-38, 158-C-1	do.	Dec. 12	5 sedans and 25 station wagons	William O. McKay Company.	Seattle, Wash.	[12] 20,282.75	F. o. b. Dearborn, Mich.	*1939* Jan 13
1154-D	Salt River, Ariz.	Dec. 28	Power-drive equipment for operating gate hoists, Power Canal.	Commercial Iron Works	Portland, Oreg.	1,120.00	F. o. b. Portland	Jan. 11
1153-D	Columbia Basin, Wash.-Deschutes, Oreg.	Dec. 27	3 clutch-operated, crawler-traction-mounted, full-revolving, Diesel-engine-powered, convertible-type dragline excavators.	Northwest Engineering Co.	Chicago, Ill.	[13] 16,990.00	F. o. b. Green Bay, Wis.	Jan. 18
						[14] 27,940.00	do.	Do.
B-47, 370-A	Central Valley, Calif.	Dec. 9	Steel reinforcement bars (1,000,000 lbs.)	Columbia Steel Co.	San Francisco, Calif.	23,592.00	F. o. b. Neroly, Calif.; discount ½ percent, 7½ cents less.	Do.
1152-D	All-American Canal, Ariz.-Calif.	Dec. 27	13 radial gates and 12 radial-gate hoists.	Smith Corporation d/b/a General Iron & Steel Works.	Portland, Oreg.	[13] 7,366.00	F. o. b. Portland	Do.
						[14] 10,468.00	do.	Do.
A-38, 254-A	Columbia Basin, Wash.	Dec. 28	3 60-horsepower and 3 95-horsepower Diesel-engine-powered crawler tractors.	Caterpillar Tractor Co.	Peoria, Ill.	42,216.81	Discount $300	Do.
33,054-A	Central Valley, Calif.	do.	Ties and timber	J. H. Baxter & Co.	San Francisco, Calif.	37,214.90	F. o. b. Seattle	Jan. 19
814	Shoshone-Heart Mountain, Wyo.	Dec. 20	Construction of Shoshone River siphon and Buck Springs Creek siphon.	Utah Construction Co.	do.	[1] 84,537.50		Jan. 23
				Consolidated Steel Corporation, Ltd.	Los Angeles, Calif.	[15] 212,100.00	F. o. b. Los Angeles	Do.
				Barnard-Curtiss Co.	Minneapolis, Minn.	[16] 31,864.50		Do.
1159-D	All-American Canal, Ariz.-Calif.	*1939* Jan. 3	Preparation of concrete aggregates near station 116, All-American Canal.	San Gorgonio Rock Products.	Banning, Calif.	49,270.00		Jan. 27
1161-D	Colorado-Big Thompson, Colo.	Jan. 5	Construction of 51½ mile, 69,000-volt transmission line, Green Mountain Dam to Grand Lake	W. O. Allison Co.	Grand Junction, Colo.	31,960.50		Do.
33,015-A	Central Valley, Calif.	*1938* Nov. 30	Track materials	Tennessee Coal-Iron & R. R. Co.	Denver, Colo.	[1] 162,702.08	F. o. b. Redding	Jan. 28
				Colorado Fuel & Iron Corporation.	do.	[2] 28,105.60	F. o. b. Minnequa; discount ½ percent b. p. v.	Do.
				do.	do.	[7] 15,480.93	F. o. b. Minnequa items 12 and 13. F. o. b. Columbus balance; discount ½ percent.	Do.
				Pettibone-Mulliken Corporation.	Chicago, Ill.	[17] 17,051.80	F. o. b. Redding	Do.

[1] Schedule 1.
[2] Schedule 2.
[3] Schedule 3, Items 8, 9, and 10.
[4] Schedule 3, Item 11.
[5] Schedule 3, Item 12.
[6] Schedule 4.
[7] Schedule 5.
[8] Schedule 6.
[9] Schedule 7.
[10] Item 3.
[11] All bids rejected, readvertised as 1183-D.
[12] Items 1 and 2.
[13] Item 1.
[14] Item 2.
[15] Schedules 2 and 4.
[16] Schedule 3.
[17] Schedule 8.

Grand Valley Industry

THE Grand Valley Rural Power Lines, Inc., completed construction of additional transmission lines in the Orchard Mesa district at a cost of $48,000, which will serve 142 additional farms with electricity, with more to come in later.

Proposed High School on Sun River Project

CONSTRUCTION of a high school at Fairfield, Mont., headquarters of the Sun River project, is expected to be under way in the near future.

Turkey Trade Profitable to Yakima Project

ABOUT 65,000 turkeys were marketed on the Yakima project during the Thanksgiving and Christmas seasons, returning to the growers a total of $242,540.

Ice Factory Required for Construction of Water Dam

AFTER 5 years of preliminary work on a comprehensive hydraulic development project in the Harz Mountains, which will include the ultimate construction of seven dams, masonry work on the largest unit is about to be started—the so-called Grosse Rappbodesperre. With a height of 100 meters and a length at the top of 400 meters, it is stated that this dam will be the highest ever built in Germany. A technical procedure that is entirely new in Germany will be applied in the construction of this concrete dam. As concrete develops considerable heat, sometimes up to 55° C., during the binding process it is stated that the huge quantities of ordinarily mixed concrete as will be required for this dam, would necessitate far too long a period for cooling off, thereby involving the danger of irregularities in the composition of the concrete. In order to get around this difficulty, constructing engineers have decided to use finely ground ice for the mixing of the concrete instead of water. The concrete would thus have a temperature of 3° to 5° C. only, or about 20° less than the surrounding temperature. The heat developing in the concrete would therefore not exceed 55° C. and distortions and breaches thus should be rendered impossible, according to the claim of engineers. In order to supply the enormous quantities of ice required for this procedure, a large-scale ice factory will be constructed in the immediate vicinity of the dam site.

As this is the first trial ever made in Germany with ice-cooled concrete, it remains to be seen whether results will come up to expectations.

—*Magdeburgische Zeitung, November 6, 1938.*

Huntley Project To Have New High School

GROUND was broken on December 29, 1938, for a new high school building to be erected at Worden, Mont., on the Huntley project, at a cost of approximately $85,000.

CONTENTS

THE RECLAMATION ERA • FEBRUARY 1939

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date)..

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

February 1939.

(Name)..

(Address)..

....

[1] Do not send stamps.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

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(Continued on page 37)

The Imperial Dam, All-American Canal System, Boulder Canyon Project

By D. M. FORESTER, *Engineer, Yuma, Arizona*

ACROSS the Lower Colorado River, about 20 miles above Yuma, Ariz., the Bureau of Reclamation has just completed the construction of Imperial Dam, built to divert water to the All American Canal on the California side of the river and to the Gravity Main Canal of the Gila project on the Arizona side. The All-American Canal project, of which the dam is a part, is one of the three construction features authorized under the Boulder Canyon Project Act, approved December 21, 1928, the other two being the Boulder Dam and power plant.

The diversion facilities will provide 15,000 second-feet of water for the All-American Canal and ultimately 6,000 second-feet for the Gila project. The All-American Canal will provide an adequate supply of irrigation water for the Imperial and Coachella Valleys, which are parts of the Salton Sink, a below-sea-level basin in southern California. Furthermore, water which is now diverted to the Yuma Project Canal at Laguna Dam, about 4 miles below the Imperial Dam, will in the future be supplied from the All-American Canal. Laguna Dam will hereafter serve only as a tailwater control for the Imperial Dam. The present construction at Imperial Dam provides for a diversion of 2,000 second-feet of water to the Gila Canal, to be used for irrigating the first unit of the Gila project. Headworks have been provided for the ultimate diversion.

The reservoir created by the dam has a storage capacity of 85,000 acre-feet and a surface area of 7,500 acres. This storage, however, is not required nor considered a feature of the project as the reservoir will soon become filled with silt, probably within a very few years after being placed in operation.

The uncontrolled drainage area contributing to the flow at Imperial Dam is only 10,000 square miles. The remaining area is controlled by the Parker and Boulder Dams, which are upstream 150 and 300 miles, respectively. It is estimated that the maximum flood that will reach the Imperial Dam may never exceed 150,000 second-feet. With the sluiceway gates open, a flood of this magnitude may be discharged with a depth of 8.5 feet of water over the crest of the overflow weir. However, for design, the maximum depth of water to flow over the crest has been taken as 10 feet, which corresponds to a maximum flood of 200,000 second-feet.

The site on which the dam is built is an alluvial flood plain having a width of 2,300 feet between rocky abutments and an elevation of 160 feet above sea level. The alluvium consists of very fine sandy silt overlying coarse sand and gravel. The plane of intersection between the silt and the coarse sand and gravel is at elevation 138, approximately, but thin layers of clay and fine silt are found at various depths. It is probable that the depth of this waterborne material is about 200 feet. The rocky abutment, rising on the California side, consists of vesicular rhyolite overlying an ancient metamorphic crystalline formation. On the Arizona side, the ancient metamorphic crystalline rock is overlain by tuffaceous volcanic ash which in turn is covered by fanglomerate.

The dam is a concrete structure of the monolithic slab-and-buttress type. It has a total length of 3,485 feet, inclusive of non-overflow sections, headworks, sluiceway and overflow weir or spillway. The abutments and a portion of the gate structures are founded on rock; the remaining gate structures are supported on battered concrete bearing piles. The overflow spillway, of the floating type, rests on compacted till, 10 to 12 feet thick, which in turn rests on the coarse sand and gravel found in the river bed at an approximate elevation of 138. To provide some flexibility, all the various structures are divided into units which have rubber joint-seals between them. Throughout the length of the dam there is an upstream apron of reinforced concrete extending to the rock abutments at each side of the river. Under this apron three rows of sheet-piling have been driven in order to increase the length of the path of percolation under the structures. The tops of these pilings are embedded in a mastic filler of bitumen to provide for any pos-

Looking along upstream face of sluiceway gate structure showing overflow weir and Gila headworks beyond

sible settlement of the apron without its being cracked or ruptured. The portion of the apron upstream from the California abutment and the headworks of the All-American Canal was covered with 12 feet of backfill so as to raise the floor of the headworks approach. A groin wall, which was built at the junction of the overflow weir and sluiceway, extends upstream to the edge of the apron. It acts as a channel training wall, and also facilitates the deposition and retention of the silt on the apron upstream from the overflow weir. This apron extends upstream from the axis 213 feet, or 170 feet from the upstream toe of the spillway section. Provision has been made for the drainage of percolating water under the dam in order to reduce the uplift pressure under the structures and the downstream aprons. The drainage provides a greater safety factor against sliding and also permits a reduction to be made in the thickness of concrete in the lower apron. To prevent the fine sand from being washed out from under the structure, the drain pipe is surrounded by a filter of graded sand and gravel. In the downstream side of the overflow weir the drain will discharge through ejectors which will act as automatic siphons. At periods when water will pass over the weir, the ejectors will maintain a water pressure under the dam considerably lower than that corresponding to the flood water level downstream.

In general, the dam may be divided into six divisions: The California abutment, the All-American Canal headworks, the sluiceway, the overflow weir, the Gila headworks, and the Arizona abutment and dike.

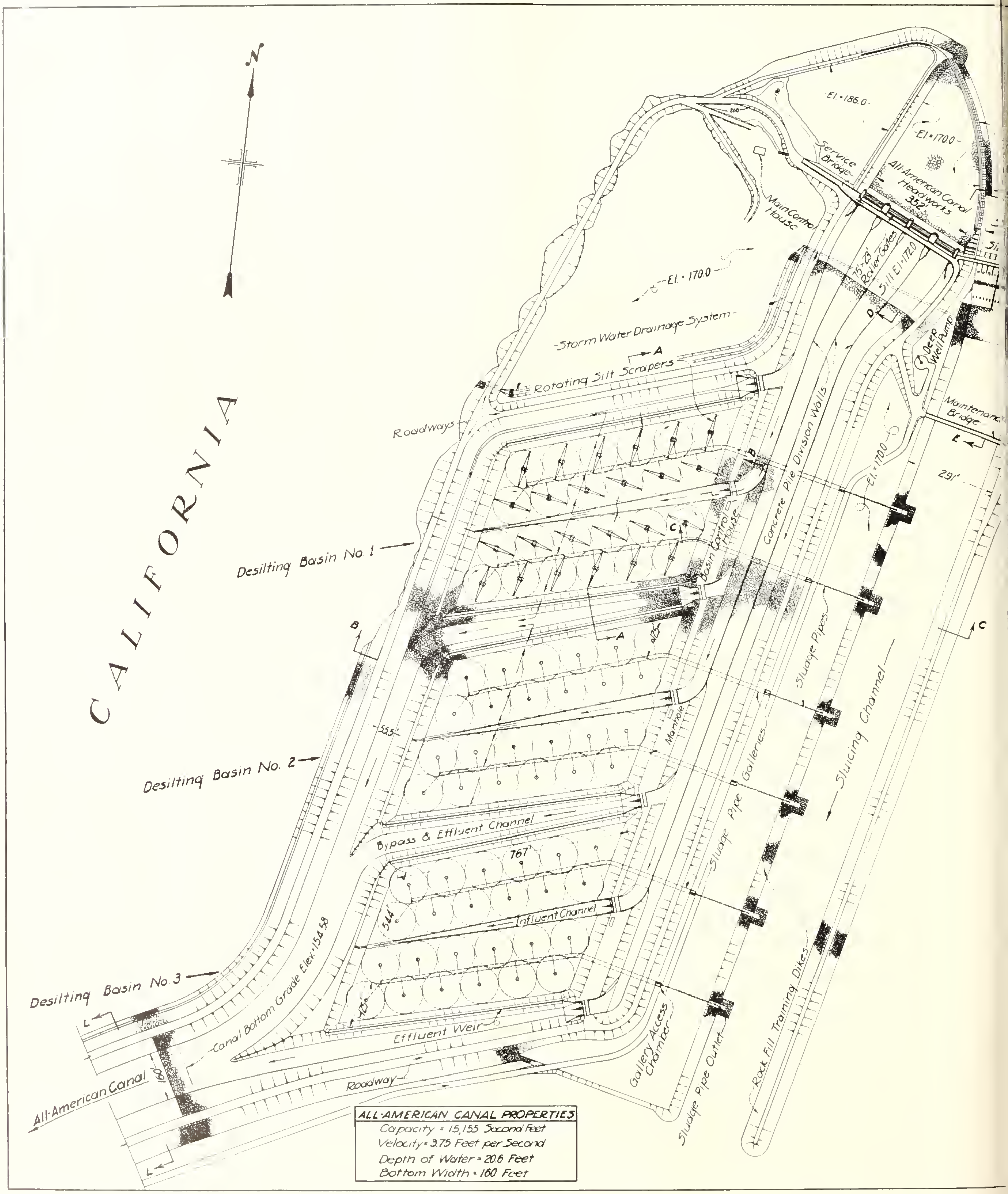
California Abutment

The entire California abutment, which has an over-all length of 231 feet, is founded on rock. To secure a satisfactory foundation for the easterly end of the abutment, and also for pier No. 1 of the All-American Canal headworks, the excavation was made to elevation 111. This depth was approximately 47 feet below the normal water surface of the river during construction. The maximum height of the dam occurs at this section, the roadway deck being 85 feet above the foundation. A 4-foot cut-off wall was constructed along the toe of the upstream face slab and grouted under pressure.

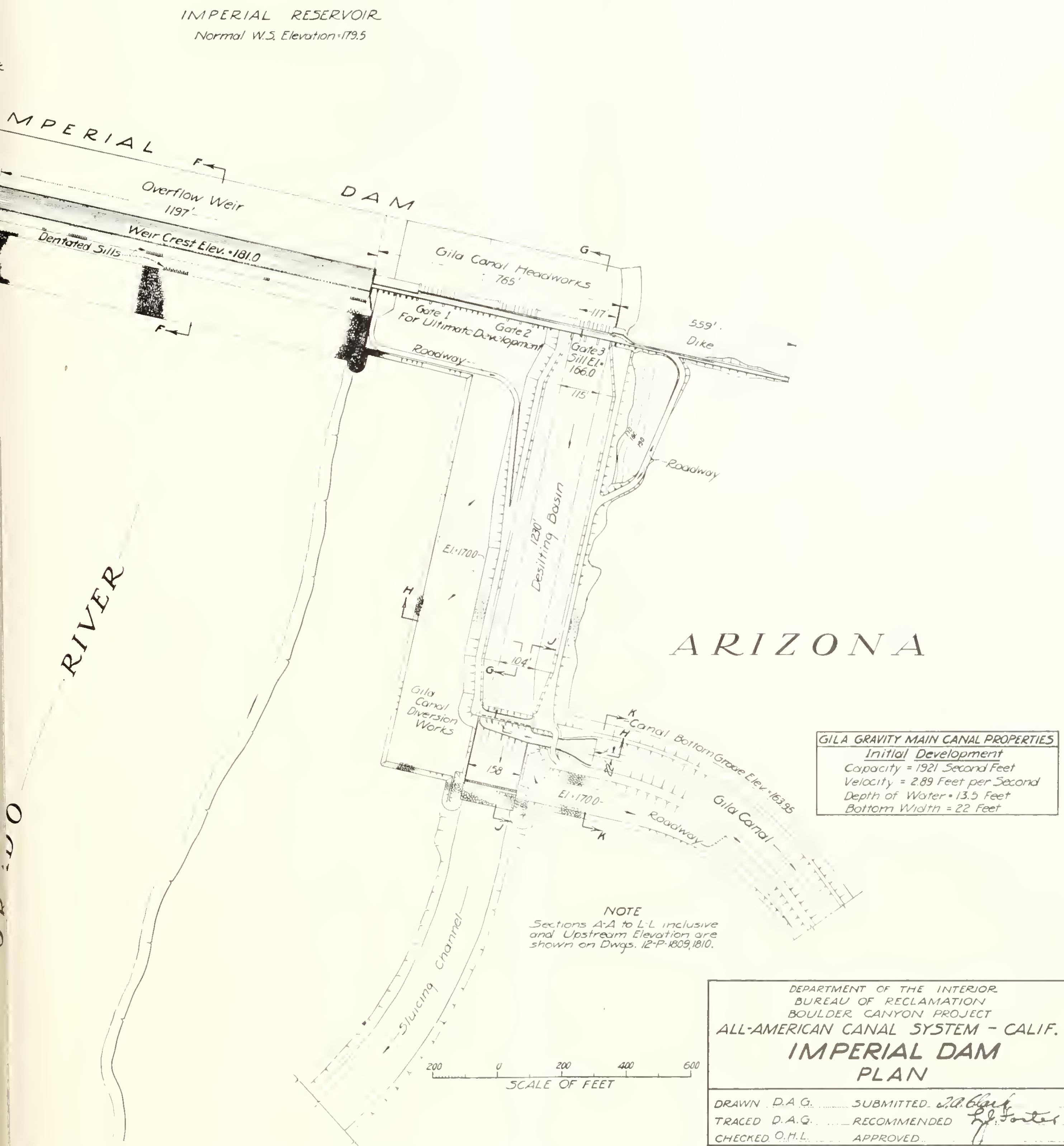
Overflow weir

All-American Canal Headworks

The headworks of the All-American Canal has an over-all length of 386 feet. Diversion into the canal will be controlled by four roller gates, each 75 feet long and 23 feet high, which are operated by hoists installed in houses constructed on piers Nos. 2 and 4. The gate sills are at elevation 172. Pier No. 1, adjoining the California abutment, was placed on rock foundation at elevation 111; the remaining four piers are supported on 50-foot concrete piling. The piles were driven on a 1:3 batter, up or down stream, in alternate rows normal to the axis of the dam. A bridge consisting of steel girders supporting a reinforced concrete deck carries the roadway across the headworks. A trashrack structure, about 585 feet long, extends upstream from the river side of the headworks to the end of a rockfill training dike. The dike, about 500 feet long, runs from the upstream end of the trashrack structure to the west end of the headworks. The trashrack structure consists of structural steel frames supported on concrete footings which in turn rest on 32-foot wood bearing piles. To provide a cut-off and to prevent undermining of the structure, there is also a line of 20-foot Wakefield wood sheet-piling under



N
CALIFORNIA
El. = 186.0
El. = 170.0
Service Bridge
All-American Canal Headworks
352'
Main Control House
El. 170.0
15'x23' Roller Gates
Sill El. = 172.0
Storm Water Drainage System
Rotating Silt Scrapers
Deep Well Pump
Maintenance Bridge
Roadways
Concrete Pile Division Walls
El. = 170.0
291'
Basin Control House
Desilting Basin No. 1
Sludge Pipes
Sluicing Channel
Manhole
Desilting Basin No. 2
Sludge Pipe Galleries
Bypass & Effluent Channel
767'
544'
Influent Channel
Desilting Basin No. 3
Canal Bottom Grade Elev. 154.58
Effluent Weir
All-American Canal
160'
Roadway
Gallery Access Chamber
Sludge Pipe Outlet
Rock Fill Training Dikes
ALL-AMERICAN CANAL PROPERTIES
Capacity = 15,155 Second Feet
Velocity = 3.75 Feet per Second
Depth of Water = 20.6 Feet
Bottom Width = 160 Feet



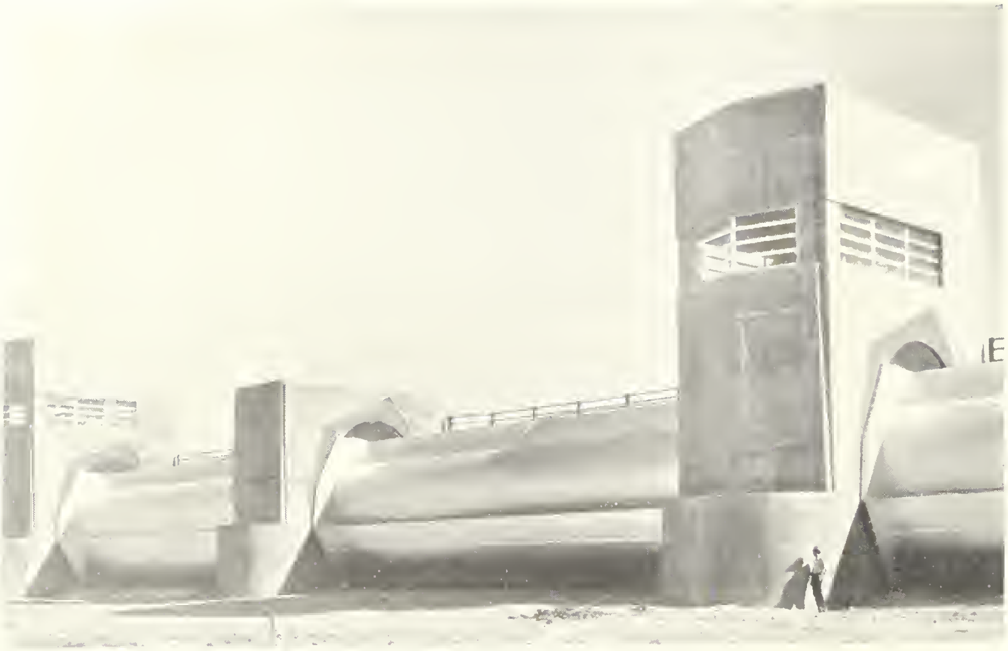
GILA GRAVITY MAIN CANAL PROPERTIES
Initial Development
Capacity = 1921 Second Feet
Velocity = 2.89 Feet per Second
Depth of Water = 13.5 Feet
Bottom Width = 22 Feet

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT
ALL-AMERICAN CANAL SYSTEM – CALIF.

IMPERIAL DAM
PLAN

DRAWN D.A.G. SUBMITTED [signature]
TRACED D.A.G. RECOMMENDED [signature]
CHECKED O.H.L. APPROVED

12-P-1808 | YUMA ARIZONA – MAY 24, 1938



All-American Canal headworks

the footings. The area between the trashrack and the headworks was backfilled and surfaced with 18-inch dry-rock paving at elevation 170. The clear opening between the bars of the trashrack grating is $2\frac{3}{16}$ inches. The location and design of the trashrack were made on the basis of model tests giving the best hydraulic conditions and excluding the maximum amount of silt from the headgates.

Immediately downstream from the All-American Canal headworks is the desilting works for the All-American Canal which has been previously described in an article appearing in the August 1938, issue of the Reclamation Era.

Panorama of Imperial Dam and desilting works

Sluiceway

The sluiceway, which is adjacent to the All-American Canal headworks, has the capacity to pass 31,000 second-feet of water at normal reservoir level, i. e., elevation 179.5. At maximum flood it has the capacity to pass 42,500 second-feet. This structure has twelve 16- by 7-foot radial gates with sills at elevation 163.0. These gates are installed with top seals, and are automatically controlled by a float switch, so that they will maintain any desired water surface in the reservoir. The sluiceway section, which has an overall length of 347 feet, rests upon 50-foot concrete bearing piles similar to the All-American Canal headworks. A sluiceway channel extends downstream 3,000 feet with rock-fill training dikes on each side of the channel. The bottom of these dikes is at elevation 140 and the top at elevation 170.

Overflow Weir

The central portion of the dam is a hollow overflow weir 1,197.5 feet long divided into 15 units, 14 of which are 78 feet 6 inches long, each having 4 buttresses at 20-foot centers. The face and bottom slabs overhang the buttresses at both ends. The middle unit is 98 feet 6 inches long with five buttresses but is otherwise the same as the other units. The slabs, which are monolithic with the buttresses, are designed as continuous beams. The crest is at elevation 181, and the bottom slab subgrade is at elevation 150. The buttresses are 2 feet 6 inches thick; the upstream slab varies in thickness from 2 feet 1 inch to 18 inches. The crest is 2 feet $5\frac{1}{8}$ inches thick, and the floor or bottom slab is 22 inches thick. To provide additional weight, the interior of the weir was ballasted with pit-run sand and gravel, to a depth of approximately 9 feet.

The portion of the river bed which consisted mainly of fine, sandy silt, was excavated to the underlying coarse sand and gravel at approximately elevation 138. It was then backfilled to subgrade (maximum elevation 150) with selected material. After the material was compacted, it was used as a foundation on which the concrete structure was placed.

The selected earth material, after compaction, had a density of 120 pounds per cubic foot which is approximately 20 percent greater than the density of the material in its natural state at the borrow pits. The selected material was transported from borrow pits located approximately $2\frac{1}{2}$ miles from the dam.

The downstream apron, consisting of reinforced concrete 8 feet thick, with two rows of dentated sills, extends 66 feet downstream from the toe of the weir. At the downstream edge of the apron there is a line of 32-foot steel sheet-piling. The tops of these piles were embedded in mastic as were the tops of the upstream piles. The sheet-piling acts as a cut-off, and also increases the length of the path of percolation under the structures. Heavy rock riprap extends an additional 150 feet downstream from the apron. The design of the apron was based on extensive model studies.

Gila Headworks

The diversion into the Gila Canal on the Arizona side of the river will be through three gate structures which are separated by short nonoverflow sections. The nonoverflow structure adjacent to the overflow weir and the first gate structure are founded on 50-foot concrete bearing piles. The remaining two nonoverflow and two gate structures are founded on cemented tuffaceous volcanic ash and on the ancient metamorphic crystalline rock. Each nonoverflow structure is divided into two units. Each gate structure has three 35-foot 8-inch by 14-foot 6-inch radial gates with top seals. The gate sills are at elevation 166. During construction, the river was diverted through the two easterly gate structures. The bottom slab was constructed lower so as to give a diversion channel floor at elevation 152. After diversion was completed sill foundations were placed to bring the sills to elevation 166. For initial diversion to the Gila Canal only one gate structure will be used. From the gate structure the water will pass into a concrete-lined desilting basin, 1,230 feet long with a bottom width of 120 feet at the upper end and 108 feet at the lower end. The bottom slopes from elevation 160.5 at the upper end of the basin to elevation 157.2 at the lower end. The concrete lining on the side slopes of the basin was placed to elevation 184.5, and the embankment tops were placed to elevation 188.5. The water flowing through the basin with a velocity of 0.7 foot per second will drop the undesirable coarse part of its silt load before passing to the canal. At the lower end of the basin, a gate structure is provided for sluicing and diversion to the Gila Canal. As the natural ground at this location was unstable water-bearing river silt, this structure is founded on 2,040 60-foot wood bearing piles. The foundations were excavated to elevation 148.5 and the piles driven to required grade. A tamped backfill of selected material, 4 feet thick, was made around the piling to the required subgrade. The structure is equipped with 8 diversion and 8 sluice gates each approximately 17 feet 5 inches wide by 8 feet high. They are of the fixed-wheel vertical-lift type.

The silt carried into the basin and deposited on the floor will be periodically sluiced, through the sluice gates, into the river below the dam. The clarified water from the basin will be diverted into the Gila Canal through the diversion gates located immediately above the sluice gates. The sills for the sluice gates are at elevation 156, and those for the diversion gates are at elevation 173.

Trashrack, All-American Canal headworks

A three-foot reinforced concrete apron extends 106 feet downstream from the gate structure, and is followed by an additional 50-foot of heavy riprap. A cut-off, consisting of 20-foot wood sheet-piling, was placed at the downstream edge of the concrete apron. The sides of the basin are compacted embankments having slopes of 2:1 and a 17-foot crown. The concrete lining of the basin was laid on gravel 12 inches thick at the bottom and slopes, and was provided with 2-inch weep holes spaced 7 feet 6 inches by 3 feet 9 inches to prevent uplift during sluicing operations. An under-drainage system similar to that in the dam is provided under the gate structure.

Arizona Abutment and Dike

The abutment on the Arizona side rests upon fractured crystalline rock. It is built

Gila desilting basin, Gila headworks in background

in an "L" shape with one leg of the "L" abutting on the easterly pier of the gate structure, the other leg acting as a longitudinal cut-off wall. Upstream from the abutment, the slope of the diversion channel used during construction is paved with reinforced concrete to elevation 192. It extends upstream from the axis 213 feet. The rock excavation for the abutment and paving was made on a slope of 1½ : 1. At the abutment the slopes were backfilled to elevation 192 with selected material and then compacted. The remaining fill at the abutment and for the dike was of rock. The upstream face of the dike is paved with concrete. The total length of the abutment and dike is 557 feet.

Electrical

Operations of the various gate structures are controlled from a main control house located on a hilltop near the California abutment.

The incoming power supply to the main control house has a potential of 2,300 volts. It enters a switchboard which has manually-controlled oil circuit breakers. A gasoline-engine-driven generator provides an emergency source of power sufficient to operate the various gates if the main power supply fails.

All the gate-hoist motors receive their power and control supply from 2300/460-volt transformer banks located in rooms in the various structures near or adjacent to the motors. The motor controllers are all across-the-line starters with thermal overload trip elements. All the controllers except those for the All-American Canal headworks are mounted in weather-proof cabinets near the various hoists. "Raise–Lower" push-button stations are mounted on the sides of the cabinets for operation while repairs or adjustments are being made. The controllers for the All-American Canal headgates are located in the hoist-houses of piers Nos. 2 and 4. Each of these roller gate hoists has a control switch and selsyn position indicator on the control desk at the main control house and also a control switch and mechanical position indicator in the hoist house. The 12 radial gates in the sluiceway structure are operated in sets of 4 by "Raise–Stop–Lower" switches on the control desk in the main control house. These gates are also controlled by float switches set so as to maintain a constant reservoir level.

The Gila headworks radial gates and the fixed-wheel vertical-lift diversion gates at the Gila Canal diversion structure may be controlled and operated from the main control house and their positions shown by selsyn indicators.

The control desk on the Gila Canal diversion structures has control switches for the radial headgates and the fixed-wheel vertical-lift diversion and sluice gates at the structure. There is also a selsyn indicator to indicate the position of the headgate.

All power cables are lead-covered. They are carried through clay tile ducts in earth embankments and through metallic conduits or cable trays through concrete structures. All control points throughout the structures are connected by telephone to the main control house.

Construction

The sequence of construction operations was first the building of the California abutment, the All-American Canal headworks, and the Gila headworks, then turning the river through the two easterly gate openings of the Gila headworks on the Arizona side and the building of the sluiceway and overflow weir. The river was then turned back through the completed sluiceway channel on the California side and the Gila diversion works and gates completed in temporary cofferdams. To protect the work, the contractor built a cofferdam surrounding the California abutment and the All-American Canal headworks. From a point approximately at the east side of the sluiceway and across the river channel a wooden bridge on pile bents, approximately 1,200 feet long was constructed to the channel bank on the Arizona side of the river. A second cofferdam enclosed the Gila headworks. Prior to the beginning of construction of the overflow weir, the river was diverted from the main channel. This was accomplished by connecting the two cofferdams. After the cofferdams were completed across the channel the bridge was removed.

One of the earliest construction operations was the manufacturing of concrete bearing piles and wood sheet-piles. The bearing piles were all 20-inch, octagonal shape, 35 feet, 45-feet, and 50-feet long with embedded 2-inch jet pipe. The 35-foot piles were reinforced with ⅞-inch longitudinal bars and the other lengths with 1-inch longitudinal bars, and all with 6-inch pitch ⅜-inch spirals except in the top 3 feet of the piles where the pitch was reduced to 3 inches. The "Wakefield" wood sheet-piling was made up from three 3-inch by 12-inch planks of Douglas fir, of the required length, by spiking together with 10-inch spikes in such a manner as to provide tongues and grooves.

Concrete was mixed in two plants, one located near the California abutment and the other near the Gila headworks. Each plant was equipped with a 2-yard mixer and weigh-in-batcher bins. The concrete was pumped to the various structures, except to the overflow weir, through 8-inch pipe lines. Concrete for the overflow weir, downstream aprons and isolated structures was placed by cranes using 2-cubic-yard buckets. The concrete was transported from the mixer to the cranes in 2-cubic-yard agitators or transit mixers.

The flexible joint-seals were made by using

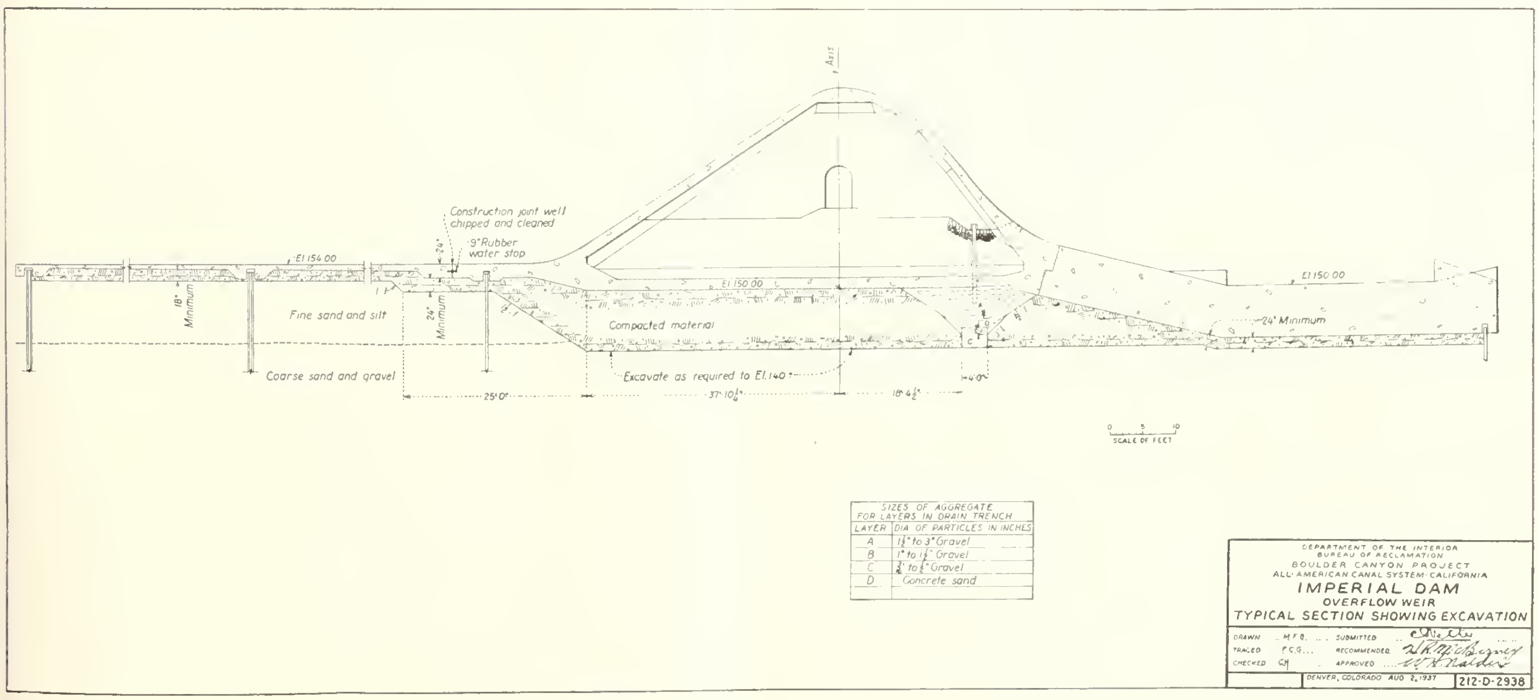
Gila headworks

two 5½- by 3-inch bulb angles embedded at the upper edge of the joints, the 5½-inch leg forming part of the joint facing. The 3-inch leg was fitted with ½-inch bronze bolts on 12-inch centers. Rubber strips, 6 inches wide and ½-inch thick, were bolted to the angles using ⅜- by 2-inch metal backing strips. The joint was separated by ¼-inch asphaltic felt. On the sections of the flexible joint-seal above the normal water surface and exposed to sunlight, a special synthetic rubber facing on the strip was used to prevent deterioration. All joints in the rubber were vulcanized in the field.

One of the major problems encountered during construction was the high ground water level and the resultant necessity for pumping operations to permit excavation and construction. For the excavation for pier 1 of the All-American Canal headworks, a cofferdam of steel sheet-piling was used to enclose the area, the piling being driven to rock. The area was then dewatered by well points and sump pumps. The same procedure was used for unit 1 of nonoverflow structure 2, Gila headworks. The dewatering for the overflow weir was done by deep well pumps and well points. Nine deep wells, 12 inches and 20 inches in diameter, equipped with 1,200 gallons per minute pumps, and 1,073 2-inch well points, with pumps for each 40 to 50 points, were required to maintain the ground water at sufficient depth to permit construction.

Completed overflow weir, looking upstream

Climatic conditions were exceptionally severe during summer months, with temperature as high as 118° F. and with monthly averages for June, July, August, September, and October of 87° F. Concreting operations were suspended on all work above elevation 160 from June 1 to September 30, and none was placed when the temperature of the batch exceeded 90°. In contrast to widely studied methods of placement of concrete in cold weather, the work on Imperial Dam faced the opposite extreme, namely of finding means of placing concrete in temperatures so high that normal operations were not possible. However, by use of certain simple expedients concreting was carried on safely under temperatures which would have made placement impracticable if precautions had not been taken. These precautions consisted of the control of the temperature of the water and aggregate, the precooling of the mixer, delivery pipe, agitator, and the reinforcing in the forms. During hot summer months the concrete mixer, which consists of several tons of metal, reached such a temperature that cool water had to be run through the mixer for 10 or 15 minutes before the first batch was introduced. The water, at a constant temperature of 70° F., came from a deep-well pump. The aggregate was ordinarily hauled directly from the screening plant to the mixer storage bin. Thus advantage was taken of the cooling effect of recent washing. When



the material had to be taken from the aggregate stock-piles, it was sprinkled as it was placed in the mixer bin. The bin was also surrounded by a burlap covering on which water was sprinkled continually. Just before the concrete was placed, the forms were given a final sprinkling, and particular attention was given to cooling the reinforcing steel in the same way. When placement was made through delivery pipe by pumping, the pipe was covered by burlap on top of which a small water pipe was laid for the full length of the line. Closely spaced perforations in this small pipe permitted 70° well water to trickle continuously onto the burlap. The rapid evaporation under the sun's rays accomplished a greater amount of cooling than would be obtained under ordinary climatic conditions. The custom was to cool the line an hour or 2 before starting the placing of concrete. The temperature of the concrete was actually lowered 1° to 3° during the period of its transit through the cooled delivery pipe.

During the winter season when the air temperature was several degrees above freezing, the cooling effect possible with the rapid evaporation that attends low humidity was frequently noted by the formation of ice at small leaks in the water lines. The evaporation was so rapid in the very dry air that the wetted surface was cooled to a temperature below freezing and actually caused ice formation.

The contract for the construction of Imperial Dam and the All-American Canal desilting works, under Bureau of Reclamation Specifications No. 644, was awarded to the Morrison-Knudsen Co., the Utah Construction Co., and the Winston Bros. Co., in December 1935. Contract work was started in January 1936, and completed in July 1938.

Progress of Investigations of Projects

ARIZONA-CALIFORNIA: *Colorado River Valleys surveys.*—Work was continued by the Forest Service on preparation of the aerial mosaics.

CALIFORNIA: *Kings River-Pine Flat project.*—Preliminary studies of reservoir sites on the Kings River, including Pine Flat Reservoir, plans and estimates of cost of Tehipite, Cedar Grove, and Silver Creek Dams and all diamond drilling were completed.

COLORADO: *Blue River transmountain diversion.*—Report of project was nearly completed.

Eastern slope surveys.—Revised water supply studies were made of the North Republican River and Trinidad projects; plan and estimate of dam at Trinidad site were completed.

Western slope surveys.—Preparation of reports of the Collbran and Florida projects was continued; diamond drilling was continued at State line dam site and test pits begun at Red Mesa site on La Plata project; water supply studies were continued on the Paonia, Piceance, and Silt projects, and test pit work was completed at Harvey Gap dam site.

IDAHO: *Southwest Idaho investigations.*—Preparation of reports on Payette River storage and Weiser Basin development is in progress.

Snake River Storage, South Fork.—Water supply studies continued and designs of dam at Elk Creek site begun.

MONTANA: *Gallatin Valley project.*—Surveys and drilling at Spanish Creek Dam site were completed and work on plans and estimates continued.

Madison River project.—Water supply studies were continued and investigation of Canyon Ferry Dam site made.

Marias project.—Field surveys of irrigable lands were completed and soil and water samples were to be tested.

Rock Creek project.—Surveys were completed and preparation of a report begun.

MONTANA-NORTH DAKOTA: *Fort Peck pumping project.*—Canal and land classification surveys were continued with 70,000 acres covered to date.

NEBRASKA: *Mirage Flats project.*—Diamond drilling at the dam site on Niobrara River was completed; surveys were continued of canal and diversion dam site, and mapping of 3,000 acres completed.

NORTH DAKOTA-SOUTH DAKOTA: *Missouri River pumping project.*—Assembling data for commencing fieldwork in the near future was in progress.

OKLAHOMA: *Altus project.*—Water-supply and flood-control features of the project were being studied, and an investigation of rural resettlement possibilities was in progress.

Canton project.—Topographic surveys and water-supply studies from the North Canadian River were continued.

Washita project.—Arrangements were in progress to make a reconnaissance of the valley.

OREGON: *Grande Ronde project.*—Reservoir capacities were studied and power development at Catherine Creek site. Preparation of report continued.

Medford project.—Plans and estimates of dams at Lake, Little Butte Creeks and plans for raising existing Four Mile Lake Dam were in progress, and preparation of report continued.

Willamette Basin reconnaissance.—Plans for an early reconnaissance of the valley with a view of obtaining attitude of people on irrigation was arranged.

UTAH: *Blue Bench and Ouray Valley.*—Preparation of reports was in progress.

Price River-Gooseberry investigations.—Survey of Willow Creek Reservoir site was completed and studies of canal lines and of Lower Joes Valley and Scofield Reservoir sites were continued; data was collected for use in design of Gooseberry Reservoir Dam.

Weber River investigations.—Survey of canal from Hard Scrabble Creek to East Canyon Reservoir was completed and estimates begun.

UTAH-IDAHO-WYOMING: *Bear River surveys.*—Surveys of the Woodruff Creek Dam site were completed and of the lower Oneida Canyon site begun. Studies of water table, ground water conditions, and return flow in Idaho were in progress.

Colorado River Basin.—Land classification work was in progress in Green River Basin, Wyo., and in Little Colorado River and William River Basins in Arizona; and a report of the land classification of entire basin was prepared. Surveys were begun of Bullshead Dam site on Colorado and Alamo site near Aquila on Williams River. Water supply studies were made of Little Snake River and Elkhead River watersheds. Reconnaissance was made in San Juan River Basin, Colorado-New Mexico, of several diversion canals. In Utah, survey of Dewey Reservoir was continued, and surveys of Dry Fork Canyon Reservoir completed. Studies of power market in the general vicinity of Salt Lake City were continued and preliminary report commenced. Water supply studies were continued in Wyoming and a report prepared on the rehabilitation of Boulder Lake Reservoir. A comprehensive index of Colorado River data is in course of preparation.

Boulder Habitat of Birds

A TOTAL of 210 different birds have been found in the Boulder Dam Recreational Area by the National Park Service, according to a recent news item. The Boulder area lacks only 10 of reaching the record claimed by Yellowstone National Park, with a total of 220, the highest reported for any national park.

4-H Club Active on Belle Fourche Project

4-H CLUB lamb feeding has been again in evidence on the Belle Fourche project as a means of educating the youngsters and farmers in this line of industry. Each of the boys had 15 lambs, which were kept on feed until the latter part of January and then were judged and shipped to market.

Northern California Chapter A. G. C. To Meet in San Francisco

SAN FRANCISCO is to be host from March 6 to 11, inclusive, of the twentieth annual convention of the Associated General Contractors of America, and the organization will then experience first-hand that great city's world-famed hospitality in action. These 6 days in San Francisco have been designated "Associated General Contractors of America Week," and during this period San Francisco will also be the scene of the American Road Builders' Association National Exhibit and Road Show; the Annual Convention of the Western Association of State Highway Officials, representing the 11 western States; and the annual convention of the National Equipment Distributors' Association.

In addition to the scheduled conventions in San Francisco, an invitation has been extended to the Canadian Construction Association to participate in the A. G. C. convention activities in San Francisco, and it is expected that large delegations from Toronto, Montreal, and Vancouver, British Columbia, will be in attendance. The construction industry of the Hawaiian Islands also is sending a representative group, looking toward the establishment of a territorial chapter during the convention. Also in attendance will be many outstanding national figures, including high cabinet and other governmental officials and industrial leaders. Many of these guests will bring messages of vital importance to the construction industry of America.

During the convention there will be general sessions devoted to various problems of the construction industry. These will include labor relations, national legislation, public works construction, industry cooperation, revival of private construction, and many other timely and important subjects. There will be special sessions of bridge and dam contractors, heavy construction and railroad contractors, highway contractors, and building contractors.

Numerous conducted tours of inspection are being planned for the visitors during the convention period, including such monumental structures and engineering wonders as Boulder Dam, the Central Valley water project, Grand Coulee Dam, and many other smaller but equally interesting projects.

Transportation and Accommodations

For the information of those who contemplate visiting this convention, which will be held during the Golden Gate International Exposition—California's widely heralded World's Fair—special provisions have been made for the transportation and accommodation of tourists as follows:

Special convention rates from all parts of the United States have been arranged, by rail, air, and steamship lines, with liberal stopover privileges either en route to or returning from San Francisco. At the same time the national offices of the Associated General Contractors have announced a special Santa Fe train, leaving Chicago on the evening of March 1, and arriving in San Francisco on March 5 at 4 p. m. The convention special will make two 1-day stopovers, the first at Santa Fe and the second at Grand Canyon. Chapter groups desirous of availing themselves of this facility are urged to communicate with the national offices as soon as possible in order that the necessary space arrangements may be made.

In order to facilitate the departure of the convention special and for the accommodation of A. G. C. members en route for San Francisco via Chicago, convention headquarters have been established at the Palmer House. A staff will be on hand to aid in making rail, air, and hotel arrangements and to otherwise assist members bound for San Francisco.

The Pacific Northwest branch of A. G. C. also is sponsoring a special train out of Portland, Oreg. This train will be routed via Southern Pacific Lines. Those desirous of traveling to San Francisco from the Northwest or from eastern points via Northwest may arrange their itineraries so as to connect with this train.

Travelers by automobile will find no difficulty west of Chicago. The central route, via Denver, Cheyenne, Salt Lake City, Reno, and Sacramento, is kept open throughout the year. The road is paved the entire way and is in excellent condition. All southern routes into Los Angeles via Texas, New Mexico, and Arizona are ideal during the months of February and March, and offer appropriate alternate routings going to and returning from the convention, thus providing a wide diversity of scenic attractions.

Routings between San Francisco and the Pacific Northwest, especially the scenic Pacific Highway, are open throughout the year and are in splendid condition. This holds true with respect to the Northwest route, traversing Montana and the Dakotas.

Motorists making the trip to San Francisco by steamship from New York, via the Panama Canal, may find it convenient to carry their autos with them at a comparatively reasonable expenditure. This will enable them to drive home by any route they may choose at the conclusion of the convention.

Articles on Irrigation and Related Subjects

(*Continued from page 27*)

TOWL, ROY N.

Skew profiles, diagram North Platte River dams, Civil Engineering, January 1939, vol. 9, p. 39.

WARING, GERALD C.

Wells on the public range, illus., Engineering News-Record, December 15, 1938, vol. 121, pp. 757–758.

WEED BURNING

Weed burning continues on canals of Salt River project in Arizona, Western Construction News, November 1938, vol. 13, p. 399.

WEYMOUTH, FRANK E.

Biography, honorary member of American Society of Civil Engineers, Civil Engineering, January 1939, vol. 9, pp. 58–59.

WHITAKER'S ALMANACK

Almanack of 1939. London, England, 1,096 pp. Account of Bureau of Reclamation, p. 916.

WINTER, I. A.

The 115,000-hp. turbines at Boulder Dam (Part 2) illus. and inset, Engineering, London, November 25, 1938, vol. 146, No. 3802, pp. 608–610, Part 3. December 9, 1938, No. 3804, pp. 669–671 and inset; December 16, 1938, pp. 693–695.

YOUNG, H. W.

Giant steel trestle erected in 90 days, illus., Contractors and Engineers Monthly, December 1938, pp. 1, 21, and 32.

W. I. Swanton, Engineering Division

Yuma Cotton

PICKING of cotton was continued throughout the month of December without interruption. A total of 1,478 bales was ginned on the project during the month, of which 45 bales were from the Gila Valley. The total ginned for the season to the close of the year was 4,405, of which 201 were from the Gila Valley.

Belle Fourche Crops

THE crop summary for 1938 shows results slightly above the 10-year average, with 40,612 acres actually irrigated and per-acre returns up to $22.18. This favorable showing is due principally to a good beet crop that averaged 12.3 tons per acre, equal to the former high mark set in 1930.

Early in December the sugar company distributed the final payment to project farmers for beets, the crop having a total value, including tops, of $407,000.

Dams Completed During Past Five Years

ON NOVEMBER 23, 1938, Commissioner of Reclamation John C. Page reported to the Secretary of the Interior completion of Fruit Growers Dam, on Alfalfa Run near Austin, Colo.

Fruit Growers Dam, 53 feet high and 1,500 feet long at the crest, is an earth- and rock-fill structure, constructed at a cost of $200,000 for the storage of 4,100 acre-feet of water for use by fruit growers and farmers on 2,050 acres of highly developed lands lying just downstream. It replaced an old dam, built by the irrigators in 1898, which was breached and failed during a flood on June 13, 1937.

Completion of Fruit Growers Dam brings to 14 the number of water conservation and storage dams commenced and completed by the Bureau of Reclamation since it undertook an expanded program of construction in 1933 with allotments of funds from the Public Works Administration.

Fruit Growers Dam was started this year. Its costs, like that of other reclamation structures, are to be returned to the United States in 40 years by payments from the water users.

The farming area served by this structure is old and was highly developed. It was entirely dependent for its irrigation water supply on the dam which failed 17 months ago. The unregulated flow of the stream upon which the irrigators rely is inadequate to their needs. Faced with loss of their orchards and crops, these farmers were in a critical situation after the 1937 flood. Immediate reconstruction of an adequate dam was essential. The new dam will be able to store water for their farms next season.

Other dams begun and completed in the past 5 years are:

CALIFORNIA: *Imperial Dam*, a concrete structure in the Colorado River, 350 miles below Boulder Dam, is 45 feet high and 3,430 feet long. The cost including desilting works and the Gila Canal headworks, was approximately $7,500,000. It was completed in 1938 to serve as the diversion structure for the All-American Canal, serving the Imperial and Coachella Valleys in California, and the Gila and Yuma Federal reclamation projects in Arizona.

Parker Dam, a concrete structure 322 feet high and 800 feet long in the Colorado River 155 miles below Boulder Dam, costing approximately $8,800,000, serves as a means of diverting water for the Metropolitan Water District of Southern California, and for generation of power for the Gila project pumps. It was completed in 1938.

COLORADO: *Taylor Park Dam*, on the Taylor River above Altmont, Colo., 206 feet high and 616 feet long at the crest, is an earth- and rock-fill structure, creating a reservoir holding 106,230 acre-feet of water to supplement the supply of the Uncompahgre project. It was completed in November 1937 at a cost of about $1,350,000.

NEVADA: *Rye Patch Dam*, an earth- and rock-fill dam 75 feet high and 850 feet long at the crest, was completed in 1936 at a cost of about $600,000, to create a reservoir of 179,000 acre-foot capacity for provision of an adequate and reliable water supply for lands of the Humboldt project.

NEW MEXICO: *Alamogordo Dam*, an earth- and rock-fill dam 142 feet high and 2,900 feet long at the crest, including an abutting dike, was completed in 1938 at a cost of about $1,800,000. It has created a reservoir to store 157,000 acre-feet of water, providing a reliable supply for the Carlsbad project. Alamagordo Dam was built in the Pecos River, near Fort Sumner.

Caballo Dam, on the Rio Grande below Elephant Butte Dam, was completed in 1938. It is an earth- and rock-fill structure 90 feet high and 4,250 feet long at the crest. Its cost was about $1,300,000. This dam serves to re-regulate the river below Elephant Butte, permitting power generation there; as a feature of the river rectification program of the International Boundary Commission; and to store additional water for the Rio Grande project.

OREGON: *Agency Valley Dam*, an earth- and rock-fill dam on the Malheur River, 93 feet high and 1,746 feet long, was completed in 1936, creating a reservoir to hold 60,000 acre-feet of water and to irrigate lands of the new Vale project. It cost $840,900.

Unity Dam, principal structure of the new Burnt River project, was completed in 1938. It is an earth-fill structure, rock faced, 78 feet high and 300 feet long, costing about $600,000.

UTAH: *Hyrum Dam*, on the Little Bear River, is an earth-fill structure, 90 feet high and 520 feet long, storing 18,000 acre-feet of water for the Hyrum project. It was completed in 1935 at a cost of $568,000.

Moon Lake Dam, an earth-fill structure 110 feet high and 1,120 feet long, was completed in 1938 at a cost of about $1,150,000. It will store 30,100 acre-feet of water.

Pine View Dam, an earth-fill structure in the Ogden River, is 100 feet high and 541 feet long. It was completed in 1937 at a cost of about $1,460,000. It has created a reservoir holding 41,830 acre-feet for use on lands of the Ogden River project.

WYOMING: *Bull Lake Dam*, on Bull Lake Creek, is an earth-fill dam, 75 feet high and 3,400 feet long which was completed in 1938 at a cost of about $911,000. It will store 150,000 acre-feet of water for the Riverton project.

Alcova Dam, the diversion structure for the Kendrick project, was completed in 1938 at a cost of about $2,616,000. It is an earth-fill dam, rock faced, 256 feet high and 900 feet long. Its reservoir has a capacity of 180,000 acre-feet.

Important Conventions Held at Phoenix

PHOENIX, ARIZ., headquarters of the Salt River project, was host in December to three important conventions that dealt with the problems of the western irrigation States. The eleventh annual convention of the Association of Western State Engineers met December 8–10. There were papers and discussions on State control of Federal construction projects, interstate compacts, Federal claims to unappropriated waters, the need for correlation among Federal and State agencies in studying and developing water resources, and some technical problems of stream run-off and transportation losses of reservoir water over long distances.

The Colorado Drainage Basin Committee of the National Resources Committee met on December 12 and 13 with representatives of seven States attending. A discussion of the "present status of water planning in the Colorado Basin" was engaged in by the representatives of the States, the Army engineers, the Departments of Agriculture and Interior, the Federal Power Commission, and other agencies.

A follow-up to this committee's work was a meeting of the Basin States Committee of Fourteen, which was held on December 14–18 with a membership made up of representatives to the above Drainage Basin Committee. This committee reached agreement as to changes in the Boulder Canyon Project Act which Congress will be asked to make. The principal recommendations are that the rate of firm power generated at Boulder be reduced from 1.63 mills to approximately 1 mill per kilowatt-hour; that Arizona and Nevada accept a yearly payment to each of $300,000 until 1987 in lieu of the 18.75 percent of excess power revenues allotted to them in the Boulder Canyon Project Act; and that a special yearly fund of $500,000 to be set aside from power revenues shall be used first for a 3-year survey of the entire basin and shall then be used in the upper basin States for the 12 years following, or until 1955, after which it may be used any place in the basin.

Recommendations were also made that amortization of the $25,000,000 of Boulder's cost charged to flood control be postponed until the balance of the cost shall be amortized, or until 1987, without interest; and that interest on the balance of the cost be cut from 4 to 3.5 percent or less.

Green Mountain Dam, Colorado-Big Thompson Project

THE Green Mountain Dam, a 270-foot structure under construction on the Blue River in Colorado, about 10 miles above the mouth and 16 miles southeast of Kremmling, will be the second highest and largest earth and rock-fill dam in the United States and will form a reservoir with a capacity of 152,000 acre-feet, covering an area of 2,100 acres. This dam will be an important feature of the Colorado-Big Thompson project, the function ot which is the diversion of surplus waters from the headwaters of the Colorado River on the western slope of the Continental Divide to provide a supplemental supply for 615,000 acres on the eastern slope in northeastern Colorado.

Green Mountain Dam, Colorado-Big Thompson project, Colorado

Dams Under Construction

Percent of completion, December 31, 1938

Project	Dam	Percent
Salt River, Ariz	Bartlett	92
Central Valley, Calif	Shasta	6
Colorado-Big Thompson, Colo	Green Mountain	1
Pine River, Colo	Vallecito	26
Boise, Idaho	Twin Springs	0
Upper Snake, Idaho	Grassy Lake	67
Milk River, Mont	Fresno	61
Truckee Storage, Nev	Boca	81
Tucumcari, N. Mex	Conchas [1]	82
Deschutes, Oreg	Wickiup	0
Colorado River, Tex	Marshall Ford	81
Moon Lake, Utah	Duchesne Diversion	7
Provo River, Utah	Deer Creek	30
Columbia Basin, Wash	Grand Coulee	38
Yakima, Wash	Roza Diversion	35
Kendrick, Wyo	Seminoe	96

[1] Under construction by the War Department.

Irrigation Farmer Honored

BY NAMING him "Eminent Farmer" the State College of South Dakota has formally elevated August Maass to a position among the State's notable citizens. Each year State College so distinguishes two outstanding farmers.

A well-known farmer and stockman of the Horse Creek Country, 20 miles east of Belle Fourche, Mr. Maass is a leader in all the movements to advance the interests of the irrigated area. Starting as a cowboy in northwestern South Dakota, he rode range until the big outfits disappeared from his home prairies. He meanwhile built himself a ranch and added to his herd of cattle. When the Belle Fourche Federal irrigation project was completed he devoted his time to his stock business with a small amount of farming on the side.

Sheep feeding on farm of August Maass

Since construction of the Belle Fourche project he has served as director of the irrigation district board and director of the Black Hills Beet Growers' Association, and has represented both of these groups at national meetings on many occasions. His interests and activities include also chairmanship of the board of trustees of the Lutheran Church and officership of the Odd Fellows Lodge, the Western South Dakota Lamb Feeders' Association, and the Patrons' Oil Co.

Yuma Lettuce Excellent

SHIPMENTS of lettuce from the Yuma project averaged 12 carloads per day during December. The quality this season has been excellent. The first car was shipped on December 5.

Reclamation Organization Activities

Secretary Ickes and Commissioner Page in West

SECRETARY ICKES left Washington for the coast the second week in February. He will be joined there by Commissioner Page. Conferences will be held at San Francisco and Fresno on national park and reclamation matters.

Assistant Commissioner Williams Returns to Washington

ASSISTANT COMMISSIONER WILLIAMS returned from California the morning of February 9, and during the absence of Commissioner Page is Acting Commissioner.

Wesley R. Nelson Speaks at Cosmos Club

WESLEY R. NELSON, Chief of the Engineering Division, gave an illustrated lecture on the Bureau's construction work, at the regular meeting of the Washington Society of Engineers, which was held on February 15 at the Cosmos Club in Washington.

Mr. Nelson was the dinner guest of the society prior to the meeting. In his talk he discussed the work now under way on the Grand Coulee Dam, the All-American Canal, the Parker Dam, and the Bartlett Dam.

H. W. Bashore in Washington

H. W. BASHORE, Construction Engineer of the Kendrick project, Wyoming, arrived in Washington the second week in January for some special work in connection with his official duties.

J. S. Moore Returns to Yakima

J. S. MOORE, Superintendent of the Yakima project, Washington, has returned to his official station after a month's stay in the Washington office.

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been authorized by the Secretary of the Interior:

Appointments

Washington office:

Senior attorney: Ivan A. Schwab, detailed from Office of the Solicitor.

Denver office:

Assistant engineers: Thomas G. Owen and Kermit K. Young.

Junior engineers: Ezio Rock, Joseph D. Zwahlen, Lowell H. Erickson, and Harold A. Black.

Central Valley:

Associate attorney: William W. Buchtel.

Assistant attorney: Edward L. Edmundson.

Assistant engineers: Mikael S. Nielson and Paul T. Ragle.

Junior engineers: Ramon M. Whann and Howard A. Stoddard.

Columbia Basin project:

Junior engineers: William C. Trude, Jr., Hiram De Puy, Jr., Calin H. MacDonald, Clifford D. Lawrence (vice Leighton W. Johnson), Athol C. Garing, Kenneth E. Tilton, Stanley J. Bohman, and Fred M. Goldsworthy.

Colorado River Basin Investigation:

Junior engineer: E. Richard Anesi.

Buffalo Rapids:

Associate engineer: Joseph Talla.

All-American Canal:

Junior engineers: John E. O'Fallon, Paul A. Oliver, Donald A. Gray, Chas. F. Keeler, and Gilbert A. Fitch.

Sun River:

Assistant engineers: Thos. J. Looney and Fred C. Walker.

Boulder Canyon:

Junior engineers: Robert P. Sedgwick and Paul W. Rothi (A. A. C.).

Pine River:

Assistant engineer: Evan W. Parry.

Ft. Peck Investigations:

Junior reclamation economists: F. Elmer Foutz and Edward K. Daniels.

Rio Grande:

Senior engineer draftsman: Frank J. Gago (vice Leon L. Batson).

Tucumcari:

Chief of field party: Laren Coleman Matthews.

Shoshone, Heart Mountain division:

Junior engineers: Gordon H. Brodrick, Allan W. Holliday, and Allan G. Love.

Provo River:

Junior engineers: Rex L. Greenhalgh and O'Dean Anderson.

Yakima:

Junior engineer: James J. Robertson (vice Garland S. Tinsley).

Colorado-Big Thompson:

Consulting engineer: Carl R. Rankin.

Parker Dam:

Reservoir superintendent: Boyd E. Coffey.

Transfers

To Denver:

Associate engineer: Fred H. Nichols, Marias project investigations with headquarters at Denver, formerly at Shelby, Mont.

Junior engineer: Julius S. Conrad, from Upper Snake River project.

To Central Valley:

Junior engineer: John S. Hamilton, from Denver.

To Columbia Basin:

Senior engineer: Horace A. Parker, from construction engineer, Upper Snake River project.

To Rio Grande:

Assistant engineer: Chas. F. Palmetier, Jr., from Denver.

To Colorado-Big Thompson:

Associate engineer: Glenn G. Walter, from Boulder Canyon project.

To Eastern Slope Surveys:

Junior soils technologist: Keith E. Davis, from Green River-Bear River investigations.

To Deschutes:

Chief Clerk: Noble O. Anderson, from Yuma, Ariz.

Separations

Denver office:

Junior engineer: Lewis H. Austin.

Columbia Basin:

Assistant engineer, Olaf W. Lindgren.

The resignations of these employees were accepted without prejudice.

Klamath Turkeys

BETWEEN December 17 and 22 there was a rapid increase in the price of turkeys on the Klamath project, the price advancing from 21 cents to a top of 31 cents per pound, and the entire turkey crop of 25,000 to 30,000 birds was disposed of.

Energy Sold to Contractors, 1938

Month	Total kilowatt-hours sold	Month	Total kilowatt-hours sold
January	135, 227, 190	July	113, 216, 700
February	127, 518, 780	August	120, 823, 370
March	115, 863, 820	September	123, 303, 690
April	122, 512, 020	October	130, 704, 560
May	117, 632, 130	November	131, 667, 300
June	109, 652, 138	December	147, 771, 163

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

John C. Page, Commissioner — Roy B. Williams, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; D. S. Stuver, Asst. Gen. Supr.; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Chief, Mails and Files Division; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

R. F. Walter, Chief Eng.; S. O. Harper, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts; L. S. Davis, Engineer, C. C. C. Division

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal [1]	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr.	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr.	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Denver, Colo.	Porter J. Preston	Supervising engr.	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr.	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Constr. engr.	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr.	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Lovelock, Nev.	Stanley R. Marean	Superintendent	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo.	H. W. Bashore	Constr. engr.	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr.	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Pine River	Bayfield, Colo.	Charles A. Burns	Constr. engr.	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah
Provo River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr.	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. C. Koppen	Constr. engr.	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr.	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr.	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt.		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr. [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr.	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Noble O. Anderson	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Fuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River, Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	V. W. Russell	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler and P. J. Preston	Senior engineers.
King's River-Pine Flat (Calif.)	Fresno, Calif.	S. P. McCasland	Associate engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo.	A. N. Thompson	Engineer.
Gallatin Valley (Mont.)	Denver, Colo.	W. G. Sloan	Engineer.
Marias (Mont.)	Denver, Colo.	Fred H. Nichols	Associate engineer.
Canton and Fort Supply (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo.	J. R. Iakisch	Senior Engineer.
Black Hills (S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Salt Lake Basin (Utah)	Provo, Utah	E. O. Larson	Construction engineer.

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THE DESERT RECLAIMED. DATE, CITRUS, AND PECAN GARDEN

THE RECLAMATION ERA

MARCH 1939

MARTIN FALLS AND THE DEVIL'S PUNCH BOWL
UPPER GRAND COULEE, COLUMBIA BASIN PROJECT, WASHINGTON

NATIONAL RIVERS AND HARBORS CONGRESS

The annual convention of the National Rivers and Harbors Congress convenes in Washington, D. C., March 23 and 24, at the Mayflower Hotel. The Bureau of Reclamation is asked to contribute to the activities of the convention again this year. On March 23, I plan to address the group on the subject of the Multiple Purpose Project.

This year "Reclamation atmosphere" will be furnished by an exhibit featuring the Columbia Basin project. A large model of the Grand Coulee Dam will be installed in the exhibit space and this will be supplemented by photographs of the project arranged in such sequence and with such titles as to give a good running story of what the project involves and what its progress is to date.

These annual meetings are fine opportunities for the exchange of information in the conservation group.

John C. Page, *Commissioner.*

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • MARCH 1939 • NUMBER 3

The Grand Coulee of the Columbia

By S. E. HUTTON, *Assistant Director of Information, Coulee Dam, Washington*

"THIS is the deathbed on which Pluvius writhed and agonized in the last throes of desolation, before departing this vale of tears, that now lies there so placidly in the Chalice of the Gods at your feet," says the poetic caretaker at the Dry Falls State Park in central Washington, as he introduces to visitors, with a sweep of his arm toward the 400-foot abyss at the foot of the Dry Falls, the Grand Coulee, most spectacular of the remaining geological phenomena that are accountable for the Columbia Basin Reclamation project.

The history of the project really goes back not just a few years, nor a few thousand years to the creation of the Grand Coulee and the Dry Falls, but several million years, to the beginning of a series of lava flows that issued from great fissures in the surface of the earth, and built up the Columbia Lava Plateau.

At least seven such great lava flows occurred. Some of them were separated thousands of years from their predecessors and their successors. Soil technologists are of the opinion that nature takes 100 to 1,000 years to form an inch of soil. In some cases, so much time elapsed between successive lava flows that deep soil was formed, and a variety of trees grew to great size, only to be destroyed by new flows of lava. Much of this story has been read by geologists from the walls of the Grand Coulee.

With respect to the Columbia Basin project, there were at least two significant consequences of the lava floods—the extensive Columbia Lava Plateau, part of which is to be irrigated under the project, replaced low land and great bodies of water, and the Columbia River, source of the water and the power required for the project, was forced out of its short course from the Colville Valley southwestwardly toward the Columbia Gap in the Cascades, and into the Big Bend, where it cut a 1,600-foot gorge between the lava plateau and the older rocks of the Okanogan Highlands and the Cascade Mountains.

Early Glaciers Close River Canyon

All that happened long before man came upon the earth.

Many thousands of years ago, when man was, mentally, a rather primitive animal, and but little advanced toward civilization, a great ice cap covered the northern part of the continent. Twice, at least, arms of the great glacier were pushed down the Okanogan Valley and across the Columbia River Gorge, closing the canyon and forming a glacial lake extending far back toward the headwaters of the stream.

Overflowing to the southward, tremendous floods of glacial water swept away soil and cut rugged channels in the surface of the lava plateau. Scabland areas, observable in many places along roads west of Spokane, are such old water courses, the greatest of which is now known as the Grand Coulee.

Water, filling the river canyon, backed up in Rattlesnake Canyon, near the site of the dam, spilled over a divide about 15 miles south of the river into the channel of a small stream which originated on the Waterville Plateau and flowed off to the southwest. North of Coulee City and near Soap Lake, rapids were formed at declivities in the distorted lava plain. They developed into waterfalls, which cut the wide, deep upper and lower Coulees, the latter terminating at the awe-inspiring Dry Falls, and the former at the Columbia River Canyon, which it intersected 600 feet above the bottom of the gorge.

Two or more advances of the Ice Cap seem to account for the creation of the Grand Coulee. The so-called Spokane Ice Lobe appears to have closed the Spokane River and the Columbia above its junction with the Spokane River, while another lobe at the same time occupied the Okanogan Valley, closed the Columbia from the vicinity of the dam site westward to some point above Chelan, and covered the northwestern part of the Waterville Plateau as far south as Mansfield. The San Poil Valley and the Columbia from the dam site eastward to the Spokane River remained open. During this period of many thousand years, the erosion of the upper Coulee and of the greater part of the lower Coulee was accomplished.

Subsequently, the Okanogan Lobe, after releasing the river for a period, again advanced, 4,000 feet in thickness, closed the river and covered the Waterville Plateau from the west wall of the upper Coulee to a point on the river below Chelan. During this last phase of the Ice Cap, the Dry Falls advanced about 3 miles to their present location, and the channel on the southeast side of Steamboat Rock was probably formed or enlarged. Striations on the top of Steamboat Rock indicate that the channel on its northwest side was closed by the later ice advance. Drainage from the Okanogan Lobe created Moses Coulee, and the disappearance of the ice sheet left moraines and "haystack" rocks—huge blocks of basalt—which are outstanding features of the Waterville Plateau.

While the river canyon was blockaded by the Ice Cap, below the Grand Coulee, finely ground rock and sand and gravel carried in by streams and boulders dropped by floating icebergs filled the canyon to a depth of several hundred feet. Terraces along the canyon walls are the remains of such deposits. One of them, nearly a thousand feet above the river, is the source of sand and gravel for the dam.

When the upper Coulee intersected the river canyon, great quantities of material deposited in the canyon were swept out through the Coulee, some of it to be carried to the sea. Though the ice dam disappeared many thousands of years ago, the river has not yet succeeded in carrying away all of the rock flour dropped in the glacial lake that so long occupied its valley. At the site of the dam, it was necessary to remove 20 to 70 feet of hard clay from granite bedrock which before the Ice Age was the site of rapids in the river.

The Upper Grand Coulee is about 25 miles long, 1½ to 5 miles wide, and 800 to 900 feet deep. In it will be formed, by two earth dams, a balancing reservoir that will occupy practically its entire length. The outstanding landmark of the upper Coulee is Steamboat Rock, a remnant of the lava plateau, 2 miles long and three-quarters of a mile wide, standing in midchannel near the upper end of the Coulee. It was left, apparently, when a channel already eroded on its right side was blockaded by the last advance of the ice cap while a relief channel was cut on its left. Some geologists have been of the opinion that the two channels were cut simultaneously by a tremendous volume of water tumbling over 800-foot twin cataracts with a combined width of 5 miles.

In the Coulee above Steamboat Rock and in the channel on its left are numerous rounded granite hills. They are the tops of foothills or low mountain peaks in an arm of the Okanogan Highlands, which were submerged millions of years ago by the floods of lava that formed the Columbia Lava Plateau, and were exposed later by erosive waters from the Ice Cap thousands of years ago. On this granite spur rests the Coulee Dam, at the bottom of the canyon cut across it by the river before the last Ice Age.

The upper Coulee was eroded in a terrace of the lava plateau elevated about 900 feet above the next similar terrace by the forces that raised the Okanogan and Cascade Mountains. About 25 miles from the river, the Coulee walls slope downward about 800 feet in a mile to the level of the Hartline Basin. These sloping walls are sections of the Coulee Monocline, the inclined bend in the lava beds between the high Waterville Plateau and the lower Hartline and Quincy Basins. Torrents of abrasive turbid glacial water pouring down this slope developed rapids that grew into the stupendous waterfall which by headward erosion created the upper Grand Coulee.

Lower Coulee

Water, pouring out of the upper Coulee, spread out and laid down deep deposits of gravel, sand, and silt over an area of 50 square miles in the Hartline Basin, a minor structural depression bounded at the southwest by High Hill and Pinto Ridge. Overflowing these, the flood cut deeply into the rim of the basin five canyons, one of which finally drained the Hartline Basin almost completely through a channel which became a part of the lower Coulee. Large scabland areas and numerous canyons east of the lower Coulee mark the intricate paths of the earlier outlets of the Hartline Basin. Through this deeply channeled district will some day pass the main canal and parts of the east and west canals of the Columbia Basin reclamation project.

Erosion by the 400-foot waterfall that originated in one of the outlets of the Hartline Basin, cut, as a part of the lower Grand Coulee, a 17-mile box canyon to the northeast, 13 miles of it along the Coulee Monocline, leaving on the west side walls nearly 900 feet high and in the lakes that now occupy much of the lower Coulee islands showing the downward southeasterly pitch of the lava beds in these remnants of the Coulee Monocline.

Four beautiful lakes, fed meagerly by thawing snows, occupy the greater part of the lower Coulee, which is traversed by a hard-surface highway. Park Lake, at the upper end of the lower Coulee, and Blue Lake, next below it, are fresh water lakes much used for water sports. Long, narrow Lake Lenore is alkaline; and Soap Lake, last in the chain, having no outlet, is highly mineralized. It is the site of numerous health and pleasure resorts.

Between lava beds in the Coulee walls, geologists and others have found fossil leaves and tree trunks of great variety. Fossils of plant species, now found only in humid climates or in semitropical parts of the world, give evidence of the mild and humid climatic conditions that existed before the rising Cascade Mountains so greatly reduced rainfall in central Washington that a once verdant country is now a desert.

The lower Coulee opens into the Quincy Basin, where a lake covering an area of 250 square miles was formed. In it, gravel, sand, and silt were deposited to depths as great as 500 feet. Part of the area to be irrigated by the Columbia Basin project lies in the bed of this ancient lake, which disappeared when its overflowing waters, cascading into the Columbia River Canyon at three points to the west, eroded side canyons to levels below the lake bottom. The highway to the Vantage Bridge descends one of these side canyons of the Columbia.

Dry Falls

Dry Falls, head of the lower Coulee, is in the horizontal lava beds of the Hartline Basin which have their westerly end at the foot of the Coulee Monocline. Visitors ordinarily see but a small part of the 5-mile brink of this group of ancient cataract sites. From a vista house near the public highway, there is available an excellent view of two huge alcoves with little lakes filling the plunge pools at their feet. A third may be seen at a distance, and beyond it a long canyon extending off to the east and having within it Deep Lake, a body of fresh water a mile and a half long, accessible by road from the public highway in the lower Coulee. Spectacular potholes in the lava floor of the Coulee testify to the terrific force and erosive power of the falling glacial flood.

The cataract at Dry Falls was two and a half times as high and five times as wide as Niagara, and higher than and three times as wide as the greatest existing cataract, Victoria Falls, in Africa. The only fall known to have exceeded it in magnitude was that which created the upper Coulee.

The waters that cut the Grand Coulee and numerous minor channels out of the Columbia Lava Plateau overflowed the Columbia

(Continued on page 48)

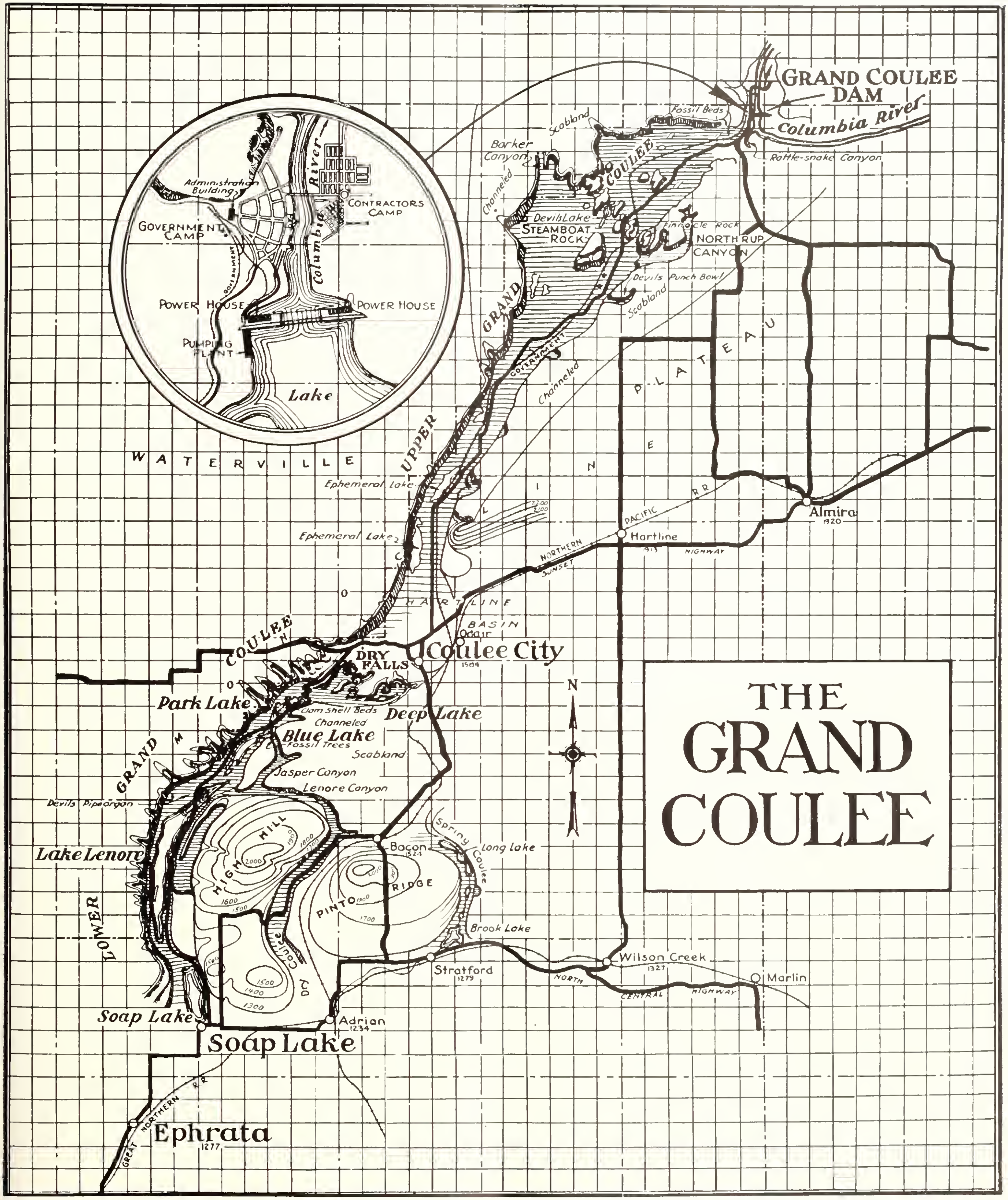
THE MAP on the opposite page, shows by shaded lines, the high vertical walls of the upper Coulee and the high west wall of the lower Coulee. The low east wall of the lower Coulee, and similar vertical walls of canyons tributary to it are shown by similar lighter lines. A few contour lines give a general idea of the topography of certain localities of special interest.

There should be observed particularly the Waterville Plateau, which occupies the upper and the left-hand parts of the map, and the Coulee Monocline, a slope connecting the high Waterville Plateau and the lower Hartline and Quincy Basins. It extends diagonally across the country southwesterly from the vicinity of Hartline and the lower end of the upper Coulee. It lies to the west of the Dry Falls, is lost in the lower Coulee, and reappears in the hills northwest of Ephrata. Note that the upper Coulee was cut in the Waterville Plateau, from the Coulee Monocline (near the center of the map) northeasterly to the canyon of the Columbia River, indicated in the upper-right-hand corner of the map.

When an arm of the Cordilleran Ice Cap blockaded the Columbia River below the dam site, back water filled the river canyon and overflowed to the southwest in a stream 10 miles wide at its origin. The course of that stream covered the site of the upper Coulee and the areas east and west of it represented as scabland. As the upper Coulee was cut out by the headward erosion of a waterfall which originated where the water plunged down the Coulee Monocline, side streams flowed into the upper Coulee at numerous points along the east wall and along the upper 10 miles of the west wall. In the spring, run-off from the plateau enters the coulee through many ancient stream beds.

Water issuing from the upper Coulee spread over the Hartline Basin, bounded on the northwest by the Coulee Anticline and at the southwest by the High Hill and Pinto Ridge Anticlines. Outlets from the Hartline to the Quincy Basin were eroded east of Pinto Ridge, between it and High Hill, and along the Coulee Monocline. Erosion was greatest in the channel in the broken rock of the Coulee Monocline, and it finally drained the more easterly channels as the waterfall formed at its southerly end progressed toward its destination, the Dry Falls. Thirteen miles of the lower Coulee are in the Coulee Monocline. Two deep canyons and many hanging valleys connect the lower Coulee with older water courses to the east. About 3 miles north of Soap Lake, on the east side of the Coulee and along the west side of High Hill, is a wide hanging valley entering from the north, wherein a great stream once flowed in a syncline below the Coulee Monocline.

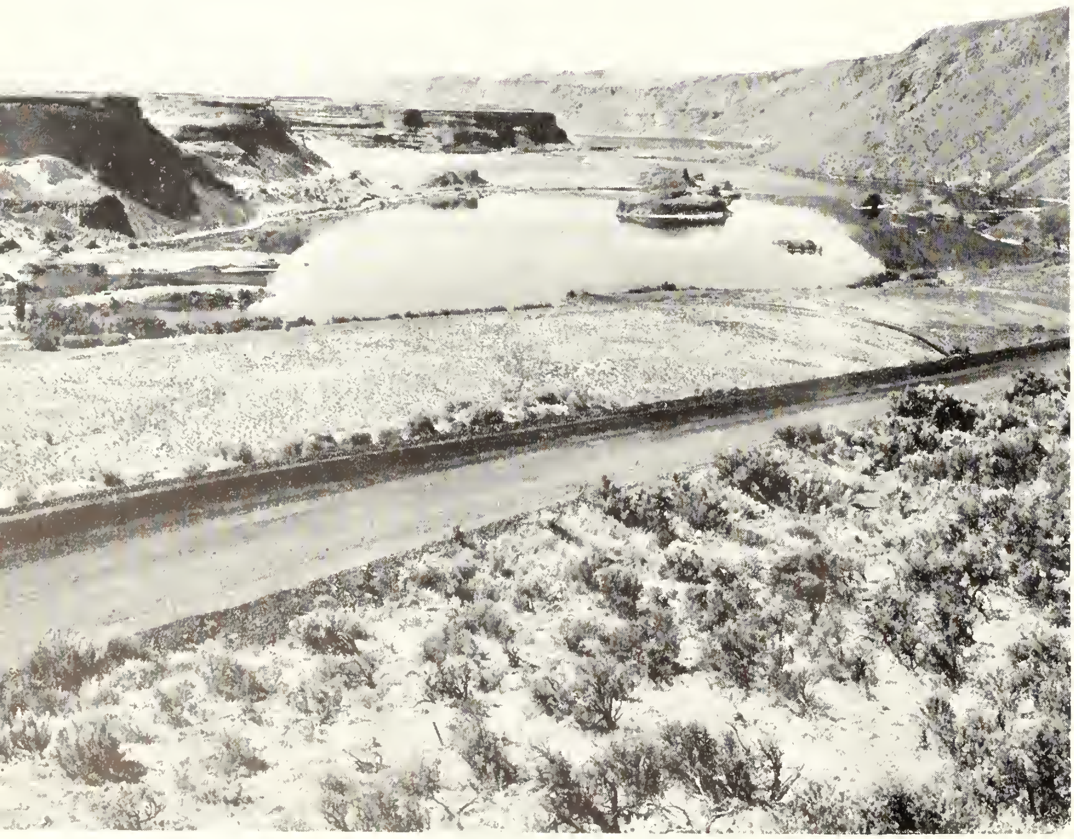
Gravel bars show that currents were reversed in many of the side canyons, and that the erosion of the lower Coulee and the scabland east of it was the result of a very complex series of events covering a long period.



THE GRAND COULEE
GRAND COULEE DAM
Columbia River
Fossil Beds
Scabland
Barker Canyon
Rattle-snake Canyon
Channeled
Devils Lake
Steamboat Rock
Pinnacle Rock
Northrup Canyon
Devils Punch Bowl
Administration Building
Contractors Camp
Government Camp
Power House
Pumping Plant
Lake
Waterville
Plateau
Upper Grand Coulee
Ephemeral Lake
Hartline
Almira
Northern Pacific R R
Sunset Highway
Hartline Basin
Odair
Coulee City
Dry Falls
Park Lake
Deep Lake
Clam Shell Beds
Blue Lake
Fossil Trees
Jasper Canyon
Lenore Canyon
Devils Pipeorgan
Lake Lenore
High Hill
Bacon
Long Lake
Spring Coulee
Pinto Ridge
Brook Lake
Lower Grand Coulee
Dry Coulee
Stratford
Wilson Creek
Marlin
North Central Highway
Soap Lake
Adrian
Ephrata
Great Northern R R

STEAMBOAT ROCK

Terraced in a manner that reminded some early explorer of things quite distant and different, this great landmark in the upper Grand Coulee was named Steamboat Rock. In this view from the mouth of Northrup Canyon, one looks across the left channel toward the west Coulee wall and the distant Okanogan Highlands. In the foreground are granite knobs, once the tops of foothills or mountains, later flooded by highly liquid basaltic lava, and subsequently exposed by erosive glacial floods from the Cordilleran Ice Cap. All along the east side, and along the upper 10 miles of the west side of the Coulee, the torrent poured into the Coulee as headward erosion of a great waterfall carved it out. The Ice Cap once covered the plateau on the west side of the Coulee, and it set down huge boulders, locally called "haystack rocks" as it finally melted. It also crossed Steamboat Rock, and it might have caused the erosion of the nearer channel by closing a wider and deeper channel on the farther side of the rock.



THE LOWER GRAND COULEE

Highly fluid basaltic lava, issuing from fissures in the earth's surface millions of years ago in many successive floods, covered an enormous area between spurs of the Rockies and the rising Cascades with many horizontal strata of rock forming the Columbia Lava Plateau. The forces building the Cascade Mountains and the Okanogan Highlands lifted the rim of the plateau at the north and west, and produced the Coulee Monocline, an abrupt southeasterly declivity in the northwest corner of the plateau.

A 13-mile section of the lower Grand Coulee was eroded out of the broken rock in the fold of the Coulee Monocline. Here, in a view down the lower Coulee over Park Lake, the most northerly of its four lakes, there may be seen on the right lava cliffs rising to the northwest as much as a thousand feet above the lakes, and on the left, 500 feet lower, part of the lava plain at the foot of the monocline. Inclined bedding planes, clearly visible in the rugged islands in the lakes, show the pitch of the vanished monocline. Many fantastic canyons enter the Coulee from the left, from a weird and rugged scabland area in a synclinal valley that probably carried the ice cap melt water before the lower Coulee was formed.

THE DRY FALLS OF THE COLUMBIA

Gullible as people seem to be, no visitors to the Dry Falls are ever sufficiently credulous to believe that the lava cliffs before them are really 400 feet high. Here, thousands of years ago, around a perimeter of more than 5 miles, water from the Cordilleran Ice Cap, poured out by the upper Grand Coulee into the Hartline Basin tumbled violently from that basin into the head of the lower Coulee.

At the middle and left of the picture, is the largest of the many alcoves of the Dry Falls. Falls Lake fills its plunge pool. To the right is a second alcove with an alkali lake, or in dry weather an alkali flat at its base. Further to the right are other alcoves and a long canyon extending off to the east and containing Deep Lake, a body of fresh water a mile and a half long. About a mile to the south the outlets from the several alcoves join in a single canyon, the lower Grand Coulee.

From a point 6 miles to the north, where the upper Coulee opens into the Hartline Basin through the Coulee Monocline, a broad strip of scabland extends southwesterly along the east side of the lower Coulee to its southerly end. It was probably the channel of the earlier glacial floods in a synclinal valley southeast of the Coulee Monocline, before the lower Coulee was carved out in the broken rock at the base of the monocline. A part of that channeled scabland is visible above the falls.

SOAP LAKE

At the lower end of the Grand Coulee is a body of alkaline water known as Soap Lake because a high content of sodium carbonate produces on the bank in rough weather a fringe of white foam. In addition to 14 parts per thousand of sodium carbonate, the lake water contains about 6 parts of sodium sulphate, about 5 parts of sodium chloride and small precentages of many other mineral compounds. This high mineral content is the result of the draining of Park, Blue, and Lenore Lakes one into the next, and the last into Soap Lake, which has no outlet.

To the left in the picture is a part of the Pinto Ridge Anticline and further up the Coulee are parts of the High Hill Anticline. Through them, early floods cut numerous channels thousands of years ago as melt water from the Cordilleran Ice Cap overflowed from the Hartline into the Quincy Basin, which is visible in part at the right. Forty cubic miles of hard basalt was cut out to form the coulees, and tremendous quantities of material were brought down from higher points and poured out into Lake Quincy, a prehistoric body of water south of the Grand Coulee that had an area of 250 square miles. On the bed of that ancient lake is some of the land to be irrigated by the Columbia Basin project. Among the interesting features of the Quincy Basin are its flat fertile areas, dunes of lava sands near Moses Lake, and the abandoned cataract sites through which the lake was drained into the Columbia River Canyon at the west, the highway to Vantage Bridge descends one of them.

Widespread Benefits From Grand Coulee Construction

FORTY-FIVE States have contributed their products, and have shared the 46 million dollars spent for materials and supplies for the Grand Coulee Dam. Nearly 12 million dollars of the total were added in 1938, about 5 million by the Bureau of Reclamation and nearly 7 million by the contractor.

There was revealed on February 10 in a report of Commissioner of Reclamation Page to Secretary of the Interior Ickes detailing the wide spread throughout the Nation of regenerative economic, industrial, and employment effects springing from Federal construction of the world's largest dam on the Columbia River in Washington.

To the end of 1937, $21,849,605.73 were spent in pay rolls; and in 1938 the contractor paid out in wages $5,712,740.60 and the Bureau $1,170,081.92, bringing the total for labor to the first of the year to $28,732,328.25, and the total for labor and materials to $74,730,010.93.

The man-hour total of 27,469,743 at the end of 1937 has been increased to 34,192,953, by 5,243,763 man-hours worked by the contractor's employees and 1,479,447 hours put in by the Bureau's workers.

Six eastern States—Alabama, Illinois, Indiana, New York, Ohio, and Pennsylvania—sold from a million to three and a quarter million dollars worth of goods to the project; Minnesota and New Jersey sold nearly a million each; Iowa nearly half a million; and nine other States over two hundred thousand each. Three Western States were large beneficiaries, California through oil sales, Washington and Oregon by selling timber, and all three through their agencies for eastern manufacturers.

The distribution of expenditures by States is shown in the following table:

State	1938	Total to January 1, 1939
Alabama	$1,068,805.91	$1,477,028.69
Arkansas	----------	656.38
Arizona	4,324.51	4,324.51
California	1,428,201.24	3,687,403.01
Colorado	166,211.78	329,818.73
Connecticut	115,344.74	233,215.13
Delaware	10,078.62	208,619.87
Florida	3,000.00	4,536.23
Georgia	4,050.10	11,333.88
Idaho	13,674.51	26,449.94
Illinois	1,127,938.57	3,257,824.88
Indiana	154,465.20	2,294,877.30
Iowa	253,546.74	445,465,96
Kentucky	2,883.05	10,995.51
Kansas	3,217.66	10,999.66
Louisiana	----------	5.40
Maine	6,083.30	9,249.94
Maryland	246,535.47	357,399.73
Massachusetts	45,140.02	166,873.43
Michigan	98,300.64	344,244.78
Minnesota	33,558.95	876,244.78
Missouri	79,945.66	261,001.13
Montana	4,891.51	57,572.65
New Jersey	143,037.03	976,756.13
New Mexico	162.63	162.63
New York	874,205.72	2,603,963.19
North Carolina	3,000.00	5,947.77
New Hampshire	6,000.00	6,170.86
Nebraska	4,937.22	5,184.64
Nevada	10,621.53	12,029.88
Ohio	313,499.89	2,290,921.05
Oklahoma	3,011.43	3,011.43
Oregon	491,234.06	1,293,575.86
Pennsylvania	329,827.27	1,922,794 79
Rhode Island	8,734.21	19,130.45
South Carolina	3,227 23	5,431.40
Tennessee	----------	617.22
Texas	3,608.91	4,676.91
Utah	3,934.09	7,301.63
Vermont	6,000.00	6,000.00
Virginia	3,011.15	3,895.41
Washington, D. C	134,377.28	266,334.92
Washington	4,699,384.28	22,018,196.50
West Virginia	7,470.28	42,640.93
Wisconsin	62 467.68	356,614.26
Wyoming	183.30	183.30
Total	11,982,133.37	45,997,682.68

Salmon Control at Grand Coulee Dam

SECRETARY of the Interior, Harold L. Ickes, announced on January 19 the award of a contract for the purchase of eight specially equipped tank trucks to be used by the Bureau of Reclamation in the program for control of salmon in the Columbia River, Grand Coulee Dam.

Each of the trucks will be equipped with a 1,000-gallon tank in which from 650 to 800 pounds of live fish can be carried, and each will be equipped with a cooling system to regulate the temperature of the water in which the fish are carried. The water also will be aerated. An ice compartment of a capacity of 1,800 pounds of ice and circulation pump are provided for temperature control within the tank.

The contract was awarded to the Kenworth Motor Truck Corporation of Seattle, Wash., on its bid of $59,041.12, the lowest of five bids submitted to and opened by the Bureau of Reclamation at its Denver, Colo., office on December 29, 1938. The first of the trucks must be delivered within 75 days. The purchase of the trucks is a part of the program for the salvaging of the salmon runs which will be cut off as Grand Coulee Dam increases in height. Construction of fish traps at Rock Island Dam below Grand Coulee and the building of adequate roads to the traps are other parts of the plan. These features are now being constructed.

"The 1939 run of Steelheads and salmon will be handled on a temporary but adequate basis," John C. Page, Commissioner of Reclamation, said. "They will be trapped and transported to spawning areas or to streams in which the fish can make their way to spawning areas. Subsequent runs may be handled differently and will be handled in accordance with a plan being devised by special consultants.

We do not expect to lose any of the fish. The salmon which now run above Grand Coulee Dam—and this does not constitute a large percentage of the salmon of the Columbia River—will not be able to reach their habitual spawning grounds when the dam gets a little higher. Salmon, after being hatched in fresh water, make their way to the sea and return to streams where they were hatched to spawn and die. The life cycle is 5 or 6 years.

"The plan is to take the fish which are bound to waters above Grand Coulee Dam, in the traps at Rock Island Dam and to place them or their spawn in other tributaries. Thus the runs can be transplanted and after 5 or 6 years the fish will be running naturally to spawning areas below Grand Coulee Dam."

The trucks bought today are designed so that the fish compartments can be completely filled with water to avoid jouncing the salmon while they are being transported. The temperature of the water at Rock Island Dam, it is estimated, will vary from 50 to 75 degrees and the temperature of the water into which the fish will be released normally will be approximately 10 degrees lower. While the live fish are being transported, it will be necessary to cool the water in the fish compartments gradually and uniformly so that when the fish are released, the temperature of the water in the traps will not be more than 3 degrees above the temperature of the water into which the fish are released.

Controls for the cooling apparatus and special thermometers will be mounted on the dashboards of the trucks so that the driver can supervise the cooling of the tanks.

It is expected that the trucks will be in continuous service during the period of from July 1 to September 30 of each year and will be used only intermittently during the remainder of the fish run, which extends, roughly, from March 15 to December 15.

Settlement and Development on Minidoka Project

RECENT sales of farm property on the Minidoka project, Idaho, include two 80- and one 40-acre tracts. One of the 80-acre farms, lying 3 miles west of Paul, brought a price of $5,000. There were no building improvements on this farm.

Grand Valley Has Many New Homes and Business Houses

THE city building inspector for Grand Junction, Colo., reports new buildings erected in the city during 1938 in the amount of $316,617. This figure includes 44 new homes valued at $98,355 and 15 business buildings costing $151,077.

Articles on Irrigation and Related Subjects

CENTRAL VALLEY PROJECT

Plans include $30,000,000 new work in 1939, Western Construction News, January 1939, V. 14, pp. 24 and 30.

CHASE, STUART

Great Dam (article on Grand Coulee Dam condensed from Atlantic Monthly). Readers Digest, January 1939. Vol. 34, No. 201, pp. 85–88.

COLORADO-BIG THOMPSON PROJECT

Work starts on Colorado-Big Thompson, illus., Western Construction News, January 1939, V. 14, pp. 21–22.

COLUMBIA BASIN PROJECT

The Columbia Basin Grand Coulee project, illus., Spokane Chamber of Commerce, May 1938, 40 pp.

CRECELIUS, COL. SAM'L F.

Green Mountain Engineer. Portrait and Biography. Colorado Engineers' Bulletin, January 1939, V. 23, p. 15.

GLOVER, KATHERINE

America Begins Again. illus., with foreword by Stuart Chase, 392 pp. McGraw-Hill Book Co., N. Y., 1939. (Account of Work of Bureau of Reclamation and illus. of Boulder, Grand Coulee and other dams.)

GRAND COULEE DAM

Processing ten million cubic yards of sand and gravel at Grand Coulee, illus., Southwest Builder and Contractor, January 6, 1939. V. 93, pp. 10–11.

GROVER, C. G.

Building a road around Deer Creek Dam, illus., Pacific Road Builder and Engineering Review, January 1939. V. 50, No. 1, pp. 17–19.

HALLORAN, J. J.

Earth movement at Fort Peck Dam, illus. Military Engineer, January–February 1939, V. 31, pp. 5–8.

HEADGATE ROCK DAM

Spillway for Headgate Rock Dam started, illus., Western Construction News, January 1939, V. 14, p. 23.

ICKES, HAROLD L.

"This living world," radio discussion of conservation, American School of the Air, Columbia Broadcasting System, January 25, 1939. 9 pp., 5 by 8 inches, mimeographed. Free. (Discussion of Territories and Island Possessions, Reclamation, Indians and Parks.)

JOHNSON, FRED W., *Commissioner*

Land of the Free. Account of the Public Domain and the General Land Office, illus., 18 pp. and map, 1938.

KENSIT, H. E. M.

The Shasta Dam, California, illus., The Engineer (London). Vol. 166, No. 4327, pp. 677.

LANE, E. W.

Entrainment of air in swiftly flowing water, illus. Civil Engineering, February 1939, V. 9, pp. 89–91.

LIGHTBURN, C. M.

Green Mountain Dam and Power Plant, illus. Colorado Engineers' Bulletin, January 1939. V. 23, pp. 4–6, 24–25.

LIPPENCOTT, J. B.

Achievements of Southern California engineers. Jas. D. Schuyler, Mulholland, Seeley Mudd. Louis C. Hill and Homer Hamlin. Southwest Builder and Contractor, January 6, 1939, V. 93. pp. 17–20.

LOS ANGELES AQUEDUCT

Aqueduct pumps at intake plant given service test, Southwest Builder and Contractor. January 13, 1939, V. 93, p. 104.

First water flows through Colorado Aqueduct, illus. Engineering News-Record, January 12. 1939. V. 122, p. 3 (59).

MITCHELL, L. H.

Noxious weeds. their source. spread. root habits and how to control them. Fall, 1938, manuscript, 29 pp.

NEUBERGER, RICHARD L.

J. D. Ross; Northwest dynamo, illus. Survey Graphic, December 1938, Vol. 27, No. 12, pp. 586–590.

PAGE, JOHN C.

Peak of construction All-American Canal has been passed, Page reports, Southwest Builder and Contractor, January 6, 1939, V. 93, p. 11.

PARKER, H. A.

H. A. Parker appointed irrigation engineer for Columbia Basin, Portrait, Pacific Builder and Engineer, January 7, 1939, V. 45, No. 1, p. 26.

PARKER DAM

Gene Reservoir filled and engineers ready to test pumps for next lift, illus. Southwest Builder and Contractor, January 20, 1939, V. 93, No. 3, p. 29.

PROGRAM; 1939

Bureau of Reclamation Construction program increased for 1939, illus. Western Construction News, January 1939, V. 14, pp. 13–18.

Bureau of Reclamation projects, tables and detail description of work. Southwest Builder and Contractor, January 20, 1939, Vol. 93, pp. 11–12.

RIDGEWAY, ROBERT

Robert Ridgeway dies, Subway builder and on Colorado River Board, Portrait, Engineering News-Record, December 22, 1938, Vol. 121, p. 777. Editorial p. 781.

SEMINOE DAM

Seminoe Dam to store water this year, illus. Western Construction News, January 1939, V. 14, p. 22.

SHASTA DAM

Work totaling $40,000,000 under contract at Shasta Dam, illus. Pacific Builder and Engineer, January 7, 1939, Vol. 45, No. 1, pp. 30–32.

SPERRY, G. L.

Pumping plant to supplement gravity on the Flathead Irrigation project, illus. Pacific Builder and Engineer, January 7. 1939, V. 15, No. 1, pp. 27–29.

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Summarized Data, All projects. January 1939. Mimeographed, lettersize, 227 pp. (No. 48,388).

TEXAS POWER

Markets for Texas hydroelectric power. Texas State Planning Board, May 1937. W. M. Massie, Chairman, Austin, Texas, 58 pp., numerous maps and charts.

TURNBULL, W. J.

Trencher digs and mixes cut-off materials, including bentonite, illus., Tri-County project, Nebraska, Engineering News-Record. January 19, 1939. V. 122, pp. 63–64.

WHITE, HON. COMPTON I.

Development of the Clarks Fork of the Columbia River, Congressional Record, February 1. 1939, V. 84, No. 22, pp. 1468–1469.

WILLIAMSON, SYDNEY B.

Sydney B. Williamson dies, was First Chief of Construction of Reclamation Bureau, Engineering News-Record, January 19, 1939, Vol. 122, p. 40 (78).

YOUNG, HENRY W.

"Rubber Railway" at Grand Coulee, Conveyor belt shipped in eight 10-ton pieces, illus. Contractors and Engineers Monthly, January 1939, Vol. 36, No. 1, pp. 1, 11, and 36.

YOUNG, WALKER R.

Construction program on Central Valley project, Southwest Builder and Contractor. January 27, 1939. V. 93, p. 11.

Progress of Investigations of Projects

ARIZONA-CALIFORNIA: *Colorado River Surveys.*—Work was continued on the preparation of the aerial mosaic map of the areas along the lower Colorado and Gila Rivers.

CALIFORNIA: *Kings River-Pine Flat project.*—Surveys of the Piedra dam and reservoir site were begun; data on assessment of properties compiled and preliminary draft of report completed.

COLORADO: *Blue River Transmountain Diversion.*—Review of the report of the project was continued.

Eastern Slope Surveys.—Surveys of Arkansas Valley and classification of 350,000 acres of land begun; draft of report on Trinidad project completed; report of estimate of cost of dam on Purgatoire River, and draft of report on the water supply for North Republican River project completed.

Western Slope Surveys.—Report of Florida project nearly completed; surveys of Gold Bar and Long Hollow reservoir sites, and drilling of State line and Red Mesa dam sites completed and report of La Plata project continued; studies and surveys of Mancos, Paonia, and Silt projects in progress.

IDAHO: *Southwest Idaho.*—Progress report on the Payette watershed was completed, and preparation of the Weiser watershed report continued.

Snake River Storage—South Fork.—Water supply studies were continued of Grand Valley and Elk Creek reservoirs and designs of dam sites in progress.

MONTANA: *Gallatin Valley.*—Studies were continued of Spanish Creek reservoir site.

Madison River diversion project.—Studies were continued of the Canyon Ferry reservoir site on Missouri River and design begun of a dam 176 feet high and 700 feet long.

Marias River project.—Field work was completed and land classification of 390,000 acres summarized.

Rock Creek project.—Land classification has been completed and preparation of report begun.

MONTANA-NORTH DAKOTA: *Fort Peck pumping project.*—Topography of 104,000 acres of land between Fort Peck Dam and Milk River completed, canal lines surveyed and 236,000 acres of land classified.

NEBRASKA: *Mirage Flats project.*—Nearly all field surveys were completed and land classification begun. Data were assembled for preparation of a report.

NORTH DAKOTA-SOUTH DAKOTA: *Missouri River pumping project.*—Preparation was in progress looking to commencing field work in near future.

OKLAHOMA: *Altus project.*—Several agencies of the Department of Agriculture are investigating farming possibilities and rural settlement. Flood control operation of Lugert Reservoir is being studied.

Canton and Fort Supply projects.—All field work of the Canton project was completed. A study of the Oklahoma City water supply is being made.

Washita River project.—Arrangements for an extensive reconnaissance of the project in the near future were made.

OREGON: *Grande Ronde project.*—Studies were continued of the Catherine Creek and Little Minam Reservoirs and possible power development.

Medford project.—Preparation of report was in progress, and designs and estimates of Lake Creek and Four Mile Lake Dams completed. Water supply studies of Buffalo Gap project were continued.

SOUTH DAKOTA: *Black Hills projects.*—Studies of flood control on the Angostura project were made and studies of Jackson Narrows and Horse Camp dam sites begun.

Shade Hill project.—Surveys of the dam site and canals were begun.

UTAH PROJECTS.—Preparation of reports of the Blue Bench and Ouray Valley investigations was continued; preparation of a report on the Price River-Gooseberry investigations was begun; and also of the Weber River investigations.

UTAH-IDAHO-WYOMING: *Bear River Surveys.*—In spite of adverse winter conditions surveys were completed of Thatcher and Lower Oneida dam sites; and a study of the aerial mosaics prepared by Forest Service was begun, and also of the enlarged Cutler reservoir site.

COLORADO RIVER BASIN: Land classification in Little Colorado River and San Juan River Basins was continued and plans made to begin work along the Hassayampa, and in Palo Verde and Cibola Valleys. *In Arizona* a survey of the Hassayampa Reservoir and Alamo dam site was begun, and diamond drilling of Bullshead dam site was in progress; investigation of two sites on Williams River are being considered. Water supply studies of Little Snake River were in progress. *In Utah* a topographic survey of Dewey Reservoir was continued; drilling of Split Mountain dam site was begun; hydrometric surveys of Virgin River Basin were continued, and study of power market in the vicinity of Salt Lake City. *In Wyoming* hydrometric work was continued in the Green River Basin, including studies of the Lyman and Pinedale projects. A draft of report of the Lyman project was in progress.

The Grand Coulee of the Columbia

(*Continued from page 42*)

River Canyon at many places along a 100-mile front when the Cordilleran Ice Cap blockaded the Columbia and Spokane River canyons at many points below and above the dam site. Strips of scabland, denuded of soil and grotesquely eroded, extending southwesterly to the Snake and Columbia River canyons in southern Washington, were the courses by which the spill water found outlets to the lower Columbia and thence to the sea. In the vicinity of the junction of the Grand Coulee with the Columbia River Canyon, glacial waters overflowed the left canyon wall in a stream 10 miles wide, creating the scablands lying on both sides of the upper Coulee, and now crossed by highways extending to the southeast toward Wilbur and Spokane and to the northwest toward Alameda and Del Rio.

As the upper Coulee grew, side streams entered it from this flood all along its easterly edge and along the northerly 10 miles of the west wall. Sites of many ancient waterfalls along the Coulee walls and a few deep canyons, notably Barker Canyon on the West and Northrup Canyon on the east, mark points at which such side streams entered before headward erosion of the main stream tapped the reservoir in the original river canyon, lowered the water level in the reservoir, and concentrated in the Grand Coulee the entire stupendous flow from the Ice Cap, to form the greatest river of which any evidence remains upon the earth.

Coulee Irrigation District Approved

LANDOWNERS of the central Washington desert voted overwhelmingly on February 19 to form the largest irrigation district in the country and the first of two to be watered by the Grand Coulee Dam when it is completed.

The landowners voted 709 to 34 to form the district covering 500,000 acres, and elected five directors to administer affairs of the project in conjunction with the Bureau of Reclamation. The name of the new organization will be the Quincy-Columbia Basin District.

It is planned to construct a huge canal to carry water from a reservoir behind the dam. Smaller canals will be constructed to lead in to areas that now are barren and windswept during the summer. Proponents of the project estimate it will be 3 years before water will enter the canals.—*Ellensburg Daily Record.*

Boulder Power Plant

By IRVING C. HARRIS, *Director of Power*

THE generation of electrical energy is not the primary purpose of the Boulder Canyon project, but as the revenues from electrical energy are expected to repay a large part of the cost of the project, this function is a most important one. From a constructional and operative standpoint, the power plant is of unprecedented size.

Contractual Conditions

Before the construction of the project was authorized all of the available firm energy was allocated and contracted to be taken and paid for by responsible allottees under the terms of 50-year firm contracts for lease of power privilege entered into as of April 26, 1930. This is an unusual condition in any case and, in view of the large quantity of energy involved, is quite unique.

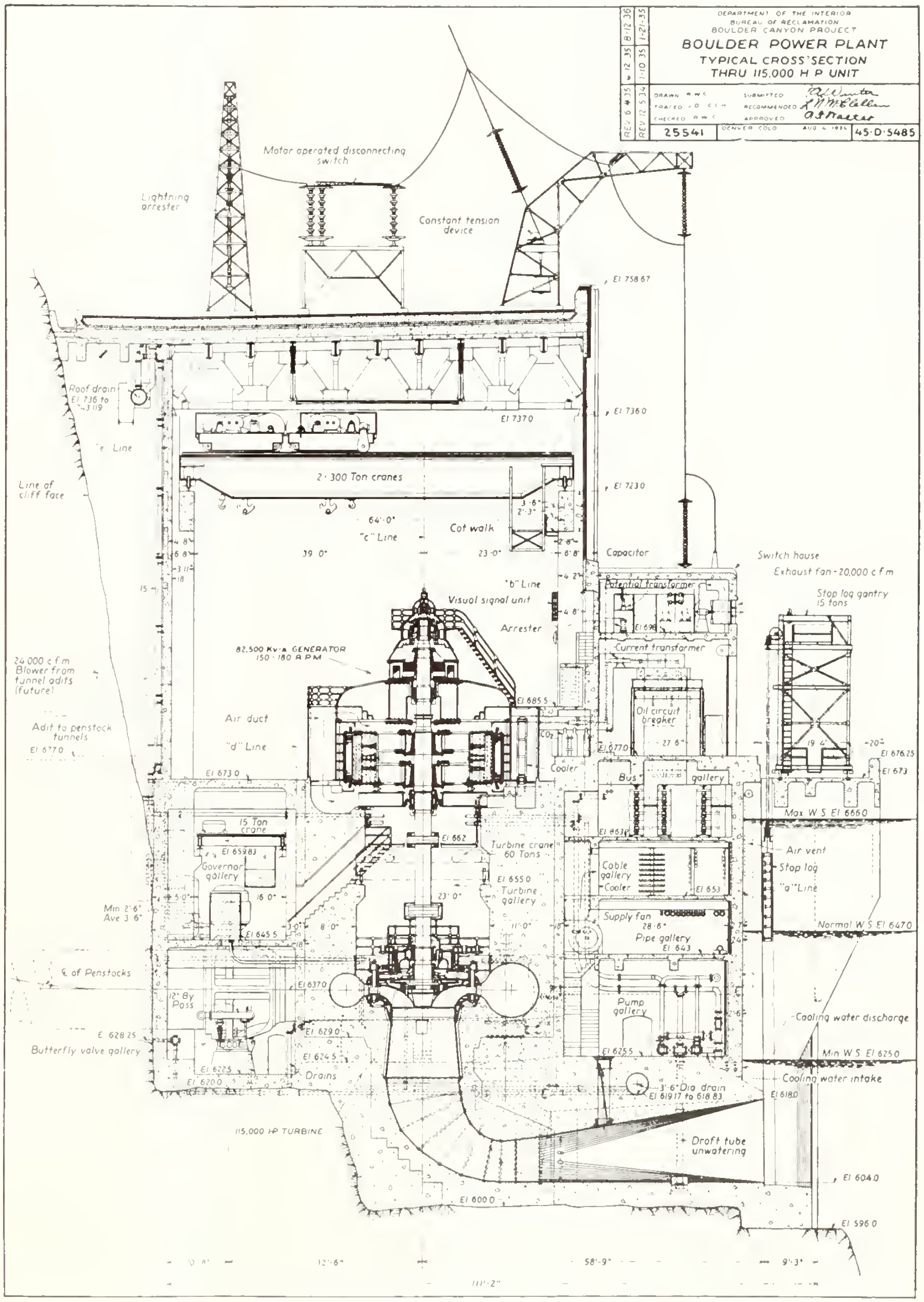
The energy that may be generated is classified as firm and secondary under definitions that provide that firm energy is the energy that the allottees in the aggregate are obligated to take and pay for and that secondary energy is energy that may be generated in excess of the amount of firm energy contracted for. The amount of firm energy that may be generated was estimated in accordance with the classification as to availability ordinarily used in the industry.

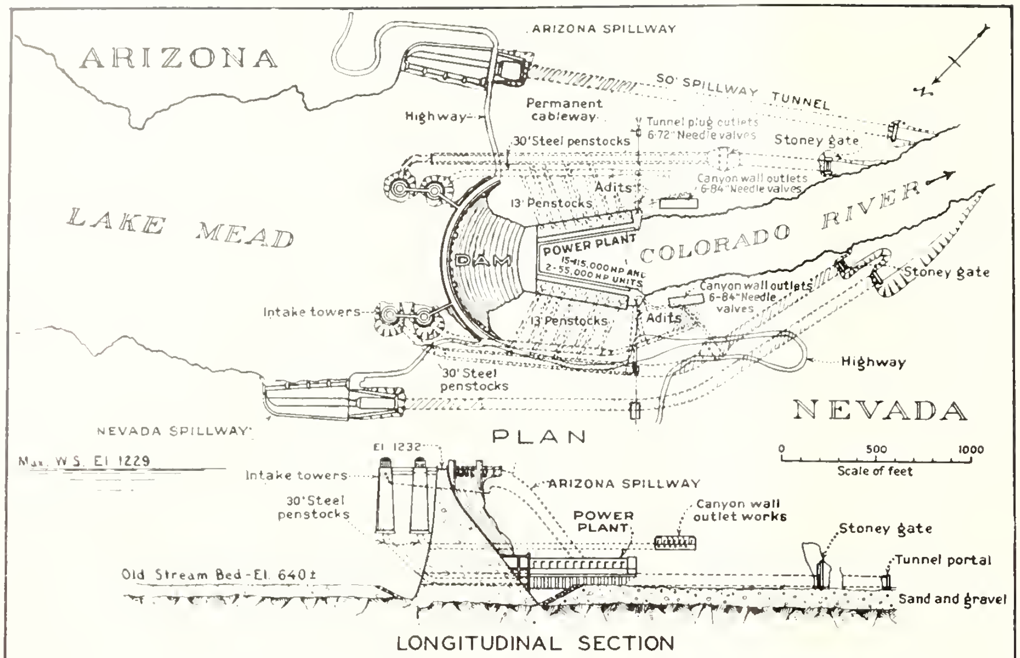
The total amount of firm energy estimated to be available during the first year of operation is 4,330,000,000 kilowatt-hours. The amount of firm energy is reduced by 8,942,000 kilowatt-hours each year after the first to cover the estimated diminution due to diversion of water in the upper basin. The allocation of firm energy is as follows:

	Percent
A—State of Nevada for use in Nevada	18
B—State of Arizona for use in Arizona	18
C—Metropolitan Water District of Southern California	36
D & E—Municipalities of Burbank, Glendale, and Pasadena, and the City of Los Angeles	19
F—Southern California Edison Co., Ltd., Nevada California Electric Corporation, San Diego Gas & Electric Corporation, and Los Angeles Gas and Electric Corporation	9
	100

The city of Los Angeles has acquired the interest of the Los Angeles Gas & Electric Corporation in the allocation in F above.

The allocations to the States of Nevada and Arizona are optional; and the States may take any part or all under specified conditions of notice. The city of Los Angeles and the Southern California Edison Co., Ltd., are obligated to take all energy not used by the States, in case the Metropolitan Water District does not exercise an option it has to take part of the States' allotments. The district has the prior right to take all of the secondary energy it may need for pumping water into and in its aqueduct, but for no





BOULDER DAM AND APPURTENANT WORKS

other purpose. Any not taken by the district may be taken by the city and the Southern California Edison Co. equally.

The contracts for lease of power privilege provide that the Government will furnish falling water for the generation of energy and that generation shall be by two designated generating agencies who shall operate and maintain generating equipment to be installed and owned by the Government and leased by the agencies, which shall pay lease rentals which will retire the original investment in generating equipment in a term of years originally specified as ten but being extended to the 50-year term of the contract for lease of power privilege.

The city of Los Angeles and the Southern California Edison Co. are designated generating agencies, the former to generate for itself, the Metropolitan Water District, the municipalities, and the States, and the latter for itself and the other private corporations. The city has been designated to operate certain common facilities of the power plant. The Government operates and maintains the dam, outlet works, power plant building, and all common facilities not operated by the city of Los Angeles.

The amount of firm energy estimated to be available and made the basis of the minimum guarantee obligations of the power contractors, namely, 4,330,000,000 kilowatt-hours per annum for the first year, is at the rate of 494,292 kilowatts at 100 percent load factor. In addition to this, it is estimated that there will be 1,550,000,000 kilowatt-hours of secondary energy.

Generating equipment installed and owned by the Government includes the switchyards and lines connecting them to the power plant. The transmission lines are built, owned, and operated by the respective lessees and allottees.

Generating Equipment—General Features

One of the outstanding things about this project is its compactness. It involves a great concentration of features of unprecedented size, of large number and variety, all encompassed within a relatively small space.

The restriction of space affects the power plant greatly because of the essentially large number and complexity of details of any power plant. This is true in this case to a greater extent than usual because of the fact that this is not a simple, single power plant but virtually four power plants, merged in some details but separate in others, all contained within one structure.

Under the contractural set-up above described, the plant has been designed to accommodate the lessees and allottees with generating equipment in groups as follows:

(a) Generating equipment for serving the city of Los Angeles and the State allottees.

(b) Generating equipment to serve the Metropolitan Water District, to be operated by the city.

(c) Generating equipment to serve the Southern California Edison Co.

(d) Generating equipment to serve the Nevada California Electric Corporation, to be operated by the Southern California Edison Co.

Each of the four groups is separate from the others, connects to different transmission lines at different voltages; and one of them, the Edison group, has a different frequency. There are provisions by which interconnections between groups can be made by installing a small amount of equipment.

In order to accommodate these complex requirements, the plant was designed for the installation of a maximum of 17 units, two of which will be of 40,000 kilovolt-amperes and the rest of 82,500-kilovolt-ampere capacity,

The main control room for the operation of units for public agencies in the central section of the power plant

making a total of 1,317,500 kilovolt-amperes. Of these units, five were allotted to serve the city of Los Angeles and the municipalities, two for the States, four for the Metropolitan Water District, and four 82,500 kilovolt-amperes and two 40,000 kilovolt-amperes for the Southern California Edison and the other private corporations.

The power plant is housed in a U-shaped building, the central section of which is built on the downstream toe of the dam and the two wings against the Nevada and Arizona cliffs. The total length is 1,650 feet. Each wing is 650 feet long and 150 feet high above normal tailwater and 229 feet above lowest foundation level. Construction involved 455,000 cubic yards of excavation, 240,000 cubic yards of concrete, 24,000,000 pounds of reinforcing steel, and 12,000,000 pounds of structural steel.

Six 115,000-horsepower turbines in Nevada wing

Generating Equipment—Hydraulic

Turbine pits were provided in the Nevada wing for eight 115,000-horsepower, 82,500-kilovolt-ampere units, of which the upstream four were allotted to the City of Los Angeles and the other four to the Metropolitan Water District. The four city units and two of the metropolitan units are now installed and in operation. Pits were provided in the Arizona wing for seven 115,000-horsepower, 82,500-kilovolt-ampere units, of which the upstream unit was allotted to the City of Los Angeles, the next two to the States of Arizona and Nevada, and the other four to the Southern California Edison Co. Pits were also provided for two 55,000-horsepower, 40,000-kilovolt-ampere units to serve the Nevada California Electric Corporation and the other private corporations. One of the 40,000-kilovolt-ampere units is now installed and operating. Two of the Edison units, designated as A–6 and A–7, are being installed at this time. It is expected that the units designated as A–1 and A–2 will be installed within the next 3 years.

Six 82,500-kilovolt-ampere generators in Nevada wing of power plant

Energy required to operate the station service facilities is obtained from two 3,000-kilovolt-ampere station service generating units, driven by Pelton waterwheels, one at the upstream end of each wing, and may also be taken through a transformer bank connected through reactors to a transfer bus connecting through breakers to any one or more of the four city units.

Four steel penstocks, 30 feet in diameter, two on each side, each with four branches 13 feet in diameter, supply water to the 17 turbines, the downstream 13-foot branch on the Arizona side branching to serve the two 55,000-horsepower turbines. A hydraulically operated butterfly valve is provided at the end of each branch as a stop valve for the turbine. Each of the four main penstocks is equipped with cylinder gates in the intake tower to control the connection with the lake. A station service penstock, 42 inches in diameter, with connections to all four main penstocks, provides water for operating the station service generating units and other facilities requiring station service water.

The main generating units are of the conventional three-section shaft, three-guide-bearing type with the thrust bearing above the generator rotor. The 60-cycle units operate at 180 revolutions per minute and the 50-cycle at 150 revolutions per minute. The 55,000-horsepower, 40,000-kilovolt-ampere unit operates at 257 revolutions per minute. The turbines are of the Francis type, with cast steel scroll case embedded in concrete, with draft tube discharging through an elbow with two outlets to the tailrace each provided with a tailgate for unwatering purposes. Each turbine is provided with a pressure regulator valve, connected to a branch from the scroll case and discharging downward through an energy absorber and an elbow to the tailrace through a single outlet equipped with a tailgate, duplicating those of the turbine, for unwatering purposes. The pressure-regulator valve may be operated either as a synchronous bypass or as a water-saving valve; and has a discharge capacity of 80 percent of the turbine discharge.

Control of the turbines is by means of oil-pressure servomotors under control of actuators. A twin unit, consisting of two oil pumps and pressure tanks serves two turbines. The governor head is driven by a synchronous motor connected to a permanent magnet generator on the generator shaft.

Generating Equipment—Electrical

The main generators are air-circulated water-cooled and equipped with CO_2 fire pro-

Nevada Governor Gallery showing governor actuator and butterfly valve operating mechanism

tective apparatus. Excitation is by means of a main and pilot exciter with automatic voltage regulator control. The generator voltage is 16,500 for the 82,500-kilovolt-ampere generators and 13,800 for the 40,000-kilovolt-ampere generator.

For the City of Los Angeles lines, the current is stepped up from 16,500 volts to 287.5 kilovolts through 55,000-kilovolt-ampere water cooled transformers in two banks located on the transformer deck, each bank serving two generating units. For the Metropolitan units, the same arrangement is used, but the line voltage is 230 kilovolts.

The generator voltage circuit breakers in switch houses on the transformer deck are of an armorclad type, rated at 4,000 amperes and 2,500,000-kilovolt-ampere rupturing capacity. The high tension breakers in the switchyard are of the same rupturing capacity. The connections between generators, generator voltage breakers, and transformers is by means of 6- by 6-inch hollow, copper bus in sheet copper housing, each phase in a separate duct and mounted on insulators. The connection between transformers and the switchyard and the wiring of the switchyard is by means of a hollow copper conductor 1.4 inches in diameter, the same as is used on the city's 287.5 kilovolt lines.

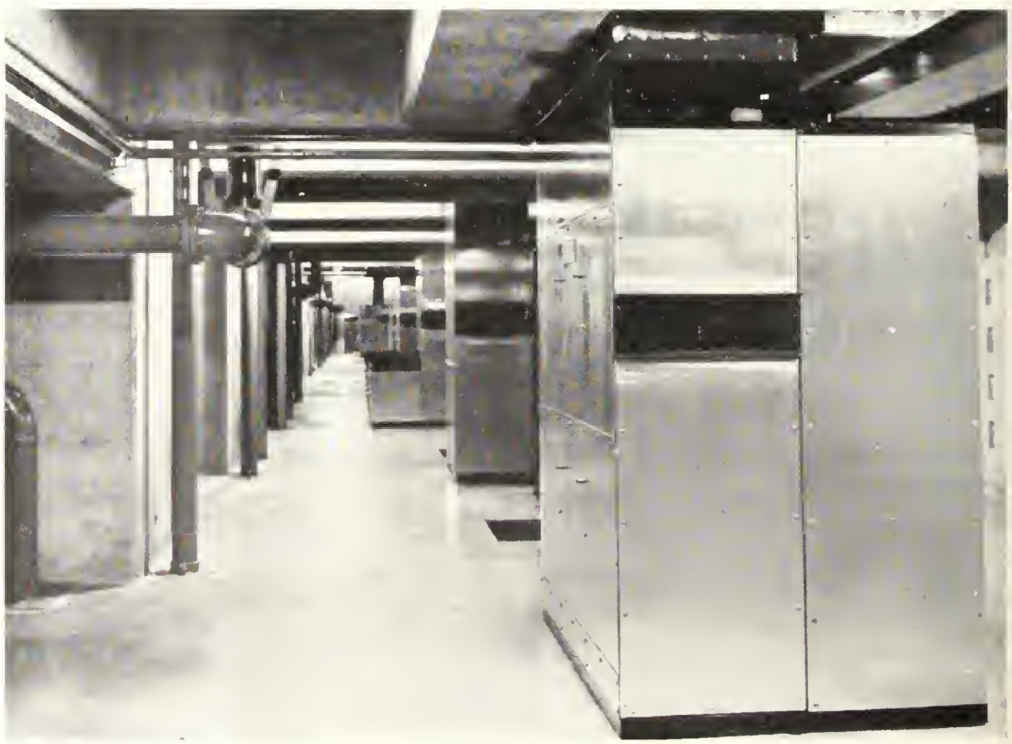
The units to serve the Edison Co. are to be operated on the unit system, with a bank of transformers for each generator. There will be no generator voltage breaker, the only breaker being the 230-kilovolt breaker for each unit in the switchyard. The transformers are installed on the transformer deck with a ground Fault Neutralizer coil connected to two transformer banks. The 40,000-kilovolt-ampere generator is connected through a 2,000-ampere, 500,000-kilovolt-ampere rupturing capacity, armor-clad oil circuit breaker to an external-heat-exchanger, oil-cooled transformer bank, stepping the voltage up to 138 kilovolt-ampere. The switchyard is equipped with an oil circuit breaker and thyrite lightning arresters.

In each of the four installations, control is provided at two points, one at a cubicle on the balcony in the generator room near the generator and the other in the control room, which is the normal point of control. The control system is very complete, using the maximum in protection, and providing virtually automatic operation. After the butterfly valve is opened by an operator in the governor gallery, a unit may be started automatically from the control room, the speed being matched by a speed matcher and the unit synchronized by an automatic synchronizer. Load and frequency control and time control from a master clock in a clock room are provided.

The switchyards are located at a distance from the power plant on the Nevada side. The control cables serving the relay rooms and breakers in the switchyard are carried in an inclined control tunnel leaving the power plant central section just below the roof and having branch connections to the several switchyards.

The high tension lines connecting the transformers on the power plant transformer deck and the switchyard are carried up the cliffs to inclined rim towers and thence to the switchyards on standard tower supports. For protection of the switchyard and connecting lines of the City of Los Angeles 287.5-kilovolt installation, a system of lightning diverter cables is carried on high towers in a position

Enclosed 16.5-kilovolt copper bus in Nevada wing



above the power conductors such as to provide lightning protection for the entire installation. Lightning arresters of the thyrite type are installed at the switchyards and on the roof of the power plant on the high tension lines.

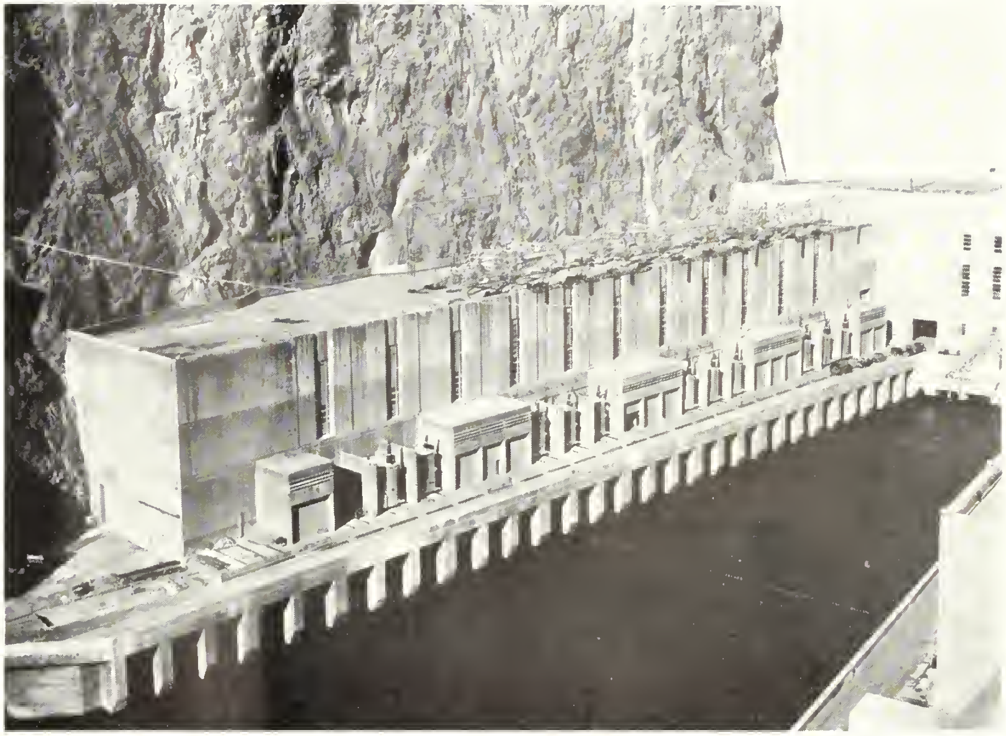
The several lessees and allottees have service requirements that, in the opinion of their respective engineers, call for or permit different standards of service reliability. The City of Los Angeles places the most dependence on this plant; and its installation is designed to provide the maximum of reliability, calling for the most complete protection known to the art in the plant and on their transmission lines. The Southern California Edison Co. will not place as much dependence upon service reliability from this plant because of its other sources of energy, including a very large steam power plant at Long Beach, Calif.; hence, the power plant installation and transmission line are designed for a somewhat lower standard of reliability and call for a smaller expenditure. The Metropolitan Water District can use an even lower standard of service reliability; since a shut-down of even several days' duration will not be serious, because of the reserve capacity provided by its system of reservoirs along the aqueduct. Consequently, the district's installation is based on this assumption and makes it possible to realize considerable savings in the construction cost of power plant equipment and lines.

Generating Equipment—Station Service Facilities

Station service facilities include the station service generating units, station power and light equipment, unit auxiliaries, eductors for circulating cooling water and for unwatering, pumps for unwatering, air compressors, and cranes. Storage batteries and charging sets are provided for the direct-current supply for the control system.

There are two 300-ton, two main and two auxiliary hoist, traveling cranes in each wing providing for the handling of any of the equipment. The 600-ton generator rotors are handled by means of two 300-ton cranes and a special lifting beam equipment. A 50-ton crane serves the machine shop; and there are cranes for the governor galleries and the pump room in the central section. A special crane equipment is provided for removing the intermediate shaft section of any main unit and handling all of the parts of the turbine without disturbing the generator when doing maintenance work.

A machine shop in the central section at generator room floor level is equipped with a boring mill large enough to turn runners, three lathes, a milling machine, shaper, universal tool grinder, radial and upright drill presses, a wheel press, and miscellaneous shop equipment suitable for doing a wide range of work, as is necessary because of the distance from shops having such facilities.



Nevada wing of power plant from roof of Arizona valve house, showing transformers, switch houses, and roof structures

Power Transformers Ordered for Boulder Power Plant

THREE large power transformers for the Boulder power plant, Boulder Canyon project, Arizona-California-Nevada, were ordered on February 9 by Secretary of the Interior Harold L. Ickes.

The successful bid of $376,350 for manufacturing and delivering the transformers was submitted by the General Electric Co. of Schenectady, N. Y., and was the lowest of three proposals received and opened by the Bureau of Reclamation at its Denver, Colo. office on January 3, 1939.

These three main power transformers, while they are similar to others already manufactured for the Boulder Dam power plant, have no other equals in size. They will be connected with generating units Nos. 1 and 2 in the Arizona wing of the Boulder Dam powerhouse, located at Boulder Dam on the Colorado River, about 7 miles northeast of Boulder City, Nev.

The three transformers of 55,000-kilovolt-ampere capacity, connected with the two large generating units of 82,000-kilovolt-ampere capacity, will be capable of stepping up the power of 287,500 volts for transmittal to the City of Los Angeles, Calif., a distance of approximately 265 miles.

The contractor is required to deliver the transformers within 250 calendar days and the Bureau of Reclamation will install the apparatus.

Six of the large 82,500-kilovolt-ampere generators and one of the smaller 40,000-kilovolt-ampere generators are now in operation at the Boulder power plant, and two more of the large ones are now being manufactured. When the installation is complete, it will include 15 of the large and 2 of the smaller generators with a combined capacity of 1,835,000 horsepower.

New Vale Map Available

A NEW MAP of the Vale project, Oregon, has been issued by the Bureau of Reclamation, which may be obtained upon application to the Bureau, payment to be made in advance by check or money order drawn to the Bureau of Reclamation. *Postage stamps are not acceptable.*

No. 38-375 (1938). Colored; size 10½ by 15¾. Price 10 cents each.

No. 38-375A (1938). Colored; size 21 by 31½. Price 25 cents each.

Erratum

ON page 9 of the January 1939 issue of the ERA, under the head Reservoir at Parker Dam Fills, the statement is made that "The ultimate capacity of the aqueduct will be 1,500 second-feet, or a million gallons a day." The word "million" obviously should have been "billion."

Tunnel Construction

Roza Division, Yakima Project, Washington

By C. L. ALBERTSON, *Associate Engineer, and* C. deVERE FAIRCHILD, *Inspector*

CONSTRUCTION of the Roza Division of the Yakima project which will provide for the irrigation of 72,000 acres, with a water allocation of 375,000 acre-feet, was approved by President Roosevelt on November 6, 1935. In the diversion, conveyance, and distribution of this quantity of water to the highest point of each 40-acre tract lying within the boundaries of this division, which extends over 100 miles from point of diversion, many interesting engineering problems are involved. Of particular interest was the construction of tunnels Nos. 1 and 3, aggregating 3.38 miles in length. Owing to the danger involved in this type of construction, the congestion of activity in the limited area, and the fact that spectators detract the attention of the miners, which is a matter of serious consequence, very few spectators are permitted to witness in person this feature of construction. It is the purpose of this article to portray the method of procedure, and to acquaint the reader with the more important details of construction involved in driving a 20-foot tunnel nearly 2 miles.

Geology

The basalt formation in the vicinity of the tunnels in question is a part of the extensive lava flow extending from Idaho to Oregon and covering a portion of Washington, which, with the exception of that in India, is said to be the most extensive lava deposit on the globe. The lava flow encountered is known to have a depth in excess of 3,500 feet. In the tunnel area, Wenas basalt predominates, and its age is fixed as early and middle Miocene.

Tunnel No. 1.—With the exception of a stratum of sand encountered at a point approximately 4,950 feet from the south portal and 1,250 feet below the surface, the formation throughout tunnel No. 1 was of basalt in varying degrees of hardness and texture. The apex of the ridge was 1,500 feet above the tunnel. From a geological standpoint, the sand stratum was of particular interest. It laid on an angle of 8 degrees, dipping to the south, the upper 18 to 24 inches being of the nature of a top soil in which considerable quantities of vegetable matter were embedded. Specimens of wood were found, some of which would burn with the aroma of sandalwood. The grain was exceptionally close, showing a growth of 20 years per inch. The curvature indicated that the original trees were 6 to 8 feet in diameter. The upper surface of the stratum showed clearly the action of flowing lava. The upper 2 inches was fused, protruding wood specimens were burned off, and the embedded specimens in the contiguous lava flow were converted into charcoal.

Tunnel No. 3, showing steel 6-inch I-beam supports, lagging, rod ties, and wooden spreaders. On left is 6-inch air and 3-inch water line for drill operation, and electric cable. On right is a 20-inch sheet metal ventilating pipe

Tunnel No. 3.—The ridge which this tunnel penetrates rises to a height of 900 feet above the tunnel. The strata encountered show that following numerous lava flows there was a long period of vegetative activity, with accompanying sedimentary deposit, followed by a lava flow of considerable magnitude, which in turn was covered by an alluvial deposit 140 feet in depth, forming the present surface. The most recent lava flow rests upon a smooth and uniform surface of sandstone on an inclination of 33 to 35 degrees, the sandstone showing but slight discoloration due to the flowing lava. Identical in form with a similar deposit in tunnel No. 1, the upper 2 inches of clay and dust on the surface of the sandstone are fused with the lava flow.

In the lower alluvial formation, a deposit of camel bones was found, the knuckle bones of which were well preserved although the contact material of fine silt showed discoloration due to the decomposition of the animals. In the upper alluvial formation, directly upon the upper surface of the last of the lava flows, a deposit of 10 feet of fine silt was found which showed evidence of having been quicksand at the time of original deposit. In this formation, 130 feet below the present ground surface, a complete set of mastodon teeth and a portion of the tusks were found. The outer surface of the teeth was coal black, the teeth were well preserved and free from decay of any kind. The wearing surface of the "grinders" showed plainly that the animal had fed on medium sized branches. Prof. Harold E. Culver, supervisor of geology, State of Washington, who examined the tunnel several times during its construction, states that the fossils found may reasonably be tentatively placed in the latter part of the Tertiary or in the early Pleistocene periods. In one of the lava flows, approximately 4,100 feet from the north portal and 700 feet below the present ground surface, a large petrified log was found encased in the lava rock, giving positive proof that at some prehistoric period a petrified forest had been swept by the lava flow.

The lava rock encountered showed a great variation of texture and form. Some strata were of dense, brittle texture, breaking with sharp edges. Others were of blocky basalt in hexagonal columns with mud seams, and other deposits were of the porous type with beautiful clear water crystals formed in the cavities. In some deposits, the formation was of a volcanic clinker type with open cavities 4 to 12 inches in diameter and 3 to 6 feet in length, showing plainly the presence of numerous gas pockets in the original flow. Clay seams were encountered which had the appearance of functioning as lubrication joints in the slow upward movement of the ridge, contact surface grooves positively identifying such action. In only one instance was swelling ground encountered. This seam, 10 feet in thickness, was a soft, blue clay with free water lying between two lava structures on an inclination of 30 degrees. With the exception of the maximum flow of 350 gallons per minute, 7,300 feet from the north portal, no great amount of water was encountered. Many small flows of 2 to 20 gallons per minute were encountered which, as a general rule, soon dwindled to insignificant flows. The temperature of the rock and the flowing water ranged from 62° to 64°.

As the observer strolls through tunnel No. 3 and takes note of the geological changes wrought through the past ages, it requires the application of the most vivid imagination to portray the scene of the past, when luxuriant forests abounded and mastodons and camels roamed the level stretch where the Yakima Ridge now rises a thousand feet above the valley below.

Equipment

The formation encountered in tunnel No. 3 was of greater variation than that of tunnel No. 1. The dates of contract, progress, and completion varied slightly, but the equipment used and method of procedure were identical in the two tunnels, so that the following description of driving tunnel No. 3 will apply to tunnel No. 1. Owing to the size and length of the tunnel it was essential that the equipment installed be of ample capacity and of high quality to withstand the strain of heavy and continuous duty. The efficiency of the installation and maintenance is exemplified in the fact that the total of all delays, from all causes, inclusive of compressor, pipe lines, jumbo, mucker, electrical, and all derailments, was slightly in excess of 2 percent.

Face of Tunnel No. 3 just after blasting. The Conway mucker, with empty 4-cubic yard car behind, is moving up to begin loading

The main items of equipment were as follows:

Three air compressors, total of 350 horsepower, 2,500 cubic feet per minute.

One blower for ventilation, 50 horsepower, 7,000 cubic feet per minute.

Three electric motors, combination trolley and battery.

Twenty-two dump cars, 4 cubic yards capacity.

Ten Worthington automatic drills.

One Conway mucker.

One jumbo, equipped with car hoist and mounting seven drills.

One drill sharpener, with oil furnace.

Two miles each of 22-inch ventilation pipe, 6-inch air line, and 3-inch water main.

Three miles of track, 40-pound rails.

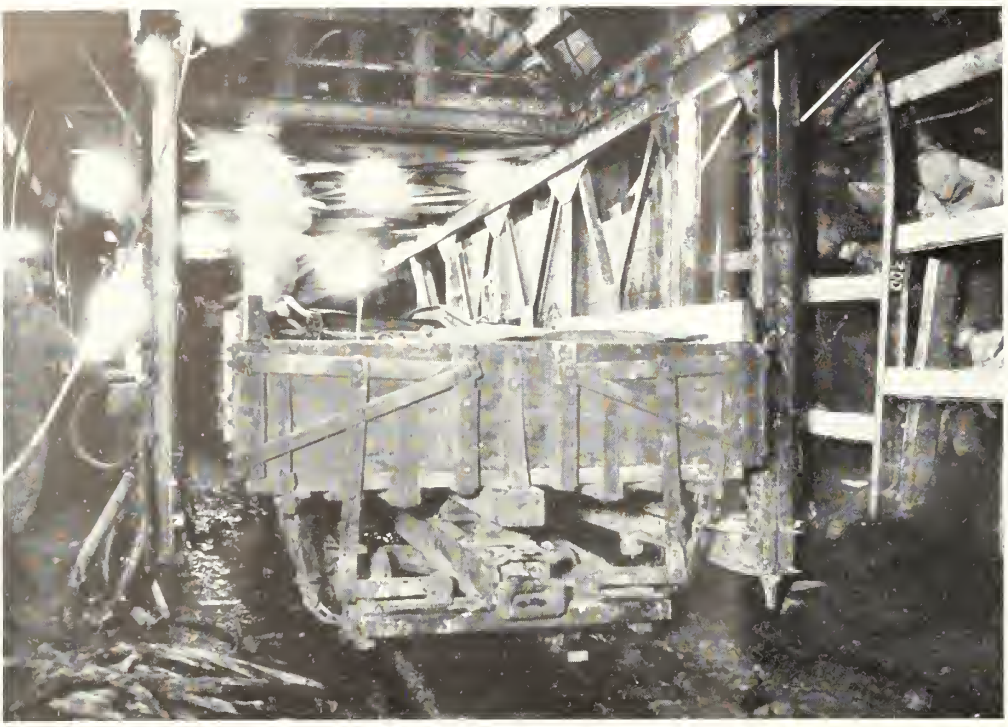
Three miles of trolley line.

Power was obtained from the local power company.

Procedure

Although the construction of tunnels has been carried on extensively for many decades, it remained for the construction of the large tunnels of the Boulder Dam to witness the perfection of the "jumbo," which revolutionized tunnel construction. The jumbo used in tunnel No. 3 was of steel frame construction, operating on a track of 10-foot gage. The top deck, approximately 11 feet above invert, afforded a platform from which the miners were able to work efficiently in timbering and drilling the upper holes in the heading. Three drills were mounted above deck and four drills on the lower portion, so that when the jumbo was moved in the heading seven drills, manned by seven miners and seven chucktenders were in readiness to start drilling. By raising or lowering arms and moving drills in or out on the fixed arms, the miners were able to locate the machines in proper position to drill all holes in a heading 20 feet in diameter. On the upper deck of the jumbo an electrically operated car hoist was mounted, termed the "cherry picker." In action, the operator would lower a frame which two attendants would hook to the empty car. The car would then be hoisted clear of the loaded car being removed from the mucker, and after its passage the empty car would then be lowered to the track and shifted to and attached to the mucker. During the loading of this car the motor would spot another under the cherry picker and the process would be repeated.

The Conway mucker is an electrically driven power shovel of special design, built exceptionally heavy to withstand hard use. A heavy shovel bucket is hinged to a short, heavy, iron trough of the same width as the shovel. The trough is pivoted and operated with heavy chains and can be swung from side to side. In operation, the shovel is lowered and the mucker, with one empty car attached, is moved forward with considerable impetus into the muck pile. The shovel is



Steel drill carriage or "jumbo" in position for making up a train. An empty car is picked up from a train of empty cars and set down behind the mucker. In this way a loaded train is made up without the usual switching on a sidetrack

raised to closure, the trough is then raised and the load slides onto a conveyor belt which conveys the same on an angle to the horizontal extension which is of sufficient height and length to deposit the excavated material in the dump car.

Throughout the progress of the work, a constantly changing formation called for specific solution, and no fixed plan of procedure or timbering was possible. In a few instances, the clay had invisible seams which seemed to contain compressed air. Upon exposure, a fine crack would develop, followed by complete fracture in a sudden movement. The miners termed this formation "popping clay." In ground of clay formation, entirely lacking of inherent stability, it was impossible to support the roof with crown bars, and pilot tunnels, 5 by 5 feet, had to be driven in advance of the heading. The roof of the pilot tunnel was about 30 inches above the heading proper, permitting the placing of heavy timbers to carry the roof load directly in front of the steel supports, also to permit the driving of side piling. Breast boards were utilized in extremely heavy ground. Three superimposed sets were used, supporting the entire face of the heading, leaving only a slight opening in the roof to assist in the proper driving of the lagging. A narrow trench would then be opened along each side wall to the foot block to facilitate placement of steel supports. Upon completion of placing the steel support and lagging, the upper, center, and lower sets of breast boards would be advanced in their respective order sufficient to permit the insertion of another support.

Despite the fact that 92.5 percent of the tunnel driving was in rock, 28.8 percent of the 3.38 miles driven required supports. Steel was used throughout in place of timber. One advantage of steel is that the smaller dimensions of columns and arch beams, as compared with timber posts and segments, decrease the size of the excavated section, resulting in smaller quantities of muck to be handled and concrete to be placed. A feature of the steel was the transverse reinforcing for the concrete lining. These ribs were made of 6-inch, 12.5-pound, I-beams in two pieces, extending from invert to crown, where they were bolted together in a butt joint welded at right angles to the end of each section of the support. The supports were spaced with ¾-inch tie rods and 4- by 6-inch timber spreaders. The spacing varied from double welded 1-foot to single 6-foot, depending on the ground to be supported. Two-inch timber lagging was used, except in heavy ground, where the thickness was increased to 3 inches.

Deposits of sedimentary material were encountered in which no explosives were required, it being practical to dislodge the material with jackhammers equipped with chisel or chipping points. In material of this nature, every effort was exercised to avoid the possibility of mass movement. With cemented gravel, hard pan, soft sandstone, and block basalt, it was possible to advance without breast boards by the careful and judicial use of crown bars in advance of the steel supports. The most dangerous formation encountered was "blocky basalt." Having developed its stratification before the upheaval of the ridge, it tilted backward at an angle of 33 to 35 degrees, thus creating an extremely hazardous condition in the roof and necessitating the placing of steel supports directly contiguous in the heading.

Tunnel Activity in Hard Rock

The following description of tunnel activity in hard rock, where no timbering was required, covers an average period of 6 hours 35 minutes, during which the average advance was 9 feet 5 inches. The loading of 46 holes in a heading of hard basalt having been completed, the jumbo was moved back to a point 400 feet from the heading, the mucking machine having been spotted on the nearest passing track with seven empty dump cars in the rear. The 46 pairs of lead wires from the primer in each hole were connected to an upper and lower pair of buzz wires, heavy copper wires free from covering. Approximately 200 feet from the heading the shift boss connected the small lead wires leading from the buzz wires to the "firing line." About 500 feet farther, the shift boss connected the main firing line at a point where it had been disconnected previous to loading. The motor now conveyed the crew and shift boss to the firing switch located about 2,000 feet from the heading. At this point, the first act of the shift boss was to connect the firing line that had been disconnected with a short and a long end to avoid any possibility of contact. The keys to the two switch boxes were in the exclusive possession of the shift boss who then unlocked the switch boxes and made the final connection of firing line by throwing the switch in the first box. The throwing of the switch in the second box was instantly followed by 10 shots in regular sequence. The switches were thrown back, checked for position, the boxes were locked, and the firing line outside of the boxes was again disconnected. The adoption of this procedure and regularity of application throughout was a contributing element in the complete elimination of any accidents in connection with the handling and use of explosives. Immediately after the shot, the engineer in charge of the compressor was notified by telephone from the shift boss to start the ventilating fan on "suction." The fan was run on "suction" 15 to 20 minutes. It was then shut off and changed to "blowing." Thirty minutes after the shot the crew was able to return to the heading.

While the shift boss made his examination of the heading, and the electrician, with the assistance of chucktenders, was replacing the light line to the heading, the jumbo was being moved as near to the heading as would permit the motor and seven cars to clear the cherry picker and the mucking machine. In the meantime, the mucking machine had been cleaning up the scattered rock along the tunnel. Following the examination of heading by the shift boss, the safety miners mounted the muck pile and with bars carefully checked the roof and barred down all loose rock. Though these men were of the rough and ready type, by training and experience they were qualified to quickly discern all dangerous rock and apparently did their work fully cognizant of the fact that not only their lives but the life of every man in the tunnel depended upon the thoroughness of their examination of the entire area of the roof, sidewalls, and heading.

Upon completion of mucking operations, loading an average of 36 cars per shot, requiring an average time of 2 hours 35 minutes, the inspector in charge established a point on the heading on the center line of the tunnel and a given distance below the spring line. With a plumb bob and tape, the center of the "A" line radius was established, the "A" line being the neat line to the actual line of excavation. By the time the jumbo was moved up to the heading, the "A" line had been painted from the spring line to the invert with white paint, and the inspector had checked and recorded the distance from the "A" line to the actual line of excavation. From the upper deck of the jumbo, the "A" line above the spring line was painted and the inspector completed the tabulation of overbreak measurements and recorded data determining the overbreak as avoidable or unavoidable. Although the average time required from completion of mucking to commencement of drilling was 17 minutes, there were instances when only 11 minutes were required.

The engineers carry line and grade on the side of the tunnel. From there the inspector transfers same to the heading after every cleanup by use of level boards, causing no interruption to the contractor. Permanent concrete bench marks every 300 feet in the floor and permanent alignment hubs in the roof

Drilling

In hard basalt, 46 holes were drilled, 13-foot steel being used in drilling cut-holes and 11-foot steel in the remaining holes. In other material, the number and depth of holes was subject to wide variation, owing to the great variance of the explosive effectiveness in the formation encountered. In hard rock, 40-percent dynamite was used. In porous lava and soft rock, 20-percent dynamite was found to be more effective. Powder requirements varied from 1 to 4 pounds per cubic yard. Previous to completion of drilling, the powder car, with separate compartments for primers and powder, was spotted in the rear of the jumbo. During loading, the power line was disconnected from the jumbo to avoid the possibility of a short circuit causing a premature explosion. Upon completion of loading, having used seven 50-pound boxes of dynamite, all tools were gathered and moved back and the connection of wires was commenced, as described in the beginning of this narrative.

Operations were continuous from 4 p. m. Sunday to 8 a. m. the following Sunday, twenty 8-hour shifts being performed by four crews, each working five 8-hour shifts per week.

The following data relative to operations from October 19 to December 24, 1936, a period of 67 days during which the progress was 2,209 linear feet, are representative of the time required for the various features of the work involved in driving a 20-foot tunnel in basalt rock:

Detail	Time per round		Percent
	Hours	*Minutes*	
All delays	0	09	2.3
Clearing gas	0	30	7.6
Mucking	2	35	39.2
Preparing to drill	0	17	4.3
Drilling	2	39	40.3
Loading and shooting	0	25	6.3
Total	6	35	100.0

Transportation

Western dump cars, hauled by combination trolley and storage battery motors, were utilized. At the commencement of operations, three-car trains were used. As the work progressed, the trains were increased to seven and eight cars but were reduced to six cars on the longer haul. Passing tracks having a capacity of 12 cars in the clear were installed at an approximate distance of 2,000 feet. The gage of the tracks was 3 feet. With the exception of an occasional derailment, there was no delay on account of lack of empty cars. The longest haul required 35 minutes to make the round trip from passing truck to dump and return, one motor being required for switching cars at the heading and one motor hauling to the dump. During the period of favorable progress, approximately 1,000 tons of rock were moved from the heading to the dump during each 24 hours.

Trimming

In order to accurately determine the area of rock projecting within the A line, a movable template was utilized. The outer perimeter of the template was formed to a line 18 inches inside of the A line. On this form, at 18-inch centers, spring steel feelers were attached, the outer edge of which designated the A line. As the template rolled on the concrete curb, constructed to accurate alignment and grade, the A line was painted on all projections, and after these projections were removed the area in question was rechecked by the repassage of the template. The efficiency of this method was manifest when the steel forms for concrete arch were placed.

From time of approval, the construction of the Roza Division has proceeded as outlined, under the direct supervision of C. E. Crownover, construction engineer, assisted by C. L. Albertson, field engineer; R. F. Skinner, concrete engineer; and H. W. Pease, office engineer.

The contract for excavation and concrete lining of tunnel No. 3 was awarded to Morrison-Knudsen Co., Inc., on January 9, 1936. Upon completion of camp construction, installation of equipment and approach excavation, work commenced on the north portal on March 23, 1936. Driven entirely from the north portal, the tunnel, 9,588 feet long, "holed out" on June 25, 1937, 459 days later.

The operations involved in driving large tunnels become so methodical that lost motion is reduced to a minimum. The casual observer would be under the impression that every action was a race against time. The magnitude and rapidity of action in such a confined area, with the attendant volume of noise, makes it essential that every workman be on the alert. By experience and training, each worker acquires a knowledge of where danger lurks, and the remarkable low record of accidents in the excavation of more than 200,000 cubic yards of tunnel excavation is a tribute to the precaution exercised throughout by the workers in tunnels Nos. 1 and 3.

As the interested spectator stands within the portal of the tunnel and observes the bright light which designates the other portal, nearly 2 miles distant, there develops a feeling of intense emotion. As the mind grasps the significance of the achievement and a realization of the permanency of the completed structure, the impulse will be irresistible to stand for a brief period in silent tribute and pay honor to those men, who, by their united and untiring energy, have successfully completed this structure, which, on through the coming centuries, will continue to function and contribute to the health and happiness of mankind long after the world has forgotten even the most famous of today.

CONTENTS

THE RECLAMATION ERA • MARCH 1939

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) . . . .

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

March 1939.

(Name) . . . . . .

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. . . . . .

[1] Do not send stamps.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

NOTES FOR CONTRACTORS

Specification No.	Project	Bid opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
816	Central Valley, Calif.	*1939* Jan. 19	Furnishing and installing four 75,000 kilovolt-amperes generators for the Shasta power plant.	General Electric Co.	Schenectady, N. Y.	$2,190,999.00	F. o. b. Schenectady	*1939* Feb. 3
818	Boulder Canyon, Ariz.-Nev.	Jan. 3	Power transformers for units A-1 and A-2, Boulder power plant.	do	do	376,350.00	F. o. b. Boulder City	Feb. 4
1159-D	All-American Canal, Ariz.-Calif.	do	Preparation of concrete aggregates near station 116, All-American Canal.	San Gorgonio Rock Products.	Banning, Calif.	49,270.00		Jan. 27
1161-D	Colorado-Big Thompson, Colo.	Jan. 5	Construction of 51½ miles, 69,000-volt transmission line, Green Mountain Dam to Grand Lake.	W. O. Allison	Grand Junction, Colo.	31,960.50		Do.
1163-D	Columbia Basin, Wash.	Jan. 4	18 cast-steel, draft tube pier roses for Grand Coulee power plant.	American Rolling Mill Co.	Middletown, Ohio	18,669.20	F. o. b. Middletown; discount ½ percent.	Feb. 6
1166-D	Boulder Canyon, Ariz.-Nev.	Jan. 19	2 turbine inlet pipes for units A-6 and A-7, Boulder power plant.	Consolidated Steel Corporation, Ltd.	Los Angeles, Calif.	18,155.00	F. o. b. Los Angeles.	Feb. 7
1167-D-1	Columbia Basin, Wash	Jan. 25	Miscellaneous metalwork for fish traps for migratory fish control at Rock Island Dam.	Steel Construction Co.	Portland, Oreg.	5,200.00	F. o. b. Rock Island; discount ½ percent.	Jan. 27
1169-D	Boise-Payette, Idaho	Jan. 20	Earthwork "A" Line Canal laterals 10.7 to 19.9.	J. A. Terteling & Sons	Boise, Idaho	11,799.90		Feb. 7
1170-D	Central Valley, Calif.	Jan. 24	Plate-steel discharge pipes and flap valves for pumping plants Nos. 1, 2, 3, and 4, Contra Costa Canal.	California Steel Products Co.	San Francisco, Calif	[1] 5,654.00	F. o. b. San Francisco; discount 2 percent.	Jan. 31
				The R. Hardesty Manufacturing Co.	Denver, Colo.	[2] 2,400.00	F. o. b. Denver	Do.
1176-D	do	Jan. 30	1 full-revolving, convertible-type, truck crane with power-shovel attachment, mounted on a 4-wheel drive, heavy-duty truck.	Bay City Shovels, Inc.	Bay City, Mich.	9,600.00	F. o. b. Bay City; discount $50.	Feb. 6
33,056-A	do	*1938* Dec. 30	Steel reinforcement bars (866,900 pounds).	Pacific States Steel Corporation.	San Francisco, Calif	18,015.83	F. o. b. Delta; shipping point Niles.	Feb. 3
B-47,440-A	do	*1939* Jan. 19	Steel reinforcement bars (721,870 pounds).	Judson Steel Corporation.	Oakland, Calif.	[3] 37,214.90	F. o. b. Los Medanos; discount ½ percent.	Feb. 8
33,015-A	do	*1938* Nov. 30	Track materials	Tennessee Coal, Iron & Railroad Co.	Denver, Colo.	[4] 162,702.08	F. o. b. Redding	Jan. 28
				Colorado Fuel & Iron Corporation.	do	[5] 43,586.53	F. o. b. Minnequa, Colo. and Columbus, Ohio; discount ½ percent.	Do.
				Pettibone Mulliken Corporation.	Chicago, Ill.	[6] 17,051.80	F. o. b. Redding	Do.
1171-D	Kendrick, Wyo.	*1939* Jan. 25	1 gantry crane, 35,000-pound capacity, for raising and lowering bulkhead gates at Seminoe Dam.	The Euclid Crane & Hoist Co.	Euclid, Ohio	8,015.00	F. o. b. Euclid	Feb. 7
1172-D	Central Valley, Calif.	Jan. 27	Structural steel for cover section of diversion tunnel for temporary Southern Pacific R. R. relocation.	California Corrugated Culvert Co.	Berkeley, Calif.	3,971.00	F. o. b. Chicago	Feb. 8
1147-D	do	*1938* Dec. 7	Telephone apparatus for use at Government camp at Friant Dam.	American Automatic Electric Sales Co.	Chicago, Ill.	2,077.00	F. o. b. Chicago	Feb. 13
1173-D	Columbia Basin, Wash.	*1939* Jan. 30	Stop-log guides and appurtenances for installation at intakes at Grand Coulee pumping plant.	William C. Schmitt d. b. a. Schmitt Steel Co.	Portland, Oreg.	17,928.00	F. o. b. Portland; discount ½ percent.	Feb. 17
1177-D	Gila, Ariz.	Jan. 31	Top-seal radial gates and radial-gate operating and control equipment for Gravity Main Canal.	Commercial Iron Works.	do	[7] 10,549.00	do	Do.
1175-D	Colorado-Big Thompson, Colo.	Feb. 2	Construction of 30-mile transmission line from Loveland, Colo., to east portal of Continental Divide Tunnel.	Vetter & Son and T. J. Faires.	Colorado Springs, Colo.	16,485.60		Feb 21
1178-D	Yakima-Roza, Wash.	Feb. 8	Radial-gate hoist at Roza diversion dam headworks.	Smith Corporation d. b. a. General Iron & Steel Works.	Portland, Oreg.	1,475.00	F. o. b. Portland; discount ½ percent.	Feb. 17
A-33,819-A	do	Jan. 21	Steel reinforcement bars (575,619 pounds).	Northwest Steel Rolling Mills.	Seattle, Wash.	11,512.38	F. o. b. Seattle; discount ½ percent.	Feb. 20
822	do	Feb. 8	Hoists for two 110-foot roller gates at Roza diversion dam.	Foote Bros. Gear & Machine Corporation.	Chicago, Ill.	41,577.16	F. o. b. Chicago	Feb. 21
1183-D	Colorado-Big Thompson, Colo.	Feb. 20	Heating system for dormitory at Government camp at Green Mountain Dam.	Jardine & Knight Plumbing & Heating Co.	Colorado Springs, Colo.	1,374.00		Feb. 24
819	Kendrick, Wyo.	Jan. 26	Construction of transmission line from Seminoe Dam to Cheyenne, Wyo.	Larson Construction Co.	Denver, Colo.	59,678.00		Feb. 27

[1] Item 1.
[2] Item 2.
[3] Schedules, 1, 2, and 3.
[4] Schedule 1.
[5] Schedules 2 and 5,
[6] Schedule 8.
[7] Items 1 and 2.

Livestock Feeding Improves Soil Fertility

On the Lower Yellowstone project 170 farmers are feeding livestock and consider it an important practice in good farm planning. During the fall and winter they have been fattening 109,000 lambs, 600,000 ewes, and 700 head of cattle. They have also wintered 13,000 head of ewes and 700 head of cattle. This profitable farm business makes a market for home-grown alfalfa, sugar-beet tops, grain, and other forage crops and keeps the fertility on the farm.

Fishing Boat on Lake Mead

REMODELED as a fishing boat for the use of visitors to Lake Mead, the *Navajo* was launched on January 23 by the Grand Canyon-Boulder Dam Tours, Inc.

The boat was properly dedicated by Ernest E. Tossot, Bob Ferguson, Earl Brothers, and Harold Jenkins, who comprised the first fishing party to cruise the boat through Boulder Canyon.

The *Navajo* will be available for charter by parties desiring to go fishing.—*Las Vegas Age.*

American Concrete Institute Meets in Annual Convention

THE thirty-fifth annual convention of the American Concrete Institute was held in New York, March 1–3. Members of the technical staff of the Bureau of Reclamation in Denver, Senior Engineer Arthur Ruettgers and Engineer E. N. Vidal, who are chairmen of two important standing committees and hold active memberships on other committees of the institute, represented the Bureau at the meeting and presented data and papers at the convention sessions.

General Information Concerning the Glendive Division of Buffalo Rapids Project, Montana

By PAUL A. JONES, *Construction Engineer*

THE Glendive Division of the Buffalo Rapids project, Montana, is situated on the north and west side of, and adjacent to the Yellowstone River between Fallon and Glendive, Mont., in the counties of Prairie and Dawson. The entire Buffalo Rapids project, as laid out in reports by the Bureau of Reclamation, covers all arable areas adjacent to both sides of the Yellowstone River between the mouth of the Big Horn River and the Lower Yellowstone irrigation project, Montana and North Dakota.

In consideration of the fact that the Glendive Division is the first project, or portion of a project, that has been started by the Bureau in cooperation with the Works Progress Administration, the description of such a project would not be complete without a chronology leading up to its inception.

In 1933 the Mid-Yellowstone Recovery Association, an organization of business men in the district, for the purpose of promoting development of natural resources within the district as a means of eliminating or relieving the depressive conditions, had been formed and it was through the efforts of this organization that the Bureau of Reclamation made an investigation and issued a report in August 1935 on the areas lying between Miles City, Mont., and the Lower Yellowstone project. A supplementary report by the Bureau was issued in January 1937 on the lands between Miles City, Mont., and the mouth of the Big Horn River.

Three schemes of development of the area were taken into account in the original report and considered, namely, a gravity scheme for diversion of water for irrigation, a pumping scheme, and a combination of gravity and pumping scheme. None of these schemes was considered feasible from a strictly economic standpoint, i. e., the land could not be expected to return the total construction charge for any one of the plans, and therefore, in order to develop any part of the Buffalo Rapids project, part of the construction cost must be furnished by some source other than the landowners.

It was not considered possible to secure grant from W. P. A. or other Government agencies sufficient to begin construction of the entire project for the reason that the grant would be out of proportion to the population affected, and for this reason the pumping scheme for separate divisions of the project was selected as the most practical means of development, and the Glendive division, consisting of approximately 18,000 acres, was selected as the most feasible division for development under some scheme of cooperation of governmental agencies.

It was not until June 1937 that the Secretary of the Interior issued his finding of feasibility, and then only with regard to engineering features and restricted the economic feasibility to a reimbursement of $776,000. Before Congress adjourned that year the Glendive division of the Buffalo Rapids project was approved along with other projects, but no provision was made to furnish funds for construction.

On August 26, 1937, the President allocated $1,605,000 of that portion of the fund appropriated for Emergency Relief Administration which had been earmarked for public buildings, water supply, etc., for the construction of the first, or Glendive division of the Buffalo Rapids project. About October 10, 1937, all regulations, concerning the expenditure of the fund, were established, which placed all the funds at the disposal of the Bureau of Reclamation but required $829,000 to be expended in accordance with all the regulations of the Works Progress Administration's method of procedure for relief labor and to be nonreimbursable. No special restrictions were placed on the expenditure of the $776,000, which is subject to the general regulations of the Bureau of Reclamation on other irrigation projects and which is reimbursable as a construction cost.

As this project was inaugurated partially, and you might say, principally as a relief project, it was important that construction be started before the winter weather became too far advanced. It was not until October 28, 1937, that definite plans had been approved for beginning construction, and it was therefore necessary to borrow equipment to get under way before the ground became too badly frozen. One dozen four-horse fresnos were borrowed from the W. P. A. headquarters at Miles City, Mont., a four-horse grading or road plow was borrowed from a resident of Dawson County, and a small beginning was made on November 12, 1937, which gradually increased, thus absorbing the relief load until at present the Buffalo Rapids project has practically eliminated the unemployment situation in this district.

Practically all the land within the proposed boundaries of the project are in private ownership. An examination of the arable area was made by a Bureau of Reclamation agriculturist, and the areas considered feasible for irrigation were divided into three classes. The approximate area of each class is as follows: Class I, 7,700 acres; Class II, 9,400 acres; and Class III, 300 acres. Most of the ownerships are in relatively large holdings, varying from one-half sections to two or three sections.

Crops suitable for most of the northwest irrigated lands will be suitable for this project, but undoubtedly will be confined principally to alfalfa, grain, potatoes, and sugar beets, with alfalfa and sugar beets as the principal crops.

Construction Features

The project features consist of a pumping plant, main canal, and lateral system.

The pumping plant is being constructed for a lift of 102 feet, and will contain three pump units with a capacity of 119 second-feet each, two of which are to be installed at present and the third sometime in the future for relift areas. The relift areas are not being considered at this time owing to insufficient funds and cheap power. The power is furnished under contract by the Montana-Dakota Utilities Co. and consists of its excess power under its present generating facilities.

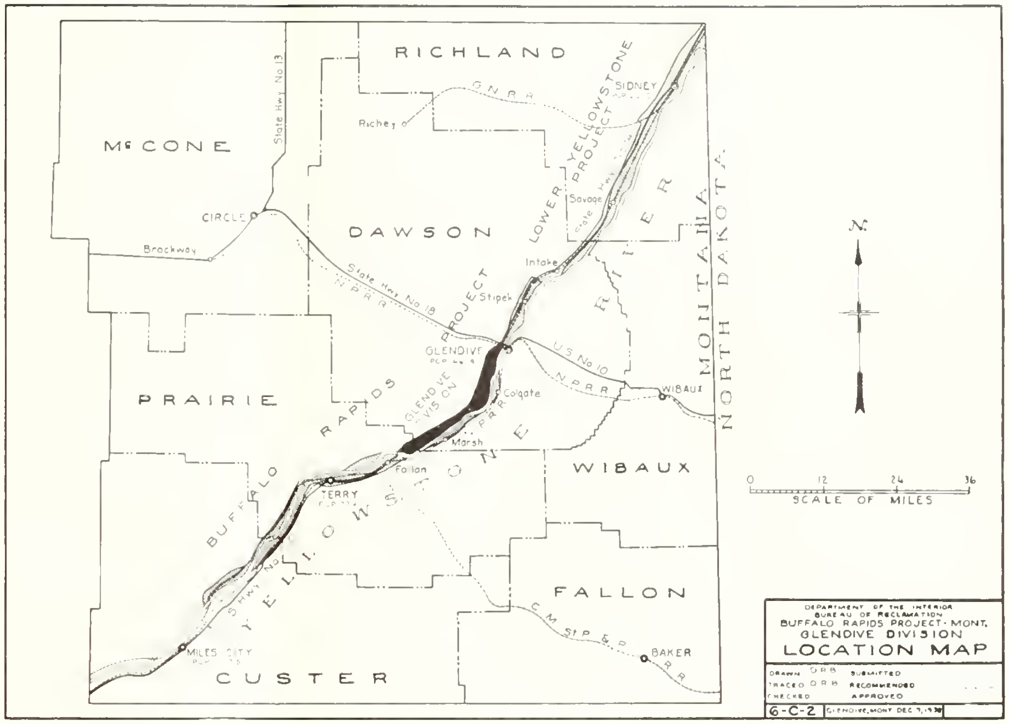
The main canal is designed to irrigate the entire area of 18,000 acres, and is approximately 30 miles in length, following close to No. 10 highway for the upper one-half of its length. There are five highway bridges and 12 inverted siphons included in the principal structures.

The lateral system is designed to deliver water to the high point of each 80 acres, and in most cases the laterals extend down fairly steep slopes requiring many drops, checks, and chutes, which are all being constructed of concrete.

There will be approximately 9,000 cubic yards of concrete, 1,300,000 cubic yards of main canal and pump plant excavation, and 140,000 cubic yards of lateral excavation as the principal items of construction.

The project as of November 1 last was about 40 percent complete; 1,215 cubic yards concrete, 646,000 cubic yards main canal and pump plant excavation, and 54,000 cubic yards of lateral excavation having been completed.

All construction is being done by Government forces. As stated above this project is being constructed in cooperation with the Works Progress Administration and all labor, excepting owner-operators and 10 percent exemptions based on the number of laborers on security wage, is furnished by the employment division of the W. P. A., and the other is secured through the National Reemployment office. It has been the policy of this project office to reclassify security wage earners to owner-operators and exempt positions wherever possible, and in this manner relieve the unemployment situation to the greatest extent. As of November 15, 1938, there were only 25 noncertified employees as compared to 680 certified employees in the construction force, which includes 58 owner-operators of four-horse teams, and 43 owner-operators of two-horse teams. Thirty-three employees of the engineering and office force are not included. No difficulty has been encountered in obtaining capable help, and it seems to be generally agreed throughout the State that much more is being accomplished on this project per dollar expended in comparison with other W. P. A. projects in general. This is probably due to the fact that the excavation is being done principally with teams and the majority of the certified laborers are farmers, or farmers' sons who are familiar with this type of construction, also the district is relatively close to Fort Peck where some of the certified laborers have had previous experience.



Settlement

Nothing definite has been done to date regarding the settlement of the project. The principal reason for this is the fact that to date a contract with District No. 1 of the Buffalo Rapids project for the repayment of operation, maintenance, and construction charges has not been completed, nor has the appraisal of excess lands been completed and released for publication, which has also a retarding effect on the real estate transactions.

It is probable that water will be available for about 3,000 acres sometime in May 1939, which will insure a crop on this area next year, and it is also probable that the contract with the district and release of appraisals may be made in time to insure settlement of most of this area.

Facilities

The project is adjacent to Glendive, Mont., with a population of approximately 5,000, and where may be found all the accommodations of any typical American city of this size. Cross-country paved highway No. 10 extends full length of the project. The present division as being constructed is served by the Northern Pacific Railway Co., and the Chicago and Milwaukee Railway Co. is only a few miles from the upper end of the division.

Boulder and Parker Dams To Meet Power Shortage

SECRETARY of the Interior Harold L. Ickes has announced that a tentative agreement has been reached with the Salt River Valley Water Users' Association and the Central Arizona Light & Power Co., by which power can be supplied from Boulder and Parker Dams to meet a critical power shortage expected to develop this year in central Arizona because of a shortage in water supply.

Under the agreement the Bureau of Reclamation would construct a transmission line from Parker Dam, on the Colorado River, to Phoenix, and would complete the powerhouse at Parker Dam and install three 30,000-kilovolt-amperes capacity generators there.

Parker Dam, built by the Bureau for the Metropolitan Water District of Southern California, is 155 miles downstream from Boulder Dam. Half the power to be generated at Parker Dam belongs to the United States and the Government has the right to use or dispose of the other half until such time as it is needed by the Metropolitan Water District. A transmission line already has been constructed by the Metropolitan Water District from Boulder to Parker Dam. Until the electrical installation at Parker Dam is completed, it would be possible to supply the power required by central Arizona over this line.

The estimated cost of the Parker power development is:

Parker power plant	$7,831,000
Parker-Phoenix transmission line	1,300,000
Phoenix terminal substation	325,000
Total estimated cost	9,456,000

Of this cost, approximately $1,000,000 has already been expended in construction of the forebay and powerhouse substructure, this having been done while Parker Dam was being built.

The annual revenues from the sale of power from Parker Dam are estimated at $920,000, and the Salt River Valley Water Users' Association and the Central Arizona Light & Power Co. each is ready to guarantee a minimum annual payment of $220,000. Part of the power from the Parker plant will be necessary to pump water on the Gila Reclamation project, now under construction near Yuma. The revenues are estimated to be sufficient to repay the cost of the power development and transmission line with interest at 3½ percent in 17 years.

If funds are provided so that this program can be carried out in time to meet the critical situation with respect to power which is developing in the vicinity of Phoenix, it will be necessary to start work on the surveys for the transmission line at once. It is estimated that 2 years will be required to complete the installation of the units in the Parker power plant.

The Salt River Valley Water Users' Association is the organization which, under contract with the Government, operates the Federal facilities in connection with the Salt River Valley reclamation project. The association supplies power from plants at the dams on the Salt River widely in central Arizona. The Central Arizona Light & Power

(*Continued on page 64*)

Reclamation Trains the CCC Enrollee

By ALFRED R. GOLZÉ, *Supervising Engineer, CCC*

THE conservation activities of the Civilian Conservation Corps have not been limited to the wise development of our natural resources. From its inception in 1933, the corps has offered an unequaled opportunity to unemployed young men and those in needy circumstances to acquire by practical training the elements of craftsmanship and good character that would make them useful citizens. The Congress, in the act approved June 28, 1937, establishing the CCC as a successor to the original Emergency Conservation Work, recognized this educational obligation on the part of the Federal Government, stating vocational training to be one of the purposes of the CCC.

The widespread conservation operations of the Bureau of Reclamation of the Department of the Interior, in reclaiming for agriculture the fertile soil of the arid western United States, have provided an unusual opportunity for the training of CCC enrollees, coincident with the construction and operation of irrigation reservoirs, the canals and the related structures required for the efficient delivery of irrigation water to the farm lands.

Varied Types of Reclamation CCC Work

CCC enrollees from the 42 camps located on Federal Reclamation projects are engaged in a great variety of work designed to be of permanent value to the projects. This work includes the construction of small dams, the clearing of reservoir sites, the construction of parapet walls on major dams, the construction of main and lateral canals, the building of water-control and water-measuring structures throughout the canal system, the construction of operation roads paralleling the canals, the lining of canals with concrete to eliminate seepage of valuable irrigation water and to control erosion, the building of flumes and siphons, the riprapping of natural and artificial waterways with rock or gravel to eliminate bank erosion, the planting of special plants and grasses for the purpose of demonstration, controlling weeds on Government land, and the development of recreational areas at water-storage reservoirs.

The thousands of CCC men at work on these widely divergent construction activities are learning daily the fundamental details that will prepare them to earn their own living when they leave the CCC. Because of the great importance of this training program, records of the enrollees who accept employment in other fields on leaving the corps are kept whenever possible. These records do not tell the complete story of job training, however, since many boys who leave the CCC at the end of their enrollment period and secure work in their home communities do not always report this employment to the CCC authorities in the camps.

In the calendar years 1937 and 1938, 997 cases of enrollees who were discharged from camps on reclamation projects to accept jobs were reported to the Washington office of the Bureau of Reclamation. Based on these cases, a study has been made of the relationship between the actual work in the camp and the type of employment accepted by the boys after leaving the camps.

Reclamation CCC Work Related to Jobs

The 997 cases on record were examined and it was found that 65 percent, or approximately two-thirds of the boys, accepted work in four primary fields: 20 percent went on farms, 16 percent became store clerks and attendants, 15 percent were hired as unskilled workers, and 14 percent became truck drivers. The large group of boys who accepted work on farms is attributed to the fact that in this 2-year period the majority of the boys assigned to Reclamation camps came from farming areas in the Middle and far West. Their experience gained in Reclamation work so closely allied with agriculture, and including a newly acquired familiarity with machinery and equipment of all kinds, was particularly beneficial to them as farmers.

Included in the large group of store clerks and attendants are many boys now employed in grocery stores, in hardware stores, in drug stores, in filling stations and automobile service stations. While in the CCC, these boys were employed primarily as clerks in the camp offices and tool rooms, and as truck drivers and equipment operators.

In the third group of unskilled workers are those boys who accepted unskilled work, but work which required some knowledge of what constitutes a day's labor. They were hired principally by factories, steel mills, shops, and by contractors on construction operations.

The number of boys in the fourth group able to secure good jobs as truck drivers in private employment is proportionately large, owing to the fact, it is believed, that many of them while in the CCC operated the trucks and tractors which are required in large

CCC enrollees constructing canal diversion dam and sluiceway, Hyrum project, Utah

numbers by the Reclamation camps for the many tasks of moving huge quantities of earth, gravel, rock, timber, cement, and miscellaneous supplies.

It is of interest to trace the employment records of the enrollees in the other one-third of the cases not included in the foregoing discussion. The work of this group is subdivided into eight general types of work: Miscellaneous employment 37 percent, United States Government permanent employment 16 percent, auto mechanics 11 percent, carpenter helpers 11 percent, miners 8 percent, tractor operators 7 percent, lumbermen 6 percent, and painters' assistants 4 percent.

All of these classes of employment are related to the field work of the Reclamation camps and their primary construction program. The influence of equipment in training the enrollees for gainful work is especially noticeable, not only for the truck drivers, tractor operators, and mechanics, but also for the farm boys and the many clerks and attendants connected with the operation of privately owned establishments for servicing and selling equipment.

During 1937 and 1938, 55 men from the Reclamation camps were appointed to permanent positions in the Federal Government. Twenty-five of the men were appointed by the Secretary of the Interior to responsible positions as clerks, foremen, and subforemen connected with the operation of the CCC camps allocated to the Bureau of Reclamation. The other 30 enrollees were employed by other Government departments; many went into the United States Navy. In addition to the 25 men appointed from among the enrollees in the Reclamation camps, the Secretary also appointed in this 2-year period, 19 enrollees from camps of other services to act as junior assistants to technicians on CCC Reclamation work. Nearly all of the Reclamation camps have as one member of their supervisory personnel, a former enrollee who earned his promotion by plain hard work.

The wages and salaries paid these boys, who have left the enrollee ranks to earn their own way, are no less interesting as a study than the types of work. The average CCC boy, who left a Reclamation camp in 1937 or 1938 to accept a job, was hired at a wage of $67.41 per month. The individual wages earned range from $21 per month for men enlisting in the Navy to $200 per month ($1.25 per hour) for semiskilled work as a welder. The wage groups show that 5 percent of the boys received $30 or less per month; 29 percent received $40 to $60; 37 percent received $60 to $75; 22 percent from $75 to $100, and 14 percent received over $100 per month. The wages reported in the lower brackets, usually paid to the farm boys and those who enlisted in the military service, do not include any allowance for subsistence or quarters, which accommodations are usually furnished with that type of employment. This consideration would tend to raise the general level of the wage scale paid to enrollees who have left the camps.

CCC enrollees lining small canal with concrete, Yuma project, Arizona

A few typical cases are of interest. One enrollee who served 30 months in a Reclamation camp in Montana as warehouse and toolroom clerk later was employed at $90 per month as a stockroom clerk in an automobile agency. A boy who spent a year in a Reclamation camp in Nevada assisting carpenters on concrete form construction was hired by a silver mining company at $5 per day as a rough carpenter. A boy who drove a truck for 16 months in a Reclamation camp in Oregon returned to his home State of Kentucky to accept a job as truck driver for an oil company at $3 per day. Another CCC truck driver from a Reclamation camp in New Mexico returned to his home in Pennsylvania to drive a truck for a local hardware store

Masonry steps and walls under construction by CCC enrollees, Elephant Butte Reservoir, Rio Grande project, New Mexico

and supply house at a wage of $22.50 per week. An enrollee who operated a tractor at a Reclamation camp in Idaho, was hired by an Idaho farmer at $4 per day.

Many of the CCC camps allocated to the Bureau of Reclamation are occupied by CCC companies from other sections of the country. The records show that when a boy leaves a Reclamation camp, the job he accepts is usually in the same general section of the country from which he originally enrolled in the CCC. Only 6 percent of the 957 enrollees on record as having secured jobs were former eastern boys who accepted permanent employment in the far West.

These actual job histories, while interesting and founded on fact, cannot be considered as a criterion for the CCC as a whole. The records do show unquestionably that the work projects are providing the types of training for useful citizenship.

Practical experience on the job and related classroom instruction off the job, provided by the technical agency's supervisory personnel, combined with the more academic education received from the educational advisers assigned each camp, have proven generally successful in training CCC enrollees. An orderly way of living, acquired by the enrollees from their camp life under Army supervision, has strengthened their character. The men who leave the camps are able to command respectable salaries and become valued employees in private industry.

Boulder and Parker Dams to Meet Power Shortage

(Continued from page 61)

Co. is a utility operating in the same genera vicinity. Both these agencies are threatene with a power deficiency because of sma stream run-offs in central Arizona and a extended drought there.

The plant to transmit power from Park Dam to Phoenix is a new developmen brought up for immediate consideration be cause of the emergency in central Arizon The plant to complete the powerhouse a Parker Dam and to install the generato there, however, is not new, but was include in the plans of the Metropolitan Water Dis trict for its Colorado River aqueduct, and i the plans of the Bureau of Reclamation fo the Gila project. To construct these facilitie at this time will simply mean advancin the date at which their construction wa planned.

"If this plan is carried forward," Commis sioner of Reclamation Page states, "it wi enable us to meet an emergency situation i central Arizona and at the same time t utilize power potentialities at Parker Dam i the immediate future, instead of delaying thi utilization for several years.

"It seems to me that it is in the interests o the Government to put this power to wor and to obtain a return on the investment a once."

Ferry To Operate on Lake Mead

ACCORDING to press reports, the Gran Canyon-Boulder Dam Tours, Inc., made ap plication on February 15 to the Mohav County Board of Supervisors for a franchis for the construction, operation, maintenance and upkeep of a ferry across that part o the Colorado River now known as Lak Mead, at the location commonly calle Pierces Ferry.

The ferry will eliminate about 100 mile from the route traveled from the strip o Arizona north of the Colorado River t Kingman, Ariz., the county seat of Mohav County.

Bean Sorting Machines Installed on North Platte Project

CHESTER BROWN, the largest dealer i beans on the North Platte project, has in stalled a battery of "electric eye" bean sort ing machines at Morrill, Nebr. These ma chines separate black from white beans an do the work formerly done by hand picking Thirty-two of these machines have been in stalled at Morrill, and an additional thirty two are being installed at Gering.

Large Siphons on Belle Fourche Project

Constructed by the Civilian Conservation Corps

By F. C. YOUNGBLUTT, *Project Superintendent and Regional Director, CCC*

RECENT rehabilitation work completed on the irrigation system of the Belle Fourche Federal Reclamation project in western South Dakota, by the enrollees of the Civilian Conservation Corps has included construction of three major siphons, two of concrete lock-joint pipe on the North Canal, and one of monolithic poured-in-place concrete on the South Canal. An outstanding feature of the North Canal siphons was the casting of the necessary concrete pipe in a pipe plant during the winter months when outside work was at a minimum.

The Pipe Plant

The pipe was cast in a plant at the Newell, S. Dak., project headquarters, housed in a frame structure 50 by 100 feet with two furnace stoves to maintain suitable temperatures. The plant had a capacity of 8 pipe units or sections per day, requiring 16 base rings to give a minimum curing time of 44 hours before handling. The plant layout provided for pouring concrete in two rows, with a U-shaped platform extending around the outside of the pouring area on a level with the top of the forms, the finished pipe being rolled out the open end. A traveling beam-derrick with hoist spanned both rows to handle forms and pipe.

Mixing proceeded at the closed end of the platform with the mixer elevated sufficiently to give an equal ramp lift for the boys wheeling aggregate and for those wheeling to the forms. A low-pressure boiler supplied steam during the night to each pipe section and by covering them with tarpaulins, temperatures were maintained at 80° to 100° F. within the shell, for about 10 hours before stripping forms and again the next night before the pipe was handled. Following removal of the pipe sections from the plant, a curing compound was applied to all pipe surfaces.

About 30 enrollees arrived on the job each morning 5 days per week, and all had definite assignments in order to coordinate the various steps in the process. One group promptly began removal of the pipe poured 2 days before and cleaned the base rings. Others stripped pipe sections poured the preceding day, cleaned and greased the metal surfaces and set forms and reinforcement for the day's work. In the meantime, aggregate was heated and measured outside the building. The mixer was started when four or five forms were ready, usually about 10 a. m. Pouring was generally completed by 2:30 p. m. which left an hour for cleaning up. Fabrication of reinforcement cages and copper strips was carried on each day with six or seven men. The mix was standard requiring nine sacks of cement per pipe section, each 4-foot pipe section weighing 4,320 pounds and containing 1.1 cubic yards of concrete.

North Canal Siphon

Prior to the establishment in 1934 of Camp BR-2 at Orman Reservoir, an old wood pipe siphon 3,200 feet long and laid on the ground surface at Mile 43.5 on the North Canal, carried irrigation water across a natural depression. In use over a long period of years, this structure was in poor condition, and because of unsatisfactory economic conditions, its replacement had become a major problem. Solution of the problem was accomplished by reconstructing the siphon as a CCC work project, using 60-inch diameter concrete lock-joint pipe placed underground.

Manufacturing of pipe for the North Canal siphon began September 28, 1935, and was completed April 3, 1936, with 796 four-foot units ready for use. Three CCC dump trucks were used for hauling to the site 6 miles northeast of Newell, each carrying one pipe section securely fastened by a chain clamp. Through a system of pit loading no machinery was required. For unloading, the trucks drove alongside the previously excavated trench and the pipe sections were then handled by a chain hoist traveling on a beam. In this way they were placed in the trench to proper line and grade. The I beam was of sufficient length to span not only the trench but also the driveway and was supported on A frames traveling on rails laid parallel with the trench. A heavy iron "clothes pin" slipped over the 5¼-inch pipe shell to form the fingers of the handling equipment.

The North Canal siphon design provided for its construction on a center line offset from the existing wood structure to permit installation of a major portion during the irrigation season while the wood siphon was still in service. A monolithic section at the lowest point or blow-off was first constructed and laying of the pipe sections began June

Dry Creek siphon under construction

4, 1936. Progress was at the rate of 20 pipe or 80 linear feet per day and the end connections were completed on October 16. Work was suspended from August 5 to September 21 to await the end of the irrigation season and removal of the old siphon. Trench excavation was done by the project dragline, but the CCC crews took care of all other work, including backfilling by tractors, except that more experienced men were used on the monolithic portions and to supervise important details, as pouring joints. A 6-inch drain tile line embedded in gravel was laid under the siphon to take care of seepage. The gravel also provided a suitable base for the concrete pipe.

Dry Creek Siphon

In 1937, CCC enrollees undertook a similar project in the reconstruction of Dry Creek siphon on the North Canal at Mile 35.4, 5 miles north of Newell. Pipe for this structure was manufactured during the preceding winter. The new structure was designed as a double barrel 60-inch lock-joint concrete pipe line 886 feet in length to replace a badly deteriorated No. 180 metal flume and was offset 50 feet from the old structure. The construction procedure followed the same general plan as in the preceding year, but at this location it was necessary to deal with probabilities of storm water, and field operations did not commence until June 19, normally a time when spring rains have ceased. The blow-off section had been completed and several hundred feet of pipe had been laid in both lines when a rainy spell set in July 10 that sent the creek flooding over the protecting dikes and over the entire job, ending operations until July 21. No equipment was lost, but some was rescued under difficulties. The pipe installation was finally completed on October 8, and construction of the inlet and outlet connections to the canal required another month.

Subsequent canal operation has proven the worth of both siphons, leaks and maintenance being nonexistent in contrast to the old structures that had averaged $530 upkeep cost per year, had leaked valuable irrigation water profusely at a time when water supply was short, and whose imminent failure threatened to cut off the water supply of an important sector of the project.

Stinkingwater Siphon

For the season of 1938, the Stinkingwater siphon on the South Canal at Mile 9.7, located 1½ miles southwest of Nisland, was planned as the principal CCC enterprise to replace a double No. 192 metal flume, 200 feet long. The design called for monolithic concrete construction, 8 feet in diameter with an 8-inch shell, heavily reinforced to withstand the rigor of a 39-foot dip under creek.

A considerable portion of the structu could not be completed until the close of t irrigation season and removal of the flum The preliminary excavation work began Jul 20. Following the dragline excavation, temporary wooden flume was erected to tal storm water over the trench. Circular-for work and placing ring steel was new for th CCC boys, and required a great deal of i struction on the job, although suitable pro ress was maintained by experienced e ployees, where needed. After the first barr section was poured August 19, the work b came smoother and the various groups a signed to cutting and bending steel, assistin on carpenter work and wiring reinforcemen and removing forms all became more ade in their duties. The last of the concret work was finished December 9, 1938, an backfilling a week later. An important fea ture of the improvement was the constructio by CCC tractors of a new section of canal t connect with the siphon outlet, which r quired excavation of about 15,000 cubic yard and provided a substantial channel, replacin one with insecure banks.

These siphons are only a few of the pe manent betterments to the Belle Fouche Fed eral Reclamation project accomplished b CCC Camp BR–2 in the 4½ years of opera tion on the project. The conservation o water and greater security of water suppl provided by these structures came during period of farming distress brought abou largely by drought and the resultant wate shortage. They have made it possible t keep land under irrigation that otherwis might have returned to the desert. At th same time, the CCC enrollees have gaine valuable experience in lines that may late mean permanent pursuite in concrete co struction or equipment operation.

Concrete pipe yard adjoining pipe plant

Milk River Holds Annual Livestock Feeders' Day

THE annual livestock feeders' day was hel on the Chinook Division of the Milk Rive project early in January. This event ha been growing in popularity for the past sev eral years, and about 450 persons attende this year's event. Many feeders from Grea Falls, Conrad, and Valier districts of the Su River project, as well as from all countie in the northern part of the State, wer present.

Much interest was displayed in the prog ress which is being made and the results ac complished by the feeders of this section, an it is believed the tour will do much towar the promotion of livestock feeding on th other divisions of the project more remot from the sugar factory and therefore not s accessible to the byproducts of sugar manu facture.

Malheur County Farmers Attend Feeding Tours

ON January 24, 1939, Russel McKennon, Malheur County agricultural agent, assisted by H. A. Lindgren, Oregon State College livestock specialist, conducted a party of 150 interested farmers and business men on a tour to observe methods of livestock feeding on the Owyhee project. The purpose of this tour was to acquaint Owyhee project settlers with the opportunities for greater profits to be found in the development of this branch of farming.

Early in the forenoon the caravan assembled at the Cooperative Stock Yards near Ontario, Oreg., where a short talk was given by the yard manager, Mr. Adrian, dealing with mixtures and amounts of feed used in preparing stock for market. The cattle are started on a ration of chopped hay, corn, and a small amount of beet pulp. The amount of beet pulp in relation to the hay and grain is gradually increased as the animals become accustomed to the new food. The use of beet pulp has proved to be economical as well as practical in the fattening of livestock as one ton of beet pulp at the current price of $2 will replace in feed value a $6-ton of hay. After Mr. Adrian finished his talk, a number of questions were asked which brought out the fact that beet pulp conditions stock as well as hay or grain, and the animals stand shipment with a minimum amount of shrinkage. Since the inauguration of beet pulp feeding, sickness in herds of beef cattle has also been considerably reduced.

Above: Tour party inspects feed lots

Left: Feeder lambs on Fred Trenkel ranch

Right: Tour party listens to talk on feeding methods

Specialist Addresses Tour Party

The next visit was to the feeding pens on the ranch of Fred Trenkel where about 500 April lambs were being fattened for market. Mr. Trenkel gave a short summary of his methods of fattening and caring for feeder lambs. Mr. Lindgren, at the request of County Agent McKennon, demonstrated the methods used by buyers in selecting lambs for market. The caravan then moved on to other feed lots where the owners were interviewed concerning methods and costs of feeding.

Lunch for the party was served by the American Legion Ladies Auxiliary at Nyssa. After lunch Mr. Lindgren spoke briefly, outlining the possibilities for development of livestock feeding in the Owyhee project area. Mr. Lindgren pointed out that facilities for winter stock feeding on the project had been substantially increased by the construction of the Amalgamated Sugar refinery. The pulp, produced as a byproduct in refining, when mixed with chopped alfalfa hay (of which a plentiful supply is readily obtainable) and a small amount of grain, provides an unexcelled low-cost stock feed. These facts, coupled with the present grain surplus in the Northwest and proximity to Coast markets, place the Owyhee project stockraiser in an enviable position as compared to stockmen in other sections of the country.

Following the address by Mr. Lindgren the group visited the Amalgamated Sugar Co. feeding yards where some 2,300 beef cattle are being fed. Officials of the company invited those in the party to inspect the interior of the new $2,000,000 refinery where they were given a opportunity to observe the manufacture of beet sugar.

Reclamation Organization Activities

Commissioner Page Returns to Washington

JOHN C. PAGE, Commissioner of Reclamation, returned to Washington on March 1 from a 2 weeks' official visit to the west coast.

Commissioner Addresses Rivers and Harbors Congress

COMMISSIONER of Reclamation John C. Page addressed the annual meeting of the National Rivers and Harbors Congress on March 23, at the Mayflower Hotel, his subject being The Multiple Purpose Project. (See inside front cover page.)

The Commissioner appeared before the Bureau of the Budget on March 8, in support of items proposed for the second deficiency bill.

W. R. Young at A. G. C. Convention

WALTER R. YOUNG, supervising engineer of the Central Valley project attended the twentieth annual convention of the Associated General Contractors in San Francisco and addressed a division meeting of heavy-construction and railroad contractors on March 8.

Carl A. Lyman in Washington

CARL A. LYMAN, examiner of accounts, arrived in Washington on March 10, on a special assignment of work in connection with the Minidoka project, Idaho.

Theodore L. Sundquist Appointed Second Administrative Inspector, Civilian Conservation Corps

THE increased number of CCC camps allotted to the Bureau of Reclamation has made the services of a second administrative inspector, CCC, necessary. Theodore L. Sundquist of Grand Junction, Colo., has been appointed by the Secretary of the Interior to this position. Mr. Sundquist has a varied background of engineering and CCC experience that well qualifies him for this important work. On completing his education at the Colorado School of Mines in 1917, Mr. Sundquist served in the 341st Field Artillery until the close of the war. From 1919 to 1931 he was engaged in contracting, drafting and general engineering connected with the mining industry. From 1933 to 1935, Mr. Sundquist served as technical foreman and engineer in CCC camps of the Forest Service and Division of Grazing. In August 1935 he was appointed superintendent of Camp BR-22, Grand Junction, Colo., a position he held until his appointment as administrative inspector.

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been authorized by the Secretary of the Interior:

Appointments

Columbia Basin:

Junior engineers: Gilbert G. Drake, and Hiram DePuy, Jr.

Provo River:

Junior engineers: Ellis L. Armstrong, Robert W. Jennings, and Wesley A. Behling.

Central Valley:

Assistant engineer: John A. Gilmont.

Engineering draftsman: Newton A. Miller.

Assistant engineering draftsman: K. Kenneth McNaughton.

Owyhee:

Reservoir superintendent: Dick R. Stockham.

Transfers

To Denver:

Associate engineer: George Tarleton, from Kendrick project (Seminoe Dam).

To Central Valley:

Senior engineer: Grant A. Bloodgood, from engineer on the All-American Canal project, Yuma, Ariz.

To Central Valley, Kennett Division:

Assistant engineer: Ralph H. Nelson, from Upper Snake River project, Ashton, Idaho.

To Tucumcari:

Associate engineer: Charles S. Rippon, from Kendrick project (Seminoe Dam).

To Colorado Big-Thompson:

Senior engineer: Miles E. Bunger, from Denver.

Reinstatement

All-American Canal:

Chief of Field Party: George E. Belden.

Separation

Denver Office:

Assistant engineer: Donald G. Worth, to accept position at the Bonneville Dam, Oreg.

Changes in Washington Office Effective March 13

J. W. MYER, formerly chief of Mails and Files, has been promoted to the position of Assistant Chief Clerk. He will report to Chief Clerk McCulloch, in whose absence he will serve as Acting Chief Clerk.

J. C. Beveridge, Jr., former Assistant Chief of Mails and Files, has been designated Acting Chief.

H. E. Rocker, former clerk in Mails and Files, has been designated Acting Assistant Chief. In the absence of the Chief of Section he will have supervisory charge.

Gordon B. Kaufmann Consulting Architect, Honored

GORDON B. KAUFMANN, F. A. I. A., Consulting Architect to the Bureau of Reclamation, has been the recipient of many honors during the past year.

In the spring of 1938, the American Institute of Architects elected him to Fellowship. The following July he was notified that he had been awarded two medals at the Paris exhibition—the gold medal for his design of the Times Building in Los Angeles and the bronze medal for the grandstand and clubhouse at Santa Anita Race Track designed in 1934.

The Boulder Canyon project was selected by the American Institute of Architects to be included in an exhibition of 100 noteworthy architectural subjects in the United States to be placed on exhibition in England. This exhibit will remain in England 1 year and upon its return will make a circuit of the principal cities of the United States.

In September 1938, Mr. Kaufmann served on a jury, together with Professor Hartley Burr Alexander and Millard Sheets, to judge the competition for a sculptural group to be placed on the Los Angeles County Fair Grounds at Pomona.

Recently he was awarded "Distinguished Honor Awards" by the Southern California Chapter of the American Institute of Architects for his design of the Medical Library, as well as one for the Times Building.

Mr. Kaufmann's private practice includes a variety of work. During the year 1938 he was engaged in designing a school, several private residences, additions to Santa Anita Clubhouse, Earl Carrol's Theatre Restaurant in Los Angeles, and an office building for Myron Selznick. His former work included some buildings at the California Institute of Technology and the entire development of Scripps College at Claremont, Calif. At present he is working on an engineering building for Vultee Aircraft Corporation and a large resort hotel in California.

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

John C. Page, Commissioner — Roy B. Williams, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; D. S. Stuver, Asst. Gen. Supr.; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Acting Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

R. F. Walter, Chief Eng.; S. O. Harper, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts; L. S. Davis, Engineer, C. C. C. Division

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H J S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Constr. engr	C B. Funk	B E Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Superintendent	George B. Snow	J. R Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	H. W. Bashore	Constr. engr	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B E Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam	Earp, Calif	Boyd E. Coffey	Resident supt		R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo	Charles A. Burns	Constr. engr	Frank E Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif
Sanpete	Provo Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont	A. W. Walker	Superintendent		W. J Burke	Billings, Mont
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr. [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C B. Elliott	Superintendent		R. J Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Adress
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitcheil.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River, W. U A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson Utah	S. W Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigatinn district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	V. W. Russell	Manager	G. L. Sterling	Ellensburg.

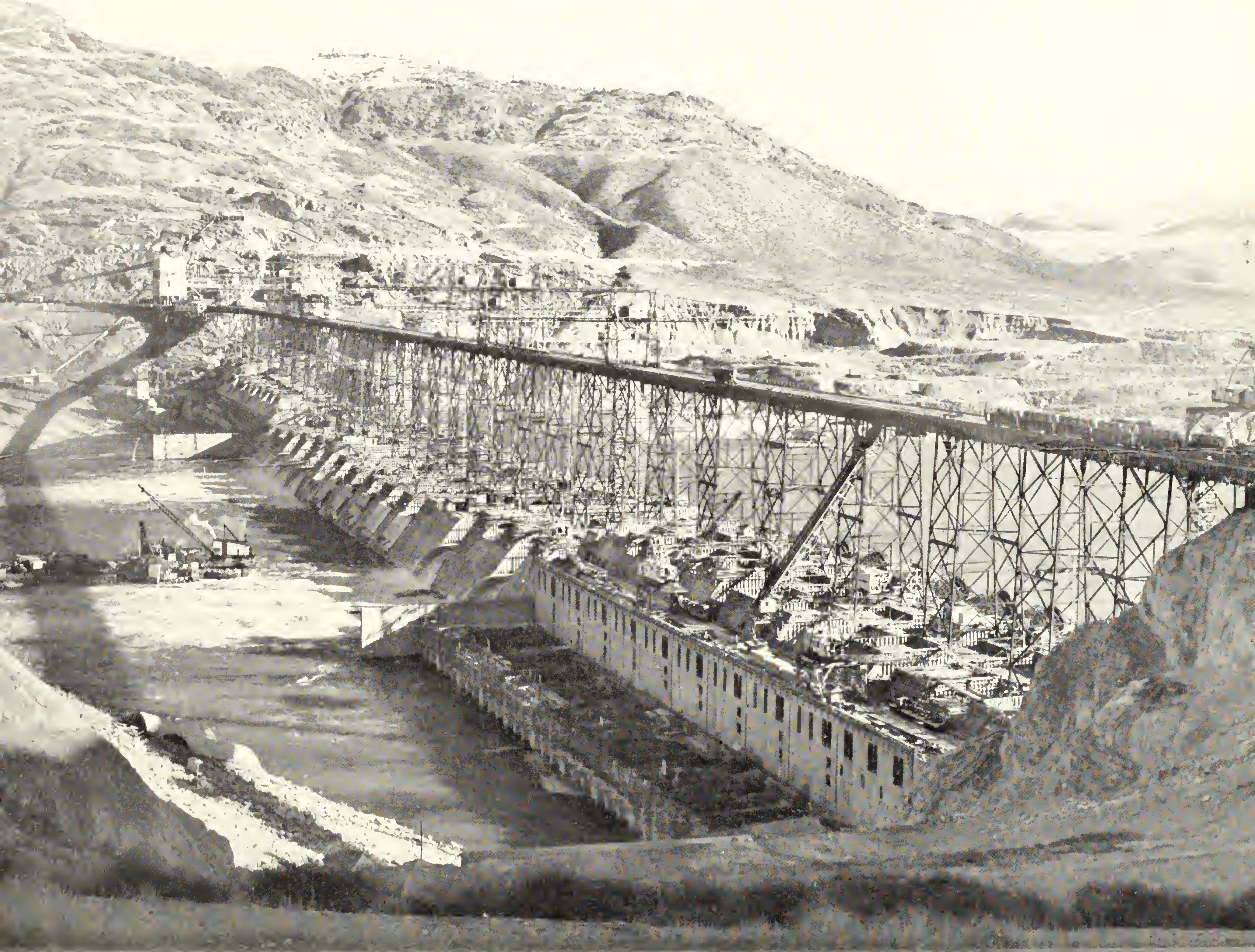
[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
King's River-Pine Flat (Calif.)	Fresno, Calif	S. P. McCasland	Associate engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Colo	W. G. Sloan	Engineer.
Marias (Mont.)	Denver, Colo	Fred H. Nichols	Associate engineer.
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo	J. R. Iakisch	Senior Engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate Engineer.
Balmorhea and Robert Lee. (Tex)	Austin, Tex	E. A. Moritz	Construction engineer.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

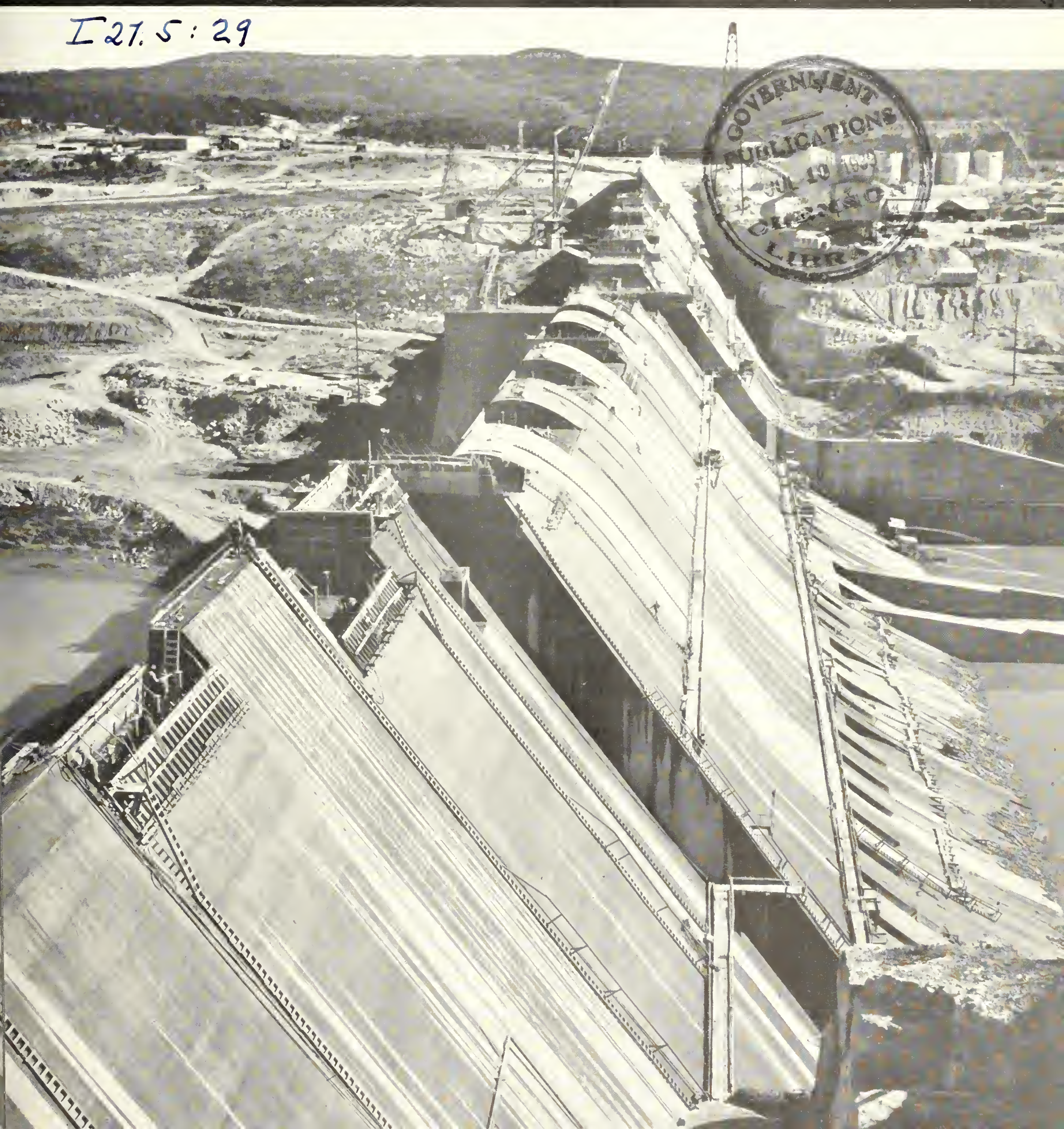
GRAND COULEE DAM, SHOWING PROGRESS ON POWERHOUSE CONSTRUCTION IN FOREGROUND



THE RECLAMATION ERA

APRIL 1939

MARSHALL FORD DAM, COLORADO RIVER PROJECT, TEXAS



Plans for Control of Migratory Fish at Grand Coulee Dam Approved

PLANS for permanent control of the migratory fish in the Columbia River were approved by the Secretary of the Interior, Harold L. Ickes, early in April.

Four hatcheries and other works costing approximately $2,500,000 will be constructed by the Bureau of Reclamation in connection with the Grand Coulee Dam.

The fish-control program is made necessary by the fact that, when completed, Grand Coulee Dam will be too high to permit the ascent by Columbia River salmon beyond the dam. The permanent works will be ready to care for runs subsequent to the 1939 runs of chinook, steelhead, and blueback salmon, which now reach Grand Coulee Dam in numbers totaling between 20,000 and 25,000 annually bound upstream to spawn. The 1939 runs will be handled on a temporary but adequate basis. They will be trapped at Rock Island Dam, below Grand Coulee Dam, and transported by means of a fleet of specially designed tank trucks to tributaries which enter the river below Grand Coulee Dam.

The plan as adopted is practically the same as the Brennan plan drawn up by the Washington State Department of Fisheries. The program includes the following features: Roads to Rock Island Dam, fish traps at Rock Island Dam, lake storage at Snow Lake, and purchase of a fleet of specially designed tank trucks. It includes construction of these additional features: Holding ponds at Icicle Creek; Icicle pipe line; a large hatchery at Leavenworth, equipped with screen chamber, rearing ponds, a fish-food plant, garages and a warehouse, an incinerator, and a hatchery building; the Wenatchee Canal, by which water to supplement the water taken from Icicle Creek will be provided; the necessary residences, right-of-way, and landscaping, walks and fences, water, sewerage, and drainage; a hatchery on the Entiat River, the Methow hatchery, the Okanogan hatchery, and necessary transportation equipment. The hatcheries on the Entiat, Methow, and the Okanogan Rivers are to be supplemental to the main hatchery at Leavenworth.

Secretary Ickes in commenting on the program said: "The plan has been very carefully worked out. It was given close attention by officers of the State of Washington and by the Federal Bureau of Fisheries, and then reviewed and checked in detail by three consultants employed by the Bureau of Reclamation. These consultants were R. D. Calkins, professor of economics, University of California, Berkeley; W. F. Durand, professor of mechanical engineering (Emeritus); and Willis H. Rich, professor of biology, Stanford University, Palo Alto, Calif.

"While it is recognized that the program may be experimental in some respects, there seems to be ample assurance that at least the present runs of migratory fish in the river will be protected and probably that the runs will be increased in the future."

Any proposals for a sound plan for State operation, which will offer additional savings or greater promise for complete success of the program, will be given careful consideration, Mr. John C. Page, Commissioner, Bureau of Reclamation, assured State officials.

Mr. Page emphasized the fact that all migratory fish had been included in the program and said that the Bureau will proceed with the construction in conformity with the approved procedure.

It is estimated that the value to the fishery industry resulting from the catch from the runs which go naturally above Grand Coulee Dam averaged during the period 1928–37 about $225,000 annually. Based on this estimate, conclusions were reached that the program is justified.

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • APRIL 1939 • NUMBER 4

Conservation and Democracy

By Hon. HAROLD L. ICKES, *Secretary of the Interior*[1]

DURING the past 6 years, to the extent that newspapers and foreign dictators have permitted me, I have been devoting my thoughts and energies to the conservation of natural resources.

Just now I am wondering why we have the word "conservation" in the English language. Or rather, why we do not have a shorter one with the same meaning. Why is it that we have no one-syllable Anglo-Saxon word to express the thought of keeping things from loss or injury for the public good? I will tell you why. It is because the thought of conservation—the bare idea of it—has come too recently into the minds of the people.

In the English language, nearly every idea which was in the minds of the people before the Norman conquest has two words to express it—a long Latin word and a short Anglo-Saxon word, both having the same meaning—for instance, agriculturist and farmer.

Now, when we get new thoughts, which require new words, we usually coin new words out of Latin or Greek to express them—long words like automobile or telephone. We never coin a new one-syllable Anglo-Saxon word. It cannot be done.

So, whenever you find an idea expressed by a 12-letter Latin word that has no short, crisp Anglo-Saxon counterpart, you may feel sure that the idea itself is something new under the sun. This is the case with conservation of natural resources. One of the reasons why the principles and policies of conservation have had to struggle so long and so hard against the opposing forces of ignorance and selfishness is because the roots of the idea do not sink deep enough into our racial thinking.

However, the fact that we had to coin the word "conservation," or give it a special meaning, in order to express the idea that it contains, reflects a change in our thinking. The new idea had to germinate before we looked for a word to express it, and the extent to which the word is now used registers the extent to which the idea has spread.

Today, the conservation of natural resources is the declared policy of the Government of the United States, and of practically all State governments. Unfortunately, the declared policy is not always the actual policy. However, this much has been achieved; the goal of protection has been officially set up as a substitute for waste and destruction. But to reach this goal, the path is long and the way is difficult. The first need, both for the States and the Nation, is for a real understanding of the problem. The second need is for a better organization of public agencies to deal with the problem.

Why do we not teach conservation in our schools? Is the waste and pillage and threatened physical destruction of our country less important than the names of State capitals? Is the pollution of a river by sanitary sewage and industrial waste less important than the location of that river on a map? Or is conservation so new a subject, so novel a thought, that we are incapable of expressing it in simple language, either for children or adults? Must knowledge be old, with long white whiskers, before it is knowledge fit to be acquired?

Carry this problem into the schools, carry the reality of it into the schools, in living words and phrases, not as dry-bone generalities, and the problem would be solved within a generation.

This is no slight assignment that I offer the American educational system. The subject is as extensive as the continent. Let us observe, in the case of the National Government, how broad is the field of conservation.

First Link in National Park System

The first notable expression of a national conservaion policy occurred in the setting aside, in 1872, of nearly 4,000 square miles of public land in Wyoming to form the Yellowstone National Park. This was the beginning of our national park system.

Twenty years later, farsighted men began to be alarmed about the disappearance of our forests, and so our Government stopped or partially stopped giving away the timber lands that belonged to the American people. From these timber reserves the national forest system developed.

During the first decade of the twentieth century, it became apparent that the migratory waterfowl of North America could not withstand much longer the unending bombardment by hunters, combined with the drainage of swamps, etc., and it likewise became apparent that because these birds were migratory, they could not be protected by individual State action. This led, in 1913, to the Migratory Bird Treaty between the United States and Canada, and to the act of Congress putting the enforcement of this treaty into the hands of the Bureau of Biological Survey.

Even earlier than this, in 1892, a treaty between the United States and Great Britain had led to international protection of the fur seal. Still earlier, another British-American treaty had caused the establishment of our Bureau of Fisheries, but it was many years before this bureau became charged with conservation duties.

Thus, in the first half century of the conservation movement, this line of development appears: First, protection of remarkable scenic areas by the establishment of national parks; second, the setting up of the national forest system; third, Government protection of wildlife.

In the past 20 years, and more particularly during the past 6 years, there has been a new broadening of the conservation field. A partial awakening to the reckless wastage of petroleum and coal has led to protective measures, which, however, especially with respect to our rapidly diminishing store of petroleum, still fall far short of what we need. Finally, the American people have been forced to recognize that the greatest national possession of all, the land itself, is being destroyed. So our Government is undertaking soil conservation, and the protection of watersheds, in order to stop, if already it is not too late, the loss and injury that threaten to turn millions of acres of fertile land into a desert.

In building up the agencies of Government to carry on this broad but haphazard program of conservation, far more attention

[1] Address delivered February 27, 1939, before sixty-ninth annual convention of the American Association of School Administrators, at Cleveland, Ohio.

has been paid to detail rather than to the plan as a whole. In fact, there has been no plan as a whole. Conservation activities that are closely related to each other are scattered among separated Government departments, with neither rhyme nor reason to determine their location. This makes it harder to get rid of the old system of waste and despoliation. This also makes it harder to understand why some sincere conservationists oppose the creation of a Department of Conservation.

For generations the chief business of our Government seemed to be to get rid of natural resources as fast as possible, and the richer they were the faster and more freely we handed them out. The land hunger of a growing population fostered this state of mind, but it took deeper root in a rugged individualism which turned the forests and the mineral wealth of the country over to adventurous exploiters, and made it the duty of the Indian Office to steal land from the Indians to give away to white men.

This state of mind prevailed through successive generations, down past the Civil War period, down through the years when the railroads were getting enormous land grants from the Middle West to the Pacific coast, and through those later years when these same railroads traded part of their lands back to the Government again—traded back barren sagebrush plains for wonderful forests of pine and fir on an acre-for-acre basis, while Congress closed its eyes and the people turned their backs. Here was an era of exploitation, waste, and downright theft. Whatever belonged to the Nation belonged to anybody who could filch it from the Nation.

National Timber Reserves Formed in 1891

However, this could not go on forever, even in the America of the 1880's, when the robber barons reigned in their glory. Have you ever heard of Richard Franklin Pettigrew, the first senator from South Dakota? If you turn to the files of the newspapers of the period when he served in the Senate, you will discover that he was an evil, dangerous man, a demagogue—a malicious liar, as they put it, who was trying to destroy the reputation of great and good men. If Senator Pettigrew were alive today, these same newspapers would undoubtedly denounce him as a "Communist." The trouble with Senator Pettigrew was that he told the truth about the shameful exploitation of our national resources. He exposed the frauds in the western timber entries, but nobody listened except to find something to denounce, just as they denounced Tom Walsh years later when he began to expose the corruption of Teapot Dome.

Nevertheless, this Dakota Senator who had no friends, this Senator who was excoriated by the American press, won a great victory even while he seemed to be losing. In 1891, by the sheer force of his reiterated charges, he drove through Congress a resolution putting 150,000,000 acres of timberlands into national timber reserves. A few years later these were organized into national forests in the Department of the Interior.

The creation of the national forests, like the creation of the first national park, set up an object which people could see. It established a principle, and brought standards into existence by which to judge fidelity to that principle. In other words, a true conservation policy began to reveal itself, not in the Government as a whole, not in a governmental department as a whole, but in at least two important and conspicuous spots—the national parks and the national forests, both of them in the Department of the Interior.

When we try to round out the national park system of the country, victories must be won by those who believe in national parks for the people against an array of selfish adversaries who spring into action whenever they fear that private commercial interests, no matter how trivial or remote, will be encroached upon by the creation of the park. Yet victories are being won.

A bill is pending before the present Congress, to establish the John Muir-Kings Canyon National Park in California, thus dedicating the most beautiful mountain wilderness in America to the perpetual enjoyment of the people, and saving a magnificent privately owned grove of California Big Trees, comprising 7,000 giant sequoias, from immediate destruction. One of those trees is so enormous that if it were cut off 160 feet above the ground, 157 men could stand on the upright cross-section of its trunk.

I am happy to say that public opinion in California, where I have just been, is rallying to the support of this bill. Yet the supporters of this proposed national park are compelled to fight a highly organized propaganda machine based on commercialism—based rather on a false appeal to commercialism, on the claim that is not true in fact, that the area proposed for the park has an economic value which would be lost through the establishment of a national park.

Logic in Proposed Government Reorganization

The affirmative attitude of the people and their congressional representatives, in dealing with small segments of the problem of conservation, impresses me all the more with the need to make the issue clear-cut in its larger aspect, as it affects the entire Nation. This calls for executive reorganization in our Government. It calls for an assembling of conservation agencies so that the executive branch of the Government can take its full share of responsibility for framing and administering a sound conservation policy.

During the formative period at the beginning of the twentieth century, a great opportunity presented itself, to create a Department of Conservation, headed by a Secretary of Conservation, and thus make th principle so plain that departure from would be virtually impossible.

At that time, practically all conservatio activities centered in the Department of th Interior. This department administered th national forests, the national parks, the In dian lands, the unclassified lands known a the public domain, also mining and fish eries—practically everything relating to pub licly owned natural resources and thos strongly affected with a public interest.

Unluckily, the Interior Department wa overgrown in other directions. The hug Pension Bureau was a part of it. Its ex penditures were greater in 1904 than thos of all the other civil departments of the Gov ernment combined.

In 1905, at the suggestion of Secretary o the Interior Ethan Allen Hitchcock, the For est Service was transferred from the Depart ment of the Interior to the Department o Agriculture. Various reasons for this wer given, but the real one was that the Interio Department, measured by expenditures, wa 25 times as big as Agriculture and receive its money through numerous separate ap propriation bills, which made it hard to ge money for the national forests. The trans fer was made to equalize the department and make it easier to get forestry appro priations. The result was equalization tha did not equalize because today, measured b expenditures, the Department of Agricultur is many times larger than the Departmen of the Interior.

Conservation Activities Scattered

Later, the Pension Bureau, the Bureau o Fisheries, and the Bureau of Mines wer transferred to the new Department of Com merce and Labor, to help build it up. I 1933 President Roosevelt retransferred th Bureau of Mines to the Department of th Interior, but the Bureau of Fisheries con tinues as a conservation activity in a depart ment that has no other connection with con servation.

The result of these actions was harmful i two directions. It scattered the conservatio activities relating to the public land an other natural resources through many Gov ernment departments, thus making it im possible to build up a strong, coordinate conservation policy. In the second place, i made it harder to get away from the old ide that natural resources were meant to be ex ploited. It gave the public no central point no focus of responsibility, at which it coul hold the Government to account if it faile to guard the public lands, or the petroleum or the fish and birds and animals. The re sult of this has been to weaken the Govern ment in the face of heavy selfish pressure upon it, and to intensify those selfish pres sures.

Let me give a few instances of what thi has actually meant in the field of conserva tion. You remember the great conflict over Secretary of the Interior Ballinger, during the presidency of Mr. Taft. An Interior Department investigator, Mr. Glavis, charged that the Guggenheim copper interests were getting possession of mineral lands in Alaska by making illegal entries on the public domain. Ballinger fired Glavis. Gifford Pinchot of the Forest Service came to his support, and President Taft fired Pinchot for criticizing a cabinet member. Public opinion then fired Ballinger. Some of us here tonight were part of that public opinion.

What was the matter with Ballinger? In his home State of Washington he rated high. He had the typical, old-fashioned idea of the oldtime westerner that the business of the Government was to give away public property. His title as a member of the Taft cabinet said nothing about conservation. The law establishing his office said nothing about it. There was no legally established standard, no publicly proclaimed objective, to exert influence upon the President in naming his cabinet, or to influence the cabinet member after his appointment, or to bring public opinion to a quick, sharp focus in defense of our natural resources. The naming of Mr. Ballinger was President Taft's mistake, but the set-up of the Government was more to blame than was Mr. Taft. You will have such mistakes, you will have such consequences flowing from mistakes, until the conservation of natural resources is put in charge of a Secretary of Conservation, whose title establishes his responsibility for conduct in accordance with the objectives of the office.

Centering Conservation Activities

Until this is done, those who are fighting for the conservation of our natural resources will always be fighting against odds. It is difficult enough when we have a President and cabinet members devoted to the principles of conservation, for even in such a comparatively happy situation the lack of a visible standard of conservation increases the hostile pressure upon Government agencies, and the scattering of conservation activities in various departments causes friction, discord, and waste of effort, even among men who have common objectives.

I do not suppose that it would be possible to find two Government establishments more unlike each other than the Department of the Interior as it exists today, and as it was under Secretary Ballinger. In saying this, I am not trying to praise myself. Rather, I would praise Walter L. Fisher, whom President Taft appointed to succeed Ballinger, and Franklin K. Lane, Secretary of the Interior under President Woodrow Wilson. For myself, I will give but one pointed illustration of the change that has occurred. Gifford Pinchot's right-hand man, back in 1911, was a young and ardent volunteer conservationist named Harry Slattery. Working for a year or more without pay, he brought together the evidence that led to Ballinger's resignation. Harry Slattery is now Under-Secretary of the Interior.

Yet I recognize the fact that at anytime, a change in the presidency may bring a man into my office who will revert to the exploitation policies of a half century ago, and who will be able to say, in justification of his policies, "What is there in the law that says I must be a conservationist?"

At any time, a change in the presidency may give us a Secretary of Agriculture who will abandon the policies of Secretary Wallace, and deliver the Biological Survey to be once more what William T. Hornaday called it, in the later 1920's, a football of the wealthy duck hunters of the country.

Would it not be far more difficult for a President to sabotage the conservation work of the Federal Government, either deliberately or by negligence, if, when he entered upon his duties, one of those duties was to appoint a Secretary of the Department of Conservation?

Nor is this the whole story. In fact, it is less than half of the story. Not only I, but other members of the Roosevelt cabinet, have seen, felt, and resisted the pressures that come upon Government officials when they undertake to defend the natural resources of the country. I know that my work would have been lightened, it would have been lightened by half, if I could have said in refusing various requests: "I am the Secretary of Conservation. My duty is to guard this property and keep it from damage. You are asking me to violate my oath of office."

Could I or any other man say this, it would seldom be necessary to say it. Men who are unthinking, not vicious, make injurious demands upon the Government today. They demand of me that the public domain shall continue to be overgrazed, though it would mean the ruin of the public lands. They demand of the Department of Agriculture that wild ducks and geese shall once more be shot over baited waters and with the use of live decoys, though a return to those outlawed practices would mean the extermination of all the waterfowl on the continent. They demand of the Department of Commerce that fisheries shall be treated as a purely commercial affair, for present profit, though to follow that policy would destroy the fisheries for the future. They demand that the national forests shall be opened to lumbering by private contractors, and the hope of such exploitation is back of every fight that is made by lumbermen against the transfer of lands from national forests to national parks.

How could such demands be made upon a Department of Conservation? How could they be made effectively? How could they be made at all?

In speaking of the conservation activities which might wisely be brought together in a Department of Conservation, I have confined myself to three functions; first, those which relate to the common property of the people—to the publicly owned lands, the national parks, the national forests, the public domain, the Indian lands for which the Nation is trustee; second, those which relate to those resources in which the people have a common interest, as in the wildlife of the country; third, those which relate to petroleum and other minerals vital to the national welfare, where there is a close administrative connection between private and public holdings.

This, I should point out, does not cover the field of conservation, but it covers a logical administrative field in which there is a central objective and a central problem—that of preserving and wisely using the common property of the Nation.

Outside of this, there remains a vast theater for conservation work; in particular, the conservation of the soil, a subject almost as big as the United States. The problem of soil conservation is a unit, scientifically, but politically it is sharply divided according to public or private land ownership. Soil conservation on public lands is a simple though sometimes difficult detail of the question of how and by whom the public lands shall be used. The problem is subordinate to control of the land itself, by its custodian, the Federal Government. For ease in administration, all public lands ought to be in one Government department, and for effective results, to resist pressure, that should be a Department of Conservation.

Soil conservation on lands in private ownership is a different and bigger proposition. This involves a delicate relationship between the Government and millions of farmers living on their own or on rented land. Administratively, it fits in with other scientific aids to agriculture, and with the Nation-wide program of farm relief. This work belongs where it is now, in the Department of Agriculture.

I have said little about the waste and conflict that occur in Government work because of the haphazard way the Government departments have been built up. This has been discussed on many occasions, in the past year, in connection with the President's request that he be given authority to reorganize the executive departments, so as to establish some orderly connection between the bureaus, and get rid of duplications. For 50 years this necessity has been growing, and for almost 50 years Congress has been trying to deal with it, but failing because of the pulling and hauling of conflicting interests in the Government service.

I had not thought to discuss Government reorganization tonight, except as it bears on the special subject of conservation, but let me take this occasion to say that the way the Congress meets this issue this year will indicate how our Government is going to meet the critical problems of the next few years.

(*Continued on page 76*)

CCC Reconstructs McMillan Dam and the Avalon Dam Spillway, Carlsbad Project

By ERLE W. SHEPARD, *Chief Clerk, Carlsbad Project*

A MAJOR FLOOD of the Pecos River in New Mexico, caused by heavy precipitation over the entire watershed, reached the McMillan Reservoir, 14 miles north of the city of Carlsbad, on May 29, 1937, and the river was at flood stage for 10 days. During the peak of the flood, a serious crack developed in the McMillan Dam which threatened failure of the entire structure. The break was quickly cut off with sand bags by CCC enrollees who had been detailed to the McMillan Dam as a protective measure and were patrolling the dam and various structures. During this flood, a 60-foot break also developed in the east embankment, causing greatly increased leakage of water through the gypsum caverns back of this dike. At the time of the flood and immediately thereafter, temporary protective measures were taken, using the regular operation and maintenance crew with large forces of CCC men.

The McMillan Dam was built as a private undertaking in 1894. It is an earth-and-rock-fill structure with a crest length of 2,070 feet and a height of 57 feet. The maximum reservoir capacity is 40,000 acre-feet with flashboards set to elevation 3,267.7.

On June 12 and 13, 1937, immediately following the flood, S. O. Harper, Assistant Chief Engineer, and F. F. Smith, Engineer of the Denver office, inspected the McMillan and Avalon Dams. Plans were then prepared by the Chief Engineer's office for the reconstruction of McMillan Dam.

In general, the plans included the excavation of the existing earth fill down to elevation 3,265 and the excavation of a trench along the face of the old rock fill down to elevation 3,258 and the placing of a portion of the earth so excavated on the downstream side of the dam. The balance of the earth and rock excavated from the old fill was to be placed on the upstream face of the dam below elevation 3,260 to form a coffer dam, as a protection against water held in storage during the construction period. The new embankment was to be constructed from compacted earth fill faced on the upstream slope with a 24-inch thickness of rock riprap. The top width of the dam was to be increased from 16 to 25 feet. It was planned to use as many CCC enrollees and as much equipment as possible, with such heavy construction equipment as needed, the latter to be leased by the Bureau of Reclamation.

CCC Goes into Action

Actual work on reconstruction of McMillan Dam was commenced in November 1937 with a large force of CCC men cleaning and grubbing the downstream face of the dam and doing other preliminary work, such as building construction roads and erecting temporary sheds for shop and equipment. A gravel pit was tentatively located at the junction of Seven Rivers and the Pecos River, approximately 2½ miles below the dam. Test pits were dug and samples taken. A construction road was located, brushed out, and leveled with a 35-horsepower tractor and bulldozer. Suitable material for earth fill for the dam was located approximately 1,500 feet west of the main dam. Test pits were dug and samples taken and later the borrow pit area was terraced, in order that it could be flooded to obtain a proper moisture content. A pumping plant was installed at the edge of the reservoir and 1,600 feet of 4-inch pipe line was laid to the borrow pit area. On the downstream toe of the dam, 1,350 feet of drainage tile was laid.

When the excavation and hauling from the gravel pit was commenced, several 1½-ton dump trucks belonging to the CCC were used with eight 7-yard heavy-duty dump trucks leased by the Bureau. It was soon found that the smaller trucks were not suitable for this heavy hauling and also interfered with the operation of the heavy trucks. As a safety measure, and also to conserve the CCC equipment, the smaller CCC trucks were only used in hauling gravel at intermittent periods.

A rock quarry containing suitable rock to be used as riprap on the upstream face of the dam was located approximately 1½ miles east of the main dam and quarrying operations were carried on with CCC equipment and men operating the air compressor and drills. Blasting was done under the supervision of a trained CCC powder man. The rock was loaded on the heavy-duty dump trucks by power shovel and stock-piled at the west end of the dam.

The cleaning of the face of the old rock fill and placing the gravel filter was started as soon as the dragline had made sufficient excavation to allow the CCC men to enter the core trench. All loose dirt was thrown back from the base of the trench; earth which adhered to the face was cleaned off and small rocks were inserted into the face where excess voids were evident. As soon as this excavation was completed, sand an gravel were dumped from the top of the rock fill with the 1½-ton CCC trucks and placed to a thickness of 2 feet against the face b the CCC men. After the core trench had been filled, the gravel was then dumped agains the face from the lower side and shovele into place. All trimming was done by han after excavation by the dragline.

After the new fill and embankment wa commenced the enrollees were used i spreading and trimming the fill. The fill wa rolled on 8-inch lifts by a 75-horsepowe tractor with a set of sheep's-foot rollers an the CCC 35-horsepower tractor was engage in spreading the fill and spotting trucks CCC dump trucks were used during this oper ation intermittently to facilitate the handlin of the earth fill. The 3-foot riprap fill o the upstream face of the embankment wa hauled and dumped by the heavy-duty trucks then spread and placed by the enrollees. A a final operation on the dam, a gravel road way was placed on the top and final gradin and alignment of the dumped rock ripra was completed.

Whenever the operations on the main dan permitted, work was continued on the clos ing and repairing of the breach in the eas embankment. Considerable rock and eart fill was used in this operation, and the roc riprap along the entire reservoir side of th east embankment was repaired and replace where necessary.

McMillan Dam Outlet Channel

A large cavity had been eroded immedi ately below the head gates in the outle channel by water being released through th headgates. Considerable eroded material ha been washed into the channel immediatel below this cavity, which necessitated the ex cavation and building to grade of the entir channel below the outlet gates. The cavit was backfilled with rock and gravel closel compacted to form a base for a concret apron.

A reinforced concrete apron, 15 inche thick, was placed in the channel floor for distance of 100 feet below the head gates The slabs were poured in 15- by 20-foot sec tions and finished with steel trowel. Mino seepage from the reservoir required drainag under the apron to relieve hydrostatic pres sure. This was provided by 12-inch sewe pipe laid in gravel along the center line o

2. This work consisted of excavating the gravel and rock which had been deposited by water at the extreme lower end of the channel and the excavation of some 20,000 cubic yards of earth, rock, and shale on the east side of the spillway channel near the upper end. At the beginning of this job, some 78 cubic yards of concrete were placed on the floor near the upper end of the channel in an endeavor to stop the erosion of the rock floor.

A considerable portion of the excavation on the west side of the channel required drilling and blasting for excavation by power shovel. All drilling and blasting work was done by CCC men under the direct supervision of a trained CCC powder man. All earth and rock excavated were transported in 7-cubic-yard dump trucks and placed in an embankment on the east side of the channel immediately below the toe of the west wing of the Avalon Dam. This embankment was built as a protective measure to forestall any erosion which might develop in spillway No. 2 at that point. The embankment material was placed in layers, wet down and rolled with a 75-horsepower tractor and sheeps-foot roller. A considerable quantity of very heavy rock was placed on the channel side of the embankment as further protection against erosion. All operations in connection

(*Continued on page 79*)

CCC enrollees reconstructing McMillan Dam

the apron. All the concrete work was done by CCC men using a Bureau of Reclamation mixer. A total of 168 cubic yards of concrete was used in this structure.

In addition to the concrete apron in the outlet channel immediately below the outlet gates, improvements were made to the head walls, and rock masonry retaining walls were built near the head gates. These retaining walls greatly improved the appearance of the structure and added needed safety protection at that point.

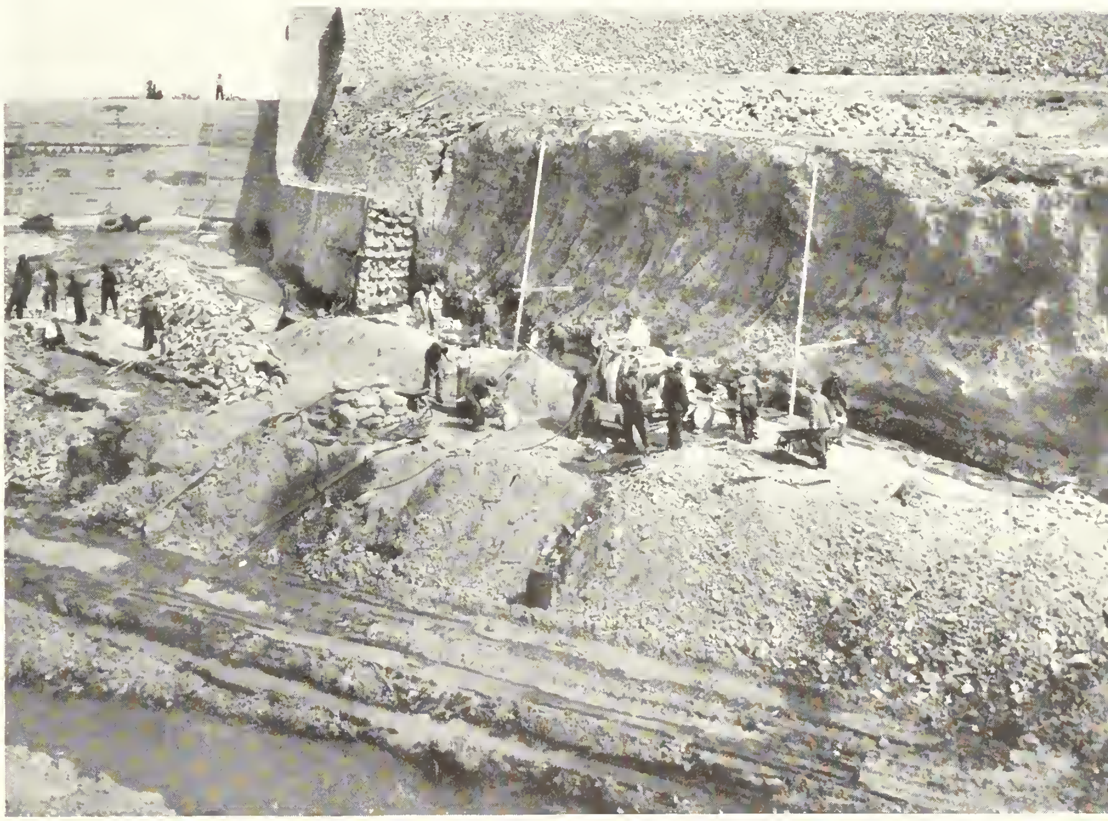
Practically all of the work in connection with the reconstruction of the McMillan Dam was completed by the CCC at the end of March 1938.

During the flood of May and June 1937 and while the spillway No. 2 was in operation, a wire-netting protective work at the lower end of the spillway was completely destroyed and a large hole was washed out immediately below the lower end of the spillway. In the early part of April 1938 repairs and protective work were started on this structure with CCC forces. All loose rock was excavated from the cavity immediately below the downstream end of the spillway and a rock masonry and concrete wall was constructed from the bottom of the excavation to the toe of the existing structure. This masonry and concrete wall was constructed on a ¼ to 1 slope and was built for the purpose of preventing further erosion and undercutting of the spillway structure. All of the reconstruction of this structure was performed by CCC forces under the general direction of a Bureau concrete foreman.

Avalon Dam Spillway Channel

Immediately after the heavy equipment work at McMillan Dam was completed, a portion of the heavy equipment, together with CCC equipment and men, was transferred to Avalon Dam to begin the enlargement and improvement of the channel of spillway No.

Masonry retaining wall under construction, Avalon Dam spillway



Why Irrigation?

By WILLIAM E. WARNE, *Director of Information*

WHY is it necessary to irrigate farms in the West?

To one familiar with the West this may seem to be a foolish question, but it is asked so often by those who do not know western conditions and who are sincerely puzzled that it deserves an answer.

Geography books at one time in general use in our schools labeled all the West as "The Great American Desert." In truth most of this territory would be included in the best definition [1] of the term—a desert is "a barren tract incapable of supporting any considerable population without an artificial water supply and almost destitute of moisture and vegetation."

West of the 100th meridian lie in excess of 740,000,000 acres—more than one-third the land area of continental United States—which receive on the average less than 20 inches of rain a year. In excess of 150,000,000 acres of this total receive an average of less than 10 inches of moisture a year.

"With regard to precipitation, as related to agriculture," says the Department of Agriculture, "the United States may be divided into an eastern and a western part. The dividing line roughly coincides with the 100th meridian in the vicinity of which the average annual rainfall is about 20 inches. In general, east of this line precipitation is usually sufficient for crop production by ordinary farming methods, but in the West large areas have deficient rainfall, necessitating for crop growth, special methods for artificially supplying moisture or for conserving it in the soil. The minimum amount of rainfall needed for ordinary farming, *under favorable seasonal distribution*,[2] is usually considered to be about 15 inches in a relatively cool climate where the mean summer temperature is about 65 degrees, and 20 to 25 inches in areas, where the mean summer temperature is 75 to 80 degrees. This difference in requirements is due largely, of course, to evaporation from the soil, transpiration from plants, etc., more pronounced in warmer climates."

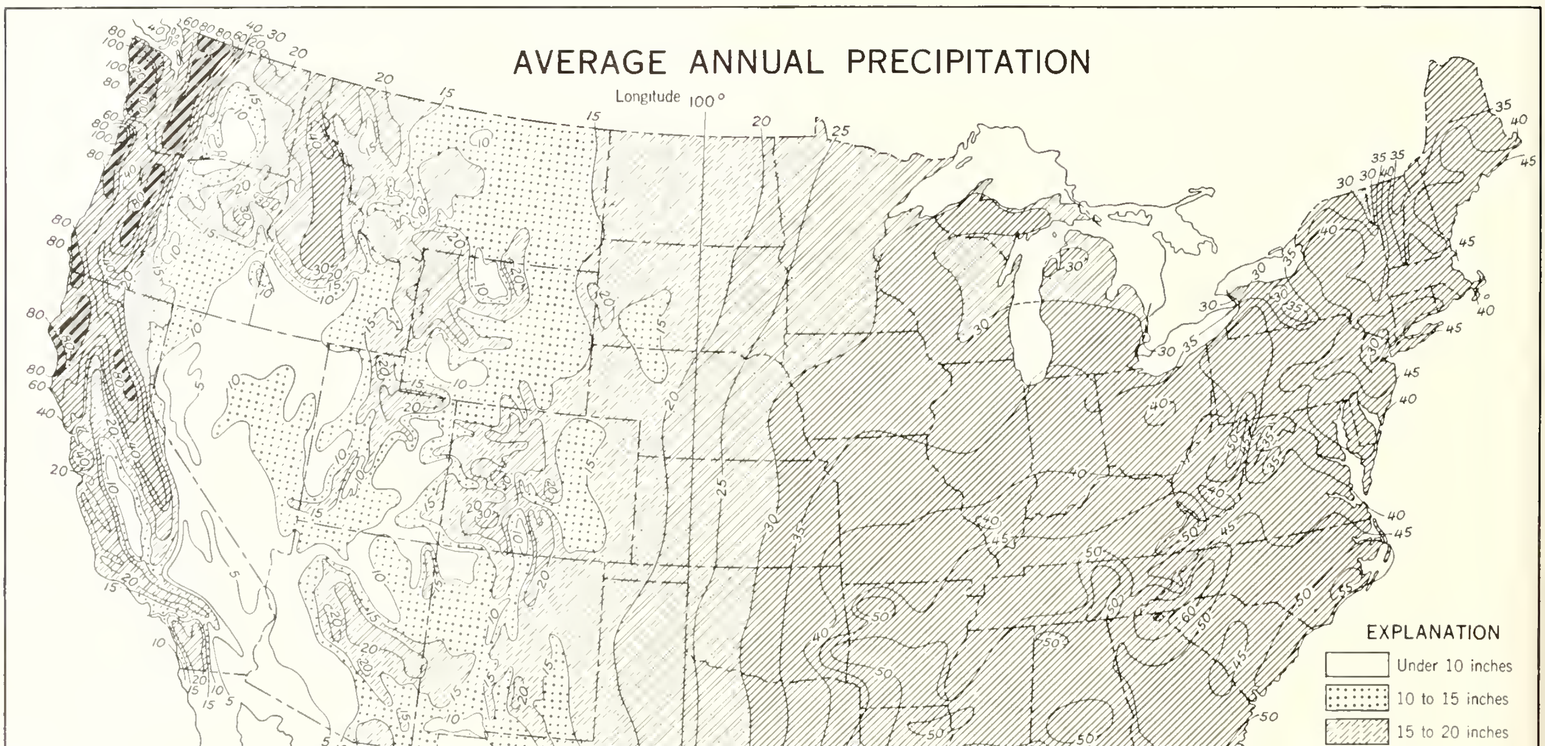
Seasonal Rainfall Deficiency Demands Irrigation

It should be noted that both the total rainfall and the distribution of the rainfall among the seasons are important to successful farming without irrigation.

Two maps have been prepared to illustrate the average annual precipitation characteristics of various sections of the United States, and to show the percentage of the total precipitation which is received on the

[1] Webster's New International Dictionary.

[2] Italics supplied.



AMOUNT OF PRECIPITATION	LAND AREA, ACREAGE	PER CENT OF TOTAL LAND AREA OF U. S.
Under 10 inches ...	153,634,432	8.1
10 to 20 inches ...	588,775,719	30.9
20 to 30 inches ...	314,258,301	16.5
30 to 40 inches ...	320,089,545	16.8
40 to 50 inches ...	324,846,189	17.1
50 to 60 inches ...	160,366,829	8.4
60 to 80 inches ...	28,898,105	1.5
80 to 100 inches ...	9,430,528	0.5
Over 100 inches ...	2,915,712	0.2

FIGURE 1

average in various areas during the period from April 1 to September 30 of each year, the ordinary growing season for crops.

Figure 1 shows clearly how the United States is divided into two parts by the 20-inch rainfall line, which roughly follows the 100th meridian, with sufficient rainfall to the east of this line for crops and, for the most part, with insufficient rainfall west of this line for unirrigated crops. To the west of the 100th meridian, except for high mountains and a strip along the northern Pacific coast, less than 20 inches can be expected in a normal year. Those tremendous areas shown as receiving 15 inches or less of rainfall are true deserts. These arid lands and the semiarid lands, which receive between 15 and 20 inches, taken together, include all of the State of Nevada, and all but mountainous areas in Arizona, New Mexico, Colorado, Utah, Wyoming, Montana, and Idaho; all but small patches, principally mountainous, of the three Pacific Coast States—Washington, Oregon, and California; and these include the western parts of those States of the Great Plains, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

All Federal Reclamation projects are located in areas shown on this map to receive on the average less than 20 inches of rainfall annually. Virtually all the irrigation practiced in the United States is confined to this area. Of the 742,410,151 acres which are arid or semiarid only about 20,000,000 acres are irrigated by private, cooperative, and Federal projects, combined. Some irrigation for special crops, such as rice, is practiced in areas with humid climates, as for example, in Louisiana, but for the purposes of this discussion, irrigation in humid regions is not included.

If 20 inches of rainfall, or even if 15 inches, could be counted upon during the growing season for crops in these Western States, irrigation might not be required. It is important, therefore, to investigate the seasonal distribution of rainfall in the West to determine the prospects in the average year during the period April 1 to September 30.

Figure No. 2 shows the percentage of the average annual rainfall which is received during the growing season for crops. The greater part of California is shown to receive less than one-fifth of its average annual rainfall during the growing season; in a second band, covering most of Washington, Oregon, and parts of Idaho, Nevada, California, and Arizona, only about one-third of the total falls in the growing season; in the third band, covering the whole central part of the West, between 40 and 60 percent is received in the growing season; while the next band, covering the middle part of the United States, is more favorably treated by the weather and receives more than 60 percent of its rain when it is most needed for the growth of crops.

Considering these two figures together it will be noted that from the Continental Divide westward virtually nowhere but in high mountains which cannot be farmed, can more than 8 or 10 inches of rain be expected during the period from April 1 to September 30, the period when moisture is most needed for crop growth. Between the Continental Divide and the 100th meridian in only a few tillable areas can as much as 15 inches be anticipated during the growing season.

In other words, not only does the area west of the 100th meridian, for the most part, receive less than 20 inches of rainfall in the average year, but also the moisture which does fall there is unfavorably distributed through the seasons so far as agriculture is concerned.

Remembering the statement by the Department of Agriculture, that between 15 and 25 inches of rain, depending on summer temperatures, are necessary during the growing season for farming without irrigation, it readily can be seen that irrigation is essential to farming in virtually all the West.

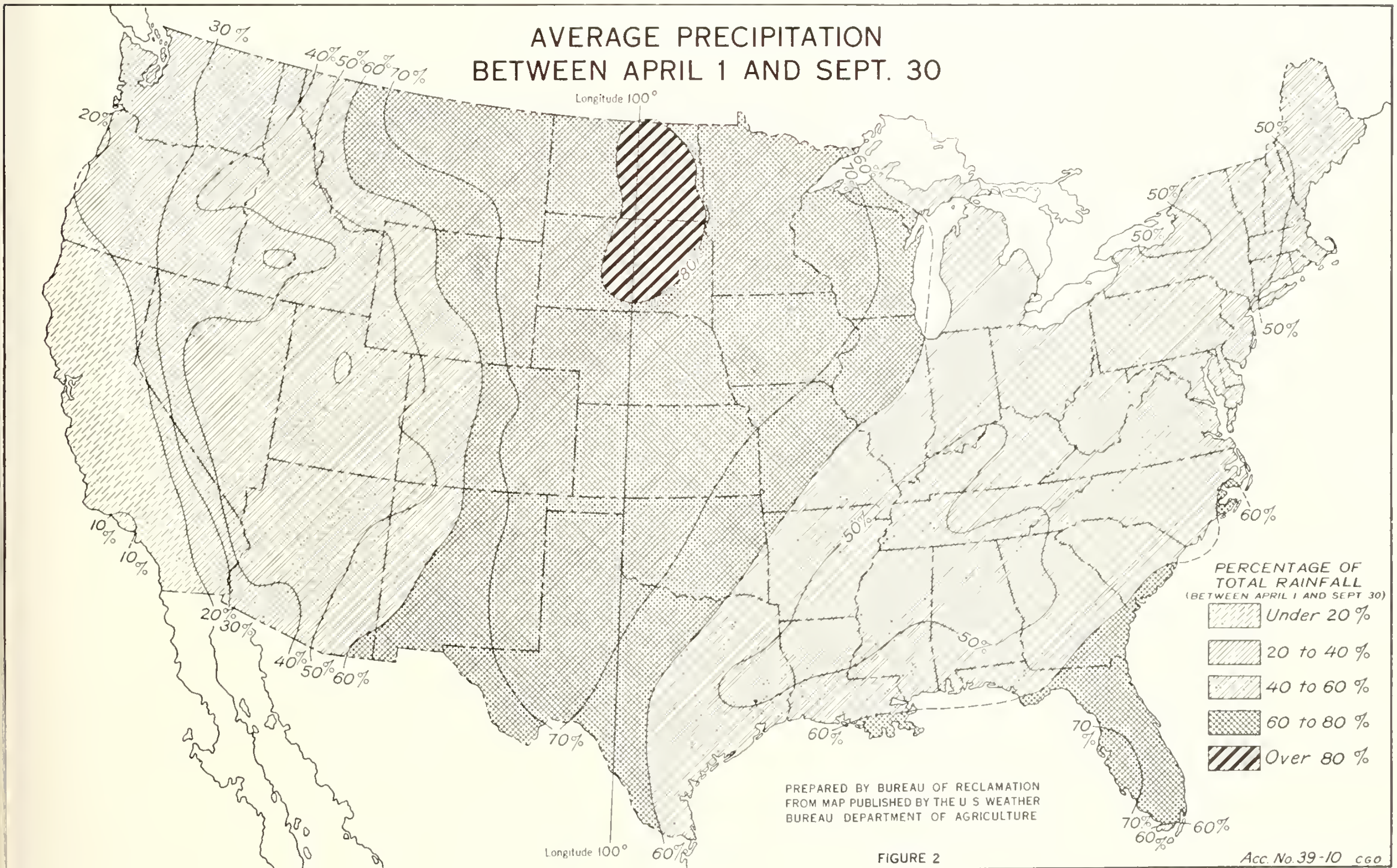


FIGURE 2

Ranching—Dry-farming—Irrigation

In humid sections farming is a term denoting all types of agricultural pursuits. In the West this word is supplemented by such terms as "ranching," "dry-farming," and "irrigation." In the arid and semiarid sections, irrigation farming alone is comparable to the general farming common to the humid sections.

Dry-farming, that is, farming without irrigation, is a precarious operation. Except for wheat, few crops have been successfully grown by dry-farming in the West. Small, isolated areas are exceptions. Even wheat production by dry-farming methods is uncertain, since favorable spacing of winter and spring storms is necessary to mature the crop. In many localities where dry-farming is practiced extensively the farmers consider themselves fortunate if one crop in three matures, and in some sections the average is one crop in five.

Ranching, although the term is used loosely even in the West, generally denotes a type of agriculture unknown in humid sections. Livestock is the principal product. Little or no soil is tilled. The stock is grazed on the ranch and on public lands in the vicinity, feeding on the natural grasses produced by the scant rains. A cattle or sheep ranch may have a hay meadow, from which it cuts winter feed. These meadows usually lie along streams, and the hay produced is ordinarily cut from natural grasses, although some meadows are well enough watered by the streams or by irrigation to produce alfalfa. In ranch country often the carrying capacity of the range is no more than eight head of cattle for each section of land.[1]

Both dry-farming and ranching, of course, are types of agricultural pursuits. They are practiced in the West without the aid of irrigation. Irrigation is necessary in the arid and semiarid sections for general, cultivated agriculture.

Few areas in the arid and semiarid West are dry-farmed, except in the Great Plains. The recent extended drought in the Great Plains, with its consequent uprooting of tens of thousands of farm families, has served to demonstrate the precariousness of this type of agriculture. The President's Great Plains Committee, and others who have studied the situation there, recommend introduction of new land-use programs which largely would eliminate dry-farming in the Great Plains.

Ranching, if the term be used, as here, as synonymous with cattle and sheep raising in the ill-watered areas, is a more stable type of agriculture, and also one practiced much more widely in the arid and semiarid section. In excess of 300,000,000 acres are given over to grazing. The livestock industry founded on ranching is one of the most important, if not the most important, in the West. Because of the great disparity between the areas devoted to grazing and those irrigated, it should be noted that approximately half of the feed units needed by the livestock industry come from the irrigated lands. There is, therefore, a direct complementary relationship between ranching and irrigation farming in the arid and semiarid section.

Dry farms encompassing one or two thousand acres are not uncommon. Ranches may include one section or 100,000 acres, as do some in Texas, but regardless of their size, those in the States having public grazing lands are but headquarters for livestock operation on the public pastures. Irrigation has made possible the subdivision of holdings and the establishment of farms on tracts of 10 to 160 acres, each capable of supporting a family.

Irrigation is essential to general farming, and it is the only means of providing for close settlement of rural areas in the arid and semiarid section, encompassing more than one-third of the land area of continental United States.

[1] The Division of Grazing of the Department of the Interior gives as the amount of grazing land needed for pasturing each herd of cattle in the West a minimum of 12 acres (in North Dakota) and a maximum of 320 acres (in Arizona).

Conservation and Democracy

(Continued from page 71)

This is a time when democracy is put to a severe test, to prove its ability to function in a world of new problems and fast-moving events. There is need at this moment for an exercise of statesmanship, among those qualified to lead American thought, as high and unselfish as that which presided at the birth of our country.

We cannot go forward, politically or economically, in the kind of a world that we live in, leaving our destinies to the negative decrees of those who have closed their eyes to the problems of the Nation. We cannot stand still in the world of today. To attempt it would be to roll backward into chaos.

No matter what political party comes into power, no matter what group rises to control within a political party, the crisis which impends in our social and economic order rises above that party, above that faction, and we can no more conjure it away than a ship in a storm can conjure away the breakers that threaten.

To go forward, to ride the storm, we must keep the wind in the sails, and let somebody hold the wheel who knows enough not to let go.

I ask you, where in this picture is there a place for a political party divided against itself? Where is there a place for a political party, no matter what its name, that is against everything, and for nothing? Where is there a place for Government by high powered mail order propaganda, whose goal is to coerce Congress, and coerce the executive departments, into a policy of doing nothing at all?

The kind of propaganda campaign which was successfully conducted last year against the Government reorganization bill, a campaign conceived in deceit and born in mental dishonesty, represents a force in American political life which cannot continue to operate successfully, in the broad field of its ambitions, without bringing our social order to the verge of dissolution.

Here we have of conservation in its broadest aspect—the conservation of the American Nation as a functioning society of human beings. It is here, in the relationship between the people and their representatives, that the mischievous hand of a powerful and unscrupulous propaganda can wreck the processes of representative Government. What proportion of the keenest brains in America—not the best, but the keenest—what proportion of the keenest brains in America are devoted to making government function for the people, and what proportion to keeping it from functioning for the people? Answer this, and you answer the question: Where lies the danger to America?

I am not directing this criticism at the Congress. I am directing it at the forces that keep the Congress from functioning at the level of the merit that is in its membership. I am directing it at the forces that restrain the functioning of the executive department, at the forces that too often touch the judicial branch with mental palsy.

Education in Conservation Needed

I said that there was need to teach conservation in the schools—the conservation of natural resources. There is an even greater need to make all America a school in which to teach the conservation of democratic Government, by making it function; the conservation of American principles of liberty and equality by putting them into practice; the conservation of responsible citizenship by inducing citizens to meet their responsibilities. Here is our ultimate tasks in conservation, in these United States of America, and it cannot be left for future undertaking. It is our responsibility, here and now.

Yakima Project Fruit

EARLY in February the Yakima Horticultural Union held its thirty-sixth annual meeting in Yakima. Reports showed that the cooperative's growers produced 2,992 cars of fruits in 1938, which was 97 percent of the average production in the past 10 years. Approximately 40 percent of the apple tonnage handled is shipped to foreign markets.

All American Canal Seasoning Operations

SEASONING OPERATIONS through the first 22 miles of the All-American Canal were in progress throughout February, while heavy releases of water from Lake Mead were being made at Boulder Dam.

About 1,500,000 acre-feet of water were released from Lake Mead in order to empty the lake to a point where it can handle without difficulty the spring flood of the Colorado River as anticipated on March 1. Snow surveys indicated in February that the run-off of the river would be slightly above the average this spring. If additional heavy snows are received, there will be time to make additional withdrawals from Lake Mead prior to the flood which is expected in late May or early June.

The heavy releases at Boulder Dam provide a flow at Imperial Dam where the All-American Canal heads 300 miles downstream from Boulder Dam, of approximately 24,000 cubic feet per second, the largest amount which has been noted there since 1933.

These releases also, through scouring the river bottom, carried heavy silt loads. The river carried more silt during February than in any comparable period during the past 5 years.

Bureau of Reclamation officials at Imperial Dam had been awaiting a rise in the silt content of the river to begin large scale seasoning operations on the All-American Canal, since silty water was desired to seal the sides and bottom of the canal.

The silty water was allowed to flow through the desilting basin to determine the actual compactness of the "fills" or walls enclosing the basins and the tightness of the basin floors. Progress planned on the basis of this and subsequent tests is significant to all of the area to be surveyed by the canal system, for before Colorado River water can be released for actual use in the canal, operation of the desilting works must be demonstrated.

The ultimate maximum diversion of water into the All-American Canal will be 15,155 cubic feet per second. Some idea of the tremendous task which the desilting works must perform can be gained from studies which indicate that on the average approximately 8,000,000 cubic yards of silt will pass the headgates annually during the first 10 years of operations. The three pairs of basins now installed are designed to remove 70,000 tons of silt every 24 hours when in full operation, eliminating an annual expense of approximately three quarters of a million dollars which would be necessary for canals and laterals if the silt were permitted to flow into the system. Provision has been made for additional units later, if required.

The desilting basins are located immediately downstream from Imperial Dam, and are equipped with 72 rotary type scrapers, each 125 feet in diameter. Silt deposits will be moved by the scrapers into trenches, forced through a disposal system into a sluiceway channel leading into the river below the dam. Only water from which the heavy silt has been removed will flow down the canal system. Each basin is approximately 269 feet by 769 feet, with a rated capacity of 2,000 second-feet. The embankments separating the basins are compacted with selected material, and the slopes are paved with 18-inch dry-rock paving.

During the tests the large revolving scrapers were not in operation, and a limited flow of water which was not desilted was admitted into the All-American Canal. On February 7, the flow reached the Pilot Knob Wasteway, a distance of approximately 22 miles, from Imperial Dam.

While the discharge through the canal was not large in amount, the hydrographic and other observations taken during its passage and since, will be of value in the seasoning and priming operations.

Commissioner Page Presides at Sessions of Tennessee Meeting of A. S. C. E.

COMMISSIONER PAGE plans to preside at the Symposium on Masonry Dams to be held April 20 at the Chattanooga, Tenn., meeting of the American Society of Civil Engineers. The list of papers scheduled to be submitted to the presiding officer and the authors are as follows:

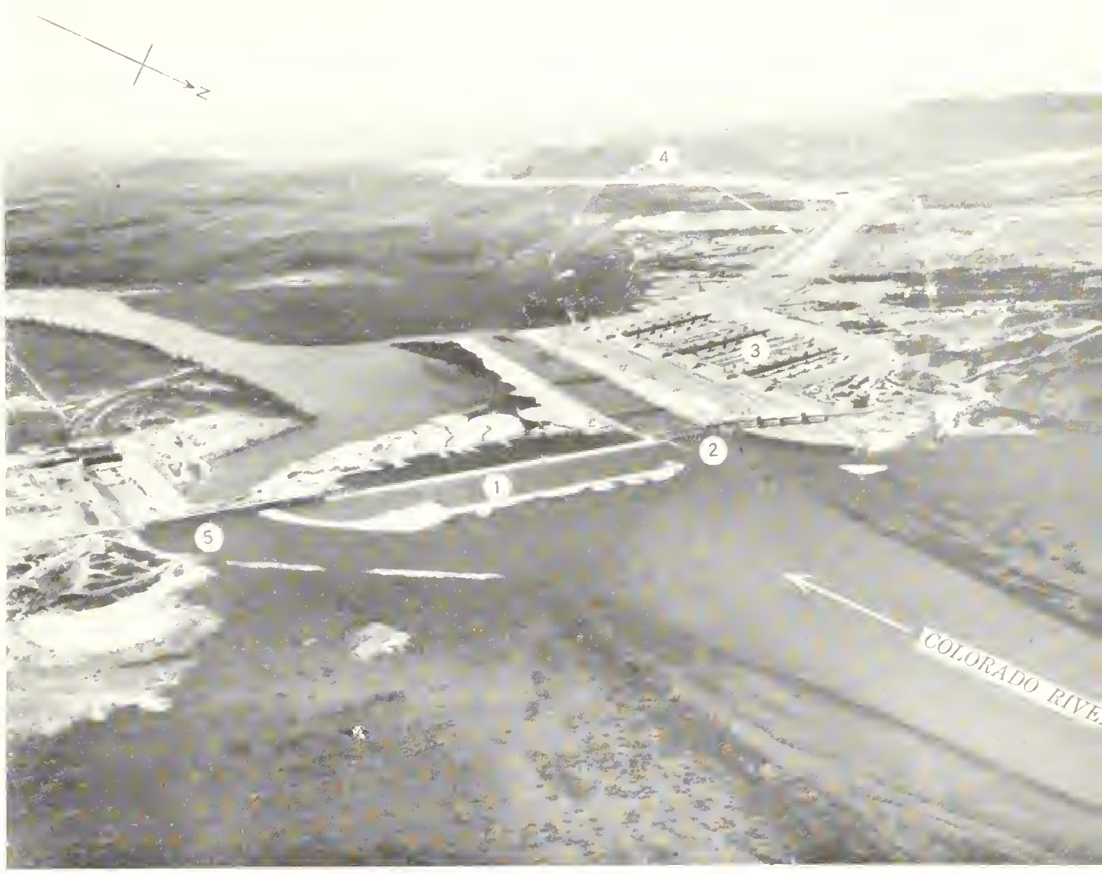
SESSION I

Masonry Dams—Basic Design Assumptions—John L. Savage and Kenneth B. Keener.
Design of Gravity Dams—A. L. Alin.
Design of Arch Dams—R. S. Lieurance.
Design of Special Dams—C. H. Howell.

SESSION II

Geology of Dam Sites—Irving B. Crosby.
Determination of Elastic Properties of Foundation Rock—R. K. Bernhard.
Methods of Improving of Foundation Rock—J. B. Hays.

Air view of All-American Canal project, showing major construction features
(1) Imperial Dam (2) All-American Canal headworks (3) Desilting basins
(4) All-American Canal (5) Gila Main Canal headworks



Fencing Ditch Rights-of-Way for Pasture To Control Noxious Weeds

By A. W. BAINBRIDGE, *Associate Engineer, Rio Grande Project*

ON THE Rio Grande project the prevailing noxious weeds are Johnson grass and bindweed. Johnson grass is a pest over the entire project and its partial control is a material item of cost to all project water users. Bindweed has been in evidence on the project for about 20 years. In a number of places the weed has taken over entire fields and the land is practically out of profitable use.

The infestation and spread of these and other noxious weeds on ditch rights-of-way has long been a matter of serious concern to the project management and water users. Various methods of controlling noxious growths along the distribution system have been tried out in an attempt to find a practical, low-cost method.

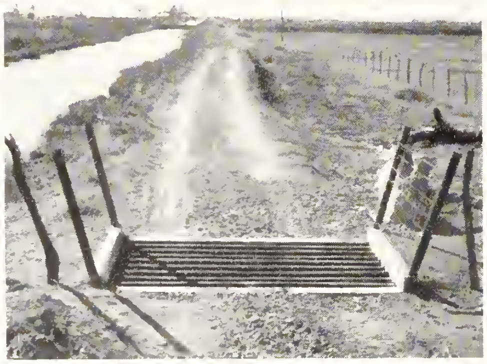
The plan of fencing canals, laterals, and drain rights-of-way for pasturage was undertaken partly because of the poor results obtained from experiments with other control and eradication methods and partly because of the opportunity to obtain fence posts salvaged from reservoir clearing operations.

To show the activities leading up to the adoption of the plan for fencing rights-of-way, the other control and eradication methods which have been tried, are reviewed briefly. During the past 15 years experiments with calcium chlorate have been made at various times. A quite extensive test with this chemical was made possible in 1936 and 1937 through the facilities of the Civilian Conservation Corps. Only partial eradication was obtained after several applications. In places where apparent eradication was obtained in one year, the plants reappeared the next year. Further, the expense of this chemical has prohibited its use on any large areas. Old crankcase oil, Diesel oil, and mixtures of both were tried out in 1937. The application of oil was about as effective as clean cultivation.

Demonstrational Projects

In 1936 a start toward a program of fencing ditch rights-of-way for pasturage, became possible through the facilities of the CCC camps on the Rio Grande project. Farmers were of the opinion that the cost of posts and wire necessary for fencing the narrow strips of rights-of-way would be greater than the feed value of the pasturage. But project officials believed the plan held promise of great benefits both in weed control and in providing more pasture. Therefore, arrangements were made for CCC enrollees to build two demonstrational fencing projects on Government rights-of-way.

The first demonstrational fencing job consisted of a mile and a half of the Daughterty and Ysla laterals along the J. B. Worsham farm near Clint, Tex. Since its completion in October 1936, Mr. Worsham has kept this ditchbank pasture well stocked with sheep. Part of this area was infested with bindweed. Grazing the bindweed for 2 years has not completely killed it, but has kept it under control. Many of the project farmers were impressed with the results. However, this demonstration did not directly bring applications for fencing under the program requiring the applicant to furnish the materials.



Ditch right-of-way fenced for pasture with cattle guard

The next demonstrational fencing job was undertaken in March and April 1937 on the Chamberino East Lateral, east of La Mesa, N. Mex., on Government right-of-way through the properties of J. L. Esslinger and O. H. Kull. This reach of lateral extended a distance of 11,975 linear feet and was one of the worst infested stretches of right-of-way on this division. It had a dense growth of a species of small willow as well as Johnson grass and other noxious weeds. Both of these water users were so well satisfied with the demonstration that many project farmers became interested in the plan and project officials received a number of applications for fencing canals and laterals in the New Mexico part of the project.

Program Expanded

In 1938 the further expansion of the program to fence ditch rights-of-way was made possible through the opportunity to salvage fence posts from trees cut in clearing the site for the Caballo Reservoir. A CCC work project was arranged to provide for hauling the posts and treating them with either creosote or charring to kill worms and larvae in the bark. The supply of fence posts and the help of CCC enrollees in constructing the fences was a big inducement to farmers to have the Government rights-of-way adjoining their farms fenced during the season. As a result, a total of 24 agreements was made for fencing 13 miles of laterals in New Mexico and 2 miles in Texas, requiring 27 miles of fence to enclose about 85 acres of pasture. In several places existing fences along the rights-of-way were used.

Fencing has been completed on a total of 19 miles of laterals on the Rio Grande project. It is estimated that about 1,000 sheep are being grazed on this right-of-way pasture.

All fencing of ditch rights-of-way is built under agreements. The applicant is required to furnish the necessary wire and the material for any gates or cattle guards which he desires for his own convenience. If cattle guards are for the use of the project operation and maintenance forces, or the public, the material is furnished by the project from operation and maintenance funds. Nineteen cattle guards have been built for operation and maintenance use.

The fence consists of posts, set one rod apart, with one intermediate stay. Standard field fencing 32 to 35 inches in height is used. This has one strand of barbed wire at the bottom and one about 6 inches above. The prevailing field fencing is 32 inches high, having top and bottom strands of No. 11 wire, with six variably spaced intermediate strands and 6-inch spaced vertical stays of No. 14½ wire.

The necessary wire for fencing in New Mexico was obtained at cost through the cooperation of a local lumber company. Wire used in Texas was purchased at 2½ to 3 cents per foot.

In developing right-of-way pasture, grasses and clovers should be seeded only on those areas where the capillary action of the water maintains sufficient moisture for plant growth. The tops of ditchbanks are generally so dry that only a few weeds, course grasses, and brush survive.

Sheep Industry Increases

The full benefits from pasturing rights-of-way are not evident at this time, but the results obtained thus far are most encouraging. Pasturing banks for 9 months or longer with approximately 50 sheep per mile of ditch has given effective control of weed growth. Sheep required the minimum of attention. As with other pasture, proper management should be exercised to prevent overgrazing. If the pasture is overstocked the first year, a large percent of some weeds and grasses will be eradicated, leaving a less productive pasture for the next year, with the possibility of wind and rain damage to barren banks.

For the past 20 years cotton has been the best cash crop on this project. This has attracted many cotton growers from other cotton sections. Generally the cotton growers have not diversified and sheep particularly have not appealed to most of them. The growers, who have participated in fencing, are beginning to realize the importance of some source of farm income other than cotton. Some now appreciate that a few sheep will be a profitable sideline, as a reasonable number can be cared for on any farm with little cost and attention by using ditchbank pasture and unsaleable forage. One farmer whose sheep-pasturing started in May 1938 stated recently that so far his sheep had not required any feed in addition to that on the ditchbanks and other available pasturage on his farm. He said further that this year's returns from the wool clip and the increase in his flock would nearly pay for the cost of both the fencing wire and the sheep.

Those who have participated in the right-of-way pasturing plan on the Rio Grande project believe that it will greatly reduce the cost of weed control and that it is the most economical method for controlling noxious weeds on ditch rights-of-way.

National Irrigation Policy Its Development and Significance

IN RESPONSE to the request of Senator Carl Hayden of Arizona, there has been compiled by the Bureau of Reclamation a pamphlet which bears the above title but which Acting Commissioner R. B. Williams in his letter of transmittal states might be called a treatise on "What Reclamation Means to the United States."

The publication briefly describes the problem confronting the arid and semiarid western third of the United States with an area of about 750,000,000 acres; traces the history of irrigation development and the record of the Bureau of Reclamation; the results of the drought and the future needs for relief as a national problem.

The pamphlet is divided into separate chapters as follows:

1. Why Irrigation?
2. The Beginning of Federal Reclamation.
3. The Reclamation Law of 1902.
4. Some National Benefits.
5. Reclamation and the Western States.
6. Achievements of Federal Reclamation.
7. Results of Construction Program.
8. Reclamation Crop Production.
9. Electric Power and Reclamation.
10. Financial Aspects of Reclamation.
11. Indian Irrigation Projects.
12. Extent of Irrigation—Present and Future.
13. Federal Reclamation and Readjustments in Land Uses.

In addition there is an appendix containing numerous tables, charts and maps, and other data, closing with an address by Commissioner John C. Page entitled "Reclamation Fulfills Its Mission" reviewing the achievements of the 36 years.

The report consisting of 72 pages is available for free distribution as long as the comparatively limited edition is available. Application should be made to Commissioner, Bureau of Reclamation, Washington, D. C.

CCC Reconstructs McMillan Dam and the Avalon Dam Spillway

(*Continued from page 73*)

with this work were carried on by CCC forces with the exception of the operation of the power shovel and the heavy duty dump trucks which were operated by regular Bureau employees.

After the excavation and embankment had been completed a rock masonry retaining wall was placed on the east side of the spillway channel for a distance of 170 feet from the east spillway abutment, to prevent further erosion of that side of the channel. This rock masonry wall was constructed entirely by CCC enrollees, the Bureau of Reclamation furnishing the necessary cement.

The following CCC equipment was used on the reconstruction work:

Seven 1½-ton dump trucks.

Three 1½-ton stake body trucks for transportation.

One 35-horsepower tractor with bulldozer.

One 25-horsepower tractor.

One air compressor and drills.

Miscellaneous small tools.

Throughout the entire construction period, this CCC equipment functioned satisfactorily. Very close supervision was maintained, which resulted in a minimum of breakdowns, even though the equipment was used continuously and severally.

A great deal of interest and enthusiasm was maintained by the CCC boys throughout the reconstruction of the McMillan Dam, and the enlargement of the spillway channel at the Avalon Dam. The men were given an opportunity to participate in major construction jobs and were able to observe modern construction practices at close range. Many of the boys received excellent training in the handling of both light and heavy construction equipment. All safety practices were enforced throughout the jobs and in many instances practical demonstrations of safety methods were given. Shortly after the completion of the job, several of the boys were able to obtain positions with contractors on construction work, as a result of their experience gained on the reconstruction of McMillan Dam and the improvement work at Avalon Dam.

All of this reconstruction and improvement work was done under the supervision of L. E. Foster, Regional Director, CCC. J. R. Yates, Superintendent of Camps BR-3 and BR-82 at Carlsbad was in immediate charge of the CCC forces. The office of the Chief Engineer at Denver, Colo., furnished general supervision and inspection of the engineering work.

Railroad and Highway Construction Around Shasta Dam Site

RELOCATION of portions of the Southern Pacific Railroad and United States Highway No. 99 around the Shasta Reservoir site was advanced another step today when the United States Bureau of Reclamation received bids for 5 more miles of railroad construction and 2½ miles of parallel highway construction in the vicinity of Pollock and Delta in Shasta County.

The lowest bid was $296,899.70, submitted by Granfield, Farrar & Carlin, of San Francisco, which firm now is engaged in building the first 12½ miles of the relocated railroad between Redding and Bass Hill.

Second low bid on the new work was submitted by Eaton & Smith, of San Francisco, at $298,424.40.

The highway construction is the first portion of 15 miles of United States Highway No. 99 which will be relocated above the high-water line of Shasta Reservoir. The railroad construction is an additional section of a total of 30 miles of railroad relocation made necessary by the building of Shasta Dam by the Bureau of Reclamation in the Sacramento River Canyon, 12 miles north of Redding.

Ten more miles of railroad and 12½ miles of highway remain to be advertised for construction. Walker R. Young, supervising engineer of the Central Valley project, said bids are expected to be called for this work before summer.

Growing Strawberry Clover on Wet and Alkaline Lands

THREE YEARS of study of strawberry clover by the Bureau of Reclamation indicates that this crop may assume great importance as a means of increasing the usefulness of seeped land on irrigation projects, especially those in the North.

Many acres of nonproductive farm land now covered with saltgrass, foxtail, and other weedy plants apparently can be converted into income-producing pasture through the planting of strawberry clover.

The increase in production of strawberry-clover seed during 1938 should greatly stimulate the introduction of this comparatively new pasture crop in new areas on all irrigated sections in the Northern States. During the past year the farmers on six Federal Reclamation projects fenced all or a part of their strawberry-clover pasture to take off a seed crop. More than 6,000 pounds of seed were harvested. Growers obtained yields of 200 to 300 pounds per acre. The seed has been selling at prices ranging from $1.50 to $3.50 per pound, according to the purity of the seed and local market conditions.

Strawberry clover, known botanically as *Trifolium fragiferum*, is primarily a pasture crop. It will grow on land too seepy and alkaline for other paying crops. More than 400 acres of strawberry-clover pasture are reported on Bureau of Reclammation projects. On the Sunnyside Division of the Yakima project in Washington, strawberry clover is found as pasture mixed with grasses on low-lying seeped areas and as predominantly strawberry-clover pasture on scattered tracts totaling 158 acres.

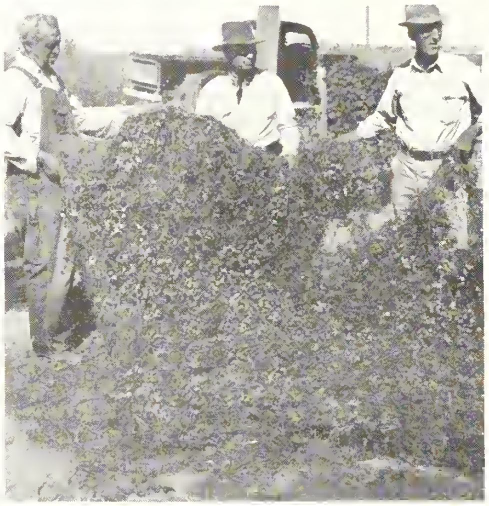
On the Uncompahgre project in Colorado there are 200 acres of strawberry-clover pasture, established for more than 5 years. This acreage consists largely of seepy, alkaline land and is found scattered in plots ranging from small, wet spots in grass pasture to permanent pastures of 20 to 40 acres in extent.

High Forage and Seed Yields

Farmers on Federal reclamation projects who have tried strawberry clover report that they consider it the most satisfactory perennial legume that can be planted for permanent pasture on seepy or alkaline soil. Strawberry clover spreads by creeping stems strawberry-fashion and by profuse seeding. When established it forms a thick mat of palatable and nutritious forage. Cattle, sheep, pigs, turkeys, and poultry select it in preference to other forage. It can be pastured from early spring to late fall. Experienced growers state that it will not cause bloat.

Last year a record yield of seed for a 2-year stand of strawberry clover was obtained on the Owyhee project in Oregon by a farmer who harvested 308 pounds of seed from one-third of an acre of alkaline land. Other good seed yields were obtained by farmers on the North Platte project in Nebraska; on the Minidoka project in Idaho, and in several other localities.

The carrying capacity of strawberry-clover pasture, as reported by farmers on Federal projects, has been very high. In 1937 an established 10-acre pasture of strawberry clover on the North Platte project provided forage for 37 head of mixed stock from May to October. In 1938 the owner of this pasture allowed his stock to feed on the entire 10 acres until the latter part of June. Then after fencing off 8 acres for seed, he pastured on the remaining 2 acres, 6 cows, 4 calves, and 3 work horses until the middle of September.



Strawberry clover vines from one-third acre plot on the Owyhee project in Oregon

Strawberry clover is not a "magic" plant. It requires the same care as any other small seed crop planted for permanent pasture. The important requirement for success with this crop is that moisture be maintained to the depth of the plant roots, either by seepage or by irrigation. Strawberry clover likes "wet feet."

If strawberry clover is grown on well-drained soil, usually it requires about the same irrigation as other pasture crops. If grown on alkaline soil it should be given light frequent irrigations. Frequent irrigations weaken the alkali solution and wash away some of the surface salts.

A grower should examine a few plants to learn the depth of the root systems and should apply water to that depth. On wet alkaline land strawberry clover usually has a shallow root system, only a few inches deep, but on well-drained soil the roots may penetrate 2 or 3 feet.

How to Get a Stand Started

For best results in starting strawberry clover pasture, attention should be given to the preparation of the seedbed, the method of planting, and the method of treatment of the seed.

After plowing the ground, a firm, smooth seedbed should be provided. If the ground is marshy and thus too wet to plow, it should be worked with a disk to get a shallow surface mulch and to retard other vegetation until the clover becomes well-rooted.

If the ground is too wet to work with any farm implement, the "spot" method should be tried. A grub hoe can be used to dig up spots 3 or 4 feet square. These spots can be seeded by hand. The clover can obtain a foothold on these spots from which it will spread. Scattering strawberry seed in salt grass or other vegetation without any preparation of the ground usually proves disappointing. An alkaline field which is to be irrigated by the corrugation method should be seeded on the sides of the corrugation and not between them. The corrugations should be spaced closely so that the vines can cover the surface as quickly as possible to provide shade and to prevent crystallization of the alkali.

Strawberry clover has a high percentage of hard seed. For that reason it is recommended that the seed be scarified before planting, to increase germination. About 2 pounds of seed per acre are generally sufficient. The seed should be planted at a shallow depth.

Although strawberry clover is more alkali-tolerant than most other plants, the most trying period for the crop when planted on alkaline ground is when the plants are young. Once the roots penetrate below the highly concentrated area of soluble salts the plant becomes increasingly vigorous. For that reason it is practical in some instances to plant a small amount of seed in rows of good soil and to transplant the plants in the second year on the alkaline soil.

Care of the Crop

A strawberry clover pasture should be given an opportunity to thicken its foliage before livestock are permitted to graze it. This means that probably during the first year strawberry clover should not be pastured, especially when planted on poor soil. Special precautions may be necessary also to prevent destruction of the young plants by grasshoppers, wild fowl, poultry, and rabbits, which seem to prefer strawberry clover. Once strawberry clover is established it withstands heavy grazing. Some growers state that heavy grazing improves an established stand.

(*Continued on page 82*)

Marshall Ford Dam Nearing Completion[1]

ON April 1, 1939, the first stage of construction at the Marshall Ford Dam on the Colorado River project in Texas was approximately 94 percent completed. Brown and Root, Inc. of Austin and the McKenzie Construction Co. of San Antonio, contractors for the dam, who started work on February 10, 1937, expect to complete their contract in the autumn of 1939, with earnings of approximately $6,650,000.

The dam is on the Colorado River about 12 miles northwest of Austin. It is a concrete structure of the straight-gravity type to contain 969,000 cubic yards, and is being built to a height of 190 feet. Adjoining the east abutment is a rolled-earth embankment 35 feet high and 1,100 feet long. Eventually the concrete dam will be increased 78 feet in height by the addition of a section 58 feet thick and 268 feet high to the upstream face, while the earth embankment will be enlarged to a height of 105 feet and crest length of 2,500 feet. There are 24-flood-control outlets, each consisting of an 8½-foot diameter conduit, controlled by a 102-inch diameter paradox gate. An ogee-type spillway in the river section of the dam will have a capacity of 160,000 second-feet. Three 16-foot diameter penstocks are being installed to provide for future power development. The reservoir behind the low dam will have a storage capacity of 800,000 acre-feet and the proposed high dam will store 2,550,000 acre-feet.

The project has a threefold purpose—flood control, power development, and irrigation storage. The city of Austin and the Colorado River Valley below that city are periodically menaced by floods. Power will be developed by the Lower Colorado River Authority, which will build the power plant and install machinery and equipment. Stored waters will provide a supplemental supply to a large area of rice lands in the river valley below Columbus, Tex.

In October 1938 construction of the base for the high dam to elevation 520, with 28 blocks across the river section containing 120,000 cubic yards of concrete, was started with a Public Works Administration allotment of $1,250,000. The estimated cost of the initial development is $12,473,000 and of the ultimate development $25,582,000.

[1] See illustrations on front and back cover pages of this issue.

CONTENTS

THE RECLAMATION ERA • APRIL 1939

Development of Supplemental Water for Operations on Payette River

THE investigation of methods of developing supplemental water in the vicinity of Boise, Idaho, has resulted in the outline of three tentative proposals for operations on the Payette River.

The Payette River produces annually about 2,200,000 acre-feet of water and the comprehensive land and water development contemplate the ultimate construction of about 2,000,000 acre-feet of storage within the watershed to conserve and regulate the water for irrigation use on lands within the Payette basin and for exportation to other watersheds, particularly the Mountain Home area on the plains north of the Snake River between Glenns Ferry and Boise, where 400,000 acres of irrigable, arid lands lie.

Storage is needed in the immediate future to provide a full water supply for Black Canyon lands of the Payette Division of the Boise project and to supplement the irrigation supply of about 85,000 acres of irrigated land under the old ditches of the lower Payette Valley.

The new storage requirements for immediate future irrigation are estimated at 230,000 acre-feet, if it is assumed that the Deadwood Reservoir will be operated primarily to augment the power output at the Black Canyon power plant. If Deadwood storage should be used entirely for irrigation purposes, new storage capacity of 130,000 acre-feet will be sufficient to meet immediate needs.

Deadwood Reservoir, with a capacity of 162,000 acre-feet, was completed in 1930. Releases from this reservoir augment the low-water flow at the Black Canyon power plant near Emmett to produce energy needed for construction, for irrigation pumping on the nearby Owyhee project and in the Emmett Irrigation District, and for assistance in filling American Falls Reservoir on the Snake River by means of power exchanges with the Idaho Power Co.

John R. Riter, Bureau of Reclamation Engineer in charge of the study, says:

"A review of storage possibilities within the Payette watershed and of possible transmountain diversions from the Salmon River suggests three alternative plans to meet the immediate future storage needs for lands dependent upon the Payette River for their irrigation supply.

"(a) Deadwood Reservoir, combined with 37,000 acre-feet of storage in upper Payette Lake and 95,000 acre-feet of storage at the Carbarton Reservoir site on the North Fork of Payette River near Cascade. The total cost of this plan is $2,917,000, including $1,367,000 already invested in the Deadwood Reservoir. Annual costs under this plan would be $39,000, for repayment of the new investment of $1,550,000 and $11,000 for operation and maintenance, a total of $50,000.

"This plan would require Deadwood Reservoir to be operated primarily for irrigation purposes with complete stoppage of its present partial use in aid of winter power production. Such a change may lead to complete loss of present income to the United States of $50,000 from the production of power for the Minidoka project. At times the Black Canyon power output for irrigation pumping would need be curtailed below the present output.

"(b) Cascade Reservoir, on the North Fork of Payette River near Cascade, Idaho, with a capacity of 230,000 acre-feet at a cost of $3,000,000. With this plan Deadwood storage could be used to a greater extent than at present in augmenting the winter power output at the Black Canyon power plant. The average annual power output at the Black Canyon Dam would be increased by about 2,300,000 kilowatt-hours, with an estimated annual income of about $6,000, which is sufficient to meet annual operation and maintenance cost of the dam and reservoir. With repayment of construction cost in 40 years without interest, the net annual cost under this plan would be $75,000.

"(c) Cascade Reservoir constructed to its ultimately required size of 700,000 acre-feet at a cost of $3,666,000. In addition to meeting immediate future storage needs in the Payette Valley, this plan would heavily augment the power output at the Black Canyon power plant and also secure desirable flood-control benefits on Payette River below Emmett. Annual costs for repayment and operation and maintenance of the reservoir are estimated as $99,000.

"The increased possible annual output at the Black Canyon power plant of 18,000,000 kilowatt-hours annually is estimated to have an annual value of $45,000, without material increase in production costs at the Black Canyon power plant. With the increased power income credited to the cost of the reservoir, the remaining net annual cost under this plan would be $54,000.

"Flood-control benefits secured under this plan are estimated at $600,000. If a construction credit of this amount can be secured, the net annual cost under this plan would be reduced to $39,000."

Central Valley Project Award

CONTRACT was awarded March 3 for relocation of an additional 5 miles of the Southern Pacific Railroad around Shasta Reservoir, to Granfield, Farrar & Carlin, of San Francisco. Its bid was the lowest of 16 proposals.

Growing Strawberry Clover on Wet and Alkaline Lands

(Continued from page 80)

Weeds, especially high-growing weeds, should be removed from the pasture, or at least should be kept mowed. Shading will retard the spreading of the strawberry clover vines.

Although a good initial stand is desirable, a complete cover can be obtained normally by the second or third year in areas where only one seedling comes up on each square foot the first year. A small amount of seed may be produced the first year. This can be used to thicken the stand.

Farmers desiring to harvest strawberry clover seed from established stands, either to increase their acreage or for sale, are advised by experienced growers to cut the clover before it is fully ripe and while it stands upright. At maturity the clover falls and is very difficult to cut and a good deal of seed is lost. The seed will mature if cut early, growers claim. Growers emphasize that it is important that the clover be kept well irrigated up to the time of harvest. If allowed to dry out even for a short time, the plants wilt badly.

Farmers may inspect this comparatively new pasture crop by visiting demonstrational plots on Federal projects planted during the past two years by the Civilian Conservation Corps and the Bureau of Reclamation. Information concerning seed and further details of method of growing strawberry clover may be obtained from local seed growers, county agents, or superintendents of Bureau of Reclamation projects.

Progress Report, 1938 National Resources Committee

THE National Resources Committee's Progress Report, covering the past 5 years, was released on February 27, 1939, and copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents per copy.

This report reviews the problems and progress with which the Committee as a planning agency has been concerned during the past 5 years. It demonstrates the usefulness of the kind of planning service which, as recommended by the President of the United States to the Congress, should be provided as a permanent establishment within the Federal Government. The report covers four chapters under the following subjects:

I. Introduction.
II. The Planning Pattern.
III. Planning Progress.
IV. Summary Statement of Organization.

NOTES FOR CONTRACTORS

Specifications Nos.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
815	Yakima-Roza, Wash.	Jan. 9	Earthwork, canal lining and structures, Yakima Ridge Canal, station 1952+00 to station 2387+00.	Nat McDougall Co	Portland, Oreg.	[1] $211,144.50		Mar. 4
				L. Coluccio and Macri Bros	Seattle, Wash.	[3] 152,401.75		Do.
178	Boulder Canyon, Ariz.-Nev.	Jan. 10	287.5-kilovolt oil circuit breakers, disconnecting switches and lightning arresters for Boulder power plant.	General Electric Co	Schenectady, N. Y.	[1] 235,600.00	F. o. b. Boulder City	Mar. 2
				Bowie Switch Co	San Francisco, Calif.	[2] 61,300.00	do	Do.
				General Electric Co	Schenectady, N. Y.	[3] 17,050.00	do	Do.
1179-D	Yakima-Roza, Wash.	Feb. 9	7 revolving fish screens and 1 additional roller chain for canal headworks.	Steel Construction Co	Portland Oreg.	22,862.00	F. o. b. Portland. Discount ½ percent.	Do.
1180-D	Boise-Payette, Idaho	do	Structures, Black Canyon Canal laterals 24.8 to 26.2 and A-Line canal laterals 2.0 to 4.4.	Jesse Latham & Co	Caldwell, Idaho	19,943.00		Mar. 6
1184-D	Owyhee, Oreg.-Idaho.	Feb. 23	Earthwork and structures, Mule Creek drain and Mule Creek 1.1 branch drain.	Geo. B. Henly Construction Co.	Ontario, Oreg.	13,560.00		
1186-D	Yakima-Roza, Wash.	Feb. 15	Furnishing and delivering 6,600 tons of sand and 1,800 tons of gravel for the Yakima Ridge Canal.	Pioneer Sand & Gravel Co	Seattle, Wash.	[1] 560.00	F. o. b. Pioneer Pit	Feb. 24
						[3] 1,792.00	do	Do.
1187-D	Boulder Canyon, Ariz.-Nev.	Feb. 27	Structural steel for bus-structure extension for the city of Los Angeles in Boulder switchyard.	International Derrick and Equipment Co. of California.	Torrance, Calif	19,744.00	F. o. b. Torrance. Discount ½ percent.	
1188-D	All-American Canal, Ariz.-Calif.	Feb. 28	Mechanisms for 8 gate-hoist switches and 4 alarm switches for power plants at drops.	Valley Iron Works	Yakima, Wash	750.00	F. o. b. Yakima. Discount 5 percent.	Mar. 7
1190-D	Yakima-Roza, Wash.	Feb. 21	Furnishing and delivering 2,300 tons of sand and 6,700 tons of gravel.	L. Romano Engineering Corporation.	Seattle, Wash.	13,789.00	In stockpiles at damsite.	Mar. 2
A-38278-B	Columbia Basin, Wash	Feb. 7	Four 4-door sedans, 15 station wagons and 2 pickup trucks.	William O. McKay Co	Seattle, Wash.	13,987.03	F. o. b. Dearborn, Mich. Includes trade-ins.	Do.
824	Kendrick, Wyo.	Feb. 23	Petersen coils and step-voltage regulators for Seminoe power plant, Gering, Greeley, and Cheyenne substations.	General Electric Co	Schenectady, N. Y.	[1] 25,656.00	F. o. b. destination	Mar. 10
				Allis-Chalmers Mfg. Co.	Milwaukee, Wis.	[2] 27,392.00	do	Do.
1192-D	Yakima-Roza, Wash.		One 28- by 15-foot radial gate for Yakima Ridge Canal headworks.	California Steel Products Co	San Francisco, Calif.	1,559.00	Discount, 1 percent	Mar. 11
A-38293-A	Columbia Basin, Wash	Feb. 16	Steel reinforcement bars, 5,180,000 pounds.	Bethlehem Steel Co.	San Francisco, Calif.	134,263.00	F. o. b. Odair, Wash., shipping point Seattle; discount ½ percent.	Mar. 21
1196-D	Colorado-Big Thompson, Colo.	Mar. 8	Structural steel for bridges on roads to east and west portals of Continental Divide Tunnel.	Joseph T. Ryerson & Son Inc.	Chicago, Ill.	[1] 1,899.00	F. o. b. Chicago	Mar. 15
				American Bridge Co.	Denver, Colo	[2] 4,856.00	F. o. b. Gary, Ind.	Mar. 21
820	do	Feb. 9	Six 5-room, twelve 4-room, and six 3-room residences at Estes Park headquarters camp.	Anderson and Davidson	Leadville, Colo.	110,000.00		Mar. 25
821	Gila, Ariz.	Mar. 1	Fortuna wasteway at station 948 and bridges at stations 876+75 and 987+12, Gravity Main Canal.	Norman I. Fadel	Los Angeles, Calif.	58,857.80		
825	Central Valley, Calif.	Mar. 3	Earthwork and structures, Southern Pacific R. R. relocation, milepost 282.80 to milepost 287.81, and earthwork, structures and surfacing U. S. Highway No. 99, stations 454+00 to 587+60.38.	Granfield, Farrar and Carlin.	San Francisco, Calif.	296,899.70		
1194-D	All-American Canal, Ariz.-Calif.	Mar. 7	One clutch-operated, crawler-traction-mounted, full-revolving, Diesel-engine-powered, dragline excavator.	Northwest Engineering Co	Green Bay, Wis.	23,839.00	F. o. b. Green Bay	Mar. 24
1199-D	Colorado River, Tex., Columbia Basin, Wash.	Mar. 15	Transfer car for 102-inch gates at Marshall Ford Dam, transfer car for 102-inch gates and truck for transporting gate stems for 102-inch ring-follower gates at Grand Coulee Dam.	Hesse-Ersted Iron Works. H. S. Mitchell, Receiver.	Portland, Oreg.	4,876.00	F. o. b. Portland	Do.

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3.

Additional Roza Division Contracts Awarded

TWO contracts for construction of an additional 8-mile section of the Yakima Ridge Canal, Roza Division, Yakima project, Washington, were awarded on March 9, by Secretary of the Interior Harold L. Ickes.

The contract awarded to the Natt McDougall Co. of Portland, Oreg., on a bid of $211,144.50 covers, in addition to the excavation of this section of the canal, some concrete lining and embankment construction.

The other contract, which includes the construction of three monolithic-concrete siphons on this section of the canal, was awarded to L. Coluccio and Macri Bros. of Seattle, Wash., on their bid of $152,401.75.

Seven proposals were received and opened by the Bureau of Reclamation at its Yakima, Wash., office, on January 9, 1939.

The contractors are required to begin work within 30 days after receipt of notice to proceed and to complete all of the work within 400 calendar days. The section of the canal thus placed in construction lies about 14 to 19 miles southeast of Yakima, Wash.

The Roza division is adjacent to divisions of the Yakima project already completed. Water will be diverted from the Yakima River at the Roza diversion dam, located about 4 miles north of Pomona Siding. Immediately upstream from the west end of the dam are the headworks for the Yakima Ridge Canal. A power plant will be located at the end of a 12-mile section of the canal. When completed the Yakima Ridge Canal will extend from the Yakima power plant in a generally southeast direction, a distance of 87 miles to carry water to 72,000 acres of dry land included in this new division of the project.

Twenty-one miles of the canal have been completed and work is now in progress on 24 additional miles. It will be necessary to build laterals to serve the lands before the first water can be delivered, probably in 1940.

Left: Harold L. Ickes, Secretary of the Interior; Mrs. Ickes; John C. Page, Commissioner of Reclamation; and Irving C. Harris, Director of Power, Boulder Canyon project, see Boulder Dam from the 150-ton Government cableway that spans the canyon
Right: Secretary Ickes and party in the Nevada wing of Boulder Dam powerhouse

Four Giant Generators Ordered for Shasta Power Plant

FOUR giant generators have been ordered for the Shasta power plant, Central Valley project, California.

The General Electric Co. of Schenectady, N. Y., was awarded the contract for furnishing and installing the generators on its bid of $2,490,999, which was the lowest of three proposals received and opened by the Bureau of Reclamation at its Denver, Colo., office on January 19, 1939.

These four main generators, each of 75,000 kilovolt-ampere capacity, will comprise the initial installation, except for the station-service units, in the Shasta Dam power plant, located at Shasta Dam on the Sacramento River north of Redding, Calif.

The powerhouse, 446 by 116 feet in plan and seven stories high, located downstream from the dam on the west bank of the river, will be arranged for an ultimate installation of five main generating units of the 75,000 kilovolt-ampere capacity, and two station-service units, each having a capacity of 2,500 kilovolt-amperes.

These huge generators to be installed at Shasta power plant can compare with the 108,000 kilovolt-ampere generators to be installed at Grand Coulee and the 82,500 kilovolt-ampere generators now operating at Boulder Dam.

The Shasta generators are described as generators of unity-power-factor, 138½ revolutions per minute, 13,800-volt, 3-phase, 60-cycle, vertical-shaft, alternating-current generators.

The four generators will be installed by the contractor at different times within 1,320 calendar days.

Bids for furnishing four 103,000-horsepower turbines, to harness the energy of falling water at Shasta Dam and drive these giant electric generators, have been invited by the Bureau of Reclamation. Each turbine will be direct-connected by a vertical shaft to a 75,000 kilovolt-ampere generator. The turbines will receive water from the reservoir through 14-foot diameter plate-steel penstocks.

The power will be used to operate Central Valley project pumping plants on the Contra Costa Canal and the San Joaquin pumping system, and the surplus power will be available for sale in the northern and central California markets for municipal, industrial, and agricultural use.

Record Sugar Beet Season On Milk River Project

THE season's campaign of the Utah-Idaho Sugar Co. on the Milk River project was completed on February 12, having continued almost 5 weeks longer than in any past year. About 185,000 tons of sugar beets were processed. The winter was particularly favorable to this long run and no interruptions were necessary.

CCC Activities on the Kennett Division Central Valley Project

By SMITH A. KETCHUM, *Assistant Engineer*

THE CCC Camps BR-84 and BR-85 are located on the McCloud River about one-half mile north of Baird, and 17 miles north of Redding, Calif., at the site of an abandoned United States fish hatchery. Shasta Dam, now under construction by contract, is approximately 12 miles from the CCC camps downstream on the Sacramento River. The principal factors leading to the selection of this site were as follows: Location with regard to the work to be undertaken, accessibility from United States Highway No. 99, existing water supply, topography, telephone facilities, existing buildings which could be rehabilitated, and Government ownership of the land. The camps are situated on a bench at elevation 840 on the right bank of the river and approximately 120 feet above the present water level in the McCloud River. Tall pine and large oak trees provide an abundance of shade and protection from the sun and wind and, combined with the precipitous limestone cliffs across the river to the east, greatly augment the scenic beauty of the site.

The work to be accomplished by the CCC men on the Kennett Division of the Central Valley project consists of miscellaneous minor construction at the Government town, known as Toyon, which is located 2¼ miles southeast of Shasta Dam, and clearing the reservoir area behind the dam (approximately 24,000 acres) of trees, brush, and debris between elevation 818 and 1,070. The estimated period required for clearing the reservoir area is 5 years. In addition to the above work the CCC enrollees are subject to call at all times by the United States Forest Service in the event of forest fires in the vicinity.

On August 16, 1938, the erection of portable camp buildings which had been transferred from other CCC camps was started. The first regular enrollees arrived on October 15, 1938, and on October 19, 1938, a crew started work in Toyon.

Program at Toyon

The town of Toyon, a small city in itself, built by the Bureau of Reclamation to house the Government personnel employed on the Kennett Division of the Central Valley project, occupies an area of approximately 45 acres. In addition to an office building and annex, two 2-story dormitories, a warehouse, a combination garage and fire station, a concrete testing laboratory, and 100 residences comprise the town. The plan of Toyon embodies the conventional gridiron system of streets running north-south and east-west, with modifications on the north side consisting of diagonal streets to fit the topography. A block, centrally located, containing 2.5 acres, has been reserved for a park and recreation center. The public streets, sidewalks, and driveways were constructed under contract.

The work underway at Toyon by the CCC men includes grading, constructing minor sidewalks, seeding lawns, planting trees and shrubs, building rockeries, developing the park area, erecting fences, and the construction of recreation facilities.

The CCC enrollees are now actively at work grading around the camp buildings, cleaning up the park area and vacant lots, and placing the base course for driveways and sidewalks, all of which are practically completed. Because of the poor and unworkable soil overlying the town site, it was necessary to excavate for 4 inches below grade where lawns are to be planted. The areas thus excavated will be covered with a 4-inch blanket of sandy loam, amounting to a total of approximately 2,500 cubic yards. The proposed recreational development includes the possible construction of tennis courts and handball courts on the south end of the park and clearing and grading for a soft ball field, the location of which has not yet been definitely determined.

Clearing the Reservoir Area

On November 21, 1938, the first crew of CCC enrollees started clearing the reservoir area that will be created by Shasta Dam, and as new enrollees arrived additional crews were put to work until now there are seven crews engaged in the clearing operations. The first clearing was adjacent to Camps BR-84 and BR-85 at Baird. From here the operations were broadened to cover areas west of the CCC camp near the head of Johns Creek, east across the McCloud River, and south (1½ miles) on the Pit River. The area on Azelle Creek, which is 2 miles east of the last mentioned area, will be the next plot to be cleared.

CCC Camps BR-84 and BR-85 in background
Partially cleared reservoir area in foreground

Looking north on Second Street in Toyon. CCC enrollees working at Bureau of Reclamation headquarters

A growth of pine trees, some as high as 150 feet, oak trees, and manzanita brush constitute the principal vegetation to be cleared. Generally, the large trees are found in scattered inaccessible areas of the reservoir not served by roads suitable for heavy trucking. Practically all of these trees are of a species that yield a poor quality of lumber, making salvage infeasible. The proper felling of the large trees requires no small amount of skill on the part of the enrollees. The general clearing procedure is: First, to cut and pile the brush; second, to fell and trim the trees; third, to burn the trees, brush, and debris. Where the ground is flat or with little slope, the trees and brush are placed in convenient piles, but where the terrain is steep, it is more convenient to roll the material to the bottom of the ravines where it is compacted and burned.

Thirty-four enrollees, under the immediate supervision of a foreman, constitute the average size clearing crew.

Few roads exist within the reservoir area. In order to gain access to the remote areas, it will be necessary to construct approximately 100 miles of minor truck trails and numerous small timber bridges. One crew of six enrollees is occupied full time at this work.

The personnel at Camps BR-84 and BR-85 consist of 424 enrollees, equally divided between the two camps, seven representatives of the United States Army, and the supervisory and facilitating personnel employed by the Bureau of Reclamation. The entire work program is under the immediate supervision of the construction engineer at Redding, and the general supervision of the supervising engineer at Sacramento, Calif., and the chief engineer at Denver, Colo.

Owyhee Project Being Settled Rapidly

EAGER farmers already have settled virtually all the irrigable public land on the Owyhee irrigation project.

Homesteaders, many of them from drought areas, have applied for all except 397 of the 12,460 acres of public land which have been made available from time to time on the new project in eastern Oregon and western Idaho. On the last section opened for homestead entry late last year four farmers applied for every unit offered. The new farm units of earlier openings which remain unclaimed are rather rough and difficult to handle.

The State and privately owned lands on the project are also well settled. Only about 4,000 of the 53,000 irrigable acres available on such lands remain unoccupied. The project also will supply water for this land.

The project achieved successful settlement despite high qualifications required of applicants. For Government land an examining board carefully graded the would-be irrigation farmers on their character, industry, financial condition, and past farming experience.

For State and other lands a local organization of farmers and business men in the area whose officials serve without pay investigated the applicants. The high type of settler obtained is expected to go far toward insuring full success of the new project.

The project lands have had little turnover in new settlers since the first group of farms was opened for entry in 1935. Those who succeeded in getting farm units have usually remained, and a great many have flourished in their new homes. Their chief irrigated crops are alfalfa and clover seed. Good prices for both in 1937 put many of them "in clover." Others grow specialty crops like sugar beets and lettuce on their irrigated farms.

Irrigation canals and other necessary ditches on the new project are still incomplete. While homesteaders of the first few sections have had water for four seasons, others have been irrigating their farms only two seasons and some only one, and this year 8,000 additional acres will receive water.

The Owyhee project will ultimately irrigate 123,000 acres of land. Half of it was previously under irrigation but in need of supplemental water which it now will receive. The remainder was sagebrush. About 80,000 acres of this land lie in eastern Oregon near the Owyhee and Snake Rivers and 43,000 are across the State boundary line in western Idaho.

Daniel W. Mead Receives Washington Award

WE ARE indebted to the Engineering News-Record for the following statement concerning Daniel W. Mead, who was a member of the board to examine and report on Boulder Dam, in which capacity he served from July 1928 to November 1932:

"The four founder societies and the Western Society of Engineers at a joint meeting in Chicago on February 20 presented the Washington award to Daniel W. Mead, consulting engineer and professor emeritus of hydraulic and sanitary engineering at the University of Wisconsin. Mr. Mead, a past president of the American Society of Civil Engineers, received the award 'in recognition of preeminent service in advancing human progress,' and 'for his superior contribution to sound theory, good practice, and to high ethical standards.' "

Orland Processing Plants

THE Orland project, California, has two processing plants operated on farms and in conjunction with farm operations. One is a plant for extracting olive oil and the other is a plant for extracting the meats from walnuts. The latter plant contains special machines developed and largely constructed by the owner. The machines are working successfully and have attracted a great deal of attention. These plants not only provide an outlet for farm products but furnish needed seasonal employment for a number of persons.

GOVERNMENT OF THE UNITED STATES

EXECUTIVE BRANCH
THE PRESIDENT

BUREAU OF THE BUDGET

LEGISLATIVE BRANCH
CONGRESS

SENATE
THE VICE PRESIDENT

96 SENATORS

HOUSE OF REPRESENTATIVES
435 REPRESENTATIVES

2 DELEGATES

2 COMMISSIONERS

JUDICIAL BRANCH
SUPREME COURT

CIRCUIT COURTS OF APPEALS

UNITED STATES DISTRICT COURTS

COURT OF CLAIMS
COURT OF CUSTOMS AND PATENT APPEALS
U S CUSTOMS COURT
DIST OF COLUMBIA COURTS
TERRITORIAL COURTS

1. DEPARTMENT OF STATE
DIVISION OF FOREIGN SERVICE ADMINISTRATION
DIVISION OF EUROPEAN AFFAIRS
DIVISION OF FAR EASTERN AFFAIRS
DIVISION OF NEAR EASTERN AFFAIRS
DIVISION OF AMERICAN REPUBLICS
DIVISION OF TRADE AGREEMENTS
OFFICE OF PHILIPPINE AFFAIRS
CONSULAR COMMERCIAL OFFICE
FOREIGN SERVICE BUILDINGS OFFICE
DIVISION OF PROTOCOL
DIVISION OF CURRENT INFORMATION
DIVISION OF RESEARCH AND PUBLICATION
DIVISION OF INTERNATIONAL CONFERENCES
DIVISION OF CULTURAL RELATIONS
DIVISION OF CONTROLS
PASSPORT DIVISION
VISA DIVISION
TREATY DIVISION
DIVISION OF INTERNATIONAL COMMUNICATIONS

2. DEPARTMENT OF THE TREASURY
COMMISSIONER OF ACCOUNTS AND DEPOSITS
- DIVISION OF BOOKKEEPING AND WARRANTS
- DIVISION OF DEPOSITS
- DIVISION OF DISBURSEMENT
- SECTION OF SURETY BONDS

TREASURER OF THE UNITED STATES
COMPTROLLER OF THE CURRENCY
PUBLIC DEBT SERVICE
- DIVISION OF LOANS AND CURRENCY
- DIVISION OF ACCOUNTS AND AUDIT
- DIVISION OF PAPER CUSTODY
- REGISTER OF THE TREASURY

DIVISION OF SAVINGS BONDS
DIVISION OF TAX RESEARCH
BUREAU OF ENGRAVING AND PRINTING
BUREAU OF THE MINT
BUREAU OF INTERNAL REVENUE
PUBLIC HEALTH SERVICE
BUREAU OF CUSTOMS
BUREAU OF NARCOTICS
SECRET SERVICE DIVISION
COAST GUARD
PROCUREMENT DIVISION
- PUBLIC BUILDINGS BRANCH
- BRANCH OF SUPPLY

DIVISION OF RESEARCH AND STATISTICS
FEDERAL ALCOHOL ADMINISTRATION
DIVISION OF MONETARY RESEARCH

3. DEPARTMENT OF WAR
WAR DEPARTMENT GENERAL STAFF
OFFICE OF THE ADJUTANT GENERAL
OFFICE OF INSPECTOR GENERAL
OFFICE OF JUDGE ADVOCATE GENERAL
OFFICE OF QUARTERMASTER GENERAL
OFFICE OF SURGEON GENERAL
OFFICE OF CHIEF OF FINANCE
OFFICE OF CHIEF OF ENGINEERS
- BOARD OF ENGINEERS RIVERS & HARBORS
- MISSISSIPPI RIVER COMMISSION
- CALIFORNIA DEBRIS COMMISSION

OFFICE OF CHIEF OF ORDNANCE
ARMY WAR COLLEGE
OFFICE OF CHIEF SIGNAL OFFICER
OFFICE OF CHIEF OF AIR CORPS
OFFICE OF CHIEF OF CHAPLAINS
OFFICE OF CHIEF OF CAVALRY
OFFICE OF CHIEF OF FIELD ARTILLERY
OFFICE OF CHIEF OF COAST ARTILLERY
OFFICE OF CHIEF OF INFANTRY
ARMY INDUSTRIAL COLLEGE
BUREAU OF INSULAR AFFAIRS
- GOVERNMENT OF COMMONWEALTH OF PHILIPPINES
- DOMINICAN CUSTOMS RECEIVERSHIP

OFFICE OF CHIEF OF CHEMICAL WARFARE SERVICE
NATIONAL GUARD BUREAU
DIRECTOR OF AIRCRAFT PRODUCTION

4. DEPARTMENT OF JUSTICE
ATTORNEY GENERAL S OFFICE
SOLICITOR GENERAL
- ASSISTANT SOLICITOR GENERAL

ANTI TRUST DIVISION
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Progress of Investigations of Projects

Arizona-California: *Colorado River Valley surveys.*—Work was continued on the aerial mosaics of the lower Colorado and Gila River Valleys. Another flight was made from Parker Dam to the Gulf of California, including irrigated lands in Mexico, to note conditions due to a discharge of 25,000 second-feet. Studies in Palo Verde Valley were made.

California: *Kings River-Pine Flat project.*—Topographic surveys of Piedra Dam and Reservoir were completed and preparation of a report was begun.

Colorado: *Blue River transmountain diversion.*—A review of plans and estimates was made, and the report was in course of preparation.

Eastern slope surveys.—Report of Trinidad project was nearly completed; plans are being made for a storage dam on North Republican River at junction with Chief Creek; surveys in Arkansas Valley below Caddoa dam site are in progress, and land classification begun.

Western slope surveys.—The report of the Florida project was about completed; snow prevented continuation of reconnaissance of Gold Bar Reservoir, but water supply studies were continued on the La Plata project; additional surveys of Mancos project are to be made; water supply studies were continued on the Paonia project, and economic studies of the Silt project were in progress.

Idaho: *Boise-Payette-Weiser project.*—A report of the storage requirements on the Payette River was completed and data in regard to construction of Cascade Reservoir prepared.

Idaho: *Snake River storage, South Fork.*—Preparation of a report was continued, and geologic reports of the Narrows and Burns Creek dam sites completed. Plans for Grand Valley Reservoir with capacity of 1,500,000 acre-feet were nearly completed.

Montana: *Gallatin Valley project.*—Water supply studies were continued and designs were prepared for a concrete dam at Canyon Ferry site on the Missouri River.

Marias project.—Water supply studies and soil analyses will be completed in the near future.

Rock Creek project.—Field work was completed and preparation of a report was in progress.

Montana-North Dakota: *Fort Peck project.*—Land classification and surveys of canal lines along Milk and Missouri Rivers were continued.

Nebraska: *Mirage Flats project.*—Field work was completed and a report is in course of preparation. An analysis of Niobrara River water was made.

North Dakota: *Missouri River tributaries.*—Field work will be begun in the near future.

North Dakota-South Dakota: *Missouri River pumping project.*—Field headquarters were established at Mobridge, S. Dak., and at Bismarck, N. Dak., and surveys begun.

Oklahoma: *Altus project.*—The Department of Agriculture is continuing economic investigations of types of farming and rural resettlement.

Canton and Fort Supply projects.—A review of land and water studies of Fort Supply project was made and economic data collected regarding the Canton project.

Washita River investigations.—Land classification of lands in Custer and Roger Mills Counties was in progress.

Oregon: *Grande Ronde project.*—Preparation of a report was continued. Additional studies of Catherine Creek Reservoir were made.

Medford project.—A report of the project was complete.

Willamette Basin.—A reconnaissance was made in January and February of the basin. Studies are being made of a sprinkler irrigation system for the Canby project.

South Dakota: *Black Hills projects.*—Power plant studies were continued on the Angostura project at Jackson Narrows, and reservoir operation studies were continued of the Buffalo Gap project.

Shadehill project.—Surveys of the project were completed; samples of the Grand River water were obtained, and a general map of the project is being prepared.

Texas: *Balmorhea project.*—Initiation of field work on this project located in southwestern part of State, 190 miles east of El Paso, is planned for near future, including establishment of stream-gaging station.

Robert Lee project.—This project is located on the upper Colorado near Robert Lee, and field work will begin in the immediate future.

Utah: Preparation of reports of the Blue Bench and Ouray Valley investigations was continued; on the Price River-Gooseberry project, land classification in San Rafael drainage basin was completed, designs and estimates of dams are being made and a draft of report was in progress; on the Weber River project water supply studies and draft of report were continued.

Utah-Idaho-Wyoming: *Bear River surveys.*—Topographic maps were made of reservoir sites on Sulphur and Pleasant Valley Creeks; printing of the final mosaic sheet was in progress; tabulation of areas in Cache Valley and on Upper Bear River was continued.

Wyoming: *Big Horn and Powder Rivers.*—Reconnaissance examination of irrigation possibilities will soon be commenced.

Colorado River Basin.—Land classification surveys were completed in Little Colorado and Williams River basins in Arizona; surveys of Wittman project were begun, and a reconnaissance of Palo Verde and Chucawalla Valleys in California was made. In Arizona, surveys of Bullshead and Alamo reservoir sites were continued, and that of Box reservoir site on Hassayampa completed; data are being assembled regarding the Little Snake River basin in Colorado and Wyoming; in Utah, topographic mapping of Dewey reservoir site was continued; drilling of Split Mountain dam site was continued; study of the power market in Salt Lake City region was continued. In Wyoming, water-supply studies and preparation of topographic maps of dams and reservoir sites were continued.

Yuma Project Citrus

At the end of March, 60 percent of the season's grapefruit had been harvested.

Storage Reservoirs on Snake River

A LIST of reservoirs on Reclamation projects, published sometime ago in the Era, disclosed that the total storage capacity on the Minidoka project was exceeded only by the Boulder Dam project, with its huge Lake Mead. This distinction of being "next to the head" is, perhaps only temporary, for a number of reservoirs are now under construction, each of which, when completed, will surpass Minidoka's total, but if "beneficial use" be a criterion for judging them, the reservoirs of the Snake River will have few superiors.

Jackson Lake

One of the first storage dams to be built by the Bureau of Reclamation, or "Reclamation Service," and the first on Snake River, was at Jackson Lake in Wyoming, some 20 miles below Yellowstone Park. Here was a natural lake, with an area of some 18,000 acres, and in 1906 and 1907, the site was utilized by constructing a temporary timber crib dam across the river. In this way, about 350,000 acre-feet of storage were obtained for use on the Minidoka project, then being developed.

This temporary crib dam was replaced in 1911 with a concrete dam, thus providing a storage capacity of 380,000 acre-feet. Two years later enlargement of the reservoir by raising the height of the dam, was begun, and was finished in 1916, increasing the reservoir capacity to 789,000 acre-feet. Funds for this work were advanced by the Kuhn Irrigation & Canal Co., now the Twin Falls North Side Land and Water Co., and the Twin Falls Canal Co., and the additional storage was divided in the proportion of 61/80ths to the former company, and 19/80ths to the latter.

Further storage amounting to some 58,000 acre-feet was obtained in 1919 by dredging out a bar across the channel of Snake River below the dam, which permitted the lake to be lowered by about 2 feet. At present, some 18 Warren Act contractors own storage rights in the reservoir, in addition to the Minidoka project rights, allocated to the Minidoka and Burley Irrigation Districts. All rights in the reservoir are shown in the accompanying table.

Jackson Lake, when full, covers an area of nearly 26,000 acres, and has a maximum depth at gate sill of 41 feet. It was first filled in 1921, and in 10 of the 17 years since that time, storage in it has reached capacity. In every year except 1934, however, the old or bottom rights have been filled and have furnished a water supply to more than 300,000 acres of Minidoka project and Upper Valley lands.

Lake Walcott

Although the Minidoka Dam, built across Snake River at the head of the Minidoka project, was intended only for diversion purposes, and to furnish a head for the power plant, it was early apparent that Lake Walcott, the name of the reservoir formed by this dam, possessed storage possibilities. The reservoir spillway was an ogee structure nearly a half mile long and on this foundation concrete piers were set at 7-foot intervals and equipped with flashboards. In this way nearly 100,000 acre-feet of storage was obtained, the power head was increased by 5 feet, and the flow of the river more fully regulated.

Nominal capacity of Lake Walcott is 95,180 acre-feet, at elevation 4,245, and at this level it covers about 12,000 acres. Occasionally, however, either during floods or by design, the reservoir capacity has been increased by 5,000 acre-feet or more. Lake Walcott is wholly a Minidoka project reservoir, and its storage is allocated in the proportion of 66.5 percent to the Minidoka Irrigation District and 33.5 percent to the Burley Irrigation District.

American Falls

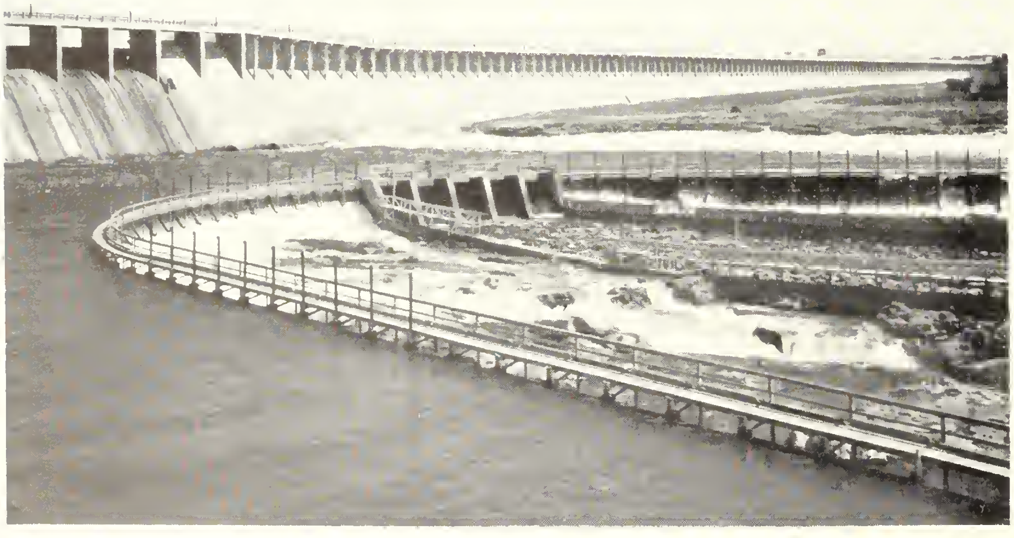
The third and largest of the reservoirs to be built on Snake River was that at American Falls, Idaho. The site of the dam is about 10 miles above the headwaters of Lake Walcott and its construction involved the inundation of about three-fourths of the old town of American Falls. This necessitated the removal of the buildings in the submerged area, most of which were taken to the new town laid out on higher ground.

Nearly 2 miles of the main line of the Oregon Short Line Railroad was moved, with that portion across the river being raised some 20 feet. Nearly 55,000 acres of farm lands, of which about 25,000 acres were white owned and 30,000 acres Indian lands, were acquired for the reservoir, and highways, bridges, and other improvements were moved and rebuilt.

It was first planned to built a reservoir of 3,000,000 acre-feet capacity, since up to that time, the available water supply had appeared ample for a reservoir of that size. Even in 1919, the dryest year so far experienced, the spill over Milner Dam, the point below all canal diversions, was 2,000,000 acre-feet. The year previous, in 1918, this spill had been more than 4,400,000 acre-feet.

Contracts for 3,000,000 acre-feet of storage could not be obtained from water users, however, and the size of the reservoir was reduced to 1,700,000 acre-feet, its present capacity. When full, it covers an area of 56,000 acres. Construction was begun in 1925 and completed in 1927, and it was first filled in the latter year. It was again filled in 1928 but during the long cycle of dry years from

American Falls Dam, Minidoka project, Idaho



1929 to 1935, inclusive, the full capacity of the reservoir was not reached. For the past 3 years, however, not only has the reservoir been filled but there has been annually a large surplus, and it now appears probable that the season of 1939 will see another recurrence of flood conditions.

Storage rights in this reservoir are owned by water users both above and below American Falls. Those whose lands are above American Falls obtain their water supply from Jackson Lake by exchanging their own storage in American Falls for an equal amount of the Minidoka project storage in Jackson Lake. Such an arrangement is mutually beneficial, since it furnishes these upper valley lands with water otherwise unobtainable, while the Minidoka project is saved the seepage loss between Jackson Lake and Lake Walcott. This seepage is estimated at 12.8 percent, equivalent to more than 40,000 acre-feet, out of the Minidoka storage, a loss it would sustain if its water were brought down from the upper reservoir.

Moreover, in previous years, other severe "losses," now happily avoided, occurred in this stored water during its passage down the river when the normal flow of the stream was almost exhausted and canals were cut to their decreed rights.

Contractors for storage space in American Falls Reservoir number 28, their respective rights ranging from 79 to 447,421 acre-feet. The names of these contractors and the amounts of their storage are set out in the subjoined table, and of this total, nearly 266,000 acre-feet are for use above American Falls, and the balance below.

It will be noted, also, that the United States is the owner of 437,000 acre-feet, or more than 25 percent of the reservoir capacity. This Government storage was originally intended for use on a tract of about 100,000 acres of public land adjoining the Minidoka project on the north and west and known as the North Side pumping extension. Pending construction of this extension, the storage space referred to is leased to other contractors and water users for a lump sum of $50,000 per year.

Island Park and Grassy Lake

The three reservoirs so far described are all located on the main stream of the Snake River along which the principal irrigated area is situated. But on the North or Henry's Fork of Snake River, and its most important tributary, the United States has recently provided two more reservoirs for watering lands in Fremont and Madison Counties. The largest of these is the Island Park Reservoir which has just been completed. It is near the head waters of the North Fork and will have a capacity of 126,600 acre-feet. Grassy Lake Reservoir, with a capacity of 15,000 acre-feet, is the "baby" of them all. It is situated on Grassy Creek, Wyo., just south of Yellowstone Park, and according to present plans, will be completed by the end of the 1939 season.

Operation of these two reservoirs will necessarily be coordinated with that of the three reservoirs on the main river, since the former have junior storage rights. It is probable that all of the available runoff as it occurs will be stored in these North Fork reservoirs, and such portion of it later released as may be necessary to fill prior storage rights at American Falls.

Mention has already been made of the large quantities of water spilled over Milner Dam in the past 3 years for lack of storage facilities. The total amount thus lost was more than 2,000,000 acre-feet, and it has resulted in widespread agitation for additional storage facilities on Snake River. Surveys and studies of numerous sites have been made, both in Wyoming and Idaho, for reservoirs ranging up to 1,500,000 acre-feet, and this work is still going on. As an alternative, consideration has been given to a plan to raise the American Falls Dam and increase the size of this reservoir to its originally intended capacity of 3,000,000 acre-feet.

An interesting feature in connection with all of these reservoirs has been the constant increase in their construction costs per acre-foot. The storage obtained at Lake Walcott by building piers on the spillway involved an additional expenditure of only 63 cents per acre-foot. The Government's bottom storage at Jackson Lake averaged $1.46 per acre-foot while the cost of the enlargement by raising the dam was $1.78 per acre-foot. American Falls Reservoir costs rose to $4.43 per acre-foot, while those of Island Park and Grassy Lake Reservoirs will average several times that sum. It is to be expected that, as storage costs increase, there will be a correspondingly higher valuation placed on the water supply thus provided and the requirements for beneficial use will be more exacting.

The storage rights in American Falls and Jackson Lake Reservoirs now amount to a total of 2,547,000 acre-feet.

SYDNEY B. WILLIAMSON

1865–1939

SYDNEY B. WILLIAMSON, appointed chief of construction in the Reclamation Service on December 10, 1914, was born at Lexington, Va., April 16, 1865. In 1884 he graduated in civil engineering from the Virginia Military Institute, following which he taught school and worked until 1890 for several railroads in the Northwest and on municipal work in the South. In 1890 he moved to Montgomery, Ala., and engaged in a general engineering practice, including the design and construction of sewers, several small dams and highway bridges, street paving, land surveying, etc.

In 1892 Mr. Williamson was employed by the Government on the Tennessee River improvements and became principal assistant to General Goethals on the Muscle Shoals Canal, where he remained until 1900, except for a few months when he served in the Army during the Spanish-American War in 1898. In 1900 he was transferred to Newport, R. I., as assistant engineer in charge of the fortification work in that district, the work consisting of designing details and building about 18 gun batteries—all of concrete—and in keeping all completed forts in repair. In this work also he was associated with General Goethals.

In 1904 Mr. Williamson resigned to accept the position of engineer of the Expanded Metal Engineering Co. in New York, preparing designs and estimates for reinforced concrete structures, mainly buildings and floor systems. After about 1 year he left the company and opened a consulting office in Baltimore, also representing the Corrugated Bar Co. of St. Louis.

In May 1907, after 3 years of private practice, Mr. Williamson was appointed engineer in charge of the Pacific locks of the Panama Canal and was promoted to division engineer of the Pacific division in the reorganization of 1908, which divided the entire construction department into three divisions designated, respectively, as the Atlantic, Central, and Pacific. When Mr. Williamson took charge a large proportion of the municipal work had been done and dredging was in progress in the vicinity of the Pacific entrance. Otherwise no work had been planned or begun. The force employed on this division averaged about 5,000.

In December 1912, Mr. Williamson resigned from the Canal Commission service, when the work of the division was nearing completion, to accept the position of construction engineer with J. G. White & Co. He was appointed chief of construction in the Reclamation Service at Denver on December 10, 1914, from which position he resigned in January 1916 to enter private employment.

Mr. Williamson was a civil engineer of high attainments, broad experience, and distinguished record. His passing in his native city on January 13, 1939, is noted with sorrow by the Bureau of Reclamation, which he served so ably during his brief tenure in office.

Sun River Project To Have New High School

CONTRACT for the construction of a high school at Fairfield, Mont., has been awarded and it is expected that construction will start as soon as weather conditions permit.

Reclamation Organization Activities

W. R. Nelson Addresses Rotary Club

WESLEY R. NELSON, Chief of the Engineering Division, will address the Rotary Club of Ellicott City, Md., on May 18, 1939, on the subject of the operations of the Bureau of Reclamation.

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been authorized by the Secretary of the Interior:

Transfers

To Boulder Canyon:

Associate engineer: Virgil L. Minear, from Denver.

To Minidoka:

Assistant superintendent: Stanley R. Marean, from superintendent, Humboldt project.

To Central Valley, Kennett division:

Assistant engineers: John S. Smith and Carl H. Kadie, Jr., from Truckee Storage project, Boca, Calif.

To Bear River investigations:

Junior engineer: Ivan F. Richards, from Denver.

Separations Without Prejudice

Denver office:

Associate engineer: Donald Van Court Birrell, resigned to accept employment in United States Engineer Office, War Department, Washington, D. C.

Assistant engineers: Scott M. Bair, resigned to accept employment with War Department, United States Engineer Office, Providence, R. I., and Leslie Paul Witte.

Junior engineers: Harold H. Feldman, resigned to accept private employment in Chicago, Ill., Laren D. Morrill, and John W. Adolphson.

Boise-Weiser-Payette investigations:

Engineer: Lester C. Walker.

Moon Lake:

Construction engineer: Ernest J. Westerhouse.

H. V. Kaltenborn Lauds Service to Visitors

"UNEQUALLED elsewhere, within my knowledge", describes the facilities for visitors at the Grand Coulee Dam, in the words of H. V. Kaltenborn, international traveler and lecturer.

"It is gratifying to see how far the Bureau of Reclamation has gone here in enabling visitors to learn quickly what is going on at the moment, what has happened in the past, and what the purposes and the reasons for this project are. You show in 2 minutes, with your model, the results of a stupendous excavating job that took 2 years, and, in an instant, what the finished dam will look like. You make things understandable and interesting to the nontechnical visitor. It is right that people should know what the Government is doing, and why. This is a fine example of worth-while adult education," said Mr. Kaltenborn.

One written complaint of inadequate lecture service has been received by the Bureau during the 4-year period within which three-quarters of a million people have visited the dam. It came from an early morning tourist who appeared before the local work day began.

During the summer months, visitors arrive at all hours from 6 in the morning until 9 o'clock at night. Lecturers are on duty from nine until 6, seven days a week. One model shows various stages in the construction, and another the seasonal phases of operation.

The stream of visitors never ceases. On the shortest day of the year, 101 visitors represented 13 States and two foreign countries. The 5,288 visitors in December came from 35 States and several foreign countries. Attendance varies from 5,000 a month in midwinter to 7,000 on a single summer holiday. Vacation months average above 40,000, and the annual flood of visitors is above 300,000.

CCC Completes Shoshone Telephone Line

CCC enrollees from the camps on the Shoshone project have recently completed reconstruction of the 6½ miles of telephone line from Cody, Wyo., to the Shoshone Dam. This line, which is used jointly by the Forest Service and the Bureau of Reclamation, was built through the hazardous granite-walled Shoshone Canyon without a single lost-time accident. It is of the metallic circuit type with number 12 wires for the Bureau of Reclamation, and number 9 wires for the Forest Service, carried on 20-foot poles spaced 40 poles to the mile.

Yakima Project, Washington

AT the end of March, planting of sugar beets was completed and in the lower valley early cutting of asparagus was begun.

Most fruit trees were in bloom in the lower valley.

Early lambing was completed and range lambing was well under way.

Contra Costa Canal, Central Valley Project, California. Looking at trimmed section from top of bank

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

John C. Page, Commissioner — Roy B. Williams, Assistant Commissioner

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; D. S. Stuver, Asst. Gen. Supr.; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Acting Chief, Mails and Files Division; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

R. F. Walter, Chief Eng.; S. O Harper, Asst. Chief Eng ; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts; L. S. Davis, Engineer, C. C. C. Division

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Denver, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Constr. engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Reno, Nev	Chas. S Hale	Superintendent	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	H. W. Bashore	Constr. engr	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam	Earp, Calif	Boyd E. Coffey	Resident supt		R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo	Charles A Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre, Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Constr engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Fuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	V. W. Russell	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Colo	W. G. Sloan	Engineer.
Marias (Mont.)	Denver, Colo	Fred H. Nichols	Associate engineer.
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo	J. R. Iakisch	Senior Engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.

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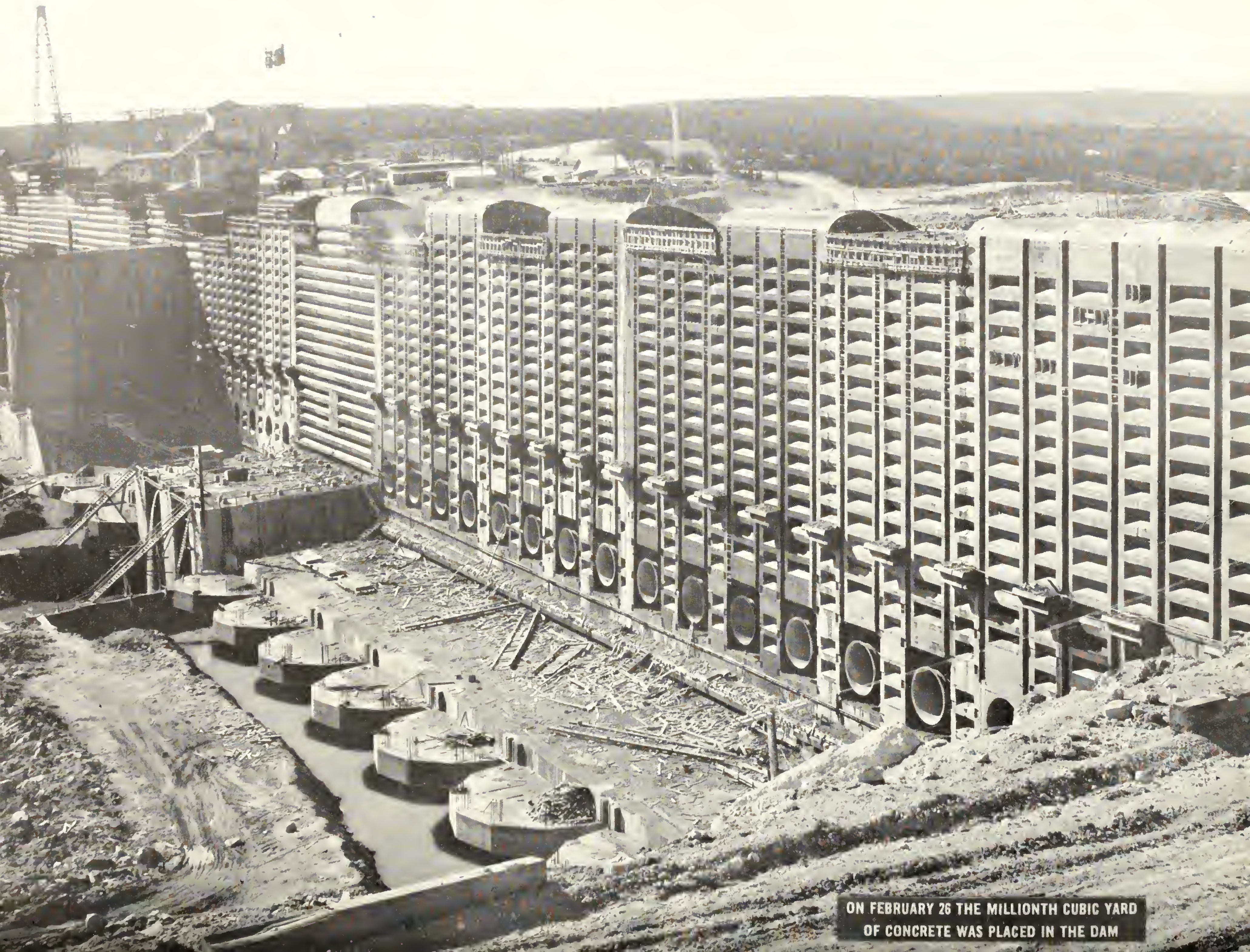


ON FEBRUARY 26 THE MILLIONTH CUBIC YARD OF CONCRETE WAS PLACED IN THE DAM

THE RECLAMATION ERA

MAY 1939

SPRINGTIME ON A FEDERAL RECLAMATION PROJECT

Appropriations, Fiscal Year 1940

APPROPRIATIONS for construction by the Bureau of Reclamation for the fiscal year, commencing July 1, 1939, total $65,223,000, an amount sufficient to provide a program commensurate with those of recent years when appropriations were supplemented from emergency funds. The Interior Department Appropriation Act and the Third Deficiency Act contain the following items:

Arizona:	
Gila project	$700,000
Parker Dam power project	4,000,000
California: Central Valley project	10,000,000
Colorado:	
Colorado-Big Thompson project	1,500,000
Paonia project	300,000
Pine River project	1,000,000
Idaho:	
Boise-Payette project	500,000
Minidoka project	100,000
New Mexico:	
Carlsbad project	100,000
Tucumcari project	250,000
Elephant Butte power project	483,000
Oklahoma: Lugert-Altus project	500,000
Oregon:	
Deschutes project	400,000
Owyhee project	270,000
Texas: Marshall Ford Dam	5,000,000
Utah: Provo River project	1,350,000
Washington:	
Grand Coulee Dam project	23,000,000
Yakima-Roza project	900,000
Wyoming:	
Kendrick project	925,000
Riverton project	100,000
Shoshone project	495,000
Various general investigations	900,000
Boulder Canyon project	4,000,000
All-American Canal project	2,000,000
Water conservation and utility projects	5,000,000

The appropriations for the continuation of work now under way will provide for an adequate construction program. Three new projects are provided for, i. e., the Parker Dam power project in Arizona-California, the Paonia project in Colorado, and the Lugert-Altus project in Oklahoma.

It is worthy of special note that an appropriation of $900,000 was made for general investigations of proposed projects by the Bureau of Reclamation. This exceeds greatly any amount appropriated for similar purposes in the past. The Bureau for many years has recommended larger appropriations for investigations on the grounds that intelligent planning for the future required that the data on proposals be gathered well in advance.

The appropriation this year of $5,000,000 for the Marshall Ford Dam project in Texas, means that this dam will be carried beyond the so-called first stage of development, and thus recognizes the necessity of building the dam to its full height for flood control.

In connection with the Pine River project in Colorado, the appropriation of $1,000,000 for the coming year was made on a nonreimbursable basis and this amount was allocated to flood control benefits.

The appropriation for the Lugert-Altus project in Oklahoma was made on a basis new to reclamation projects, in that cooperation between the Bureau of Reclamation; the Corps of Engineers, War Department; and the Agriculture Department in the allocation of costs among various benefits to be derived from the construction, was required.

The appropriation of $4,000,000 for the Parker Dam project was carried in the Second Deficiency Act, while all other appropriations listed were made in the regular Interior Department Appropriation Act. The Parker Dam power project contemplates the construction of a transmission line from Parker Dam to Phoenix, and commencement of work on the power plant at Parker Dam

Included in the Interior Department bill under the Bureau of Reclamation heading was an appropriation of $5,000,000 for water conservation and utility projects to be constructed in the Great Plains drought area.

This fund is to be allocated by the President and is to be supplemented by relief expenditures in the construction of projects in the critical drought areas. The restrictions on the appropriation require that those portions of the costs which can be repaid by the water users shall be made on a reimbursable basis.

J. C. PAGE,
Commissioner of Reclamation.

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • MAY 1939 • NUMBER 5

The Multiple-Purpose Project

By JOHN C. PAGE, *Commissioner of Reclamation* [1]

THE KEY to the gate from which will flow the best use of the water resources with which nature has endowed this country is the construction and operation of projects serving more than one function in the public interest. The engineer has used his increasing technical skill and his greater vision in perfecting the multiple-purpose project in response to a general demand by the public itself that maximum benefits be made to flow from public expenditures for stream improvements. It is an expression in engineering terms of a new social consciousness.

It has not been long since the day when an irrigation dam was designed for no purpose in addition to irrigation; when a structure for the improvement of navigation was designed with only that thought in mind; when a power dam was a power dam and nothing more so far as the designer and the operator were concerned. In that time many structures were built which served well their individual purposes, but failed to develop valuable related uses; structures which will have to be duplicated because the related uses were overlooked.

You will notice that I have said these dams were designed with only a single purpose in mind. Despite this, many of these structures do serve other ends, to a limited and inadequate degree. Others have actually defeated or obstructed the performance of related functions that might have been included.

Almost every reservoir designed to reduce floods would serve, ill or well, some other purpose. The water held back would have to be released at times of lower flow. This definitely would effect other activities on the stream below.

It would be impossible to design a dam that would concentrate the fall of a stream and so make water power available, but would serve no other purpose. Every dam creates a reservoir, large or small, and every reservoir delays the flow of water at high stages.

[1] Address delivered March 23, 1939, before the National Rivers and Harbors Congress at the Mayflower Hotel, Washington, D. C.

Advance Planning Saves Money

The multiple-purpose project, which now is the subject of much discussion, is the result of recognition by forward-looking engineers that the single-purpose project, in many instances, needs little expansion when in the planning stage to serve as well important related functions. Through thus increasing the efficiency of the project, 50 cents has been made to do the work of a dollar in some instances in the provision of storage for irrigation, for example, and the other 50 cents has, at the same time, served to lower the cost of providing protection from floods or of the generation of electric energy.

Perhaps the multiple-purpose project should be defined in order that we can be perfectly sure that no misunderstanding exists. Such a project may be, for example, a dam; a dam and other works; a series of dams; or a series of dams and other works designed and operated so as to perform efficiently more than one function in the field of water utilization and control. The project may serve navigation and, in addition, power; or flood control and also irrigation. River regulation for pollution abatement or improvement of domestic or industrial water supplies may at the same time provide recreational facilities for millions. The multiple-purpose project may join any and all of these with still other useful functions.

All-Purpose Project

There is one great project now under construction, for example, that will serve the following diverse purposes: Improvement of navigation on two important rivers; reduction of flood damages to highly developed lands along these rivers; irrigation of about 1,000,000 acres of equally rich lands now inadequately supplied with water; the production of low-cost power for a rapidly growing market; and the regulation of the fluctuating flow of the river for domestic water supply, for industrial water supply, and for the protection of 400,000 acres of fertile delta lands now threatened with ruin by the infiltration of salt water. Westerners will recognize from this description the Central Valley project in California.

At this point I want to make it perfectly clear that not every project can be adapted for multiple purposes by special provisions in the plans for more than one use. Some projects are so simple or are so situated that only one purpose is worthy of special consideration. Some necessarily involve dam sites which are inadequate for structures capable of serving fully more than one end. Some are on streams and in areas where the water and the need are limited. It is essential, however, that all possibilities be studied in every instance and that, wherever feasible, all related functions be included or provided for in the final designs for the project.

Bureau of Reclamation Territory

In the West, where the Bureau of Reclamation operates, there are more than 740,000,000 acres of arid and semiarid lands. The streams are comparatively few and their flow fluctuates more widely than the flow of rivers in humid regions. Mountainous areas receive most of the precipitation, much of which comes as snow in winter. When the snows melt in spring, floods occur. When the floods pass, the streams dwindle and some of them actually go dry. Fortunately, these conditions make most floods predictable, so that it is easy to combine flood reduction with irrigation storage. Irrigation is necessary in the West for general farming, and it is essential for close settlement of rural areas. Since the maintenance of most of the population is dependent on irrigation, the use of the available water for irrigation generally is considered the primary use, excepting only its use for domestic purposes.

The regulation of most streams in the arid and semiarid regions has irrigation as its first purpose. The character of the streams and the requirements made by irrigation on reservoirs are such, however, that nearly all irrigation storage dams are valuable also for flood reduction. The regimen of the streams and the operation of the reservoirs for irrigation also make many of these dams valuable from the standpoint of power development, usually without very material alterations in the plans for the structures that would be required for irrigation alone.

Where water is scarce, particularly, and where it must be conserved for irrigation to support the population, it would be ridiculously wasteful to refrain from making more than one use of this limited and vital resource. In passing through a turbine before entering an irrigation canal, water loses none of its usefulness for irrigation; but by passing it through a turbine the over-all benefits from the irrigation project may be greatly increased, and the cost to the irrigators may be greatly reduced.

There has been much discussion in recent months about the principle of developing the streams for more than one purpose in the public interest. There has been criticism to the effect that more than one function could not be well performed. Some of this criticism may be traced to a resistance against comprehensive planning for conservation and control of our waters. Some of it is apparently inspired by those who would becloud a larger issue in order to prevent the use of publicly owned power resources that otherwise would be wasted.

The multiple-purpose project is much too important a weapon in our offensive against riotous nature to permit these general attacks upon it to go unanswered. As a result of a flood on the Colorado River of Texas, where a multiple-purpose project involving several dams has been begun, a flurry of attacks, mostly editorial, were made recently against the idea of combining flood control and power in a single project. Last July when the flood occurred only one of the series of dams was completed and in operation. It was the upper dam, Buchanan, designed primarily for power to produce revenues and help to pay for the rest of the project. Farther downstream the Marshall Ford Dam being constructed by the Bureau of Reclamation and designed as the major flood control unit of the series, had not progressed above the river level. The project as a whole, involving several dams, was incomplete when the flood came. It is still under construction today.

Based on the fact that the single dam which was completed did not prevent but only reduced one of the largest floods ever recorded on the Colorado River of Texas, a powerful and dangerous stream, a hue and cry was raised against the combination of flood control and power in a single project. Virtually all the published comments neglected entirely to mention the fact that the project as a whole was not completed and that the principal flood control dam at Marshall Ford was not above river level. Many of the editorials were in strikingly similar language. Apparently there was concerted agitation behind such misrepresentation, the purpose of which was to mislead the public.

Multiple-Purpose Projects in Operation

What are the facts? There are many multiple-purpose projects already completed and operating. Let us examine a few of them.

Mr. Nathan B. Jacobs, president, Morris Knowles, Inc., consulting engineers of Pittsburgh, Pa., in a paper presented before the American Society of Civil Engineers, said:

"Another typical multi-use reservoir is the one on the Tygart River, in West Virginia, which was designed primarily to aid navigation on the Monongahela River, which can and will be used for flood-control purposes as well . . . The Pymatuning Reservoir, on the Shenango River in Pennsylvania, was designed primarily for low-water control and for recreational purposes. Since its completion in 1933, however, it has been responsible for lowering flood heights at Sharon, Pa., and other communities."

Concerning this same reservoir in another paper presented before the same society, E. K. Morse and Harold A. Thomas, members, American Society of Civil Engineers, said:

"Experience with the recently completed Pymatuning Dam demonstrates the effectiveness of the reservoir method of flood-control under conditions encountered on the rivers of western Pennsylvania. This dam was constructed by the Commonwealth of Pennsylvania to provide an adequate supply of water for manufacturing and domestic use during periods of low discharge on the Shenango River . . . The first year's operation of the Pymatuning Dam has proved its effectiveness in improving dry-weather flow and in controlling floods . . . Since its completion the Pymatuning Dam has prevented two floods . . . The owners of important industries in the Shenango Valley claim that the Pymatuning Dam paid for itself the first year of its life."

Edwin S. Cullings, hydraulic engineer, of Watertown, N. Y., in a letter published in the February 1939 issue of Civil Engineering, describes the successful operation of a multiple-purpose project by the Black River Regulating District in New York State. This project has been in operation since 1925 and controls about half the flow of the river. He says in closing:

"While multiple-purpose reservoirs can be successfully operated for several purposes, such reservoirs will not be 100 percent effective for every purpose. Compromise will be necessary in cases of conflicting usage, but," says Mr. Cullings, note this carefully, "the aggregate benefit to the community can be made far greater than would be possible if the reservoirs were operated for only a single purpose."

Mr. Cullings was discussing a comparatively small project which did not even provide complete control of the river. What he says is true for such projects. It is possible, however, to construct multiple-purpose projects on rivers to provide complete control of the flow when the conditions are right. This was done with the construction of Boulder Dam. This dam serves each of its several purposes without compromise.

Turbulent Colorado River Tamed

Frederick S. Delenbaugh, who went with Maj. John Wesley Powell down the Colorado River on one of his memorable expeditions long ago, described the Colorado River as a wild bull of a river. He compared the more gentle rivers of humid regions with cows, saying they were easily domesticated and put to use by man, but the Colorado was the untamable bull of the herd. Yet a ring was successfully put in the nose of the Colorado River with the construction of Boulder Dam. The Colorado now has been broken to yoke to serve in many and varied ways.

Lake Mead, created by Boulder Dam, has a capacity about twice the average annual flow of the Colorado River at Boulder Dam. Of this capacity, 9,500,000 acre-feet, or more than half the average annual flow of the river, is reserved for flood control. Three weeks ago, early in March, we completed drawing out of the reservoir 1,500,000 acre-feet in anticipation of the flood which annually comes in May or June. If later snow surveys indicate that more than 9,500,000 acre-feet of storage will be needed for flood control this year, we shall draw Lake Mead down still lower.

The storage in Lake Mead is about five times the annual demand for irrigation downstream. It can be safely stated that no flood is anticipated which would necessitate release of water at Boulder Dam in quantities which would cause a serious flood below. It can be stated with equal assurance, in addition, that through regulation of the flow at Boulder Dam the irrigators downstream will never again have to face the water shortages which formerly threatened to destroy their crops each year.

In 1934, the year before Boulder Dam was completed, the Colorado River went virtually dry in the late summer after the flood had passed. Farmers in the Imperial Valley alone as a result sustained crop losses estimated at more than $10,000,000, and many of them lost trees and groves of mature and bearing fruit, that could not be replaced in less than 5 years. But early in the summer of 1935, the newly completed Boulder Dam caught and held a flood, which otherwise probably would have breached the levees protecting the Imperial Valley, since the levee system was in poor condition as a result of extended drought. Had the levees been burst the damage would not have been less than $10,000,000.

It is difficult to evaluate in dollars the contribution made by Boulder Dam in regulation of the flow for domestic water supplies. An indication of the value of this service can be gained from the fact that 13 cities in Los Angeles and adjacent counties in southern California have prepared to spend about $220,000,000 in construction of an aqueduct to the Colorado River. This aqueduct is nearing completion. It would not have been built except for the control of the river provided by Boulder Dam. It is hard also to assign monetary values to such recreational uses of Lake Mead and the stream as are now being made as a result of the construction of Boulder Dam. More than 500,000 people last year visited the project to spend a part of their leisure time. They go to glory in the spectacle of the dam and its magnificent surroundings, to fish, to bathe, and to boat.

Boulder Dam, Good National Investment

A definite monetary value can be placed, however, on the power generated at Boulder Dam. With less than half the units installed, revenues from the power plant to the United States approach at this time $400,000 a month. Power is incidental to the other uses, but the sale of the energy under contracts now in force will repay the entire cost of the project in 50 years—the whole cost of this great project, $130,000,000, for all of these highly valuable purposes—with interest at 4 percent.

Other outstanding examples of successful multiple-purpose projects are the Tennessee Valley dams and the Sacandaga Reservoir project of the Hudson River Regulating District. Good recent discussions of these projects can be found in the section on Water Power and the Drainage Basins in the report of the National Resources Committee entitled "Energy Resources and National Policy," recently transmitted by the President to the Congress.

Flood Control and Power Combine Successfully

Doubts have been aroused in the public mind in recent months with respect to whether it is practicable to combine flood control and power. The answer to these doubts should be clear from the examples I have cited. I am not giving you merely my own opinion. There is agreement on this point.

Maj. Gen. Julian L. Schley, Chief of Engineers, United States Army, answered this question last spring as follows:

"Yes; the same dam and reservoir can be used for both purposes under either one of two conditions: First, what amounts to two reservoirs but both behind a single dam, one on top of the other, the flood-control reservoir being on top; and second, where the identical capacity can be used for both purposes because you know exactly when the storm rains are going to start and stop."

National Resources Committee Comments

In its report, "Drainage Basin Problems and Programs, 1937 Revision," the National Resources Committee, representing all the interested Federal agencies, said on the subject of multiple benefits:

"Not to promote the integrated development and utilization of latent water resources as promptly and fully as all relevant technical, economic, and social conditions warrant is to invite waste of potential wealth and so is incompatible with the public interest.

"Integrated control and use of water implies planning and constructing projects for dual or multiple benefits wherever practicable. Actually, almost every water project of magnitude may be made to contribute to the solution of more than one problem. Not to realize all of its feasible potentialities is inimical to the public interest. A large dam and storage reservoirs built and used solely for flood control is a wasteful maladjustment, socially if not economically, provided it could have been practicable to design, construct, and operate the dam to regulate the flow of the stream for other purposes as well as flood control, to develop marketable power, or to realize incidental reservoir values in connection with recreation and wildlife conservation. Coming years, like the last few years, should witness increasing emphasis on multiple-purpose projects. The regulation and integrated development of rivers for all useful purposes is an attainable goal."

This report was prepared by the Water Resources Committee of the National Resources Committee. It is the considered judgment of representative State engineers and university authorities, as well as that of all of the major Federal agencies engaged in water planning.

The Congress, 14 years ago, was seeking a comprehensive national plan for multiple-purpose development of all our navigable rivers, as shown in section 3 of the Rivers and Harbors Act of March 3, 1925.

The public long since has approved the multiple-purpose project as a means of increasing the efficiency of public works in the development of our water resources. There are indications that public opinion has gone a step farther than general approval of the multiple-use principle.

"Whether for better or worse, people are beginning to view the control of a stream for flood reduction as an integral phase of the use of that stream for power, navigation, irrigation, public water supply, and sanitation. To the writer it is an evolutionary step of merit."

This is abstracted from a paper by Mr. Abel Wolman, chairman of the Water Resources Committee, and president of the American Public Health Association, delivered recently before the American Society of Civil Engineers.

It is my experience also that public opinion is insistent that power development be included in the plans for irrigation projects, where feasible from the engineering and economic standpoints.

Before closing it should be noted that multiple-purpose development has been accomplished almost entirely through public enterprise. For the very good reason that by its very nature the multiple-purpose project is not inviting to private developers, who must look for an actual cash return on their investments, it is apt to remain the responsibility of public agencies. With few exceptions, water power is the only one of the many purposes which can be served by river development which now interests private industry. Conservation and control of water for other purposes very largely has been a public endeavor for many years. It is generally accepted today that flood control, irrigation, domestic water supply, navigation, recreation, wildlife protection, and, for the most part, sanitation, are fields for community action, either local, State, or national. Since this is so, I do not see how the public can be denied the right to develop all of the possibilities which are created by the public's work.

It is the duty and the task of the designer, as stated in Energy Resources and National Policy, and of those who guide the application of public policy to develop all of the potential benefits of great river systems in such manner that their sum shall be a maximum. Each should be and can be developed in harmony with the others; each should contribute its share to obtain a total benefit much larger than would be possible by separate exploitation, and that at lower total cost.

Irrigation District, Political Subdivision of a State

SEC. 617 (a) of Title IV of the Revenue Act of 1932, as amended, imposed a Federal tax on gasoline. Sec. 620 (3) of the act, as amended August 30, 1935, 49 Stat. 1025, exempted any political subdivision of a State from the payment of the tax. In an opinion dated February 4, 1937 (39 Op. A. G., No. 72), Attorney General Cummings held that an irrigation district is a political subdivision of a State, within the meaning of the act.

Boise Project Crops

MORE special crops are being planted this year on the Boise project, Idaho. The grain acreage to be planted will be less and in its place onions, peas, and sugar-beets are being planted.

Fair Facilities Planned at Orland

THE Glenn County Fair Association has purchased a 40-acre tract adjoining the town of Orland, Calif., and plans are being made to provide permanent quarters for this outstanding organization.

The Human Side of the Owyhee Development

By WALTER K. M. SLAVIK

THE construction of a great dam with its diversion works and hundreds of miles of canals and ditches is only the beginning of a reclamation development.

No matter how difficult and lengthy their engineering work, irrigation dams and diversion works are never ends in themselves. They are merely the means to an end. The end is the reclamation, conservation, and utilization of the Nation's land for its people, by its people. The real end is the provision of new homes and new opportunities for thousands of American citizens eager for a decent American livelihood and a measure of security.

These Americans who settle on these new lands of opportunity tell the real tale of a reclamation development.

How does it fare with these settlers who came to the irrigation development from all parts of the United States and even from its possessions across the seas, full of hope, of anxiety perhaps, but courageous and willing to try to make a living for themselves and their families in a new environment?

To hew a homestead out of raw sagebrush land calls for a stout heart and good old-fashioned sweat. New settlers on reclamation land may be compared to our original pioneers. They tame unconquered frontier land. They must erect a home, farm buildings, clear their land. And then, if they do not already know how, they must learn how to irrigate properly. Upon their success depends their all. It is, for many of them, an utterly new and daring venture.

On every reclamation development the fortunes of these new settlers really tell the story of success or failure. They are the foundation, the fundamental bedrock on which the entire structure rests. It is their cumulative fate which determines the fate of the development. It is their fortune which decides whether the Government's investment has provided the new opportunities it intended, and successfully added still another increment to the total material and human wealth of the Nation. For the investment must be repaid, and the settlers are the ones who repay it

Pioneer, 1938. Note, left to right, the plow, the washtub, the radio antenna lead-in, the sack of potatoes, and the sacks of feed

The Bureau has received a report on the Owyhee development in eastern Oregon and western Idaho, where water has been provided for approximately 100,000 acres of irrigable land. The report contains a number of case histories of the settlers who have come to this new development from all over the United States, and especially the dust-bowl area in the Midwest whence they were driven by drought and adversity. How did they fare?

Direct from the field and unedited, the report reads as follows:

The farmer, irrigating his field of beans

The Settlers

"The success of a project such as the Owyhee, costing approximately $189 per acre, depends largely upon the quality of the settlers. Most observers agree that, generally speaking, a man with an irrigation background makes the best settler. Perhaps the most desirable settlers are ambitious sons of irrigation farmers, or successful renters of irrigated farms. But first because the life is not an easy one, the settler should be a healthy, rugged individual, imbued with a tenacious will to succeed, and irrigation experience is not an absolute necessity. Community leaders on the Owyhee project speak with pride of the high type of settlers who are pioneering the new lands.

"In recent years reclamation projects have been spoken of as areas where ruined dust-bowl farmers might reestablish themselves. The Owyhee project has contributed to this cause. The secretary of the settlement association estimates that about one-third of the new settlers have come from the dust bowl. The greater number of this class of settlers came from Nebraska, the Dakotas, Colorado, and Montana contributing most of the balance. It is also estimated that over half of the settlers are experienced irrigation farmers from Idaho, Utah, Washington, Oregon, and California.

Case Histories

"One settler says that he had a well-stocked farm in Kansas before the drought and dust storms. Feed became so scarce he was forced to chop down his trees and use the bark and twigs as fodder to keep his cows alive. In

1936 he acquired a homestead on the Owyhee project. After 3 years he believes that his homestead is now more valuable than his Kansas farm was at its best.

"A settler arrived on the Owyhee project in July 1934, with $180, a family, and an old truck. Local people advised him not to try to establish himself on the project because of his inadequate finances. He was able to obtain a few short jobs and in November of the same year he made the down payment on a 40-acre tract. That winter the family lived in a tent. When the first water arrived the next spring he was able to plant 15 acres. Since that time he has purchased an additional 52 acres, built a modest house, acquired livestock, has a part-time job driving a school bus, and is otherwise well established in a growing community.

"A farmer who had lived 30 years in Idaho moved onto 160 acres in the Mitchell Butte section in 1930, 5 years before the water came to his land. He cleared the land and raised a little dry-farm rye to feed his horses, while waiting for water. At the present time he has 650 tons of alfalfa hay stacked on his place, produced in 1 year from 115 acres of land. He uses six horses to work his farm.

"In 1936 a dust-bowl farmer arrived on the project with a 1925 Studebaker and very little else. In 1937 he had a good crop of clover seed which commanded a high price. He was able to pay his bills, buy a 1938 Studebaker and drop the daytime job with the watermaster which he had been holding down while he farmed at night.

"A man and his wife owned 200 acres of good land near Adrian, Oreg. The farm work was all done by hired help and the owners did not live on the farm. For the first 4 years, all of the land was planted with clover and alfalfa. In the fall of 1938 the farm was sold at the appraised value of nearly $20,000 in spite of the fact that there were practically no buildings. The man who managed this farm was on relief when he got his job in 1935. When the place was sold he had $1,000 in cash which he expected to apply on the purchase of land on the project.

"A farmer purchased a farm in the Succor Creek Division in 1936. This man came from the Tule Lake area in northern California and had capital enough to build a fine home and improve his farm. Water was put on his place in the spring of 1938. After one season of farming with very low prices for his produce, he is still well satisfied with his prospects.

"An Idaho man with many years of irrigation experience acquired a homestead in the Succor Creek Division in the spring of 1938. He moved onto the place May 1, hired his leveling done, and had the entire farm of 75 irrigable acres planted and irrigated on June 30 of that year. He now has 65 acres of his farm in clover. He thinks that the Owyhee project ranks well with any irrigated section in Idaho.

"A local man farming on the Adrian bench of the project built a modern $5,000 home last year from receipts of his clover-seed crop.

"A family from the Uintah Basin of Utah settled on the project in the spring of 1935. These people have not met with outstanding success in raising high-price crops. They have some good cows now and plenty of hay to feed them. They have a comfortable house to live in and are able to send their children to school. The best thing they have is a spirit of cheerfulness, optimism, and independence. They do not want to go back to Uintah Basin.

"One large family from eastern Colorado came to the Dead Ox Flat with little means but great determination and leased a small tract. In 100 days from the time they arrived they had cleared and seeded the place and had a very large and flourishing garden with every variety of garden stuff, enough for a small army. Plenty to eat for that family."

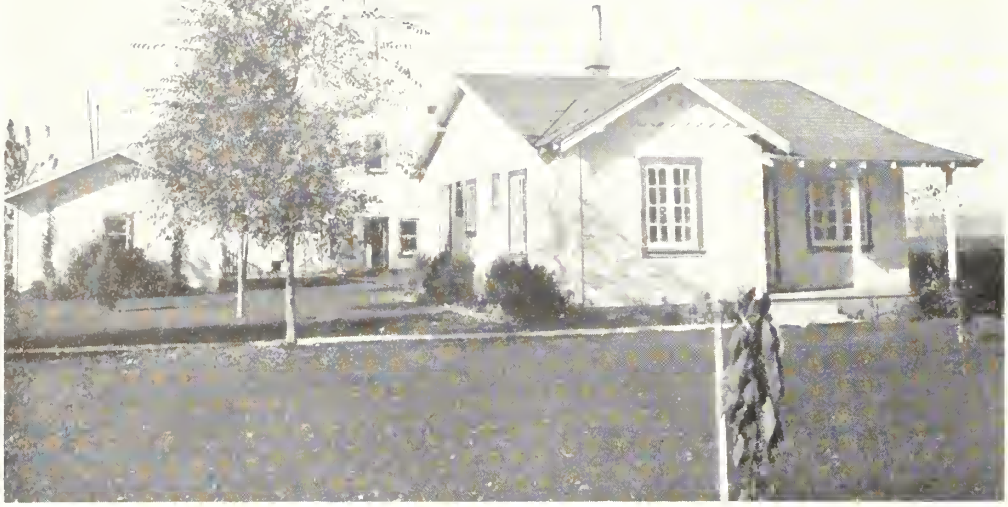
These are the stories of some of the settlers on the Owyhee development. They sketch promising outlines in this relatively new and unfinished design for a decent living in the arid West. The final outcome of the Owyhee development rests in the future, but, like the Bureau of Reclamation's other 48 irrigation developments throughout the United States, success depends in large measure on the settlers themselves.

The Bureau is required by law to make a careful selection of homesteaders on public-land farm units. One of the qualifications stressed is the possession of adequate financial resources. Without them the homesteader's undertaking would be hopeless from the start. Present regulations require a minimum of $2,000 or its equivalent.

But governmental regulations of this nature apply on public lands only. Like other irrigation developments of the Bureau, Owyhee has State and privately owned lands which also receive water from the Bureau's diversion works, and are also open to settlement. Several of the families mentioned in the case histories reported were settled on such land.

In order that the ultimate success of the settlers and the irrigation development as a whole may be assured, local organizations cooperate with the Bureau by investigating prospective settlers on other than public lands. On Owyhee, the Vale-Owyhee Land Settlement Association supplements the Bureau's efforts to select applicants who give promise of becoming successful irrigation farmers. This association, composed of local farmers and businessmen, has a board of directors which serves without pay. The

Irrigated farms. Fine farmsteads were once sagebrush land



Above: Irrigated clover seed and baby lima beans built this neat Owyhee farm home
Below: Sugar beets built this one

association reviews all applicants for privately owned lands on Owyhee in Oregon.

Although "irrigation experience is not an absolute necessity," as the report says, both the Bureau's examining board, appointed by the Secretary of the Interior to determine the qualifications of homesteaders, and the Vale-Owyhee Land Settlement Association place emphasis on farming experience, and especially irrigation farming. They know that ignorance or unwillingness on the part of the new settler to master the essentials of irrigation practice may lead to disaster.

The case histories of three irrigation farmers on the Owyhee development give point to the importance of past experience. The first, a young chap, had learned to irrigate on his father's farm in southern Idaho's Twin Falls irrigation district. When he bought 160 acres on the Owyhee development and started a home for himself he knew just how to clear the land and prepare it for irrigation. He wasted little time and effort, he made few mistakes, and the very first season brought him $8,000 for his crop of clover seed.

The next case of an inexperienced settler told another story. This settler knew nothing of irrigation practice and apparently declined to listen to the advice of his neighbors. He insisted on flooding his brand-new head ditches and corrugations with 100 inches of irrigation water, immediately and all at once, instead of feeding the water to them slowly at first, to let them settle. What happened? The water broke his ditches, rutted his corrugations, gullied his farm, washed away valuable topsoil. It ruined his farm for that season and perhaps the next.

The third case illustrates the needlessness of that settler's error. A settler from the edge of the dust bowl in Nebraska, very much aware of his ignorance, persuaded his brother-in-law, irrigating a farm in the next county, to show him just how to level his land, make his ditches and corrugations, and apply the irrigation water. Today that settler from the dust bowl is a successful irrigation farmer on the Owyhee development.

Irrigable land on the Owyhee and other Bureau of Reclamation developments is highly prized, and with reason. Irrigation removes one of the major hazards faced by the American farmer, drought.

Substitution of a dependable supply of irrigation water for the uncertainty of rainfall is a priceless advantage, and farmers realize it, case histories received by the Bureau show. After one season of irrigation farming on the Owyhee development a former dry farmer from Calloway, Nebr., wrote home about it. Within a short time 27 other families from Calloway joined him in making new homes on the Owyhee development. It was the opportunity they, like thousands of other Americans, had always been seeking.

Grand Valley Project

THE growing of pinto beans, which has become the largest single producer of revenue of this project in recent years, was commenced about 1917 and has increased in volume and importance since that time.

Originally no cleaning facilities were available and beans were bought by dealers on their appearance. In 1925 a cleaner was installed in a warehouse at Loma by the Fruita Potato Growers Association for cleaning their own beans and to do custom work. This association became affiliated with the Colorado Bean Growers Association in 1927 and assumed the name of Fruita Bean Growers Association. It now has marketing connections with the Farmers Grain and Bean Association of Denver. The association reports a production of approximately 350 cars of pintos, 600 sacks per car, in 1938.

Olathe Corn and Potato Show

By J. P. HARTMAN, *County Extension Agent, Montrose County, Colorado*

TWENTY-TWO years ago corn was grown on a very limited acreage on the Uncompahgre project in western Colorado. Seed from eastern or other outside areas would not mature. The project being at an average elevation of 5,500 feet above sea level required a strain of corn that would mature in a short growing season. It was evident that if Uncompahgre farmers were to grow corn successfully they must select seed in the fall from their crop and develop a corn locally that would be satisfactory.

To help farmers solve this problem, Ralph Wilson, Smith-Hughes vocational agricultural instructor at Olathe, and his agricultural class, in 1917 sponsored the first annual seed show. The show was started as a teaching method to instruct farmers in the selection and production of corn. It was held at Olathe, the central town of the project.

For several years at the Olathe Show, farmers scored various ears and samples of corn on a score card. This scoring, along with the competitive part of the show, has been largely responsible for the 10,000 acres of high-yielding corn now grown on the Uncompahgre project and adjoining farm land.

During the first years of the show about 50 samples of all seed constituted a large show. At the twenty-second annual corn and potato show, held in February 1939, there were 257 entries representing 132 individual exhibitors. There were also seed displays of many individual seed producers which were not entered in the show, as well as extensive educational displays of new potato varieties and hybrid corn results.

The 1939 show was again sponsored by Ralph Wilson and his Smith-Hughes boys with the generous financial support of Olathe business men who erected interesting commercial displays. The show was held on February 22, 23, and 24, and drew a record attendance of interested farmers.

An outstanding event of the Olathe corn and potato show is the banquet at which honors for the year are awarded to winning members of the 100-Bushel Corn Club and the 600-Bushel Potato Club.

The 600-Bushel Potato Club was started in Montrose County in 1929. During the 1929 show a corn and potato banquet was held. This helped to interest farmers in the new club. To date 53 potato growers have qualified for the 600-Bushel Potato Club by producing 600 bushels or more on a measured acre. The honor of being potato king goes to Clarence Sanburg, who obtained a yield of 834 bushels per acre.

The 100-Bushel Corn Club was started in 1931. To date 19 farmers have produced 100 bushels or more of corn on a measured acre.

In 1938 Wilson Brothers, of Olathe, produced 125.7 bushels of Minnesota No. 13 corn on a measured acre. From this they selected a 10-ear sample which won sweepstakes at the 1939 show. At the banquet held during the show they were presented with the corn-king trophy offered by the Rural Service Club.

For 20 years Wilson Brothers have been growing corn and selecting seed annually. They plant about the middle of May and by timely cultivation keep the crop free of weeds. Irrigation water is applied as the crop needs it to keep it growing throughout the season. The corn is picked late in the fall, generally beginning in November.

The Olathe corn and potato show has been a big factor in increasing yields and quality of all the crops grown on the Uncompahgre project. It has encouraged farmers to plan adapted, weed-free, high-purity and high-germination seed.

The 600-Bushel Potato Club and the 100-Bushel Corn Club have also offered farmers an incentive to produce better crops and higher yields. These clubs have been so successful that plans are now under way to start a 1,000-Bushel Onion Club during the present season.

Corn entries

Colorado-Big Thompson Project Starts

WORK will soon begin on this project under awards made by Secretary of the Interior Harold L. Ickes for roads to the east and west portals of the tunnel under the Continental Divide. The contractors, the Driscoll Construction Co. of Pueblo, Colo., and J. H. and N. M. Monaghan of Denver, Colo., are required to complete the work within 100 calendar days after notice of award has been received.

The Continental Divide Tunnel will be the chief feature of the Colorado-Big Thompson project which will provide for the diversion of surplus water from the headwaters of the Colorado River on the western slope of the Continental Divide to lands on the eastern slope in northeastern Colorado to supplement the present inadequate irrigation supply, and also to develop hydroelectric power. Water will be diverted through this 13.1-mile tunnel, which extends from the east end of Grand Lake through the Continental Divide to a point in the watershed of the Big Thompson River near Estes Park.

It is expected that the invitation for bids for the construction of the Continental Divide Tunnel will be issued soon.

Poultry Producers of Nevada Are Organized

THESE operators are doing business under the name of The Nevada Poultry Producers, Inc., with headquarters at Reno, Nev. The business is entirely farmer-owned by membership certificates. It started with seven cases of eggs on its first day of business in 1931, and is now the largest cooperative poultry and egg establishment in the State, doing a yearly business of about $300,000.

Civilian Conservation Corps at Alcova Reservoir, Kendrick Project—Wyoming

By AVA HAYS GAVIN, *Assistant Clerk*

IN land-locked central Wyoming, where a pond is gratefully dignified by the name "lake" and where the deer and the antelope roam a long way for a drink, the Bureau of Reclamation has completed Alcova Dam on the North Platte River, and has, thereby, provided delighted citizens with a new and very practical plaything—Alcova Reservoir with a capacity of 200,000 acre-feet of water and a 33-mile shore line.

Now, the little town of Alcova, situated on the old Oregon Trail, was laid out in 1891 by an eastern syndicate which proposed to pump water from the North Platte River for irrigation of the grounds of a health resort, chief attraction of which would be the hot springs arising in the adjacent canyon walls. But long before this ambitious dream had faded, General Fremont, in August of the year 1842, with his indomitable exploring party, had succeeded in conquering the canyon rapids at the expense of losing most of his equipment and endangering the lives of the members of his party in the raging torrent. His report to the Congress was the first official recognition of a place which eventually was to become the site of a development of major importance in the arid Rocky Mountain West. Fremont Canyon, vast and awe inspiring, was named for this determined scientist and adventurer, and now provides a setting of great natural beauty for a part of the new Alcova Reservoir.

Lake Invites Water Sports

After the Bureau of Reclamation had effectively calmed the turbulence of the North Platte by the construction of Alcova diversion dam and its resultant lake, the population of central Wyoming evinced definite symptoms of wholesale seagoing. As was to be expected, the first summer a number of Wyoming sailors fell happily into the new reservoir from a varied assortment of craft ranging from tubs to power boats. But these skippers suffered only from a thorough ducking as a reward for their naive ignorance of navigation, and each time they fell in they seemed more enthusiastic.

In fact, the local enthusiasm appeared for a time to be growing beyond the bounds of reasonable restraint. Bureau of Reclamation files in the Casper, Wyo., offices bulged with applications for sites for cabins, docks, resort amusement concessions, boathouses, and boat permits. A boat club was formed and an "admiral" elected. Important citizens besieged the offices of the construction engineer with insistent demands for instant permission to go sailing, swimming, boating, fishing, and possibly drowning. A new lake was there; moreover it was theirs, and they wanted to play with it.

CCC Camp BR–79 in foreground, Alcova Dam and spillway in background; village of Alcova across the river

CCC Work Program

Therefore, in July 1938, arrangements were made for the Civilian Conservation Corps to start preliminary work on the construction of recreational facilities. Two hundred New England CCC boys arrived from previous quarters at Walden, Colo., established camp, and went to work in a very creditable manner. Their first task was to finish clearing the reservoir site, a job about 90 percent previously completed by the Kendrick project forces. The second part of the program called for the construction of $4\frac{1}{2}$ miles of roadway along the north shore of the reservoir, and this work is now under way. The men are busy learning to run tractors; to drive trucks properly; and to drill and blast with accuracy and, most of all, with safety. Some of the enrollees may eventually be instructed in the fine art of operating a dragline, while others will be taught practical concrete mixing and placing. In camp these young men are learning how to cook, serve food, wash dishes, administer first aid, and to keep their quarters clean and in order. In the office some boys are being trained in office work; in the machine shop others are learning practical mechanics. Various classes of an educational nature are conducted in the evenings. Photography, mining, welding, and leader's training are particularly popular subjects.

The road along the lake shore on which the boys are now at work will be about $4\frac{1}{2}$ miles long, 20 feet wide, and with a maximum grade of 7 percent. It will make available cabin and dock sites along the north shore of the Government reservoir, besides providing a scenic drive. When it is completed it will connect with United States Highway 87 E, at a point approximately 2 miles west of the village of Alcova, and lead to a loop at the mouth of Fremont Canyon where the deep gorge and magnificent cliffs of the canyon will permit no further progress by highway. Only a boat can take you beyond this point and into a wondrous place of natural beauty.

The Bureau of Reclamation ran the preliminary surveys on this road, and continues to supervise the engineering features, assisted by two CCC enrollees. For the most part the formations are sandstone and shale, requiring a considerable amount of drilling and blasting. This work is carefully directed by an experienced "powderman." Ditches and culverts will be necessary to provide adequate drainage on this feature, and guardrails will be constructed at some points.

Major equipment being used in the road building includes jackhammers, portable compressors, tractors, trucks, a rooter, grader, and scrapers, and a ½-cubic-yard dragline.

Camp Operation Details

In the Alcova Camp, as in all CCC camps, the work of the United States Army is to see that enrollees are properly fed, clothed, disciplined, and that medical attention is provided. Food is the best obtainable on the market; it is carefully prepared for a balanced diet suitable to the work being done and the climate.

Each man is allowed the following clothing: Six pairs of socks, three suits of clothes, two suits of underwear, one overseas cap, one olive drab windbreaker, one overcoat, two pairs of shoes, one raincoat, one sleeveless jerk-on jacket, one pair of mittens and one pair of gloves, three olive-drab shirts, a complete set of toilet articles, ties, and handkerchiefs.

An enrollee is allowed $30 per month and room and board. About $22 of this money goes to his dependents, and the balance is his for personal incidentals.

Civilian supervisors, of which there are four appointed by the Secretary of the Interior, a superintendent and three junior foremen, have charge of all instruction on the job and of the related educational work carried on in the evening classes. A mechanic and powderman are employed as facilitating personnel.

It required 882,332 pounds of material for the construction of the Alcova CCC Camp which is known as Camp BR-79. The buildings are the portable type, 5 carloads of which were shipped from Anniston, Ala., and 19 carloads from Viva, Tex. After arrival of the materials, it required 30 days to complete the camp, including clearing and leveling the site.

In all there are 19 buildings at Camp BR-79, 5 barracks, 3 garages, 1 mess hall, an education building, a recreation building, 1 supervisory personnel quarters, 1 for Army officers' quarters; 1 combination building for Army supplies and office space, 1 oil house, 1 warehouse, and a blacksmith shop. The other 2 buildings are a hospital and a latrine. In addition, the Bureau of Reclamation is constructing a building which will serve as a permanent machine shop for the project.

After preliminary work was under way at the camp, the Army dug a well near the river to supply a reliable source of pure drinking water and made arrangements for effective sanitation for all camp requirements.

Development for public use of the area surrounding the Alcova Reservoir is bringing to central Wyoming long-needed facilities for recreation in connection with the development of the Kendrick reclamation project. Completion of the first stages of the project is being eagerly anticipated by the prospective users of the improvements.

CCC enrollees from Camp BR-79 placing 60-inch precast culvert on Alcova Reservoir scenic drive

CCC Aids in Construction of the Deschutes Project

By C. C. FISHER, *Construction Engineer and Regional Director, CCC*

THE better lands of Jefferson County, located in the Madras-Culver area of central Oregon, known locally as the North Unit District, were largely settled some 40 years ago, mainly by homestead entry in 160-acre tracts. The lands were first devoted largely to grazing. Favored with a cycle of good precipitation years, dry wheat farming grew rapidly into favor, reaching a peak of some 80,000 acres in cultivation in the early 1920's. With this cultivation, through elimination of the less successful or the transient settlers, the farms were mainly gathered into large holdings of one to several sections. The community rapidly developed and prospered during this early period; the farms were well improved, including substantial farm buildings; several small towns came into being; a pumping plant and pipe-line domestic water system were installed for the community; two railroads were built in from the main lines on the Columbia River; a trans-State paved highway was constructed through the district.

During the last 15- to 20-year period the precipitation dropped back to average and somewhat below. As a result the crop yields, and also to some extent the acreage in crop, have shrunken from year to year until at present the agricultural industry is but a semblance of its former activity and prosperity.

The towns have similarly suffered. Irrigation of the north unit area is the only practical solution to this problem. A number of irrigation engineering studies were made between 1920 and 1935, and following an extended Federal survey of 1935, a feasible plan of irrigating the lands of the north unit was developed. The entire north unit plan, including the reservoirs, main canal, and distribution laterals, is generally known as the Deschutes Federal reclamation project.

The project was approved for construction by the Government when the *Finding Regarding Feasibility of Project*, signed by T. A. Walters, Acting Secretary of the Interior, under date of September 24, 1937, was approved November 1, 1937, by President Roosevelt.

The construction plan of the north unit, as proposed in the recent investigation report and as approved in the finding of feasibility is briefly:

(a) Storage in the Wickiup Reservoir site to the capacity of 180,000 acre-feet. This requires an earth dam 84 feet high above stream bed, with a crest length, including a long dike on one end, of 14,000 feet; also a second dike to a maximum height of 28 feet and a length of 3,200 feet. The area to be submerged is 11,300 acres, practically all heavily timbered and requiring clearing.

(b) A main canal diverting from the Deschutes River from an existing diversion dam at Bend, some 45 miles by road below the reservoir. The main canal will have a capacity of 1,000 second-feet and a length of 65 miles. Its construction requires extensive rock excavation, rock paving, cement grouting or concrete lining, a high-pressure 500-foot siphon crossing the Crooked River gorge; 6,600 feet of tunnel, 800 feet of bench flume, and 1,600 feet of cut-and-cover conduit through the "Smith Rock Section"; several long concrete chute drops; and, finally, a high-pressure 1,636-foot siphon crossing Willow Creek canyon near Madras.

(c) A new 1,500-kilowatt power unit is required at the existing private hydroelectric plant on Crooked River, 40 miles north of Bend, to replace the power depletion at the present Bend plant, resulting from the proposed winter storage. This power cost is to be charged to storage. A lateral distribution system to cover a net irrigable area of 50,000 acres.

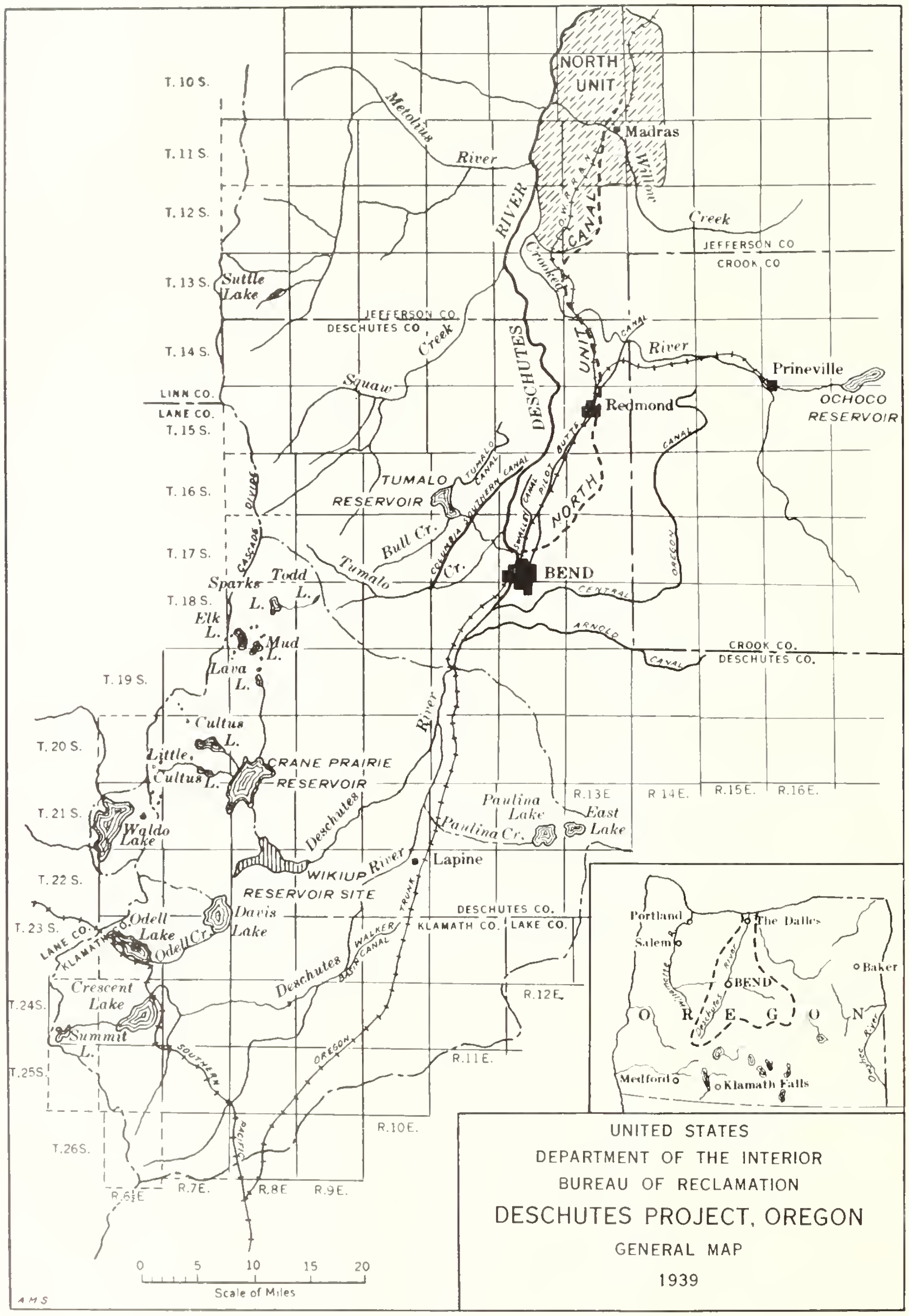
Estimated cost of construction.—The estimated cost of construction by principal features is as follows:

Storage	$2,540,000
Main canal	3,970,000
Major laterals	190,000
Minor laterals	800,000
Miscellaneous	500,000
Total	8,000,000

Contribution of the Civilian Conservation Corps

The finding of feasibility of the project is conditioned on part of the construction being done by the Civilian Conservation Corps and three CCC companies of approximately 200 men each have been assigned to this project. The first company, which arrived early in June 1938, came by transfer from the Bureau of Reclamation CCC camp near Stanfield, Oreg. The other two arrived in July 1938 and came direct from Indiana and Kentucky in the Fifth Army Corps Area. These were mainly new recruits, young lads just from home and with no construction experience such as they would soon be called upon to do.

Camp Redmond.—On arrival of the first CCC company, construction of a camp in which to quarter the boys had not been completed, and temporary quarters were rented in Redmond. A 40-acre tract of unimproved land in Redmond was leased from the city, and the construction of a three-company camp to house 600 enrollees, the largest single group in the West and occupying 20 acres, was started at once by the Army and was rushed to completion. The camp is a complete village within itself with three sets of barracks and mess halls, each with a capacity for 200 men; four



Army offices, a camp store, officers' quarters, quarters and office for Bureau of Reclamation supervisory personnel, a large educational building, a woodworking shop, infirmary, radio station, recreation hall, laundry, and the required garages, shops, etc.

The special purpose of the Redmond Camp is to house the CCC during the winter months when the deep snows drive them out of the mountains where they will spend their summers on the reservoir work. The boys will spend their winters on the construction of the North Unit Main Canal, the upper 30 miles of which are within easy reach of Camp Redmond.

Camp Wickiup.—The major work proposed on the project for the CCC is at the Wickiup Reservoir, located in the mountains some 40 miles southerly from Bend, the project headquarters, while the Redmond Camp is 16 miles north of Bend. It is planned to continue the CCC work on the reservoir as long each season as the weather will permit. To care for the boys here, therefore, another complete three-company camp is required. The construction of such a second camp was authorized by the Director, CCC, but on the condition that it be built with Bureau of Reclamation funds, and that the plans of the buildings and the camp set-up meet with Army approval. In order to hasten the beginning and completion of the camp, the Army consented to the older "permanent type" of buildings in place of the newer "portable type," which is now standard with the Army.

The camp has, accordingly, been built by force account, with a maximum crew of 36 skilled carpenters and a similar number of helpers or laborers. New and select materials were used throughout with shingle roofs, fir flooring, wallboard insulation, and plywood interior finishing in the principal buildings. The camp will be occupied each spring when conditions will permit moving the boys to the reservoir site. It is another village complete with 34 buildings, and added to the usual CCC camp set-up there is a large auditorium having a seating capacity in the wings for 500 to 600 men with room for a basketball court on the main floor.

The camp is located in the reservoir basin, but at an elevation near the proposed water surface. It is therefore temporary and must be removed before the reservoir is completely filled. It is on a high promontory overlooking the beautiful Deschutes River, with Wickiup Butte in the distance, set in a wilderness of virgin pine forest extending for miles around. With this beautiful setting, the special high class of the construction and the completeness and large capacity of the camp, it is said by the Army officials to be the one outstanding CCC camp of the West, if not of the entire Nation.

Construction program

By CCC forces.—The construction program proposed for the Civilian Conservation Corps insofar as it has been outlined, includes:

Portion of camp for CCC enrollees at Wickiup reservoir site, under construction by Bureau of Reclamation

(a) The clearing of the densely timbered area of the Wickiup Reservoir basin covering 11,300 acres. This is the largest single job proposed for CCC attention and it is estimated it will require 4 to 5 years to complete.

(b) The foundation clearing and stripping of the Wickiup Dam and the two large embankments, and also that of the borrow pits required for their construction. The required stripping is estimated at 500,000 cubic yards.

(c) The building of the main earth dam and the two embankments, except for the outlet works. This involves the following estimated principal quantities:

	Cubic yards
Earth and gravel fill	1,580,000
Rockfill and riprap	234,000

(d) During the winter months when the snow is too deep for efficient operation at Wickiup, the CCC will be engaged on the Main North Unit Canal construction from Camp Redmond. The upper 30 miles, from the diversion point at Bend to the crossing of Crooked River, will be constructed by the CCC for this purpose. It will include a large amount of rock excavation and rock paving of earth canal banks; also the rock cuts must eventually be sealed with cement grout where found necessary to prevent heavy leakage.

As we are living in the "machine age" the construction will be mainly a machine job. This, on the dam construction, will involve the use of tractors with "dozers" for uprooting and piling the timber and stripping the foundations and borrow pits; power shovel and dump trucks for loading, hauling, and placing the embankment material; tractors with graders and heavy rollers for spreading and compacting the embankment fills, etc.

On the canal construction the order of machine operation is: First, the clearing, involving the up-rooting of trees—large juniper—and the stripping, with tractor and dozer; second, the plowing of the surface material with tractor-drawn "rooters"; third, the excavation of the surface earth and placing it in the banks by tractor and dozer; fourth, drilling and blasting the rock with air-compressor and jackhammer drills and electric blasting machines; fifth, removing and placing the blasted material with power shovel or draglines and dumptor trucks; sixth, borrowing earth material for canal bank fills with power shovel and dumptors or with tractor-drawn 12-yard scrapers.

This construction job is an outstanding opportunity for the CCC boys in their training in the operation and repair of the many items of equipment in use, and it is encouraging to observe their eagerness to handle the machines and, in many cases, how quickly they become efficient operators and handy mechanical helpers in the repair shops. All of the equipment above mentioned, and also the many trucks in use, are operated by the enrollees, except the power shovel and draglines, which are manned by specialists.

(*Continued on page 115*)

Construction of Island Park Dam Upper Snake River Project, Idaho

By H. F. BAHMEIER, *Engineer*

CLOSING of the gates in the diversion tunnel on November 15, 1938, marked the final completion of construction of the Island Park Dam and the commencement of storage in the reservoir. Extreme water shortages on improved farm lands in the valley of Henrys Fork of Snake River during years of deficient moisture brought about exhaustive explorations in search for suitable dam sites to create reservoirs for a supplemental supply. Surveys were initiated as early as 1904 of dam sites on numerous streams in the watershed. Additional surveys were made between 1922 and 1927. Final investigations began in 1932, extending over a 3-year period, which included detailed explorations of foundation and abutment conditions at two sites and the ultimate adoption late in 1934 of the Island Park site on Henrys Fork River.

Location

The dam site on Henrys Fork River, a tributary of the main Snake River, is located 36 miles upstream from Ashton, Idaho, and 1 mile west of Island Park post office, which is on the main highway to the west entrance of Yellowstone Park. Water stored in the reservoir will flow down the river a distance of 45 miles to the first diversion point just below the junction of Henrys Fork and Fall River.

Construction Features

The main items of construction included a concrete-lined diversion tunnel averaging 12.5 feet in diameter, 800 feet long, with control gates and operating house; an open section spillway and inclined tunnel, connecting with the downstream end of the outlet tunnel; and the main embankment with a maximum height of 85 feet and a crest length of 1,632 feet. The earth fill is protected by rock riprap on the upstream face, and a heavy rock fill on the downstream slope. The dike, constructed of earth and rock materials and completed during the 1936 season, extends from the east end of the dam for a distance of 7,900 feet, averaging 10 feet in height. (Refer to drawing 42 D-170.) The reservoir created by this dam and dike has a capacity of 128,000 acre-feet, covering a surface area of 7,600 acres. Approximately 20 percent of the area to be flooded required clearing of a heavy growth of pine timber.

Distribution of stored water.—Storage water from the Island Park Reservoir, in addition to serving lands on Henrys Fork, will supplement the natural flow of the Teton River made possible by the construction of a concrete diversion dam on Henrys Fork River and a 7-mile cross-cut canal, extending from Henrys Fork to the Teton River. Structures have been constructed where this canal crosses the North, Middle, and South Branch Canals from Fall River to provide for supplying exchange water on lands served by those carriers. Late-season water will be available for such cash crops as sugar beets and potatoes grown extensively in Fremont and Madison Counties. Commencement of construction was contingent upon the execution of a repayment contract between the United States and the Fremont-Madison Irrigation District. This contract was executed on July 15, 1935, providing for the repayment by the district of the entire cost of construction spread over a period of 40 years. Title to the reservoir and related works will remain in the United States. Distribution of the stored water to the 116,000 acres benefited will be through existing canals of 40 separate canal companies who have entered into suitable contracts with the district for such distribution.

Diversion tunnel, outlet works, and spillway.—Construction of the diversion tunnel, outlet works, and spillway was completed during the 1937 construction period. A circular concrete-lined diversion and outlet tunnel, 12 feet in diameter and approximately 350 feet long, connects with and discharges into the lower portion of the spillway tunnel. A circular trashrack structure, 20 feet in diameter, is located at the intake end of the tunnel. The gate chamber is constructed in an enlarged section of the tunnel immediately upstream from its outlet into the spillway tunnel. The flow from the reservoir through the outlet tunnel is controlled by two sets of high-pressure, hydraulically operated slide gates installed in the tunnel plug under the gate chamber. Access to the gates is provided by a spiral stairway from the operating house through a concrete-lined shaft and passageway. The main spillway constructed in the west abutment of the dam and directly over the diversion tunnel consists of a concrete-lined open section with an overflow U-shaped crest 260 feet long. The open spillway converges into an inclined tunnel transition leading to the 13-foot circular section which discharges into the river channel below the dam. The spillway is designed for a capacity of 5,000 second-feet, with a 3-foot water depth over the crest.

Excavation tunnel and spillway.—A period of 6 months' time was required to excavate the tunnel and spillway. The nature of the badly jointed rock in the tunnel caused considerable overbreakage beyond the neat lines. Temporary timbering, installed for safety, was replaced by steel liner plates in the circular sections and fabricated structural steel ribs and arches in the transitions. Space back of the liner plates was filled with gravel and rock spalls, the voids in the packing being filled with cement and sand grout, requiring some 26,000 cubic feet. Seepage from numerous springs along the invert was pumped into a pipe line by four air-operated sump pumps. Drainage water from the two sumps at inlet and outlet portals was discharged into the river by 4-inch electric-driven centifugal pumps. Operations were started on the 12-foot circular section at the inlet end and continued downstream for about 420 feet. A pioneer bore was driven from the lower end, the rock being first removed above the spring line and then enlarged to the full 13-foot diameter. The downstream half was excavated with a 5-cubic-foot capacity mucker, air operated; the material was loaded into mine cars and hauled to the dump by cable and electric hoist. Leyner drifters mounted on a Jumbo frame were used for all drilling. Trimming was done with jackhammers.

The open section of the spillway was excavated by dragline, after the berm around the spillway crest was dug with a gas-powered shovel. The excavated materials were loaded into dump trucks and wasted.

Concrete.—Because of the inferior quality of concrete materials near the dam site, it was necessary to secure the aggregate from Teton Basin some 80 miles distant. A separate contract was awarded to Max J. Kuney Co., the principal labor contractor, for furnishing some 13,000 tons of sand and gravel.

The equipment for concrete placing consisted of a central weighing and batching plant which reclaimed the aggregate from stockpiles, separated it into three sizes, proportioning ingredients into the proper concrete mix. Aggregate with a maximum size of 1½ inches was used in all structures. Two transit mixers loaded at the batching plant mixed the concrete en route and deposited it into a pumpcrete machine, which pumped the mix through a 7-inch steel pipe line to the point of placement in the structure. The contractor used wooden panel forms, built in sections, for all structures. Reinforcement

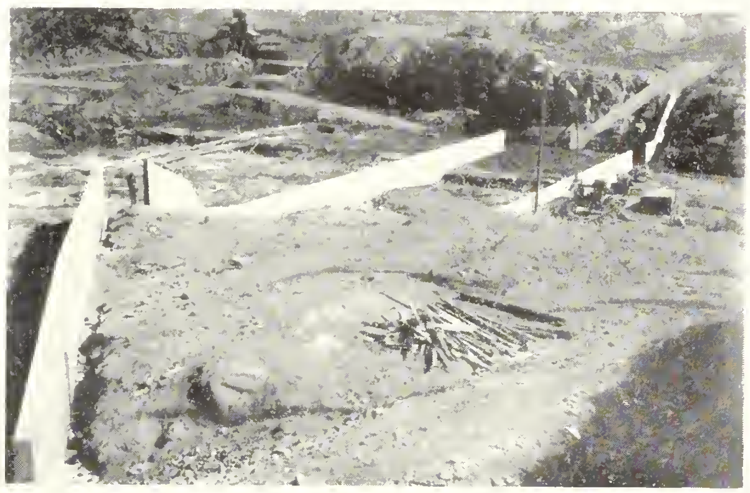
Above: Portion of reservoir clearing

Above: Placing earth embankment

Left: Upstream face of dam

Below: Spillway

Below: Foundation and cut-off walls

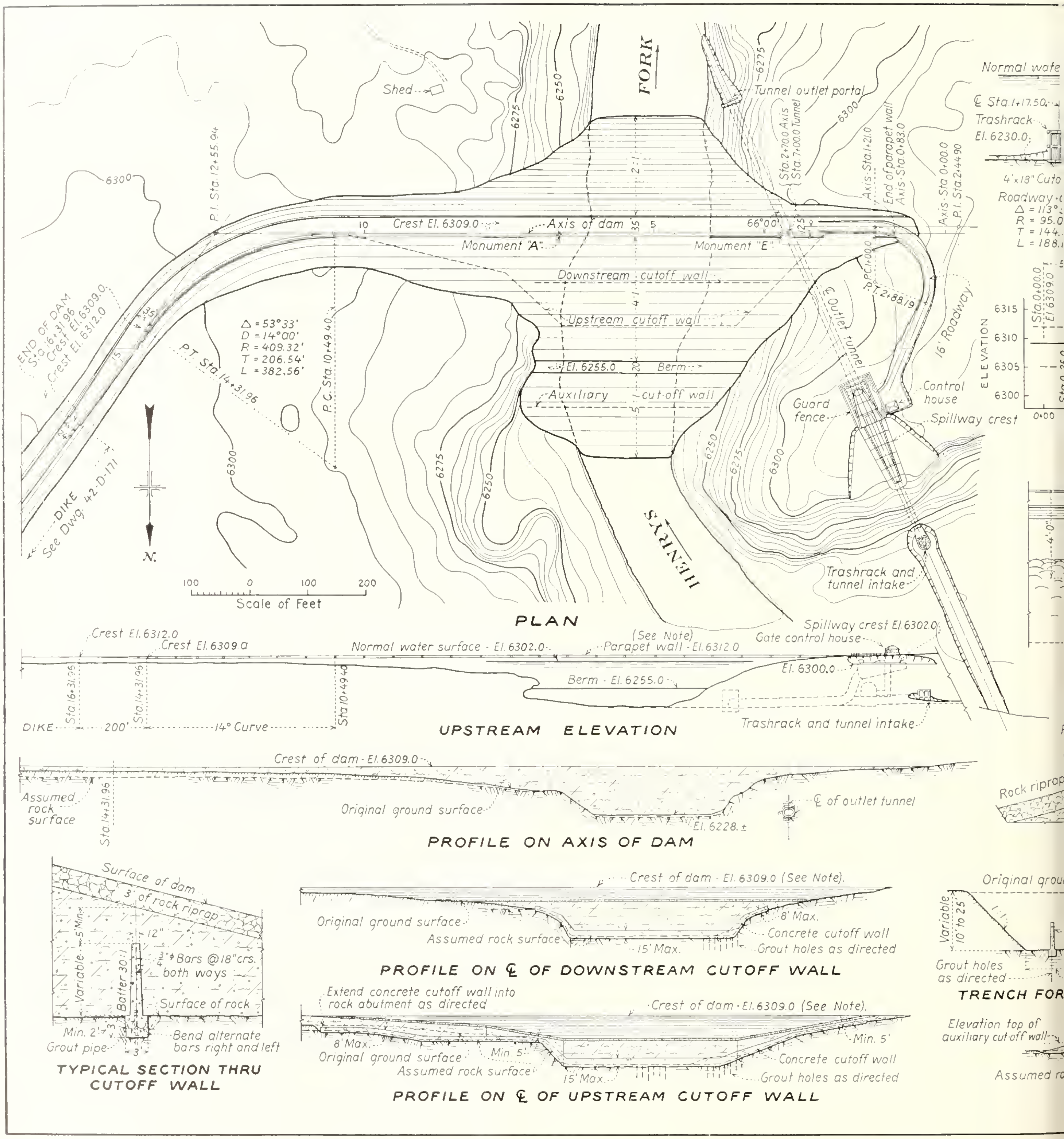


bars were used in the trashrack, gate chamber, shaft, spillway, cut-off and parapet walls as well as a 30-foot section at the portals of the tunnel.

The following characteristics show the average conditions of the concrete mix used:

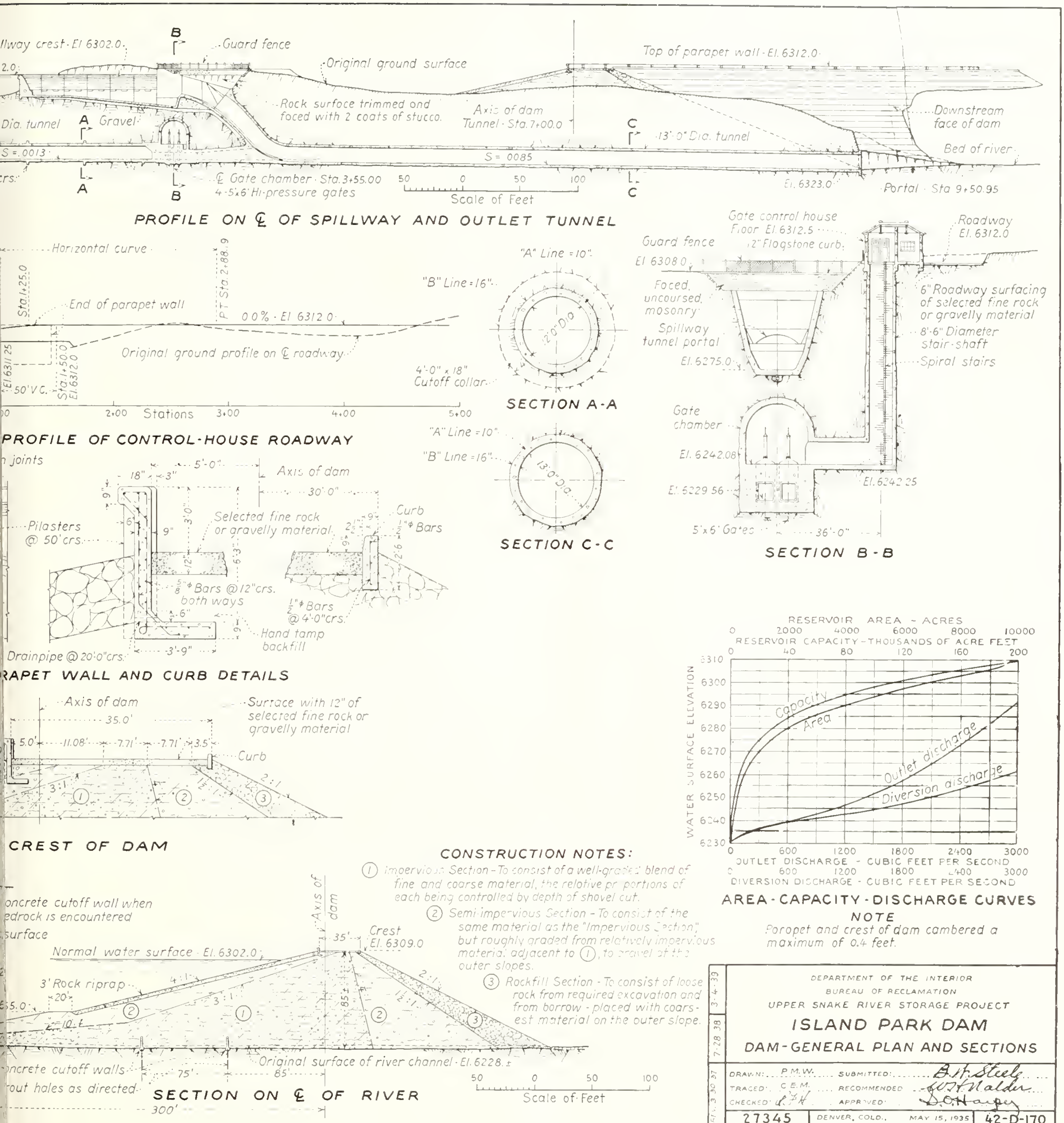
Mix by weight ____ _ 1 : 2.3 : 3.8.
Water-cement ratio __ 0.57 by weight.
Slump _____________ 4 inches.
Cement content ___ _ 1.40 bbl. per cubic yard.
Gravel-sand ratio ___ 1.65.
Cement to aggregate by weight ________ 1 : 6.1.
Average fineness modulus of sand _______ 2.70.
Average compressive strength ________ 4,230 lb/sq.in. in 28 days.

Concrete cut-off walls.—Two concrete cut-off walls were planned in the original design. A third wall averaging 5 feet high was constructed across the river bed 300 feet upstream from the dam axis to facilitate development of an effective cut-off in lieu of sealing off the springs in the area between this wall and the upstream toe of dam. The two lower walls are 10 feet high, 12 inches wide at the top, and 18 inches at the bottom. They extend across the river bed and up the two abutments. Cut-off trenches under the walls were excavated in the foundation rock to an average of 3 feet deep and 3 feet wide. Grout pipes were placed in the trench prior to placement of the concrete footing. Concrete



mixed at the batching plant was pumped a total horizontal distance of 700 feet to the west end of the upstream wall. Wooden forms built in 12-foot sections and held in place with tie rods were moved along the footing with a dragline. The average length of wall poured at one operation was 60 feet.

Parapet and curb walls.—Completion of the earth-fill between stations 8+00 and 16+32 during the 1937 season made it possible to proceed with the construction of the parapet and curb walls between those stations while the embankment was being constructed across the river channel during the 1938 season. By the time that section was finished, the earth-fill across the river had been completed and balance of wall and curb was constructed. Provision was made for possible settlement of



the embankment in the river section by constructing that portion of the wall four-tenths of a foot at the center point above the finished grade at the ends.

Stripping dam and dike foundations.—Equipment used in excavating the unsuitable materials from the abutments, the stream channel, and the foundation of the dike was two power shovels, a dragline, one tractor with bull-dozer attachment, and one tractor with 12-yard LeTourneau carry-all scraper. Stripping material from the dike area was wasted on the reservoir side. A cut-off trench averaging 6 feet deep, 6 feet wide on the bottom, with 1:1 slopes was excavated with the dragline beneath the dike for its entire length, stock-piling the suitable materials which were later placed in the embankment after the trench was filled with impervious material from the borrow pit.

Unsuitable materials from the river bed and two abutments were loaded into trucks and wasted upstream from the site.

Unwatering and cleaning foundation.—Diversion of the river through the tunnel was accomplished on June 8, 1937, after the upstream cofferdam was completed across the river at a point 250 feet upstream from the upstream toe of the dam. The uneven rock floor and the scattered outcropping of many springs required several pumps at different locations to unwater the foundation area.

The rhyolite rock on the river bed was found to be a structurally weak igneous rock varying from a relatively hard rock to a disintegrated material that could be excavated with a pick and shovel. Many channels had been eroded by water action in the upstream portion of the foundation with a deep eroded channel extending from the natural sump at the upstream toe to the downstream wall location. These channels were filled with gravel and other unsuitable materials that required removal by excavation with dragline and bulldozer. This equipment pulverized the soft rock necessitating a large amount of clean-up work by hand methods prior to completion of the grouting program and placement of the embankment.

Grouting foundation rock.—Grouting of the foundation rock presented a difficult and unique problem in sealing off the large inflow from the numerous springs. The quantity of water entering the foundation from this source in the area below the auxiliary wall was estimated to be 4,000 gallons per minute, all of which would need to be sealed off before earth material could be placed. Grouting operations extended over a 4-month period in 1937, being finally completed in July 1938 after the inflow had been reduced to a measured quantity of 26 gallons per minute. This small quantity was then confined to tile and gravel drains which were later filled with a cement and bentonite grout after the embankment had been placed to an average depth of 35 feet over the drains. A total of 66,375 cubic feet of grout was pumped into 27,500 linear feet of holes, or 2.4 cubic feet per foot of hole.

Sealing off the water from the many crevices in the soft rock necessitated the creation of a grout blanket by drilling shallow holes spaced on 20-foot centers over the foundation and grouting under very low pressures (not over 2 pounds per foot of hole depth). The grouting procedure finally adopted included grouting in 10-foot stages until an effective blanket about 20 feet deep was created. More effective results were secured by using holes drilled on an angle from 30° to 45° from the vertical and so located that drill would intercept the rock jointing not less than 4 feet below the surface. Grout holes spaced on 10-foot centers under the three concrete cut-off walls and along the two abutments were then drilled and grouted in stages to a total depth of 50 feet. Holes 1½ inches in diameter to the 20-foot depth were drilled with percussion drills (jackhammers and wagon drills); and between 20 and 50 feet, with a core drill rig. Grout was mixed with a 7S trailer type mixer, dumped into a sump and pumped with a double-acting pump. Relatively thick grout was used, the water-cement ratio varying from 0.62 to 1.5 by volume. Where leaks could not be sealed with neat cement grout, sand, and sawdust were added. Screened sawdust added to the mix in varying amounts from 1 to 4 gallons to a three-sack batch (water-cement ratio 0.75 by volume) gave excellent results on the larger springs. While a cement and sand grout is pumpable, it creates excessive wear on pumping equipment. Placing it by the pneumatic process in a broken, soft rock is very objectionable. Three grades of Bentonite were tried, the No. 80 mesh finally being adopted in lieu of sand. Bentonite expands very rapidly when moisture is added and should be mixed and placed immediately. An amount up to 10 percent by weight was added to neat cement grout by first mixing it dry with the cement and restricting the mixing and placing time to a maximum of 3 minutes, using a water-cement ratio of 0.70 by volume. Neat bentonite eroded from the rock crevices where large volumes of water were encountered. It did, however, create a temporary plug, and when followed by a thick mix of neat cement grout assisted materially in stopping bad leaks.

Grout leaks occurring from many of the seams in the rock could not be calked with oakum or burlap forced into the crevices with wooden wedges where the rock was too soft and brittle to hold the material. Excellent results were secured with excelsior calked into the larger crevices while thick grout containing sawdust was pumped. Lead wool was more effective than oakum on the finer seams. When other methods failed, a concrete slab or cap was poured over the rock surface, from 6 to 12 inches thick, the areas varying in size from 50 to 150 square feet. Shallow holes were drilled in the crevices to develop a greater flow in which 2-inch pipes were grouted with "flash set" cement. Seepage was held below the rock surface by self-priming gas-driven pumps, and pumping was continuous until concrete had set. The concrete slab confined most of the inflow to the pipes and dispersed the balance until the thick grout sealed the leak.

Embankment.—Construction of the dike section containing 136,500 cubic yards of earth and 14,600 cubic yards of rock riprap was completed during the 1936 season. The extensive grouting program in the river section prior to August 1, 1938, limited operations on the dam embankment during 1936 and 1937 to a section on the left abutment. Furthermore, the severe winter climate accompanied by snow depths between 5 and 6 feet limited the construction season for placement of earth materials from June 15 to October 15. Rapid progress, however, was made on the main fill in 1938, a total of 347,200 cubic yards of earth and rock materials being placed in a 60-day period.

Suitable materials were located in the reservoir basin after 7 separate areas were prospected by excavating, some 40 test pits supplemented by many borings with post-hole augers. The embankment was constructed with a mixture of sand, gravel silt, and clay, rolled to 6-inch compacted layers by a sheep's-foot roller, made up of two units of three rollers each, mounted in tandem. The total unit weighed 27,600 pounds, creating a compacting pressure of 218 pounds per square inch. The most impervious material was placed in the center section and the semi-impervious to the outside. Correct moisture content was maintained by the use of sprinkling systems in the borrow pits and on the embankment.

Three borrow pits were utilized, the major difference in the pits being the percentage of fine and coarse materials. Thickness of the several layers was such that proper blending was accomplished by reworking with power shovel on the face of the cut. Hauling equipment consisted of a fleet of trucks varying in capacity from 5 to 12 yards. Upon reaching the embankment, the material was spread to an average thickness of 8 inches with bulldozer. Twelve passes with the roller were required to give the desired compaction. The earth material was of such a nature that a dense, impervious embankment was placed. Laboratory tests indicated permeabilities as low as 0.01 foot per year. The materials were compacted in the embankment to an average dry density for minus ¼-inch materials of 116.8 pounds per cubic foot at a moisture content averaging 11.7 percent of the dry weight of the materials. The materials contained an average of 17.4 percent, by weight, of stone between ¼ inch and 5 inches in size. A constant check was maintained on the density, compaction, and permeability of the embankment by means of daily tests taken during construction, the samples being compared to a field laboratory standard.

The broken character of the rock in the abutment walls required special treatment to consolidate the material used to fill the many crevices where the sheep's-foot roller was not effective. Impervious material was compacted in the larger crevices with power tampers and puddled in the finer seams that could not be filled otherwise. Two-inch pipe risers were placed in all crevices before filling to permit grouting with a cement and sand mixture after the embankment had reached an elevation averaging 35 feet over bottom of the pipe. The best impervious material obtainable was used in a strip 30 feet wide along each abutment in the upstream section, from the foundation to the finished 4:1 slope, replacing more pervious material originally planned for that zone. Other changes included the placement of an impervious blanket over the upstream area between the foundation and elevation 6,240 and extending the boundary for zone 1

(*Continued on page 110*)

Improving Irrigation on Utah Farms

By WILLIAM PETERSON, *Director Utah State Agricultural College Extension Service*

HOW much water is required to grow a crop? This seems to be the question that needs answering in the irrigation sections of Utah, where water is the limiting factor in agricultural production. Because of the scarcity of water in this State there seems to be a belief among farmers that to apply an abundance of water is an advantage to the crop. This belief has influenced irrigation practices in Utah, but until recently no one was able to settle the question for the farmers as to just how much water a crop should have.

The optimum requirement for alfalfa, sugar beets, wheat, or potatoes has been determined on experimental plats, but it is quite a common statement of the farmers that "This does not apply on my farm. My farm is different."

With this problem before us, a request was made to the Agricultural Adjustment Administration to allow a benefit payment in 1937 for carrying out recommended irrigation practices in two counties of Utah. Provision for benefit payments were: First, that each cooperator should install a weir at the head of the farm so that the water might be measured accurately on each parcel of land irrigated independently through different feed ditches on the farm; second, that not more than 6 acre-inches of water should be applied per acre in any single irrigation. This last requirement made the farmers timid, for, while they had irrigated for many years, they were not sure whether they had been using 3 acre-inches or 3 acre-feet.

With some persuasion, 89 farmers agreed to install measuring devices and proceed with the practices outlined by the AAA officials. Alton H. Peterson, a young engineer, was employed by the Agricultural Adjustment Administration, and immediately set out to instruct the farmers how to install the water-measuring devices. The project was supervised by the county agricultural agent.

Measuring Devices

Five types of measuring devices were used: Rectangular weirs, trapezoidal weirs, V-notch weirs, Parshall flumes, and submerged orifices. A four-page pamphlet was prepared by George D. Clyde, dean of the school of engineering and head of the department of irrigation and drainage at the Utah State Agricultural College, indicating how the weirs should be installed. Contained in the pamphlet, also, was a discharge table for each type of weir. The weirs were built of various materials. Some farmers used wood, some concrete, some steel; however, most of the Parshall flumes were built of steel.

Farmers were aided in positioning their weirs so they would measure accurately the water flowing through them. Generally speaking, the farmers did their own measuring; however, their methods and figures were checked at regular intervals. A card was prepared to be filled in, indicating the time when the water started to flow through the weir, the reading on the index staff and the time when the irrigation of the particular plot of land was completed. It was understood that if the farmer should apply 6 acre-inches in a single application, he was to receive a reduced payment, and if this mistake happened twice, he was to lose his payment entirely. Out of the 89 who started the project, 80 qualified for payment.

The location of the land and the crops chosen were such as to give a fair cross section of the lands that are used in crop production of the area. No restriction was placed on the number of irrigations, but the washing of soil in the irrigation process and surplus water run-off were both charged against the practice as being unsatisfactory.

The crops irrigated included alfalfa, grains, potatoes, sugar beets, onions, and orchard land. The soil varied from a light sandy or gravelly soil to a heavy clay loam. The gradient of the farms varied from 5 to 6 percent to less than 1 percent. The ditches, of course, were irregular. In some, the water flowed rapidly and considerable work had to be done to install the weir properly. Other ditches were constructed on such a low gradient that only a Parshall flume could be used.

Every cooperating farm was inspected several times during the season by officials of the Agricultural Adjustment Administration. Three field tours were conducted, allowing many interested persons to see the results of irrigation under management as contrasted with lands under no specific supervision. Two beet patches contiguous to each other were noted. On one the water was measured and applied carefully, while on the other, water had been used in large quantities and practically every row was washed to the plow sole.

Cooperators on irrigation demonstration

Name	Crop	Acres	Yield [1]	Number of irrigations	Irrigation in inches			Seasonal use
					Maximum	Minimum	Average	
No. 1, 36-inch trapezoidal weirs	Alfalfa	3.50	9.30	8	4.35	2.60	3.73	28.2
	Beets	3.25	18.70	8	5.77	3.36	4.16	25.7
	Peas	2.25	3.22	3	4.94	4.08	4.37	13.1
	Beets	3.75	18.70	10	5.55	3.12	4.16	31.7
	Tomatoes	2.00	13.00	8	3.79	2.34	3.17	25.3
	Alfalfa	2.00	9.25	11	5.75	3.12	3.98	41.7
No. 2, V-notch weirs	Beets	2.00	13.10	5	3.64	.95	2.25	11.2
	Onions	2.60	510.0	12	3.30	.37	1.90	22.8
	Alfalfa	3.00	6.00	5	1.97	1.12	1.52	7.6
	do	2.00	6.00	5	4.92	.98	2.90	14.5
	Alfalfa and wheat	2.00	32.50	6	3.61	.84	1.94	11.6
	Alfalfa and peas	2.00	2.75	8	4.60	1.35	2.06	11.8
No. 3, 9-inch Parshall flumes	Peas	2.00	4.50	2	3.87	2.14	3.06	6.1
	Alfalfa	13.00	2.25	9	4.76	.86	2.37	13.8
	Barley	4.00	87.50	2	3.10	1.87	2.28	3.4
	Beets	7.00	21.40	10	3.69	1.72	2.72	27.2
No. 4, 24-inch rectangular weirs	Potatoes	3.00	133.0	5	3.77	2.10	2.99	13.9
	do	1.50	217.0	5	3.28	1.63	2.54	12.7
	do	4.25	217.0	7	2.26	1.81	2.03	14.3
	Beets	4.70	17.40	8	3.64	2.52	2.98	23.8
	do	3.50	17.40	6	3.48	2.05	2.58	15.4
	do	3.19	17.40	7	3.57	2.02	2.74	19.2
	do	2.04	17.40	7	4.25	2.78	3.36	23.5
	Wheat	2.10	51.00	3	4.37	3.78	4.02	12.0
	do	4.25	51.00	3	3.56	2.48	3.08	9.3
	Alfalfa	4.00	6.25	6	3.98	.98	3.24	19.4
	do	3.28	6.25	3	3.73	2.34	3.23	9.6
	do	3.79	6.25	7	5.01	2.54	3.50	24.5
	do	2.93	6.25	5	4.98	2.78	3.84	19.2
	Alfalfa seed	1.90	---- ----	3	2.40	1.00	1.70	5.1
No. 5, 24-inch rectangular weirs	Alfalfa	7.00	3.68	4	2.25	1.61	1.89	7.6
	do	1.00	3.68	4	3.50	2.50	3.16	12.6
	Oats	6.50	44.00	1	2.82	2.82	2.82	2.9
	do	3.00	44.00	1	4.08	4.08	4.08	4.1
	Beets	10.00	7.50	4	8.40	.63	1.06	4.2
	do	6.00	7.50	2	2.91	1.35	2.14	4.3
	Wheat	4.00	32.00	2	4.60	4.28	4.48	8.9
	do	2.00	32.00	1	5.83	6.83	6.83	6.8
	Potatoes	2.00	67.00	5	2.67	1.21	1.80	9.0
	do	1.00	67.00	4	5.74	2.50	3.62	14.5

[1] Yields are reported in following units: Alfalfa, sugar beets, peas, tomatoes, in tons per acre; wheat, barley, and oats in bushels per acre; potatoes and onions in hundredweight per acre.

Crop Yields

One of the questions which found expression many times during the demonstration was: Will the crop yields be comparable in quantity to those grown under ordinary irrigation practices used in the district. To determine this, yields were measured on most of the farms. Unfortunately, the harvest on a few of them was such that accurate yields could not be obtained. The data recorded indicated the crop planted; the acres contained in each parcel of land which had to be irrigated separately; the number of irrigations; the maximum, minimum, and average acre-inches applied in each irrigation; the total seasonal use; and the yield per acre.

In the trials 1,752.77 acres were irrigated. The seasonal use, on the average, was 21.2 inches on those lands which complied for benefit payment. This was thought by the farmers to be materially less water than that which is regularly applied; and, it was definitely applied in a manner that allowed a larger absorption by the soil irrigated.

The farmers, generally, seemed to be happy in the results obtained. However, a story was spread that the measuring of water was to determine actual needs, and the balance would be taken away from one farmer and given to another. Of course, this story had no foundation. Conditions developed which indicated that some farmers had more irrigation water than they needed, but they were definitely told if they had water for disposition that they, themselves, should have the authority to sell the water and benefit by whatever the water right was worth.

Saves Soil and Water

I, personally, visited many of the farms while this test was being made and I am convinced that this orderly method of applying water is economical from the standpoint of making the highest use of water available and preserving the top soil. The process resulted in a minimum of washing and preserved fertility of the top soil.

The cost of installing a proper weir varied from $10 to $40. In many cases, the payments received the first year did not exceed the cost of installation.

During the summer of 1938, 335 farmers adopted the method of installing weirs and measuring the amount of water they applied to their farms. The project was set up differently for benefit payment and the practices were not so carefully supervised. An engineer was not available in 1938 and the follow-up depended entirely on the county agent.

Enough data have been gathered from this short-time test, however, to indicate that the process is beneficial. I believe that if the practice were applied to reclamation projects there would be a decided economy in the water used and much more fertile farm soil would be preserved.

Island Park Dam

(*Continued from page 108*)

materials some 40 feet downstream from the dam axis. These changes increased the yardage of impervious material by about 60 percent over the quantities provided for in the original design.

The rock fill in the downstream section was constructed along with the earth embankment from a rhyolite rock, placed in 3-foot layers, the finer materials being sluiced into place by water pressure. A very hard and dense basalt rock was used for riprap on the upstream face of the dam and placed after the embankment was completed. The loaded trucks backed down the 4:1 slope under their own power, being pulled back up the slope with a tractor. About 25 percent of the basalt rock was oversize, requiring drilling and blasting and then reworking by hand labor. The downstream face of the rock fill was trimmed with a dragline.

Relocated roads.—Construction of the reservoir necessitated the relocation of a portion of the county road leading westerly from highway U. S. 191 to Dubois and Spencer, Idaho. A farm road through the reservoir was also replaced by a road extending around the west end and joining the county road.

A 200-foot timber bridge with concrete piers was required over Henrys Fork and a similar bridge 16 feet long was built over Hotel Creek. About half the road was through thick pine timber. The work was done under contract by Burggruf & Brennan, of Idaho Falls, during the 1936 construction season. The total contract earnings were $24,300.

Clearing reservoir site.—Contract for clearing the timber from the reservoir basin was let to the Nevada Construction Co. of Nevada, Mo., in four schedules and work started on July 12, 1936. The size of the timber did not justify the use of power equipment. Trees were felled by hand labor and the larger logs piled with the aid of horses. Fifteen men directed by a foreman comprised a working crew. Weather conditions prevented completion of all schedules during 1936, the contract not being completed until 1937. A total of 1,160 acres was cleared at a cost of $63,600.

The contractor's construction program on the dam called for diversion of the river through the tunnel early in 1936. This would have flooded timbered areas below the 6,250-foot contour level before they could be cleared under the above contract. A CCC camp was established and about 70 acres cleared late in the summer of 1935, when the camp was moved to another project. The balance of approximately 100 acres was cleared by Government forces. Removal of some 35 miles of log fences in Shot Gun Valley, together with four groups of farm buildings, was accomplished by Government forces just prior to storage of water.

Hydrostatic-pressure indicators.—In order to determine the hydrostatic pressures at different elevations in the embankment of the main dam during periods of storage, test apparatus was installed by Government forces after the fill was completed. A total of 54 indicators was placed along two parallel lines perpendicular to axis stations 4+50 and 6+10, beginning at a point 215 feet upstream from the axial line and extending downstream 115 feet from the axis. Sixteen holes, 4 inches in diameter, were drilled in the earth embankment to bedrock with a churn drill, the bottom indicators being set adjacent to the foundation. The number of indicators in each hole varied with the depth of hole, the vertical distance between indicators averaging 15 feet. After indicators were embedded in coarse sand they were insulated from each other by filling holes with a cement-and-sand grout. Connections are provided between each indicator and a terminal board at the concrete curb wall on crest of dam by copper tubing containing an insulated wire. To determine the hydrostatic pressure in any indicator, dry-cell batteries and a flashlight bulb are connected in series with the copper tubing and insulated wire, thereby forming a closed circuit. Air pressure is applied through the tubing to the diaphragm in the indicator until the light goes off. The air pressure at that instant is indicated on a gage calibrated in feet of water which shows directly the water pressure at the diaphragm. Readings taken weekly will provide the data for determining the path of the percolating waters through the earth materials.

Sugar Beets Thrive Under Irrigation

THE Hyrum, Utah, development of the Bureau of Reclamation has resulted in growing better crops in this sugar-beet region, reports the Logan *Cache American.*

"The best beets raised in Cache Valley last season," it states, "were grown under the Hyrum Reservoir project. These beets came off land that had been farmed for years and years to dry farm wheat.

"Under the project about 7,000 acres of land are being irrigated. About half of this acreage is new land as far as irrigation goes, while the other half that was formerly partially irrigated, is now getting water to mature their crops, the flow being held back in the reservoir for late irrigation.

"While storage water is perhaps a new thing to farmers of Cache Valley, yet since the completion of this project farmers under it are beginning to appreciate the fact that 1 acre-foot of storage water is equal to 3 acre-feet of river flow. The reservoir is able to regulate the flow when the farmers want the water. When it rains the water can be stored instead of permitting it to run down into Bear River and be lost to irrigation. The water thus stored can be liberated when the dry season is on.

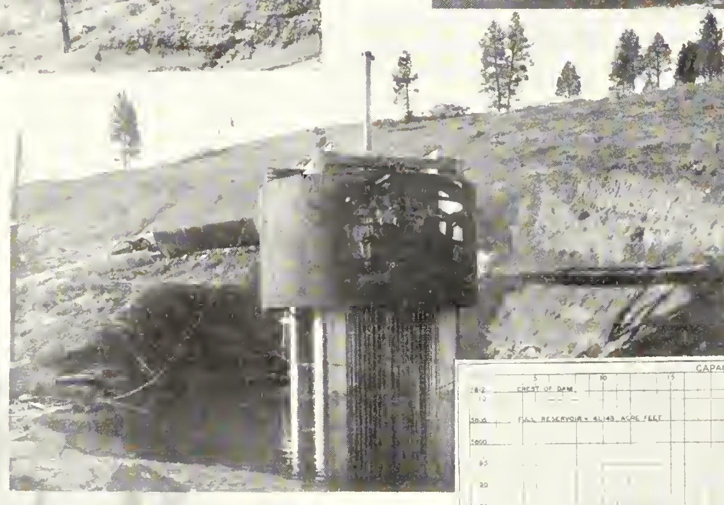
NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
828	Central Valley, Calif.	Mar. 9	Substation and motor-control equipment for pumping plants Nos. 1, 2, 3, and 4, Contra Costa Canal.	American Transformer Co.	Newark, N. J.	[2] 1,092.72	F. o. b. Oakley, Calif.	Apr. 4
				Johnson Manufacturing Co.	Atlanta, Ga.	[3] 830.75	do	Do.
				do	do	[4] 220.90	do	Do.
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif.	[5] 7,990.00	do	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[6] 1,830.00	do	Do.
				do	do	[7] 66.00	do	Do.
				do	do	[8] 1,259.68	do	Do.
				General Electric Co.	Schenectady, N. Y.	[9] 951.00	do	Do.
821	Gila, Ariz.	Mar. 1	Fortuna wasteway at station 948 and bridges at stations 876+75 and 987+12, Gravity Main Canal.	Norman I. Fadel	Los Angeles, Calif.	58,857.80		Apr. 6
825	Central Valley, Calif.	Mar. 3	Earthwork and structures, Southern Pacific R. R. relocation mp. 282.80 to mp. 287.81 and earthwork structures and surfacing U. S. Highway No. 99, stations 454+00 to 587+60.38.	Granfield, Farrar and Carlin	San Francisco, Calif.	296,899.70		Do.
826	Kendrick, Wyo.	Mar. 2	Synchronous condenser, power transformers and 115,000-volt disconnecting switch and lightning arrester for Gering substation.	Bowie Switch Co.	do	[10] 2,480.00	F. o. b. Gering, Nebr.	Mar. 28
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[11] 3,106.00 (12)		Mar. 21 (13)
827	Colorado-Big Thompson, Colo.	Mar. 16	Roads to east and west portals of Continental Divide Tunnel.	Driscoll Construction Co	Pueblo, Colo.	[14] 80,033.10		Apr. 6
				J. H. and N. M. Monaghan	Denver, Colo.	[15] 106,969.40		Do.
830	Columbia Basin, Wash.	Mar. 20	Pipe, fittings, valves and appurtenances for Grand Coulee Dam.	Associated Piping & Engineering Co. Ltd.	Los Angeles, Calif.	[1] 167,600.00	Discount ½ percent; F. o. b. Odair, Wash.	Apr. 11
				Crane-O'Fallon Co.	Denver, Colo.	[2] 8,113.80	Discount 2 percent, F. o. b. Odair, Wash	Mar. 28
				Jenkins Bros.	Chicago, Ill.	[3] 4,002.00	do	Do.
				American Radiator and Standard Sanitary Corporation.	Denver, Colo.	[4] 2,297.00	Discount 2 percent; F. o. b., Pittsburgh.	Do.
1197-D	Colorado-Big Thompson, Colo.	Mar. 13	Disconnecting switches, lightning arresters and outdoor-type transformers for Granby Dam substation.	Johnson Manufacturing Co.	Atlanta, Ga.	[1] 2,074.90	F. o. b., Granby, Colo.	Mar. 27
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[2] 2,070.00	do	Mar. 28
				do	do	[3] 103.50	do	Do.
1198-D	Milk River, Mont.	Mar. 14	Four 5- by 6-foot high-pressure gates with frames, hoists, gate hangers and appurtenances for outlet works at Fresno Dam.	Goslin-Birmingham Manufacturing Co., Inc.	Birmingham, Ala.	23,996.00	Discount ½ percent	Apr. 5
33,167-A	Central Valley, Calif.	Mar. 10	Galvanized corrugated metal pipe and coupling bands.	Western Pipe and Steel Co. of California.	San Francisco, Calif.	[16] 11,919.56	Discount ½ percent; schedule 3, f. o. b., Canton, Ohio.	Apr. 6
				Collins Concrete and Steel Co	Portland, Oreg.	678.24	F. o. b. Portland	Mar. 24
836	Columbia Basin, Wash.	Mar. 16	Gate frames for reverse-flow coaster gates for the Grand Coulee pumping plant.	American Bridge Co.	Denver, Colo.	124,078.00	F. o. b., Gary, Ind.	Apr. 11
832	do	Mar. 13	Pier plates and erection trusses for 11 drum gates at Grand Coulee Dam spillways.	Mississippi Valley Structural Steel Co.	Melrose Park, Ill.	[2] 8,690.00	F. o. b., Melrose Park	Mar. 27
1200-D	Rio Grande, N. Mex.	Mar. 16	One 40-ton, motor-operated, overhead traveling crane with an 8-ton auxiliary hoist for Elephant Butte power plant.	Harnischfeger Corporation	Milwaukee, Wis.	12,570.00	F. o. b. Milwaukee	Apr. 18
1208-D	Shoshone-Heart Mountain, Wyo.	Apr. 6	One 10- by 11-foot radial gate and one 3,600-pound capacity radial-gate hoist for South Eaglenest siphon at station 1097+60, Heart Mountain Canal.	Commercial Iron Works	Portland, Oreg.	[1] 344.50	Discount ½ percent	Apr. 13
				Pekrul Iron Works	Denver, Colo.	[2] 228.50	do	Apr. 14
33,119-A-1	Central Valley, Calif.	Mar. 20	Copper-steel plates, 949,000 pounds	Republic Steel Corporation.	Warren, Ohio	27,291.63	F. o. b. Sacramento	Apr. 20
A-38,311-A	Columbia Basin, Wash.	Mar. 24	Steel reinforcement bars, 4,435,000 pounds.	Bethlehem Steel Co.	San Francisco, Calif	114,091.00	F. o. b. Odair; discount ½ percent b. p. v.	Do.
A-38,346-A	Yakima-Roza, Wash.	Mar. 30	Steel reinforcement bars, 598,543 pounds.	do	do	13,048.24	F. o. b. Buena; discount ½ percent b. p. v.	Do.
1193-D	Colorado-Big Thompson, Colo.	Mar. 6	One 10-ton, 2-motor traveling crane for Government warehouse at Granby.	Roeper Crane & Hoist Works Inc.	Reading, Pa.	2,682.00	F. o. b. Reading; discount 2 percent.	Apr. 8
1206-D	Moon Lake, Utah	Apr. 5	Two 10- by 6-foot radial gates, one 12- by 12-foot radial gate, two 2,300-pound and one 7,500-pound capacity radial-gate hoists.	Commercial Iron Works	Portland, Oreg.	[17] 1,727.00	F. o. b. Portland; discount ½ percent.	Apr. 12
1207-D	Parker Dam, Calif.	Apr. 4	Five gate-position indicators for 50- by 50-foot spillway regulating gate hoists.	Valley Iron Works	Yakima, Wash.	437.00	F. o. b. Yakima; discount 5 percent.	Apr. 10
1208-D	Shoshone-Heart Mountain, Wyo.	Apr. 6	One 10- by 11-foot radial gate and one 3,600-pound capacity radial-gate hoist for South Eaglenest siphon.	Commercial Iron Works	Portland, Oreg.	[1] 344.50	F. o. b. Portland; discount ½ percent.	Apr. 13
				Pekrul Iron Works	Denver, Colo.	[2] 228.50	F. o. b. Denver; discount ½ percent.	Apr. 14

[1] Item 1. [2] Item 2. [3] Item 3. [4] Item 4. [5] Item 6. [6] Item 7. [7] Item 8. [8] Item 9. [9] Item 10. [10] Schedule 3. [11] Schedule 4. [12] Schedules 1 and 2. [13] All bids rejected. [14] Schedule 1. [15] Schedule 2. [16] Schedules 1, 3, and 4. [17] Items 1 and 2.

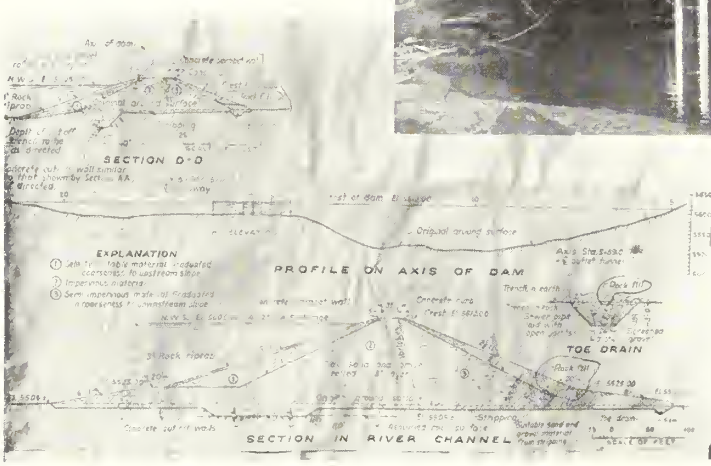
Above: Zoned embankment placing operations. Average elevation 5,533.5 reached September 10, 1938

Above: General view of spillway structure and downstream face, with embankment placed to elevation 5,600, November 1, 1938

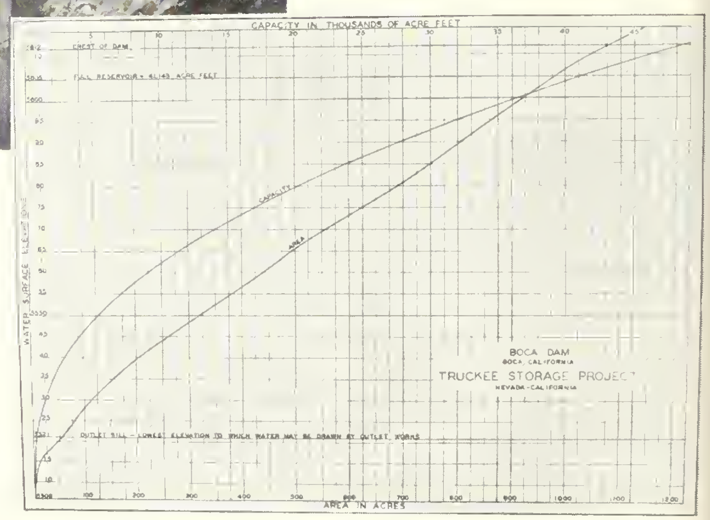


Left: The combination fish screen and trashrack structure with the screen in the raised position

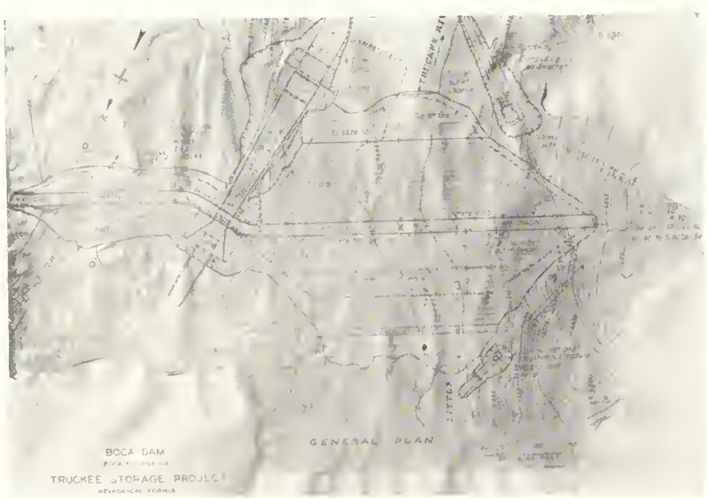
Below: Sections and profile on axis



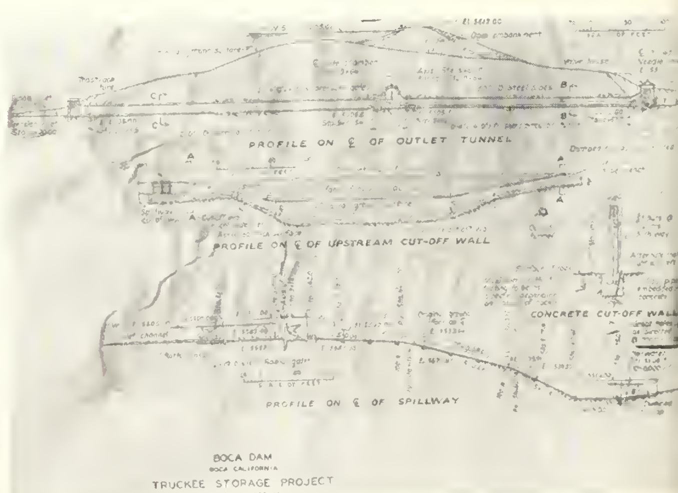
Below: Capacity curve



General plan



Profiles



Boca Dam, Truckee Storage Project Nevada-California Construction Progress

By F. M. SPENCER, *Associate Engineer*

CLIMATIC conditions in the mountain areas, especially at the higher elevations, are always uncertain and frequently force radical changes in work and other programs. Some such forced changes have occurred in connection with the construction of the Boca Dam since the writing of the article, Boca Dam, Truckee Storage Project, which appeared in the February 1939 issue of THE RECLAMATION ERA. In that article, it was stated that the conditions for economical and practical construction at the Boca Dam site were generally favorable except those of a climatic nature and those unfavorable climatic conditions were explained. It was also stated in that article that, early in November 1938, the embankment, exclusive of rock fill and riprap, had been placed to elevation 5,602, that there remained only 10 feet of height to reach the contemplated crest elevation of 5,612, and that certain work was expected to be completed before colder weather began. On November 6 the minimum temperature at Boca dropped 16° below the average minimum for the month up to that date and frost began entering the earth fill to such an extent that considerable difficulty was had with embankment placing. On November 10 this work was abandoned, the 8th being the last day on which a full shift was worked. By November 12 the temperature became as low as 11° below zero, the frost penetrating the earth fill to such a depth that there was no reasonable expectancy of its removal by any warmer periods before spring.

At the time embankment placing was abandoned an average elevation of 5,604 had been reached, leaving only 8 feet in height to be placed, or approximately 3 full days of work at the usual rate of progress. Rock work was continued until December 18, when all rock fill and riprap had been placed to the present top of the embankment at elevation 5,604. While it was somewhat disappointing to be forced to suspend earth-placing operations with the work so nearly complete, it was gratifying to have reached a point in construction at which the structure could be left for the winter with assurance that it was in all respects safe from damage by winter conditions and spring floodwaters.

Although cold weather continued, there was little snowfall and by the use of special protection the concrete construction program for that period was followed to completion. All concrete in connection with the spillway, except the road and operating deck over the gate structure, was poured by November 23. The spillway channel was excavated by December 18, thus placing the entire structure in condition to pass possible floodwater without gate operation, the gate and operating mechanism installation being deferred until the coming summer. Concrete pours and metalwork installations for the combination trashrack and fish-screen structure were completed so that the stop logs could be placed on December 8, and installation of the high-pressure gates in the tunnel gate chamber immediately started. The latter installation, together with the surrounding concrete plug, was completed on December 24. Work consisting of the placing of the outlet pipes and some minor activities within the outlet tunnel was continued until complete suspension of work on January 26, 1939, all outside work having been discontinued on December 18.

Protection for Fish

The fish-screen part of the trashrack structure was an addition to the outlet works as originally designed and does not appear on the accompanying drawings. Its general form can be realized, however, from the photograph herewith included which shows construction nearly complete. In that photograph the screen, which is circular, 23 feet in diameter, is in its raised position and exposes the bars of the trashrack proper. The vertical bars of the screen are of knife blade form with the narrow edges, one-sixteenth of an inch thick, placed toward the center of the structure and welded to the supporting beams. The outer edges are one-fourth of an inch thick with one-half-inch spacing between bars. While only 1 inch wide the bars seem to have sufficient strength except for a slight tendency to warp under temperature changes. The screen is 13 feet and 2 inches high and may be lifted by a centrally located hydraulic hoist in case of clogging.

Dam Will Be Completed this Summer

As soon as climatic conditions permit, which will probably be about the first of May, it is intended to resume construction work and bring all features to completion during the summer. The placing of the remaining portion of the embankment, consisting of approximately 26,370 cubic yards of earth and 9,500 cubic yards of rock, will be the most important and controlling part of the work. Total quantities will be somewhat less than those shown by original estimates because suitable foundation material was encountered at a much less average depth than expected and considerably less stripping was required.

Settlement Leaflets

STATEMENTS as to the settlement possibilities on a number of reclamation projects have recently been issued and are available for free distribution on application at the Washington or project offices as follows:

- Belle Fourche project, South Dakota.
- Boise project, Idaho.
- Carlsbad project, New Mexico.
- Grand Valley project, Colorado.
- Huntley project, Montana.
- Klamath project, Oregon-California.
- Milk River project, Montana.
- Minidoka project, Idaho.
- North Platte project, Nebraska-Wyoming.
- Okanogan project, Washington.
- Orland project, California.
- Owyhee project, Oregon-Idaho.
- Riverton project, Wyoming.
- Shoshone project, Wyoming.
- Strawberry Valley project, Utah.
- Uncompahgre project, Colorado.
- Vale project, Oregon.
- Yuma project, Arizona-California.

The project offices are listed on the inside of the back-cover page of this magazine.

The mimeographed statements describe briefly: Location, towns, railroads, climate, soils, water supply, lands, cost of water-right, crops, markets, schools, roads, churches, farms available, and other matters of interest to prospective settlers.

Government Organization Chart Available

THE chart of the Government of the United States, which appeared at page 87 of the April issue of the RECLAMATION ERA has been reprinted for free distribution in quantities up to 50 by the National Emergency Council, and for sale distribution at $1 a hundred by the Superintendent of Documents.

Requests should be addressed: National Emergency Council, Washington, D. C., or Superintendent of Documents, Government Printing Office, Washington, D. C.

Purchasing Power of Federal Reclamation Projects

MANUFACTURERS of the East, Midwest and South receive $200,000,000 of business a year from federally developed irrigation areas according to an estimate of Commissioner John C. Page of the Bureau of Reclamation.

The estimate was based on full carload lots of goods shipped by rail into one of the Bureau's 50 irrigation developments, the Boise area in Idaho, which showed merchandise rolling into the region from 30 different non-Western States.

According to the Idaho State Planning Board on whose survey the estimate is made, the Boise area received nearly 400 carloads of goods from the State of Michigan alone. Texas, Ohio, Wisconsin, Missouri, Pennsylvania, and Kentucky each shipped more than 100 carloads to the area, while Indiana sent 75 and Louisiana, Arkansas, and New York 50 each.

The purchases of the farmers and townspeople of the area were as diverse as they were widespread. Michigan manufacturers and businessmen sold them 312 carloads of automobiles and trucks, 50 carloads of electrical goods, furniture, and household equipment, and 29 full carloads of cereals.

Texas industry supplied nearly 150 carloads consisting chiefly of food, which totaled 55 full carloads, and gasoline and oil, 25 carloads. Citrus fruit growers of the State shipped in 13 carloads. Miscellaneous merchandise from other Texas businessmen reached 40 carloads.

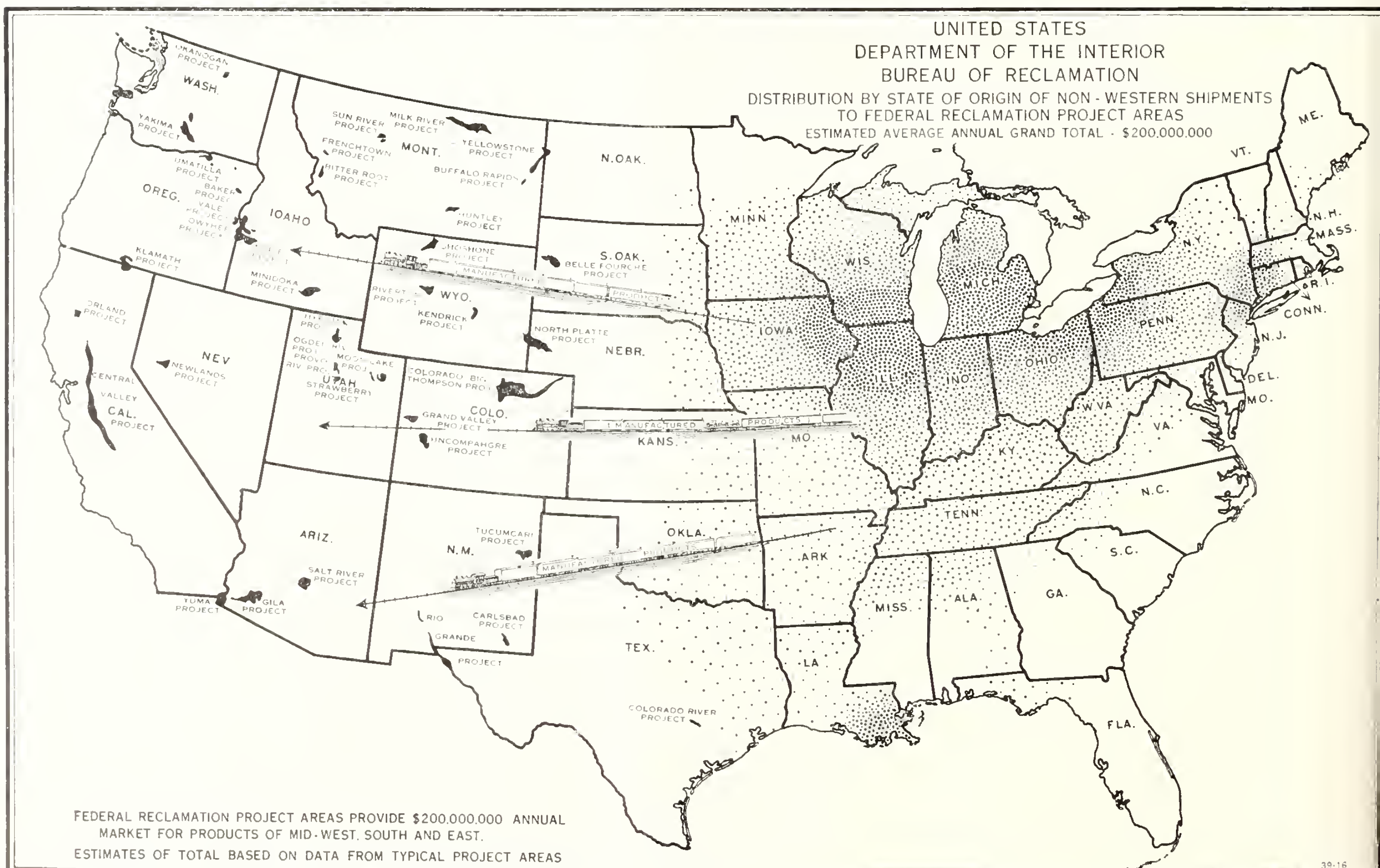
Wisconsin also came in for a goodly share of the business created by the Boise irrigation development. It sold farmers and townspeople of the area 140 carloads of farm equipment and supplies, foodstuffs, furniture, and building materials.

Ohio businessmen also shipped 134 carloads of industrial products, including agricultural implements and other farm supplies, electric refrigerators and general household equipment, building materials, and miscella-neous goods.

Michigan was not the only State to shi[p] automobiles to the Boise area residents. Au-tomobile and truck assembly plants in Mis-souri also shipped 57 carloads. Other Mis-souri manufacturers sent more than tha[t] number of carloads of processed foods, build-ing material, and miscellaneous.

From Pennsylvania industries came 11- carloads of lubricating oils and greases, processed foods, electric ranges, and steel an[d] steel products.

Citrus fruits and fresh vegetables an[d] canned goods came in carload lots fro[m] Florida; foodstuffs and other supplies fro[m] Mississippi, Alabama, Tennessee, Maryland, North Carolina, and Virginia. Nearly every State in the Union participated in the busi-ness created by the demands of the farmers and townspeople of the Boise irrigatio[n] project area, the survey showed.



The Boise project covers seven counties in western Idaho near the Oregon State boundary line. Its irrigation farmers grow alfalfa hay, clover and pasture, grain, potatoes, sugar beets, apples, prunes, vegetables, and seed crops. About 15,000 persons live on its 4,000 farms and 50,000 more make a living in the towns created by those farms and dependent upon them for most of their business.

Boise irrigated farms brought their owners an average return of about $29 an acre in 1937. With the average farm of about 56 acres, this return meant a gross income of more than $1,500 for the farm family's needs, of household supplies, processed foods, farm equipment and supplies, radios, and automobiles, etc.

The cost to date of the Boise irrigation project has been about $16,500,000, or approximately $77 per acre of irrigable land. About 150,000 acres of land were completely dependent, aside from the sparse rainfall, upon the Bureau's diversion works for their supply of water, and a similar total received a supplemental supply.

Under the Reclamation Act, which requires repayment to the Bureau of Reclamation of the funds advanced for any irrigation development, the Boise irrigation farmers have already repaid one-fourth of the cost of the development.

The drawing on the opposite page shows the Federal irrigation development areas, including Boise, which provide this $200,000,000 annual market for the products of manufacturers and the merchandise of businessmen in the East, Midwest, and South.

CCC Aids in Construction of Deschutes Project

(*Continued from page 103*)

By Bureau of Reclamation forces.—It is proposed to construct the outlet works at the Wickiup Dam by contract. On the distribution unit (canals and laterals) it is contemplated that the Main Canal north of Crooked River and the lateral system will be built with Bureau of Reclamation funds, probably by contract. It may be that some of the canal work south of Crooked River will also be done with Reclamation forces, either by force account or contract. Two new draglines and several other pieces of heavy equipment were recently purchased with Bureau funds for use on the CCC job, and these machines are operated by Bureau employees. The canal job now under way, therefore, though it is classed as a CCC job, is to a minor degree also a Bureau job.

Construction progress.—The construction of the project may be said to be only just begun. The only work done to date at the Wickiup Reservoir, except for the completion of the CCC camp, is a small amount of reservoir clearing—70 acres—done last fall from a temporary CCC camp.

On the canal, though the construction started the latter part of September, it was with only a small force and but little equipment on hand in operating condition. This has been gradually built up until it just now may be said to be a well-equipped plant for the handling of the three CCC companies on the canal construction.

At the present time there are 8 miles of main canal (capacity, 1,000 second-feet) opened up, with the first 4 miles nearing completion. A considerable percentage of this work is rock excavation, requiring extensive drilling and blasting. The job is equipped with a blasting machine capable of discharging 800 blasts simultaneously, and this has been recently accomplished. The blasted rock is now being efficiently handled with a 1½-cubic-yard power shovel loading into dumptor trucks, and to this have been added the two new 2-cubic-yard draglines. In short, the project construction is now off to a running start, and with the CCC boys well in the lead.

CCC Camp Routine

The life of the average CCC boy in the Redmond or Wickiup CCC camps is very much the same as in other CCC camps. These camps are in reality three separate 200-man CCC camps built adjacent to each other, but it is possible to develop more of a community relationship and to provide more complete educational and recreational facilities than in the single 200-man camp.

From Monday to Friday of each week the CCC enrollees are under the supervision of the Bureau of Reclamation for an 8-hour period, which includes their lunch time and travel time to the scene of the work operations. If adverse weather conditions prevent the enrollees from working at any time during the Monday to Friday period, the lost time is made up on Saturday of the same week. At all other times the boys are under the supervision of United States Army officers, assigned by the War Department, who are responsible for the feeding and clothing of the enrollees and providing medical care and recreation.

Educational training is arranged by a trained educational adviser assigned to the camps who is responsible for the proper conduct of vocational and academic classes. Training enrollees to qualify for jobs that may be related to the work they do while in camp, is given by the Bureau of Reclamation regular and CCC supervisory personnel, both on the job itself and in the classrooms after the work hours. Participation in the camp educational program after working hours is entirely voluntary on the part of the enrollee. No military training of any kind is given in the camp.

The enrollee receives $30 a month, $22 of which must be allotted to dependents or set aside until he leaves the corps. Enrollees placed in responsible charge of work are promoted to assistant leaders at $36 per month and to leaders at $45 per month.

The CCC act limits enrollment in the corps to young unmarried men between the ages of 17 and 23, inclusive, but permits the enrollment in each CCC company of five men, termed "project assistants" without regard to the age limits or marital restriction. Project assistants are assigned to the technical agency (Bureau of Reclamation). The law also exempts from these restrictions one mess steward, three cooks, and one leader who are assigned to the Army. These men all receive the same rate of pay as enrollees and may be rated assistant leaders and leaders.

CCC Constructs 18-Mile Range Drift Fence Owyhee Project

CATTLE raising is one of the principal industries of Malheur County in eastern Oregon. The cattle range borders on the irrigated lands and during the dry season the cattle come to the valleys for water. The recently constructed north canal of the Owyhee project serving the area north of the Malheur River has been damaged to a considerable extent by cattle using the canal as a watering place.

In cooperation with Grazing District No. 3 of Malheur County a plan was developed by the regional director, CCC, at Boise, Idaho, for construction of a range drift fence to protect the canal and to provide watering places only at specially selected locations. Under the plan as adopted the grazing district furnished all the fence materials and the CCC forces of Camp BR-42, Ontario, Oreg., provided the necessary equipment and labor.

Construction of the fence began about 6½ miles northwest of Ontario, Oreg., and followed the section lines adjacent to the north canal southward to the outlet of the Malheur Siphon, thence going westward along section lines adjacent to the north canal lateral to a point 5 miles north of Vale, Oreg., for a total distance of 18.33 miles. Good sites for watering places were provided at sharp bends of the canal and in gulches.

Fence construction consisted of four strands of barb wire on wood posts averaging 332 per mile. All post holes were dug the proper depth and the posts were tamped in place to proper alignment. Brace posts, anchor posts, and deadmen were used as required. The CCC enrollees were divided into crews for different phases of the work and considerable rivalry developed between those digging holes and those setting posts. Stringing of the wire was done by using a sled with four rolls of wire on spindles, hauled by a 22-horsepower tractor. Three hundred and two spools of wire and six kegs of staples were used.

The finished work is of a high standard and provides adequate protection from range cattle for the canal and the new irrigated lands below the canal on this section of the Owyhee project.

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Chief Engineer Speaks

AT the annual meeting of the Idaho State Reclamation Association at Twin Falls on May 13, R. F. Walter delivered a talk illustrated with lantern slides and motion pictures.

James Munn Dies

Mr. James Munn, former engineer of the Bureau of Reclamation, was found dead in bed at his hotel in Los Angeles, Calif., the morning of April 29.

Reclamation Organization Activities

The following *appointments* to the Bureau of Reclamation have been made by the Secretary of the Interior:

Assistant engineers at Denver, Colo.: Jason E. Barton; James D. Church, Jr.; Ray A. Culp; John A. Gustafson; Marion Humphreys, Jr.

Junior engineers at Denver, Col.: Harold E. Aldrich; Harold E. Spires; John W. Stanley.

Leopold I. Mastrofini, assistant engineer, Central Valley project, Sacramento, Calif., transferred from Kings River-Pine Flat secondary project, Fresno, Calif.

Richard J. Carr, assistant attorney, Legal Division, Washington office, detailed to office of the Solicitor.

Henry E. Pelham, junior engineer, Salt Lake City, Utah.

Frank M. Clinton, assistant engineer, secondary investigations, Billings, Mont.

Clifton C. Kukuk, junior engineer, secondary investigations, Bismarck, N. Dak.

Hazen A. Sandwick, junior reclamation economist, Columbia Basin project, Ephrata, Wash.

Eugene L. Goehnauer, junior engineer, Coulee Dam, Washington.

The following *transfers* have been approved:

Arthur J. Chaput, inspector, from Denver, Colo., to Portland, Oreg.

Floyd M. Johnson, junior engineer, from the Kendrick project, Parko, Wyo., to the Buffalo Rapids project, Glendive, Mont.

Dee M. Wren, inspector, from Kendrick project, Casper, Wyo., to the Delta Division, Central Valley project, Antioch, Calif.

George Angelovic, junior engineer, from the Seminoe Dam, Kendrick project, Wyo., to the Delta Division, Central Valley project, Antioch, Calif.

Carl H. Kadie, Jr., assistant engineer, from Truckee Storage project, Boca, Calif., to Central Valley project, Redding, Calif.

Gilbert Waddell, inspector from Vallecito Dam, Pine River project, near Bayfield, Colo., to Deer Creek Dam, Provo River project, near Provo, Utah.

Wilford H. Nelson, junior engineer, from Seminoe Dam, Kendrick project, Wyoming, to Denver, Colo.

The following *separations* have been effected:

William C. McLaughlin, inspector, Rio Grande project, New Mexico, resigned without prejudice.

Robert M. Miller, junior engineer, Denver, to accept position in Navy Department, Mare Island, Calif.

THE monthly bulletin put out by the agricultural development department of the Northern Pacific Railway for the month of February carries the following interesting item on the subject of First Irrigation in the State of Washington:

"Dr. Marcus Whitman was the first man to irrigate land in the State of Washington. This occurred at the Whitman Mission 6 miles west of Walla Walla. Dr. Whitman constructed a ditch in 1846 to divert water from Doan Creek."

It is interesting to note that this took place 1 year before the recorded activity in irrigation by the Mormons in Utah.

Low Dams

A Manual of Design for Small Water Storage Projects

THIS volume was prepared by a committee on small water storage projects of the National Resources Committee, of which Mr. Perry A. Fellows was chairman and Mr. E. T. Giles was representative from the Bureau of Reclamation. It was issued in March 1939, and consists of 431 pages, profusely illustrated, and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price $1.25 per copy, fabricoid cover. Orders should be accompanied by remittance in the form of personal check or money order made payable to the Superintendent of Documents and mailed to him at the Government Printing Office, Washington, D. C.

The manual is divided into 13 chapters, with 9 appendices, 431 pages, and discusses: Project study and investigations; hydrology; selection of type of dam; foundations; spillways; outlets; earth, rock-fill, concrete, arch, buttress, and timber dams; and operation and maintenance. The appendix discusses flood flows, soil mechanics, subsurface exploration, watershed features, working stresses for timber, outline of report on design of small dam, construction methods, specifications, State laws affecting design and construction, and tables of river discharges.

A number of views of dams constructed by the Bureau of Reclamation are included in the book, together with drawings of irrigation structures.

Progress of Investigations of Projects

ARIZONA-CALIFORNIA: *Colorado River surveys.*—An inspection of the Palo Verde headworks and levees was made, and a report is being prepared of the overflow and seepage conditions and effect of dams at headworks.

CALIFORNIA: *Kings River–Pine Flat project.*—Studies of power development and flood control were continued and preparation of report begun.

COLORADO: *Blue River transmountain diversions.*—A review of the designs of dams and estimates of costs is in progress.

Eastern slope surveys.—In the Arkansas Valley, surveys were made in the vicinity of Lamar and Caddoa dam site, and land classification as far as Garden City, Kans., was begun; water supply studies continued of North Republican project, including the Wray Reservoir; the report of the Trinidad project was completed.

Western slope surveys.—Water supply studies and the assembling of economic data were continued on several projects, including the Collbran, La Plata, Piceance, Silt, West Divide, and Troublesome projects. The report of the Florida project was completed, and the La Plata project report is being prepared. A reconnaissance of the Shiprock South Side project was made.

IDAHO: *Cabinet Gorge project.*—Investigation of the economic feasibility of a hydroelectric development was continued.

Rathdrum Prairie project.—The report was completed.

Boise-Payette-Weiser investigations.—Water supply studies were continued.

Snake River Storage—South Fork.—Preparation of a report on water supply and storage possibilities of the Upper Snake River was continued, including studies of Elk Creek and Grand Valley sites and enlarging of the American Falls Reservoir.

MONTANA: *Gallatin Valley.*—Studies of water supply and economic features were continued, including study of Spanish Creek dam and reservoir.

Marias project.—Water supply studies were completed; areas adjusted in accordance with soil studies, and preparation of maps begun.

Rock Creek project.—The report of the project is nearly completed.

MONTANA–NORTH DAKOTA: *Fort Peck pumping project.*—Surveys were continued of canal lines; topography of 95,000 acres completed in March; land classification continued; surveys were made of the possibility of pumping to lands 60 miles south of Malta in the vicinity of Sun Prairie.

NEBRASKA: *Mirage Flats.*—Foundation exploration of Running Water dam site was in progress, and preparation of report of project was continued.

NORTH DAKOTA: *Missouri River tributaries.*—Field work on irrigation possibility will be begun in near future.

NORTH DAKOTA–SOUTH DAKOTA: *Missouri River pumping project.*—Surveys and land classifications were continued, 52,500 acres surveyed, and pumping requirements being studied.

OKLAHOMA: *Altus Project.*—The Department of Agriculture is continuing the economic investigation of the project in regard to types of farming and resettlement. Conferences were held in regard to Lugert Reservoir flood control reserve.

Canton and Fort Supply projects.—Economic study of the Canton project was continued and survey of a diversion dam on North Canadian near Woodward made.

Washita River investigations.—Land classification continued and field work completed in six counties; analysis of water for irrigation purposes is to be made.

OREGON: *Grande Ronde project.*—Preparation of a report was continued.

Medford project.—Report of the project was completed.

Willamette Basin surveys.—Feasibility of sprinkler irrigation on the Canby project is being studied.

SOUTH DAKOTA: *Black Hills investigations.*—On the Angostura project, plans for Jackson Narrows dam and reservoir and Horse Camp diversion dam were completed.

Shadehill project.—Field work has been completed.

TEXAS: *Balmorhea project.*—Water supply studies were begun.

Robert Lee project (upper Colorado).—Hydrometric studies were begun.

UTAH: *Blue Bench and Ouray Valley.*—Reports of the investigation are in course of preparation and a foundation exploration of Bottle Hollow dam site is to be made.

Price River-Gooseberry investigations.—Preparation of report was continued and water supply studies for the San Rafael investigations were in progress.

Weber River investigations.—Preparation of report was continued; estimates of cost made for diversions from Silver and Hardscrabble Creeks; additional water supply studies made; and land classification of the area was completed.

Woodruff and Clarkston Creeks (Newton) investigations.—Stream gages were installed on these two creeks.

UTAH-IDAHO-WYOMING: *Bear River surveys.*—Printing of aerial mosaic map was in progress and areas being computed; water supply studies were continued; surveys of upper Oneida Narrows and Pleasant Valley reservoir and dam sites to be made.

WYOMING: *Big Horn and Powder Rivers.*—All available data regarding the area ar[e] being assembled and field will begin in Apri[l] with office at Billings, Mont.

Colorado River Basin investigations.—Lan[d] classification surveys were completed in th[e] Little Colorado and Williams River Basins i[n] Arizona and were continued on the Wittma[n] project on the Hassayampa River and in th[e] Cibola Valley, and summary made of area[s] from Continental Divide to Colorado-Uta[h] State line. *In Arizona* diamond drilling a[t] Bullshead dam site was begun; topographi[c] surveys were completed of the Bullshead an[d] Hassayampa dam sites and three-fourths com[-]pleted of the Alamo dam site; study of Buck[-]eye Irrigation District begun. *In Colorad[o]* in addition to the western slope survey[s] already mentioned, water supply studies wer[e] continued in the Yampa, White River, an[d] Little Snake River Basins. *In Utah* diamon[d] drilling was continued at Split Mountain da[m] site, and topographic mapping continued o[n] the Dewey and Split Mountain reservoi[r] sites; survey of a canal line in Ashley Val[-]ley was completed; compilation of Gree[n] River run-off records continued; topographi[c] surveys were made of two reservoir sites i[n] the Virgin River Basin, and study of powe[r] market in Salt Lake Basin area continued. *In Wyoming* hydrometric work was con[-]tinued and conferences held with a view o[f] cooperating with other agencies. A compre[-]hensive index of all data in the Colorad[o] River Basin was in course of preparation.

Visitors to Boulder Dam

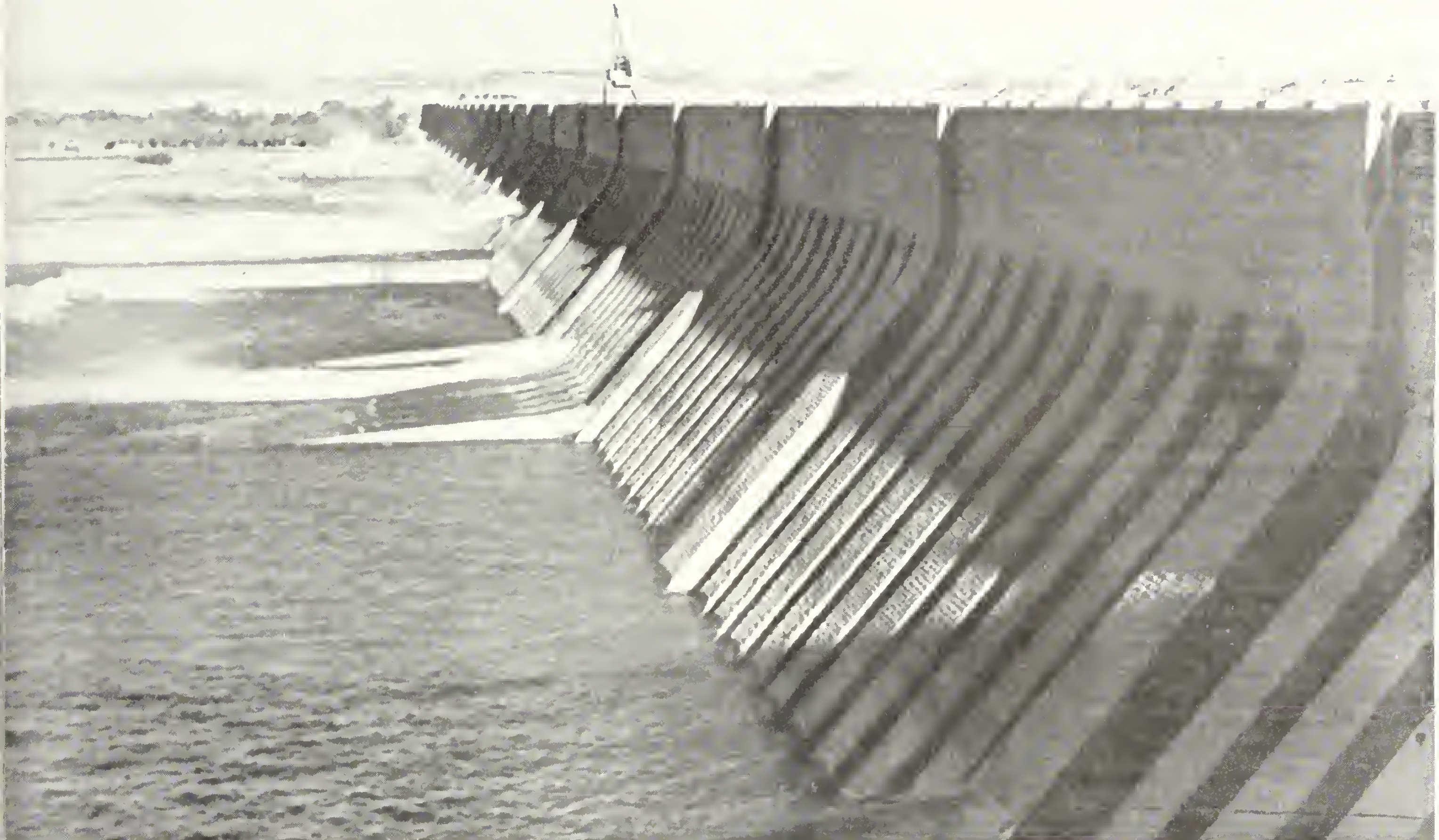
A CHECK of visitors during the month o[f] March showed 27,168 persons traveling i[n] 10,012 cars; also entering the area were 12[-] planes carrying 332 passengers, and 1,25[-] persons in 172 busses.

Persons making the trip to the power[-]house by the elevators numbered 17,105, o[f] which 14,734 were paid admissions; 1,61[-] were children under 16 years of age, and 75[-] persons, mostly employees, were not charged.

This project continues to be a major touris[t] attraction.

Shasta Dam Visitors

A CHECK of visitors was made betwee[n] March 16 and April 1 at the Pacific Con[-]structors' guard station at the left abutmen[t] parking area, Shasta Dam, Central Valle[y] project, California, and a total of almos[t] 3,000 persons visited the dam to view con[-]struction activities. This is an average o[f] about 188 persons per day.



Assuan Dam dedicated by King Farouk of Egypt, January 29, 1939

The above photograph of the dam was received from Professor John C. King of Robert College, Istanbul, and formerly of the Bureau's staff at Denver. It shows the dam, without which modern Egypt could not exist, raised to its final height.

This dam, with a length of 6,400 feet, is one of the longest high concrete gravity dams in the world. Originally built in 1898, with a height of about 124 feet above the lowest foundation, on account of its enormous value to Egypt it was raised 22 feet in 1907, and finally another 29 feet in 1929, giving a final height of 175 feet. Storing something over 4,000,000 acre-feet of water with the auxiliary storage on the White Nile above Khartoum, it is responsible for the irrigation of 1,740,000 acres. This acreage compares with 1,500,000 acres directly dependent on the Boulder Dam, and with 1,200,000 acres for the Grand Coulee Dam.

Vote 709 to 34 For Big District[1]

QUINCY, Wash., Feb. 19.—Landowners in part of the vast Columbia River basin desert of central Washington voted overwhelmingly today to form the largest irrigation district in the country and the first of two to be watered by the Grand Coulee Dam when it is completed.

The vote favoring formation of the 500,000-acre district was 709 to 34. A two-thirds majority was required. Five directors also were elected to administer affairs of the project and work in conjunction with the United States Bureau of Reclamation.

Plans call for a huge canal to carry water from a reservoir behind the dam and smaller canals will lead it into areas that are now barren and wind-swept during the summer. It has been estimated it would be 3 years before water would enter the canals.

A special train from Seattle brought several hundred landowners here to vote. Voting was held in four towns of the district. The vote here was 367 to 27; Ephrata, 191 to 0; Soap Lake, 141 to 7; and Winchester, 10 to 0.

[1] Spokane Spokesman-Review, February 20, 1939.

New Report

THE National Resources Committee has issued the third report of the Special Advisory Committee on Water Pollution entitled "Water Pollution in the United States."

It has been printed as House Document 155, Seventy-sixth Congress, First Session.

New Mexico Legislation

STATE legislation consisting of an act setting up machinery whereby any conservancy district might enter into a contract with the Bureau of Reclamation was passed by both the Senate and House and received the Governor's signature on March 11, 1939.

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THE RECLAMATION ERA • MAY 1939

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) . . . .

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

May 1939.

(Name) . . . .

(Address) . . . .

. . . .

[1] Do not send stamps.

NOTE.—36 cents postal charges should be added for foreign subscriptions.

41776 U. S. GOVERNMENT PRINTING OFFICE 1939

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HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Reno, Nev.	Chas. S. Hale	Superintendent	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo.	H. W. Bashore	Constr. engr	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam	Earp, Calif.	Boyd E. Coffey	Resident supt		R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo.	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr. [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Adress
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Logan, Utah	Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney
Milk River: Chinook division [4]	Alfalfa Valley irrigatinn district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
Nnrth Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River, W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	V. W. Russell	Manager	G. L. Sterling	Ellensburg

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Coloradn River Basin, sec. 15 (Coln., Wyn., Utah, N. Mex.)	Denver, Colo.	E. B. Debler	Senior engineer
King's River-Pine Flat (Calif.)	Fresno, Calif.	S. P. McCasland	Associate engineer
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Cnlo.	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Calo.	W. G. Slnan	Engineer.
Marias (Mnnt.)	Denver, Cnlo.	Fred H. Nichols	Assnciate engineer.
Cantnn and Fnrt Supply (Okla.)	Denver, Calo.	A. N. Thnmpson	Engineer
Big Horn & Powder River (Wyn.)	Denver, Calo.	W. G. Sloan	Engineer.
Black Hills (S. Dak.)	Denver, Colo.	W. G. Slnan	Engineer.
Bear River (Utah, Idahn, Wyn.)	Salt Lake City, Utah	E. G. Nielsen	Associate Engineer
Balmnrhea and Robert Lee, (Tex)	Austin, Tex.	E. A. Moritz	Construction engineer

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

THE MAJESTY OF THE SCENERY ON LAKE MEAD

THE RECLAMATION ERA

JUNE 1939

IRRIGATED AGRICULTURE IN LOWER CALIFORNIA

New Reclamation Repayment Legislation

HEARINGS were begun June 15 by the Irrigation and Reclamation Committee of the House of Representatives on H. R. 6773, introduced by Representative Compton I. White, a carefully prepared bill to introduce flexibility into the contracts under which water users repay their project construction charges and for other purposes.

The bill was transmitted a few days previously to the Congress by Acting Secretary of the Interior Harry Slattery, after it had been cleared by the Bureau of the Budget. An identical bill S. 2591 was introduced by Senator O'Mahoney in the Senate.

The permanent repayment legislation is considered among the most important bills ever proposed bearing on Federal Reclamation. Through provisions for flexible repayment contracts, it will protect the integrity of the repayment principle in the fundamental reclamation law and will gear repayment of construction charges to the ability of water users to pay year by year. It has other elements as well, but the core of the bill is in the provisions dealing with repayments.

Representatives of the National Reclamation Association and the Federal Irrigation Congress, and representatives of individual water users organizations have endorsed the bill without reservation. There seems to be a determination on the part of all interested parties that the bill shall be acted upon at this session of the Congress.

Meanwhile, George O. Sanford, General Supervisor of Operation and Maintenance, is in the field on a 2 months' trip making the investigations contemplated in the temporary relief bill enacted on May 31, 1939. Under this act relief, where conditions warrant, can be granted in much the same manner as relief was extended in 1937 under the act which created the Repayment Commission.

At present there are varying types of contracts in force; the two principal types are the crop repayment or Fact Finders Act contracts, under which the farmers are required to pay each year 5 percent of the value of their crops on the basis of the average for the past 10 years; and the 40-year repayment contract, under which, for the most part, the charges are divided into 40 annual installments, with one installment coming due each year. Nearly all of the new contracts are being written on the basis of 40 annual installments. The provision of the law under which the 5-percent contracts were written was repealed after a few years, because it was found virtually impossible to administer the act and to operate under the contracts. There are a number of other contracts, some with individual water users, some with irrigation districts, some requiring 20 annual installments, some requiring 30, and some on other special bases.

All of these types of contracts have had one identical fault. They have not been flexible enough. They have not proved effective in the extraordinary situations which are bound to arise in years of general crop failure or of deeply depressed prices.

In these emergencies in the past, the Congress has by special acts granted moratoria on all construction charges. This has meant that on some projects relief was granted which was not needed, and it has proved not a solution for but a postponement of the problem. In one instance the Congress set up a special commission to study the problem, and incidentally to determine what relief should be granted to which projects for the year 1937, which was not a good year. The Repayment Commission met the emergency of 1937 by recommending the postponement of various amounts on various projects, the total of postponements coming to about 10 percent of the total due during the year; and the Commission recommended a flexible repayment plan.

Nearly everyone agrees that the 10 percent relief granted in 1937 was equitable. Yet in 1936, which by comparison with 1937 was a good year, 50 percent relief to all had been granted under the moratoria plan. When working on an inflexible basis it was necessary to extend to all the consideration due the most needy.

What the water users want and what we want is legislation under which contracts flexible enough to meet their emergent needs can be written, which will do away with the necessity for the moratoria expedient, and which will protect and preserve the repayment principle of the fundamental Reclamation law.

There have been comparatively few years when conditions were poor on all projects, but with so many projects scattered so widely over a really vast area and specializing in such a variety of cash crops it is equally true that there is scarcely a year when bumper crops and good prices have coincided on all projects.

H. R. 6773 is very carefully drawn. The normal and percentages plan of repayment proposed in the bill is a sound, flexible plan of repayment. We have set up dozens of hypothetical cases under the plan and are prepared to state that the plan will work. The plan is simply this: In poor years the water users pay less; in good years they pay more; in 40 years, or in the case of revised crop repayment contracts longer periods, they are expected to repay all unless the below-normal years exceed in number the above-normal years or unless the severity of depressions more than offsets the bounty of periods of prosperity. The amounts, if any, postponed by operation of the plan beyond the normal period for termination of the contract would bear interest at 3 percent.

H. R. 6773 contains a provision for needed reclassification of project lands. Some projects have at this time just complaints that their lands were not properly classified. Some lands are listed as productive and charges are assessed against them, although the lands in fact are not productive. The reclassifications under this bill would be made half at Government and half at water users' expense. When the studies are completed, a report will be made to the Congress, which will have to approve specifically any adjustments to be made.

There are other provisions in the bill of interest and importance. This is not an attempt to analyze the bill, but rather to high-light it. An analysis will be carried in these pages in a future issue.

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • JUNE 1939 • NUMBER 6

Construction of the Shoshone Canyon Tunnel

Heart Mountain Division, Shoshone Project, Wyoming

THE Shoshone Federal irrigation project is located in Park and Big Horn Counties in northwestern Wyoming, near the Yellowstone National Park. It comprises five divisions; namely, the Garland, Frannie, Willwood, Heart Mountain, and Oregon Basin, with a total irrigable area of 163,000 acres. The first three divisions have been completed and settled, the Heart Mountain division, with a total estimated irrigable area of 41,000 acres, is now under construction, and the Oregon Basin division remains for future development.

One of the outstanding features of the project is the Shoshone Dam, which was completed in 1910. It is a beautiful rubble-concrete arch dam, located in a narrow granite gorge of the Shoshone River about 7 miles west of Cody, Wyo., just below the confluence of the north and south forks of the river. The gorge at the dam site is only about 70 feet wide at stream bed and widens gradually to about 200 feet at the top of the dam. The dam is 329 feet high and has a top width of only 10 feet. Twin mountain peaks rise majestically on each side of the dam, Cedar Mountain on the south and Rattlesnake Mountain on the north. The Cody-Yellowstone highway to Yellowstone National Park winds along the Shoshone Canyon, between the rolling, tumbling river on one side and sheer, awe-inspiring cliffs on the other, past the dam and the reservoir above it, which stores the run-off of the north and south forks of the Shoshone River, each of which drains hundreds of square miles of the snow-covered Rockies. Every summer hundreds of tourists stop each day at the top of the "dam" hill and walk out on the dam in order to get a better view of the breath-taking grandeur of the canyon.

The dam raises the river level about 230 feet and the Shoshone Reservoir thus formed has a storage capacity of 456,600 acre-feet, which is sufficient to supply the completed divisions and the division now under construction, with water for irrigation. Additional storage probably will be required for the Oregon Basin division.

For the Garland, Frannie, and Willwood divisions, the water stored in the Shoshone Reservoir is released into the Shoshone River and diverted to these divisions by means of diversion dams several miles downstream from the Shoshone Dam. For the Heart Mountain and Oregon Basin divisions, however, water must be taken from the reservoir about 100 feet above the stream bed, as the irrigable lands of these divisions are located at considerably higher elevations than the lands of the completed divisions. The lands of the Heart Mountain division lie north of the Shoshone River and the lands of the Oregon Basin division are some distance south of the river. When preliminary plans were being made, consideration was given to two conduit lines, one on each side of the river. Continued investigation, however, led to the conclusion that a single large conduit and a short siphon across the lower end of the Shoshone Canyon would be more economical than the two smaller conduits. It was finally decided to build a conduit, consisting of tunnel section through the granite and limestone bluffs and cut-and-cover section elsewhere, on the south side of the river, with the intake located in the Shoshone Reservoir, upstream and adjacent to the south end of the Shoshone Dam, and a division works located at the outlet portal of the tunnel, about 3 mile downstream from the intake. From this division works water could be diverted to the Heart Mountain division, via an inverted siphon over the Shoshone River, or directly to the Oregon Basin division, or to both divisions, as required.

Specifications providing for the construction of a conduit in accordance with the latter plan were issued and bids for the work were received December 5, 1935. The Utah Construction Co. of Ogden, Utah, submitted the low bid, amounting to $634,509.50 and stipulating a deduction of $20,000 from the final payment if awarded all three schedules under the specifications. The specifications covered the construction of three tunnels and two cut-and-cover sections, between station 8+00 and station 147+20. The contract was awarded to the low bidder on January 6, 1936. Notice to proceed was received by the contractor on January 30, 1936, and work was begun under the contract on February 21, 1936.

There was some doubt as to the feasibility of constructing cut-and-cover sections along the unstable talus slopes encountered along the original alinement of the conduit and, after an extensive investigation had been made in the field by diamond drilling along a proposed all-tunnel line, the field office recommended various changes in location and alinement which were approved by Chief Engineer R. F. Walter, and orders for changes were issued providing for the construction of one continuous tunnel from stations 8+00 to 147+20. The control works at the intake, and the tunnel upstream from station 8+00 are proposed for construction in 1939.

Excavation

Order for changes No. 1, dated February 15, 1936, made a change in the location and alinement of tunnels Nos. 1 and 2, and the contractor was required to construct an adit at station 44+34 of the new tunnel line. The contractor began the excavation of the approach cut to this adit (adit No. 1) with a bulldozer on February 21, and completed it on March 13. Tunneling operations at adit No. 1 were begun on March 13. Drilling was accomplished with jackhammers, leyners and drills mounted on a bar. The material encountered in the adit varied from talus, containing large limestone blocks, at the portal, to thin bedded limey shales and sandstone and had to be supported throughout the entire length. Three segment timber arches, of 10- by 10-inch timbers, supported by 10- by 10-inch posts on 6- by 8-inch mudsills or blocks, were placed at 5-foot centers, and lagged with 3- by 8-inch timbers, the amount of lagging required varying according to the character of the material encountered, and the cavities behind the lagging were packed tightly with timber slabs.

A type 60 Conway mucker was used to load 5-cubic-yard side dump mine cars drawn by

100-volt battery electric locomotives to the spoil dump area at the portal of the adit.

Adit No. 1 has a length, including the approach cut, of 525 feet, and a cross-sectional area practically the same as that of the tunnel. After completion of adit No. 1, tunneling operations were carried on by excavating the full section of the tunnel in one operation as was done in adit No. 1. Drilling was accomplished from a home-made jumbo, running on a track, on which was mounted a battery of six pneumatic drills.

From the adit, the tunnel was driven both ways so that while drilling operations were progressing in one heading, mucking operations were being carried on in the other and then the drilling and mucking equipment were interchanged from one heading to the other, with practically no delay.

Where the nature of the material encountered was such as to require permanent supports, 5-inch I-beams, curved to fit the section (horseshoe shape), were set on wood sills or blocks and 3-inch timber lagging was placed back of the I-beams as required and directed. The spacing of the ribs, or I-beams, was governed by the character of the rock, which was indicative of the loading to be expected. The spacing of the I-beams varied from 5 feet to as little as 12 inches.

The formations, their respective locations and length, encountered west from adit No. 1, are as follows: Stations 44+34 to 41+45, limey shales (slight seepage); stations 41+45 to 40+54 oolitic haematite; stations 40+54 to 35+15, light brown or yellowish massive sandstone, and from stations 35+15 to 8+00, the end of the present construction, precambrian granite was encountered.

It was necessary to permanently support through the limey shales and for a length of 30 feet at the junction of the sandstone and granite formations.

In the shale formation the usual drill round consisted of 36 holes, 11 feet in depth and pulled about a 10-foot depth when blasted. In the haematite and sandstone 40 holes per round, and in the granite 46 holes, 9 feet deep were required to get 8 feet of tunnel per round. Progress through shale was about 11 feet per day, through haematite and sandstone 25 feet per day, and through granite averaged 17 feet per day.

The explosives used were fired electrically from a 440-volt circuit. After each blast the noxious gases were removed by compressed air and a low pressure ventilation system consisting of rotary blower pumps and 15-inch diameter sheet metal pipe. In the softer formations 80 to 150 pounds of 40 percent powder were used per round of about 60 cubic yards. In the granite, 200 pounds of 40 percent powder and 150 pounds of 60 percent powder were required for a round of 48 cubic yards. The powder used per cubic yard of pay yardage of excavation averaged 4.8 pounds.

While the contractor's forces were engaged in excavation operations from adit No. 1, government forces carried on diamond drilling operations and as a result of these borings, order for changes No. 2 was issued. This order for changes eliminated the remaining cut-and-cover section and made the conduit one continuous tunnel.

The excavation of the approach cut for adit No. 2, together with the excavation of the tunnel portal, had been subcontracted and had been completed during the summer of 1936 by the subcontractor, who used a ¾-yard northwest crawler-type shovel and trucks for this work. The contractor began excavation of adit No. 2 on December 22, 1936, with the equipment moved from adit No. 1. Clay and small limestone boulders were encountered in the adit and supports were required throughout. At the junction of the adit and the tunnel, station 121+00, a small cave was encountered, and at intervals, depending upon barometric pressure, carbon dioxide was found to be present in this cave.

West from adit No. 2, the tunnel was in clay and boulders to station 120+00; limestone from 120+00 to 106+80; soft chalky material requiring breast boards, from 103+00 to 101+70; limestone cut by large cracks, from 101+70 to 90+05; and shales and layers of flat pebble conglomerate, from 90+05 to 82+23.

East from adit No. 2, the tunnel was in limestone with the exception of the last 120 feet at the outlet, which was in earth. The limestone was found to be altered to an increasing extent as the work progressed eastward and was more or less replaced by sulphates and in a few instances by almost pure sulfur rock "blobs."

The tunnel required the installation of permanent steel supports and lagging for a length of 6,000 feet, most of the supports being required in the shales, pebble conglomerates and the shattered or altered limestone (stations 91 to 139). The shales were somewhat unstable and slacked when exposed to air. The total overbreakage in excavation amounted to 13.6 percent, varying from 5.9 percent in the earth section to 16.3 percent in the granite. The quantity of water encountered, which occurred mostly in the shales, was not enough to require drainage.

Numerous small caves were encountered, most of which contained gas and were more or less lined with sulphates. At station 139+40 the tunnel intersected a large cave which extended to station 141+00. The friction created by dry drilling through this section of tunnel was sufficient to ignite the sulfur rock and wet drilling had to be used. On April 25, 1937, sulfur fumes issuing from the tunnel east of adit No. 2 indicated that sulfur was burning somewhere in that reach of tunnel. Work was suspended to the east and the tunnel bulkhead off just east of adit No. 2, and at the request of the project office a Bureau of Mines representative was sent out from Denver to investigate conditions and make recommendations for safety measures. The fire, however, had burned itself out prior to his arrival and investigation disclosed that the fire had occurred in the vicinity of station 137+90 and was thought to have been caused by a cigarette or match carelessly dropped by someone going in to examine the large cavern into which the tunnel had been driven a day or so previously and which was lined with beautiful crystals and stalactite and stalagmite formations.

A muck fill was constructed across the large cave (the bottom of which extended below the tunnel grade) by hauling and dumping muck from the west heading into the cave. The fill had a maximum height of 40 feet and the roof of the cave extended some 50 feet above the invert grade and an undetermined distance to the right and left of the center line of the tunnel. Carbon dioxide and sulphur dioxide were present in the cave and the level of these gases was observed to raise directly with a decrease and lower with an increase in the barometric pressure.

The tunnel was holed through at the outlet portal, station 147+20.5 on July 19, 1937, and between adits 1 and 2 at station 82+23 on September 14, 1937. Steel supports, at centers ranging from 8 inches to a maximum of 5 feet, were required in many sections of the tunnel, a total of 527,446 pounds being installed, and 512,578 board feet of permanent timbering was erected.

Lining

Adit No. 1 was left open to permit access to the west heading at station 7+95 when the work of completing the tunnel to the intake and the construction of the controlling works is undertaken. A flume section, 140 feet in length, was designed and constructed to carry the water through the large cave.

The concrete in the lining had a cement to aggregate ratio of 1:6.2 and a gravel to sand ratio of 1.6.

Several types of cement were used, namely, standard, modified, modified and low heat (blended), sulphate-resisting (slow setting, to which ½ percent of CaCl was added to decrease time of set) and sulphate resisting cement. The shales and the seepage waters in the tunnel below station 80 were found to be alkaline and for that reason sulphate-resisting cement was used, probably for the first time in tunnel construction.

Lining operations were started by the contractor on May 1, 1937. The tunnel section, through both the supported and unsupported reaches, is a standard 12-foot horseshoe section with a 6-inch A line and a 10½-inch B line, having a grade of 0.002 and an estimated capacity of 1,200 cubic feet per second. Through caves and across fault zones the lining was partially or wholly reinforced.

Concrete aggregates and sulphate-resistant cement were furnished by the Government. Dry batching of aggregates and cement for concrete lining above station 81+10 was done at a plant located near the entrance to adit No. 1. Lining operations from this plant were carried out in the following sequence: (1)

Clean-up for curbs; (2) placing curbs; (3) placing sidewall and arch concrete; (4) clean-up for invert; (5) placing invert. The lining below station 81+10 was carried on from a batching plant located below the tunnel outlet portal and the curb and invert sections were placed as a unit, followed by the sidewall-arch section.

The concrete for the curbs above station 81+10 and for part of the invert was mixed at the batching plant and transported to the point of placement in W-bottomed cars, with a gate in each side, which delivered the concrete into flat chutes 3 to 4 feet in length running to the curbs, the concrete being shoveled or pushed down the chutes into the curb forms. The concrete was held to about a 2-inch slump.

Aggregates and cement for all the other concrete in this reach of tunnel were dry-batched at the plant and transported to the mixer near the point of placement. Dry batching was accomplished by cumulative weighing in a Fairbanks hopper scales, the flow of the aggregates from overhead bins into the batching hopper being regulated by manually operated radial gates.

Steel forms, in 10-foot sections, were provided by the contractor for the sidewall and arch section of the lining. These forms had 5-inch angle rib supports, with 3/16-inch skin plates and were hinged at the upper quarter points. Each section was provided with three doors, one 18- by 18-inch door on each side and a 26- by 29-inch hatch in the top. A form jumbo, equipped with the necessary jacks was provided for moving and setting the forms, a 20-foot section being handled at one time.

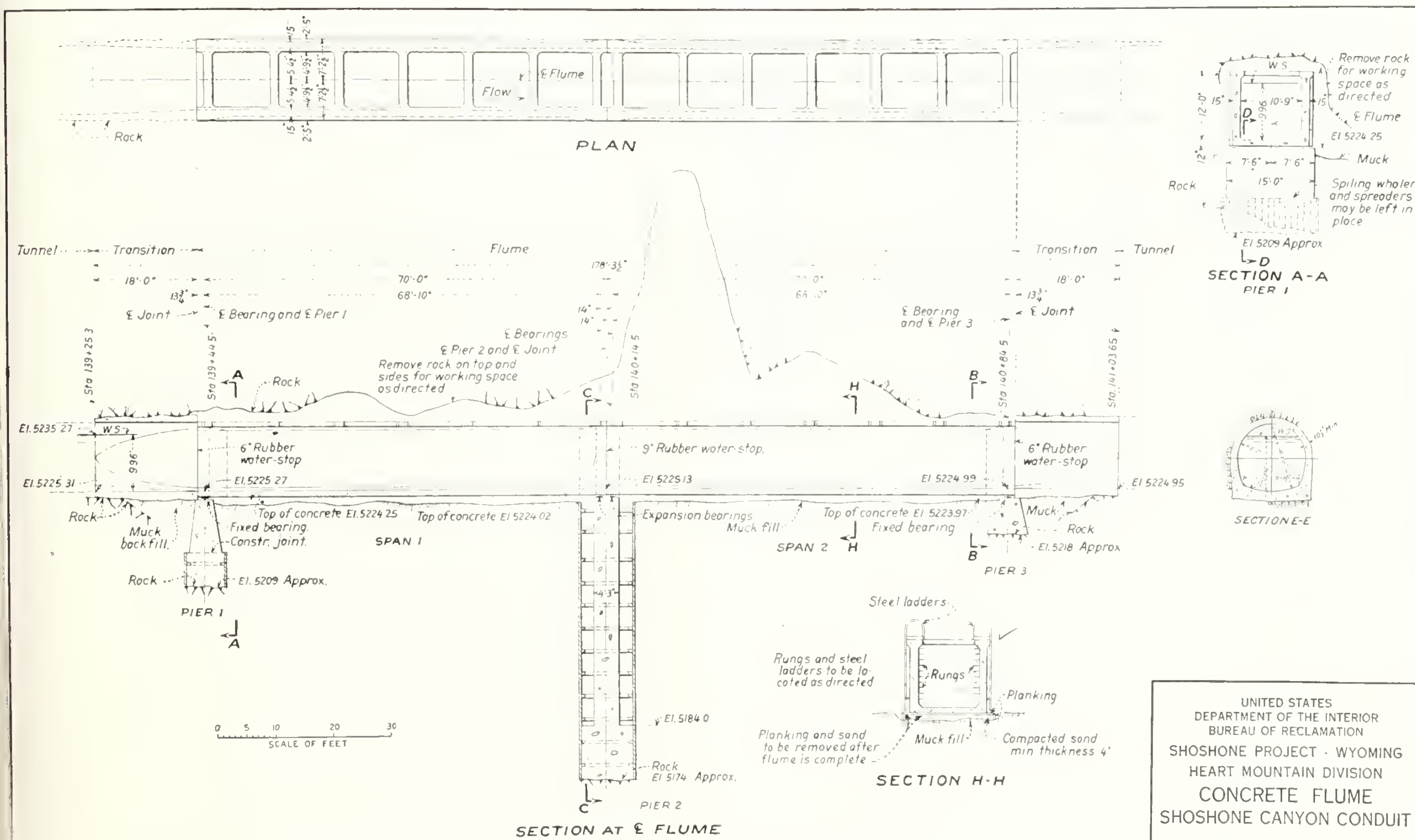
Vertical wooden bulkheads were constructed at the end of each day's pour and a tapered 2- by 4-inch "key" was placed in the center of each joint from the invert to well above water line. Dry rock and lagging were wet down several times in the 24 hours preceding the pouring of a section. For these pours, four-sack dry batches were made up in train loads of 12 batches, being hauled by 100-volt battery locomotives. Upon arrival at the mixing set-up the train was pushed up an incline to a section of track elevated above a conveyor belt. This conveyor belt fed a 21-S Osgood paving mixer, which in turn discharged the concrete onto a second inclined belt conveyor feeding the intake hopper of a Rex, single-cylinder pumpcrete machine. This whole set-up, conveyor system, elevated tracks, mixer, pumpcrete and discharge pipe was built as a self-propelled unit, being moved as pouring progressed by motor-driven winch.

The concrete discharge pipe was carried above the forms along the arch center line to within 2 or 3 feet of the back bulkhead of the 90-foot section being poured. One 4-sack batch of grout and two batches of concrete with half the regular amount of intermediate gravel were pumped ahead of the regular mix to lubricate the equipment, insure a good joint, and form a cushion for the regular mixed concrete.

After placing had progressed to a point where the first few feet of arch was covered, an auxiliary air line was brought into use. A 1½-inch air line carried along the pumpcrete discharge pipe entered the pipe about 14 feet from the discharge end, and, by means of a quick action valve, introduced a small shot of air every 6 to 12 strokes of the pumpcrete. This helped to free the end of the pipe, prevent line plugging and hang-ups in the forms. In sections with a foot or more opening over the arch, 8 to 12 feet of pipe was kept submerged, but in tight sections, with only 6- to 8-inch clearance, only 3 to 8 feet of pipe could be kept buried. The shooting pipe was pulled 1 to 5 feet at a time, depending upon conditions in the arch. Pulling pipe was accomplished by moving back with the whole mixer-pumpcrete set-up.

Working of the concrete behind the forms was accomplished by a combination of vibrating, booting, spading, and form rapping. Curing of the concrete was by hand sprinkling, and, as the humidity in the tunnel was fairly high, wetting the newly stripped concrete at 2-hour intervals was usually sufficient.

The usual arch pour was 90 feet in length, the forms being removed generally in 36 hours.



Most of the concrete placed by the pumpcrete was restricted to a slump of 3 to 4 inches, as 4-inch slump concrete segregated and flowed on a long flat slope that was hard to keep "alive," and concrete slumping under 3 inches would pile up on top and hang up in the tight places along the sides.

Concrete for the invert of the tunnel from stations 8+47 to 44+78, was mixed in a 10-cubic foot mixer at the batching plant at adit no. 1, and hauled to the point of placement with the same equipment as was used for mixing and transporting concrete for the curbs. On reaching the section of the invert to be concreted the loaded car was run out on an elevated track, supported by ties resting on the curbs, to above the point of placement. The slump was controlled between 2 to 4 inches at the mixer, or 1½ to 2 inches when placed. Screeding was accomplished with a heavily weighted steel slip form running on the curbs. Finishing with wooden floats and steel trowels followed the screeding.

The placing of concrete from the set-up at adit No. 1 was completed December 11, 1937, and the lining operations for the remainder of the tunnel to station 139+25 were carried on from the batching plant at the outlet portal. This batching plant was built over the open cut approach to the portal and about 90 feet from the portal. Heated water for mixing concrete during freezing weather was piped from a boiler to a receiving tank at the Y of adit No. 2, and thence to the mixer.

Since the curb and invert below station 81+10 was placed as a unit, only one cleanup operation was necessary. The methods of placing and curing the lining in the sidewall and arch sections were the same as previously described. About 400 feet of lining, through caves and across fault zones was partially or wholly reinforced with steel furnished by the Government. A reinforced concrete plug was constructed at the junction of adit No. 2 with the tunnel at stations 120+68 to 121+26. The concrete was delivered to the forms by pumpcrete methods.

Placing of the combined curb and invert was begun at station 81+10. Concrete slumping 1½ to 2 inches was discharged directly from the pumpcrete pipe into the invert sections and worked by vibrating and booting. All other concrete operations were the same as those used above station 81+10.

Below station 139+25 the batch cars, belt conveyors and movable pumpcrete set-up was abandoned and the pumpcrete machine was set up directly under the batching plant at the portal and the concrete pumped by pipeline directly to point of placement.

Flume Construction

Through the large cave encountered between stations 139 and 141, ordinary tunnel section could not be used. A reinforced concrete flume, having two 70-foot spans supported by three reinforced concrete piers, was designed by the Denver office to carry the water through the cave. The flume, as designed and constructed, is rectangular in cross-section, 10¾ feet wide by 12 feet deep, with walls 15 inches thick and floor 12 inches thick. Closed transitions, 18 feet long, from horseshoe to rectangular section, and rectangular to horseshoe section respectively, at the inlet and outlet ends of the flume were also constructed. The flume had fixed bearings at the end piers and expansion bearings on the center pier.

In order to found the center pier on good undisturbed rock it was necessary to carry the foundation excavation some 53 feet below invert grade of flume. The upstream and downstream piers were founded 12 feet and 5 feet respectively below flume grade. Gaseous conditions in the cave interfered considerably with this work and there were several occasions when the ventilation system proved inadequate to remove the sulphur dioxide and it was necessary to suspend operations for a period of from 24 to 96 hours until the gas subsided below the working level. Extra work order No. 1 was issued to cover the work of excavation for the piers and order for changes No. 3 covered the construction of the transitions, piers, and flume superstructure, as well as other changes necessitated by conditions encountered in the cavern and crevice areas through which the tunnel passes.

Owing to the very limited working space and the gaseous conditions in the cave, a unique method of supporting the flume forms was employed. A sand base of 4-inch minimum thickness was laid and compacted by the addition of water and tamping, on top of the muck fill between the piers. The 2-inch planking of the floor form was laid directly on the sand and the wall forms built up from this floor. Upon removal of the side forms the sand was flushed out with high pressure water jets and the planking withdrawn, thus allowing the flume spans to swing clear of the fill between the center pier and end piers or abutments.

Reinforcing steel for flume and piers was furnished by the Government and it is interesting to note that, in computing the amount of steel needed to resist bending in vertical planes parallel to the length of the flume, the allowable unit stress for the steel was taken as 12,000 pounds per square inch instead of the usual figure of 18,000 pounds per square inch. It was decided that the lower stress and the correspondingly lower elongation of the steel would result in cracks no larger than hair cracks. In a structure of this kind, cracks are particularly undesirable because the water penetrates them and causes corrosion of the reinforcing steel.

In determining the steel needed to resist transverse bending a 1-foot section of the flume was considered as an inverted, two-hinged bent, the tops of the sidewalls corresponding to the hinges. Acting on the sidewalls are triangular loads due to water pressure, and acting on the bottom is a uniform load due to the weight of the water and the weight of the concrete. In addition to the reinforcement steel required to resist bending in longitudinal and transverse planes, the sides and the bottom of the flume were reinforced with ½-inch round bars to prevent cracking due to shrinkage stresses. Approximately 115 pounds of steel was required per cubic yard of concrete.

Concrete was delivered to the point of placement by pumpcrete line and about 40 feet of tunnel lining was placed with each of the flume transitions. Concrete was placed in the flume piers through hoppers and elephant trunks and because of the presence of acids in the ground around the piers a 1:5.9 cement aggregate ratio, with 1½-inch slump, was used. Each of the two spans of the flume superstructure was made in two pours, the floor and 16 inches of side wall being poured first and the rest of the wall and the cross (or tie) beams in a second operation. After the flume was completed, a drip of dilute sulphuric acid from the roof of the cave near the upper end and over the flume, was taken care of by a wooden trough, lined with sheet lead, constructed to catch the drip and carry it away from the structure.

The Completed Structure

Under the specifications covering the construction of tunnels Nos. 1, 2, and 3, Shoshone Canyon Conduit, the work was to be completed within 750 calendar days from date of receipt of notice to proceed, or on or before February 18, 1938. Extensions of time were granted in connection with the orders for changes and the completion date was moved ahead to December 15, 1938. Accepted by the Government on September 30, 1938, 77 days before the contract time had elapsed, it required more than 2½ years to complete this structure which, because it is buried beneath the towering cliffs and precipitous slopes of Cedar Mountain, affords no visible indication of the magnitude of the job. In excess of 100,000 cubic yards of material were excavated, 416,730 pounds of powder being used, and 68,325 electric delays being required for blasting. The contractor's forces installed over 260 tons of steel tunnel supports and more than one-half million board feet of timbering. During excavation operations 1,736,170 kilowatt-hours of electricity were consumed and 413,640 kilowatt-hours were used during lining operations. Power was furnished the contractor by the Government, at 2,300 volts, at 1 cent ($0.01) per kilowatt-hour, at a substation located adjacent to the 33,000-volt Shoshone-Powell Government transmission line, and across the Shoshone River from adit No. 1.

More than 40,000 barrels of cement, 50 tons of reinforcing steel, and 35,000 cubic yards of sand and gravel were furnished by the Government for tunnel lining and flume construction. More than 1,000,000 man-hours of work were provided at the site of the work and several hundred thousands more were provided in various industries furnishing materials for the construction, those industries being widely distributed throughout the United States.

The completed structure is a concrete-lined conduit with about 2¾ miles of 12-foot diameter, horseshoe-shaped tunnel section and 140 feet of 12- by 10¾-foot rectangular flume.

The concrete lining, which required very little patching upon the removal of forms, is of excellent quality and the alignment is excellent. The rectangular reinforced concrete flume section, consisting of two 70-foot spans, located as it is, deep underground, is somewhat of an engineering innovation and serves to relieve the smooth symmetry of the tunnel and provides access to an interesting cave formation. The finished structure is sloped so that it has a vertical drop of 2 feet in a horizontal distance of 1,000 feet, and, for the designed capacity, the computed velocity of the water which will some day flow through it, is 11.26 feet per second. The carrying capacity of the tunnel is 1,200 cubic feet per second and about two-thirds of this capacity will be required for the use of the Heart Mountain division when it is finally completed, the remaining capacity being available for diversion to the proposed Oregon Basin division.

The extension of the upper 800 feet of the Shoshone Canyon Tunnel to the Shoshone Reservoir, together with the construction of the controlling works at the inlet end, and the diversion works at the outlet end, during the fiscal year 1940, will bring to completion the Shoshone Canyon Tunnel, a major feature in the development of thousands of acres of arid lands whose latent resources have been dormant for thousands of years and will at last be beneficially used to make homes for thousands and add immeasurably to the prosperity of the entire Nation, and should tend to make more binding the ties that lead to national economic, social, and political unity.

Danish Royalty visiting Boulder Dam. Crown Prince Frederik and Princess Ingrid of Denmark visit Boulder Dam on their tour of the United States. Left to right (front row): Major Buechler, War Department, Los Angeles; A. C. Wingo, Superintendent of Generation, Los Angeles Bureau of Power and Light; Guy D. Edwards, Supervisor Boulder Dam Recreational Area; Irving C. Harris, Director of Power; Crown Princess Ingrid; Crown Prince Frederik; and Otto Wadsted, Danish Minister. (Back row) I. V. F. Vest; Lord Chamberlain; Karl Eskeland, Danish Press Chief; Mrs. Rann, Private Secretary to the Danish Minister; Countess Reventlow, Lady in Waiting; R. L. Bannerman, Department of State; and Captain Weilback. April 15, 1939.

Conchas Dam and Proposed Tucumcari Project[1]

THERE have been several interesting articles written on the engineering and construction of the Conchas Dam. One of the foremost is an article printed in the October 1938, issue of the Journal of the Boston Society of Civil Engineers, by Capt. James H. Stratton, Corps of Engineers, War Department, under the title, The Engineering Features of the Conchas Dam Project.

Another interesting article featuring engineering problems and construction was published in the June 9, 1938, issue of the Engineering News-Record. Following this article in the same issue is an article describing methods of supplying concrete aggregate and mixing operations as used by the Bent Brothers, Inc., and Griffith Co., contractors on the main dam construction. In the American Society of Civil Engineers Proceedings for January 1939, is a very descriptive write-up on geological conditions which features foundation conditions and how difficulties in constructing this type of dam were met.

For the benefit of the readers of THE RECLAMATION ERA, the intent of this article is to acquaint them with the design, purpose, and progress of the construction of the Conchas Dam.

The Conchas Dam project had previously been investigated by the Corps of Engineers and included in the "308" report of the Arkansas Basin. It is located on the South Canadian River immediately below its junction with the Conchas River, in the northeast section of New Mexico, about 170 miles east of Albuquerque, N. Mex.

Construction of the Conchas Dam project was initiated under the Emergency Relief Act of 1935, and later authorized by Congress in the Flood Control Act of June 1936, to provide flood control, irrigation, and municipal water supply benefits. Work will be completed in the early fall of 1939.

The Corps of Engineers in a program of building dams and construction work for control of floods and conservation of water, have worked in complete harmony with the Bureau of Reclamation in accomplishing the work at hand. On this particular project, irrigation interests are destined to become a vital part in the development of Tucumcari, N. Mex., and vicinity as a result of the building of the Conchas Dam. A general outline of this feature will conclude the article.

In order to present the picture, some facts as to the history and early developments are pointed out.

[1] Article, illustrations, and other data assembled through courtesy and assistance of Capt. Hans Kramer, district engineer, and Assistant Engineer D. W. Persons, Corps of Engineers, Conchas Dam.

The State of New Mexico has a colorful history, having as a background the early conquest of this area from the Indians by the Spaniards 400 years ago. The Indians were fairly well advanced, living in walled cities and pueblos, and making a living from irrigation farming. The Spaniards' first penetration into this area, however, did not last, they being driven out by the Indians about in 1680. However, the Spanish returned in 1684 and a good many settlements were established. Naturally they settled by live streams near the mountains where natural resources were found and farming by irrigation was favored. The area settled first, and which has proved a lasting development, includes the Rio Grande, Pecos, and the upper reaches of the Mora and Canadian Rivers. At this time all of the irrigated area on the South Canadian River and its tributaries are above the Conchas Dam, comprising some 250,000 acres. As any further developments from the waters of the South Canadian River would require a high expensive dam, being generally in a deep canyon through the State of New Mexico, early development was not undertaken. Floods have been allowed to continue uncontrolled and have contributed to considerable damage throughout the drainage system and the main stream below the dam site in New Mexico, Texas, and Oklahoma.

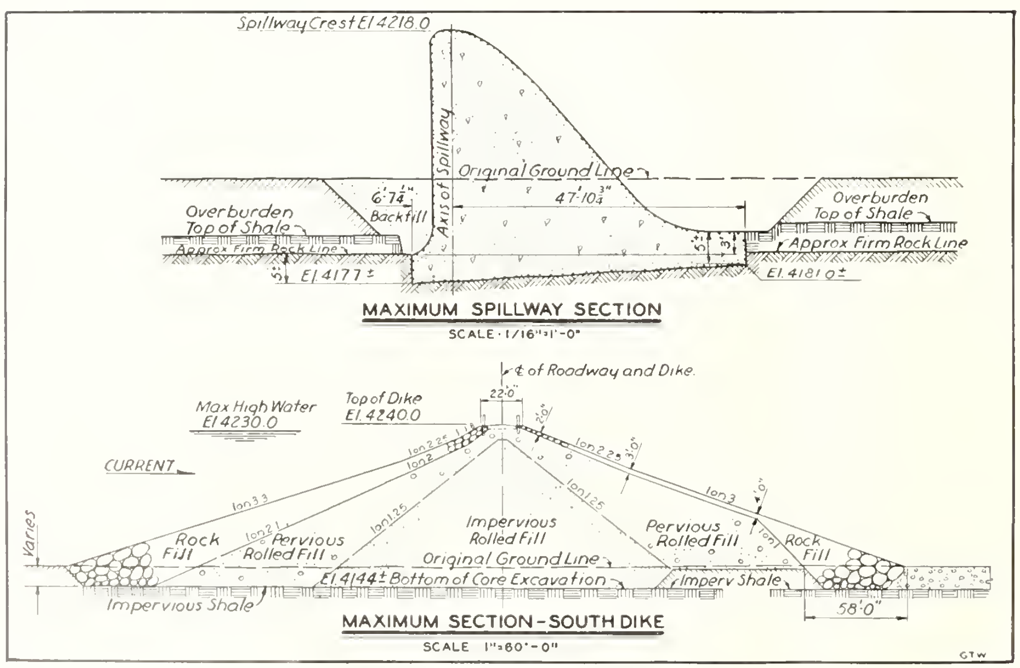
General Description of Conchas Dam Project

The 600,000-acre-foot Conchas Reservoir will serve flood control and conservation. The lower 100 feet, 100,000 acre-feet, will be for dead storage and recreation. The next 46 feet, to elevation 4,201, the service spillway level, will be reserved for conservation purposes, principally irrigation. Storage in this increment will be 300,000 acre-feet, and at elevation 4,201 will have an area of 15½ square miles. Between the service spillway level, elevation 4,201, and the emergency spillway level, elevation 4,218, 200,000-acre-foot capacity is reserved for flood control. Pool area at elevation 4,218 is 21½ square miles. Top of dam is elevation 4,240. All but floods of unusual proportions will be reduced to the bank-full capacity of the stream below the dam in passing through the reservoir and the 300-foot clear opening of the service spillway, which is without gates.

The principal features of Conchas Dam are as follows:

Main Dam

This is a gravity type concrete dam across the South Canadian River immediately below



CONCHAS DAM
SOUTH DIKE AND EMERGENCY SPILLWAY
CIRCULAR NO. 294

the junction of the Conchas River with the South Canadian River. Maximum height from the foundation to the crest is 235 feet. Length of crest is 1,250 feet and a width of 25 feet at the top provides a roadbed of 18 feet wide for travel across the Canadian River. Incorporated in this structure is a 300-foot service spillway, without gates, at the center of the dam, which will accommodate ordinary high-water flows. Below this spillway is a stilling basin, over-all length of 127 feet, with end sill and baffles designed to deenergize the flow. Penstocks have been installed through the dam to provide outlets for possible future use of impounded water for municipal water supply and electric power generation. The main dam contains about 750,000 cubic yards of concrete.

Wing dams of earth-rock fill construction extend from the ends of the concrete main dam to high ground 1,000 feet north from the left abutment and 4,000 feet southeast from the right abutment. These wing dams contain 730,000 cubic yards of rolled earth fill and 243,000 cubic yards of rock fill and have a maximum height of 100 feet.

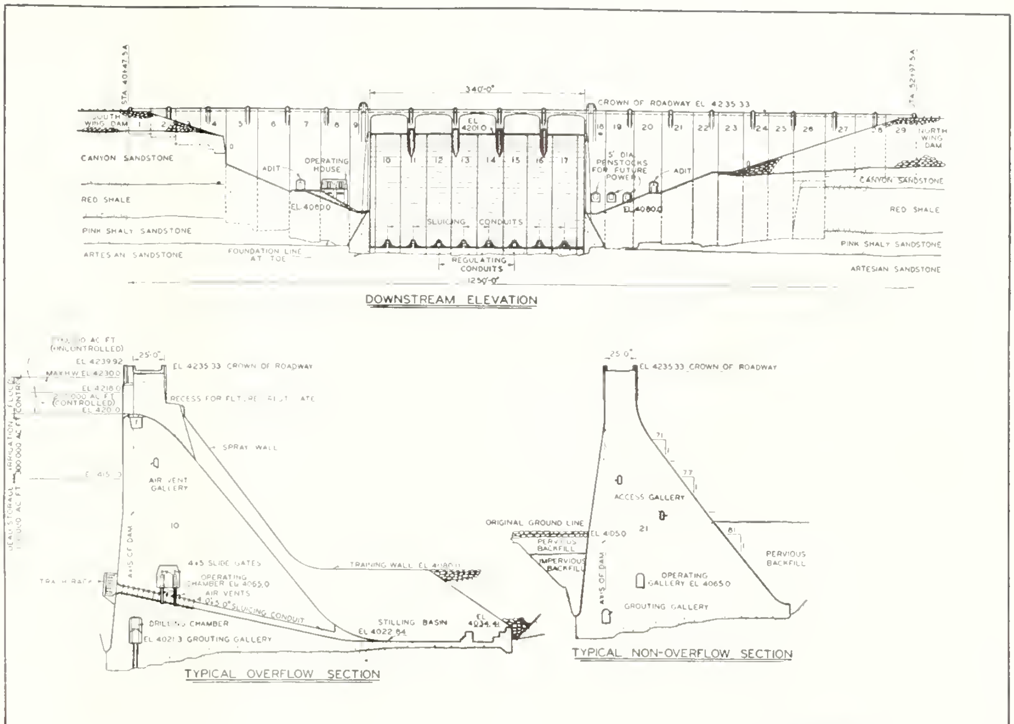
North dikes and emergency spillway

A 3,000-foot concrete Ogee section emergency spillway is located 1 mile to the north of the main dam, flanked by two earth-fill dikes extending to high ground at either end. Elevation of the crest is 17 feet higher than the main dam spillway and water will top it only in event of unusual flood. Total earth yardage in both dikes is 47,000 cubic yards and 15,500 cubic yards of rock fill. These earth dikes were built by hired labor drawn principally from local relief rolls and totaled 25,000 man-days. The emergency spillway contains 71,000 cubic yards of concrete. Maximum height of this section is about 40 feet. Discharge from this emergency spillway can in no way endanger any of the structures, as flow will reenter the river 1½ miles below the main dam.

South dike

The south dike is a rolled earth-fill dam with rock fill on upstream and downstream slopes. Nearly 190,000 man-days of labor, drawn principally from local relief rolls, were used in this work. This labor was well suited and trainable to the type of work required for quarrying of rock and placement of fill. Maximum height of this dam is 96 feet, with an over-all length of 6,400 feet and crown width of 22 feet which accommodates a roadway leading across to the wing dams and main dam.

The foundation of this dike is sandstone and shale. Stripping of 300,000 cubic yards of waste material was required and 1,900,000 cubic yards of earth fill and 515,000 cubic yards of rock fill were placed in the structure. A majority of the materials for the rolled earth fill were obtained from borrow areas within a radius of about a mile from the dike. Materials were irrigated at the pit and brought to proper moisture prior to excavation.



CONCHAS DAM
ELEVATION AND SECTIONS

Irrigation headworks

The irrigation headworks for the Conchas Canal consists of a concrete-lined tunnel through the right abutment of the south dike. The diversion tunnel, 700 feet long, consists of 328 feet of 11-foot-diameter circular pressure tunnel, a gate chamber and 310 feet of horseshoe tunnel 22 feet wide by 15 feet high in which are located two 90-inch steel penstocks leading from the gate chamber to the outlet gate house. In the gate chamber will be two hydraulically operated 6 by 7 feet 6 inches emergency gates and at the outlet gate house, two operating gates similar to those in the gate chamber will be installed.

Contracts

Contracts were awarded to the following contracting companies on the various features:

Contract for the main dam and wing dams was awarded to Bent Brothers, Inc., and Griffith Co., of Los Angeles, Calif., with low bid of $4,587,676.25, and actual work commenced October 15, 1936.

McCarthy Improvement Co., of Davenport, Iowa, was the successful bidder on the irrigation headworks tunnel construction and was awarded the contract for $307,107.25. Operations were begun on this contract on October 19, 1938. Bent Brothers, Inc., and Griffith Co., were awarded the contract for installation of gates and operating equipment, with a low bid of $123,910.40. Work was commenced on March 10, 1939.

Construction of the emergency spillway was let by a separate contract to Ernest W. Everly, of Albuquerque, N. Mex., for $269,-824.75. Work was started on September 8, 1938.

Labor situation

One of the principal reasons for the initial authorization to construct the Conchas Dam project was to provide work to the unemployed in the area. Certain features were constructed under relief appropriations and employment was exclusively from relief rolls except for civil-service supervisory personnel. In other features of the work the contractor was required to use as much labor as practicable from relief rolls.

The major features built using labor drawn exclusively from relief rolls consisted of the construction camp, 235,000 man-days; south dike, 190,000 man-days; Newkirk-Conchas Dam highway and project roads, 45,000 man-days; Tucumcari-Conchas Dam natural gas line, 26,000 man-days; north dikes and excavation for the emergency spillway, 25,000 man-days; preliminary work at the main dam, 20,000 man-days; and surveys, exploration, and design, 63,000 man-days.

As the dam site is 60 miles by road from the nearest town of consequence, it was necessary to build a construction camp at the site of the work. This included quarters for 132 families and dormitories for 1,400 workers. Mess hall, school, hospital, theater, and stores were included in the building program. In order to employ a maximum of relief labor, materials native to the country and with which the workers were familiar, adobe and sandstone, were used. A complete

Irrigation headworks for Conchas Canal looking toward reservoir

town of typical southwestern architecture was thus developed, including all essential utilities, during the winter and spring of 1935–36. It was during this period that the first peak of employment occurred. In July 1936, 2,350 were at work, of which nearly 2,000 were from the relief rolls of northeastern New Mexico and the Panhandle of Texas.

A second peak of employment was reached in April 1938, when hired labor work on the south dike was at its peak and contract work at the main dam at its height of activity. At this time 2,500 were employed on all features of contruction, of which 1,750 were workers who had been taken from local relief rolls.

The average daily employment through December 1938, was 1,335, of which 927 or 69 percent was relief labor.

Construction problems

Perhaps the most difficult construction problem encountered, fully described in the articles previously referred to, was in connection with excavation of shale formations which underlie the cap rock of sandstone on both the right and left abutments of the main dam. This abutment shale was a perfectly competent foundation material in a fresh, unweathered condition. The problem was to excavate and place concrete against the shale without permitting weathering. At the south, abutment shafts were sunk at 15-foot centers on the line of the proposed abutment face. These shafts were then concreted to form columns between which a concrete curtain wall was placed in sections as the shale was excavated. Against this curtain wall, 55 feet in height, and sealing the shale from the elements, the slower work of placing the abutment monolith was completed.

At the north abutment a different procedure was used to accomplish the same end. Her construction of the abutment monolith wa accomplished by excavating vertically throug the shale to foundation rock below it and the placing concrete. Excavation and concretin was done in six sections. Length of the ur supported shale face, 70 feet high, was thu reduced by one-sixth and could be further re strained by cross-bracing as each of the si shafts or sections was put down. Construc tion by this method minimized exposure o the shale face. When this monolith was com pleted excavation riverward was accomplishe by normal open-cut methods. Constructio joints are to be grouted to restore monolithi action. Throughout the balance of the main dam the 50-foot monoliths were poured in 5-foot lifts, with vertical keyways providin for expansion and contraction joints. A per manent system of sealing wells was place at the contact between the contacting mono liths and the abutment formations. This con sisted of three 15-inch wells half in concret and half in formation, the center well con taining bentonite, the outside ones a bitumi nous compound. These latter wells are pro vided with a system of piping whereby ma terials may be reheated if it becomes neces sary for a reseal at any time.

Six 4 by 5-foot sluicing conduits pass through the dam for draining the reservoir. These are controlled by hydraulically operated slide gates within a longitudinal gallery. Two conduits with 48-inch needle valves are provided for regulation of the reservoir level and low-water flow as necessary.

On the left of the main dam spillway, three 5-foot penstocks were provided for possible

Artist's conception—Conchas Dam and reservoir project, Conchas Dam, New Mexico

future power development. On the right of the spillway, one 4-foot-diameter penstock was installed for possible municipal use of cities downstream. A 2-foot-diameter penstock is located on this side and serves a turbine and 150-kilowatt generator which was considered necessary for power and lighting operations. An 18-inch pipe line was provided for delivery of water to lands to be irrigated on the Bell Ranch in the immediate vicinity of the dam.

It is interesting to know that the main concrete section of the Conchas Dam was built without providing a diversion tunnel for bypassing the natural flow of the river. Cofferdams of sheet steel piling protected construction first in the right and then the left half of the riverbed. One flood of sizable proportions occurred during the latter part of May and early June 1937. Some delay but no appreciable damage was caused, as a portion of the lower elevations of the monoliths were submerged and had to be cleaned of muck when the stream subsided, and could again be handled by a low cofferdam and bypassing where it would not interfere with the work in progress.

Storage was commenced on December 28, 1938, and on April 30, 1939, amounted to 25,000 acre-feet. On the basis of a total cost of $16,000,000, the construction of the dam and its appurtenant works, was about 95 percent complete as of April 30, 1939.

General description of proposed Tucumcari Project

This is one of the first irrigation projects to be built in connection with flood control as a part of the plan on a cooperative basis between the Bureau of Reclamation, Interior Department, and the War Department.

The area composing the Tucumcari project consists of 80,980 acres, of which about 50,000 acres are potentially irrigable.

In 1937 the Arch Hurley Conservancy District was organized, which comprises approximately 100,000 acres of land, including the town of Tucumcari. When this district was formed the members were not sure that the Reclamation Bureau would build this project, and thought that perhaps by organizing as a conservancy district, this district would raise the money by bond issue guaranteed by increased potential benefits not only to the lands of the project, but also to the city of Tucumcari and utilities.

By an act passed April 9, 1938, the Bureau of Reclamation was authorized to build this project, providing certain conditions were met, namely:

(a) A finding of feasibility.

SCENES OF CONCHAS DAM
Top: Downstream face
Center: Side view of dam
Bottom: Emergency spillway showing upstream face

(b) Execution of a contract with an irrigation or conservancy district.

(c) Contract agreements shall have been made with each owner of more than 160 acres, whereby the owner agrees to dispose of his excess lands at the appraised value or less.

(d) Contracts shall have been made with owners of not more than 160 acres of irrigable land if single, or 320 acres if a man and wife, whereby they agree that if the sale price exceeds the appraisal value, one-half of such excess shall be paid to the United States to be applied in the inverse order of the due dates upon the construction charge installments on the land sold, coming due thereafter from the owners of said land, one-half retained by the owner selling.

The President approved the finding of feasibility November 1, 1938, and a repayment contract was executed on May 11, 1939, with the Arch Hurley Irrigation District. The contracts mentioned in subparagraphs (c) and (d) are now being negotiated.

The water supply of the project will be entirely from storage in the Conchas Reservoir, where 300,000 acre-feet of storage space is provided for irrigation. The estimated annual draft is 135,000 acre-feet, allowing 2.5 acre-feet per acre-foot at the reservoir diversion point. Two acre-feet per acre at point of delivery to the land, allows 0.5 acre-foot loss by seepage and evaporation.

The average annual precipitation is approximately 16 inches, with 12 inches occurring during the irrigation season, which supplemented by the 2 acre-feet should insure sufficient moisture for the crops adapted to this project.

Soils of the project are generally good, and where sufficient moisture is applied very good results have been obtained. Irrigation has been practiced only by pumping from wells, or diverting from creeks, and in no case has it been on a very large scale. The nearest irrigation of consequence is on the Pecos River at Fort Sumner, N. Mex., about 90 miles southwest of Tucumcari.

Dry farming has been practiced only in a small way, as the natural precipitation was not dependable without supplementary supply. This has been fortunate, as the wind erosion has not been nearly as great as in other areas, such as the plains of Texas and Oklahoma.

The cattle industry has been the most practical, and quite successful. The native grasses and forage are ordinarily good, and even during the past 7 years of drought the range has remained in good condition, especially when overgrazing was not practiced.

Canal System

The main canal, with a capacity of 700 second-feet for the first 38 miles, has the distinction of being through a portion of one ranch called the Bell Ranch, belonging to the Red River Valley Co. This ranch contains approximately 450,000 acres, and is devoted to cattle raising.

The main canal has a total length of 75 miles. The first 38 miles is a very expensive canal, calling for four tunnels with a total length of 5.2 miles, the longest of which is 9,656 feet. There are 22 siphons in this stretch and a total of 31 siphons in the full 75 miles. Total length of siphons is 10 miles, the longest one being 4,696 feet.

There probably will not be any water delivery for irrigation within the first 37 miles of the canal, at which point the main body of the project is reached.

The estimated cost of the main canal, including the Hudson Canal, is $6,605,420, and of the distribution and drainage systems, $1,549,580, making a total estimated cost of $8,155,000.

Irrigation Guide in Print

THE Farmer's Irrigation Guide, booklet on how to irrigate the farm, is now in print and will soon be available. Publication is expected to meet a long-felt demand. Prepared by Mr. L. H. Mitchell, Irrigation Advisor of the Bureau, the booklet covers 30 years of irrigation experience on Government projects. It is clearly, simply written and generously illustrated. Distribution will be free on request.

Grand Coulee Dam Impounds Rapidly Growing Lake

A 25-MILE lake has already formed behind partly finished Grand Coulee Dam on the Columbia River. The lake is 100 feet deep at the dam site. It will take many months to reach its full size of 375 feet deep and 151 miles long, growing as the dam rises.

A fleet of boats of all kinds and sizes is now on the lake. By next summer it is expected the lake will be twice as deep and long.

Construction on the central spillway section of the dam has been temporarily suspended for the high-water season of the summer. Concrete placing in the section will be resumed in the fall.

Klamath Scores at San Francisco World's Fair

THE Future Farmers of America and 4–H entries from the Klamath project, at the Junior Interstate Livestock show, held in April at the San Francisco World's Fair, were awarded 1 champion, 3 blue ribbons, and a number of other awards from second to fifteenth places. Interest in livestock shows continues lively.

Federal Irrigation Reservoirs

A set of the area and capacity curves of the Reclamation reservoirs, listed below, is available upon application to the Bureau of Reclamation, Washington, D. C., at $2.50 per copy, or single drawings, letter-size, at 10 cents each.

Name	State	Area	Total capacity
		Acres	*Acre-feet*
Agency Valley	Oregon	1,950	59,924
Alamogordo	New Mexico	4,520	156,750
Alcova	Wyoming	2,500	165,765
American Falls	Idaho	56,055	1,704,290
Anita	Montana	34	400
Arrowrock	Idaho	3,000	286,500
Avalon	New Mexico	970	7,000
Bartlett	Arizona	4,000	201,500
Belle Fourche	South Dakota	8,010	209,770
Black Canyon	Idaho	1,050	44,300
Boca	California	985	41,185
Bull Lake	Wyoming	3,155	155,000
Bumping Lake	Washington	1,300	37,300
Caballo	New Mexico	11,500	361,000
Clear Creek	Washington	270	5,300
Clear Lake	California	26,500	453,690
Cold Springs	Oregon	1,500	50,000
Columbia River	Washington	82,000	9,700,000
Conconully	do	480	13,000
Crane Prairie [1]	Oregon	4,800	50,000
Deadwood	Idaho	3,000	164,000
Deaver	Wyoming	80	681
Deer Creek	Utah	2,650	150,000
Deer Flat	Idaho	9,835	190,150
Easton (Diversion)	Washington	200	4,000
East Park	California	1,850	51,000
Echo	Utah	1,470	74,000
Elephant Butte	New Mexico	38,240	2,273,674
Fresno	Montana	8,750	245,437
Friant [1]	California	4,500	450,000
Fruit Growers [1]	Colorado	450	4,100
Gerber	Oregon	3,800	94,265
Gibson	Montana	1,360	105,000
Granby [1]	Colorado	6,943	482,860
Grassy Lake	Idaho	313	15,542
Green Mountain [1]	Colorado	2,098	152,000
Guernsey	Wyoming	2,340	54,610
Horse Mesa	Arizona	2,600	245,138
Hyrum	Utah	480	18,686
Island Park	Idaho	6,900	114,000
Jackson Lake	Wyoming	25,540	847,000
Lahontan	Nevada	10,000	294,400
Lake Alice	Nebraska	900	11,400
Lake Cle Elum	Washington	4,800	529,254
Lake Como [1]	Montana	872	33,000
Lake Kachess	Washington	4,540	239,000
Lake Keechelus	do	2,550	170,500
Lake Mead	Arizona-Nevada	147,000	30,500,000
Lake Minatare	Nebraska	2,240	60,766
Lake Tahoe	California-Nevada	120,000	732,000
Lake Walcott	Idaho	12,200	107,240
Magic	do	3,450	191,500
Marshall Ford	Texas	16,500	976,946
McKay	Oregon	1,260	73,800
McMillan	New Mexico	4.950	40,000
Midview	Utah	400	5,785
Moon Lake	do	770	46,280
Mormon Flat	Arizona	945	58,000
Nelson	Montana	4,560	85,450
Owyhee	Oregon	13,000	1,120,000
Parker	Arizona-California	25,000	716,600
Pathfinder	Wyoming	22,700	1,070,000
Pilot Butte	do	901	31,550
Pine View	Utah	1,700	41,838
Pishkun	Montana	1,340	38,458
Ralston	Wyoming	200	1,493
Roosevelt	Arizona	17,800	1,420,000
Rye Patch	Nevada	10,750	179 000
Salmon Lake	Washington	310	15,700
Seminoe	Wyoming	20,000	1,075,000
Shasta	California	29,580	4,493.133
Sherburne	Montana	1,730	66,100
Shoshone	Wyoming	6,600	456,600
Stewart Mountain	Arizona	1,270	70,500
Stony Gorge	California	1,280	50,200
Strawberry	Utah	8,370	283,000
Taylor Park	Colorado	2,180	118,000
Thief Valley	Oregon	750	17.570
Tieton	Washington	2,500	197,000
Twin Springs [1]	Idaho	1,500	172,000
Unity	Oregon	910	25,820
Upper Klamath Lake	do	91,000	524 800
Vallecito	Colorado	2.720	129,675
Warm Springs	Oregon	4.400	171,400
Wickiup [1]	do	10,000	180,000
Willow Creek	Montana	1,050	18,900
Winter Creek	Nebraska	360	3,056
Total		955,816	66,281,531

[1] Area and capacity curves drawings not yet available.

Reclamation Engineers Assigned to New Posts

TWO important personnel changes in the Bureau of Reclamation, resulting from the prospect of early commencement of work on the Friant Dam near Fresno, Calif., were announced by Secretary of the Interior Harold L. Ickes on May 15, 1939.

Roy B. Williams, Assistant Commissioner, Bureau of Reclamation, has been designated construction engineer of the important Friant division of the Central Valley project, California. Harry W. Bashore, construction engineer of the Kendrick project, Wyoming, will take over Mr. Williams' duties in Washington as assistant commissioner.

"Mr. Williams, through experience gained in the Washington Office and through important assignments in connection with adjusting the very difficult problems involving water rights and rights-of-way for the Friant Dam, is the best qualified man in the service to take charge of the final preparations for the construction of the Friant division and to supervise its construction," John C. Page, Commissioner, Bureau of Reclamation, said in commenting on the assignments. "He has had long field experience, having come to Washington from his post as construction engineer of the All-American Canal and Gila projects at Yuma, Ariz.

"Mr. Bashore has just completed construction of the Alcova and Seminoe Dams of the Kendrick project, which is now nearing completion. His place will be taken at Casper, Wyo., by Mr. Irvin J. Matthews, now resident engineer, who will be designated acting construction engineer of the project to complete the canal system."

Mr. Williams, 51 years of age, was born in Kentucky, and was graduated from the Montana State College with a degree of B. S. in civil engineering in 1911. He entered the employ of the Bureau of Reclamation in 1912 as a survey man on the Flathead project in Montana and has served continuously on increasingly important assignments for 27 years.

Mr. Bashore, 58 years of age, was born in Marion County, Mo. He was graduated from La Grange College with an A. B. degree in 1899, and from Missouri State University in 1906 with a degree of B. S. in civil engineering. He entered the employ of the Bureau of Reclamation as survey man in 1906, and has served continuously since on surveys, investigations, in designing, construction, and operation of projects involving both irrigation and power.

Both Mr. Williams and Mr. Bashore are members of the American Society of Civil Engineers.

Upper: Roy B. Williams
Lower: Harry W. Bashore

Bonneville Dam Appointments Approved

FRANK A. BANKS, supervising engineer of the Grand Coulee Dam project, has been appointed by Secretary of the Interior Harold L. Ickes as acting administrator of the Bonneville project to succeed the late John Delmadge Ross.

Mr. Banks, 57 years old, is a graduate of the University of Maine in civil engineering and has been employed continuously by the Bureau of Reclamation since 1906. He worked up through the field service of the Bureau to the position in 1917 of construction engineer of American Falls Dam in Idaho, and in 1920 went to the Owyhee project in Oregon as construction engineer of the great Owyhee Dam, then the outstanding engineering structure in the world. In August 1933, when the Grand Coulee Dam project was begun Frank Banks was assigned to the job as construction engineer and he has supervised the work since that date.

While acting administrator of the Bonneville project Mr. Banks will continue as construction engineer of Grand Coulee Dam.

Secretary Ickes also announced the appointment of Barry Dibble, an outstanding electrical engineer, whose home is in Redlands, Calif., as assistant administrator of the Bonneville project to work with Mr. Banks and to represent him at the Portland, Oreg., project office.

Mr. Dibble was born in St. Paul, Minn., in 1881 and was graduated from the University of Minnesota with a degree of electrical engineering in 1904. He was an electrical engineer on the staff of the Bureau of Reclamation from 1909 to 1924, and at the time he resigned from the Bureau was chief electrical engineer in the Denver, Colo., office of the Bureau. His work for the Bureau included the assignment as electrical engineer on the Minidoka project in Idaho from 1910 to 1915. During that time he sponsored and directed an electrification program on the project which is a model today of municipal and rural electrification. After leaving the service of the Bureau of Reclamation, Mr. Dibble was retained by the Bureau until 1924 and by the Indian Service since that time as consulting electrical engineer.

The new acting administrator of the Bonneville project has been closely connected with the project since the Bonneville authority was established in 1937. He has been the representative of the Interior Department on the three-man advisory board to the project administrator from the first and as such gained intimate knowledge of the policies and plans developed by the late Administrator Ross.

"Mr. Banks is one of the most prominent figures in the power picture of the Pacific Northwest," Secretary Ickes said. "Not only is he constructing the greatest hydroelectric project in the world, the Grand Coulee Dam project, which will be interconnected with the Bonneville project, but for 2 years as the representative of my Department on the advisory board he has had a close connection with the Bonneville project, itself."

Upper: Frank A. Banks
Lower: Barry Dibble

As construction engineer in charge of the building of Grand Coulee Dam, Mr. Banks has compiled an enviable record as an administrator. Mr. Banks and his staff have supervised the construction of a project which is without equal in size in engineering history, establishing new construction records and keeping the work ahead of schedule throughout.

Mr. Banks was sworn in as acting director in Washington, D. C., on May 4, 1939.

Government Camp Officially Named

THE Government camp of the Kennett division, Central Valley project, California, has been named "Toyon" after the Toyon bushes which grow on the hills adjacent to the camp. The name "Toyon" is from the Indian word "tollon" for this red berry bush which is popularly known as "Christmas Berry" or "California Holly."

Belle Fourche Warehouse Enlarged

THE largest wool warehouse in the State of South Dakota is the boast of the Belle Fourche Federal reclamation project now that the Newell wool warehouse is being enlarged 50 percent. For the past several years the building has been taxed to capacity and the addition will permit better service to wool growers and more prompt handling of the product.

Land Policy Committee Created

A land policy committee, of which Under Secretary Slattery will be chairman, has been created. The committee consists of the following persons or alternates designated by the appropriate bureau chief:

Frederic L. Kirgis, First Assistant Solicitor.

John C. Page, Bureau of Reclamation.

Julian Terrett, Division of Grazing.

Wm. Zimmerman, Jr., Office of Indian Affairs.

Ernest Gruening, Division of Territories.

Lee Muck, Forestry.

Joel D. Wolfsohn, General Land Office.

J. F. Deeds, Geological Survey.

Conrad L. Wirth, National Park Service.

Joseph H. Hedges, Bureau of Mines.

The Land Policy Committee will be advisory to the Secretary.

The Beet-Sugar Factory at Nyssa, Oregon

DURING the past year the Amalgamated Sugar Co. has built a $2,000,000 beet-sugar factory at Nyssa, Oreg., to serve the farmers of Malheur, Oreg., and Payette, Canyon, Owyhee, and Ada Counties in Idaho. Because Nyssa is located in the center of the Owyhee project, this factory is having a far-reaching effect on the development of that project.

As a trial, this area started off in 1936 with only 809 acres of sugar beets. So successful was this crop that the acreage jumped to 8,022 acres in 1937 and more than doubled again to 17,185 acres in 1938. The 1939 allotment is 16,322 acres, although application was made for planting over 20,000 acres.

This is not the first time sugar beets have been raised in southwestern Idaho. They were successfully raised about 25 years ago, until the white fly became such a problem that the growers became discouraged and stopped planting sugar beets. The development of white-fly-resisting seed has made possible a revival of the sugar beet industry. Most of the seed used in this area is raised near Las Cruces, N. Mex. Some seed is raised in the locality of Nyssa for breeding stock to further improve the New Mexico seed.

Factory Description

The Nyssa factory is the largest of the six owned by the Amalgamated Sugar Co. and is the latest and most modern equipped factory in the United States. The rated capacity is 2,000 tons of beets in 24 hours, yielding approximately 6,500 one-hundred-pound bags of sugar. A steam turbo-generator develops electricity during the sugar campaign which lasts for approximately 120 days each year, beginning about October 1. It takes 50 pounds of coal to manufacture 100 pounds of sugar.

The highest production for a 24-hour day in this campaign was 2,459 tons.

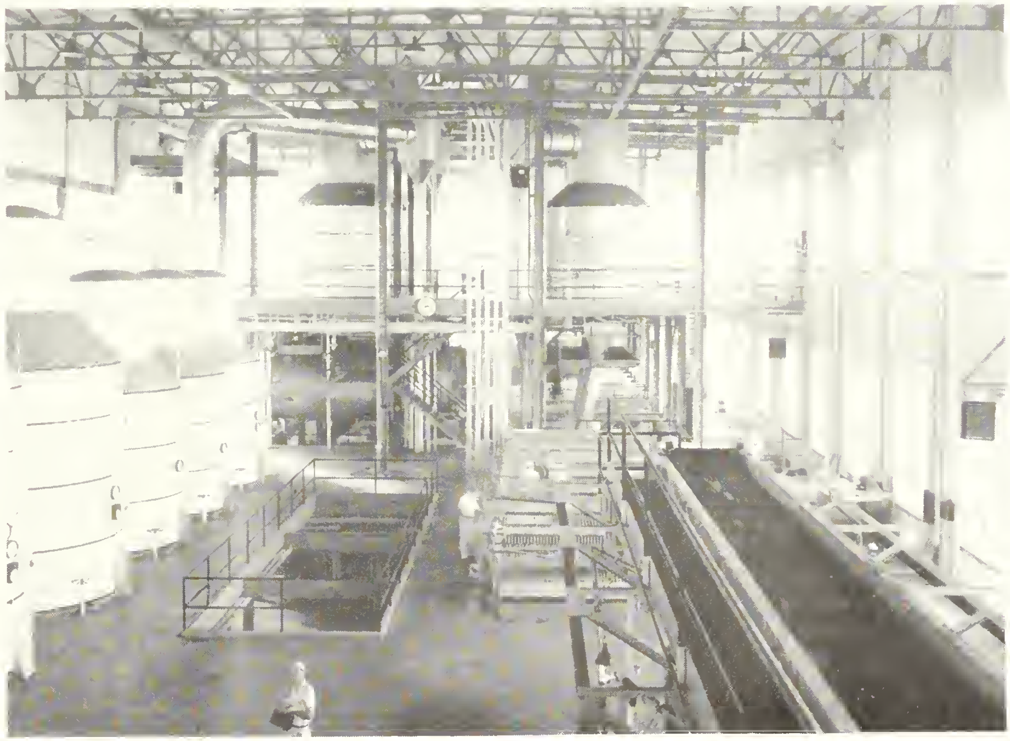
A warehouse that will store 450,000 bags of sugar adjoins the factory. The principal byproduct of the process is beet pulp, which is stored in a large pond resembling a football stadium, and sold as stock feed.

The Manufacturing Process

Beets arriving from the field in railroad cars or on trucks, after being weighed, may be stockpiled or dumped directly into the flume carrying a swift flow of water. The water carries them to a point outside the factory where an automatic feeder feeds a uniform flow of beets into a large centrifugal pump. The beets are then subjected to various processes of washing and trash removal. After a thorough cleaning they are sliced into small triangular strips resembling spaghetti. The triangular shape gives more surface area per pound of beets and this increases the efficiency of removing the sugar by osmosis. The sugar removal takes place in a battery of 14 large diffusion cells. From these cells the pulp is pumped directly to the pulp pond and the raw juice starts on its long journey of refinement.

This refinement of the raw juice involves the addition of several purifying agents and numerous filtration processes until the refined juice has all the properties which will result in the best table and canning sugar. The refined juice is then put through an evaporation process which removes the water and leaves a thick syrup. Considerable skill is required at this stage in order that the

Upper: Stock pile and conveyor of Amalgamated Sugar Co. at Nyssa, Oregon
Lower: Interior view of refinery



crystals of sugar will be the right size. At just the right point a few ounces of granulated sugar are put into the evaporating pan. This is called "shocking" and causes crystalization to take place. The granulated sugar is separated from the molasses by a battery of centrifugal machines from which the finished product goes to the sacker.

Data on Beet Production in this Locality

The sugar content of beets is affected chiefly by the growing period, time of irrigation, and the number of sunny days in the growing period. The average sugar content of the beet is about 16 percent. The average tonnage per acre for the 17,000 acres in the Nyssa area in 1938 was 17.1. This is exceptionally high considering the fact that many of the farmers were inexperienced beet growers. The record yield was 32 tons per acre.

Some beets were raised on the new land of the Owyhee project. It is considered not advisable to do this until the land has been built up by alfalfa or clover, but yields of from 12 to 15 tons per acre were reported from the new land. Barnyard manure is the best fertilizer; however, in some soils, a little commercial phosphate fertilizer is also necessary. Beets take about the same amount of plant foods from the soil as do other crops of equal tonnage. About eight irrigations per year are necessary in this area.

The following is a list of the approximate costs of raising an acre of sugar beets.

Rental on land	$15.00	Digging	$4.00
Fertilizer	3.25	Topping	17.00
Seed	2.00	Hauling	15.00
Thinning	8.00	Total	70.25
Hoeing	6.00		

This year the sugar-beet company paid $4.40 per ton and the Government will pay about $1.78, making the gross income from an average acre in this area equal to about $105.00 and the net income about $35. The tops of beets are worth $3.50 per acre for stock feed.

The company sells the pulp to the farmers for 50 cents per ton. It is a good stock food when used with hay and grain. A beef steer will eat about 100 pounds of pulp per day. A ton of beets yields 500 pounds of pulp.

There are 300 men employed in the factory during campaign. Fifty men are employed the year around at the factory. In 1938 the company operated 20 beet dumps, with two men and one woman scale operator at each dump. There are about 20 men employed the year around in the field. All other labor connected with raising sugar beets is paid for by the farmer. From $25 to $35 per acre is spent on labor. Because of the hard physical work connected with raising sugar beets, a good share of the hand labor is done by Mexicans and Filipinos.

Perhaps the best argument for raising sugar beets on the Owyhee project is the fact that it is located some distance from markets. Sugar beets may be concentrated into sugar before being shipped, thus prohibiting the freight charges from exceeding the value of the crop. Livestock used to be the concentrated crop to ship to market from this area. That industry seems to be on the decline, so sugar beets offer a solution to a difficult problem. Most of the sugar manufactured at Nyssa will be used in Oregon, Washington, and Idaho.

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By W. I. SWANTON, *Engineering Division*

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CONTINENTAL DIVIDE TUNNEL

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Concreting a siphon under dry river bed, illus., Contractors and Engineers Monthly, April 1939, Vol. 36, No. 4, pp. 8, 26, 27, 43, 44 (Gila River siphon).

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The Willamette River Basin, illus., The Military Engineer, May–June, 1939, Vol. 31, No. 177, pp. 208–211. (Estimates and cost of irrigation development and dam construction.)

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History and First Annual Report of the Metropolitan Water District of Southern California, illus., 353 pp., 1939, Los Angeles, Calif. Compiled by Charles A. Bissell.

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Development of the water resources of the Columbia River Basin, Congressional Record, March 27, 1939, Vol. 84, No. 61, pp. 4749–4750. (Address Rivers and Harbors Congress.)

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Progress on Central Valley Project reviewed by U. S. Supervising Engineer, address March 8, A. G. C., Southwest Builder and Contractor, April 7, 1939, Vol. 93, No. 14, pp. 10–11.

Progress of Investigations of Projects

ARIZONA-CALIFORNIA: *Colorado River valley surveys.*—Work was continued on preparation of aerial mosaics of the lower Colorado and Gila River valleys. A report on the river behavior in the Palo Verde Valley was completed.

CALIFORNIA: *Kings River-Pine Flat projects.*—Power studies were continued and designs of Pine Flat and Wishon Dams begun. Preparation of report has been commenced.

COLORADO: *Blue River Transmountain Diversion.*—A review of designs and estimates of dams was practically completed.

Eastern slope surveys.—Surveys in the Arkansas valley were continued and land classification completed of one-half the area between Caddoa dam site and State line. Preparation of a general map is in progress and studies of water supply are being made. Water supply studies were continued of the North Republican River project and of a dam near Wray.

Western slope surveys.—Water supply studies were continued of the Collbran, Florida, LaPlata, Mancos, Piceance Creek, Silt, and Troublesome projects. On the Paonia project surveys of possible reservoir sites were made below Grand Mesa and on Minnesota Creek.

IDAHO: *Rathdrum Prairie project.*—Additional studies of power development are in progress.

IDAHO: *Boise-Payette-Weiser project.*—Studies of major units of irrigation development in the Weiser Basin are in progress and field work will be continued.

IDAHO: *Snake River storage-South Fork.*—Preparation of report of storage and power development at Grand Valley and Elk Creek dam sites is in progress.

MONTANA: *Gallatin Valley project.*—Economic investigations are in progress including collection of data on water supply, crops, population, water requirements and price for storage.

MONTANA: *Marias River project.*—Preparation of data for a report was continued, including tunnels, Marias dam spillway, irrigation requirements and general map.

Rock Creek project.—Water supply studies were about completed and preparation of report in progress.

MONTANA-NORTH DAKOTA: *Fort Peck pumping project.*—Designs and estimates were made for canal and lateral systems for 65,000 acres between Fort Peck Dam and Milk River; surveys were continued of canals through North Dakota as far as Crosby and Culbertson; surveys of Missouri pumping units, north and south of the river, and topography of over 130,000 acres were completed.

NEBRASKA: *Mirage Flats project.*—Soil auger boring at the dam site was completed.

NORTH DAKOTA-SOUTH DAKOTA: *Missouri River pumping project.*—Mapping and land classification of areas along the Missouri River were continued in North and South Dakota. Total area classified was 57,000 acres.

OKLAHOMA: *Altus project.*—Tests of the project lands in regard to soils, drainage, and salts are to be made.

Canton and Fort Supply projects.—Field work was completed of the Canton project and estimates of costs of canals on Fort Supply project were continued.

Washita River investigations.—Field work was completed with land classification of 150,000 acres of bottom lands between Cheyenne and Chickasha, Okla.

OREGON: *Canby project.*—Plans for commencing investigation of project were made.

Grande Ronde project.—Preparation of report was continued and designs and estimates were prepared.

Medford project.—The report of project was practically completed and being reviewed.

Williamette Basin.—A reconnaissance of the lands for possible irrigation was made.

SOUTH DAKOTA: *Black Hills projects.*—Studies of power, flood control, and irrigation of the Angostura project were continued, including the coordinating of the plants at Jackson Narrows dam site.

TEXAS: *Balmorhea project.*—Surveys of reservoir sites were begun at Antelope Flats and

(*Continued on page 137*)

Sugar-Beet Seed

THE domestic demand for sugar-beet seed, once met by imports from Belgium, Germany, and other countries, is now largely supplied by farms on reclamation developments.

Two irrigation developments, the Salt River project in Arizona and the Imperial Valley in California, between them, grow most of the seed for which the country formerly depended on imports.

Farmers on the Salt River project had little success with sugar beets as a crop when it was first developed, but soon discovered that the soil and climate were ideal for culture of the seed.

The sugar-beet seed now grown on the Salt River project is a million-dollar-a-year crop, supplying most of the country's requirements, and irrigation farmers in the Imperial Valley have also found conditions suitable for sugar-beet seed culture.

Chief Clerk Wentzell Gives Address on Riverton Project

C. B. WENTZELL, chief clerk of the Riverton project, addressed the Walther League of the Mount Hope Lutheran Church at Riverton on May 21, on The Early History of the Riverton Project. The talk was interesting and informative and was well received.

Right: Close-up of field
Below: Sugar beets grown for seed

Progress of Investigations

(*Continued from page 135*)

Humble Hill, and water supply studies continued.

Robert Lee project.—Water supply studies were begun and control surveys are in progress.

UTAH: *Blue Bench and Ouray Valley.*—A study of Blue Bottle Reservoir site in Uinta Basin was made.

Lower Weber River project.—Preparation of a report was in progress.

Woodruff and Clarkston Creeks.—Investigations of reservoir sites were in progress and drilling of the Woodruff Creek site will begin in May.

UTAH-IDAHO-WYOMING: *Bear River Surveys.*—Water supply studies were continued; areas from the aerial mosaic maps were computed; topography of Upper Oneida Narrows dam site was completed; and survey of Pleasant Valley and Thatcher reservoir sites in progress.

WYOMING: *Big Horn and Power Rivers.*—A reconnaissance of lands west of Hardin, Mont., along Big Horn River was made; topographic mapping was in progress; and land classification was begun east of Peritsa Creek.

Colorado River Basin investigations.—Land classification of the Wittman project in Arizona was about completed, and maps of the Williams River area in Arizona were two-thirds completed. Drilling of Bullshead dam site was in progress; ground water maps of Salt River project were completed; a water supply study of Yampa Basin was in progress. In Utah water supply studies of Ashley Creek are in progress, and surveys of several reservoir sites, including the Dewey reservoir site are being made. A report of the Price River-Gooseberry investigations was completed. On the Middle Green River water-supply studies were continued. In Wyoming surveys of Green River were in progress together with water-supply studies.

CONTENTS

THE RECLAMATION ERA • JUNE 1939

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Bureau of Reclamation,

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Conservation by Silt Lining of Ditches

By THOMAS WILLIAMSON, *Assistant Engineer, Bureau of Reclamation, Reno, Nev.*

CONSERVATION of water is the favored slogan of the arid West. It stimulates imagination to envision broad plans of reforestation, rehabilitation of overgrazed ranges, and construction of storage reservoirs to increase and preserve the precious surplus. The value of the water saved when applied to its highest beneficial use, generally irrigation, is the measure and limit of the maximum cost of such undertakings and often justifies seemingly excessive investments.

The ordinary conservationist's first thought is of storage, the second usually watershed protection, then allocation by long canals to more productive areas. After that, the subject is exhausted or, at best, hazy.

But there are other methods that have been neglected, indifferently pursued, or little stressed in western American practice. While not so spectacular as the larger developments, some of these are highly important and deserving of more careful consideration than they have heretofore received, in order to bring to full fruition any comprehensive plan of optimum beneficial use of the limited water resources of any arid district.

It is the purpose of this article to describe the procedure and results of a demonstration of conservation by silt lining of a distribution ditch; and to outline a suggested program for a thorough examination and demonstration of the possibilities of this method, and for the developing of principles and technique for its practical application.

Individual Demonstration

On the Newlands project, Nevada, in 1938, a work project of silt lining was undertaken and completed by CCC Camp BR–34. The main purposes were to prevent loss of water and to prevent seepage damage to adjacent land. The project presented an exceptionally favorable opportunity to test the value of the work by measurement of the actual percolation losses before and after treatment. This test work was therefore included in the project as planned and supervised by the writer. The actual work of field observations, surveys, inspection and test measurements, as well as the recording, graphical plotting and interpretation of the data, and the preparation of a detailed report, was done by Mr. Glen M. Thompson, transitman, CCC. His report was transmitted through Regional Director George B. Snow, to the Denver and Washington offices, February 9, 1939.

The canal chosen for the work was the S–4 lateral in the Harmon district, capacity about 20 to 25 cubic feet per second, constructed through a stretch of very sandy soil and supplying water through the treated section to about 160 acres. The original cross-section, 5-foot base, 2-foot water depth, 1½ : 1 side slope, had been rendered more or less irregular by various causes during 20 years of service. The brush, weeds, and sod were cleared off, and the channel trimmed to approximately its original size and shape, but enlarged by removing a 4-inch layer from bottom and sides to be refilled with silt. The channel was then carefully cross-sectioned at 50-foot stations and the volumes calculated for varying levels corresponding to the range of water surface elevations when in use. The section tested was 4,035 feet long, with a tight concrete check structure at each end and another intermediate check 1,190 feet from the lower end.

For the percolation test measurements, these two sections between the checks were filled with water to the average or normal working water level and the check gates then tightly closed and kept closed during the test period so that no more water could enter, and none could pass out except by seepage. The water surface level in each section was read on a gage at timed intervals for periods of 2 days or longer. The volumes lost and the corresponding time intervals were plotted on graphs, giving a resulting amount and rate of loss for the period. Six separate test periods were run before placing the silt. Silt was then hauled in with trucks and spread evenly by hand with shovels to a uniform thickness of 4 inches over the bottom and slopes of the channel. The material was taken from a nearby spoil bank excavated several years previously from a deep drain cut. It was in a dry condition, fairly well pulverized but containing a considerable proportion of blocky lumps up to 2 or 3 inches thick and a small admixture of sand. No attempt was made to grind or pulverize it, but the loading and handling processes helped to break it down until, as placed, there was about half the total in a finely pulverized, or dusty condition. No further mixing or compacting was done and the ditch was then put into regular service for irrigation deliveries. Four sets of test run measurements were made at convenient times during the irrigation season and the results plotted for comparison with the previous series. The final computations and comparison showed an average net saving of 2½ acre-feet per day, per mile of ditch.

The importance of this particular demonstration lies in the definite quantitative record of the actual amount and rate of prevention of seepage loss effected. All conditions were favorable for accuracy of observation and measurement. The separate test runs were remarkably consistent and uniform and it is thought that no errors of any consequence crept in to detract from the clear evidence shown. A reliable "yard stick" is now available with which to measure and check estimates for further work.

The opportunity on the Newlands project for further valuable conservation by this method is plainly evident and, when viewed in the light of this demonstration, its magnitude is so great that a conservative estimate is in danger of being regarded as a visionary exaggeration. The Newlands project has 600 miles of canals and laterals. The writer is very familiar with the irrigation works of the project and he estimates that there are not less than 200 miles of these channels with seepage conditions averaging about the same as in the section above described. The flow period varies from 7 months continuous run in the longer ditches, to intermittent flows totaling about 40 days in the shorter distributaries. Assuming 150 days as a fair average and applying the rate as found above, a saving of 75,000 acre-feet per year is indicated. This is equivalent to 125,000 acre-feet reservoir draft, since operation records show an average loss of 40 percent.

Further Work Planned

These considerations lead to the conclusion that it would be well worth while to undertake a thorough study of the subject of silt lining in all its aspects. Such a study should include both laboratory and field tests. In the laboratory mechanical analyses would be made of numerous samples of soils and sands taken systematically at representative locations along the ditches where improvements are indicated to be desirable, and of silts and clay soils from locations conveniently accessible for use. Percolation rates under various water pressures or heads would be determined for the same samples and for different mixtures of sands and loose soils with silts or clays. The effects of grinding or pulverizing silts or other soils suitable for use as sealing agents would also be a part of the laboratory work.

For the field tests, which would be of the greatest interest from the standpoint of demonstrating the results, the first step would be the selection of an area of sandy or pervious soil, typical of the land across which ditches are actually operated, and the construction thereon of numerous full-size ditch sections, each 100 feet or more in length, with control gates and outlets to deliver measured

(*Continued on page 143*)

Beginning of Construction of Wickiup Reservoir by CCC Forces

Deschutes Project, Oregon

THE Wickiup three-company CCC camp, which has been under construction by Bureau forces during the past winter, reached practical completion in April. Also, the spring season was sufficiently advanced that one CCC company occupied the camp on April 19, and a second company on April 25. About 50 percent of the third company occupied the Wickiup camp the middle of May.

The clearing of timber from the Wickiup dam site was begun in a small way on April 10, with one tractor and a small crew from an advance cadre of CCC enrollees. A second CCC crew was assigned to the clearing work April 26.

The dam will be 2.7 miles in length, including a long, low, left wing. The main dam will be 1,500 feet in length with a height of 84 feet above river level. The type of construction proposed is a rolled earth and gravel fill with rock riprapped faces. The outlet works will be a double 96-inch diameter steel conduit founded on rock in an open cut through the right abutment, which will be controlled by two sets of 96-inch ring-follower gates on the dam axis and needle valves at the lower toe of the dam.

A secondary dike, the "East Wickiup Dike," will be 3,700 feet in length and 26 feet high. This dike will close a saddle back of Wickiup Butte and will have an emergency spillway through a rock cut at the left end.

It is planned to construct the outlet works by contract, and the dam and dikes by CCC enrollees and by force account.

The dam and dike areas, and also the borrow pit sites, are all heavily timbered with lodgepole pine. The dam site also contains many large green ponderosa pine stumps left by the recent cutting of the commercial timber by a local lumber company. The method of clearing the dam foundation and pit areas is to high-cut the lodgepole and to push over the stumps with tractor and bulldozer. The large stumps will be pulled over as they are undermined on one side by the required foundation stripping. All timber, including stumps will be piled, either by hand or by tractor, and will be burned. The clearing on the downstream side will extend to 50 feet beyond the tow of the dam. On the upstream side, a more liberal width will be cleared to provide working space and to make room for wasting the foundation stripping. All borrowing of material will be from the inside of the reservoir. This will be done in the interest of preserving the beauty of the surrounding forest.

The surface material in the Wickiup area for a depth of 3.5 to 4.0 feet is a granulated pumice, so light that it will float on water when dry. This pumice must all be removed from the dam and dike foundations and will be handled with three 12-cubic-yard carry-all scrapers, drawn with tractors. The material will be wasted on the upstream side or in the reservoir.

Beneath the pumice there is a stratum of 1½ to 2 feet of yellow clay-loam soil, and beneath this stratum for variable depths, ranging from a few feet to a maximum of 42 feet from the surface, there is a porous pea gravel and sand. Beneath the gravel and sand there is a great depth of tight lake-bed clay, or a mixture of fine volcanic ash and clay. A cut-off must be provided through all this porous material under the main dam and the higher part of the left wing dike. The cut-off in the right abutment of the main dam and also in the East Wickiup Dike will reach to bedrock.

The excavation of the cut-off trench will be done with 12-cubic-yard carry-all scrapers and possibly a dragline may be used on this work. The material excavated from the trench will be placed in the downstream portion of the dam. The backfill will be selected clay-sand material hauled in with the scrapers, sprinkled, and rolled.

Program of Work

The proposed program of CCC work on the dam construction for the season of 1939 is the construction of the major portion of the left end embankment of the Wickiup Dam. The construction of the main section of the Wickiup Dam, crossing the Deschutes River, has been postponed until the old temporary Crane Prairie Dam, located on the Deschutes River

Partially cleared area, Wickiup Reservoir site

above the Wickiup Reservoir, has been reconstructed. Reconstruction of the Crane Prairie Dam is scheduled to be done by contract during the 1939 season.

The organization proposed for the construction of the left end embankment of Wickiup Dam will include a division engineer to be in charge assisted by the necessary survey parties and inspectors. This engineering force, under the field direction of the project resident engineer, will supervise the contract work on the Crane Prairie Dam and Wickiup outlet works, and the CCC activities on the dam and the reservoir clearing. The supervisory and facilitating personnel required for the CCC and force account operations will include foremen for three shifts on the excavation and embankment placing operations, with instructors and mechanics as found necessary to properly carry out the construction program.

The equipment to be used on the left end embankment will consist of one 1½-cubic-

(*Continued on page 146*)

Special Motion-Picture Work

TWO special motion-picture assignments have been completed by Chief Photographer B. D. Glaha of the Sacramento office. One involved a short film of irrigation fundamentals, for use in educational work among settlers, the scenes having been taken on the Orland project, California. The other involved motion pictures of CCC activities on the Central Valley project, California, and the Newlands project, Nevada.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
823	Central Valley, Calif.	*1939* Mar. 14	Four 103,000-horsepower hydraulic turbines with governors for units 1, 2, 3, and 4, Shasta power plant.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	[1] $1,843,200.00	F. o. b. West Allis	*1939* May 1
828	do	Mar. 9	Substation and motor-control equipment for Contra Costa pumping plants.	do	do	[2] 21,440.00	F. o. b. Oakley, Calif. Shipping point, East Pittsburgh.	Do.
				Roller-Smith Co.	Bethlehem, Pa.	[3] 27,850.00	do	Do.
831	do	Mar. 15	Two 3,500-horsepower hydraulic turbines, governors, and 2,500-kilovolt-ampere generators for Shasta power plant (station service units).	The James Leffel & Co.	Springfield, Ohio	[1] 68,055.00	F. o. b. Springfield and Rockford, Ill.; discount, 2 percent.	Do.
				(4)				Do.
832	Columbia Basin, Wash.	Mar. 13	Pier plates for drum gates at Grand Coulee spillways.	American Bridge Co.	Denver, Colo.	[2] 70,245.00	F. o. b. Gary, Ind.	Do.
833	Boulder Canyon, Ariz.-Nev.	Apr. 3	Two 168-inch butterfly valves for units A-1 and A-2, Boulder power plant.	Hardie-Tynes Manufacturing Co.	Birmingham, Ala.	225,000.00	F. o. b. Birmingham	Apr. 26
834	do	Mar. 27	Two 82,500-kilovolt-ampere generators for units A-1 and A-2, Boulder power plant.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	1,454,700.00	F. o. b. East Pittsburgh.	May 1
837	Kendrick, Wyo., North Platte, Nebr.-Wyo.	Apr. 3	Carrier-current telephone apparatus.	General Electric Co.	Schenectady, N. Y.	[5] 69,264.00	F. o. b. destination	Do.
1215-D	Colorado-Big Thompson, Colo.	May 1	Construction of two 5-room, two 4-room, and two 3-room residences at Shadow Mountain camp.	(6)				May 12
44,337-A	Parker Dam, Calif.-Ariz.	Apr. 12	Ground and guy wires for transmission lines.	(6)				May 11
33,868-A	Yakima-Roza, Wash.	Apr. 24	Steel reinforcement bars (916,917 pounds).	(6)				Do.
B-22, 112-A	Kendrick, Wyo.	Mar. 20	One 5,000-kilovolt-ampere, 6,900-volt synchronous condenser for Gering substation.	Metropolitan Water District of Southern California.	Los Angeles, Calif.	17,000.00	F. o. b. Earp, Calif.	Do.
1217-D	Rio Grande, N. Mex.	May 3	Welded plate-steel penstocks, penstock-tunnel concreting equipment, penstock bypass piping, and turbine test head and test ring.	Stearns-Roger Manufacturing Co.	Denver, Colo.	[7] 1,194.00	F. o. b. Denver	May 10
				Bethlehem Steel Co.	Bethlehem, Pa.	[8] 347.82	F. o. b. Leetsdale, Pa.	Do.
1189-D	Kendrick, Wyo.	Mar. 8	Three 2,500-kilovolt-ampere transformers; one 15,000-volt step-voltage regulator; three 115,000-volt and seven 15,000-volt disconnecting switches; one 115,000-volt lightning arrester.	Pennsylvania Transformer Co.	Pittsburgh, Pa.	[9] 23,878.00	F. o. b. Laramie	May 16
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[10] 11,400.00	do	Do.
				National Electric Co.	Birmingham, Ala.	[3] 5,350.00	F. o. b. Laramie, discount 2 percent.	
				do	do	[11] 190.00	F. o. b. Laramie.	
				The High Tension Co., Inc.	Phillipsburg, N. J.	[12] 152.10	F. o. b. Laramie, discount 1 percent.	
1222-D	Boulder Canyon, Ariz.-Calif.-Nev.	May 4	Telephone apparatus consisting of automatic telephone switchboard equipment and telephones.	American Automatic Electric Sales Co.	Chicago, Ill.	3,161.00	F. o. b. Boulder City	May 11
A-22, 462-A	Kendrick, Wyo.	*1938* Oct. 28	Copper or aluminum conductor (871,200 feet).	(6)				
1217-D	Rio Grande, N. Mex.	*1939* May 3	Welded plate-steel penstocks, penstock-tunnel concreting equipment, penstock bypass piping, and turbine test head and test ring for Elephant Butte power plant.	Thompson Manufacturing Co.	Denver, Colo.	[2] 29,535.00	F. o. b. Engle, N. Mex., discount ¼ percent.	May 20
				do	do	[13] 693.50	do	Do.
839	Central Valley, Calif.	May 2	Southern Pacific R. R. relocation, milepost 278.55 to milepost 282.60. Earthwork, tunnels and structures.	R. G. Clifford	San Francisco, Calif.	1,223,186.40		Do.
33,868-A	Yakima-Roza, Wash.	Apr. 21	Steel reinforcement bars (916,917 pounds).	(6)				May 11
44,337-A	Parker Dam, Calif.-Ariz.	Apr. 12	Ground and guy wires for transmission lines.	(6)				Do.
44,338-A	do	Apr. 11	Insulators, suspension clamps, and strain clamps.	(6)				Do.
1219-D	Columbia Basin, Wash.	May 2	Structural steel and steel castings for bridge over diversion canal at Leavenworth station.	Duffin Iron Co.	Chicago, Ill.	2,504.00	F. o. b. Leavenworth	May 15

[1] Schedules 1 and 2.
[2] Item 1.
[3] Item 5.
[4] Schedule 3. All bids rejected. Will readvertise.
[5] Schedules 1, 2, and 3.
[6] All bids rejected. Will readvertise.
[7] Item 3.
[8] Item 4.
[9] Schedule 1.
[10] Schedule 2.
[11] Item 6.
[12] Item 7.
[13] Item 2.

CCC Enrollees Salvage Owyhee Railroad

By A. N. ASHLINE, *Assistant Engineer*

THE Owyhee Railroad was built by the Government in 1928 to haul construction materials and supplies from the Oregon Short Line Railroad at Dunaway, Oreg., to the site of the Owyhee Dam. Dunaway is located about 4 miles south of Nyssa, Oreg., and the Government railroad is approximately 24 miles long. The original highway to the dam site crosses the railroad about 6 miles southwest of Dunaway. The right-of-way for the railroad from Dunaway to this point reverts to the adjoining property owners, but from the highway crossing to the dam, the railroad is on a Federal right-of-way along the Owyhee River. Through the Owyhee River canyon to the dam site the right-of-way is to be used for a permanent highway, since the railroad has served its purpose and has been abandoned. The new highway replaces the old original road which meanders through the adjacent foothills with many sharp turns and steep grades. Driving conditions on the old road in the winter were dangerous and the road was likely to be closed by snow.

The railroad has been used since the completion of the dam in October 1932 to haul cement for grouting purposes at the dam and for canal structures. Late in 1937 these operations were finished and plans were made to salvage the railroad. Estimate and authority for doing the work with CCC forces was approved March 9, 1938, and the salvage work was done by enrollees of CCC Company No. 1271, a New Jersey company assigned to Camp BR-43, near Nyssa.

The plan for doing the work called for the use of a Government-owned dinkey engine to haul the cars. Four flat cars for loading material were rented from the Union Pacific Railroad at $1 each per day. A standard passenger coach was also rented at $3 per day to transport the enrollees to the work. The dinkey operator that had been hauling cement for grouting purposes was hired to operate the dinkey and he was assisted by a trainman. These two men took care of all train operations in the field and did the switching at the storage yard at Dunaway. The size of the crew used varied from 40 to 50 enrollees, and they were supervised by a CCC general foreman, assisted by a CCC junior foreman when available. As many leaders and assistant leaders were assigned to this crew as possible.

Preliminary operations required the overhauling of the dinkey engine, and the manufacture of spike bars and rail tongs. The camp blacksmith made 15 pairs of rail tongs and several spike bars. No power equipment being available for loading, an incline was built that rested on the rails and was fastened to the flatcar so that it could be moved easily. Rollers were placed on the incline to help in loading. At first, the rails were loaded with a cable pulled by a 20-horsepower tractor with a hoist, but after operating for a time this method was discarded as being unsafe on account of the length of loose cable used. The rails were then loaded on the flatcar by being carried up the incline by enrollees using rail tongs and resting the rails on the rollers. That this change was wise is evidenced by the fact that no serious or lost-time accident occurred while loading. One lost-time accident occurred while unloading steel. Considering the nature of the work this is considered a good record.

The flat cars were placed from 300 to 400 feet from end of the track and rails and ties brought on hand push cars for loading. This was done to facilitate the pulling of spikes and removal of rail and tie plates. All the different operations were assigned to special crews. Six rails were loaded on push cars at a time and taken to the car. This was found to release enough ties for a push-car load and to keep things moving in good shape. The average day's work was about 70 rails with accompanying ties, etc. Cars loaded in the field one day were unloaded in the yard the next day.

Materials salvaged consisted of rails that average 75 pounds to the yard, or about 825 pounds to the rail, spikes, tie plates, angle bars (rail connecting plates), bolts and cross ties. The salvaging of the cross ties delayed the progress of the work to a considerable extent. All the materials were hauled to the storage yard at Dunaway and piled for reshipping.

All metal salvaged from the railroad was advertised for sale and it was sold to the high bidder at $12.56 per ton (long). Ties were salvaged in order to make a supply of

CCC enrollees salvaging rails and materials from Owyhee Dam railroad

cheap fuel available for the new settlers on the project. They were advertised and the bids received varied from $0.50 to $3.50 per cord, with no one person bidding for the whole lot. After all high bidders were satisfied, the ties were placed on sale at $2 per cord and all were sold with little difficulty. All metal purchased was reloaded and shipped on orders which amounted to 65 railroad carloads and 12 truck loads totaling 3,265.85 long tons. The sale of ties was handled through the foreman of the Government concrete pipe plant. Some of the ties were piled on the right-of-way and were hauled away by the purchaser. The remainder was sold at the storage yard and was loaded and hauled by the purchaser. Ties sold amounted to 954 cords. It is estimated that approximately 150 cords of ties were too badly rotted to salvage. In addition, ties estimated at about 150 cords and approximately 100 rails were saved for future use by the O. & M. forces.

Old railroad tunnel on operating road to Owyhee Dam

The work accomplished by CCC forces in connection with this project was more than the actual work of salvaging the railroad material. At the beginning, several days were spent at the Owyhee Dam cleaning up used and surplus material and transporting it to Dunaway for future use on the project. After removing all material from the right-of-way the storage yard was cleaned up and the ties and rails reserved for O. & M. forces were moved to the pipe plant. The gasoline storage tank and other material were also moved there for storage.

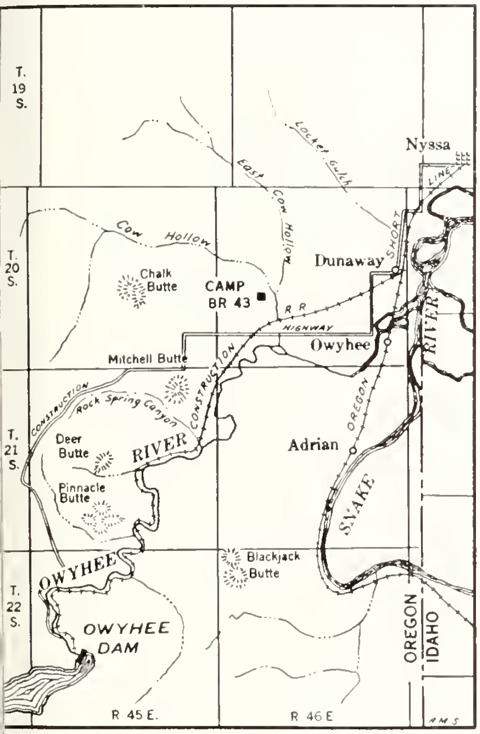
The Owyhee project paid rental on the flat cars and coach amounting to $1,400, and bought the lumber for stakes on cars, which amounted to approximately $150; $43,509.52 was realized by the Government from the sale of rails, spikes, plates, cross ties and the gasoline locomotive; 8,394 enrollee man-days were required to complete the entire salvage operation.

Considering the type of work, it is believed that the safety record was very good. The only lost-time accident occurred while unloading steel at the storage yard and was caused by a rail slipping from skid rail and hitting an enrollee on the foot, breaking one of the bones between the toes and ankle. Switching of cars nearby was a contributing cause to the accident, as the enrollee was watching them and not paying attention to his work. Time lost was 52 days or 0.6 percent of the total enrollee man-days spent on the job.

Easy access to Owyhee Dam is essential for operating purposes and abandonment of the railroad offered the opportunity of securing a fine road with an easy grade to replace the tortuous old side hill road in use during the construction period. Work on the new highway to be built on the old railroad grade started sometime ago. The widening of the road bed has been roughed in for about half the distance. An effort is being made to save as much of the gravel ballast as possible to reduce the gravel surfacing required. The width of road bed will average better than 18 feet and only a few short stretches will be less than 18 feet. Traffic on this road is expected to be light, and the road being built will take care of it for years to come, except for the two pile bridges across the river which will need repair and eventual replacement.

The travel of visitors to see the dam, which is truly a notable structure, has always been restricted by the necessity of driving over a rough road, winding through bare hills, hot in the summer and muddy when wet. The route through the canyon will be pleasant to drive, with water grade and easy curves and will be interesting, with its highly colored canyon walls, hot springs and wild fowl at all seasons. It is hoped that many local people and travelers will now get acquainted with the huge structure in its steep-walled canyon setting and with its unique and spectacular "glory hole" spillway.

Oregon State showing Owyhee railroad



Conservation by Silt Lining of Ditches

(*Continued from page 138*)

mounts of water as desired. Numerous test vells would then be installed at selected locations on the same area for the observation f ground water fluctuations.

Before treating or lining the test ditches, he next step would be the measurement of ercolation losses therefrom, following which he ditch sections would be treated with the arious mixtures found to be effective in the aboratory tests, a different mixture or thickess of the sealing agent being applied to ach ditch. After such treatment water in arying quantities and heads would be turned n, and held, and the percolation losses measred. Differences between the losses before nd after treatment would indicate the effeciveness of the various applications. The ffects of different methods and degrees of ompaction of the lining in place would also e tested.

In conjunction with or supplementing the eld tests described above, similar observaions and measurements should be made along ctual ditches that are used for the delivery f irrigation water wherever silt lining perations are undertaken.

Laboratory and field tests should be correlated as much as possible with the objective of ultimately using standard laboratory tests as a guide and control for construction operations. The writer has made a few rough tests with mixtures, which indicate that a mixture of 20 percent silt and 80 percent sand is practically as tight as the silt alone. This would importantly affect the cost, especially in localities where there is a scarcity of available silt. Further tests should readily determine this detail.

It is thought that a thin layer of silt, harrowed, or worked into the underlying soil to a depth of 6 or 8 inches, would produce the best practical effect, and would result in a firm and fairly permanent construction, good for many years of satisfactory service.

EDITOR'S NOTE.—The terms "silt" and "silt lining" appear frequently in the above article and are supported by Webster's Dictionary and local usage. Top soils on the Newlands project, which occupy a portion of the ancient Lake Lahontan, are mostly of sedimentary origin. In other localities, where fine soils are employed to stop percolation from ditches, the terms "clay" and "clay blanketing" have similar application.

Boca Dam Construction Work Resumed

AFTER the cessation of construction work on the Boca Dam, Truckee storage project, for the more inclement part of the winter, operations have been resumed with the expectation of completing such work by midsummer.

When extreme cold made earth-fill placing impracticable all main activities were discontinued on November 10, 1938, with only a limited amount of rock fill and riprap placing and some inside work being done after that date. More favorable weather was had during the latter part of November and the fore part of December but not sufficiently so to remove the ground frost and allow further earth-fill placing.

Spring weather arrived somewhat sooner than usual this year but the location of Boca is such that settled weather conditions could not be assured with reasonable certainty as early as the change actually took place, and it was not until April 10 that work was resumed. At that time a small force began outlet pipe welding and general preparatory activities necessary for the remaining outlet works construction, the completion of the spillway gate structure, and the final work on the dam embankment. The relatively light snowfall during the winter resulted in better ground surface conditions than during the previous spring and favorable progress has been made although there has been a more deliberate execution of the work on account of the type of work remaining, its variety, and the almost certain early completion of the project.

When the work was discontinued, last fall, the outlet tunnel was complete with the high-pressure gates installed, the spillway was complete except for the construction of the operating and roadway deck of the gate structure and the radial gate installations, and the embankment was complete to within 8 feet of its contemplated crest. With this point in construction reached, it was not only safe and possible, but necessary, to impound water in the reservoir. On April 23, 1939, the reservoir water surface had reached the elevation of the spillway crest and the first water flowed through the spillway. The capacity of the reservoir at this stage, water surface elevation 5,589.0, is 26,952 acre-feet, and the water surface area is 796 acres. At maximum capacity, the reservoir will contain 41,142 acre-feet of water with an area of 981 acres.

By the forepart of May all earth fill had been placed, the spillway gate operating and roadway decks poured, and preparations were being made to place the remaining rock fill and riprap, and to install the radial gates. Some delay in rock hauling occurred as it is desirable to pass over the spillway road deck in traveling from the rock pit to the main portion of the embankment and the concrete deck required considerable time for curing before such use.

Establishment of CCC Camp at Boca Dam

In connection with the completion of Boca Dam, the main feature of the Truckee storage project, Nevada-California, CCC Camp BR-92 has been established at the dam site, near Boca, Calif. The camp was previously occupied as a side camp by a detachment from Camp BR-34, Fallon, Nev., and has been improved to accommodate the full company assigned to this location. Approval was given by the Secretary for the transfer of the camp superintendent and five junior foremen, formerly employed at Camp BR-35, Fallon, Nev., to the Boca Camp. These men, being experienced in both camp activities and the work to be performed, present an advantage to the new camp.

As an aid to obtaining proper, well-appearing surroundings for the completed dam, the CCC enrollees are expected to accomplish considerable necessary landscaping, remove undesirable and unsightly structures and other materials, erect some power and telephone pole lines, replace a portion of the local water system which is within the reservoir area, possibly build the dam parapet and curb walls and do other necessary work which is not included in or related to the construction contract.

Thousand Persons Celebrate Delivery of First Water to Payette Division

47,000-ACRE TRACT DEDICATED

ON a bright Sunday afternoon, April 30, nearly a thousand irrigation-minded citizens gathered on the bank of the new Black Canyon Canal to celebrate the first delivery of Payette River water to the lands of the Payette division of the Boise project. Early Black Canyon settlers, businessmen, and statesmen alike gathered there to rejoice and thank God for the common good.

Featured on the program, of which District Judge Thomas E. Buckner was chairman, were talks by Governor Bottolfsen, former Governor Baldridge and R. J. Newell, construction engineer of the Boise and Owyhee projects.

Governor Bottolfsen, a man with 30 years of contact with irrigation on the Lost River project declared that officials who took part in this development "must be happy to have more homes, better towns, and more taxable property developed from the desert."

Former Governor Baldridge, who gave the principal address, traced the development of the project from the first plans in 1903 and the coming of homesteaders, through the early years of hope and discouragement to the organization in 1910 of the Black Canyon Irrigation District, and the completion of the first unit in 1918. He paid high tribute to Senator Borah and Congressman White for their efforts in securing funds.

Construction Engineer Newell told the throng that the "engineers are just as happy to see the water go down the ditches as any of you." He related with touches of humor some of the difficulties of the early part of the work in October 1935, when the surveying began in the rain and snow of an early winter. He spoke briefly of some of the construction difficulties and gave special credit to his engineering forces, mentioning in particular the untiring efforts of Earl Harmon, resident engineer on the Black Canyon Canal; Guy Sperry, who had charge of construction of the laterals; and Ted Nelson, water master.

Particularly gratifying to those who have associated themselves with the promotion of the Payette division of the Boise project was the recent completion of the Black Canyon Canal and the subsequent delivery of the first Payette River water into the Boise Valley. To many it was the culmination of more than a third of a century of promotion—the result of a fight longer than the Thirty-Year War. Probably experiencing the greatest satisfaction were the group of homesteaders who long ago settled on the new land only to be starved out but who now have returned to resume their original plans.

History of Payette Division

Surveys were begun by the Reclamation Service in 1903 on the combined Payette-Boise project. Construction of the Arrowrock division was started separately in 1906, leaving the Payette division (known locally as the Black Canyon) to wait. The Black Canyon Irrigation District was organized 1909–10. Much of the land was settled about this time. Engineers were hired a the project was enlarged and studied wi a view of issuing bonds to finance constru tion. Houses sprang up, schoolhouses w built, and schools and churches were co ducted. Old-timers say that homes we established on nearly all the land of the e tire division. Hopes were high and the a was full of dust from the clearing, leveli and breaking of land.

Bonds could not be sold so no water ca and the discouraged settlers were forced leave their new homes. Most of the hon steaders then relinquished to the State wi a view to development under the Carey A Again no results.

Next followed a period of agitation a requests for Government construction. 1915 and 1916 topographic surveys were ma and a plan was developed for watering part of the district with water reclaim from drains in the vicinity of Caldwe This water was siphoned under the Boi River and conducted out upon the "Fi Unit," some 7,000 acres lying north of Notu Construction was begun in 1918 and the fi water was delivered in 1919. This unit w settled solidly in 1 year.

The next development of consequence w the construction of the Black Canyon Dam 1923–24. Built 7 miles upstream from t town of Emmett, this 90-foot high, concre dam diverts the waters of the Payette Riv for the joint use of the Emmett Irrigati District and the "second unit" of the Payet division. In 1925 a power plant was built Black Canyon Dam to furnish power f pumping on the Gem District and ultimate on the "second unit."

Deadwood Dam was built in 1929–30 the Deadwood River, an upper tributary the Payette River. Having a storage capa ity of 162,000 acre-feet this dam steadi the flow of the Payette River at Black Ca yon Dam.

In 1935 an allotment of emergency fun was secured and construction of the "secon unit" was begun in earnest. The major po tion of the canal system and distribution f the gravity division is now complete. Fro the 30-mille long main canal nearly 7 milli cubic yards of earth were excavated. A purtenant to this canal are nine tunnels, miles of concrete lining, and countless small structures. The A and D line branch cana

Black Canyon Canal Completed

The main Black Canyon Canal of the Payette division of the Boise project has been completed. With normal progress on additional laterals and other necessary irrigation structures about 26,000 acres of Payette lands are expected to be in a position to receive water before the year is out.

Completion of the canal to the end of the Gravity section climaxed 2 years of construction work during which 80 miles of canal, 37 bridges, 2 miles of tunnels and culverts, and 3 of roads were built. Black Canyon Canal is itself 29 miles long, bores through high hills in its path by means of 9 separate concrete-lined tunnels, stretches over extensive reaches of concrete bench flume and steel-reinforced concrete canal lining, and crosses under numerous bridges.

Many landowners in the Payette area have been ready and waiting for the water to irrigate their future farms. Those on land capable of being served by gravity expect to get their water before the end of the year. Others will have to wait, however. Almost half the immediately irrigable Payette division lands—about 24,000 acres—can be served only by pumping. Additional water storage and pumping equipment is required.

The list of prospective homesteaders for Payette division lands, some of which may be opened to public entry late this year, is growing daily. Quick settlement of all openings is expected. Farmers and other refugees from drought areas in the Payette lands have sought all available farms and created a strong demand for the land. Few farms are for rent.

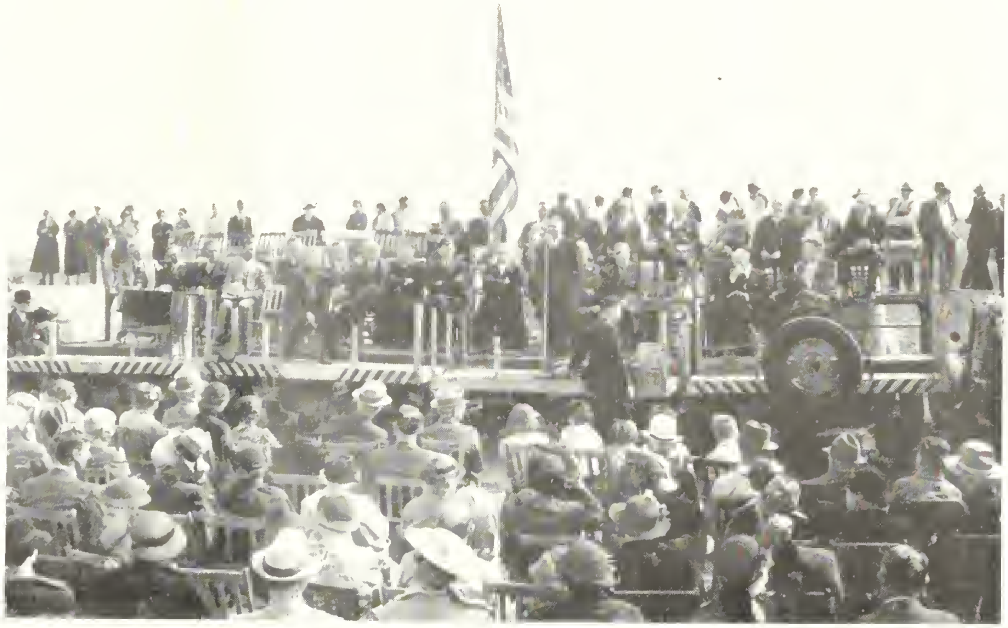
Dedication of Payette Division—Governor of Idaho speaking

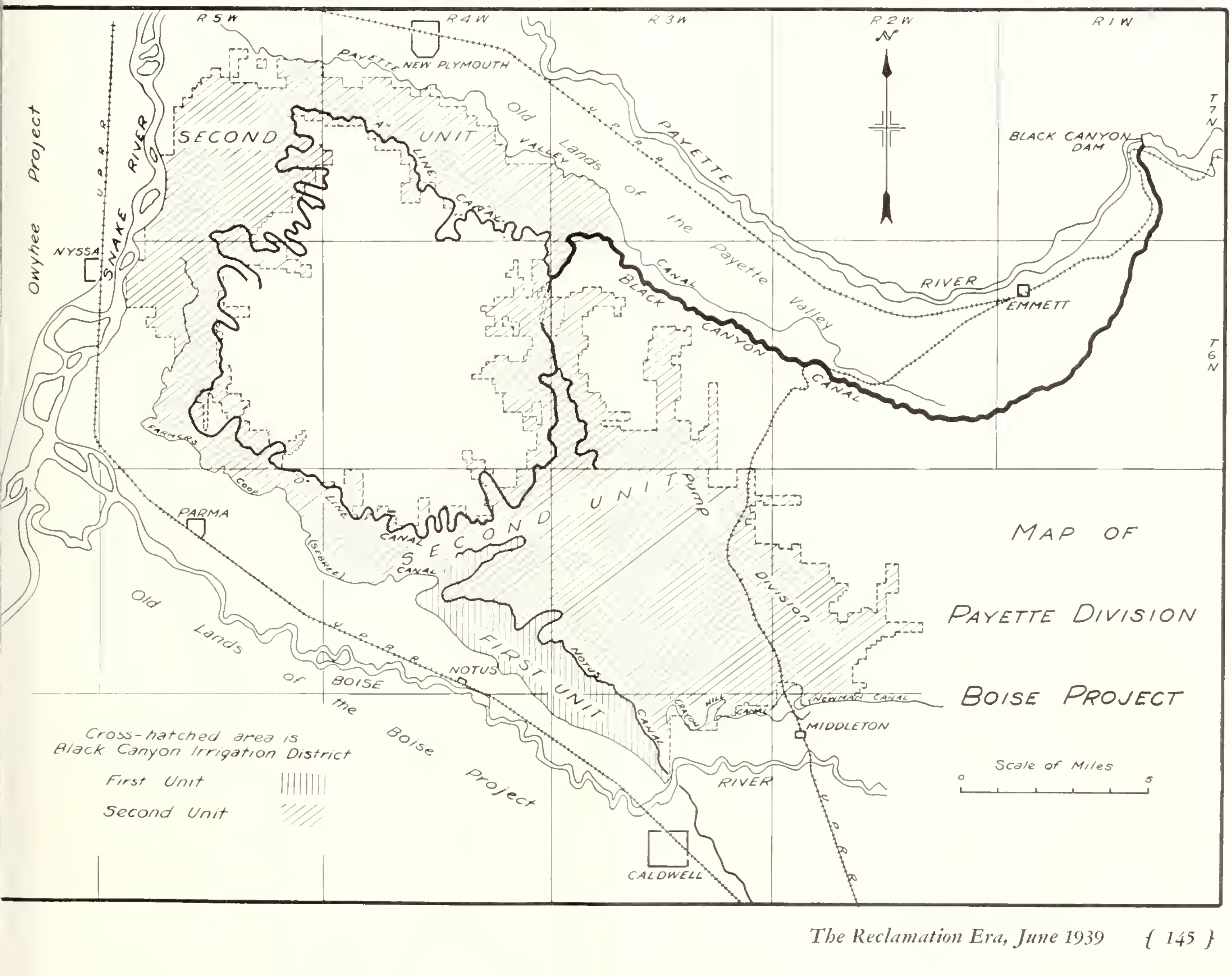
are nearing completion and the lateral system is well under way. Water is being delivered through the D line as far west as Parma.

Settlement

After nearly 30 years, history is repeating itself; again houses are springing up, land is being cleared, leveled, corrugated, and planted to crops. This time the results will be different for already water is being delivered to those who have land ready for it. Several thousand acres have been cleared and are rapidly being put in shape. On a few of the farms the crops are already up. Present developments indicate that the 1940 season will find nearly all the gravity lands being prepared for crops.

There is no problem of settlement. The 47,000 acres of the division may be accounted for as follows: Most of the land (39,000 acres) is already privately owned. This land





Top: Black Canyon Canal winds its w into the distance, Payette Valley at rig
Center: Black Canyon Canal at Tunn No. 2. Emmett Cherry Orchards at rig
Bottom: Aerial view Black Canyon Da and headworks of Black Canyon Can

is in high demand. Speculation has be discouraged by the regular reclamation co tract which provides that if land be sold f more than the appraised valuation, half tl excess reverts to the district as payment f construction and operation and maintenan charges against the land involved. There a about 5,000 acres of one time Carey Act lan pending decision on status. There are 2,3 acres of other withdrawn land which will opened to entry when water is availab About 1,000 acres of State land are still u sold. The soil of the entire region is ver deep and fertile. Old-timers opine that, whe developed, this area will compare favorab with the Wilder bench, a highly producti area on the Arrowrock division.

Central Valley Project on Convention Programs

WITH the attraction of the Golden Ga International Exposition on Treasure Islan the city of San Francisco is a mecca f national conventions this year, and the Ce tral Valley project is receiving attention o several convention programs. Supervisin Engineer Walker R. Young spoke on Recl mation and the Central Valley Project befo the Heavy Construction Section of the twe tieth annual meeting of the Associated Ge eral Contractors of America in San Francis on March 8. On April 27 Mr. Young pr sented an illustrated lecture on the proje before the San Francisco Section of the Ame ican Society of Mechanical Engineers.

In July Mr. Young is scheduled to discu Effects of the Central Valley Project upo Navigation at a meeting of the Waterwa Division of the American Society of Civ Engineers in San Francisco. Before the Irr gation Division of the same convention, Eng neer Courtlandt Eaton is to speak on Irrig tion Features of the Central Valley Project.

Construction of Wickiup Reservoi by CCC Forces

(*Continued from page 140*)

yard dragline, one 1½-cubic-yard powe shovel, three 75-horsepower tractors equipp with bulldozers, one 75-horsepower and on 65-horsepower tractors without bulldozer one 65-horsepower tractor equipped with bul dozer, three 12-cubic-yard and one 8-cubi yard carry-all scrapers, one 3-drum sheep foot roller, six 5-cubic-yard dumptor truck six 1½-cubic-yard dump trucks, pumps, an other miscellaneous equipment as required.

First water finding its way through the canal

The completed canal will serve 47,000 acres of land—A part of the Boise project

Excavating Equipment

Salt Lake Aqueduct Tunnels, Provo River Project, Utah

By J. J. BERGER, *Associate Engineer*

THE Salt Lake Aqueduct, a unit of the Provo River project, Utah, will convey storage water from the Deer Creek Reservoir, now under construction in Provo Canyon, to Salt Lake Valley for supplemental irrigation and domestic uses by the Metropolitan Water District of Salt Lake, the largest subscriber of stock in the Provo River Water Users' Association. The aqueduct will have a capacity of 150 second-feet and will be in a covered conduit for its entire length of 40 miles.

On July 27, 1938, an appropriation of $2,500,000 of P. W. A. funds was approved for the commencement of construction of the aqueduct which is estimated to cost $5,500,000. The Alpine-Draper Tunnel, 15,000 feet in length, and the Olmsted Tunnel, 3,600 feet in length, were selected as the features on which work could be started in the shortest time.

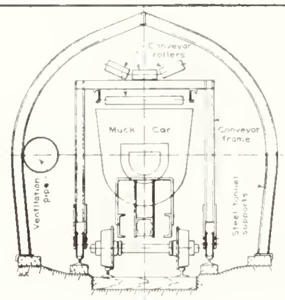


FIGURE 1
TYPICAL SECTION
6'-6" DIAMETER HORSESHOE TUNNEL

The completion of field surveys, testing, and plans and specifications permitted the advertisement of this work on September 28, 1938. The first bids, opened October 27, 1938, were rejected and as a result of the readvertisement and subsequent opening of bids on November 22, 1938, George K. Thompson & Co., of Los Angeles, Calif., was awarded the contract for the construction of the two tunnels on the low bid of $746,575.50.

This article deals solely with the construction of the 15,000-foot Alpine-Draper Tunnel, as both tunnels are being driven by similar methods and equipment, and are identical in size, each being excavated to a 7-foot, 8-inch diameter horseshoe section which will be finished to a 6-foot, 6-inch diameter when lined with 7 inches of concrete.

For making electric power available on the job, the contractor constructed a transmission line 7 miles long to both tunnel portals from the closest line, near the town of Alpine. This power line, having a voltage of 44,000, is stepped down with one 150 kilovolt-ampere and one 200 kilovolt-ampere transformer to 440 volts.

The equipment used in excavating the tunnel consists of one Ingersoll-Rand automatic-feed water leyner drill, a 5-cubic-foot capacity Eimco-Finlay air-powered mucking machine, a 120-foot belt conveyor (figs. 1 and 2), powered by a 5-horsepower air motor and a 5-ton General Electric battery locomotive which hauls ten, 62-cubic-foot dump cars of the type shown by the accompanying photograph No. 1. Air for this equipment is supplied by one Ingersoll-Rand 360-cubic-foot air-cooled compressor and one 360-cubic-foot Gardner-Denver water-cooled compressor, each powered with a 75-horsepower electric motor. Water for construction operations is pumped a distance of 1,500 feet from a spring into a 2,000-gallon storage tank.

A force of 30 to 35 men, divided into three 8-hour shifts, have advanced the tunnel an average distance of 38 feet per day and as much as 44 feet in 24 hours in the shattered quartzite formation encountered for the first 2,000 feet. The initial step in the excavation operations consists of setting up the drill and drilling a round of 7 to 12 holes, each 6 feet in depth. This work is done by one driller and one chuck tender using the drill mounted on a crossarm attached to a vertical column. The drilling operations require from 50 to 60 minutes, and while in progress, one miner and one laborer trim the walls and roof of the tunnel immediately back of the heading and install the steel supports which consist of 4-inch 13.8-pound H-sections, and the necessary lagging.

Upon completion of drilling operations and while the drill and column are being dismantled, ties are laid for the 35-pound main track rail and slide rails are moved ahead as required to provide track for the 20 feet nearest the heading. Following the drilling operations, preparations are made to blast by loading the drill holes with an average of three sticks of 40-percent gelatin explosives and moving the mucking machine, conveyor, lights, and other equipment at the heading back from the face about 50 feet. The tunnel crew, followed by the shift boss, walk back to the firing switch about 1,000 feet from the heading, from which point the compressor operator outside, is notified by telephone to shut off the ventilating fan. The shift boss, charged with the responsibility of safety precautions, makes the necessary electrical connections, which set off the blast. Approximately 50 to 80 minutes elapse between drilling and blasting, and an additional 20 to 30 minutes is required to clear the tunnel of dust and fumes, using a reversible-type blower powered by a 20-horsepower electric motor, which is started up on suction and reversed to blowing in about 15 minutes.

The next operation consists of returning to the heading and moving the loading equipment in place to begin work. The mucking machine pulls the conveyor ahead, cleaning up the floor of the tunnel as it advances.

The conveyor (figs. 1 and 2), designed by the contractor for the Aqueduct tunnels, consists of a structural steel gantry frame which supports the overhead endless belt 24 inches wide, with end rollers 120 feet apart. This length provides sufficient room underneath it for the ten 62-cubic-foot muck cars required to haul all the muck from one round of blasting. Motive power for the conveyor belt is furnished by a 5-horsepower Ingersoll-Rand air motor set on the rear end of the conveyor frame. The motor is controlled by the train brakeman who also directs the spotting of the cars for loading by signallying the train motorman. The wheels of the gantry ride on 20-pound mine rails set on 4-foot gage out-

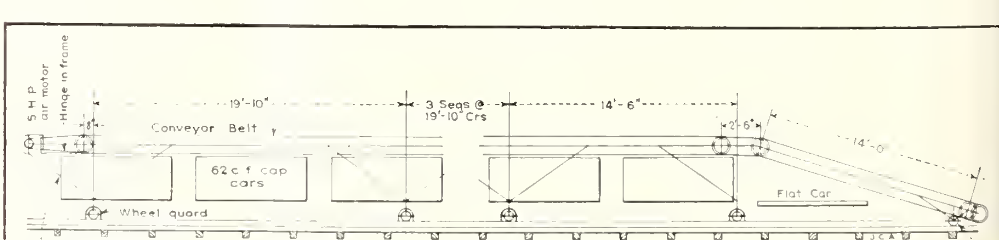


FIGURE 2
LONGITUDINAL SECTION
DIAGRAMMATIC SKETCH OF CONVEYOR

side the main track rails. The gantry rails are spiked longitudinally to 3- by 8-inch planks 15 feet long. As the conveyor moves ahead the 15-foot lengths of track are carried forward and at no time is there more than 200 linear feet of gantry track in the tunnel.

Loading operations, consisting of mucking and loading the material from one round of blasting, usually require 30 to 45 minutes, and an entire cycle of operations requires 2 hours and 35 minutes to 3 hours and 45 minutes, resulting in an average daily progress of 38 feet in the type of material encountered in the Alpine-Draper tunnel.

By reference to figure 1, it will be noted that the clearance between the muck cars and the conveyor frame is small. This feature was intentionally incorporated in the design to require the construction of the main track to close alinement and grade, and although requiring considerable care in laying track, has proved advantageous by speeding up the operation of the train through the tunnel. Photograph No. 2 of the Alpine-Draper tunnel, shows how completely the cross-section of the tunnel inside the steel supports is filled with the ventilation and air lines and the mucking equipment. This condition created a problem in projecting the tunnel lines and grades up to the heading which was solved by installing a hinge on the end portion of the gantry frame supporting the air motor. This permitted the motor, which is on the center line of the tunnel, to be lowered about 6 inches. With this arrangement and the use of a transit with tripod legs extended to a height of instrument of 6½ feet, the lines and grades are carried forward above the conveyor belt to the tunnel heading.

The practicability of using this type of equipment in the excavation of small diameter tunnels is well demonstrated in the progress made to date in the excavation of the Olmsted tunnel in a competent limestone formation where an average daily progress of 24 feet was made during the month of April using identical mucking and loading equipment and two Ingersol-Rand water leyner drills which required 2½ to 3 hours drilling time for 15 to 18 six-foot holes.

Upper: Rocker-type Steel Dump Car
Lower: Mucking Machine and Conveyor in Alpine-Draper Tunnel

Noxious Weed Eradication

WITH the Bureau of Reclamation as cosponsor, the El Paso County Water Improvement District No. 1 submitted to the local W. P. A. office a proposal for the eradication of noxious weeds in El Paso County. The proposal provided for all labor to be supplied by W. P. A. and the district to furnish all materials, supplies, and equipment. The project was approved and men put to work with the Bureau cooperating by supplying trucks for the movement of men, equipment, and supplies. Two crews were started on this eradication program, which it is planned to increase to seven to get the work well under way.

New School on Sun River Project

PROGRESS on the Sun River project in Montana is found depicted by the laying of a foundation for a new high school at Fairfield early this year.

Yakima Wool Clip

THE Yakima project, in Washington, reports 75 percent of the 1939 wool crop has been moved to market at prices ranging from 17 to 21½ cents per pound, and that this year's clip is of excellent quality selling from 2 to 4 cents above that of last year.

Representative Edward T. Taylor Honored

ON the morning of May 10, Hon. Edward T. Taylor, Representative from the Fourth District of Colorado and Chairman of the Interior Subcommittee on Appropriations of the House, was presented with a gavel and base by the National Reclamation Association representing 15 Reclamation States of the arid West. The presentation speech was made by Mr. O. S. Warden, its president, in the presence of other members of the Interior Subcommittee on Appropriations, Commissioner Page, Floyd Hagie, secretary-manager of the National Reclamation Association, and others gathered at this informal ceremony.

Mr. Warden, in a beautiful and fitting manner, presented this token with the following words which were printed in the Appendix of the Congressional Record of May 10:

"I am well along in my fourth year as president of the National Reclamation Association. In these 4 years, and those just back of them, there has been notable accomplishment until reclamation has become a permanent national policy. We are making thousands of new western homes. This has come about largely by a continually growing legislative support. The Interior Department measure that has just come from the Congress merits the grateful appreciation of each Western State.

"We have come this morning to a familiar office room for the most delightful privilege in all of my reclamation work. I wish that I could find the words that would fully measure and express the heart-to-heart gratitude and the personal admiration that the people of 15 great States of the West would like to have me use as I imperfectly convey to Congressman Edward T. Taylor thanks for great and consistent service. Through a long and earnest life he has been an unfaltering supporter of the cause of reclamation. He has been a foremost leader whom we have been delighted to follow—from the time when the Congress passed the reclamation act in the administration of Theodore Roosevelt—down to this year and day. Year after year—session after session—his counsel has always been wise, his effort has been tireless, his courage has never failed. After all of these years of faithful work any symbol th can be fashioned does but poorly reveal t accomplishment of half a century. The sto begins with the simple diversion of wat upon the land. At the end is the gre Boulder Dam and other multiple purpo enterprises.

"The choicest gift of all that we can brin to you, Mr. Taylor, is the thanks that co from thousands of new homes your effor have helped to build.

"Still those who have worked with y wish to give you something you can kee This testimonial of friendship and esteem made from wood that came from each of t 15 western reclamation States, gathered the directors of this association. The hand work of the maker of this gavel is interes ing. Reading from the dark side of t handle, the different kinds of wood appe in the order here indicated. The history many of the pieces is interesting.

"Idaho: Juniper. This piece of wood ca from the Fifield Basin juniper which is ov 1,600 years old. This tree started to gro in the year A. D. 306 in the lava fields on t Snake River plains about 15 miles southwe from Idaho Falls and was still living whe cut in 1928 by a dry farmer for fuel. As fa as known, this is by far the oldest tree eve to have been found in Idaho. The thicknes of its rings have been measured and used a an indicator of precipitation changes durin the bygone centuries.

"Wyoming: Red cedar. This wood come from the Snowy Range area west of Larami Wyo.

"Washington: Apple wood. This appl wood is a part of a limb of an apple tre of which the original stock was planted i 1879 on the old John F. McClure homestead located about 5 miles west of Yakima, an now owned by Congdon Orchards, Inc. At th time Mr. McClure set out a few trees for family orchard, the whole section in which it was planted was in sagebrush and princi pally inhabited by jackrabbits and rattle snakes. This was prior to the advent o Mr. Chester A. Congdon who visualized th potential development of what he termed th second Garden of Eden. Mr. Congdon pur chased the land and financed the Congdo Ditch Co. which is now known as the Yakim Valley Canal Co. It was one of the earl private irrigation projects in the Yakim Valley and embraced the irrigation of 4,30 acres.

"Texas: Mesquite from Harlingen, Tex.

"Arizona: Orangewood. The tree which thi orangewood came from was planted on th Yuma Mesa, part of the old Blaisdell ranch by Hiram W. Blaisdell, during the year 1892 and was a part of the first orange orchar of any size that was planted in Arizona. Th

Representative Edward T. Taylor and Commissioner Page at presentation

and now is part of a subdivision of the city of Yuma and is owned by Mr. M. A. Holmes.

"Colorado: Oak. This piece of wood came out of the original seal pieces which close the roller gates on the Grand River Diversion Dam.

"South Dakota: Cedar. This piece of wood was obtained from the Black Hills of South Dakota, which is the watershed of the Belle Fourche reclamation project, and several small irrigated areas in western South Dakota and eastern Wyoming. This wood was obtained in the vicinity of Deadwood, S. Dak., and in the vicinity of the monument erected to President Theodore Roosevelt, the father of Federal reclamation.

"Montana: Larch. This wood came from the banks of the Missouri River at Great Falls, Mont.

"North Dakota: Cedar. This wood comes from the Little Missouri River Valley where Teddy Roosevelt came as a young man seeking to regain his health. His original log cabin was built from this very type of wood which he had floated upstream in the Little Missouri. The species of wood later propagated north in the valley until today it surrounds his old ranch site. It is unique that nowhere else in North Dakota does red cedar flourish.

"Utah: Red pine. A piece of native red pine taken from one of the old floor joists of the 'Lion House,' home of Brigham Young in Salt Lake City. This edifice was located within the area which Brigham Young and his followers first irrigated, a small area of land near where the present temple and the center of Salt Lake City is located by turning the water through furrows made by use of oxen and crude plows from City Creek.

"Nebraska: Cedar. This cedar came from the North Platte reclamation project in Nebraska.

"Nevada: Redwood. This piece of redwood was taken from a diversion structure built in the year 1868, long before the Reclamation Act, at which time there were several direct diversions from the Carson River. After the Reclamation Service, then under the Geological Survey, began investigations for the establishment of the Newlands project, then Truckee-Carson project, the water rights of these old irrigators were acquired by the United States and an irrigation system was constructed and these old diversion head works were abandoned. This piece of redwood has been standing solid and firm since the day it was first erected.

"California: Orangewood. Wood of an orange tree in the Central Valley which died from lack of water due to the receding water table, a condition which the completion of the Central Valley project will correct for all time.

"New Mexico: Cedar. Old original cedar of Lebanon wood from the Arch Hurley Conservancy District near Tucumcari, N. Mex.

"Oregon: Juniper. The tree from which this wood came grew on the right-of-way now being cleared for the North Unit Canal. If you examine the ends of these pieces under the microscope, you will observe how tight the annular rings are, indicating the small annual precipitation in the area where the tree grew. It is because of this low precipitation that irrigation is needed in this country to produce farm crops. Given water, however, these lands produce abundantly.

"The core in the head of the gavel is Texas mesquite. The handle is New Mexico cedar, and the block is New Mexico cedar.

"Upon the block is this inscription:

"'In appreciation of long and valuable service to the 15 reclamation States, this gavel and base made from significant woods of each State is presented to Hon. Edward T. Taylor by the National Reclamation Association.'

"To you, then, our friend, statesman, and patriot, in a great national service, we present this gavel with the wish that there may yet remain for you many, many years in that health and happiness you so richly deserve. Whenever you sound the gavel we will be ready to follow your leadership."

Grasshopper Control in Klamath County, Oregon

By C. A. HENDERSON, *County Agricultural Agent*

GRASSHOPPER control on or adjacent to the Klamath project in California and Oregon is not a new thing. *Camnula pellucida*, commonly called the yellow-winged grasshopper, has always been present on prairies and mountain meadows. When neglected for a few years, to be followed by a drought condition, they very frequently assumed epidemic proportions and ravaged large areas of range pasture or grain lands. Numerous other hoppers occasionally do considerable damage but the yellow-winged hopper has been by far the most serious.

Areas where grasshoppers thrive best are generally thinly populated, with considerable waste land, with ideal places for the depositing of eggs. The reclamation of new lands in the Klamath Basin has generally resulted at the start in the waging of an active battle on hoppers. Frequently large areas of land have been uncovered by receding water where inflow has been diverted and dikes constructed, resulting in waste land until such time as cropping could be undertaken. A minimum amount of grasshoppers usually filter in to areas of this kind, deposit eggs, and multiply for about 2 years before being noticed. The third year generally results in a major epidemic.

Controlling these outbreaks has been an annual problem for many years and it has only been in the past 3 or 4 years that the problem has been fairly well solved. All methods of control have been tried out. At first the placing of rows of straw or hay in the fields for traps was used, but results were of little value except that this method was rather spectacular. Following this, a burner was developed, but this was found to be too costly inasmuch as these machines could not cover a very wide area. In fact, on one occasion the ground was sufficiently warmed up after the burning machine passed over, causing all the other eggs still in the ground to hatch immediately, after which more hoppers were found on the burned-over area than on the unburned. The next method that was used rather extensively was dusting with various arsenicals and cyanide dusts. Needless to say, these were not particularly effective and generally caused more headaches on the part of the users than anything else.

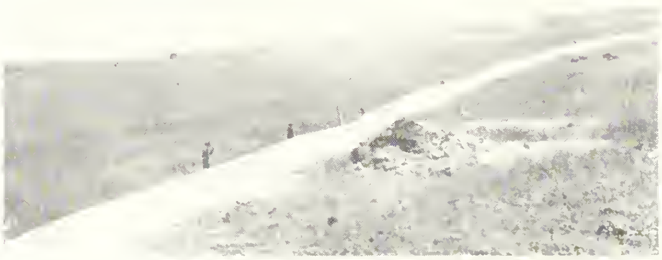
About this time oil sprays were used along with "hopper dozers" but neither of these methods could cover sufficient ground to be effective. The first tangible control, of course, was by use of poisoned bait, the old mixture of bran, sawdust, molasses, and arsenic giving reasonably good results. This material was first mixed by hand, using paris green, white arsenic, sodium fluocilicate or other arsenicals. White arsenic was found to be the most economical and effective and tons of this material were used, at one time an entire carload of barreled white arsenic being purchased. Mixing in such quantities made hand mixing difficult and unsatisfactory, resulting in the making of a large mechanical mixer capable of turning out a half ton per mix. This was operated by a gasoline engine and could be put on trucks and hauled to infested areas. At times this machine mixed 20 to 25 tons per day for periods of time extending up to nearly 2 months, millions of pounds of poisoned bran mash being used in some of these early campaigns.

Later in this work liquid sodium arsenite was thought to be more effective in that more

Typical pit 50 percent filled with grasshoppers

Fences built in a V-shape in advance of moving hordes of grasshoppers

Fourteen-inch fences prove effective in control of operations



Grasshoppers taken in one of many holes used with tin fences

even distribution of poison was secured in mixing, so this material has been used since that time and has given good results. Mixtures used during this period of time varied but all seemed to have been quite effective when properly mixed and put out. Standard mixture in use at the present time is:

1 sixty-pound sack bran.
2 tied sacks sawdust.
½ gallon sodium arsenite.
10–12 gallons of water.

Molasses was formerly used and when discarded landowners felt that the poison would not be effective as it lost the attractive odor provided by both the molasses and amyl acetate. A close check-up, however, indicates that the sawdust, bran, arsenite, and water mixture is fully as effective and perhaps lasts longer than when the other materials were used.

While poisoning has been of tremendous value in the saving of crops and in the prevention of epidemics or outbreaks beyond control, it has never completely eliminated grasshoppers from the thinly populated favorable grasshopper areas. Landowners have estimated at times that the annual saving in this county has been a half million dollars or more and poisoning has been mainly responsible for this saving.

Extermination has never been lost sight of and methods of control that might lead to complete extermination have been hoped for. Various control measures have been tried, many of which have been particularly effective. Unquestionably, one that has worked well with poisoning is that of egg-bed cultivation. Where eggs were deposited on crop land or pasture land subject to cultivation, plowing and disking have been undertaken both in the fall after the eggs were laid or in the spring months before hatching time. Usually, deep plowing in the fall or early spring has resulted in about a 90 percent destruction of eggs, while disking at weekly intervals during the late fall or early spring months has resulted in egg destruction of 70 to 90 percent. In many localities, however, plowing and disking were not possible due to the condition of the ground, as eggs were frequently deposited in shallow soil on rocky flats or on rough ground. Lands formerly badly infested with grasshoppers, now in crops and under cultivation each year, no longer serve as egg-laying areas for migrating grasshopper bands.

Another method to supplement the regular program was the use of turkeys. This was first started in 1933 when 5,800 turkeys were ranged on the grass lands or range lands adjacent to Upper Klamath Marsh. Close check was maintained in that year and it was found that in areas ranged over by turkeys, gras hopper population had been decreased fro 75 to 80 percent. In 1934, 23,000 turkeys we used in that area and in 1935 a total of 35,00 resulting in almost complete extermination grasshoppers in areas heavily grazed by tu keys. However, this quantity of turkeys wa only sufficient for a small area and could n be used as a general control method in t major districts. It has been, however, a is still recommended to landowners w expect infestations of grasshoppers to migra onto their lands from surrounding are particularly during drought years. We co sider it a major part of our grasshopper co trol program.

In 1938, another addition was made to t control program when tin fences were add to the weapons already in use. The heavie infestation of grasshoppers remaining in t Klamath area was in the Upper Klama Marsh, a thinly settled cattle district, pa of which was privately owned land and pa of which was on the Klamath Indian Rese vation. A total of 2,500 feet of 14-inch t was purchased and used in corralling or hea ing off migratory grasshopper bands. It h been found by past experience that early the season grasshoppers migrate from egg be but stay in dense bands and that these ge erally travel in a given direction. Tin fenc vere constructed in a V shape ahead of such bands, holes being dug at approximately 50-oot intervals, the holes being about 3 feet vide, 3 feet deep, and 5 to 12 feet long. The in fence was placed squarely across the midlle of the holes so the grasshoppers could fall n from either side. More than 1,000 to 1,500 eet of tin was seldom required to kill off any ingle band. It was found that the "hoppers" vould approach this fence, follow the fences ıp or down, and pour into the dug holes like vater over a dam.

In experimental work carried, a total of 92 its were dug and 3,056 cubic feet of "hoppers" vere collected. These "hoppers" were particuırly small, generally being from the first to hird molts and packed in these holes to vhere a cubic foot generally contained a milion "hoppers." Poisoning work was then ndertaken behind the barriers where the rasshoppers would mill around in a circle, lways coming back to the barriers. A checkp and count on several square feet and ards indicated that an additional 6,000 cubic eet of grasshoppers were poisoned behind hese barriers with a very small quantity f the sodium arsenite, sawdust, bran, and vater mixture, making a total of nearly 10 illion grasshoppers killed in this one area.

This particular area has been one of the ıost difficult to control in the entire district nd every year heavy egg beds have been oted on this entire front, nearly 20 miles ong. Following the 1938 control program. r. L. P. Rockwood, Federal entomologist, tated as follows, following the egg-bed surey made in September of that year: "You ad a very efficient control crew this year. am sure that their big killings on the ast side, where Camnula hatched so thickly his spring, have nearly eliminated Camnula nd probably prevented a widespread inestation of the marsh that would have ocurred after these large bands had become vinged. It is certain that there are much ewer eggs on the area where I have been ıaking regular observations, on the east side outh of the Military Crossing to the north de of the Big Wocus Bay and the west de for 4½ miles south of Bolliger's than have seen on this area in the 4 years I ave been working there."

In contrast to this highly successful program carried out on the northwest side of his area where poisoning only was underıken, and not always very well done, we gain have a large deposit of eggs. It is in his area that we hope to carry on a simar control program in 1939 in cooperation ith landowners and the United States Inian Service. We feel that tin fences have lled a gap in control that makes possible ractically complete extinction, or at least the point where natural enemies of the rasshopper can finish the job.

Objection to fences perhaps can be brought p where infestations are on wide areas of vel land, the area being too big for ecoomical use of fences. It has been our experience that if used at the right period of development of the "hoppers" before the bands spread, fences can be used as well on a prairie as on smaller areas. In fact, a part of our work was on flat bottom land several miles in width and length, results being just as good as where grasshoppers were in narrow fields or under bottle-neck conditions. We found that these bands generally moved in a definite direction and that they followed the fence very closely and poured into the holes in such numbers that "hoppers" trying to climb up the bank were generally knocked back into the pits, very few escaping. We expect to purchase an additional several miles of fence this year in an effort to exterminate grasshopper bands in our few remaining areas.

Egg-bed surveys made at the time and following egg deposits are of outstanding importance in any successful control program. These are usually made in Klamath County in conjunction with representatives of the United States Bureau of Entomology and local control officials. Egg beds are mapped with complete description of density, with definite recommendations of what might be expected the following year. Egg beds are checked regularly the following spring and control operations are undertaken as soon as the grasshoppers hatch or start to migrate. Very seldom is work delayed until "hoppers" are half grown, which is the usual case in most areas where egg beds are not properly located.

Another important factor in control is that of cooperation of landowners and public agencies involved. In the Klamath District, the United States Bureau of Reclamation, United States Indian Service, United States Bureau of Entomology, Klamath County, and landowners have worked particularly close. Landowners generally provided the major portion of the labor, considerable equipment such as trucks, wagons, or other miscellaneous supplies; Government agencies, such as United States Bureau of Reclamation, Indian Service, Oregon State College, and State of Oregon supplied poison materials, assistance and supervision, and Klamath County funds for the purchase of materials, supplies, and labor when needed, and complete supervision of the entire project.

Due to rather systematic control, a heavy infestation of grasshoppers is not anticipated on the Klamath project, although there will be considerable work required and some loss will result as the dry year in prospect will mean grasshoppers of all species and varieties will move down from their dry-land homes in higher elevations into the pasture and crop land of the irrigated districts.

Power Development, Yuma Project, Arizona

By W. A. BOETTCHER, *Office Engineer*

IN the November 1928 issue of the RECLAMATION ERA an article by L. N. McClellan, Chief Electrical Engineer, Bureau of Reclamation, described the construction of the Siphon Drop power plant on the Yuma project. The plant was placed in operation on July 26, 1926.

Briefly, the generating equipment consists of two units, each of which is a vertical shaft, 1,000 kilovolt-ampere, 3-phase, 60-cycle, 2,300-volt, alternating current generator, direct-connected to a high speed, propeller-type hydraulic turbine which operates at a speed of 112½ revolutions per minute and rated at 1,160 horsepower at 14 feet head. Power generated is transmitted over a 33,000-volt transmission line, 29¾ miles in length, passing through Yuma, at which point a substation supplies light and power for the office, shops, etc., thence to the B-lift pumping plant which supplies water for the irrigation of lands on the Yuma Mesa, and thence to the boundary pumping plant which pumps drainage water, developed in the drains of the Valley Division of the project, over the levee into the Colorado River. A second 33,000-volt circuit, about 3 miles in length, mounted on the same poles which support the first circuit, connects the Siphon Drop power plant with the Nevada-California Electric Corporation's substation at Yuma.

Contracts with power company for purchase of surplus energy

Very favorable contracts have been made with the Nevada-California Electric Corporation, successor to the Southern Sierras Power Co., for the sale of surplus power. Under the provisions of the first contract covering a 10-year period ending July 30, 1936, the company agreed to take all of the surplus power available at 1 cent per kilowatt-hour for all energy received during the hours from 8 a. m. to 8 p. m., and three-quarters of a cent for all energy during the remainder of the time. Upon the expiration of the first contract a second one was entered into with the same company but at lower rates. The company now pays 6 mills per kilowatt hour for all energy received during the hours from 8 a. m. to 8 p. m., and 4 mills per kilowatt-hour during the remaining hours. However, a more favorable provision for the project is that no demand clause was specified in the later contract for periods during which the project has to purchase power from the power company because of storms or for other causes necessitating plant shut-downs. The company under the terms of the new contract also agreed to advance necessary funds for enlarging the plant and take one-half of the surplus energy at the foregoing specified rates for reimbursement. The remainder of the power purchased by the power company is to be paid for in cash.

Electrification of project farms

All power furnished to project farms is supplied by the Nevada-California Electric Corporation lines. With the development of more efficient transmission methods, the power company has rapidly expanded its distribution system during the past few years until now approximately 75 percent of all houses in the Valley Division of the Yuma project have electrical service. The ability to secure electrical power has greatly increased the number of new, modern homes. It is expected that this trend will continue. In many cases where power is available in farm homes, electric refrigerators, air-conditioning units, ranges and other appliances are used. In addition, feed grinding and pumping are accomplished by electric motors.

Distribution of power

Since the construction of the power plant the several divisions of the Yuma project have benefited materially as indicated by the following tabulation which shows the distribution of the energy generated:

Energy delivered	Totals to Aug. 1, 1928	Totals to Dec. 31, 1938
Used on Yuma project exclusive of Yuma auxiliary project, kilowatt-hours	1, 685, 881	12, 983, 194
Used by Yuma auxiliary project, kilowatt-hours	1, 107, 900	13. 786, 700
Sold to Southern Sierras Power Co. (Nevada-California Electric Corporation), kilowatt-hours	7, 927 603	63, 286, 766
Miscellaneous sales, kilowatt-hours	17, 883	438, 151
Total energy delivered	10, 739, 267	90, 494, 811
Revenue		
Energy used by project	18, 680. 57	86, 101. 15
Energy used by Yuma auxiliary project	11, 937. 04	88, 484. 62
Surplus energy sold to Southern Sierras Power Co. (Nevada-California Electric Corporation)	71, 512. 98	519, 469. 41
Miscellaneous revenues	2, 356. 29	11, 576. 98
Total revenues	104, 486. 88	705, 632. 16
Cost of Production		
Operation and maintenance	28, 462. 27	156, 900. 92
Purchased power	5, 868. 13	27 335. 03
Depreciation	26, 681. 29	149, 957. 29
Total cost of production	61, 011. 69	334, 193. 24
Net profit	43, 475. 19	371, 438. 92
Savings in cost of power, used on project and Yuma auxiliary, over cost of power purchased at commercial rates	47, 383. 00	256, 410. 00
Total benefit resulting from operation of power system	90, 858. 19	627, 848. 92

Interior and exterior views of powerhouse

Net earnings of the power system are credited annually to the lands which underwrote the cost of construction. The total amount credited to the land to the end of 1938 was $7 per acre, or $2 greater than the total estimated supplemental construction cost for plant and transmission lines.

Yuma auxiliary lands do not participate in the distribution of net power revenues as these lands were not charged with the construction cost of the power plant, but they do benefit from the power development in that the cost of energy for pumping to the auxiliary unit is materially less than at commercial rates. The commercial rate was approximately $0.0286 per kilowatt-hour prior to construction of the plant. Commercial po rates have since been reduced at inter until now this rate is approximately $0.0 per kilowatt-hour. An estimate of $0.0175 kilowatt-hour was used in preparing the ab table, which is considered conservative as average for the period covered in this rep It is estimated the Siphon Drop power pl has saved the Yuma auxiliary lands o $150,000 since it began operating.

Enlarged plant

The Siphon Drop power plant was origina designed to operate at a higher head than w found practicable under the existing con tion of the project canal at the time the pla was constructed and through which it recei its water for power generation. With t construction of the All-American Canal a the arrangement for the Yuma project to ceive water therefrom, construction has be completed to utilize the higher head to made available. Consequently, during t period February through May 1938, the fo bay and spillway structures were rebuilt a the canal banks upstream from the pow plant raised to provide a higher pond le than formerly. When the All-American Can is placed in operation it will be possible employ a constant head of approximately feet as compared with the present one of feet. It is estimated that the capacity of th plant will be 65 percent greater than at pre ent which will be reflected in revenue i creases to the project lands receiving credi from the net profits of the plant.

The Siphon Drop power plant has alread returned a substantial profit to the wat users under the Yuma project and will co tinue to do so in the future.

Reclamation Organization Activities

Walker R. Young in San Francisco Addresses A. S. C. E.

WALKER R. YOUNG, supervising engineer of the Central Valley project, has accepted an invitation to attend and address the Waterways Division of the American Society of Civil Engineers at its annual convention to be held in San Francisco in July. His discussion will have particular reference to the effects of the Central Valley project upon navigation.

George O. Sanford Tours Projects

GEORGE O. SANFORD, General Supervisor of Operation and Maintenance, left Washington by automobile on June 9 for an extended official trip covering practically all of the Federal Reclamation projects. The object of this visitation is to give consideration t relief measures to be granted under the pro visions of the act of May 31, 1939, and othe matters connected with the operation an maintenance of the projects.

Mr. Sanford's tentative itinerary cover 11,565 miles. He probably will return t Washington August 15.

L. H. Mitchell in West

L. H. MITCHELL, irrigation adviser, lef Washington May 8 for an extended wester trip during which he will visit nearly all o the operating projects and discuss with proj ect officials and water users, problems connected with soil and water conservation, improvement of irrigation methods, control of noxious weeds and other matters directly connected with the operation and maintenance of the canal systems.

Attendants at Reclamation Association

. DONALD JERMAN, acting construction ngineer of the upper Snake River project, nd H. G. Fuller, president and Frank A. Miller, attorney for the Fremont-Madison Irigation District, attended a meeting of the daho State Reclamation Association at Twin Falls, Idaho, on May 13.

PERSONNEL CHANGES

THE following recent personnel changes in he Bureau of Reclamation have been approved by the Secretary:

Appointments

Lewis H. Tuthill, engineer, Denver, Colo.

Estes Braxton Griffith, junior engineer, Denver, Colo. (vice Harold O. Bergman).

Arthur J. Bunas, junior engineer, Denver, Colo.

Ole Overlie, reservoir superintendent, Boise, daho (vice Donald C. Keyes).

Vernal T. Holland, junior reclamation economist, Eastern Slope Surveys, Pueblo, Colo.

Transfers

Gilbert G. Rollstin, assistant engineer, rom Roza division, Yakima project to the Colorado-Big Thompson project (Estes Park, Colo.).

Robert G. Lawton, from junior engineer, All-American Canal project, Yuma, Ariz., to ame at Denver, Colo.

Earl Theodore Walters, from pump station operator, Boise project, Emmett, Idaho, to powerhouse operator, Buffalo Rapids project, Glendive, Mont.

Ture J. Hanley, assistant engineer, from Salt River project, Phoenix, Ariz., to the Central Valley project (Kennett division), Redding, Calif.

Leopold I. Mastrofini, from assistant engieer, Kings River-Pine Flat secondary project, Fresno Dam, Calif., to same at Central Valley project, Sacramento, Calif.

Edw. H. Heinemann, from assistant engieer, Colorado River project, Antioch, Calif., o the Delta division, Central Valley project, Antioch, Calif.

John J. Welsh, from assistant engineer, Kennett division, Central Valley project, near Redding, Calif., to same on the Truckee Storge project, Reno, Nev.

Howard E. Robbins, engineer, from Kenrick project (Seminoe Dam) Wyo., to Colorado-Big Thompson project, Kremmling, Colo.

Edwin G. Nielson, associate engineer, from Denver, Colo., office, to project investigations, Salt Lake City, Utah.

Robert L. Davidson, assistant engineer, from Kendrick project, Casper, Wyo., to Delta division, Central Valley, Antioch, Calif.

Joseph G. Turner, associate engineer, from All-American Canal project near Yuma, Ariz., to Columbia Basin project, Coulee Dam, Wash.

L. Rees Brooks, assistant engineer, from Riverton project, Riverton, Wyo., to the Deschutes project, Bend, Oreg.

Assistant Chief Counsel Flies to California

HOWARD R. STINSON left Washington June 5 by plane on a special assignment connected with title problems in the purchase of water rights for the Central Valley project, collaborating with W. G. Irving, special consulting appraisal attorney.

Slide Lectures Presented

AN illustrated story of the Central Valley project is being told in slide lectures by members of the Sacramento office staff. Supervising Engineer Walker R. Young appeared before the third annual Northern California Civil Engineers Assembly in Sacramento on March 17. Phil Dickinson, Assistant Director of Information, gave illustrated talks before the Fort Sutter Farm Center at Freeport, Sacramento County, on April 5 and the Associated Engineers of the Sacramento Junior College on April 27. Assistant Engineer H. S. Riddell used the slides in a talk at a meeting of Reclamation District 1000 near Sacramento on April 13.

B. E. Hayden aids in Preparing Settlement Report

B. E. HAYDEN, superintendent of the Klamath project, has been loaned by the Bureau of Reclamation to assist the Pacific Northwest Planning Commission in the preparation of a report on land utilization and settlement problems.

JAMES MUNN, 1865–1939

AS our May issue went to press a brief notice of the death of James Munn was received and carried in that number. Through the courtesy of the Metropolitan Water District the following summary of the life of this useful public servant is given:

In the death in Los Angeles on April 28, 1939, of James Munn, nationally known construction engineer and former general superintendent of the Metropolitan Water District of Southern California, the construction fraternity of the West lost one of its best loved and most highly respected members.

Born in Scotland February 19, 1865, the eldest of a family of 11 children, James Munn came to the United States in his early twenties, and soon made his way to Deadwood, S. Dak., where he followed the general contracting business in the Dakotas, Wyoming, and Montana from 1891 to 1908. In 1909 he joined the United States Reclamation forces on the Boise project, Idaho, and soon thereafter was made superintendent of construction on the Arrowrock Dam on the Boise River, on the completion of which he received considerable commendation on the fact that this work was finished more than a year ahead of schedule, and for considerably less than the estimated cost. While he was with the Reclamation Service, he joined in engineering reports on a number of important projects, among them the Columbia River Basin and Boulder Dam.

In 1917 Mr. Munn was made general superintendent of construction for the Reclamation Service, with headquarters in Denver. From 1924 to 1929 he was general superintendent in charge of construction on the Mokelumne water supply project of the East Bay Municipal Utility District, involving the building of the Pardee Dam and Reservoir and a 93-mile aqueduct to provide a water supply from the High Sierras for Oakland, Berkeley, and the other cities which line the eastern shore of San Francisco Bay.

From 1930 until his retirement from active service in 1938 he was general superintendent on the construction of the 392-mile Colorado River Aqueduct of the Metropolitan Water District of Southern California, which is now nearing completion.

Unassuming and modest in his demeanor, yet firm and forceful in presenting his conclusions, Mr. Munn was a tower of strength in any organization with which he was associated. He was affectionately known by his associates as the "Grand Old Man" of the Metropolitan Water District organization, and his retirement from active participation in its affairs on January 1, 1938, was a source of profound and sincere regret to all who knew him.

Since that date he had been retained in a consulting capacity by the district in connection with matters with which he was especially familiar, and to the end kept up an active interest in district affairs. He was a member of the American Society of Civil Engineers and a registered civil engineer in the State of California. He is survived by a son, William K. Munn, and one granddaughter, living in Oakland, Calif., also two grandsons, the latter the children of another son, J. C. Munn, who died in 1934. Three brothers and two sisters also survive.

PUMPING PLANTS OPERATED ON BUREAU OF RECLAMATION PROJECTS F. Y. 1937–

Type Pump:
- V. M. D. C. = Vertical motor-driven centrifugal pump.
- H. M. D. C. = Horizontal motor-driven centrifugal pump.
- V. T. D. C. = Vertical hydraulic turbine-driven centrifugal pump.
- H. T. D. C. = Horizontal hydraulic turbine-driven centrifugal pump.
- H. M. G. C. = Horizontal gear connected motor-driven centrifugal pump.
- O. E. D. C. = Oil engine-driven centrifugal pump.
- G. E. D. C. = Gas engine-driven centrifugal pump.
- G. E. G. C. = Gas engine gear-driven centrifugal pu
- V. T. D. S. = Vertical hydraulic turbine-driven sc pump.
- V. M. D. S. = Vertical motor-driven screw pump.
- O. E. D. S. = Oil engine-driven horizontal screw pu
- H. M. D. S. = Horizontal motor-driven screw pump

Project	Name of plant	Type of units	Plant capacity		Number of units	Static lift (feet)	First cost of plant	Cost of operation and maintenance	Estimated depreciation	Energy used for pumping (kilowatt-hours)	Acre-feet pumped	Cost per acre-foot without depreciation		Remarks
			Horsepower	Second-feet								Per acre-foot	Per foot lift	
Belle Fourche	Johnson Lateral	G. E. D. C.	125	10	1	45	$1, 960. 32	$385. 86	$300. 00		117	$3. 30	$0. 73	Data for 1937 season
Boise	Black Canyon	V. T. D. S.	1, 244	300	2	28. 5	149, 901. 39	909. 24		None	104, 193	. 0087	. 00031	
Grand Valley	Price-Stub	V. T. D. C.	125	28	1	31	46, 697. 83	487. 60	1, 000. 00	None	6, 049	. 0806	. 0026	
Huntley	Ballantine Auxiliary	O. E. D. C.	400	32	2	43. 5	71, 103. 56	2, 443. 04	3, 500. 00		2, 306	1. 06	. 0244	
	Hydraulic	V. T. D. C.	620	66	2	43. 5	73, 883. 32	901. 09	(1)		14, 236	. 0633	. 00145	
Klamath	Dry Lake No. 1	do	75	19. 3	1	51	31, 961. 11	100. 00	1, 200. 00		620	. 1613	. 0032	Operated by Lang Valley Irri. Dist.
	Dry Lake No. 2	V. M. D. C.	100	15. 4	1	44. 8	8, 366. 73	1, 530 00	400. 00	201, 480	3, 000	. 51	. 0114	Do.
	Melhase-Ryan Sump	V. M. D. S.	50	19	2	14. 0	6, 300. 00	1, 261. 35	300. 00	151, 480	4, 462	. 2827	. 0202	
	Tule Lake No. 1	do	60	25	1	[2] 4. 6	[3] 34, 804. 00	705. 85	[3] 1, 750. 00	45, 540	2, 830	. 2494	. 0542	
	Tule Lake No. 2	do	25	12	1	4. 9	[3] 34, 804. 00	310. 98	[3] 1, 750. 00	34, 380	1, 879	. 1815	. 0370	
	Tule Lake No. 3	V. M. D. C.	120	50	2	6. 7	[3] 34, 804. 00	2, 031. 18	[3] 1, 750. 00	269, 040	16, 633	. 1221	. 0182	
	Tule Lake No. 4	do	150	50	2	5. 8	11, 890. 00	2, 463. 01	600. 00	306, 400	18, 570	. 1326	. 0229	
	Tule Lake No. 5	V. M. D. S.	180	91	3	6. 5	17, 859. 00	4, 386. 65	900. 00	610, 200	39, 010	. 1124	. 0173	
	Tule Lake No. 6	do	100	50	2	5. 4	[4] 13, 153. 40							
Yellowstone	Thomas Point	H. T. D. C.	220	45	2	31	49, 970. 43	1, 000. 00	1, 640. 53		11, 410	. 144	. 0046	
Minidoka	First lift	V. M. D. C.	[5] 5, 110	1, 035	6	[2] 28. 53	258, 977. 79	(6)	(6)	13, 177, 229	270, 573			Operated by Burl Irrigation District.
	Second lift	do	[5] 3, 925	828	5	[2] 29. 87	226, 432. 40	(6)	(6)	11, 832, 40	0219, 493			Do.
	Third lift	do	[5] 2, 600	520	3	[2] 29. 2	137, 359. 05	(6)	(6)	7, 152, 120	146, 665			Do.
	South Side Drainage	3-H. M. D. C. 2-V. M. D. C.	70	23. 4	5	8–16	19, 725. 44	(6)	(6)	245, 670	(7)			Do.
	West End Pumping	H. M. D. C.	150	40	2	21. 25	18, 741. 61	(8)		531, 290	10, 000			Operated by Minidol Irrigation District.
	114 Pumping Plant	do	10	4	1	7	2, 802. 97	(8)		13, 510	(7)			
	1812 Pumping Plant	do	7. 5	2	1	4	1, 008. 76	(8)		20, 567	(7)			Do.
	Boersch Lake Drainage	do	200	50	2	20	32, 947. 72	[9] 14, 188. 78		590, 000	15, 680			Do.
	A-4 Raise	Scoop Wheel	25	20	1	3. 5	3, 328. 43	(8)		47, 200	(7)			Do.
	1817 Raise	do	15	11	1	4. 8	3, 634. 71	(8)		17, 200	(7)			Do.
	MacRae Drain	H. M. D. C.	7. 5	2	1	14	[10] 864. 77	(8)		10, 844	(7)			Do.
	C-2 Raise	Scoop Wheel	15	14	1	2. 5	(10)	(8)		36, 160	(7)			Do.
	D-4 Raise	V. M. D. C.	100	25	2	19	(10)	(8)		[11] 125, 000	(7)			Do.
	D-15 Drain	do	140	37. 5	3	16	(10)	(8)		169, 920	(7)			Do.
	Canal 20	do	150	25	1		(10)	(8)		295, 100	(7)			Do.
	Carter Drain	do	40	10	1	21	(10)	(8)		(12)	(7)			Do.
	Paul Sugar Factory	do	100	25	2	19	(10)	(8)		89, 700	(7)			Do.
	Rural Line	H. M. D. C.	30	10	2	14	(10)	(8)		55, 890	(7)			Do.
	10 small Pumps	H. M. D. C., V. M. D. C.	87. 5		10		(10)	(8)		129, 466	(7)			Do.
Newlands	Lahontan-Swingle	H. M. D. C.	400	70	2	70	21, 336. 37	790. 01	1, 241. 04	91, 200	1, 522	. 52	. 0074	
	Lee	V. M. D. C.	7. 5	2	1	6	100. 43	31. 86	5. 00	620	(13)			
	Sorimcher	V. M. D. S.	10	2	1	10. 74	1, 248. 18	363. 84	62. 41	7, 200	176	2. 06	. 191	
	Viera	do	5	2	1	8	1, 092. 13	106. 12	54. 61	2, 282	(13)			
North Platte	Dutch Flats Drainage	V. M. D. C.	70	8	3	21–52	23, 393. 94	120. 30	1, 000. 00	9, 598	52	[14] 2. 31	. 11	
Okanogan	Duck Lake [15]	H. M. D. C.	100	11	2	50–80	18, 400. 00	2, 223. 58			1, 363	1. 49	. 0229	
	Robinson Flat [15]	do	275	10	2	188	30, 077. 24	3, 642. 14			1, 360	2. 68	. 014	
Owyhee	Advancement	do	70	18. 5	2	{18. 1–26}	6, 636. 47	(16)						
	Dead Ox	do	2, 675	176	5	{50. 6–111}	109, 760. 00	5, 677. 19		5, 736, 060	41, 540	. 137	. 00056	
Rio Grande	Mesa Drain	do	75	45	3	5–8	17, 981. 38	5, 367. 43	250. 00	229, 200	14, 530	. 37	. 058	
Salt River [17]	Chandler Division	V. M. D. C., S.	1, 095	81	10	53	192, 379. 94	22, 414. 18	13, 466. 60	1, 799, 853	13, 641	1. 64	. 031	
	Laveen Division	do	480	50	7	53	51, 708. 70	16, 207. 54	3, 619. 61	1, 255, 720	15, 050	1. 08	. 0203	
	Mesa Division	do	3, 919	173	29	96	396, 127. 04	113, 560. 63	27, 728. 89	9, 719, 872	49, 835	2. 28	. 0237	
	Phoenix Division	do	2, 657	137	57	75	376, 649. 44	82, 814. 01	26, 365. 46	5, 994, 481	37, 577	2. 20	. 0294	
	Salt River Division	do	2, 047	147	31	64	239, 081. 94	51, 321. 15	16, 735. 74	4, 035, 124	33, 975	1. 51	. 0236	
	Tempe Division	V. T. D. C.	2, 940	262	29	54	171, 164. 20	73, 094. 80	11, 981. 49	5, 802, 229	51, 909	1. 41	. 0261	
	Highline	H. M. D. C.	950	105	4	50	66, 656. 83	48, 220. 34	4, 665. 98	4, 121, 075	41, 252	1. 17	. 0234	
	Joint head	V. M. D. C.	300	100	2	20	23, 000. 00	7, 987. 86	1, 610. 00	714, 087	19, 453	. 41	. 0205	
	Maricopa Garden	do	75	11	1	37	12, 930. 92	4, 685. 76	905. 16	341, 869	5, 023	. 93	. 0252	
	Booster at 15th. Ave.	H. M. D. C.	8	4	1	8	1, 000. 00	135. 94	70. 00	5, 208	(7)			
	Booster at 13¼ E-12⅞ N.	do	5	2	1	5	781. 00	32. 86	54. 67	None	(7)			
	Booster at 17¼ E-9½ N.	do	5	[18] 100	1	12	1, 113. 16	335. 11	77. 92	4, 136	(7)			
	Booster at 22 E-1½ S.	do	150	16	1	20	6, 245. 00	3, 187. 11	437. 15	254. 374	(7)			
	Booster at 23 E-10¾ N.	V. M. D. S.	15	7. 5	1	5	971. 57	396. 14	68. 00	19, 209	(7)			
	Booster at 23½ E-10¾ N.	do	20	7. 5	1	6. 5	1, 398. 00	460. 53	97. 86	26, 916	(7)			
	Booster at 24 E-10½ N.	do	20	5. 3	1	7	1, 650. 00	145. 30	115. 50	10, 088	(7)			
	Booster at 27½ E-4 N.	H. M. D. C.	50	6	1	8	2, 650. 00	194. 53	185. 50	2, 018	(7)			
Yakima: Kittitas Div.	Wippel	H. T. D. C.	1, 000	50	2	124. 9	78, 798. 00	2, 548. 00	None	None	11, 622	. 2195	. 0018	
Sunnyside Div.	Snipes Mountain	V. T. D. C.	850	22	3	200	78, 000. 00	2, 049. 38	1, 890. 00		6, 500	. 315	. 0016	
	Outlook	do	800	48	2	110	92, 000. 00	1, 329. 22	2, 480. 00		16, 271	. 082	. 0007	
	Grandview	V. T. D. C., H. T. D. C.	365	38	3	35, 78	72, 500. 00	1, 919. 53	2, 120. 00	670, 800	12, 386	. 155	. 0024	
	Hillcrest	V. T. D. C.	35	1. 56	1	103	5, 800. 00	230. 00	328. 00		285	. 806	. 0078	
	Little Snipes Mountain	H. T. D. C.	5	⅓	1	50	1, 065. 00	70. 00	68. 71		131	. 536	. 0107	
	Prosser	do	190	12	1	105	31, 968. 00	755. 39	1, 500. 00		3, 692	. 205	. 002	
	Spring Creek	do	160	12	1	90	26, 056. 00	776. 67	1, 500. 00		3, 945	. 197	. 0022	
Yuma	California Drain	G. E. D. C., G. E. G. C.	130	56	2	1. 47	6, 775. 00	95. 05	338. 00	[19] 110	65	1. 45	. 99	
	Valley Drainage	O. E. D. S., H. M. D. S.	275/525	130/300	3	10. 66	169, 270. 00	17, 314. 19	5, 970. 00	[20] 5, 891	63, 423	. 324	. 0304	
	West Yuma	P. M. G. C.	20	2. 36	1	4	1, 040. 00	104. 30	72. 00	[21] 1, 196, 500 8, 904	119	. 876	. 219	
Yuma Auxiliary	B-lift	V. M. D. C., H. M. D. C.	1, 100	105	3	71. 88	165, 204. 00	15, 752, 38	5, 520. 00	1, 635, 200	12, 414	1. 268	. 177	

[1] Plant depreciated.
[2] Average.
[3] Plants Nos. 1, 2, and 3.
[4] Cost to June 30, 1938, not final, first unit placed in operation Apr. 24, 1937; second unit placed in operation May 26, 1938.
[5] Actual input.
[6] See remarks.
[7] No records.
[8] See Boersch Lake pumping plant, operated by Minidoka Irrigation District.
[9] The cost of operating all the Minidoka Irrigation District pumps from Nov. 1, 1936, to Oct. 31, 1937, was $14,188.78.
[10] Built and operated by the Minidoka Irrigation District.
[11] Includes Carter pump.
[12] Included with D-4 drain pumps.
[13] Plant operated to pump drainage waters: operations automatic and no record of amount of water pumped.
[14] At 21-foot lift.
[15] Not operated during season of 1938.
[16] Pumps are small and automatic in operation, requiring attention by ditch rider once a day. No cost of operation and maintenance kept.
[17] Reports are for calendar year of 1937.
[18] Gallons per minute.
[19] Gallons of gasoline.
[20] Gallons of fuel oil.
[21] Kilowatt-hours.

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

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HARRY SLATTERY, UNDER SECRETARY OF THE INTERIOR (in charge of reclamation)

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Denver, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Constr. engr. [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz	E. C. Koppen	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billinga, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation idstrict	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka, Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Uaers' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: Eaat division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitaa reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.–S. D.)	Denver, Colo	W. G. Sloan	Engineer.
Marias (Mont.)	Denver, Colo	Fred H. Nichols	Associate engineer.
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo	J. R. Iakisch	Senior engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.

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OWYHEE DAM AND GLORY HOLE SPILLWAY

THE RECLAMATION ERA

JULY 1939

UPSTREAM FACE OF OUR MOST RECENTLY COMPLETED HIGH DAM: BARTLETT DAM, SALT RIVER PROJECT, ARIZONA

Great Plains Program Set Up

PLANS for administration of the Great Plains water-conservation program have been completed, but in mid-July no projects had been allocated the funds necessary to start their construction.

The President, in outlining the plan for administration of the program in a letter to Secretary of the Interior Harold L. Ickes, designated the Bureau of Reclamation as the principal agency for construction of the projects.

The Great Plains program, recommended by the Northern Great Plains Committee of the National Resources Committee, contemplates the development of water supplies and construction of irrigation projects in the area most critically affected in recent years by prolonged drought.

The Congress included in the Interior Department Appropriation Act for 1940 an item of $5,000,000 to assist in financing the necessary construction. This money was appropriated subject to allocation by the President to carry out the program with the assistance of moneys to be contributed from work-relief funds. Projects constructed would be subject to repayment by water users of so much of the costs as they equitably could bear. Nonreimbursable amounts would be considered as relief expenditures in the affected area.

Under the President's order:

1. Allocations from the $5,000,000 appropriation will be made for projects individually.
2. Recommendations for allocations will be prepared by the Department of the Interior in accordance with the general policies set forth in the report of the Northern Great Plains Committee, dated October 14, 1938, and will include the concurrence of views of the Department of Agriculture and the Works Progress Administration.
3. Each recommendation will include a description of the proposed project, an estimate of the total cost of the completed project, estimates of the work which can be performed by relief labor and of the reimbursable cost, and a statement of the proposed participation of each Federal agency concerned together with the recommended amounts of funds to be allocated to each.
4. The Secretary of the Interior acting through the Bureau of Reclamation will be responsible for the construction of projects, except as may be otherwise recommended.
5. Recommendations will be transmitted to the President through the Bureau of the Budget.
6. The National Resources Committee, through its Northern Great Plains Committee, will continue to coordinate these and related activities.

The amounts to be repaid will be determined in accordance with estimates of the ability of the water users to pay, and the repayment contracts will be negotiated and administered by the Farm Security Administration of the Department of Agriculture. The plan contemplates use of relief labor to the fullest extent possible. Engineering direction and services will be drawn principally from the staff of the Bureau of Reclamation.

John C. Page,
Commissioner of Reclamation.

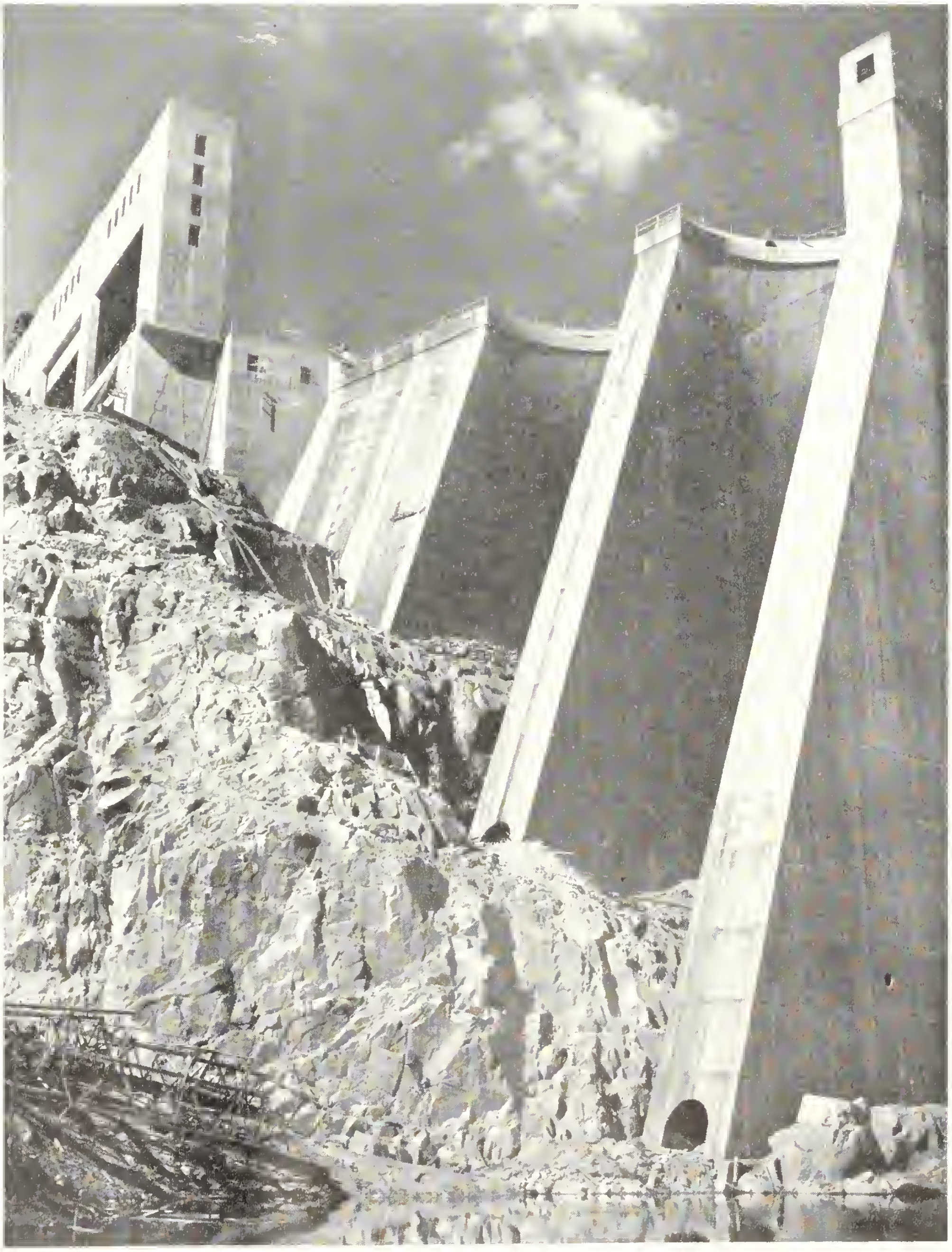
PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 29 • JULY 1939 • NUMBER 7

Fourth Annual Pilgrimage to Bartlett Dam[1]

The right side of Bartlett Dam and the spillway structures silhouetted against the sky



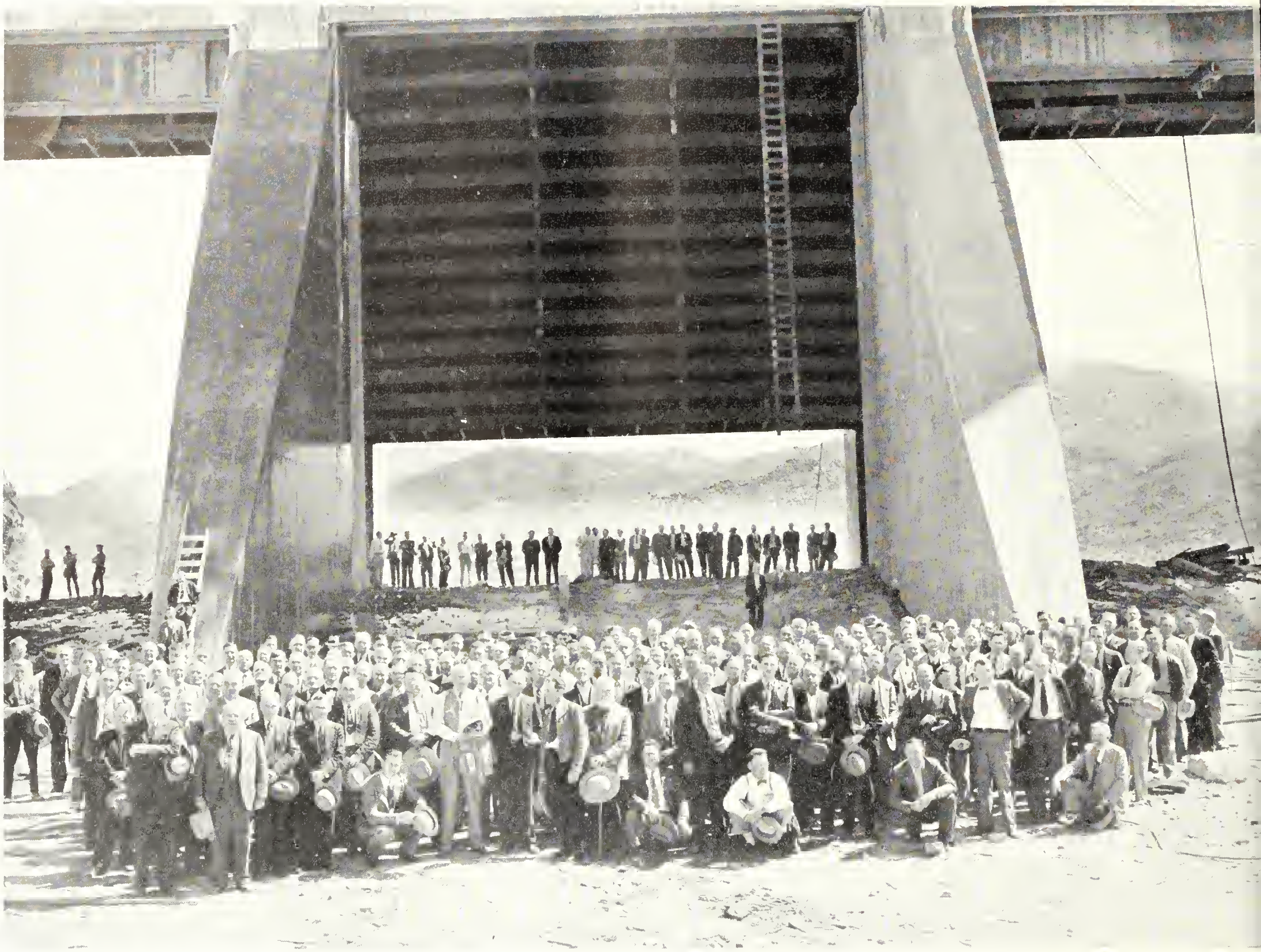
ON March 15 some 250 officers, directors, councilmen, and shareholders of the Salt River Valley Water Users' Association, together with a large representation of businessmen from Phoenix, made the annual pilgrimage to Bartlett Dam. Similar trips were made in 1936, 1937, and 1938. On the 1936 trip over the new "Lin B. Orme" highway, the visitors brought Bartlett Dam with them. This was a small model, and everybody tried to imagine how such a structure would fit into the canyon. On the day of the last visit they had the real thing to look at. And it is indeed a fine structure.

Bartlett Dam is of the multiple arch type with maximum height of 286.5 feet and a total length of 800 feet, excluding the spillway. It is slightly curved in plan. There are 9 hollow buttresses, 10 arches, and a short-gravity section at each end of the dam. The buttresses are 60 feet apart on centers with a net arch span of 48 feet. The thickness of the concrete arches and also the buttress walls varies from 7 feet at the lowest level to 2.34 feet at the top, elevation 1,795.5. The spillway around the right end will have a capacity of 175,000 cubic feet per second and consists of a curved and heavily banked, concrete-lined channel 170 feet wide and 550 feet long with 3 Stoney gates 50 by 50 feet along the crest at the upper end. The reservoir capacity is 200,000 acre-feet. Storage release is diverted into project canals at Granite Reef Dam, which is about 4 miles below the junction of Salt and Verde Rivers. Release at the higher levels is through two 66-inch needle valves, and river level release is through three 6 by 7.5-feet slide gates. Bartlett Dam cost nearly $5,000,000.

The dam provides additional storage to the extent of 200,000 acre-feet on the Verde River for the Salt River reclamation project. In operation, storage released from Bartlett or from the Roosevelt and other reservoirs on the Salt River is diverted into the project canals at the Granite Reef diversion dam, which is some 4 miles below the junction of the two streams.

When the visit was made in February 1938,

[1] See front and back covers for additional views of dam.



The pilgrims were greatly interested in the huge spillway gates and the method of operation

the dam was barely above river bed. The structure was completed in May 1939.

After a detailed examination of some 2 hours and much listening to explanatory statements, the pilgrims headed for the contractor's mess hall where excellent "eats" were disposed of with diligence. Following the feed, President Lin B. Orme took charge. Mr. Orme read messages of congratulation from Commissioner John C. Page, Senator Carl Hayden, and Governor Bob Jones. He also gave an interesting talk on the problems of the association, what they expect to accomplish for the Salt River Valley, and expressed the hope that Bartlett Dam would solve their water-supply problems.

Dr. A. S. Chandler, a leading pioneer on irrigation development, gave an interesting talk on early problems and settlement. Messrs. John H. Dobson and C. T. Thompson expressed the thanks of the board of governors and the council of the association. James Minotto and R. K. Wood, representing the senate and house of the Arizona Legislature, praised the association for their farsighted investments for the development of the Salt River Valley. C. Warren Peterson, county supervisor, spoke on early ditch digging and the development of later equipment. Lee Moore spoke for the Phoenix Chamber of Commerce. Short talks were given also by E. C. Koppen, construction engineer for the Bureau, and C. G. Clapp, superintendent for the Barrett & Hilp and Macco Corporation.

Grasshopper Menace

CONSIDERABLE apprehension has been shown by Grand Valley project (Colorado) farmers at the early appearance of grasshoppers. Mixing plants for grasshopper poison have accordingly been put in operation both in Grand Junction and Fruita, Colo. In Grand Junction the Western Colorado Producers Cooperative is operating a mixin plant, and in Fruita it is handled by th Bean and Potato Growers Association. Th bran and sodium arsenite used in the bait ar furnished by the Government this year. I appears that bran mash is just as effective i the destruction of tiny grasshoppers as th larger ones. This service is available to a project farmers through the above agencies o through the county agent.

Orland Crops

THE Orland project, California, reports cro conditions excellent. Many fine cuttings o alfalfa were harvested during the month o May, and pastures afforded a great deal o green feed for the project's dairy herds Prospects for tree crops continued excellen apricot trees were loaded with fruit, and th same was true of the majority of almon varieties.

The All-American Canal

By T. A. CLARK, *Engineer, and* C. A. PUGH, *Assistant Engineer*

LYING between the Mexican boundary and the Salton Sea, bounded on the east by the sand hills and on the west by the barren foothills of the San Diego Mountains, the Imperial Valley has become a famous garden spot of the United States. Before 1900, this area was a vast desert with no human habitation other than at the railroad stations near the Salton Sea and the old Butterfield stage depots. Now half a million acres of irrigated land produce crops exceeding $25,000,000 in value annually. December lettuce, May melons, dates, figs, oranges, grapefruit, and numerous other winter crops are shipped to northern markets where local products will not be harvested until midsummer. Alfalfa, maize, and similar farm staples are sold to adjacent markets on the coast.

The first recorded history of this region begins about 1539, when Francisco de Ulloa, Spanish navigator, sailed to the head of the Sea of Cortez, now known as the Gulf of California. Following him came other explorers and Spanish padres, hundreds of whom perished in crossing this seemingly useless desert where no water was to be found between the Colorado River and San Filipe Creek at the foot of the San Diego Mountains.

In 1853, interest was aroused in the possibility of irrigating these lands from the Colorado River. The Legislature of California, in 1859, adopted a memorial to Congress asking for a cession of 3,000,000 acres to the State of California for reclamation by irrigation. The House of Representatives acted favorably upon this application, but in 1862 the bill reported failed to pass. The route proposed for the canal was practically the same as that used 40 years later.

In 1875–76 surveys were made by Lt. Eric Bergland to determine the feasibility of irrigating these lands from the Colorado River. He reported adversely on the location of a canal in United States territory, but called attention to the route through Mexico.

Construction Began in 1900

The Colorado River Irrigation Co. was formed in 1891–92 and the entire problem of irrigating the Colorado River delta was carefully examined and the important features worked out, but financial difficulties brought about the failure of this company. The California Development Co. formed in 1896 succeeded where the original company had failed and construction of the project was begun in 1900. In the light of present-day construction, the wooden heading on the Colorado River just north of the international boundary and the main canal following largely along the sloughs of the Alamo River in Mexico, would be considered primitive. However, considering the conditions under which this work was accomplished, it was a remarkable achievement. Raising money to develop an utterly isolated stretch of desert was a major problem, while an ever-present one was the uncontrolled Colorado, with its silt load estimated at 113,000 acre-feet annually.

The period from 1904 to 1906 was the most disastrous. During 1902 and 1903 the river had been unusually low and large sand bars obstructed the flow through the headgates. Following the construction of a temporary heading south of the international boundary in 1904, unseasonal floods turned the entire flow of the river through the new heading and down the Imperial Canal. Canals and laterals were washed out and water spread over thousands of acres of farm land before reaching the Salton Sea. Until then the Salton Sea, or Salton Sink as it was then known, was a salt bed with a small area of marshland at the lowest point. Commercial salt works were being operated at the northern end of the marsh and the Southern Pacific Railroad had been constructed along the eastern edge. After several unsuccessful attempts to return the river to its normal channel, it appeared that the entire valley would be filled; the salt works had been inundated and the railroad forced to move to higher land, but in February 1907 the breach was closed and reconstruction of irrigation works was begun.

The present irrigation system consists of a heading on the Colorado River north of the Mexican border, a concrete structure with 75 vertical lift gates, discharging into a settling basin where at times two dredges have been required to remove the silt from the basin. The main canal crosses immediately into Mexican territory and for some 60 miles follows around the edge of a mesa before branching into a distribution system flowing northward into the United States. The international feature of this system has made operation and maintenance extremely difficult. Approximately three-quarters of a million dollars are expended annually in the removal of silt from the canals and maintenance of levees against the ravages of the Colorado. In spite of the dredging at the headgates and almost continuous canal cleaning, the large quantities of silt deposited on the farm lands make it necessary to relevel fields every few years.

In 1919 the Secretary of the Interior appointed a board of engineers to report on an All-American Canal to the Imperial Valley. The members of this board were Elwood Mead, W. W. Schlecht, and C. E. Grunsky. Their report recommended an All-American Canal from Laguna Dam, present diversion dam for the Yuma (Reclamation) project, to connect with the present distribution system of the Imperial Valley, and a branch canal to the Coachella Valley. Storage reservoirs on the Colorado River for control of the river, development of power, and irrigation were likewise recommended. Congress, desiring further information, authorized the Secretary of the Interior to make an examination of the conditions in the Imperial Valley and major features of the project. A report, known as the Fall-Davis report, was submitted to the Congress on February 28, 1922. This report recommended a canal from Laguna Dam to the Imperial Valley and the construction of a reservoir at or near Boulder Canyon on the lower Colorado River.

Boulder Canyon Project Act Approved

The Boulder Canyon Act, approved December 21, 1928, which authorized the construction of Boulder Dam and power plant, carried a provision for a main canal and appurtenant structures, located entirely within the United States, connecting Laguna Dam or other suitable diversion dam with the Imperial and Coachella Valleys in California. During 1929 and 1930 surveys were made and estimates prepared under the direction of Homer J. Gault for the construction of the All-American Canal and appurtenant structures. Those estimates showed comparative costs between a canal utilizing the existing Laguna Dam for diversion and a canal 21 feet higher in elevation requiring a new dam about 5 miles up the river. Since the location of the two canals was of necessity identical from Pilot Knob to the west side of the sand hills, the higher line was found more feasible. Although Laguna Dam will not be used for diversion after the All-American Canal system is put in operation, it will be essential to the proper functioning of Imperial Dam, acting as a control point in the gradient of the river. Excavation of the canal was begun in August 1934.

Imperial Dam and the desilting works for the All-American Canal have been described in previous issues of THE RECLAMATION ERA.

The other features of this project consist of the main All American Canal to the Imperial Valley and the Coachella Canal.

Course of Canal

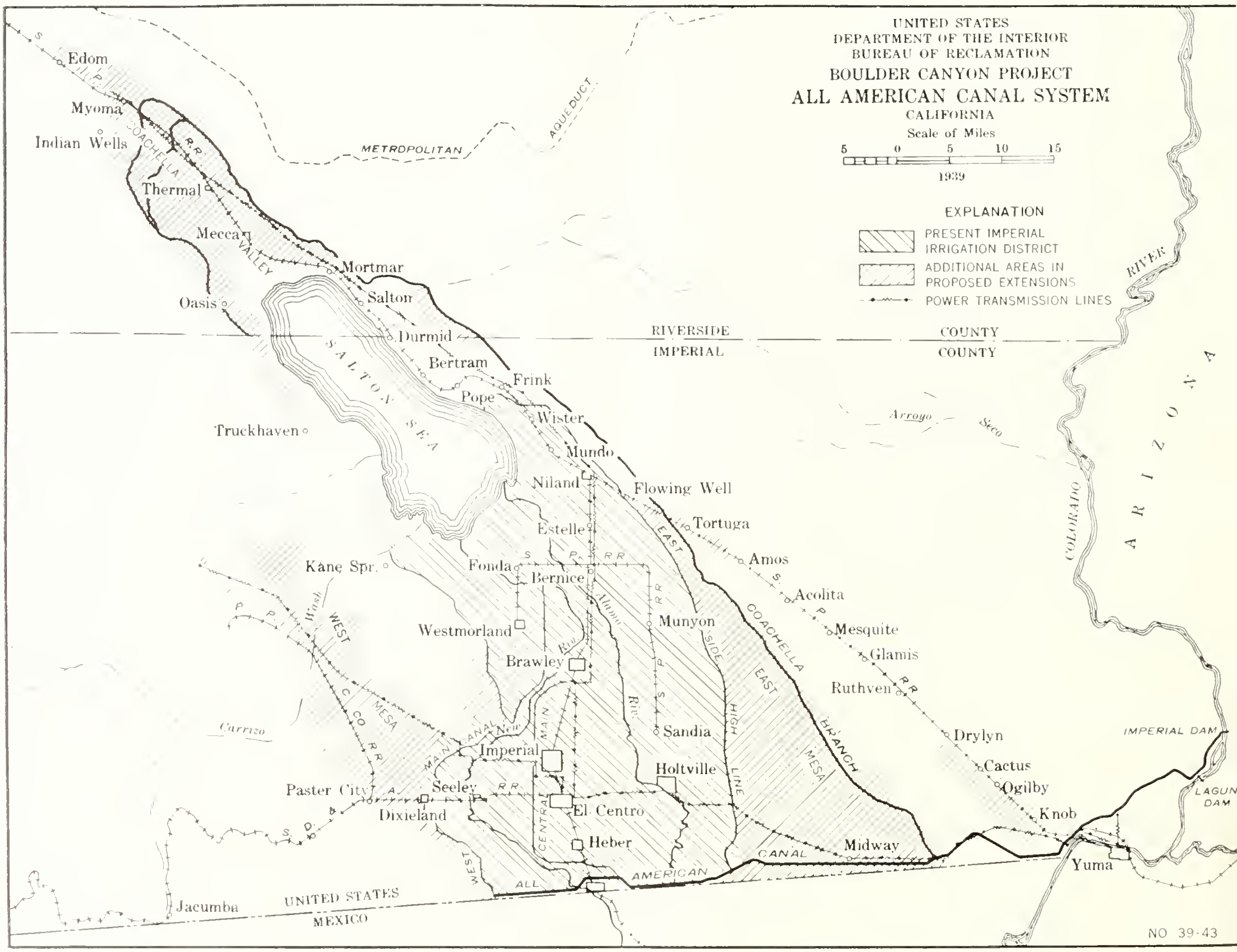
The general location of the All-American Canal is shown on the accompanying map. From Imperial Dam to Laguna Dam the canal is built around the edge of the old flood plain of the river. Cutting through a formation of solid rock at Laguna Dam, it follows along an abrupt break between the valley and the mesa, turning west below Pilot Knob to parallel the international boundary. At the eastern edge of the sand hills the canal swings northwesterly to take advantage of a natural valley in the sand hills and emerging again upon the mesa it runs due west across East Mesa, turns southward as it enters the irrigated lands of Imperial Valley, and at the Mexican border turns again westward. Except for a few miles where the canal swings out around the city of Calexico, it runs adjacent to the international boundary to its end in the West Side Main Canal.

The All-American Canal is designed for a maximum capacity of 15,155 second-feet with a velocity of 3.75 feet per second, from diversion to Siphon Drop Turout. In cut section and through average impervious material a normal earth section is maintained with bottom width 160 feet, water depth 20.61 feet, side slopes 1¾ : 1, and a free board of 6 feet. From station 144+00 to station 229+50, where the bottom grade of the canal was at or above natural ground surface, the left embankment was built of selected material compacted in 6-inch layers, with a rock fill on the outer slope and a row of 20 foot Wakefield sheet piling from station 160+00 to station 191+50 and continued with a row 30 feet in length to station 227+50 under the centerline of the crown to prevent piping or sand boils. In effect, this stretch of embankment is an earth dam 8,490 feet long and 26.6 feet high.

Through the rock cut, station 229+50 t station 244+50, the canal has a bottom wid of 94 feet and water depth of 22.75 feet, w a velocity of 6 feet per second.

At Siphon Drop, station 775+00, a turn-c has been provided to divert 2,000 second fe to the Yuma project (Reclamation) Ma Canal through the existing power pla Above this point, the present Yuma Ma Canal will be abandoned and Laguna Da the diversion weir for the Yuma project, w become a control section on the Colora River. With delivery from the All-Americ Canal and a water surface 15 feet higher th the Yuma Main it will be possible to i crease the head for the Siphon Drop pow plant and increase the average power outp from 950 kilowatt-hours to 1,750 kilowat hours.

From here to Pilot Knob Wasteway station 1093+92 the capacity is reduced 13,155 second-feet, bottom width is 150 fe water depth 19.12 feet, and velocity 3.7 in earth section. For 1,750 feet at Pilot Kn



excavation is again in solid rock. Here the bottom width is 69 feet, water depth 20.13 feet, and velocity 6.0.

A wasteway provided here has a capacity of 13,155 second-feet. By closing the seven 18- by 17½-foot radial gates of the check structure in the canal and opening the four 14- by 13½-foot gates in the wasteway structure, the entire flow of the canal can be turned back into the Colorado River. The outlet of the wasteway is in the present settling basin of the Imperial Canal between the Rockwood gates, diversion structure for this canal, and the Hanlon gates, which serve as a check during dredging operations. By closing the Hanlon gates, waste water will be backed out through the Rockwood gates.

From the wasteway to the turn-out for the Coachella Canal, designed capacity is 10,155 second-feet, bottom width 130 feet, water depth 16.59 feet, and velocity 3.75.

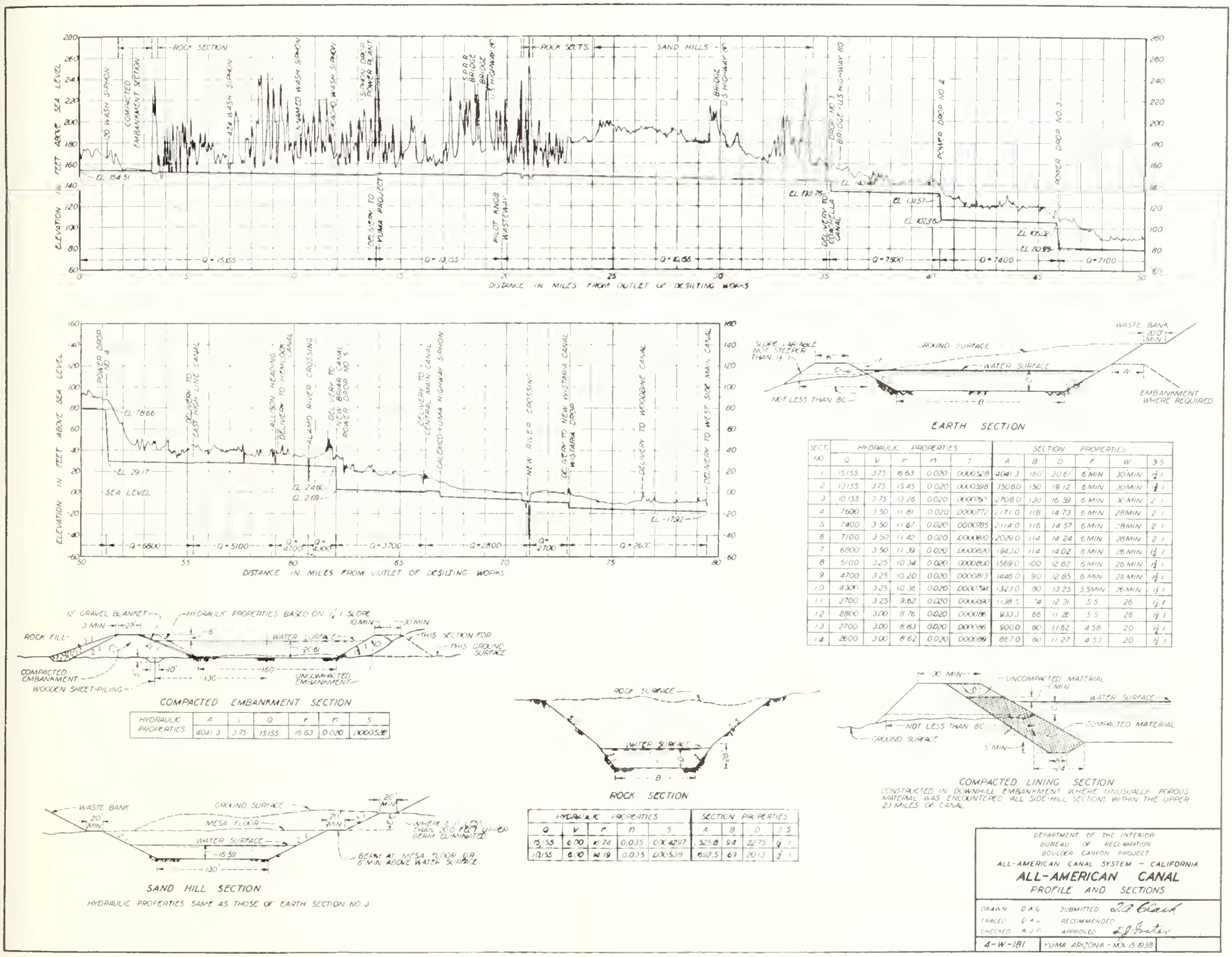
At many points between stations 51+50 and 1244+75, where the canal has been excavated in porous material or where the canal is in shallow cut, a compacted lining was placed on the inside slope of the lower embankment to ensure against excessive seepage. This minimum width of lining is 24 feet at the bottom and 18.6 feet wide at the top and is built of selected material, sprinkled and rolled as in the compacted fill above Laguna Dam. The toe of the lining extends below bottom grade of the canal and below the deposits of porous material.

Wash Channels

Numerous wash channels are crossed by the canal between the desilting works and Pilot Knob. Although the average rainfall throughout this section of the country is only 3.5 inches per year, infrequent torrential rains occur, particularly during the late summer months, and crossing these washes with a canal of this size presented one of the major problems of design and construction. Siphons were constructed to carry the canal under the four largest washes whose watersheds varied from 10.9 square miles to 41.4 square miles. Eight washes with watersheds from 3.0 square miles to 9.4 square miles are taken over the canal in overchutes. Smaller washes have been taken into the canal over concrete aprons.

Westward from the turn-out to the Coachella Canal, capacity is reduced to 7,600 second feet with bottom width 118 feet, water depth 14.73 feet, and velocity 3.5 feet per second. Several turn-outs for the future development of the area known as East Mesa utilize 800 second-feet, leaving the capacity of the canal 6,800 second-feet at the East Highline Canal, first delivery in the Imperial Valley. Successive deliveries into existing canals and laterals of the Imperial Irrigation District reduce the capacity of the All-American Canal to 2,600 second-feet where it ends in the West Side Main Canal.

Five drops, four of which may be used for



EARTH SECTION

SECT. NO.	HYDRAULIC PROPERTIES					SECTION PROPERTIES					
	Q	V	r	n	S	A	B	D	F	W	S.S.
1	15155	3.75	16.63	0.020	.0000528	4041.3	160'	20.61'	6' MIN	30' MIN	1¾:1
2	13155	3.75	15.45	0.020	.0000598	3508.0	150	19.12	6 MIN	30 MIN	1¾:1
3	10155	3.75	13.26	0.020	.0000760	2708.0	130	16.59	6 MIN	30 MIN	2:1
4	7600	3.50	11.81	0.020	.0000772	2171.0	118	14.73	6 MIN	28 MIN	2:1
5	7400	3.50	11.67	0.020	.0000785	2114.0	116	14.57	6 MIN	28 MIN	2:1
6	7100	3.50	11.42	0.020	.0000810	2029.0	114	14.24	6 MIN	28 MIN	2:1
7	6800	3.50	11.39	0.020	.0000820	1943.0	114	14.02	6 MIN	26 MIN	1¾:1
8	5100	3.25	10.34	0.020	.0000800	1569.0	100	12.82	6 MIN	26 MIN	1¾:1
9	4700	3.25	10.20	0.020	.0000813	1446.0	90	12.85	6 MIN	26 MIN	1¾:1
10	4300	3.25	10.36	0.020	.0000794	1323.0	80	13.25	5.5 MIN	26 MIN	1½:1
11	3700	3.25	9.62	0.020	.0000890	1138.5	74	12.31	5.5	26	1½:1
12	2800	3.00	8.76	0.020	.000086	933.3	66	11.26	5.5	26	1½:1
13	2700	3.00	8.63	0.020	.000086	900.0	60	11.62	4.58	20	1½:1
14	2600	3.00	8.62	0.020	.000089	867.0	60	11.27	4.53	20	1½:1

COMPACTED EMBANKMENT SECTION

HYDRAULIC PROPERTIES	A	V	Q	r	n	S
	4041.3	3.75	15155	16.63	0.020	.0000528

ROCK SECTION

HYDRAULIC PROPERTIES					SECTION PROPERTIES			
Q	V	r	n	S	A	B	D	S.S.
15,155	6.00	16.74	0.035	.0004297	2525.8	94	22.75	¼:1
10,155	6.00	14.19	0.035	.000538	1692.5	69	20.13	¼:1

the development of power, are being constructed. Drop No. 1, immediately below the Coachella turn-out, is combined with a check and has a total fall of 9.68 feet, drops Nos. 2 and 3 are identical with a fall of 24.21 feet, drop No. 4 has a fall of 49.49 feet, and drop No. 5 has a fall of 21.93 feet. Power-plant foundations are being constructed at drops Nos. 2, 3, 4, and 5, but development of power will be by the Imperial Irrigation District.

Other Structures

Other important structures along the canal include three steel and concrete bridges on highway U S 80, one bridge on the main line of the Southern Pacific Railroad, one bridge on the Inter-California Railroad, a concrete-lined section on earth fill across the Alamo River, a double-barreled, 15-foot, 6-inch steel pipe crossing at New River, many turn-outs, checks, road siphons, and bridges.

With the exception of 20 miles of canal excavation across the Imperial Valley and a few of the smaller structures, all construction has been or is being done by contract. Eleven excavating contracts totaling 56,050,370 cubic yards and 16 structure contracts, exclusive of Imperial Dam and desilting works, involving 164,380 cubic yards of concrete, have been completed. At present, five structure contracts requiring the placing of 75,455 cubic yards of concrete are under way. It is anticipated that all structures will be completed this coming fall.

A contract for excavation of the first 40 miles of the Coachella Canal was awarded on June 28, 1938, and on May 1, 1939, 13 miles of canal involving 4,237,000 cubic yards had been excavated. Additional contracts will be awarded during the coming year.

Under terms of contracts entered into with the Imperial Irrigation District and the Coachella Valley County Water District, the cost of the All-American and Coachella Canals, with appurtenant structures not to exceed $38,500,000, will be repaid by these districts over a period of 40 years without interest. The present contracts do not provide for the construction of canals and laterals necessary to irrigate new lands. It is anticipated that this development will proceed in an orderly way to meet the ever-increasing demand for irrigated farms.

Project of Unusual Interest

Construction of this project has had n of the spectacular features found in the bui ing of high dams where hundreds of n work in a small area and almost every ty of construction may be watched from one va tage point. However, from an engineer's a layman's viewpoint the fact that constructi was spread out along 80 miles of All-Am ican Canal and 130 miles of Coachella Can with as many as 15 contractors at work as many types of construction, including t dam and desilting works, siphons, overchut highway and railroad bridges, checks, tu outs, temporary flumes, preparation of co crete aggregates, and even to the removal a reconstruction of cemeteries, the project h been of unusual interest. To the farmers the Imperial and Coachella Valleys the co pleted canal system means an assured supp of irrigation water, the saving of three-qua ters of a million dollars annually in dred ing silt and in cleaning canals and the addi of another half million acres of agricultur land to the present irrigated area, therel increasing the wealth of the "winter gard of the United States."

Columbia Basin Project

Irrigation Features

H. A. PARKER, former project manager of the lower Yellowstone project, Montana-North Dakota, and recently construction engineer of the Upper Snake River storage project, Idaho, was assigned to the Columbia Basin project, Washington, in charge of the irrigation features, effective at the beginning of this year. This work includes the planning of the canal system to irrigate 1,200,000 acres, none of which is at present irrigated, and the organization of two or more irrigation districts within the area. The task of surveying and mapping the 2,500,000 acres of the project land below Grand Coulee Dam is expected to be completed in 1940.

In order to lay out the reclamation project's future canal system more than 100 townships—an area of 3,780 square miles—must be resurveyed. About 1,200,000 acres of this land, including abandoned farms, desert land and dry-farming areas, will be reclaimed or improved by irrigation during the coming years.

When the records are complete they will show the location, ownership, topography and soil constituency of every 40-acre parcel of land within the Columbia Basin project area.

The soil on every parcel will be sampled, carefully analyzed and classified, and the land and its improvements fairly and impartially appraised for the benefit of future settlers. About 600,000 acres of public domain are expected to be opened gradually to public settlement.

Settlers and other buyers will have access to all records, including the land appraisals, which set the maximum prices at which irrigable lands on the project may be sold after the government enters into a contract with the land-owners to build the irrigation works in order to avoid speculation.

The first step in the surveying program is "retracement," or the reestablishment of section and quarter-section corners located by contract surveyors 50 to 75 years ago. More than 10,000 metal markers in concrete settings will replace the wood stakes, marked stones and small charcoal deposits that formerly identified such corners. Retracement has already been completed over an area of 1,750,000 acres.

The retracement survey is the basis of the Bureau's land ownership records, which will cover not only the irrigable land but also the waste land and grazing districts interspersed with the arable land. It is indispensable to the design and the purchase of right-of-way for the canal system, and complies with the provisions of the anti-speculation act.

By comparison with benchmarks established by the Geological Survey and th Coast and Geodetic Survey, the relative eleva tions of corner monuments are determine by level parties, the second step in the su veying program. Elevations have alread been determined over an area of 1,500,00 acres. They have varied from about 1,28 feet above sea level at the north end of th project to about 400 at the south end.

As the third and final step the topographi surveyors will map contour lines at 2-foo intervals of elevation on plane tables in th field. Rodmen engaged in this work hav walked 50,000 miles, and still have 15,00 miles to go.

Orland Recreation Grounds

ON MAY 27 the new recreation grounds spo sored by the Town of Orland and constructe by W. P. A. were dedicated. The ground cover 18 acres, and a baseball diamon (equipped with lights for night playing), horseshoe court and a modern swimming poo are among the facilities provided. At th dedication, exhibitions of swimming and div ing were given by stars from San Francisc Almost $40,000 was expended and the tow possesses recreation facilities of which the may well be proud.

Coulee Dam Construction Makes Steady Progress

THOUGH it grows steadily in volume, the Coulee Dam each day presents to its builders less working area on which to place concrete. The growing length of the dam is more than offset by the diminishing thickness of the dam as the structure rises.

The base of the dam covers a 35-acre area in the bottom of the Columbia River canyon, but only 17 acres of concrete placing space remains, and it is shrinking at the rate of an acre a month. On bedrock, the dam is 500 feet wide. At the crest it is to be only 30 feet in width. The sloping downstream face accounts for the waning working area.

There has already been placed in the dam concrete equivalent to just about twice the volume of the Bureau of Reclamation's next largest job, Boulder Dam; and there is yet to be placed at the Coulee enough concrete to make another Boulder.

An average day's output of the concrete mixing plants would make over 5 miles of standard two-lane highway. A speed test on May 25 mixed 20,684½ cubic yards of concrete within 24 hours, or almost 10 miles of such highway. This was a record. The largest quantity previously poured was 15,844 cubic yards in 1937.

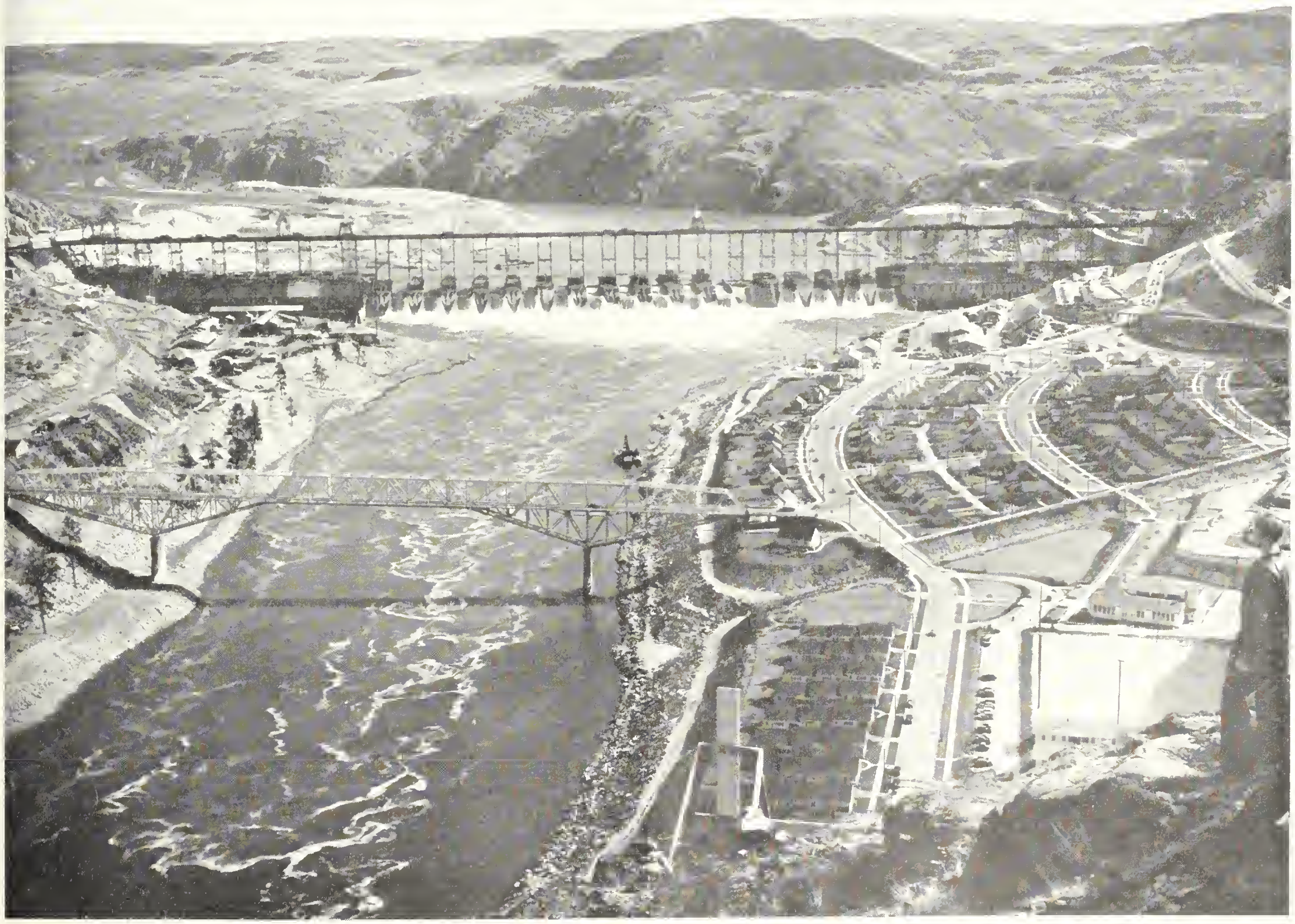
Concrete Pour Establishes World Record

A NEW world record has been established at Grand Coulee Dam where 20,684½ yards of concrete were poured within 24 hours on May 25.

Beginning a speed test at midnight, the graveyard shift mixed 6,768½ yards, the day shift topped that with 6,882 yards by 4 p. m., and at midnight the swing shift had established the record for 8 hours with 7,046 yards. Twelve yards of this concrete were rejected on account of errors in mixing.

(Continued on page 182)

The Columbia River flows through the 15 spillway outlets of Grand Coulee Dam. During the spring flood season, concreting work focuses in the powerhouses on either side and the abutment sections of the dam. The trimly laid-out town at the right is Coulee Dam, the permanent city which Bureau of Reclamation engineers have called home since 1934. On June 1, 1939, the dam was almost two-thirds complete



Lake Mead–Fisherman's Rhapsody

By WALTER K. M. SLAVIK

MOHAVE COUNTY MINER
Kingman, Ariz
JUNE 8 1934

Millions of Fish to Be Planted in Boulder Dam Lake

The great lake, or artificial pond that will be made up from the flow of the Colorado river, and impounded by Boulder dam, is to be one of the greatest fish ponds in the United States. The department of fisheries is to place in the ...and river (some 227 miles of ...of the river and south of the ... soon be acclimated and ... mil- will be the fisherman's paradise.

It will also be the great paradise for wild fowl and summer game as well, giving the fish and fowl hunters an all-the-year territory. Therefore, the dam will make an irrigation project, a power project, and will give us one of the greatest and most ideal territories for the game hunter and fisherman in the southwest.

———o———

AMERICANS have the reputation of working hard but they like to play, too. And so, even before the highest dam in the world was finished, and the work of providing for such utilitarian ends as irrigation, power generation, flood control, and metropolitan water supply was done, America turned its mind to sport, at Boulder Dam. The news clipping above, dated June 8, 1934, 5 years ago, is testimony.

Future paradise to fishermen? What is this business of fishing? Is it so important a sport?

Falconry, the chase, the turf, and polo in turn have been termed the "sport of kings," and monarchs large and small with their courts, both European and Oriental, have pursued them while their subjects found what fun they could, elsewhere.

Not so in America. Here, we have a different idea of living, and sport. The joy of playing after work is done is not confined to the high-born few who can afford the expensive equipment required by kings for their moments of relief from the burdens of State.

No. Play in America is for all, and fishing, of all our sports, is the perfect example of this great American principle. The joy of catching a fish is open to everyone, regardless of age, of sex, of vocation, or of income. From the humblest citizen to the President, from the bookkeeper to the banker, from the ragged urchin to the housemaid on a holiday—all can indulge in the sport of fishing, and enjoy it. Splendor of equipment and proficiency have nothing to do with the rewards. The small boy with a bent pin can catch the largest fish, and frequently does.

Here in America where every man is king, fishing is the sport of kings, in truth. The sport of fishing represents our different idea of living, working, and playing. It is in essence the sport of a democracy.

When Boulder Dam started to back up the muddy, turbulent Colorado River into a blue lake and the Bureau of Fisheries dumped its first 150,000 bass fingerlings into the reservoir, we began to be interested, and news articles appeared. We had already begun to use Lake Mead as a playground, and boating and bathing were growing popular. But fishing was in back of our mind. We waited. Fry do not become big fish overnight. In 10 years perhaps, this big artificial lake, largest in the world, would offer some real sport, for all of us.

Then, only 2 years after the first planting of the fingerlings, astonishing news reached us. Big, fighting, large-mouth bass were being caught in Lake Mead. An article appeared in one of the most widely read sports magazines. It was entitled: "Mystery Bass of Boulder Dam."

Fishermen all over the United States pricked their ears. Where did these big bass come from?

More articles followed, written by other fishermen who had gone to see with their own eyes and try with their own rods, this tall fish story. All verified it. And all were excited, enthusiastic, as only fishermen can be. Here is what they said.

"My friend is not a fisherman, so I had no reason to doubt his story. He said he'd seen the bass. It weighed 8 pounds! I telephoned . . . we were off. Out on the lake I spied a swirl over by the bank, and I cast to it. When I landed him, and he tipped the scale at almost 4 pounds, my fishing buddy almost bit the stem of his pipe in two. It was true!

"I kept on casting my old spinner over by a clump of brush partly submerged by water. Slowly I drew it in. On the fifth cast, when it was almost back to the boat, a sava slash threw up water like a miniature geys my rod quivered and bent double, and t reel whirred.

"On my third toss the line seemed snagge I tugged to jerk it loose—before I cou snub my reel with my thumb I lost a go 50 feet of line."

The verdict of one writer-fisherman aft his first day at Lake Mead is probably exa gerated. Fishermen have a weakness in th direction. "Into 3 hours," he insisted, "we crammed as much sport as I've had on ord nary bass lakes in 3 days.

"What fighters those Lake Mead big-mouth are! That crystal clear, cold water give them plenty of umph. They do not give u until they are whipped to a frazzle.

"Maybe Lake Mead hit me in a weak mo ment, when I was unduly susceptible afte a long fishless winter, but here's a predictio Ten years from now the biggest large-mout bass caught in the United States will be fro Lake Mead."

These are some of the rhapsodic report that have arisen about Lake Mead fishing But exaggeration and optimism discounted the fact remains that Boulder Dam's reservoir is giving fishermen real sport. It ha fat, gamey bass, and they are being caught The records prove this.

Every month the Boulder City Builder Supply Co. gives a complete set of fishin tackle for the largest bass caught in th lake. The very first month the offer wa made, in March 1938, the winner produced a bass that weighed 6 pounds 11 ounces the next month, 7 pounds 12 ounces; the next 8 pounds even; and the next, 7 pounds ounces, and so on.

At the time of this writing the bigges large-mouth bass caught at Lake Mead ha tipped the scale at more than 9 pounds. Te pounders are in the offing.

Where do these big ones come from Too short a time for fingerlings to grow t this size even if fed—as one amazed fisherman put it—"on the stuff they advertise o the radio for building strong kiddies."

Most plausible explanation according t Irving C. Harris, Director of Power, Boulde Dam, was the report that 30,000 bass fingerlings had been planted in the Virgin River— tributary of the Colorado—some 20 year before by the Bureau of Fisheries. The fis were believed to have ranged downstream and found haven within the swift water between the Colorado's precipitous canyons Here, as O. P. Senter, of the Boulder Dam Recreational Area service, remarked, "a fish erman would have had to be able to fly before he could get at them."

But now Lake Mead is where the Colorado used to be, 115 miles long, and formerly unreachable canyon walls are cozy coves lapped by lake water, clear and blue. Fishermen lucky enough to be able to make a trip to the Bureau of Reclamation's Boulder Canyon project cast gleefully in these coves, and exult in their catch forgetting its origin.

The day is not far off when fishermen on Lake Mead will be too busy pulling in the big ones to even give a thought to anything else. For the Bureau of Fisheries has enlarged its fish hatchery at Las Vegas, Nev., to place 500,000 bass fingerlings in Lake Mead every year, beginning with 1939. The Bureau has been and will continue to plant other game fish—blue gills, crappies. And below the dam, the Bureau has been planting trout.

Upper left: Lake Mead—150,000 acres, 115 miles of clear blue water full of game fish

Lower left: Casting for Lake Mead's big fighting bass right at the portals of Boulder Dam itself. Intake towers and spillway in background

Upper right: Dawn on Lake Mead. Waiting for that first strike!

Lower right: Isaak Waltons and their catch of Lake Mead big-mouth bass, fat and game

It appears that the newspaper appellation "future paradise for fishermen" applied to Lake Mead may indeed be justified.

The food and temperature of Lake Mead are apparently ideal for bass, and the lake itself is too large to be caught out, despite the thousands of fishermen who will be drawn by its fame and its open season all year. Heavy fishing may cut into the numbers of game fish but there is evidence that enough are already in the lake to reproduce a great supply, even aside from the Bureau of Fisheries' large plantings.

The best spots for fishing on Lake Mead are reported to be in the coves of the main lake and especially in Boulder Canyon, 20 miles above the dam. This may merely be another case of the adjoining pasture. They have been catching them right at the dam itself.

Boats are available at Lake Mead for all who wish to try their luck. It is recommended that an outboard motor be used. It gets to places more quickly, and also, Lake Mead is big. A stiff breeze can kick up the normally calm, clear blue water. Do not venture too far from shore with a small boat. It is unnecessary; row along the lake near the coves, if your boat is not powered, and troll with spinners or bass plugs of the popping type, or cast with them. If you do not get strikes at once, move on to the next cove. The bass in Lake Mead are as wary as they are game—and big.

Progress of Investigations of Projects

ARIZONA-CALIFORNIA: *Colorado River surveys.*—The Forest Service is continuing the preparation of the aerial mosaics. Report on the Palo Verde Valley is being reviewed.

CALIFORNIA: *Kings River-Pine Flat project.*—Preparation of the report is being continued. Additional studies are being made of the Haas site on North Fork of Kings River. Designs and estimates of Pine Flat, Piedra, and Wishon dams and power plants completed.

COLORADO: *Blue River Transmountain Diversion.*—Designs and estimates for dams at Dillon, Leal, Parshall, Two Forks, Strontia, Waterton, Tollgate, Box Elder, Ute Park, and Crystal River sites completed.

Eastern slope surveys.—Control surveys in Arkansas Valley were continued and land classification below Caddoa Dam; Water supply studies were continued and economic studies begun. Water supply studies were continued on the North Republican River and flood control studies are being made for the Trinidad project.

Western slope surveys.—Preparation of report of the La Plata project was continued and water studies and investigation of Collbran, Florida, Mancos, Paonia, Piceance Creek, Silt, and Troublesome projects in progress.

IDAHO: *Rathdrum Prairie project.*—Revised report on the project nearly completed.

Boise - Payette - Weiser investigations.—Arrangements for additional field work in Weiser Basin this season are being made.

Snake River storage—South Fork.—Preparation of report continued and designs and estimates of Grand Valley and Elk Creek Dams in progress.

MONTANA: *Gallatin Valley.*—Economic and power studies were continued and estimates for Spanish Creek Dam completed.

Madison River Diversion.—Studies of additional storage at Norris Dam were made.

Marias project.—Preparation of report was continued, including estimates of Shelby Dam, and economic data compiled.

Rock Creek project.—Economic studies of reservoir for both irrigation and flood control were made.

MONTANA-NORTH DAKOTA: *Fort Peck project.*—Nearly 150,000 acres of land were classified, and designs and estimates made of three canal and lateral systems for land between the Milk and Missouri Rivers. Preparation of plans for pumping plant at Fort Peck Dam was begun.

NEBRASKA: *Mirage Flats project.*—Estimates were continued of plans of dam at Box Butte site.

NORTH DAKOTA-SOUTH DAKOTA: *Missouri River pumping project.*—Land classification was completed of an area extending 40 miles above and below Pierre. Topographic surveys were completed of nearly 175,000 acres.

OKLAHOMA: *Canton and Fort Supply projects.*—Conference is planned with regard to the diversion of waters of the North Canadian River.

Washita River investigations.—A report on reconnaissance is in course of preparation.

OREGON: *Canby project.*—Arrangements for investigation of a sprinkler system are being planned.

Grand Ronde project.—Preparation of report was continued and study of flood control benefit being made.

SOUTH DAKOTA: *Black Hills investigations.* Preparation of report is being continued.

Shadehill project.—Estimates of cost of an irrigation project were being prepared.

TEXAS: *Balmorhea project.*—Water supply studies were continued and surveys were made of Humble Hill, Antelope Flats, and Cherry Creek Reservoir sites.

Robert Lee project.—Land classification, control survey, and stream gaging are in progress.

UTAH: *Lower Weber River project.*—Preparation of report is being continued, and economic and water supply data being assembled.

Woodruff and Clarkston Creeks (Newton).—Drilling operations on Otter and Woodruff Creeks are nearly completed, and lands in the vicinity of Clarkston and Newton were classified.

UTAH—IDAHO—WYOMING: *Bear River surveys.*—A reconnaissance of all reservoir sites in Bear River watershed was begun. A topographic survey of Thatcher dam site was made, and work on Pleasant Valley site near Evanston, Wyoming begun. Delineation of mosaic maps in Utah areas completed.

WYOMING: *Big Horn and Powder Rivers.*—Reconnaissance was continued of lands in the Big Horn Basin, topographic mapping of lands north of Williams Coulee was nearly completed, and classification was completed of lands under the High Line Canal for the pump lift at Hay Creek.

Colorado River Basin investigations.—Classification of 17,000 acres of land in the Whitman project on the Hassayampa River was completed, and of areas along the Zuni River in New Mexico; drilling was continued at Bullshead dam site on the Colorado River, and topographic maps of Box Canyon and Bullshead areas in Arizona continued. A reconnaissance in the White and Yampa River areas was made; water supply studies were continued of the Vernal-Ashley area in Utah; topographic mapping of the Dewey reservoir site was nearly completed; water supply studies of the Middle Green River were continued; economic studies of Scofield Reservoir in Utah were made; topography of Split Mountain dam site was completed, and surveys of Virgin City and Pine Valley reservoir sites in Utah were continued.

Water Laws of Utah

A HANDY booklet comprising the laws of the State of Utah relating to water and water rights has just been issued.

This compilation contains all statutes of the State, including those enacted by the 1939 legislature, relating to Water and Irrigation, the State Engineer, Appropriation of Water, Determination of Water Rights, Administration and Distribution of Water, the Utah Water Storage Commission, Withdrawal of Unappropriated Waters, and all miscellaneous laws relating to water and to the duties of the State engineer, including excerpts from the act relating to irrigation districts.

This publication is for sale by T. H. Humpherys, State engineer, Salt Lake City, Utah, at a price of 25 cents per copy.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
1218-D	Columbia Basin, Wash.	May 2	Structural steel framing for Leavenworth fish hatchery.	American Bridge Co.	Denver, Colo.	$12,260.00	F. o. b. Chicago	May 27
1220-D	Parker Dam Power, Ariz.	May 10	Wood poles, wood cross arms and ground-wire molding for transmission lines.	Weyerhaeuser Pole Co.	Lewiston, Idaho	[1] 47,062.00	F. o. b. shipping points	May 31
				MacDonald and Harrington Ltd.	San Francisco, Calif.	[2] 17,083.20	do	Do.
				Cascade Pole Co.	Tacoma, Wash.	[3] 43,791.00	do	Do.
				MacDonald and Harrington Ltd.	San Francisco, Calif.	[4] 14,236.00	do	Do.
1227-D	Colorado-Big Thompson, Colo.	May 24	Construction of 2 duplex cottages at Shadow Mountain camp.	John A. Bell	Berthoud, Colo.	8,110.00		May 27
1234-D	Central Valley, Calif.	May 26	Structural steel for highway underpass at station 5350+02.33, Southern Pacific R. R. relocation.	American Bridge Co.	Denver, Colo.	3,587.00	F. o. b. Gary, Ind.	June 5
845	Sun River, Mont.	May 9	Dikes for enlargement of Pishkun Reservoir.	T. G. Rowland	Salt Lake City, Utah	142,810.00		June 7
1229-D	Yakima-Roza, Wash.	May 23	1 gantry crane, 13-ton capacity	Schmitt Steel Co.	Portland, Oreg.	4,685.00	F. o. b. Portland. Discount ½ percent.	June 2
841	Central Valley, Calif.	May 19	18 duplex cottages at Government camp at Shasta Dam.	George Rock	Stockton, Calif.	85,003.00		June 10
1215-D	Colorado-Big Thompson, Colo.	May 26	2 5-room, 2 4-room and 2 3-room residences at Shadow Mountain camp.	John A. Ben	Berthoud, Colo.	34,545.00		Do.
1228-D	Columbia Basin, Wash.	May 29	Pipe, fittings, valves, and appurtenances for bypass and air piping, Grand Coulee pumping plant.	Jenkins Bros.	Bridgeport, Conn.	[5] 8,537.04		Do.
				The R. Hardesty Mfg. Co.	Denver, Colo.	[6] 11,880.00	F. o. b. Adair	June 27
1232-D	Rio Grande, N. Mex.	May 25	3 flowmeters for Elephant Butte power plant.	Simplex Valve Co.	Philadelphia, Pa.	2,860.00		June 8
844	Columbia Basin, Wash.	May 22	Hatchery building at the Leavenworth station, migratory fish control.	MacDonald Construction Co.	Seattle, Wash.	94,012.50		June 19
847	Colorado River, Tex.	May 31	Twenty-four 102-inch ring-follower gates for Marshall Ford Dam.	Hardie-Tynes Mfg. Co. and Koppers Co., Bartlett-Hayward Division.	Birmingham, Ala., and Baltimore, Md.	548,400.00	F. o. b. Birmingham and Baltimore. Discount ½ percent.	June 21
849	Parker Dam Power, Calif.-Ariz.	June 6	Transmission lines from Parker Dam to Phoenix and Blaisdell, Ariz.	Dwight Chapin, Jr.	Lincoln, Nebr.	[10] 209,694.50		June 19
33,208-A-1	Central Valley, Calif.	May 29	Steel reinforcement bars (1,933,900 lbs.).	Columbia Steel Co.	San Francisco, Calif.	38,602.33	F. o. b. Pollock. Discount ½ percent.	June 21
33,868-A-1	Yakima-Roza, Wash.	May 29	Steel reinforcement bars (916,917 lbs.).	Bethlehem Steel Co.	do	18,462.26	F. o. b. Buena. Discount ½ percent. Shipping point, Seattle.	June 22
44,341-A	Parker Dam Power, Calif.-Ariz.	May 25	Copper conductor and copper rod for transmission lines.	Anaconda Wire and Cable Co.	New York, N. Y.	[1] 226,536.00	F. o. b. Parker, Ariz. Shipping point, Great Falls, Mont.	Do.
				Do.	do	[3] 264,409.07	do	Do.
				Phelps Dodge Copper Products Corp.	do	[7] 33,880.00	F. o. b. Parker, Ariz. Shipping point, Bayway, N. J.	Do.
44,338-A-1	do	May 29	Insulators, suspension clamps, and strain clamps for transmission lines.	Porcelain Products, Inc.	Parkersburg, W. Va.	[1] 51,552.00	F. o. b. Parker, Ariz.	June 23
				Corning Glass Works	Cortland, N. Y.	[3] 5,563.20	F. o. b. Parker, Ariz. Discount 1 percent. Shipping point, Cortland.	Do.
				Do.	do	[4] 6,302.40	do	Do.
				Do.	do	[8] 4,820.00	do	Do.
				Do.	do	[9] 5,460.00	do	Do.
44,337-A-1	do	May 31	Ground and guy wires for transmission lines.	Bethlehem Steel Co.		[5] 43,710.00	F. o. b. Parker, Ariz. Discount – percent. Shipping point, Sparrows Point, Md.	June 26
1230-D	North Platte, Nebr.-Wyo.	May 26	Control switchboard, transformers, disconnecting switches, oil circuit breakers, and lightning arresters for Gering substation.	Allis-Chalmers Mfg. Co.	Milwaukee, Wis.	27,460.00	F. o. b. Gering, Nebr.	June 27
1231-D	Columbia Basin, Wash.	May 24	1 50-ton, motor-operated, overhead traveling crane for Grand Coulee power plant.	Bedford Foundry and Machine Co.	Bedford, Ind.	12,700.00	F. o. b. Bedford	Do.
1236-D	do	June 2	Structural-steel roof framing for Grand Coulee power plant.	American Bridge Co.	Denver, Colo.	54,079.00	F. o. b. Gary, Ind.	Do.
842	Gila, Ariz.	May 25	Pumping units for pumping plant No. 1, Gravity Main Canal.	Worthington Pump and Machinery Corp.	Harrison, N. J.	106,177.00	Pumps f. o. b. Harrison, motors f. o. b. Fortuna, Ariz. (shipping point Schenectady).	Do.
30,644-A	Deschutes, Oreg.	May 31	4 dump trucks	Koehring Co.	Milwaukee, Wis.	19,740.00	F. o. b. Milwaukee. Discount 2 percent.	Do.
846	All-American Canal, Calif.	June 1	Earthwork and structures Coachella Canal, stations 2078+16 to 4563+37 (47 m.).	Morrison-Knudsen Co. and M. H. Hasler.	Los Angeles, Calif.	[11] 2,279,212.31		July 13
848	Central Valley, Calif.	June 9	Preparation of concrete aggregates for Shasta Dam (2,800,000 tons of sand and 7,600,000 tons of gravel).	Columbia Construction Co., Inc.	Oakland, Calif.	[1] 4,413,520.00		July 17

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3. [4] Schedule 4. [5] Item 1.
[6] Item 2. [7] Schedule 5. [8] Schedule 6. [9] Schedule 7. [10] Schedules 1 and 2.
[11] Schedules 8 to 15, inclusive.

Reconstruction of Fruit Growers Dam

By STEPHEN H. POE, *Inspector*

RECONSTRUCTION of Fruit Growers Dam was completed by the Bureau of Reclamation in December 1938. The dam is located on Alfalfa Run, a tributary of the Gunnison River, 11 miles northeast of the town of Delta, Colo.

Fruit Growers Dam, 55 feet high and 1,500 feet long at the crest, is an earth- and gravel-fill structure constructed for the storage of 4,580 acre-feet of water for use by fruit growers and farmers on 2,600 acres of highly developed lands lying just downstream. It replaces an old dam, built by the irrigators, which was breached and failed during a flood on June 13, 1937.

The farming area served by this structure is old and highly developed. It was largely dependent for its irrigation water supply on the old dam. The unregulated flow of the stream is inadequate for the irrigators' needs. Faced with the loss of their orchards and crops, these farmers were in a critical situation after the 1937 flood. Immediate reconstruction of an adequate dam was essential. The new dam will be able to store water for their farms for the irrigation season of 1939.

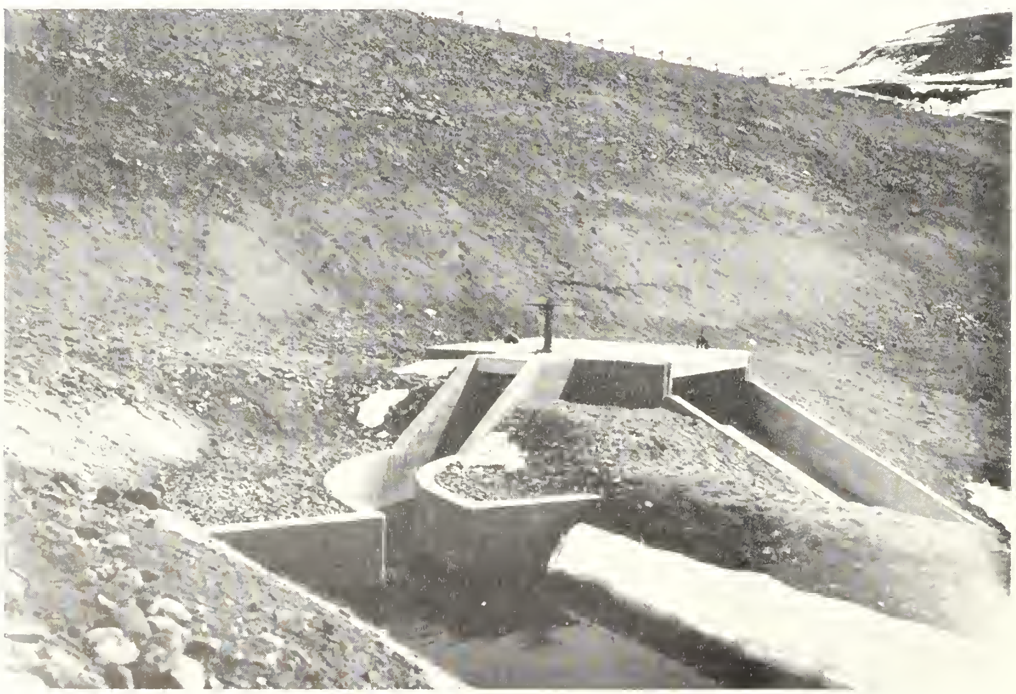
The old Fruit Growers Dam was first constructed about 1898 to supplement the natural flow rights of Alfalfa Run for the irrigation of nearby land. As more land was put under cultivation and as cultivation became more highly specialized, additional storage became necessary. As the demand for increased storage grew, the dam was brought up by stages until it reached a maximum height of about 40 feet when the structure failed. Although there was no loss of life attributed to the flood, considerable damage was done to property in and about the town of Austin.

The old dam was an earth-fill structure about 40 feet high and with a crest length of 680 feet. No spillway provision was made except for overflow around the north end of the dam on the natural ground which was but slightly lower than the dam crest. Much of the material used in the dam was shale which had been placed dry and without compaction. This material was extremely porous and evidently unstable when saturated.

On June 12, 1937, when the water surface was about 2 feet higher than it had been in previous years, a section of the downstream slope slipped, burying the outlet works, and water started from a break about 14 feet below the crest of the dam.

Faced with the probability of having the dam give way in its central portion, the owners decided to breach the dam through the more stable soil of the north abutment. Although the break was continually deepened and enlarged by the flow until practically all of the impounded water was released, it is probable that the peak of the resultant flood was less than would have occurred had the dam gone out at the central portion.

Outlet works showing circle ditch heading and upper portion of chute, Fruit Growers Dam



Following failure of the dam, the irrigation district sought Federal assistance in the reconstruction of the dam. Farms under the district depended almost entirely upon the reservoir storage for their irrigation supply, and lack of an ample supply portended not only poor crops but also possible permanent damage to the orchards. Investigations were started by the Bureau of Reclamation the latter part of June 1937 and were carried on intermittently until construction started in May 1938. Plans and specifications were drawn up during the winter of 1937–38.

Funds for financing the project were made available under the Emergency Relief Appropriation Act of 1937 with an allotment of $200,000 made on October 10, 1937, for the reconstruction of Fruit Growers Dam.

Originally it had been planned to expedite construction so that the dam would be ready for the storage of the 1938 spring run-off. And in order to complete the structure early in the season, it was decided to use Government forces for the work rather than take the time necessary for the advertising of bids, letting of contract, and other formalities that would have been necessary for construction under contract. However, construction was delayed until May 1938 owing to difficulties encountered by the district in attempting to secure reservoir right-of-way and water rights which were held in individual ownership.

Although no storage was possible during the 1938 spring season, little damage was reported to crops under the system as below normal temperatures delayed the spring run-off, assuring enough water to prevent serious damage to orchards and crops, and practically all water users had additional supply from small reservoirs on Grand Mesa. Flow through the dam area during construction was accomplished through a diversion channel and later through the concrete conduit of the outlet works and was seldom interrupted. Storage of water was begun October 31, 1938.

Dam and Reservoir

The dam will create a reservoir with a capacity of 4,580 acre-feet when the final spillway crest is constructed. Storage capacity with the present temporary crest is 2,540 acre-feet. The dam is an earth and gravel fill structure with a maximum height of 55 feet above original foundation and will raise the water 45 feet above the normal water surface of the stream bed. The dam is 1,520 feet long measured along the axis, 330 feet from upstream toe to downstream toe at maximum section, and is located 450 feet downstream from the old dam.

The slope of the upstream face is 3 : 1 except opposite the gate chamber where the slope breaks from 3 : 1 to $1\frac{1}{2}$: 1 from elevation 5,479 to the crest. The downstream slope of the earth embankment has a slope of 6 : 1 from the toe to elevation 5,450 and a slope of 2 : 1 from 5,450 to the crest of the dam at elevation 5,493.

Embankment quantities include 107,538 cubic yards of earth fill, 16,455 cubic yards of gravel fill, and 7,440 cubic yards of rock riprap. A total of 1,008 cubic yards of reinforced concrete was placed in the dam structures.

Cutoff Trench

The cut-off trench was excavated for a length of 1,380 feet across the earth foundation. The trench was located 35 feet upstream from the dam axis at maximum section and converged slightly toward the axis on the abutments. The depth of the trench averaged about 10 feet, but excavation was carried to varying depths depending upon the materials encountered. Minimum bottom width of the trench was 8 feet. However, much of the trench was excavated to a bottom width of 12 to 14 feet in order to accommodate placing equipment. Material placed in the trench contained a large portion of clay, with some sand and gravel, and showed about 45 percent passing the 200-mesh screen.

Toe drains were constructed at the downstream toe of the dam for a length of 1,420 feet. The drains were constructed by sewer-pipe tile with uncemented joints embedded in screened gravel which was covered with cobbles and pit-run gravel. The drains were laid in a trench 3 feet deep which was located under the gravel fill about 10 feet upstream from the downstream toe of the embankment.

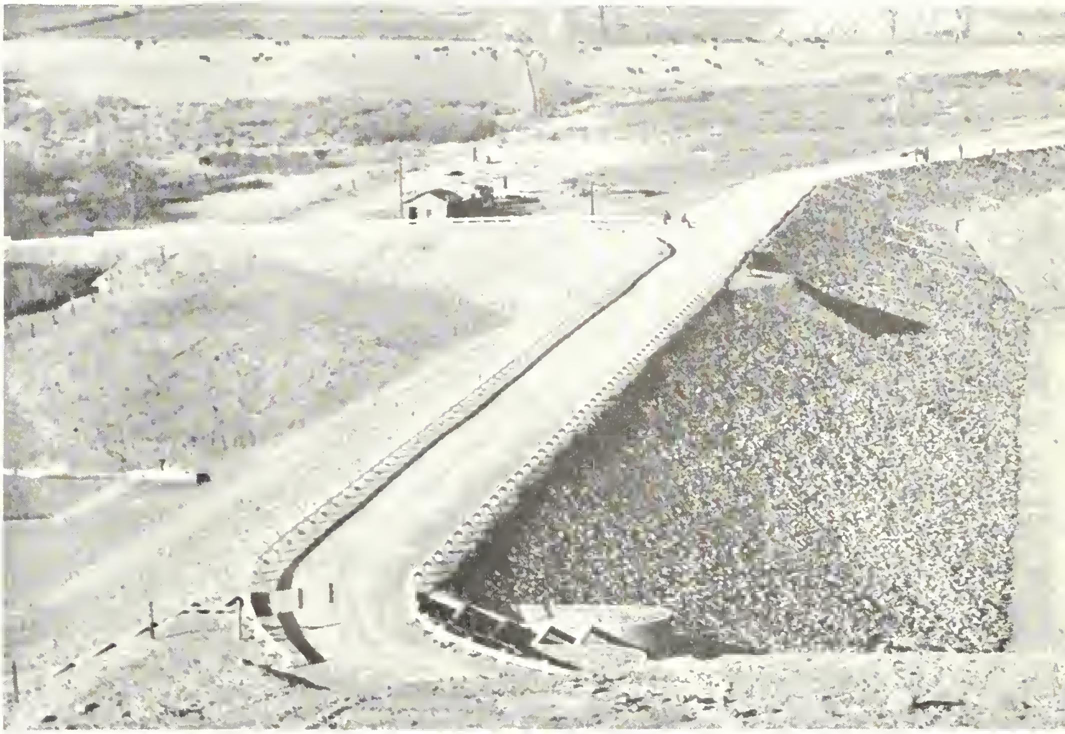
Spillway

The reinforced concrete spillway, constructed through the hard shale at the south abutment of the earth embankment, is 344 feet long and has a discharge capacity of 1,000 cubic feet per second. The spillway is at right angles to the dam axis. The channel width increases from 12 feet at the beginning of the chute section to 20 feet at the stilling basin, and the walls of the chute section vary from 5 to 16 feet in height.

Discharge from the reservoir into the spillway is over an uncontrolled crest. The present crest is constructed to an elevation of 5,480. However, the dam and spillway are designed so that the crest can be raised ultimately to an elevation of 5,485 when additional reservoir right-of-way is acquired.

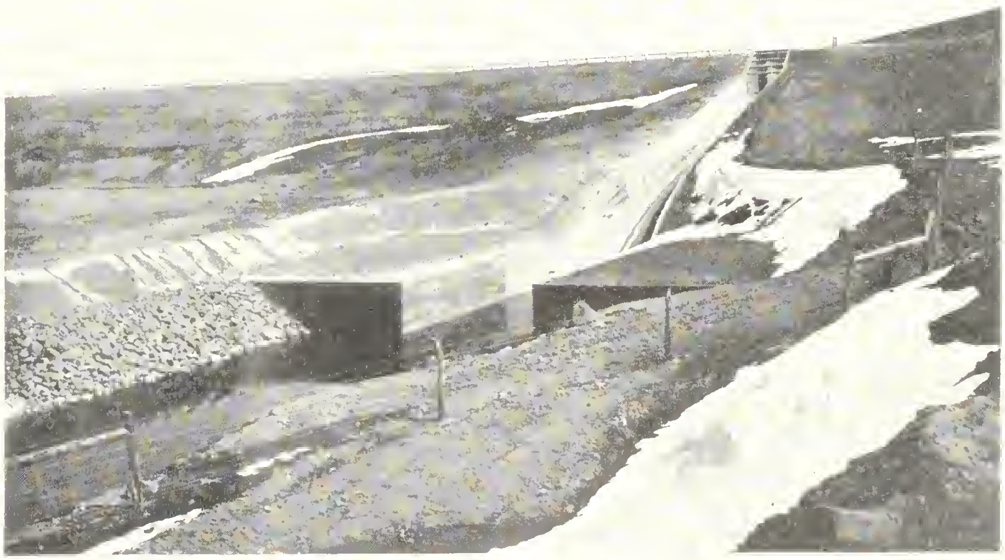
The concreted section of the stilling basin has a depth of 17 feet, a width of 20 feet, a length of 40 feet, and is provided with dentated sills. Walls of both the basin and the chute section are vertical and are back filled with gravel except at the dam area where power-tamped earth material was placed. Drains of 4-inch, open-joint tile were embedded in screened gravel at the base of the walls behind the concrete on both sides of the chute section. The walls of the stilling basin are provided with weep holes at 5-foot intervals.

Below the concreted section of the stilling basin, a pool was excavated 45 feet in length, 20 feet in width at the base, and with side slopes of $1\frac{1}{2}$: 1. The pool was riprapped with a 2-foot layer of heavy rock. There is a 4 : 1 slope from the end of the pool up to outlet grade.



General view of Fruit Growers Dam from South Abutment

Spillway on Fruit Growers Dam



The relocated county road over the crest of the dam crosses the spillway on a reinforced concrete bridge.

Outlet Works

The outlet works, which are 302 feet in length, were constructed at the north side of the valley floor where the slope of the abutment begins. The structures consist mainly of a reinforced concrete conduit leading from the trashrack to the gate chamber and from the gate chamber to the stilling box, chute, and stilling basin at the downstream toe of the dam. Regulation of the outlet works discharge is provided so as to permit discharge into either the Circle Ditch or the stream channel. Delivery to the Circle Ditch is controlled by a 24- by 24-inch cast-iron gate.

Construction Features

All work was performed by Government forces, and labor was secured in accordance with the provisions of the WPA relief act. Work performed by CCC crews was confined to clearing brush from the dam site and to rock riprap construction.

CCC forces began the work of clearing the dam site on May 2, 1938. On May 9 a dragline started excavation of the diversion channel and stripping of the foundation of undesirable materials down to a bed of firm earth. Concrete placement was begun June 3 and completed September 30, 1938. Placement of the earth fill was started July 7 and completed October 15, 1938.

Earth placing operations were carried on generally three shifts a day, each shift working 6 hours and 40 minutes. One 1-cubic yard dragline was used for stripping and borrow pit excavation until September when an additional machine, 1½ cubic yards, was started on borrow pit excavation. Material was transported from the pits to the point of placement by trucks ranging in capacity from 2 to 5 cubic yards. Most of the trucks used had a capacity of 2 cubic yards, and the usual shift with both machines excavating, required the use of about 14 trucks.

Material for the earth embankment was obtained from pits located in the reservoir area above the dam and required an average haul of about 1,600 feet. Part of the gravel fill material was also obtained from these pits. However, as sufficient gravel was not available in these pits, it was necessary to haul about half of the material for the gravel fill from pits located about 1½ miles from the dam.

Sand and gravel for concrete was hauled by truck from a screening plant set up on the banks of the Gunnison River at a point about 6 miles from the dam. Some material for backfill of tile drains was also obtained from this source.

Flow through the conduit is controlled by a 24-inch slide valve operating gate and a 24-inch slide valve emergency gate. Transition sections of steel pipe cones lead from the concrete conduit to the gates and reduce the diameter to 24 inches at the gates. A 6-foot diameter reinforced concrete shaft extends from the gate chamber to the crest of the dam to provide access to the gates. A hand-operated hoist is installed at the top of the shaft for the operation of the operating gate.

The conduit is constructed of heavily reinforced concrete with a minimum thickness of 12 inches, and is designed to withstand fully saturated earth pressure. Three concrete cut-off collars were constructed at 20-foot centers on the conduit on each side of the gate chamber to prevent the possibility of a percolation path along the contact line of the concrete and the earth fill. The collars have a thickness of 12 inches and extend a minimum distance of 24 inches from the outside of the conduit.

The foundation material upon which the outlet structures rest is a bed of fairly hard clay and the compacted earth of the cut-off trench. Special care was taken in compacting the earth in the section of the cut-off trench which is crossed by the conduit in order to secure a foundation as nearly equal to the natural clay bed as possible.

Placing Embankment

The method of placing the earth-fill material was similar to that employed on other rolled earth-fill dams. Material was dumped from trucks in evenly spaced windrows running parallel to the dam axis and spread to an even thickness by a D-8 Caterpillar equipped with bulldozer. The layers were spread to a loose thickness of 8 to 9 inches in order to produce a compacted layer not thicker than 6 inches. Following the spreading, the layer was handpicked for oversize rock and then rolled.

Rolling was accomplished by the use of a three-drum, sheepsfoot roller drawn by the D-8 Caterpillar. The roller drums were filled with a ballast of sand and water. Tests made during the early placement of earth fill indicated that 12 roller trips were required to obtain a field density comparable to standard laboratory compaction. Test averages for the season showed the field density to be 109.7 pounds per cubic foot and the laboratory density to be 110.1 pounds per cubic foot.

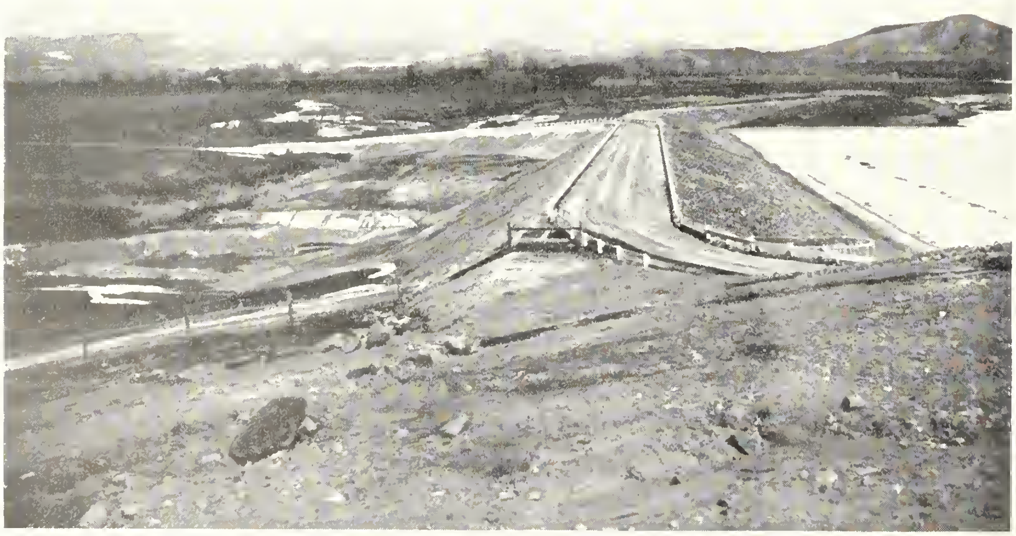
Special effort was made to secure effective rolling and a good bond along the line of contact with the abutments. The surfaces of the abutments were always moistened and rolled ahead of earth placement. Earth material placed adjacent to the concrete conduit and the spillway was power-tamped with 80-pound paving breakers equipped with tamping feet. The material was hand-placed in loose layers of about 6 inches in thickness, which tests showed was the maximum thickness that could be compacted thoroughly in a reasonable time and with an average size tamping foot.

Moisture Control

Materials in the borrow pits were moist from the seepage of nearby irrigated fields and moisture control throughout construction was accomplished by the selection of materials in the borrow pits without the necessity of wetting either by irrigating or sprinkling.

Generally, the percent of moisture depended upon the depth of the dragline cut, and the

Fruit Growers Dam from South Abutment



deeper the cut the higher the moisture content of the material. A cut of 10 to 12 feet in average material gave the desired moisture content. Materials were mixed by the machines in the process of excavation, and the moisture content of the materials as placed was generally uniform.

Tests showed the optimum moisture content to be about 17.2 percent and little difficulty was experienced in keeping the materials near this moisture. Tests made during construction showed an average moisture content of 18.1 percent in place against the laboratory optimum of 17.2 percent.

Wetting of the materials either at the borrow pits or at the point of placement was not necessary at any time during construction except that light sprinkling was used on the embankment on occasions when the surface had dried to a point that it was thought advisable to moisten the material before placing the succeeding layer in order to obtain a good bond between layers.

The earth borrow pits were characterized generally by three strata: (1) top soil, (2) sand and gravel, (3) clay sand and gravel. The top soil was of a uniformly fine particle size with silt predominating and ranged in thickness from 2 to 6 feet. About 1 foot of the surface was stripped as being unsuitable for use in the embankment. The sand and gravel layer varied in thickness from 2 to 12 feet and graded from fine sand to gravel and heavy basalt boulders. Underlying the sand and gravel stratum was a layer of clayey material containing some sand and gravel. Usually the material in this layer below a depth of 14 to 16 feet from the surface was too wet for use on the embankment; and unless the upper strata were exceptionally dry, the usual cut was to a depth of about 12 feet.

Mixing the materials by the draglines in the pits was a process employed throughout construction so that a homogenous embankment might be produced. Mechanical analyses of embankment materials showed little variation in grading except that the sand and gravel content was increased gradually toward the upstream and downstream slopes of the dam. As nearly as possible, the finer materials were placed in the central upstream portion of the embankment including the cutoff trench and graded to coarser materials at the slopes.

About 21,000 cubic yards of material were excavated by the draglines from the old dam, of which 12,000 cubic yards were placed in the new dam and 9,000 cubic yards, unsuitable for such use, were hauled to waste and leveled out on the floor of the reservoir immediately above the dam.

Measurement of the quantities of earth fill placed in the dam from all sources shows a total of 120,892 cubic yards as measured in excavation, while the measurement of the embankment in place is 107,538 cubic yards, giving a shrinkage of 12.4 percent based on embankment quantity.

CCC forces constructed all rock riprap work on the dam and appurtenant structures. In securing material for this work it was necessary to gather and load the rock by hand as there were no rock strata in the vicinity of the dam. Scattered surface rock and rock piles from cleared fields furnished most of the material for riprap although a small quantity was obtained from the oversize picked from the earth fill. During most of construction, the rock riprap on the upstream face of the dam was brought up about 15 to 20 feet behind the earth fill. All riprap was placed by hand methods so that a smooth, even slope might be obtained.

Final Costs

Construction of the dam, including engineering and overhead, cost approximately $149,500 of the originally allotted $200,000. The water users are negotiating now for the use of remaining funds for the reconstruction of the Transfer Ditch which has been used for diverting water from Dry Creek into the reservoir. The ditch is not usable in its present state of repair. Investigations were made following completion of the dam.

Ross K. Tiffany, Engineer, Dies

NEWS of the sudden death on June 1 of R. K. Tiffany was received in the Washington office after the June issue of the ERA had gone to press. We now record with sorrow the passing of this useful and beloved citizen and engineer.

Mr. Tiffany, who at the time of his death was executive secretary of the Washington State Planning Commission, was stricken with a heart attack in Colville, Wash., and collapsed at 1 p. m. on June 1, just after stepping from the automobile in which he was traveling.

The greater part of Mr. Tiffany's connection with the Bureau of Reclamation was spent on the Yakima project, of which he was superintendent in charge from July 1,

(Continued on page 182)

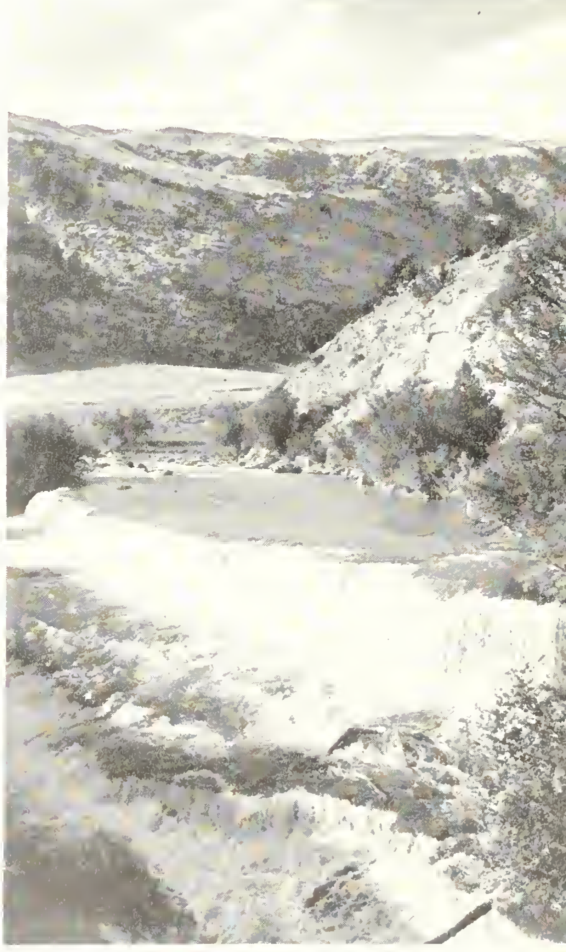
Riverton Scene Cover Page Material

By GOLDIE L. BEZOLD

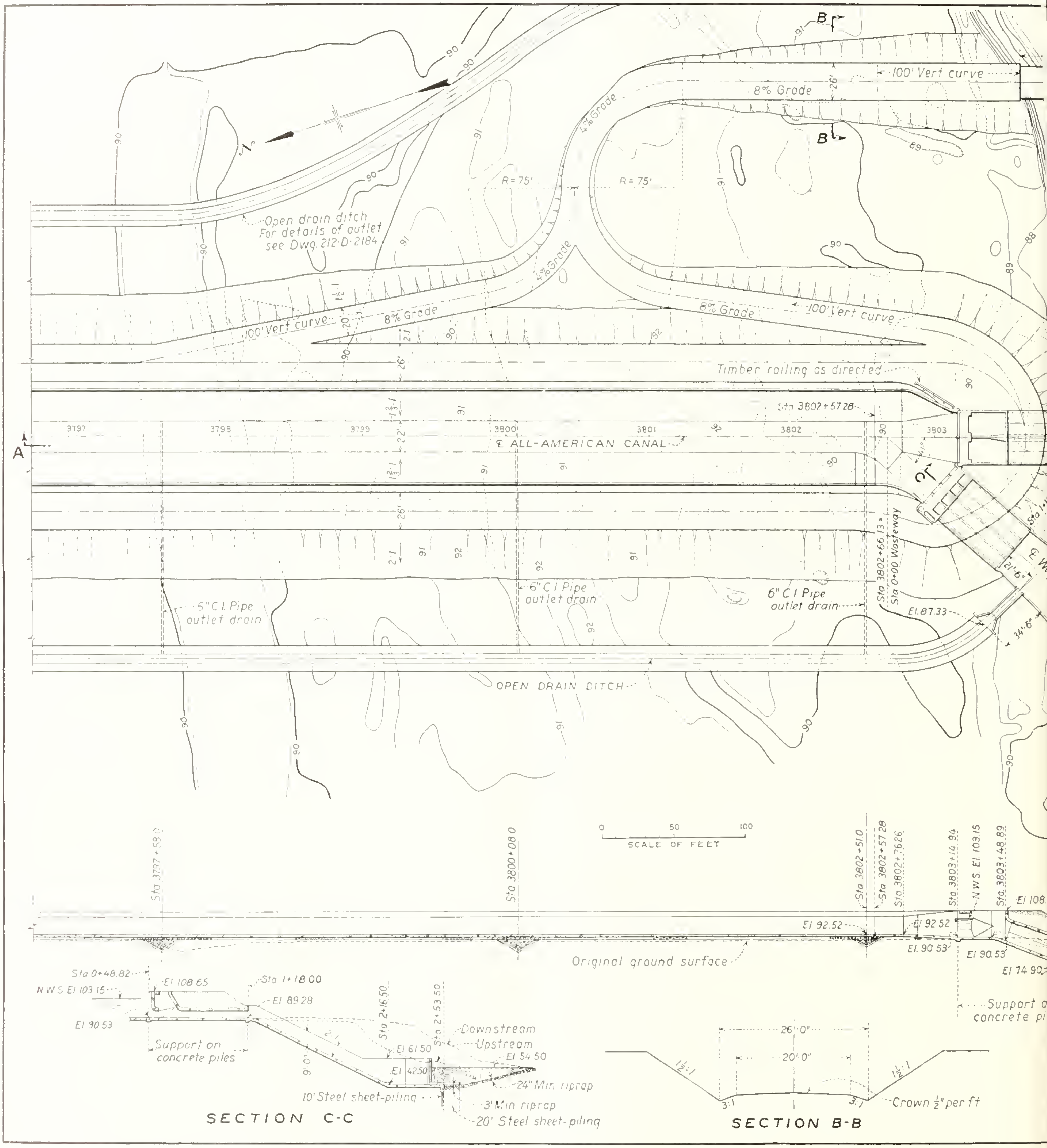
AS noisy Bull Lake creek flashes and splashes a tumultuous course down its rocky canyon, it leaves etched on the canyon floor many a scene lovely to behold. It is one of these beauty spots; namely, Bull Lake creek falls, that the Mountain States Telephone & Telegraph Co. has illustrated on the cover of its newest directory for Fremont County, Wyo.

Perhaps it is well that someone has thrust this bit of inspiring beauty before the public eye, as to see it first hand means an arduous and exhausting climb which few care to make. The sight, however, is well worth any effort as their beauty comes almost as a shock, a shock as breath-taking as a plunge into the icy waters of this creek, born in the perpetual snows of Dinwoody Glacier, the largest living glacier in the United States proper. The falls, though not high as water falls go, are unique in that the waters plunge over a wall diagonally cut back upstream, instead of in the familiar manner at right angles to the stream's course. After this crashing leap to the side, the creek which is always brimful of clear, pure water even through the hottest season, continues its original direction.

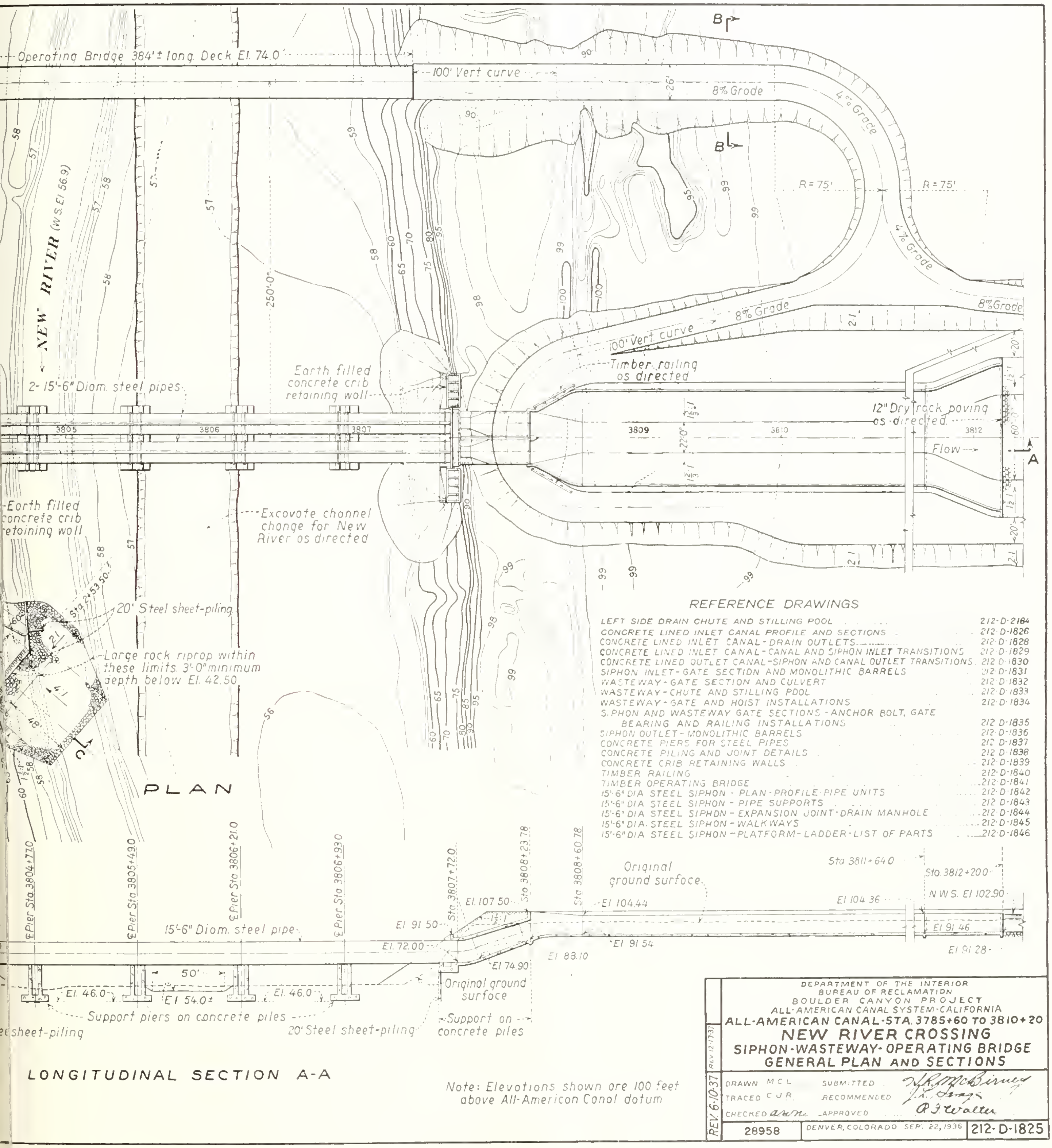
This scene photographed by B. D. Glaha, is located about 50 miles above Riverton and a short distance above high water line on the recently constructed Bull Lake Reservoir on the Riverton project.



Construction of the New River Crossing



THE recently completed New River Crossing is located 2 miles west of Calexico, Calif., at a point where the All-American Canal crosses what was once an old flood channel of the Colorado River. This channel now serves as a wasteway and drainage ditch for the irrigated sections of the Imperial Valley, discharging into the Salton Sea, and is known as New River. The All-American Canal crossing is made by means of an inverted siphon composed of two parallel 186-inch diameter welded plate steel pipes, each 374-feet long, supported at intermediate points on four reinforced concrete piers and with the ends embedded in reinforced concrete



Gate section of siphon inlet on left and wasteway inlet on right

inlet and outlet structures. The complete structure has a capacity of 2,700 cubic feet per second.

Each of the two pipes was fabricated in five units 71-feet 7-inches in length, and two end pipe units approximately 7-feet in length. Each 71-foot 7-inch unit is provided with steel supporting collars welded to the pipe 3 feet 6 inches from each end. The pipe units are connected by means of expansion couplings of the outside-packed, central-sleeve and follower-ring type. The tops of the concrete piers and of the abutment portions of the concrete inlet and outlet structures are formed to the curvature of the flanges of the supporting rings welded to the pipe, and recesses 5 inches deep by 17½ inches wide are formed in the tops of the piers. Tread stock rubber in laminated sheets 13 inches wide is centrally placed in each such recess, and sponge-rubber filler blocks are inserted in the spaces between the sides of the recess and the edges of the tread-stock rubber strips. The rubber is so placed as to extend about one-half of an inch above the surface of the top surfaces of the piers. At one end of each pipe unit, a curved steel plate, lined on the concaved surface with phosphor bronze sheets welded to the steel plates, is placed over the rubber bearing pad and serves as a bearing plate for the pipe support. The pipes are erected so that, when completely installed, the flanges of the pipe support rings rest directly on the bearing plates on one end, and on the rubber bearing pads on the other end.

The invert of the steel pipe at the inlet end is 20.5 feet below the bottom grade of the open canal immediately upstream, and the invert at the outlet end is 19.5 feet below the bottom grade of the open canal downstream. The pipes are connected with the canal at each end by inclined barrels of reinforced monolithic concrete. These barrels are supported upon concrete bearing piles, and lead into reinforced concrete transition sections with warped walls.

The flow of water through the siphon will be controlled by the 16-foot 9-inch by 13-foot 7-inch electrically operated radial gates at the inlet end of the structure.

Regulating Gates

Leaving the main structure at an angle of 41°, and just to the right of the radial gate section, is a wasteway with a capacity of 2,800 cubic feet per second which discharges into the New River channel. Four 6-foot 6-inch by 7-foot 6-inch electrically operated top-seal radial gates control the flow of water through the wasteway, thus providing a means of regulating the All-American Canal at this point. One of the 6-foot 6-inch by 7-foot 6-inch radial gates for the wasteway will be operated automatically by means of a float and an adjustable weir installed in a float well and a concrete counterweight suspended by cables attached to the radial gate. The other radial gates will be operated by motor-driven hoists manually controlled fr a cabinet on the wasteway gate structure.

The canal excavation upstream and dov stream from the siphon had been comple by Government forces prior to the award the structure construction contract. This cavation work at the upstream end h ended 1,700 feet from the structure in The natural ground surface throughout t 1,700 feet of canal line averaged 2 feet bel canal grade; thus it became necessary to b row embankment material and compact t canal banks on both sides, and also the can floor, throughout this distance. The co pacted section was then lined with reinforc concrete. The canal banks for 360 fe downstream from the siphon were also co pacted and concrete-lined in the same mann

The canal lining at the inlet end of t structure is placed upon a screened grav blanket, 12 inches thick on the floor and inches on the side slopes. A protective coa ing of gunite averaging one-half inch thickness was placed over the gravel blank to prevent its displacement during the pla ing of reinforcing steel and concrete. T purpose of the gravel blanket is to interce seepage or ground waters, and to preve uplift pressures from damaging the concre lining. The waters from these sources w then flow into gravel and pipe drains co structed transversely across the canal secti at 250-foot intervals, which in turn dischar into open drain ditches at the right and le sides of the canal.

The concrete lining was placed at nig during the month of April when daytime te peratures were reaching 100° F. Eve though the placing was done during th periods of lowest air temperatures at nigh it became necessary to wet the aggregates to 5 hours before the beginning of a shift, enable evaporation processes to cool th gravel. By following this procedure the max imum temperature of the concrete durin placement was kept to 90° F., a specificatio requirement.

A 1-cubic yard Koering paver was used i mixing the concrete for the lining, whic was placed in 20-foot sections. Hand finish ing was done from a movable timber trus bridge straddling the canal.

In preparing the ground surfaces under th compacted embankment sections, a minimum depth of 12 inches of loose material wa stripped from the entire area to be covere by the embankments. The stripped materia was composed of vegetation and fine sil After stripping, the area was sprinkled an disked.

The compacted embankment material wa obtained from borrow pits located an averag distance of 1,200 feet to the side of the cana R-D-8 and 75 caterpillar tractors with 10 and 15-yard carry-alls were used in excavat ing the material, hauling, and spreading it o the fill in 4- and 6-inch layers. Each laye was compacted with a sheep's-foot roller, de signed to produce a pressure by weight o

00 pounds per square inch on each row of feet," parallel to the axis of the roller. The completed embankment contained a predominant amount of clay and silt, with smaller quantities of sand and gravel.

Toward the latter part of the job a definite sand pocket was encountered in the borrow pit, and it was found that the best mixture was obtained by requiring one carry-all to haul only sand, while others hauled only clay. After spreading a 4-inch layer of clay, a 2-inch layer of sand was added. The two layers were then mixed by means of a disk harrow pulled in tandem with the roller.

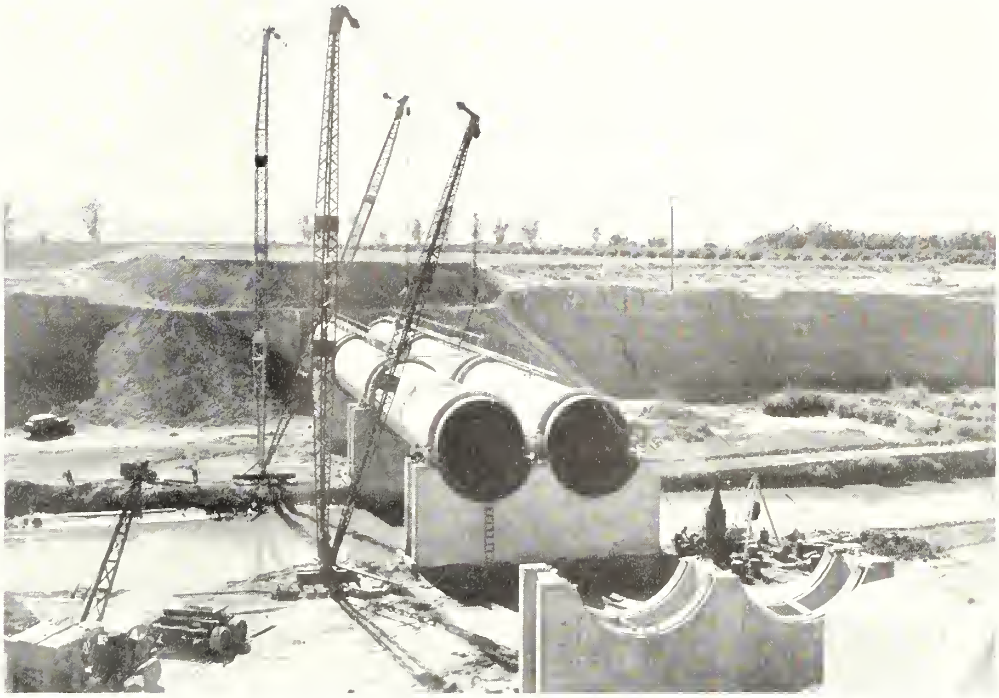
Frequent tests of the dry density of the fill were made and an increase in this density of 2 to 4 pounds per cubic foot was obtained in using the sand in the manner described. The average density on the completed job was 101.5 pounds per cubic foot. The average moisture content was 18.5 percent. The tests indicated that 10 roller trips over the entire area being compacted usually produced the results desired.

After the fill was completed, the canal slopes were trimmed to the neat lines required for the concrete paving, by means of a motor grader traveling parallel to the canal center-line and held in any desired position on the slopes by means of cables attached to a tractor traveling on top of the canal bank.

Other Siphon Work

Other work done by the siphon contractor, appurtenant to the siphon, but not an integral part of the crossing structure proper, included the construction of open drain ditches on both sides of the lined section of canal at the inlet end, with reinforced concrete chutes discharging into the New River channel; and the construction of a 20-foot-wide timber operating bridge, 386 feet in length, across the river channel, 250 feet upstream from the siphon structure.

Actual construction began during August 1937, with the manufacture of concrete bearing piling in 30-, 40-, and 45-foot lengths. A total of 24,370 linear feet of concrete piling was manufactured at the site of the structure. All piling was reinforced longitudinally with eight 1-inch square bars, held in position by a continuous spiral coil of ⅜-inch round steel. These spirals were made by drawing the ⅜-inch steel from a spool onto a motor-driven steel cone of the required shape. The piles were octagonal in cross section, the inscribed circle having a diameter of 20 inches. The lower 4 feet was tapered to a diameter of 1½ inches. Casting was done in a horizontal position using collapsible metal forms clamped against a 2-inch plank which formed the bottom side of the pile. The top was left open for pouring and hand-finishing. A 2-inch diameter jet pipe was cast in the pile, extending from the top and side, to the point. A maximum of 1-inch aggregate was used with a concrete mix of 1-2.26-1.22-2.32. This mix for 1 cubic yard of concrete requires 546 pounds of



Pipe placing operations in progress at Piers Nos. 2 and 3

cement, 1,234 pounds of sand, 666 pounds of $\frac{3}{16}$-inch to ½-inch aggregates, and 1,267 pounds of ½-inch to 1-inch aggregates. The water used was 295 pounds per cubic yard.

Although New River now carries an average flow of only 400 second-feet and is confined to a comparatively narrow stream channel, the river bottom is quite wide due to erosion by flood waters of the Colorado River, during and since the channel was first formed in 1905. Subsequent meandering of the stream flow has also contributed to the widening of the river bottom. The river bottom section, on which the four-pipe support piers are founded, at this location is approximately 300 feet in width and consists largely of quicksand formation, with ground water only 1 foot below the ground surface on either side of the main channel. Owing to the instability of the ground within this construction area it was first necessary for the contractor to haul dry earth and place a 2- to 3-foot blanket on the river bottom to facilitate transportation of construction materials and equipment to the pier sites.

Seventy-five 45-foot piles were used to support each of the four piers in the river bottom. The tops were driven to elevation 53.23, 15 feet below the surrounding ground surface. Excavation to this elevation was made possible by the use of timber cribbing and steel sheet piling placed around the entire pier footings. The type of material encountered and the presence of water in the pier excavations gave rise to several special problems in connection with the driving of the piles for the piers. Although predominantly quicksand, the material contained occasional layers of clay, usually at a depth of 30 feet below the subgrade of the pier footings. An auxiliary jet outside the pile was used only in starting and for plumbing when clay was encountered. The pile-driving rig was one of the contractor's own design, and was used in connection with a McKiernan and Terry double-acting steam hammer, type 10-B-2, rated at 15,000 foot-pounds per blow at 115 blows per minute, with 80 pounds per square inch steam pressure.

Water Problem

In order to unwater the pier footing excavations and permit the placing of concrete in the pier footing blocks, the contractor installed a small well-point system. The well-points were spaced at 4-foot centers around the outer edges of the pier footing blocks, and penetrated to an average depth of 10 feet below the subgrade of the blocks. The water problem was by no means solved by this method, but it aided materially in reducing the flow into the excavation. The contractor experimented with screens of various sizes and diameters placed at the well-point inlets, but with slight changes in the results obtained. On all points that were pulled for inspection the screens were found to be clogged with a very fine white sand. In each pier excavation there were several sand and water "boils." In some cases the "boil" would flow upward along the well-point pipe, but the screens would not pick up the water.

Even with the aid of the well-point systems the pier excavations remained too wet to permit the placing of concrete for the footings, so it was deemed advisable to place a concrete seal coat over the entire area enclosed by the timber cribbing or steel sheet piling. The seal coat consisted of an unreinforced slab of concrete, with an average thickness of 1 foot. There were several places where the ground water "boiled" through the newly placed seal coat, but the water from these sources was carried off through the forms by means of small gravel drains.

The pier footings are reinforced concrete blocks 54 by 21 by 4 feet, with the 54-foot dimension at 90° to the center line of the siphon. These blocks were cast so that the top of the concrete piles were embedded 1 foot. Each pier supports the adjoining ends of four sections of pipe, and contains 432 cubic yards of concrete. The pouring time on each averaged 19 hours.

In addition to the four piers which carry the steel pipe across the river channel there is an abutment pier at each end of the pipe, supported upon concrete bearing piles. The four steel thimbles, or end units, of the 186-inch-diameter pipe were then placed in position and supported by angle irons and anchor bolts cast in the concrete; the first concrete placed in the inclined monolithic barrels then served to encase approximately half of each thimble, and give stability during the operation of connecting the adjacent 71-foot 7-inch lengths of pipe.

The internal cross section of the inclined monolithic barrels adjacent to the steel end units is circular for a distance of 14 feet along the center line of the pipe. In the next 35 feet there is a gradual transition into a rectangular shape and from there on into the open canal sections, the warped transitions occur.

The forms for the barrels were built in segments, which were braced radially to a needle beam of laminated 2- by 12-inch planks, securely anchored at each end to overcome a "floating" tendency during concrete placing. In these inclined barrel sections the concrete mix employed was designed for a 4-inch slump, except for several more inaccessible locations, where it was advisable to increase the slump to 6 inches.

Open transitions with warped walls changing from vertical to $1\frac{2}{3}$: 1 slope are used to connect the siphon inlet and outlet barrels described above with the concrete-lined sections of open canal.

The 71-foot 7-inch pipe sections were built at the contractor's yard in Calexico from previously fabricated shorter sections which had been made up in a plant located at Alhambra, Calif. The main sections of pipe were manufactured from ½-inch steel plate with stiffener sections at each end of ⅝-inch plate. Ten complete 71-foot 7-inch sections were required in addition to the four partially embedded end units which act as anchors.

The shorter ring sections as they came from the Alhambra plant were assembled on a level concrete slab and spot welded to th correct alignment. The joints between se tions were then field welded by the electri arc method. By rolling the pipe on the co crete slab it was possible to avoid overhea work and to do all the welding from the to All sections were sandblasted to the brig metal and painted on both sides.

Hauling and Installing Equipment

The pipe sections, each weighing approx mately 45 tons, were hauled from the assen bly yard in Calexico to the structure sit about 2 miles, by means of a 10-ton transpo truck and a standard 4-wheeled dolly. Equi ment for handling at the structure site co sisted of a 76-foot gin pole and two guy de ricks, approximately 93 feet high.

A walkway consisting of steel gratings su ported on structural steel bents, welded t the pipe shells, and provided with pipe an structural steel handrails was installed o each pipe. Hydrostatic tests conducted aft the completion of the structure revealed n leaks of consequence.

All the work except that of furnishin erecting, and painting the 186-inch I.D. pla steel pipe was done by the Sharp & Fellow Contracting Co., of Los Angeles, Calif. Th pipe work was executed by the Southwes Welding & Manufacturing Co., of Alhambr Calif.

The New River crossing structure is th most notable siphon on the All-American Ca nal system, and its completion marks th passing of an important milestone in th construction of the canal.

By J. R. LAWRENCE, *Engineer, and* L. F CRAMER, *Assistant Engineer*

Pipe section of structure as it appeared after completion

Power Development on Federal Reclamation Projects

May 1939

Project	*Output (kilowatt-hours*
Arizona, Salt River	34, 514, 05
Arizona-Claifornia, Yuma	785, 05
Arizona-California-Nevada, Boulder	148, 252, 00
Colorado, Grand Valley	890, 44
Idaho:	
Boise	7, 346, 77
Minidoka	7, 482, 00
Nebraska-Wyoming, North Platte	2, 584, 98
Nevada, Newlands	658, 86
Utah, Strawberry	345, 80
Washington, Yakima	2, 045, 23
Wyoming:	
Riverton	277, 30
Shoshone	882, 70
Total	206, 065, 20

Home Building on Rio Grande Project

CONSTRUCTION of a good class of modern homes in the suburban part of El Paso, Tex., and also in the urban area of Las Cruces, N. Mex., has been quite active thus far this year.

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Use of Electricity on Farms of The Boise and Owyhee Projects[1]

By CLAUDE H. STUDEBAKER, *Assistant Engineer*

THE Capital Electric Light, Motor & Gas Co. rushed completion of its plant in order that the city of Boise might have electric lights for the Fourth of July 1887. To the residents of Boise, which at that time numbered some 2,000, and to those who came to town for the holiday, those lights alone made the celebration a success. The power plant with its two Edison dynamos having a combined capacity of 500 sixteen-candlepower lamps (about 30 kilowatts) was in itself very fascinating. The energy for this installation was secured by dropping the waters of the Ridenbaugh Canal 62 feet to the level of the Boise River. The principal use of this first energy was the lighting of streets, stores, and a few of the better homes. The tiny plant has long since been outgrown and abandoned. From this humble beginning has grown the Idaho Power Co., a system embracing 13 plants with an installed capacity of 102,135 kilowatts and serving 57,700 customers in southern Idaho and eastern Oregon.

Electrification on the Boise and Owyhee projects

By no means an insignificant part of the local power system are the rural customers of the Boise and Owyhee projects. On December 31, 1938, these farm customers numbered approximately 6,770 (this figure excludes all urban and suburban users). Notable is the percent of farms that are electrified; for the Boise and Owyhee projects the percentage is about 85. The national average is reputed to be between 22 and 32 percent.

In 1929, which is as far back as the records are complete, there was a total of 762 miles of rural pole lines in Ada, Canyon, Gem, and Payette Counties in Idaho and Malheur County in Oregon, in which counties the Boise and Owyhee projects are located. At the close of 1938 this figure had been more than doubled and stood at 1,544 miles. As might be expected, the number of customers increased in proportion to the number of miles of line. There were 3,553 in 1929 and 6,768 at the close of 1938.

The greatest increase occurred in Malheur County where the new land of the Owyhee project is being settled. Here the 109 pole-line miles of 1929 were more than tripled during the 9-year period described above. The settlers on this new land might well be described as modern pioneers. Their pioneering spirit gives them the courage to attack the desolate sage-covered land with a will to build a home and their modern education causes them to demand that that home have the conveniences of the city. Electric lights, the radio, the electric stove, and many other appliances have been removed from the list of luxuries and added to the list of necessities.

Rates far below national average

As compared with the national average, the farmers of the Boise and Owyhee projects enjoy a very reasonable rate. Only one State (Washington) has a lower rate than do Oregon and Idaho. The local farm domestic service rate is as follows:

Available to residential and farm customers for all electric service supplied to single private dwellings and individual family apartments for general domestic uses, including single-phase motors of 5-horsepower rating or less.

Net monthly rate

Kilowatt-hours	*Cents*
For first 11, or less	90. 1
For next 19, per kilowatt-hour	5. 0
For next 80, per kilowatt-hour	2. 5
For next 80, per kilowatt-hour	2. 0
For all additional, per kilowatt-hour	1. 5

When connected motor load exceeds 5 horsepower, the initial charge of 90 cents shall be increased 50 cents for each horsepower over 5 horsepower.

Customers having a water-heater installation conforming with the specifications and limitations below will receive a discount of one-half cent per kilowatt-hour on consumption used in excess of 200 kilowatt-hours, except that the discount shall not apply to excess consumption greater than the following:

Automatic electric storage tanks with interconnecting thermostats

Tank capacity (gallons)	*Heaters*	*Kilowatt-hours*
12–19	1	200
20–29	1 or 2	275
30–39	2	350
40–49	2	425
50–59	2	500
60–69	2	650
70 or more	2	800

Desirable power market

Farm customers such as those on the Bois and Owyhee projects constitute a very d sirable market for power. Their demand only slightly affected by the national econom condition, whether it be depression or pro perity. As contrasted with industrial cu tomers who occasionally find it necessar to shut down during dull times, these farme are as constant as time itself. The milkin machine must function twice daily regar less of the price of butter, and when th price of eggs is low the lights in the coo may even burn overlong to urge the hen greater productiveness. Once installed on farm the meter is rarely disconnected.

Electricity has many uses

The rapid improvement in standard ele trical appliances, together with the inventio and development of many new devices, ha induced the farmer, and more especially h wife, to install machines and gadgets to pe form many of the things which in the o days were done by hand. Listed below a some of the electrical devices:

Regular household uses

Lights, radio, range, refrigerator, wate heater, washing machine, flat iron, toaste vacuum cleaner, sewing machine, fan, h plate, waffle iron, corn popper, mixer, perc lator, air heater, stoker, curling iron, warn ing pad, hair drier, floor waxer, air cond tioner, mangle, clock, egg cooker, dish washe scalp massager, garbage disposer, shave cigarette lighter.

Special farm appliances

Feed grinder, water pump, milking machin cream separator, hay chopper, incubato chicken brooder, barn ventilator, electr fence.

Of course no one farmer has all the appliances; some have only lights and radi In most homes the number of uses increase yearly. The women take much pride in th labor-saving kitchen appliances and many the farm homes are complete with all th more common conveniences. Approximatel 50 percent have refrigerators, 53 percent ha ranges, and 23 percent have hot water hea ers. In point of appliances, the farm hom are on a par with city homes.

[1] 1,540 miles of pole line serve 6,770 customers. The number of customers has doubled during the past 9 years.

With a greater number of electrical devices vailable it would be reasonable to expect the verage per-customer consumption to increase. True enough the customer who has een using power for some time is using nore now than previously. However, whereas in the older days only the better-o-do farmers could afford electricity, now ven the less-prosperous ones are connected. The net result is that despite the greater eneral use of electrical devices the average er-customer consumption has remained about onstant for the reason that the average ustomer is now less prosperous.

It would be difficult to estimate the amount f human energy that would be required to arry on the work now being done by electricity if the power lines of the Boise and wyhee projects were suddenly to go dead. he work would require countless man- and oman-hours and many of the conveniences ould have to be foregone. Electricity represents the most adaptable form of mechanical nergy known to man. Cheap electricity liberates the farmer from the drudgery of hand ethod and brings to him many of the conveniences of urban life. In the words of one rm lady, "Electricity brings the conveniences of the city to the country, but nothing n take the quiet and security of the country the city."

NOTE.—The irrigation works of the Boise roject include two power plants: The Boise iver diversion plant, of 1,875-kilowatt capacity, constructed in 1912 to furnish power r construction of Arrowrock Dam first and timately for pumping irrigation water on e Hillcrest Division. The Black Canyon ant, of 8,000-kilowatt capacity, constructed 1925 on the Payette River near Emmett, laho, to furnish power for pumping irrigaon water on the Owyhee and Boise projects, ith a margin reserved for construction purposes. These plants are completely loaded ith pumping and construction demands and ave not entered the domestic service field.

op: Electrified milk house. Lights, separator motor, milking machines, and hot-water heater (in corner) are electric

nter: Interior view of brooder house. Brooders are electric

ottom: Rural housewives are taught to use electrical appliances. In this coach containing many kitchen and laundry appliances the farm women learn efficiency in the use of electrical appliances. Last year 175 classes were conducted with an average attendance of about 20

Irrigation of Alfalfa and Small Grains in Montana

By G. H. BINGHAM, *Irrigation Specialist, Montana Extension Service*

IF alfalfa is to produce a maximum tonnage of hay, it should be well supplied with moisture throughout the growing season. Lack of moisture will delay the growth and reduce the yield. Where two to three cuttings are obtained, the yields of alfalfa hay generally increase rapidly as the irrigation water is increased up to about 30 inches a season. Beyond 30 inches the yield increases too slowly to justify the use of so much water.

The number of irrigations necessary depends largely on the soil and climatic conditions which prevail in the locality. In the higher mountain valleys of western Montana where the days are relatively cool, and the soil is generally well supplied with moisture early in the spring, one good irrigation for each cutting may be all that is needed. If irrigation is delayed until after cutting there may be some delay in starting the next crop. On the other hand there may be some difficulty in curing the hay if the crop is irrigated too near the time of cutting.

At lower elevations in the eastern part of the State a common practice is to irrigate alfalfa four times each season; the first about 10 days before cutting the first crop, the second soon after the first crop is removed, the third just before cutting the second crop, and the fourth about 2 weeks after cutting the second crop. A fifth irrigation is sometimes applied after removing the third crop.

While alfalfa can make use of heavier irrigations than most crops due to its deeper root system, little increase in yield is realized by applying more than 6 inches of water from a single irrigation regardless of the soil type. A 6-inch irrigation is considered a heavy application and is justified only on deep-well-drained, medium-textured soils.

Alfalfa on soils of heavy texture may require more frequent irrigations with medium depths of 3 to 4 inches at each application. For shallow, coarse textured soils, light irrigations of 2 to 3 inches every 10 days may be necessary during the warmer part of the season.

New Alfalfa

At planting time the soil should contain sufficient moisture to germinate the seed and keep the small plants growing rapidly until they are at least 3 or 4 inches high before the first irrigation. This requires a firm, thoroughly prepared seedbed well supplied with moisture.

For spring seeding this may be accomplished by fall plowing and fall seedbed preparation. Where alfalfa is to follow sugar beets, beans, or potatoes, a good seedbed may be prepared by surface working after harvest without plowing.

New seedings of alfalfa, particularly when planted with a nurse crop, need earlier and more frequent irrigations than do older stands of alfalfa or small grains planted alone. Many stands are lost by allowing the surface to get too dry while the nurse crop is getting ripe and being harvested. To avoid this danger, many farmers cut the nurse crop for hay while still quite green and irrigate promptly after its removal. Others cut the nurse crop for grain as early as possible on the green side, shock the grain and irrigate at once while the shocks are standing in the field. An additional irrigation during the autumn is recommended.

At the Huntley Field station and in the lower valleys of Montana the practice of seeding alfalfa alone in the spring without a nurse crop on a well-prepared seedbed has resulted in better stands and better yields than planting with a nurse crop. Drilling alfalfa seed alone on grain stubble in early August after the grain is removed, followed by irrigation, has given similar results and is growing in favor.

Where irrigating up is necessary, young stands of alfalfa are best irrigated by the furrow or corrugation method. Heavy soils that puddle when wet and crack when dry, may be handled better by applying the water in furrows than by other methods, as this avoids wetting and baking the entire surface. The shallow corrugations are made immediately after planting.

Water Requirements of Small Grains

Total seasonal irrigation water requirements for small grains are about one-third less than that of alfalfa, or about 15-acre inches annually. This will vary from 12 inches or less in areas having short, cool seasons, and well-distributed rainfall, to 18 inches or more in areas of long, hot, growing seasons, subject to drying winds and excessive evaporation.

The total irrigation requirements of barley are less than wheat, and that of oats, more than wheat. The yields of barley and wheat increase rapidly as the total water applied each season approaches 15 to 20 inches, while the yield of oats may increase with the application of water up to 25 inches. Yields of all small grains decrease rapidly with the application of excessive amounts of water.

If the seedbed has been properly prepared, the soil should contain sufficient moisture at the seeding time, which together with spring rainfall will assure the crop a good start before irrigation is required.

If only one irrigation is given, it becomes most effective when applied early in the season, from the five-leaf to the early boot stage. Where two irrigations are given, the five-leaf and early boot stages are best for wheat and oats, with the five-leaf and early bloom stages best for barley. For three irrigations the water is applied at the five-leaf, early boot, and in the early to full-bloom stages. Usually better results will follow three irrigations than two, even though no more water is used for the larger number of irrigations. A fourth irrigation seldom increases the yield and often results in lower yields than do three applications.

When to Irrigate

Irrigation after the early dough stage not only fails to increase yields, but delays ripening and encourages lodging of the grain. Damp weather throughout the growing season or too frequent irrigations tends to promote rust.

The time of application frequently has more influence upon the yield and quality of grain than the number of irrigations or the total amount of water applied. When the grain is in the boot stage, the heads are forming and adequate moisture is required to form heads containing a large number of grains. An even greater demand for moisture occurs while the plants are in bloom to assure fertilization and subsequent filling of every kernel.

The quantity of water to apply at each irrigation depends on the stage of growth of the crop and the capacity of the soil to store water within reach of the plant roots.

Nearly 20 years ago, after several years of study of the production of grains at the Aberdeen substation, Idaho, Aicher made the following statement concerning the time to irrigate that is still particularly true of Montana and for other crops as well:

"Grain should be irrigated when the crop needs water, regardless of the stage of growth of the grains. * * * Seasons vary and the time to irrigate a crop varies considerably with the season. Summer rains often are misleading, unless they exceed a half inch. Every year they are indirectly responsible for considerable loss in the irrigated section. * * * It is a mistake to take the average shower too seriously. The immediate surface moisture is of little value in crop production, and unless the ground is moist to a considerable depth, the crop should be irri-

(*Continued on page 182*)

CCC Enrollees Reconstruct Portion of Mabton Siphon

SUNNYSIDE DIVISION, YAKIMA PROJECT

By ALFRED MANNICK, *Assistant Engineer*

'HE Mabton siphon was constructed in 908–9 to serve approximately 10,000 acres of rrigable land south of the Yakima River.)riginally this pipe line consisted of 3,165 inear feet of 54-inch (inside diameter) re- nforced-concrete pipe and 12,676 linear feet f untreated continuous wood stave pipe, of which 11,210 feet were 55 inches and 1,466 eet were 48 inches (inside diameter). The 8-inch section comprised the river crossing, 00 feet of which were under the river bed. Vhen built, those sections of the pipe not in ock cut were covered with earth, but be- ause of rapid deterioration of staves and teel bands, they were later exposed. In 917 concrete pedestals were placed under all ut 1,176 feet of pipe at the lower or south nd. These pedestals, probably made of poor ggregate, were not reinforced and did not ntirely prevent settlement and shifting of he pipe.

From time to time sections of the siphon ere renewed, including an overhead river rossing of riveted steel pipe 69 inches in iameter and 518 feet long. The renewals ft the pipe in fair condition except for 100 feet south of the river, most of which as been found hazardous to operate and xpensive to maintain.

Late in 1938, since operation and mainte- ance funds did not permit a heavy expendi- ire on major betterments, replacement of a ction of the Mabton pipe was considered for CCC project.

Approval was received November 30, 1938, r the immediate renewal of 2,000 linear et of the wood-stave siphon by CCC forces. he following day, December 1, 1938, a junior reman with a crew of about 40 enrollees gan dismantling a section of the old pipe. asmuch as only 73 working days remained fore the opening of the operating season March 15) time was an important factor be considered.

Plans for renewing this section of the phon provided for a creosoted continuous ood-stave pipe, 56 inches inside diameter, ounted on creosoted-wood cradles and an cored to concrete pedestals. The barrel of e pipe as reconstructed consisted of 34 aves to the circle 2⅛ inches thick, ranging om 13 to 40 feet in length with galvanized alleable-iron butt joints. Cradles, built by ntract, were grooved for ⅝-inch steel band d were 8 feet in length and bored for two -inch galvanized anchor bolts. Reinforced ncrete pedestals, 7 inches thick, 8 feet long, d spaced 10 feet apart, ranged in height om 8 inches to about 18 inches, depending upon subgrade material. Pedestals over a foot in height were battered.

Since the original trench for the old pipe has been excavated to accommodate pedestals only 5 feet 4 inches long with no provision made for surface water drainage along the pipe, approximately one-third of the barrel lay in muck, assisting in deterioration of staves and bands. To avoid such a condition in the new installation it was necessary to excavate a trench with a bottom width of 11 feet, allowing for a shallow drain 2 feet wide along the west side of the pipe. The excava- tion grade had to be at least 1 foot below the bottom of the pipe in order to keep the cradles well above surface water and to allow

CCC enrollees reconstruct Mabton Siphon

for future inspection and repairs. Approximately 1,300 feet of trench was through basalt with a cut of about 7 feet; the balance (726 feet) crossed a pot hole, part of which was under water. Excavation was all done by hand. Jackhammer work and blasting was necessary through most of the rock cut.

Considerable material had to be handled twice because of the deep cut and the spoil banks on either side. An attempt was made to excavate with a bulldozer in the pot-hole section after the pond had been dewatered, but the material proved so soft and wet that the machinery mired down. Therefore, pedestals through this section were supported by 3-inch metal-pipe piling, ranging from 2 to 7 feet in length with three piling to each pedestal. These were all driven to refusal by hand methods, and filled with concrete.

Inspection of the old ⅝-inch steel bands revealed that the top segments were in good condition but the bottom sections needed cleaning and a few replacements. An outside shop was set up where bands were scraped, the ends heated and oiled so that the nuts worked freely and a ¾-inch pipe bushing 2 inches long placed on each threaded end. These bushings were necessary because of a difference of 4 inches in the outside diameters of the old and new pipes. In all, 8,000 bands were thus renovated.

A crew of four men from the Tieton Division with the assistance of four to five enrollees began assembling the new pipe on February 15. Because of the many curves in the pipe alinement, this proved to be a painstaking job. Butt joints had to be carefully checked for slipping when the pipe was jacked into position. Final spacing of bands averaged about 3 inches center to center. The bands were placed by an augmented crew of enrollees and maintenance employees. In addition to the 2,000 linear feet of new pipe authorized, 26 linear feet were built to avoid making a connection on a curve. The hook-up was made March 24 and water turned into the siphon March 25 with very few leaks in evidence.

Bureau of Reclamation officials were at first somewhat disturbed about assigning a job, where so much careful workmanship was essential, to a group of inexperienced boys. An experienced bureau general foreman, working in conjunction with the CCC foremen, however, succeeded in keeping the job orderly and in training the boys in various phases of the work. Distribution of the enrollees was somewhat as follows: Band renovating, 12 to 14 boys; concrete work, 10 to 12 boys; forms, 4 boys; drilling, 4 to 6 boys; pile-driving, 4 boys. Those boys with no particular preference were assigned to dismantling the old pipe, trench excavation, and handling materials. During January a total of 110 enrollees and 3 junior foremen were kept busy on this job. Although some confusion was evident, the majority of the boys were eager to learn and proved very willing workers.

By successfully completing a job of this nature in the specified time, the enrollees of CCC Camp BR-58 have made a favorable impression upon the community and accomplished an important betterment to a major structure.

Coulee Dam Concrete Pour

(*Continued from page 163*)

The contractor, the Consolidated Builders, Inc., is justly proud of the new record which will probably stand for many years because governing conditions are not likely to be so favorable again on this biggest of all concrete jobs. The previous world record of 15,844 yards was made by the M. W. A. K. Co., builders of the base of the dam.

On the present occasion the maximum of form space, 28,000 cubic yards, was available, 18 concrete trains were in service, there was no blasting to interrupt the work, and during the day no supply cars were moved across the trestle. The capacity of the mixing plants determined the record. Good working conditions prevailed, and no accidents marred the day's performance.

Equipment in perfect working order and precise teamwork accounted for an average production rate of a cubic yard of concrete in 4⅙ seconds. Mixers were charged in a minimum period of 13 seconds, and 4-yard batches were mixed in a minimum of 1 minute 50 seconds.

The day's output of concrete would make nearly 10 miles of two-lane highway pavement. It brings the total yardage in the dam close to 7,000,000—more than twice the volume of the next largest dam in the world. It required about 90 carloads of cement, and about 40,000 tons of sand and gravel—the equivalent of 800 carloads.

All sand and gravel is handled at Grand Coulee by conveyor belts of cotton on rubber, nearly 5 miles of such belting being in use on the project, in widths of 3 to 5 feet. There is one continuous piece of 5-foot belting nearly 10,000 feet long.

Irrigation in Montana

(*Continued from page 180*)

gated, regardless of the little moisture from small rains."

Irrigation requirements for small grains are relatively light early in the season and tend to increase as the plant grows in size. The general practice is to irrigate heavily in the spring and use less water as the season advances. Water is usually plentiful in the spring, but at the time the grain is in bloom and needs water the most, the supply begins to fail or is needed for other crops. It is better to irrigate moderately in the spring. The reason is that heavy, early irrigation promotes excess straw growth at the expense of later grain development.

Apply Water to Root Zone

If carefully applied, an irrigation of 4 to 6 inches in depth is ample to fill the upper 3 feet of soil with all the moisture the crop can use at the time and also allow for a reasonable amount of waste. Applications in excess of 6 inches per irrigation usually mean excessive losses due either to surface runoff or deep percolation in the subsoil beyond the reach of plant roots.

When light soils are too dry to permit germination and initial growth, they should be irrigated before seeding.

Some difficulty is experienced as a result of irrigating heavy soils in spring prior to seeding, as the soil dries out slowly and seeding is delayed. When heavy soils are too dry to assure germination and initial growth, it is best to plant the grain in the dry soil and irrigate up. A second irrigation may then be needed before plants are large enough to shade the ground, in order to prevent damage to the emerging crop from the hard crust which usually forms on such soils after irrigation. The corrugation method of irrigation should be used in irrigating just after planting, as this method causes less crusting and packing of the top soil than do flooding methods. Where winter moisture is generally light, moisture for starting spring grain on heavy soils may be supplied by late fall irrigation either before or after fall plowing.

The irrigation applied either before or after planting to bring the crop up should be considered as an extra irrigation in addition to the usual number required during the growing season.—*From Bulletin No. 169, Irrigating Field Crops in Montana, courtesy of Montana Extension Service.*

Ross K. Tiffany

(*Continued from page 171*)

1912, to April 1, 1920. From April 22, 1920, to August 14, 1923, he served the Bureau in the capacity of consulting engineer. From 1920 to 1925 he designed and built the Spokane Valley gravity irrigation system with a total investment of about $1,000,000. He was State supervisor of hydraulics for the State of Washington, 1925–29. As works manager for the Emergency Relief Administration, 1933–34, he had general supervision of work projects involving a $10,000,000 State emergency bond issue plus $5,000,000 in local contributions. During the last few years of his life, spent as consultant for the Washington irrigation district and the State of Washington, he prepared plans and supervised the work of replacing the temporary construction on the Spokane Valley canal system with concrete-lined canals.

Mr. Tiffany was born in Union, Iowa, on June 11, 1879. He is survived by his widow, his daughter, Mrs. Robert C. Thurston of Yakima, and his son, Ross, Jr., who is an employee of the Coulee Dam project.

Klamath Junior Livestock Show

By C. A. HENDERSON, *County Agricultural Agent, Klamath County, Oregon*

LTHOUGH only 3 years of age, the Klamath unior Livestock Show has made tremendous rides. In 1935 Clifford Jenkins took over ne job as 4-H club agent of Klamath County, reg., and immediately set the wheels in otion to establish a permanent livestock now for 4-H boys and girls.

The first show was held in the fall of 936, local merchants and farmers backing e show in excellent shape. The Rotary lub of Klamath Falls sponsored the 4-H vestock project as one of their major youth rojects. The 3-day show ended with a gen-al auction of all livestock, a total of $5,772 orth of junior livestock being sold to Kla-ath businessmen.

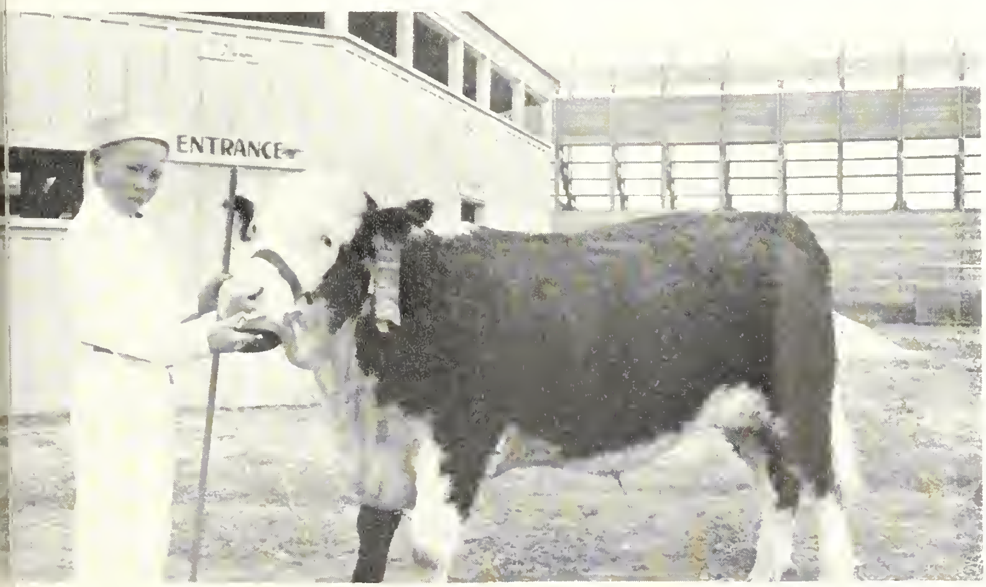
In 1937, an increased number of exhibits as the order of the day, with a total sales alue of $6,481. By this time, however, the le was becoming well known throughout e Western States as one of the best junior vestock shows held.

In 1938 the Klamath Falls Rotary Club, l 4-H leaders of livestock clubs, F. F. A. structors, and businessmen of the Klamath asin put their shoulders to the wheel and ade this event one of the most outstanding the long livestock history of the Klamath asin. Total entries in the junior show were arly double those of 1937. During the sale the final afternoon of the show a total $12,513 worth of livestock was auctioned . This was an average of 21½ cents per und for every pound of livestock sold.

4–H group inspect purebred ewe lamb

The sale opened with a capon, grown out by Dean Jones, poultry club member, this being the only capon in the sale. Henry Semon, farmer of the Klamath Basin and member of the State legislature, started the ball rolling by bidding $6.50 per pound, or a total of $58.50 for the 9-pound capon. Patty Hammond, 9-year-old sheep breeder of Merrill, next offered his grand champion fat lamb which sold to Mitchell-Lewis & Staver Co. at $1.10 per pound, or a total of $151.80 for the 138-pound lamb. The peak of the sale was reached when Jimmie Sullivan, young Hereford breeder of Olene, brought in his grand champion 4-H Hereford steer. Bidding started at 50 cents per pound but rapidly passed the $1 mark, finally ending up at $1.23, bid by Sears-Roebuck & Co. The steer weighed 1,016 pounds and grossed Jimmie $1,249.68, an all-time high for this show.

Jimmie Sullivan, Olene, and his grand champion 4–H Hereford at the 1938 Klamath Junior Livestock Show. Steer sold for $1.23 per pound



Plenty of hard work by Mr. Jenkins, 4-H club leaders, F. F. A. leaders, and members of the Rotary Club, as well as the excellent spirit of cooperation shown by merchants, businessmen, and farmers of the Klamath Basin, have made this show a success.

During the winter months, 4-H leaders and the local Rotary "sifting" committee passed judgment on the calves from time to time and "sifted" out those that were unfit for show. Calves are weighed monthly by Mr. Jenkins on a set of trailer scales attached to his automobile and hauled to all parts of the county.

Local club leaders who are livestock men give their youthful club members excellent advice in feeding and handling of their steers and other livestock, as well as taking care of them through periods of sickness or off-feed. Contests were held during the show and winners selected on the basis of fitting, showmanship, and items that show ability in the care and handling of their livestock. In addition, a number of steers are fitted

(*Continued on page 188*)

Job Training in the Reclamation CCC Camps

By RALPH W. SULLIVAN, *Assistant to Supervising Engineer, CCC*

RECENTLY the meaning of the second "C" of the CCC was doubly emphasized—the "Conservation of human resources." By approving the recommendation for establishing the CCC on a permanent basis, the people expressed confidence in the organization and its objectives. Conserving human resources for useful and happy citizenship through education and training in CCC camps remains the ultimate objective.

Several millions of our youth, before the inception of the CCC, had to contemplate the prospect of traveling rocky and blind roads to become competently trained in a job. Employers, foremen, workmen, even when they possessed real teaching abilities, all thought they were too busy to teach inexperienced job seekers. The harassed youth had to learn by himself and was expected to observe, to try, to experiment, to flounder, perhaps even to "steal" his trade. The dominance of foremen, the sharp queries of inspectors, and the disheartening experience of being fired were all part of the rough and wasteful process of "pick-up" job training, the only kind that ha been available for the millions of young work ers who were found in factories, mine stores, and often on farms.

Enrollee transitman works with survey crew

Practical training increases the efficienc of work and contributes to the health, well being and morale of the camps. One of th most important functions of the CCC edu cational program is that phase of CCC camp education which teaches enrollees to do thei field work efficiently, thus giving them a prac tical knowledge of the job they are preparing to obtain after leaving the corps. This train ing is helping to solve the problem of youth seeking employment. The employer often refuses to hire the young man who lacks ex perience, but the boy cannot get experience unless he has a job. Providing job training for the enrollees is assisting in breaking this vicious circle.

Job training in the CCC camps has two purposes: (1) It trains the enrollee to do well the job to which he is assigned; and (2) it provides the enrollee with practical training and knowledge related to the work so that he becomes experienced and qualified to accept a similar job when he leaves the camp. In addition to these two purposes, the technical foremen gain additional knowledge of project work. Regional directors, realizing the benefits received by the enrollees and that this phase of camp education improves the efficiency of the foremen and supervisors, have given much time and effort to making the job-training program a success.

The 44 Bureau of Reclamation CCC camps, located on Federal Reclamation projects in 14 Western States, provide these boys opportunities for job training in many different fields. Work by the CCC on Reclamation projects varies from the manual type of labor to the highly technical job. Enrollees receive training in some of the following work: Truck driving, operating tractors and bulldozers, auto mechanics, construction of dams, landscape improvement, surveying, construction of bridges, blasting, stone masonry, riprapping, lining canals with concrete, constructing concrete water-control structures and public park development.

Procedure

A definite procedure has been established in some camps for placing the enrollees on those jobs for which they are best fitted and in which they are most interested. First of all, however, the untrained boy must be taught how to work in order to be of real assistance in carrying forward the enormous conservation work program related to the clamation of lands. With the large amount heavy machinery now being used and the eat variety of interesting work projects now ıder construction on Federal Reclamation ojects, enrollees can learn the work on the b.

Practical off-the-job instruction supplements this on-the-job training. Just as it is nportant for the graduate of any technical hool to have some practical training in echanical skills, so it is equally important at the CCC enrollee who is being taught e mechanical aspect of a job also receive me related training along the same line. ne enrollee who knows how to operate a esel tractor should also know something out the principle of a Diesel motor. The remen analyze their jobs separately and epare outlines for both field and classroom struction which are correlated with, in pport of, and supplemental to the actual ork project. The outlines, both for on-the-) and off-the-job training, are broken down o main topics and subtopics that are closely ated to the actual corresponding work eps. For example, if one of the enrollee's ties should consist of refueling a tractor th Diesel fuel, he might receive classroom struction relative to the essential differce between Diesel fuel and gasoline. The ssroom instruction is adapted to the enlee's educational level. All lessons include actical topics designed to train the enrol for the job he is most likely to obtain after ving camp.

Owing to the large number of enrollees eded to operate trucks, tractors, and bullzers, and special interest in this type of ork, the off-the-job training classes in these ojects have good attendance. A standard C truck driver's course teaches truck drivs to reduce the cost of truck maintenance, be more efficient operators, and to be ety conscious. The proportionately large mber of enrollees who return to private ployment as successful truck drivers proves effectiveness and merits of this course.

Visual Aides

Visual aids are used extensively in off-the-) instruction. Some of the field employees the camps have constructed, accurately to le, miniature models of project structures. ese models are different types of project uctures, such as checks, turn-outs, drops, a ed section of a canal, etc. The materials ed in constructing these models are similar those used in regular field structures. ose engaged in this model work are given uable training in the construction proce-e, as the exact specifications for the fulled structure are followed as closely as sible in building the models to scale.

Motion pictures and film strips are used some of the classes. The enrollee is parılarly interested in this type of instruction, it relieves the monotony of drill in details l frequently he can visualize the matter

CCC enrollees mix concrete for lining canals

CCC enrollee measures rock for cutting to specific size

better than he can follow the language of his instructor. There is hardly a job-training subject taught by the technical personnel in which visual aid in some form cannot be used effectively.

For the success of any CCC job-training program the primary requisite is good teaching. Job-training problems and teaching techniques are discussed in the regular weekly class in leadership, conducted by the superintendent and attended by all technical foremen, leaders, assistant leaders, and key enrollees. The leadership class has been responsible for developing an "esprit de corps" among the leaders and key enrollees. In many of the camps teacher-training classes, extending over a period of several months and conducted by the camp educational advisers, have proved to be beneficial to the technical foremen. The purpose of these classes is to teach the foremen how to present their material in the off-the-job class more effectively. It has been found in the camps that it is not always the foreman with the greatest amount of education that makes the best instructor. Other personality attributes, such as understanding and tolerance, friendliness, and a sense of humor oftentimes are equally as important in the classroom as a thorough understanding of the technical aspect of the subject. Foremen wh possess these qualities in combination wit alertness of mind give practical classroom in struction in the job training.

The method of job training in the CCC ha not been criticized on the basis that the pro gram is too idealistic. Nothing has been pro posed which is impossible of accomplishment As the technical foremen become more famil iar with the presentation of their subjec material, the program will undoubtedly be even more successful in achieving the mos important goal—the conservation of huma resources.

CONTENTS

THE RECLAMATION ERA • JULY 1939

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

(Date) . . . .

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

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Reconstruction of Montrose and Delta Canal to Eliminate Hillside Construction

UNCOMPAHGRE PROJECT, COLORADO

HE reconstruction of the Montrose and elta Canal between Mile Posts 6.3 and 7 as undertaken in order to eliminate a secon of hillside construction which had been source of continued trouble and expense nce the first construction of the canal.

The Montrose and Delta Canal is one of veral large canals of the Uncompahgre roject which divert from the channel of the ncompahgre River. Between Mile Posts 3 nd 7 the canal is located on a steep hillside. ides endangering the canal have been freient in past years throughout this entire ngth. The section between Mile Posts 6.3 nd 7 has been the source of greatest trouble, nd is the only section on which the topogphy permitted of improving conditions by eans of a relocation.

During the period of 1922 to 1939 it is timated that the cost of repair and mainteince on this ¾-mile-long section totaled amount of $16,000. Hardly a season has ssed that some work has not been necesry, although in many cases the work done nsisted merely of hauling material to raise e lower bank at places where this bank owed settlement during the irrigation sean. Considerable work also has been done efforts to secure silting of the section by mping fine soil into the canal and to stabie the slope below the canal by digging ainage channels.

The most serious damage to the canal ocrred in 1922, when a large slide below the nal caved back into the canal section. On is occasion water was shut out of the canal r a period of 7 days while a timber flume 0 feet in length was constructed. Followg the construction of this flume a timberhed drainage tunnel 360 feet long was cut neath the flume into the hillside, branching rallel to the flume in both directions. This me and drainage tunnel are still in place, t timber work is beginning to decay. uring the winter of 1937 a concrete wall 200 et in length and 9 feet high, extending to a pth of 4 feet below the grade of the canal as constructed at another point. This wall l not prove fully efficient to prevent trouble this point as in May of 1938 a slide in the lside below caused the canal bank below e wall to settle to an elevation lower than e water surface in the canal along a length about 70 feet. Gravel was hauled to build the portion of bank that had settled. hile this bank continued to show considerble settlement as it was being built up, a f was finally secured that remained stable for the balance of the irrigation season. The presence of the concrete wall prevented the canal from breaking and enabled delivery of water to be made while the bank was being built up.

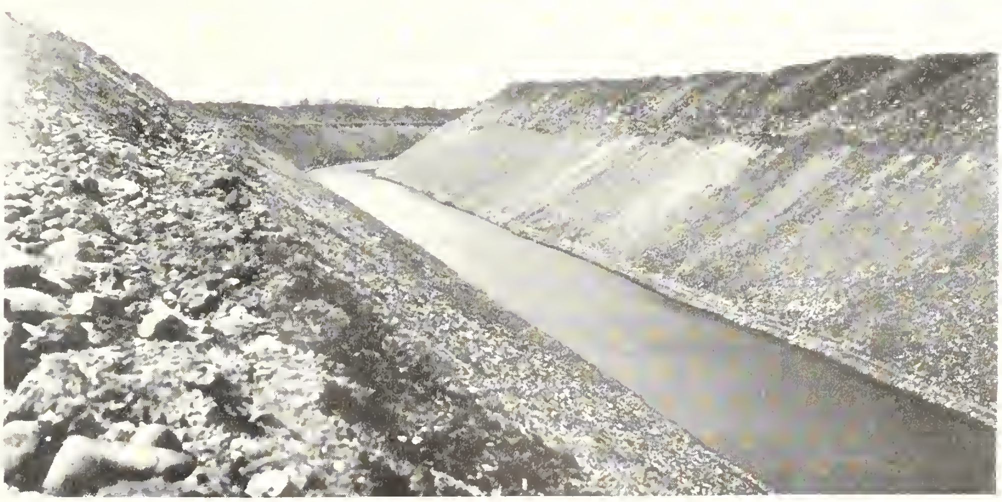
Slides on this hillside below the canal have occurred practically at all times during the irrigation season and appear to have been caused principally by seepage from the canal. The canal in this section was excavated in a rather porous fossil shale formation. Hard shale is found at a depth of several feet below the canal and slides seem to have been caused by the sliding of the saturated fossil shale upon the harder underlying formation. It was indicated that only a comparatively small amount of seepage was necessary to render the fossil shale formation unstable as the flow of water was generally very small at points where slides occurred.

The relocation of this troublesome section of canal had been under consideration for several years, especially during the past few years when it appeared that slides in this section still persisted in spite of all work which had been done on the canal. It had not previously been undertaken by the Water Users' Association, which has been operating the project since 1932, partly because of the fact that the ½-cubic-yard draglines which they owned were not considered adequate for the depth of cut that would be required. During the summer of 1938, surveys and investigations were made by the Bureau of Reclamation to determine the feasibility and cost of relocation. Two suggested locations were abandoned, as they were found to require excessive excavation with long cuts ranging to a maximum depth of 36 feet. From a consideration of construction costs, maintenance problems, and right-of-way costs the present location was agreed upon by the board of directors of the Water Users' Association and the officials of the Bureau of Reclamation. Purchase of right-of-way, which involved the moving of a house and small farm buildings, was made by the association. Negotiations for this purchase were complete in January 1939, and the work on the canal was started immediately thereafter by the Bureau of Reclamation.

Description of Reconstructed Canal

The new canal is 3,400 feet long, has a base width of 22 feet, and is designed to

Section of Montrose and Delta Canal between Stations 345 and 355—maximum depth 27 feet



carry 550 second-feet of water. The maximum depth in thorough cut is 27 feet, with side slopes of $1\frac{1}{2}:1$. The new canal begins at station 333 of the old canal where this canal is located about 36 feet in elevation below the rim of the hill. For the first 700 feet of its length it diverges slowly from the old canal, its location being similar to that of the old canal except that it is cut more deeply into the hillside and has a much heavier lower bank. For the remainder of its length (2,700 feet) the new canal is located on the benchland at the top of the hill. It parallels in general the rim of the hill at a distance of 100 to 250 feet back from the rim. This portion of the canal is in thorough cut with a maximum depth of 27 feet and decreasing gradually to a depth of 8 feet, where it reenters the old canal as this old canal starts to swing away from the hillside and across the bench. The upper portion of the cut was generally in gravel. The bottom was in hard shale or gravel mixed with sand and clay, fairly tight except in places toward the upper end, where some seamy shale was encountered. The grade line for excavation was laid about 1 foot below the grade of the old canal to permit of silting or lining with earth if found necessary.

Excavation was started January 15, 1939, by a P & H type 705, Diesel powered dragline with 45-foot boom and $1\frac{1}{2}$-cubic-yard bucket and was completed on April 14 by this same machine. For a short distance in the shallowest portion it was possible to complete the section and cast all dirt to place with one cut. As the depth increased two cuts were used. The bulk of the yardage, however, lay in the sections of deeper cut. In these sections it was necessary to make three cuts to complete the excavation of the canal section. The procedure generally followed here was as follows: The first cut, to a depth of 15 to 18 feet, was made along the left of the canal section and all excavation cast directly to place in the left spoil pile. The second cut was made to grade from the center section of the canal and excavated material cast to the right. Before the third cut could be made it was necessary to move material excavated. An RD 8 caterpillar tractor with bulldozer was used for this purpose. The third cut was then made to complete the section and all dirt was cast to place in the right spoil bank.

In the case of the hillside section at the upper end of the canal where the upper cut averages about 33 feet it was also generally required to make three cuts. Here no spoil pile was placed on the left (or upper) bank. The first cut was made to a depth of about 18 feet with the dragline standing at the top of the hill and excavated material was cast into the old canal below. A large part of the material was then moved directly to place in the lower bank of the new canal by the bulldozer although it was necessary for a portion of it to be handled by the dragline as it made the second cut.

As it became necessary to make deliveries of water before the new canal was completed a small head of water was turned through the upper portion of the new canal and bypassed to the old canal on April 1 while excavation continued on the sections below this point. Excavation of the new canal was finally completed on April 14 and the old canal entirely abandoned.

About 3 days after water was first turned through the upper portion of the canal, slides again occurred on the hillside below. Although these slides were not sufficiently serious to threaten the canal, they did indicate an undue amount of seepage which it was assumed, in the light of past experience, would endanger the canal. Water was turned out of the canal and inspection showed that seepage had been taking place in a few places through seamy shale. At this time lining of the bottom of the canal with sandy clay soil and gravel was started. The P & H dragline was used in this connection to cast the material into the bottom of the canal and against the upper slope and one of the $\frac{1}{2}$-cubic yard association draglines was used on the lower bank. Some of the material had to be hauled by trucks. Although water was again turned into the canal the next day the lining operations were continued until the bottom of the canal throughout the length of the hillside construction had been lined to over a foot in depth and lining extended well up the slopes of the canal. The canal had been excavated in this section sufficiently large to permit of such lining.

A crew of laborers was used in puddling lining to some extent, especially on the slopes as depth of water in the canal was gradually increased. Following this about 2,000 cubic yards of gravel was placed against the lower bank of the canal. The greater part of this gravel was obtained from spoil piles of excavated material, loaded by the association dragline, and hauled to place by trucks. The placing of gravel was resorted to as an extra measure of precaution to stabilize the lower bank which had, even at the minimum section near where the new construction joined the old, a free board of 5 feet and a top width of about 20 feet. That the lining was effective in decreasing seepage is shown by measurements taken over a weir placed at the base of the hill to collect the bulk of the seepage. These measurements show a flow of 0.15 of a second-foot on April 3 with 20 second-feet of water in the canal and a flow of only 0.05 of a second-foot on May 6 with the canal running at practically full capacity.

Excavation was started by the dragline on January 15, 1939, and completed on April 14. Following this the dozer was used on single shift basis to level spoil piles and build road. All work was completed on May 3. The dragline was operated on a three-shift basis with each crew working 40 hours per week and the bulldozer on a one or two shift basis as required. Total excavation amounted to 119,500 cubic yards of which about 50 percent was cast into place and 50 percent had to be rehandled. Total cost of all work including excavation, rehandling, leveling spoil banks hauling, and overhead amounted to $12,000.

Klamath Juniors

(*Continued from page 183*)

for the Interstate Junior Livestock and Baby Beef Show in San Francisco each spring. In 1937, the first year of competition, the club boys brought back the reserve grand champion ribbon as well as a number of firsts and other ribbons; and in 1938, against the most outstanding competition in the United States, again succeeded in bringing back the champion of the Aberdeen Angus breed, three firsts, and a number of other high placings.

While a large number of boys and girls feed out beef calves for both the Klamath Junior Livestock Show and the San Francisco show, many boys and girls breed and feed sheep and hogs as well, and several are now engaged in poultry raising. Unquestionably, the development of this show has aided considerably in improving the livestock business and the feeding out of fat cattle throughout the entire Klamath Basin. It has aided many youthful members in getting a start in their chosen life's work. It has united the community on a single project and brought the country people and the city people closer together than ever before.

L. A. West, old-time stockman of the Klamath Basin, was selected by 4-H club leaders as general manager of the show and leader of this project, and is still giving excellent satisfaction in this capacity. Tom Watters is general chairman for the Rotary Club and is doing yeoman service in making this work successful.

Humboldt Sugar Beets

THE sugar beet crop on the Humboldt project, Nevada, is progressing favorably. The beet growers have introduced "Rain Machines" or sprinklers on the project and the resulting economical use of water and more thorough irrigation are proving their adaptability.

Rio Grande School Facilities

A FEW of the Rio Grande project school districts have started construction, increasing the size of school buildings, and the Ysleta District expects to increase its high school floor area by about 30 percent.

Deschutes Wool

ACCORDING to local dealers on the Deschutes project, wool moved out of that territory more rapidly this spring than for many years past. Only a small portion of the smaller clips remain unsold.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Denver, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Constr. engr	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	C. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz	E. C. Koppen	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River, Greenfields division	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Rosa division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A	Wellsville, Utah			Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Colo	W. G. Sloan	Engineer.
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo	J. R. Iakisch	Senior engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.

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DOWNSTREAM FACE OF BARTLETT DAM

THE RECLAMATION ERA

AUGUST 1939

CONTRA COSTA CANAL, CENTRAL VALLEY PROJECT, CALIFORNIA

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 29 • AUGUST 1939 • NUMBER 8

Tunnel Construction, Gravity Main Canal

Gila Project, Arizona

By E. A. BLOUT, *Assistant Engineer*

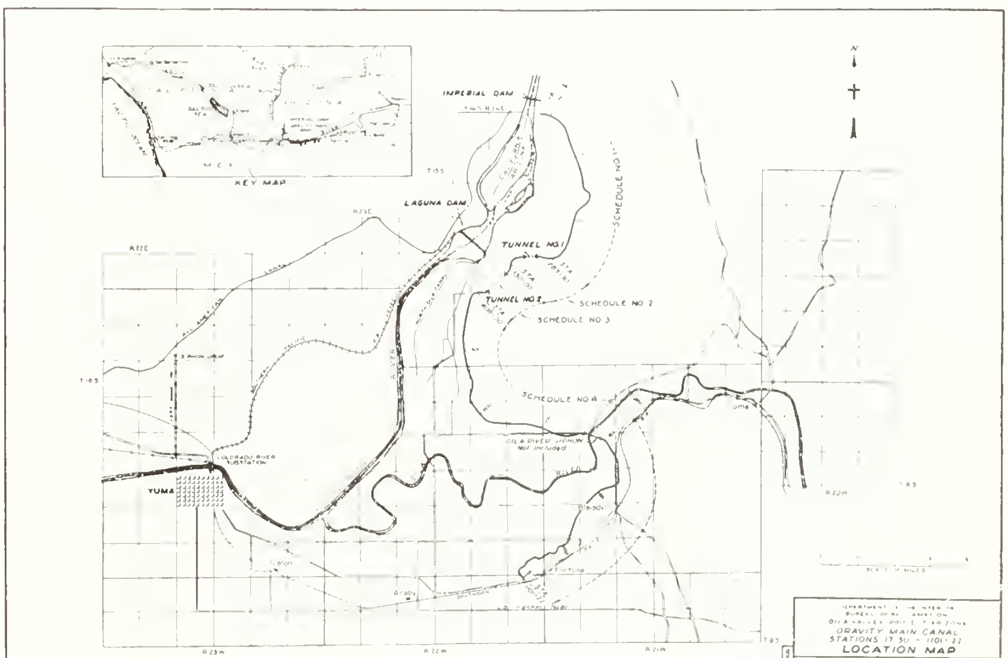
THE two concrete lined tunnels through the Laguna Mountains, recently completed, represent a significant accomplishment in the construction of the gravity main canal system for the initial unit or Yuma Mesa Division of the Gila project now in the process of development in southwestern Arizona. Rising abruptly from the Colorado River at the site of the Laguna Dam, approximately 15 miles upstream from Yuma, Ariz., the mountains extend southeasterly in a broken mass across the region between the Colorado and Gila Rivers. This region presented no practical location for the excavation of an open canal and construction was forced to proceed underground. The canal, following the natural contours of the terrain downstream from the Imperial Diversion Dam, reaches the north side of the mountains a mile and a half east of the Laguna Dam whence tunnel No. 1 has been constructed through the first of two ridges for a distance of 1,749 feet. A reach of open canal then traverses a 3,590-foot interval of washes and minor spurs to the principal arm of the range. Tunnel No. 2, 4,125 feet in length, brings the canal out on the southwest side of the region, whence the channel continues along the base of the slopes in the usual manner.

For the present development the tunnels are typical horseshoe-shaped sections, 20 feet in diameter; and are lined throughout with concrete, having an average thickness of 16 inches in the walls and arch, and 14 inches in the invert. The tunnels were designed to convey flows of 2,058 and 2,031 cubic feet per second, respectively, with a water depth of 17.4 feet. However, there is capacity sufficient to deliver 2,200 cubic feet per second which would increase the depth only 1 foot.

In the future, as additional units are added to the project requiring still greater capacity in the canal, it will be necessary to construct an additional and larger tunnel parallel to each of the constructed tunnels. Provision for the development of the ultimate sections with minimum interference from or to the operation of the canal was incorporated into the construction for the initial requirements by driving the headings for the ultimate 26-foot tunnels for a distance of approximately 10 feet beyond the ends of the closed transitions, concreting the portals and closed transitions, and completing the open transitions for the ultimate development.

The work was started by constructing the intermediate reach of the canal first. Approximately 980 feet downstream from the end of tunnel No. 1, rock from the excavation below the portal was used to place a dike 940 feet long for the right bank across a region of the terrain below the grade of the canal. Beyond this section, the canal was excavated through a cemented agglomerate formation varying from loosely bound material to solid rock in cuts of moderate depth to the beginning of the approach to the inlet portal of tunnel No. 2. The bottom of the canal then provided a convenient roadbed for a 3-foot gage contractor's industrial railroad for the construction of the tunnels.

The approach cut to the outlet portal of tunnel No. 1 was nearly 150 feet in length with a maximum depth of 75 feet. At the portal, the formation was hard dense granite but very blocky. No particular difficulty was had in starting the tunnel, but, owing to the faulted nature of the rock, it was necessary to support the work. Approximately 600 feet from the portal, the rock was less broken, but it still showed evidence of faulting. Nine major faults were encountered, the strikes being in all cases nearly at right angles to the tunnel and varying in thickness from 5 to



60 feet. The fault material consisted of finely broken fragments of country rock, which, although soft, was safer ground than the rock between the faults and, as a rule, required little or no support. Innumerable gouge seams were encountered, striking and dipping in all directions, which indicated that there had been considerable movement. As the tunnel was holed through at the inlet portals, approximately 10 feet of the brow over the portal caved off, but though the granite was extremely faulted and contained a flat mud seam dipping into and striking across the tunnel, it appeared that it would hold without further caving.

In driving the tunnel, the blasting was directed against the full face of the heading. A firing round consisted, on the average, of 50 holes varying in depth from 6 to 12 feet according to the stability of the rock. The outer ring of shots was delayed in each firing, and those at the arch were fired last. Because of the irregularity of the rock, it was necessary to resort to extensive barring down from the roof after each round was fired. It was necessary to support 1,547 feet of the tunnel, or 88.9 percent of the total distance. Steel sets were used for the supports and lagged with 3- by 12-inch lagging. Above the spring line in the lagged sections, the overbreak was tightly packed with timber. The total overbreakage amounted to 10 percent of the excavation for the entire tunnel. Work attached to supporting the tunnel impeded progress and as a result, drilling averaged only 10.24 linear feet per day.

Enlarging the portals of tunnel No. 1 to accommodate the openings for the ultimate 26-foot sections and the starting of the larger headings was a difficult undertaking. At the outlet portal, due to its fractured condition, the granite would not hold over the larger area and it was necessary to provide an additional means of support. Concrete piers were constructed on either side of the 26-foot portal to support the rock at the sides of the opening and to carry the supports for the brow. These were a group of four reinforced concrete buttresses erected on I-beams placed between the piers. Driving was then begun in the 26-foot heading, but, though the lining of the 20-foot tunnel had been previously completed to within 50 feet of any blasting, a cave-in occurred at the portal. The brow held over the 26-foot opening. It was therefore necessary to complete the concreting of the 20-foot portal before proceeding with the 26-foot heading; and an additional reinforced concrete pier was provided on the opposite side of the portal to hold the entire heading. By blasting carefully, as work was resumed in the 26-foot heading, no damage was done to the concrete, though it was necessary to conduct the work in the immediate vicinity. No further caving occurred, and the heading was advanced to a point 49 feet from the portal. The rock had to be supported, however, and framed sets of 12- by 12-inch timbers were installed on 5-foot centers and lagged with 3-inch lagging. There was some caving of material above the timber on top of the cribbing. It was not possible to pack this area and it was filled with concrete after the arch was completed.

In proceeding with the excavation at the inlet portal, a 10 by 10-foot pioneer tunnel was started in the arch of the 26-foot section in accordance with a plan to develop the area by working around the arch with timber. However, before the pioneer was finished, a slide of approximately 3,000 cubic yards occurred at the portal which took out nearly all of the pioneer tunnel and caved the 20- and 26-foot tunnels for distances of 59 and 32 feet, respectively, back from the portal. In the 20-foot tunnel, the steel sets within the limits of the slide were damaged to such an extent that it was necessary to replace them.

It was necessary to ease the ground before proceeding, and the cut was trimmed back on a 1¼ : 1 slope from an elevation approximately 10 feet above the portal. After this, work was resumed on the 26-foot heading. By using crown bars ahead, then working out the ground for a segment of a set at a time and finally removing the core, the heading was advanced 59 feet from the portal. With the work this far underground it was thought that a great deal of trouble would be avoided in excavating the future tunnel. After the tunnel was completed and timbered, a crack developed at a mud seam above the tunnel, again endangering the work. However, by placing the concrete immediately, the work was completed without further difficulty.

The approach to the inlet portal of tunnel No. 2 was excavated through 620 feet of a granite formation varying in depth from 23 to 68 feet, and the tunnel was driven through from this end. At the portal the granite was succeeded by andesite of a tough and very good character which continued for a distance of 1,514 feet within the tunnel. This was followed in turn by cemented gravel, 696 feet; a rather badly broken granite, 315 feet; cemented gravel, 275 feet; soft, partly decomposed granite, 160 feet; and cemented gravel for the remaining 1,165 feet. A flat fault, dipping approximately 10 degrees at nearly right angles to the tunnel, was encountered on the contact between the first cemented gravel and granite with the granite on top of and separated from the cemented gravel by a gouge deposit varying from a few inches to 2 feet in thickness. In general the formations were quite stable, though evidence of extensive movement was readily discernible.

The tunnel was excavated in much the same manner as tunnel No. 1. However, owing to the improved character of the formations, the driving was able to proceed at a faster rate. Only 7.2 percent of the tunnel needed to be supported and this was the result of local conditions rather than the nature of the formations. With the overbreakage amounting to 5.6 percent of the total excavation, progress averaged 20.83 feet per day for the entire tunnel, though occasionally 40 feet were driven through the cemented gravel in a 24-hour day.

The development at the portals of tunnel No. 2 was devoid of any of the trouble that occurred at tunnel No. 1. Here conditions were favorable for the additional construction, and the work was completed under normal procedure.

Gelatin powder, 40 percent, was used for most of the shooting in tunnel No. 1, while 30 percent was employed for the majority of the work in tunnel No. 2. All firing was done with electric detonators.

Tunnel Lining

The lining of the tunnels was divided into three operations. First, a curb containing a 6-inch step was placed along each intersection of the sidewalls with the invert, the top of the curb being left 6 inches below the grade of the invert. The steps were used, in the next operation, as rails for a gantry which lifted the buckets of batched aggregate from cars on the contractor's railroad to a hopper at the mixer. Concrete for the arch and sidewalls, including a 6-inch section of the invert, was next placed monolithically in one operation. This method insured good joints, and provided a means for guiding the slip form for the invert. Finally, the invert was placed to complete the lining. An all-steel form 50 feet long, finished to the neat dimensions of the lining, was used for the side walls and arch in the 20-foot tunnels.

Concrete for the work in the tunnels was mixed and placed in a continuous operation as the work progressed. A plant arrangement, composed of a typical portable 1-yard concrete mixer with a stationary batch hopper at the receiving end, preceded by a 1-cubic yard Prestweld air gun and air tank and followed by a gantry with a traveling electric hoist, was mounted on trucks of the tunnel railroad and the whole assembly coupled together so that it could be moved as a unit. Prior to mixing, the dry aggregate and cement were proportioned by weighing at the batching plant and brought to the work in batch containers on flat cars over the contractor's railroad. At the mixer the batch boxes were lifted by the electric hoist on the gantry to the batch hopper at the mixer; and while one batch was being mixed another batch of the concrete material was hoisted into the hopper. After the concrete was mixed it was transferred directly into the Prestweld air gun whence it was forced by air pressure through a 6-inch steel pipe, the outlet of which was always within 6 feet of the concrete in the lining. From the pipe outlet, the concrete fell directly into place over the sides of the form. With an average slump of 4 inches there was very little segregation. After the side walls had been filled, the concrete was forced into the voids and overbreak, first by gravity, and then by burying the end of the pipe in the concrete and forcing it back. This had to be done cautiously for the pipe would plug with concrete if too much weight was allowed to build up ahead of the outlet end. After the arch was filled, the concrete supply pipe was moved back, and the process repeated.

Internal vibrators were used to work the concrete in the side walls and as far over the arch as practicable with satisfactory results. After the concrete was thus placed it was required to set for a period of 10 to 14 hours, depending on the temperature of the weather and the amount of overbreakage, before the lining form was removed.

After the side walls and arch section in the tunnels was completed, concrete was placed for the closed transitions of both the 20- and 26-foot tunnels (with the exception of the outlet of tunnel No. 1 which was completed in the manner described), the inverts of the respective tunnels, the open transitions, and the tunnel portals in the order given. The headings of the ultimate 26-foot diameter tunnels at the inlet and outlet ends of tunnel No. 1 and the outlet end of tunnel No. 2 were lined to the ends, and bulkheads were placed in the faces. At the inlet end of tunnel No. 2, where the andesite presented a stable condition, the heading was lined for the first 39 feet only from the portal structure and the remainder left natural.

The same equipment was used in placing the inverts except that the gun and pipe were replaced by a belt conveyor. A heavy screed, pulled by the electric locomotive was used to form the surface of the invert.

Concrete for the transitions and portal structures was mixed in a portable ½-yard mixer at the site of the work. Aggregate, batched at the central batching plant, was delivered in converted 5-yard dump trucks with a capacity for four batches. The cement was added to the mix from sacks at the mixer.

Construction Plant

All construction was served from a central depot on the canal between the tunnels. Compressed air for the driving of the tunnels and for the operation of the concrete gun used for placing concrete in the tunnel lining was supplied from a compressor plant consisting of two electric-motor-driven, two-stage compressors, each having a capacity of 750 cubic feet of air per minute at 100 pounds per square inch. Air for ventilating the tunnels was delivered to the headings through a 20-inch diameter sheet-metal pipe suspended along the walls from a Sorroco type blower outside the tunnel portals. In order to keep the ventilation as free as possible from construction dust, an intake pipe was attached to the blower with the open end well beyond the reach of activity.

The batching plant for the storing and

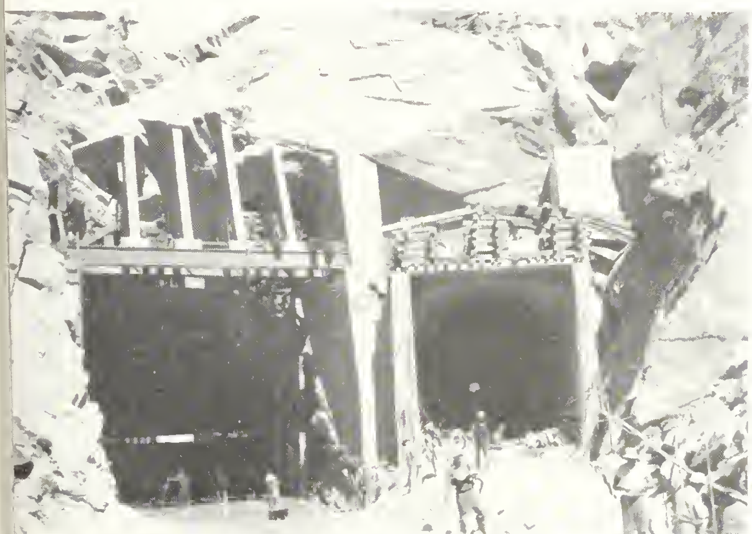
(*Continued on page 193*)

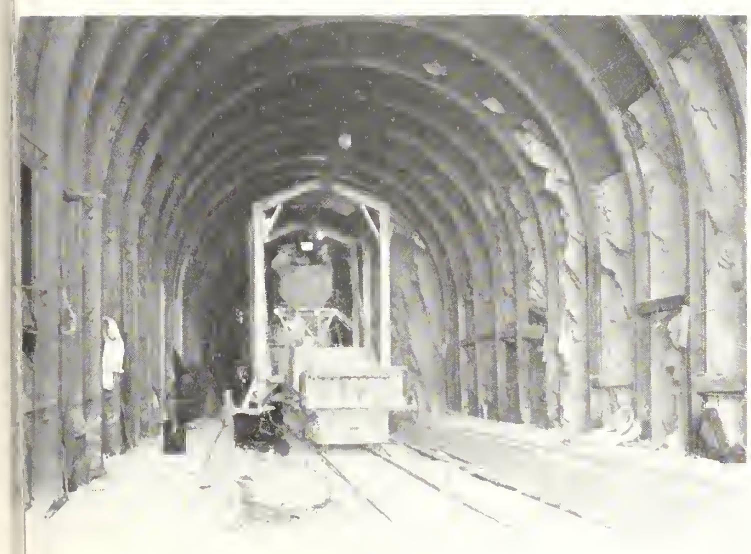
Upper left: Outlet Tunnel No. 1. After supporting the portal and concreting the closed transition of the 20-foot tunnel, driving of the 26-foot heading was resumed

Lower left: Tunnel No. 1, looking upstream from point near outlet end. Train of batch tanks under hoist; one batch tank being emptied into mixer. Metal form can be seen up left side

Upper right: The inlet portals, tunnel No. 2, completed

Lower right: Tunnel No. 2, looking downstream from inlet portal. Heading station 376+22






Edward T. Taylor Gavel Exhibit on Display

STONE axes, dinosaur vertebrae, reindeer horns, compressed paper, and materials from Grand Coulee Dam are among the interesting gavels presented to Hon. Edward T. Taylor, Congressman from Colorado, that are being displayed at the new museum of the Department of the Interior by special invitation from Secretary of the Interior Harold L. Ickes.

During the months of August, September, and October the public is invited to enjoy this unusual collection placed on exhibit in the Reclamation section of the museum. The museum is located on the first floor of the Interior Building near the C Street entrance, between Eighteenth and Nineteenth Streets NW., just three blocks from the White House.

Several of the gavels have been presented by various Bureaus of the Department of the Interior. One of them is fashioned out of actual materials from the Reclamation projects, another from timber from the 15 Reclamation States, and another from metals mined in Colorado, all related to the natural interests of the Department of the Interior.

These honorary gavels have been presented to Congressman Taylor, Chairman of the Appropriations Committee of the House of Representatives during the Seventy-fifth and Seventy-sixth Congresses, in appropriate recognition of the high achievements of a distinguished American.

The gavels are all symbols of their origin. They have come from the Arctic Circle to the Equator, from Alaska and the Hawaiian Islands, and from the Panama Canal and the Virgin Islands. Their material substances and skillful construction are as diversified as their origin. They also have a historic significance.

The gavel with its striking block presented by Secretary Ickes as a token of appreciation for Congressman Taylor's efforts in securing "imperishable contributions to the development of the West," is outstanding. The wood in the gavel and striking piece is seasoned locust taken from Headwaters Farm, the home of Secretary Ickes in Maryland. One of the four emblems on the striking block represents the Taylor Park Dam and Reservoir on the Gunnison River; another Vallecito Dam and Reservoir on the Pine River; the third represents the Taylor Grazing Act; and the fourth is the Buffalo Seal, the official emblem of the Department of the Interior.

Another gavel of unusual significance is the one presented by Secretary Ickes on behalf of the Division of Grazing, June 28, 1939, the fifth anniversary of the Taylor Grazing Act. "That act," Secretary Ickes said, "was one of the greatest conservation measures ever put into law." He called it the "magna charta" of western conservation and said if Congressman Taylor never had done anything else in his 16 consecutive terms in the House, his work in behalf of the Taylor Grazing Act would place his name in history.

The head of the gavel presented by the General Land Office is made entirely of paper which consists of hydraulically compressed layers of the Taylor Grazing Act, the Taylor 640-Acre Stock-Raising Homestead Act, and the General Land Office regulations pertaining thereto. The bronze tablet forming the center of the striking base for the gavel is the type of tablet used by the General Land Office to mark some of the corners of the surveys made in the public land States.

A replica of the trylon and perisphere of the famous "Theme Center" of the New York World's Fair and a gavel constructed of black ebony from the Golden Gate Exposition are significant.

In all there are 50 gavels. Not only are

Left to Right: Assistant Commissioner Bashore, Representative Taylor, Commissione[r] Page, Director of Information Warne, Chief Accountant Kubach they sincere expressions of the friendship and approval of Congressman Taylor's long career in the Congress, but they are symbolic records of a great man and the accomplishment of a great Nation.

Commissioner Page Presents Reclamation Gavel

On June 28 John C. Page, Commissioner of the Bureau of Reclamation, presented to Mr. Taylor a gavel made from strips of metals used in the great dams built by the Bureau of Reclamation in the West, and a striking piece, a disk of polished concrete from the greatest of those dams, Grand Coulee in Washington.

"I take pleasure," said Mr. Page, "in the presentation of these tokens of our respect for the statesmanship of a great man, because I feel so deeply what his championship of reclamation has meant to the up-building of his beloved West. * * * One could say much and not do justice to the work of Congressman Taylor. I shall say only that I cannot see how Colorado, the West, or the Nation ever could find a man adequately to take his place. These, sir, I give to you in the name of all of those working for the Bureau of Reclamation and in the name of all of those interested in the success of our work."

Nine strips of metal encircle the handle and hammer of the gavel, bronze, cast steel, aluminum, semisteel, copper, monel metal, alloy steel, steel, and stainless steel, samples representing a total of 332,459 tons used in the various dams. Engraved on the hammer are the names of the States which have furnished the metals, 16 east, and 11 west of the Mississippi.

Boulder Power Plant Now World's Largest

THE power plant at Boulder Dam is now the largest operating in the world. The seventh of the great generators to be installed in the plant has gone into steady operation. These large units, with one smaller unit, have brought to a total of 860,000 horsepower the capacity of the plant. This compares with the 746,000 horsepower capacity of the Dnieprostroy plant in Russia, previously the largest.

The ultimate capacity of the Boulder Dam plant is 1,835,000 horsepower, and eventually the plant will house 15 large generators, rated at 82,500 kilovolt-amperes each, and two small ones, rated at 40,000 kilovolt-amperes each. An additional large generator is being made ready for steady service before October 1, and two more are being manufactured at this time.

The generator which has just been placed in operation was hurried to completion in order to fill a critical need in the system of the Southern California Edison Co., which it serves. Because snowfall in the California mountains this year was only about half of normal portions, a power shortage was in prospect.

The unit was tested and connected with the company's system for the first time on June 19. Operating tests and trial loads were completed and within two weeks the generator was in regular operation at its full rated capacity.

On the day the generator went on the line for steady operation, the Southern California Edison Co. reported the greatest peak load in its history, so completion of the unit came in the "nick of time." The system served by the new unit is interconnected through the San Joaquin Light & Power system with the Pacific Gas & Electric system. Power from Boulder Dam, therefore, now is being fed on to lines reaching from the Mexican border to well north of San Francisco Bay.

The new unit is numbered A-7. This and A-8, one of the smaller units, are the only ones so far operating in the Arizona wing of the horseshoe-shaped powerhouse. In the Nevada wing six of the big generators are in operation, serving the city of Los Angeles, other municipalities, the Metropolitan Water District of Southern California, and several smaller loads. A-8 serves the Nevada-California Electric Corporation system. Ten transmission lines are being operated from Boulder Dam.

Unit A-7 is like the big units in the Nevada wing, except that it is adapted for operation at 50 cycles as well as at 60 cycles per second. Power from this unit moves over a new line extending to Chino, Calif., southeast of Los Angeles, at a voltage of 230,000.

Material reductions in the flow of mountain streams that furnish California's water power have resulted from the light snowfall of last winter. This year Boulder Dam will be able to help make up deficiencies in the power supply over most of the State.

Supervising Engineer Preston Addresses Pueblo Engineers' Society

PORTER J. PRESTON, supervising engineer of the Colorado-Big Thompson project, addressed the Pueblo Engineers' Society on the evening of May 24, 1939. Mr. Preston outlined the history of the project from the beginning of its conception in 1889 to the present-day plans. He also discussed the engineering problems in the design of the various features of the project, the formation of the Northern Colorado Water Conservancy District, the feasibility of the project and the plan of repayment of cost to the Federal Government. Mr. Preston employed the use of maps in his talk. There were more than 70 engineers in attendance.

Tunnel Construction

(Continued from page 191)

batching of cement and aggregate was erected above the right bank of the canal. A cement storage shed was built on top of the bank with an elevated runway leading directly to the bunkers and weighing bin. The aggregate was stored in wooden bunkers supported on timber cribbing over the bottom of the canal. The bunkers had four compartments with a total capacity of 440 cubic yards and were filled by backing the trucks up an inclined ramp from the canal bank. Below the bunkers manually operated gates discharged the aggregate directly into the weighing bin suspended from a Johnson bin weighing scale containing a Kron springless mechanism with the dial graduated in 5-pound increments. The batched aggregate was then transported over the contractor's railroad in the bottom of the canal to the tunnel linings, or by batch trucks to the work outside.

Water for all purposes was obtained from a cased well in the left bank of the Colorado River, approximately 1 mile upstream from tunnel No. 1. For this well, a 12-inch casing was put down 120 feet into nearly 20 feet of water bearing gravel. A deep well pump and a six-inch pipe line were installed to deliver the water to the site of the work. The water thus obtained was of very good quality and was used for domestic consumption as well as for construction.

Power was supplied the contractor by the California-Nevada Power Co., over the Siphon Drop Imperial Dam transmission line. The work was performed under contract by the Mittry Brothers Construction Co., of Los Angeles, Calif.

L. H. Mitchell Attends Irrigation Meeting

A MEETING was held at the Willwood Community House on July 26 to discuss the proper use of irrigation water with irrigation district officials, Bureau employees, and agricultural experts on the project. Officials and operating employees of the Shoshone irrigation district and of the Willwood division, and field men for the Great Western Sugar Co. and seed companies, attended the meeting. The discussions were led by Irrigation Adviser L. H. Mitchell, who also showed a preview of his moving pictures on irrigation practices.

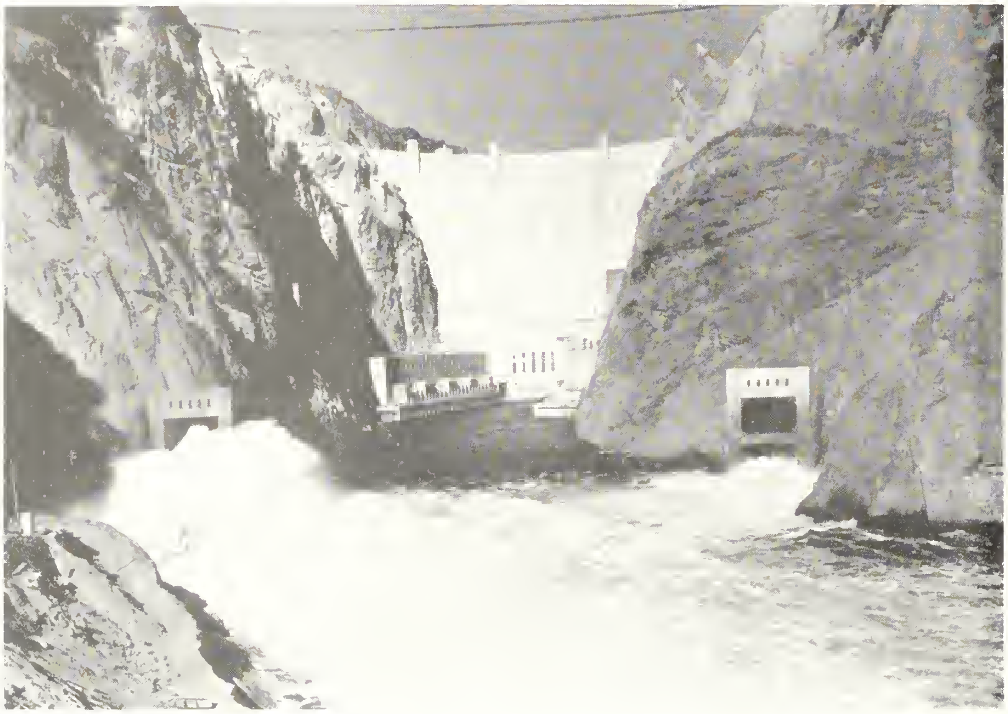
Visitors to Boulder

MORE visitors than in any previous month visited the Boulder Canyon project during June. Those visiting the powerhouse numbered 45,883, exceeding the June 1938 record by 8,010, and the previous high month, August 1937, by 5,276.

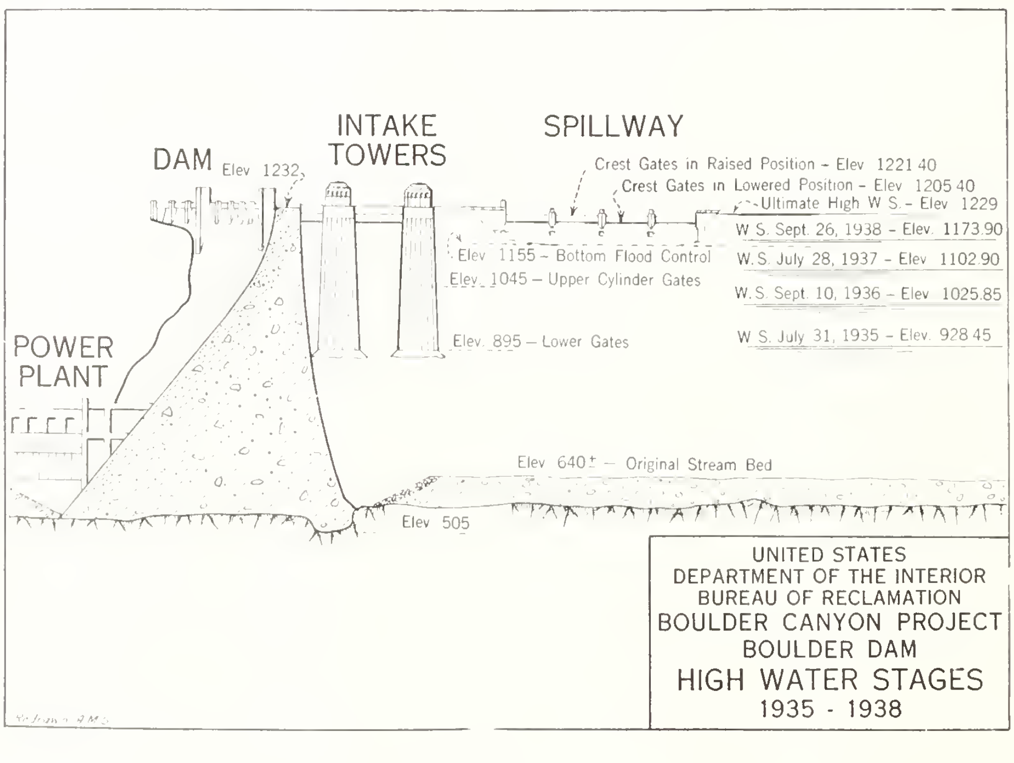
Control of Water Through Lake Mead

Boulder Canyon Project

By OTTO J. LITTLER, *Office Engineer*



Discharging water to evacuate flood-control storage during February 1939



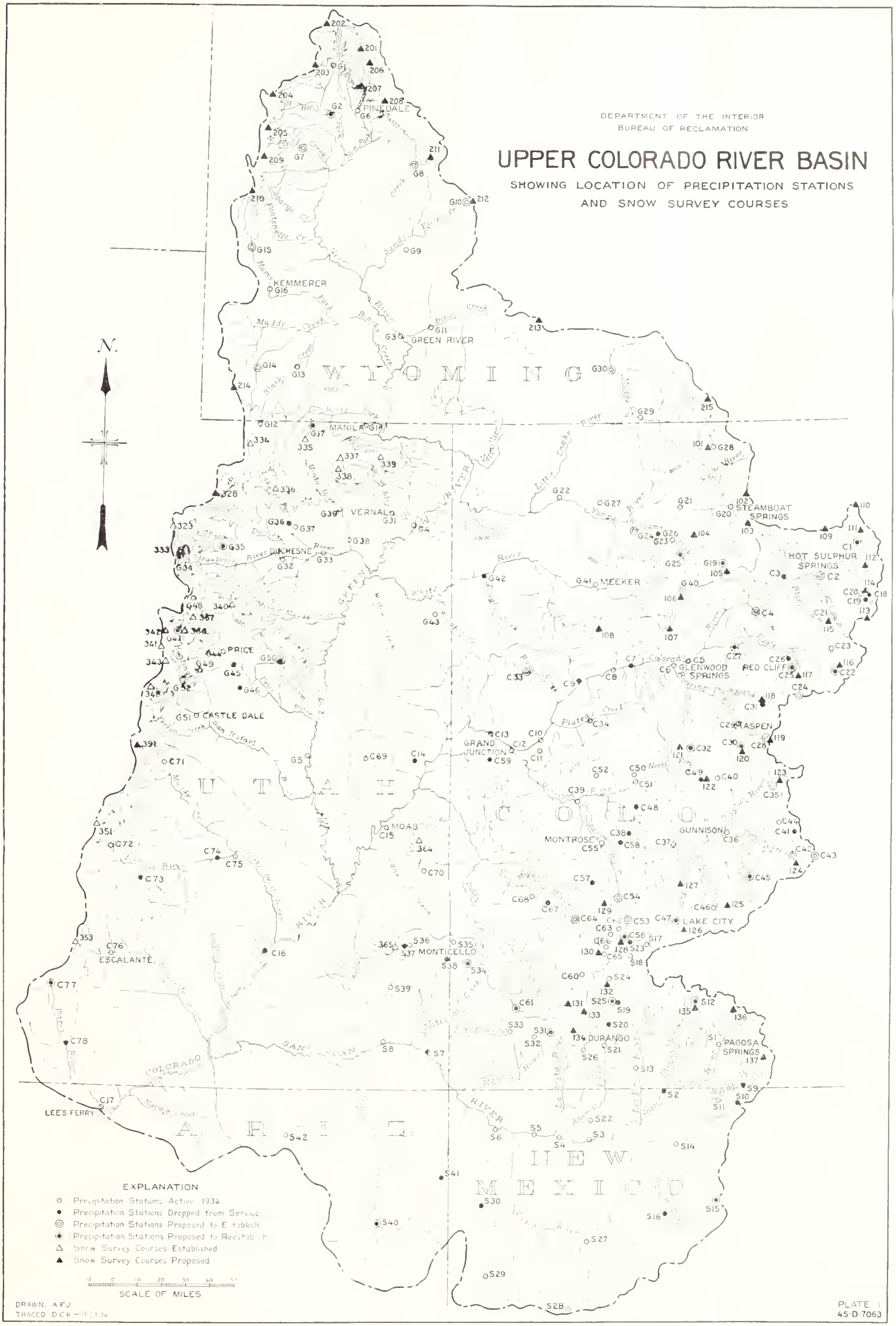
THE Boulder Canyon Project Act directs that the reservoir, now know as Lake Mead, created by the construction of Boulder Dam shall be operated for (1) river regulation and flood control, (2) irrigation, (3) silt control, (4) power development, and (5) domestic water supply. The act infers that the relative importance is in the order named; and in planning this five-purpose project, that rank has been recognized and anticipated in all operating plans. The act provides that repayment of the cost of the project shall be made through the sale of power and water. Of these two, the sale of power is by far the more important. It follows that exceptional skill and judgment must be exercised to secure the greatest power revenue without material sacrifice to flood control and irrigation.

Production of power will be of two kinds; firm power being that power which can be produced annually, as wanted at more or less a uniform total annual amount with rare shortages due to deficiency of stored water; and dump power which can be produced with surplus water, the production of which is limited to those times when the reservoir level is within the flood-control reserve or as the reservoir can be drawn below flood-control level to make room for expected heavy inflows. There may be periods as long as a decade when little or no dump power can be produced. The cost of the project will be amortized mainly from the sale of firm power. While the production of dump power will amount to about half that of firm power and the price per kilowatt-hour is much less, the income from sale of the dump power will produce clear surplus revenue and is therefore important. Thus, it is desirable to hold the lake level as high as possible.

It is also desirable to hold the lake storage as high as possible for reasons of increased output of the generating machinery and to assure adequate storage for irrigation should a cycle of dry years occur. From the standpoint of flood control, however, sufficient storage must be reserved to hold the erratic floods of the Colorado River.

Inflow into Lake

Of the total annual inflow into the lake from its 169,000 square miles of drainage basin, about two-thirds comes from melting snows during the spring months of April, May, June, and July. This quantity may vary from


DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER COLORADO RIVER BASIN
SHOWING LOCATION OF PRECIPITATION STATIONS
AND SNOW SURVEY COURSES
N.
WYOMING
UTAH
COLORADO
ARIZ.
NEW MEXICO
PINEDALE
KEMMERER
GREEN RIVER
MANILA
VERNAL
DUCHESNE
PRICE
CASTLE DALE
ESCALANTE
LEE'S FERRY
MOAB
MONTICELLO
GRAND JUNCTION
MEEKER
STEAMBOAT SPRINGS
HOT SULPHUR SPRINGS
GLENWOOD SPRINGS
RED CLIFF
ASPEN
GUNNISON
MONTROSE
LAKE CITY
DURANGO
PAGOSA SPRINGS
EXPLANATION
Precipitation Stations Active 1934
Precipitation Stations Dropped from Service
Precipitation Stations Proposed to Establish
Precipitation Stations Proposed to Reestablish
Snow Survey Courses Established
Snow Survey Courses Proposed
SCALE OF MILES
DRAWN: A.F.J.
PLATE 1
45-D-7063

2,200,000 to 24,000,000 acre feet and the mean is estimated at 11,900,000 acre-feet. Releases from the reservoir in excess of 40,000 second-feet or 2,500,000 acre-feet per month will endanger the flood plains below the dam either by overflow, increased seepage to low-lying valley lands protected by levees, or accelerated meandering of the river. Nine and one-half million acre-feet of the total 30,500,000 acre-feet total storage, which is about twice the capacity of any other artificial lake in the world, is reserved for control of floods. But even with this vast flood control storage it would be folly to attempt economical operation without some means of forecasting the inflow, since a reliable forecast allows more water—potential power—to be stored with a minimum waste.

Forecasting the flow of the Colorado River from precipitation and snowfall data presents a difficult problem. Drawing 45-D-7063 shows the location of precipitation stations for which records of value exist. The rivers which form the Colorado River system head as far as 550 miles apart and drain sparsely settled areas whose elevation varies from 1,200 to well over 12,000. The basin obtains its precipitation from storms which originate in three of four general directions and some at great distances. General storms over the entire basin are not prevalent, causing parts of the basin to have abnormal precipitation while other parts may have a deficiency. Conditions pertinent to run-off, change rapidly and in large degree not only throughout the winter but even during the period of melting snows. High winds, precipitation in the form of rain, or abnormal temperatures may mar the best of forecasts.

Since the beginning of storage in Lake Mead, February 1935, to the beginning of this year, forecasts of the inflow were of little importance as the lake was in the process of filling, and at no time was there any danger of overflow.

Flood Control Storage

Early in January of this year preliminary surveys indicated a spring run-off slightly above normal. At that time the lake contained about 22,500,000 acre-feet storage, or 1,500,000-acre-foot encroachment into the flood control storage. As a great deal of snow is normally precipitated in the watershed during February, March, and April, it was apparent that the flood control storage should be evacuated in order that there would be leeway for additional evacuation in the event of an exceptionally heavy run-off by reason of later accumulated snows.

By March the storage had been drawn down to the flood control level. As no outstanding increase in accumulated snows was then apparent and as one of the objectives of the outlined operation was to enable testing the spillways, releases were held to minimum requirements for production of power and irrigation demand.

When the May 1 precipitation and snow surveys had been completed and estimates made of the probable run-off, hopes for testing of the spillways dwindled. High, dry winds, together with deficient precipitation and abnormal temperatures, had marred a good forecast. Although the chances for testing the spillways this year are very slight, no harm has been done as the spillways were built primarily as a safety factor and are not expected to be used except on rare occasions when climatic conditions are the reverse of this year, with a run-off considerably larger than anticipated.

Lake Mead now contains more than 24,000,000 acre-feet of water. The present demand for power and irrigation is about 8,000,000 acre-feet a year; so, even if the upper Colorado River should dry up completely for a full year, the farmers dependent upon the waters of the lower Colorado River for irrigation would not suffer and the huge generators in the Boulder power plant could continue their supply of power to the Los Angeles area and to the States of Nevada and Arizona.

Lake Mead from Lake View Point

Columbia Cavalcade

SPOKANE staged, during the first week in August, a big historical and dramatic spectacle—the "Columbia Cavalcade"—featuring the city's participation in Washington State's fiftieth anniversary celebration, and marking a 5-day event with day attractions, including monster downtown pioneer and military parades which were climaxed each evening by a historical spectacle at the Old Interstate Fairgrounds.

In addition to the reenactment of past occurrences the State's glorious future was told in a stirring finale showing the great development to come through completion of the Grand Coulee Dam on the Columbia Basin project.

Commissioner of Reclamation John C. Page was unable, because of his many pressing duties in Washington, to accept the cordial invitation of the committee to attend this celebration, but he has been keenly interested in the successful outcome of the ceremonies.

Tips for Travelers

THE BUREAU has prepared a mimeographed statement of 18 pages with index designed to assist travelers who wish to visit Federal reclamation projects. Accompanying this statement is a map of the western portion of the United States showing all transcontinental highways.

Copy of the statement may be secured by writing to the Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.

Engineering Geology of Dams

By F. A. NICKELL, *Geologist, Bureau of Reclamation, Denver, Colo.*

THE number of good dam sites is being depleted by the active construction program of recent years. Continued demand for flood control and irrigation projects inevitably forces the engineer into utilizing sites passed over in previous investigations because of poor foundation or size of the proposed dam. Less apprehension is aroused now by adverse features than was once felt for similar complications. The attitude is fairly general that, within reason, a safe dam can be built if all important conditions are known before plans are drawn.

The progress in design and construction and the advance in technology of materials have gone hand in hand with engineering achievements. In early construction, following conservative principles, little notice was given details attentively appraised today. Data collected in observation of exposures, from pits and tunnels, supplemented by laboratory experiment, provide enough information in most cases. This procedure, adaptable particularly to the smaller undertaking, is justified by the fact that surprisingly few of the older dams failed on account of foundational defects. However, the response of rocks under a structure to continued submergence and load is not readily predicted. The reaction becomes extremely hard to analyze for high dams especially when the conditions at available sites are naturally complex.

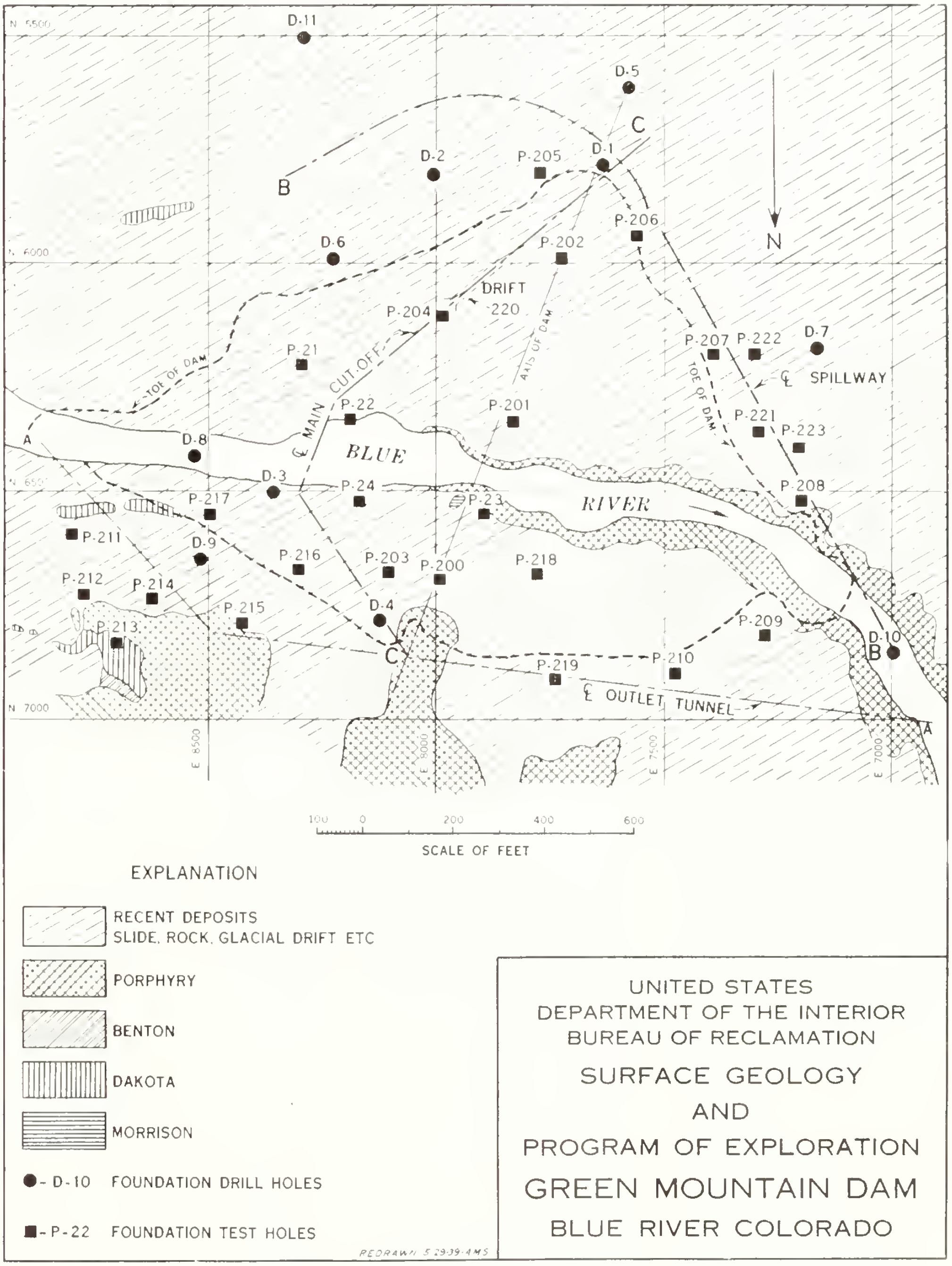
It is necessary to appreciate the significance of factors that determine practicability of proposed construction and to adopt measures that will prevent mishaps. The gradual introduction of geologic principles in some phases of engineering has led to the development of engineering geology and employment on most large projects of specialists versed in its application.

The geology of one area usually differs greatly from that of a second locality although the districts may not be widely separated. This is even true concerning identical formations since the details[1] that perhaps disproportionately influence the physical reaction of members are rarely sufficiently similar to insure parallel response.

The methods of investigating foundations are on the whole far from satisfactory. The most troublesome issue of interpretive geology is the difficulty in measuring response of rocks to assumed conditions representing future operation of the dam.

The purpose served by the dam determines to some extent how strict the standards have to be beyond insuring safety and stability. The flexibility of concept tends to disappear for large dams, but it is obvious that flood control structures are not defeated by considerable natural seepage if noninjurious, whereas conservation of run-off is essential for irrigation storage in an arid region.

The items weighed through the results of investigation at a dam site are modified by circumstances. In order to understand the situation fully, a clear concept must be obtained of local geology involving the relationship and importance of features that will be affected by construction. The next step is to pick out the things that will influence the design or success of the dam and appraise them in physical terms conforming to engineering usage. The value of geolog-



[1] A selected list of books and articles on Engineering Geology is given in Bibliography at end of paper.

ical advice in this field is largely determined by individual judgment and understanding of engineering fundamentals.

Irrespective of importance, the following subjects commonly are given consideration during geological investigations:

(a) Character and distribution of formations.

(b) Structural features of rocks, as joints, contacts, bedding, etc.

(c) Extent and effects of weathering.

(d) Thickness and character of overburden.

(e) Amount of stripping required in preparation of foundation.

(f) Adequacy of support under probable operating conditions.

(g) Identity and importance of soluble foundation materials, or those readily entrained.

(h) Special treatment of defective members.

(i) Considerations involved in tunnels, spillway, outlet works, etc.

Questions not necessarily restricted to the dam site cover:

(j) Opportunity of leakage and suggestions for control.

(k) Elevation and shape of ground water table which may determine magnitude of losses from reservoir.

(l) Seismic stability of region.

(m) Availability and kinds of construction materials.

(n) Effect of silt-laden streams entering reservoir.

(o) Scouring action of released water below dam and numerous other items peculiar to the project under consideration.

Method of Investigation

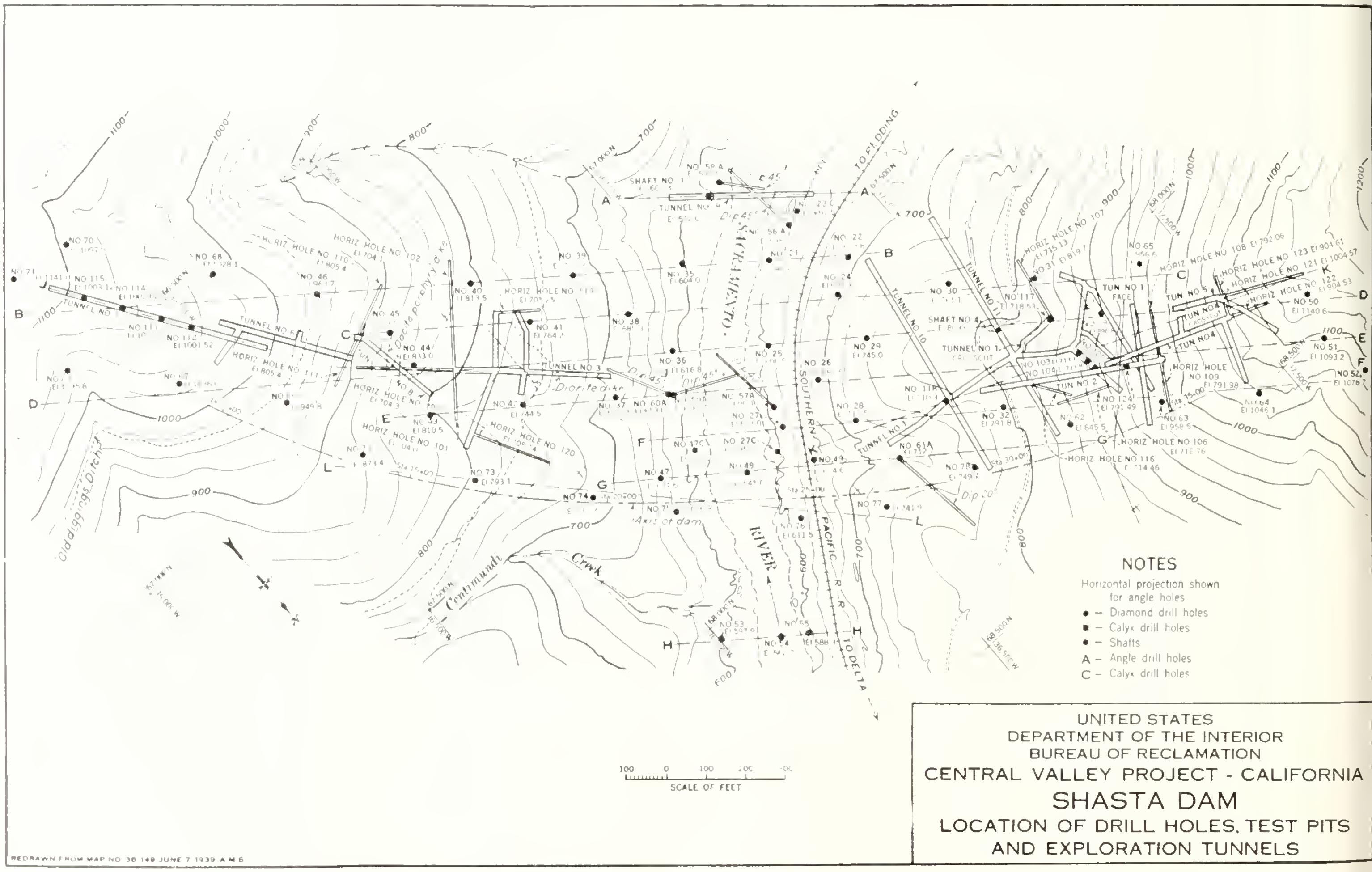
The means are limited of securing information on conditions at depth in regard to the physical characteristics of rocks under the dam. In many cases, experiment by mechanical methods yields erratic results. There is a real need for improved analysis accurately portraying long-time effects of load, submergence, and continement in place. The pressing demand for better ways to study the characteristics of poorly consolidated or soft materials on which dams are founded is generally recognized.

Exploration at the site usually is checked in the laboratory, at least, in part. Several momentous questions on stability, resistance to sliding, shearing characteristics, and rate of percolation are best answered, or should be reviewed, in the laboratory, since it is impossible to simulate actual operation on an exact scale of the dam when built. Fairly good results have been achieved with this combination.

The basis for early design was chiefly observation coupled with judgment of the situation, as disclosed by pits and tunnels. The use of the drill greatly expanded the scope of foundation exploration because the deeper horizons affected by high dams were easily reached and the progress of the search was greatly accelerated. The trend is noticeably toward core holes of large diameter obtained for example by the calyx (shot) drill making a hole up to three feet or more in diameter and permitting inspection.

The core recovered by drill, if complete, shows the detailed features and succession of rocks. Samples may be used in the laboratory for compression and permeability tests. The same holes can be analyzed further by mechanical or hydraulic packers to segregate leaky zones and show relative amount of seepage under selected pressures. Pumping or bailing of the hole establishes rate of inflow and level of ground water, facts that are indicative of possible leakage.

Test pits, tunnels, and large drill holes are accessible for bearing tests in place by means of a loaded column or hydraulic jack. This approach to the problem of supporting ability seems destined for wide application if only to calibrate laboratory data. It is regarded as invaluable, if properly applied, in dealing with soft or moderately firm materials. The results may lead to error unless the



bearing areas are ample, the load adequate, and the points of trial numerous or representative of each important supporting member.

The percolation slope in pervious foundations for dams not seated on solid rock, including alluvial material under rivers, is established in a number of ways. One of the best field procedures consists of pumping and simultaneously measuring the draw-down indicated by smaller borings spaced in concentric rings about the large central hole. This method provides definitive facts of ground water movement through undisturbed formations probably more exactly than the interpretation of rate of seepage through a layer of the same material in a laboratory experiment.

A geophysical survey by electrical, magnetic, gravitational, or seismic analysis is rapid and therefore finds increasing favor in geological investigation of large engineering structures. Because the seismic method depends on the elastic properties of rocks, a comparison is possible between deformation of the foundation under the weight of the dam and values recorded instrumentally. The electrical resistivity method also differentiates between geological horizons and establishes the level of ground water, manifested by increased conductivity. Analogy by the electrical method dealing with permeable foundations of dams is a field offering possibilities.

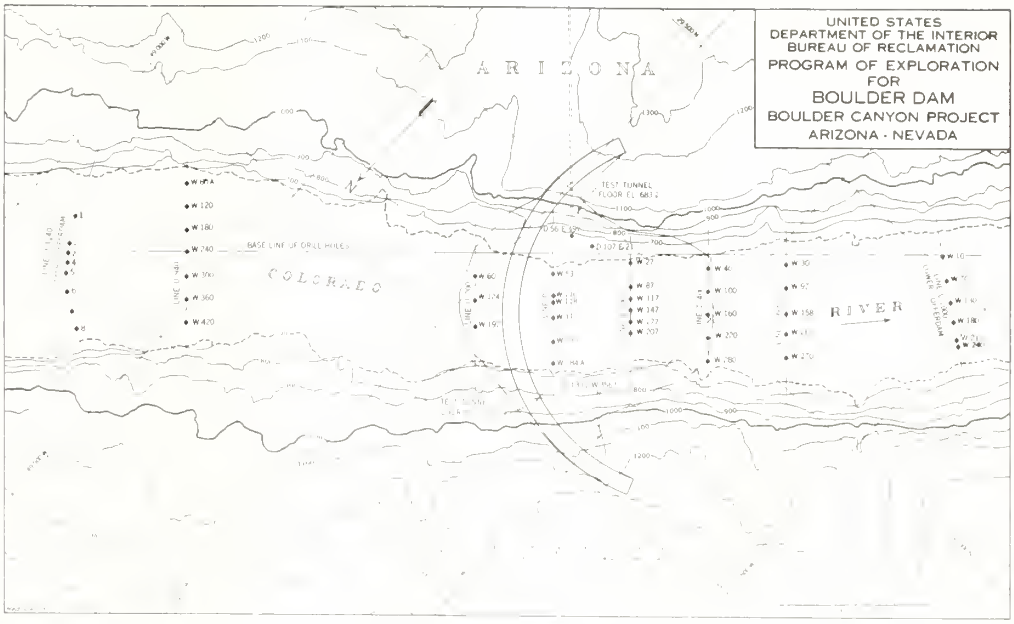
A well-equipped laboratory is essential for analyzing foundation and construction materials. Important physical characteristics can be measured including compressive strength, percolation rate, and indirectly the resistance to sliding through determination of shear strength. Selecting representative samples and directing attention to questionable zones deserving careful study are normal functions of the geologist in this work.

Scope of Geological Investigations

The character of geological investigations is defined by the nature of the project and imminence of construction. The first reconnaissance of general reservoir geology and of prospective dam sites may be immediately followed with preliminary exploration by drill holes, pits, tunnels, sampling of construction materials, and geological mapping in detail at the dam site.

New problems appear in preparation of the foundation, final location of auxiliary structures and modification of original plans, so that geological studies may be continued during construction. Geological maps are made of finished excavation in the case of most big dams.

The investigation of four better known projects is described below.



Construction of Boulder Dam, a curved concrete structure on the Colorado River in Black Canyon between Arizona and Nevada, began with the diversion tunnels in 1930. The site was chosen after a careful search for the best location where a reservoir would be created with sufficient capacity for flood and silt control, irrigation storage, and power development.

The rocks along Black Canyon[2] are chiefly of volcanic origin, including lavas, sediments derived by erosion as well as explosive discharge, and cut by numerous intrusive bodies. At the dam site, the bottom and lower portion of the cliffs are composed of a hard, cemented deposit known as Dam Breccia, overlain at higher levels by thick flows of latitic lava. The dam does not cross any of the more prominent structural weaknesses, so that repair of the rocks consisted in grouting the fractures and joints.

Diamond drilling of Black Canyon and the alternative site 15 miles upstream in Boulder Canyon was done in 1919-20. Geological studies were made to show the principal features of each place. Upon acceptance of the Black Canyon site, conditions were fairly well understood before design of Boulder Dam was far advanced.

Between the completion of preliminary investigation and beginning of construction in 1930, progressive geological studies were carried out to determine the best position for accessory features, many of which are enormous structures dwarfed only by the canyon and dam. The footing for the powerhouse wings on opposite sides of the gorge, depth to rock for sheet piling driven at the upstream cofferdam diverting the river flow, the foundation for concrete barriers to the intake portals of the diversion tunnels, percolation tests of the abutment rocks, and other investigations were in progress during the early period of construction. The writer in residence later mapped the geological features of all excavations.

Grand Coulee Dam is a concrete gravity structure on the Columbia River, in central eastern Washington. The powerful stream follows a broad valley of its own making at the dam site. Granite is exposed in places along the sides and continues in depth, providing the base for the dam.

The area is a part of the region covered by the periodical advance of the continental ice sheet, which on occasions deflected the flow of the river from the natural course into the basalt-lined Coulee to the west. In successive periods a great quantity of clays, silts, gravels, chiefly of aquo-glacial origin, accumulated in the valley and was only partly removed by later stream scour.

Several holes were drilled across the valley during the preliminary studies in 1921. The results indicated a level rock floor interrupted in places by sharp depressions. Geological reports were likewise prepared and further preliminary drilling was done in 1930. With the approach of construction, an elaborate exploratory program was undertaken in 1933 consisting of numerous drill holes, shafts, trenches, and a geophysical survey that covered all parts of the site.

When work on the dam began, geological studies were continued with the mapping of detailed features of excavation. The granite beneath a maximum of 150 feet of overburden proved to be without major defect[3] but is persistently jointed in three systems including sheeted zones trending northeast at right angles to a second set of vertical fractures, and another group of flat joints running north 70° west, dipping 5° to 15° southwest. Occasional masses of drummy rock had to be removed. The sharp notches dis-

[2] A bulletin on the geology of Boulder dam site is being prepared for publication among a series on construction of this project.

[3] Irwin, W. H. Geology of the Rock Foundation of Grand Coulee Dam, Washington. Bulletin, Geol. Soc. Amer., Vol. 49, pp. 1627-1650; 1938.

covered in preliminary exploration were found to follow fractures or, in one instance, a small fault.

Shasta Dam, a curved concrete structure being built on the Sacramento River near Redding in northern California, is a typical example of a large, thoroughly investigated project. At the dam site and for some distance in each direction, the stream is flowing through a rather open valley cut in one of the oldest formations in that part of the state. The rocks are of volcanic origin consisting of ancient andesitic lavas and thick, obscurely bedded fragmental deposits. Intense metamorphic action by pressure and heat has made the series into a physically solid mass completely changing the incoherent fragments into a resistant, rigid foundation. The principal members trend nearly at right angles to the channel and dip steeply upstream. Numerous minor intrusives from the same and different sources occur.

The meta andesite weathers more easily than many types of rocks and the depth reached by alteration at the dam site ranges from practically nothing at river level to more than 150 feet at higher elevations. The layer to be excavated may average 50 feet thick.

The investigation of the dam site was started several years before construction began. The preliminary exploration by angle drill holes and tunnels at different levels into the abutments was extended with further excavation and cross cutting, a few years later. Prior to final design in 1938, a very comprehensive exploratory program, consisting of drill holes both from the surface and underground, shafts, crosscuts, new tunnels at other levels including one beneath the river, and 36-inch Calyx holes, was completed under direction of the writer. Despite exceptionally large quantities involved, the geological conditions were all well established before the contract was released.

The Green Mountain Dam on the Blue River in north central Colorado is to be one of the world's highest earthen dams. The district is of geological interest due to extensive injection of crystalline rock (trachyte porphyry) outwardly from a central source (laccolithic sheets) along the bedding of the surrounding sediments. The stream is flowing upon limey shale of the Morrison formation but the sides of the valley are underlain at a varied depth by sandy shale and sandstone of the Dakota followed at higher levels by the Benton and other shaley formations. Erosion guided to a marked degree by resistant ribs of trachyte porphyry has formed a terraced surface with low cliffs separating smooth slopes on shale. The right (north) side is mantled by a flaggy talus of trachyte in contrast to the hummocky slope on the opposite side where the bedrock is concealed by glacial debris. A sill of trachyte at river level appears downstream (west) approximately from the axis and doubtless other similar bodies are present in depth.

The extensive exposures along the canyon supplied adequate evidence of the nature of the geological relationships between formations. The first exploration undertaken in 1936–37 by tunnels and pits was carried only to a point indicative of probable conditions. In anticipation of design, the axis as finally located was defined by numerous drill holes, pits, and a single tunnel into the glacial material midway up the left (south) abutment.

Summary

A comprehensive study of the foundation is prerequisite to design and construction of dams. Geology appears to be the best medium for directed analysis and logical interpretation.

The exploration of sites, adapted to conditions, is commonly done with drill holes, pits, and tunnels. The employment of experts in this field is a natural step because even the most elaborate program touches upon only a minor portion of the foundation and must be carefully outlined and reliably interpreted.

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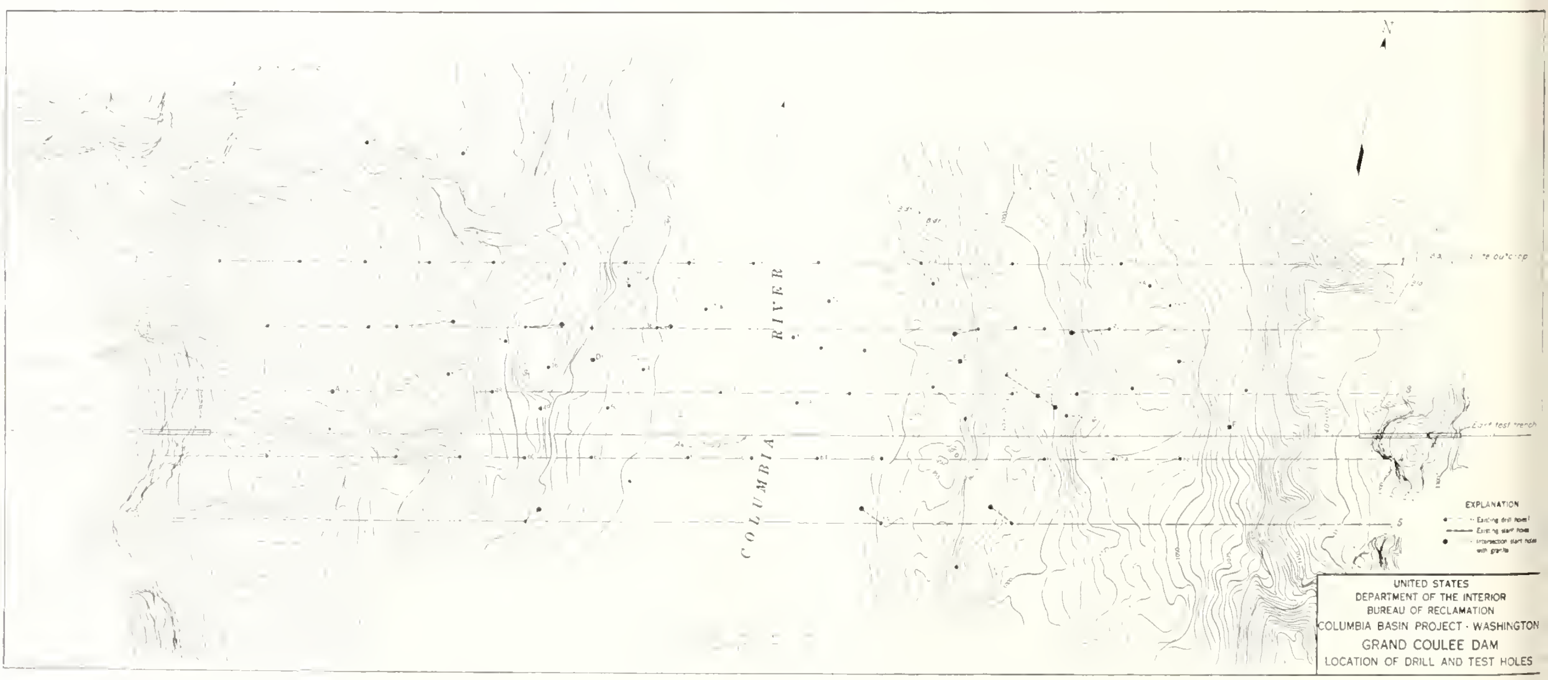


Porter J. Preston Honored by Colorado State College

INSCRIPTION ON BACK OF PLAQUE

THE alumni of Colorado State College respectfully request that at the death of the recipient, this plaque be returned to the Association in order that it may be hung with the picture in the Hall of Fame at Johnson Hall.

ONLY one other has received the honor alumnus plaque, the award made to Porter J. Preston, supervising engineer on the Colorado-Big Thompson project. The plaque, a symbol of Mr. Preston's high contribution to his fellowmen, was presented to him at the Colorado State College commencement exercises at Fort Collins, Colo., on May 29, 1939.

Mr. Preston, recognized as one of the outstanding irrigation engineers in this country, was born in Grinnell, Iowa, December 23, 1870. He received his education and was graduated in 1892 from the Colorado State College of Agriculture and Mechanical Arts.

Mr. Preston has been employed by the Bureau of Reclamation of the Department of the Interior continuously since April 4, 1915. During this time his work has included assignments of importance on many projects, including the All-American Canal, Calif.; Uncompahgre, Colo.; Yuma, Ariz.-Calif.; Yakima, Wash.; and many others. Among these are the Colorado River Basin investigations, which consists of land classification and water surveys in this basin. This undertaking was authorized under section 15 of the Boulder Canyon Project Act of December 21, 1928. Mr. Preston has been in charge of several secondary investigations, the most important of which were the Blue River-South Platte Transmountain diversion project and the Colorado-Big Thompson project.

The Colorado-Big Thompson project, a multiple-use project and the fourth reclamation project in size in the country, is one of the more diversified construction projects of the Bureau.

Because of the commendable manner in which Mr. Preston handled all the preliminary investigations of the project, to a large extent on his own initiative, and because there was probably no other man more completely familiar with its background or with the problems ahead than he, he was appointed by the Secretary of the Interior to the position of supervising engineer on this great project.

Mr. Preston is a member of the American Society of Civil Engineers and vice president of the Colorado Society of Engineers.

The Great Plains Program

PLANS for administration of the Great Plains water conservation program were completed on June 17, 1939, as announced by Secretary of the Interior Harold L. Ickes following receipt from the President of an order outlining the procedure.

The program recommended by the Northern Great Plains Committee of the National Resources Committee, contemplates the development of water supplies and construction of irrigation projects in the area most critically affected in recent years by prolonged drought.

The Congress included in the Interior Department Appropriation Act for 1940 an item of $5,000,000 to assist in financing the necessary construction. This money was appropriated subject to allocation by the President to carry out the program with the assistance of moneys to be contributed from work relief funds. Projects constructed would be subject to repayment by water users of so much of the costs as they equitably could bear. Nonreimbursable amounts would be considered as relief expenditures in the affected area.

Under the President's order:

1. Allocations from the $5,000,000 appropriation will be made for projects individually.

2. Recommendations for allocations will be prepared by the Department of the Interior in accordance with the general policies set forth in the report of the Northern Great Plains Committee, dated October 14, 1938, and will include the concurrence or views of the Department of Agriculture and the Works Progress Administration.

3. Each recommendation will include a description of the proposed project, an estimate of the total cost of the completed project, estimates of the work which can be performed by relief labor and of the reimbursable cost, and a statement of the proposed participation of each Federal agency concerned, together with the recommended amounts of funds to be allocated to each.

4. The Secretary of the Interior acting through the Bureau of Reclamation will be responsible for the construction of projects, except as may be otherwise recommended.

5. Recommendations will be transmitted to the President through the Bureau of the Budget.

6. The National Resources Committee through its Northern Great Plains Committee will continue to coordinate these and related activities.

The amounts to be repaid will be determined in accordance with estimates of the ability of the water users to pay, and the repayment contracts will be negotiated and administered by the Farm Security Administration of the Department of Agriculture.

The Bureau of Reclamation, which will be the principal construction agency, in the progress of its regular work, has investigated many projects in the Great Plains, gathering data upon which recommendations may be based. The plan contemplates use of relief labor to the fullest extent possible. Engineering direction and services will be drawn principally from the staff of the Bureau of Reclamation.

Active construction, of course, cannot be started until funds are allocated for the individual projects.

Grand Valley's Safety Record

THE Grand Valley project, Colorado, employing an average of 29 men on routine operation and maintenance work, and operation of the diversion dam, has maintained a very nearly perfect accident record since the inception of the Bureau safety program. Only one accident, that of February 1938 from an infection of a blister on the hand caused by using a shovel, has been reported by the project in the past 22 months. This record is evidence of the active and effective interest in accident prevention characteristic of the project administration.

California Legislature Visits Shasta Dam

By PHIL DICKINSON, *Assistant Director of Information*

IT WAS hot—92 in the shade, if any, on May 13. Standing on a man-made shelf high on the west slope of the Sacramento River Canyon, 300 men and women gaped into the dusty depths where dynamite, power shovels, and dump trucks had removed more than 2,000,000 cubic yards of earth and rock in 8 months, gouging broad grooves into opposite hillsides to provide a permanent anchorage for the world's second largest concrete dam.

No one paid much attention to the heat. The group stood rather silently, awed by the immensity of the operations below them. One man, a prominent State official, said:

"I had no idea * * *."

That was how everyone felt. They did not realize it was so big. You had to see it to believe it.

The scene was the Shasta dam site, 12 miles north of Redding, Calif. The group comprised members of the California Legislature, other public officials, civic leaders, interested engineers, and contractors. As guests of the Central Valley Project Association, they had traveled on a special air-conditioned Southern Pacific train from the State capital to inspect the progress of construction on this mighty Federal reclamation job.

The train—composed of four lounge cars, including an observation, two coaches, two diners, a baggage car, and locomotive—left Sacramento at 8:05 a. m. and arrived at Coram, just downstream from the dam site, at 12:30 p. m. Automobiles and trucks were waiting to take the crowd across the river and up to the camp of Pacific Constructors, Inc., the general contractor, on the east slope of the canyon. All were guests of the contracting firm at a bountiful luncheon, including delicious fried chicken and ice-cold strawberry shortcake, served in a spacious mess hall by efficient waiters.

Clarence Breuner, president of the Central Valley Project Association, which is a unit of the National Reclamation Association, served as master of ceremonies at a luncheon program. William A. Johnson, president of Pacific Constructors, welcomed the visitors to camp. State Senator Jesse W. Carter of Redding introduced members of the State senate, and Assemblyman Clinton J. Fulcher of Shasta County introduced members of the assembly. Assemblywoman Jeanette Daley of San Diego spoke for the ladies. Supervising Engineer Walker R. Young, as the principal speaker, told the legislators and other visitors that the Central Valley project is an outstanding example of a multiple-purpose project which "meets the modern demand of a con-

Above: Left abutment
Below: Right abutment

servation-minded nation that maximum benefits be made to flow from public expenditures for stream improvements."

Mr. Young said in part:

"In authorizing this project Congress has declared the primary objective to be the improvement of navigation. By stabilizing the flow of the Sacramento River—that is, by holding back water during flood periods and releasing the conserved surplus during the dry months—Shasta Dam will permit a restoration of steamboat and barge navigation on the Sacramento River as far north as Red Bluff. It will take the peak off the extreme floods which sometimes sweep down the Sacramento Valley; it will afford improved irrigation in much of the valley; it will check seasonal encroachment of salt water from the ocean into the channels of the fertile Sacramento-San Joaquin Delta; and, incidentally, it will generate about 1,500,000,000 kilowatt-hours of electricity annually for municipal, agricultural, industrial, and project use.

"Finally, when the conserved waters of the Sacramento River have performed all of these functions, and have passed every possible user on that river, they will afford a surplus for export by canal to parts of Contra Costa County and the San Joaquin Valley. I think you will agree that it would be difficult to conceive of a more complete catalog of diversified useful purposes than thus will be served by Shasta Dam."

Construction Engineer Ralph Lowry wound up the speaking program with a quick outline of the status of work on the dam. He said the general contract is more than 20 percent completed. As they left the mess hall the visitors were given a dramatic introduction to large-scale construction when a series of sharp whistles signaled workmen on the opposite abutment to shelter. Shortly thereafter clouds of smoke and dust burst into the air across the canyon and the dull boom of the explosions resounded through the hills.

Viewing Excavation

Large trucks transported the crowd up a steep road to the top of the west excavation evoking many a gasp from the half-thrilled, half-frightened sightseers as the expert drivers wheeled the big vehicles around switchback turns. Bureau of Reclamation guides accompanied each truck and pointed out interesting features of the work. At the present time the job is largely a matter of digging and more digging, they said, with excavation continuing on both abutments, in a temporary river diversion channel along the east bank, and in the area of the future spillway apron. More than 3,000,000 cubic yards of material are to be removed to provide a firm foundation for Shasta Dam. On a terrace below the point where the visitors stood, two giant electric shovels, digging 6 tons of material at a scoop in their 4¾-yard buckets, were loading a fleet of 25-yard dump trucks. On another level nearby a battery of wagon drills could be seen, preparing holes for the next series of blasts. Across the canyon the upstream and downstream limits of the future concrete dam could be traced clearly by the vast cavity excavated for the east abutment, reaching an apex more than 500 feet above the river. The guides said the uppermost water tank on the opposite hill, two-thirds of a mile away, marks the approxi-

Upper: Battery of wagon drills *Lower:* Large shovel and truck mate top of the east abutment. A woman asked whether it would require "all the concrete in the world" to fill the gap between abutments. She was told it would take about 5,400,000 cubic yards, or enough to build a solid concrete monument a city block square and higher than New York's Empire State Building. Concrete placement is scheduled to be started in March 1940.

On the way down the trucks passed a portal of the 1,820-foot railroad bypass tunnel which has been driven through the west abutment of the dam site. Concrete lining was in progress. The guides said Southern Pacific trains would be diverted through the tunnel in July to permit excavation to be completed on that side of the canyon for the base of the dam. Later, when the permanent 30-mile railroad relocation is completed on a new high-line around the reservoir site, the existing canyon railroad past the dam site will be abandoned and the bypass tunnel will be available for river diversion.

A fleet of private automobiles volunteered by citizens of Shasta County picked up the legislators and other guests for a 12-mile tour into Redding. Along the way they passed the trim village of Toyon, which is the Bureau of Reclamation camp, and "mushroom" communities such as Summit City, Boomtown, and Project City, which have grown up since the start of work on the dam. Drivers of the cars were careful to point out deficiencies of the existing county road which the legislature has been asked to vote into the State highway system. Portions of the railroad relocation, 20 miles of which are under construction, were crossed. Entering Redding, the group saw steelwork going up on the new 4,350-foot railroad bridge which spans the Sacramento River on a sweeping curve toward the hills.

The same air-conditioned train which the visitors had left at Coram was waiting at Redding to take them home. It left at 6 p. m. and reached Sacramento shortly after 11 p. m., ending an excursion which was unanimously pronounced enjoyable and educational.

High scalers at work near core wall section of right abutment

Toyon Reclamation Camp Near Shasta Dam

By SMITH A. KETCHUM, *Assistant Engineer, Kennett Division, Central Valley Project*

THE recorded history of Toyon, so named for the beautiful crimson-berried bush which grows in abundance in the vicinity, dates back to 1854 or 1855 when Porter Seamans homesteaded 160 acres of Government land, assumed to have been in section 26, township 33 N., range 5 W., Mount Diablo Base and Meridian. At that time the Government surveyors had not subdivided the township, consequently Porter Seamans probably was somewhat surprised when in 1869 the General Land Office survey revealed that half of his 160-acre homestead was in section 26 and half in section 25. The Land Grant Act of Congress gave the odd numbered sections, 10 miles each side of a constructed railroad, to the railroad company. However, an agreement between the parties concerned was reached wherein Mr. Seamans retained possession of the homestead as originally staked. During the 1860's Mr. Seamans played host to a small band of Indians who made their camp just north of the present Community House of Toyon. There they cooked their meals on heated stones, prepared acorn soup which was eaten with the aid of a grey squirrel's tail. The eating process consisted of dunking the bushy-haired tail in the soup, raising it quickly to the mouth and sucking the adhering soup from the tail. These Indians became known as Seamans' Indians, but in time they became a problem for the old gentleman and were requested to move on. Many arrow heads were found at this old Indian camp site during the construction and grading of streets at Toyon.

The present Seamans' house was built in 1909 of lumber from the old National Mine and stands by a spring near the center of the east 80. The site is that of the original house built in 1854 or 1855. After the Bureau of Reclamation took the property over in 1937, the existing house was remodeled and now serves as a center for community activities.

Reclamation Establishes Redding Office

During November 1935 the Bureau established a field office in Redding, and in 1936 serious consideration was given to the location of a construction camp for the Bureau's personnel. After a thorough study of various feasible camp sites, the Seamans' property, 9 miles north of Redding, was chosen. The area selected for the camp contains about 45 acres of mildly sloping land surrounded by low Manzanita and Toyon-covered hills. Large oak and pine trees add to the attractiveness of the site and provide considerable precious shade in the summer. Other factors leading to this selection were: Partially developed water supply with indications of an adequate ground water supply; accessibility with regard to work to be undertaken, namely, railway and highway relocation and construction of Shasta Dam, 3 miles distant, and last but not least, the surrounding hills protecting the camp from encroachment of settlement and promotion schemes which invariably follow construction projects of this size. It is of interest to note that the title of the homestead remained in the Seamans family for an 84-year period (1854 to 1937), after which the homestead again became the property of the Government.

In July 1936, a preliminary lay-out of the present camp was made, and in August 1937, actual construction was started. Camp construction was inaugurated on August 21, 1937, with the breaking of ground for a steel frame warehouse. Shortly thereafter construction was started on a concrete testing laboratory, a combination garage and fire station, an office building, 2 dormitories, 100 residences, a 150,000-gallon water tank, a 4,000,000-gallon water storage reservoir, and a sewage-treatment plant, all of which were completed on or before May 20, 1938. Construction of streets, driveways, sidewalks, and sewer and water systems was started on April 6, 1938, and completed on August 31, 1938.

The fall and winter of 1937–38 proved to be adverse climatically for camp construction, when a seasonal (October to April) total of 111 inches of rain fell at Kennett, about 3 miles north of Toyon. All work was delayed owing to the continual rains, the result being that none of the several contracts for camp structures was finished on schedule.

On September 1, 1938, Toyon was declared ready for occupancy, and by September 15 of the same year approximately 70 families had moved from Redding into the houses assigned to them. Housing conditions had been rather unsatisfactory for many of the employees in Redding because the town had increased in population from 6,000 in 1935 to 9,000 in 1938.

Plan of Camp and Accommodations

The street plan of Toyon is of the conventional gridiron pattern with an angular street across the north edge to fit the topography. The camp is situated on the west side of a branch of Churn Creek which ordinarily dries up during the summer months and therefore cannot be relied upon as a source of water supply. The water for the camp is supplied from two wells and a small storage reservoir. One well, the original, is located west of the community house in the park, and the other is located in a ravine a short distance northwest of the camp area. Tests have indicated that the combined capacity of the wells will be 165,000 gallons per day, which exceeds the estimated requirement. In order to use all available water and to conserve the ground water supply as much as possible, an earth dam 38 feet high containing 12,000 cubic yards of material was constructed about one-half mile north of camp on Churn Creek. Located about midway between Toyon and the reservoir is the 150,000-gallon steel storage tank which is the beginning of the distribution system. The tank is at elevation 1,101, which is 200 feet above the average elevation of Toyon. Water from the two wells is pumped directly into the distribution system, while water in the reservoir flows by gravity to the steel storage tank from whence it enters the distribution system. Sterilization of the water is by means of two chlorinating units, one at the original well and the other on the feeder line between the reservoir and the storage tank.

A sewage-treatment plant has been constructed one-quarter mile south of Toyon. The plant is designed to accommodate a population of 500 and is composed of an Imhoff tank, a dosing tank, a trickling filter, and two evaporating ponds.

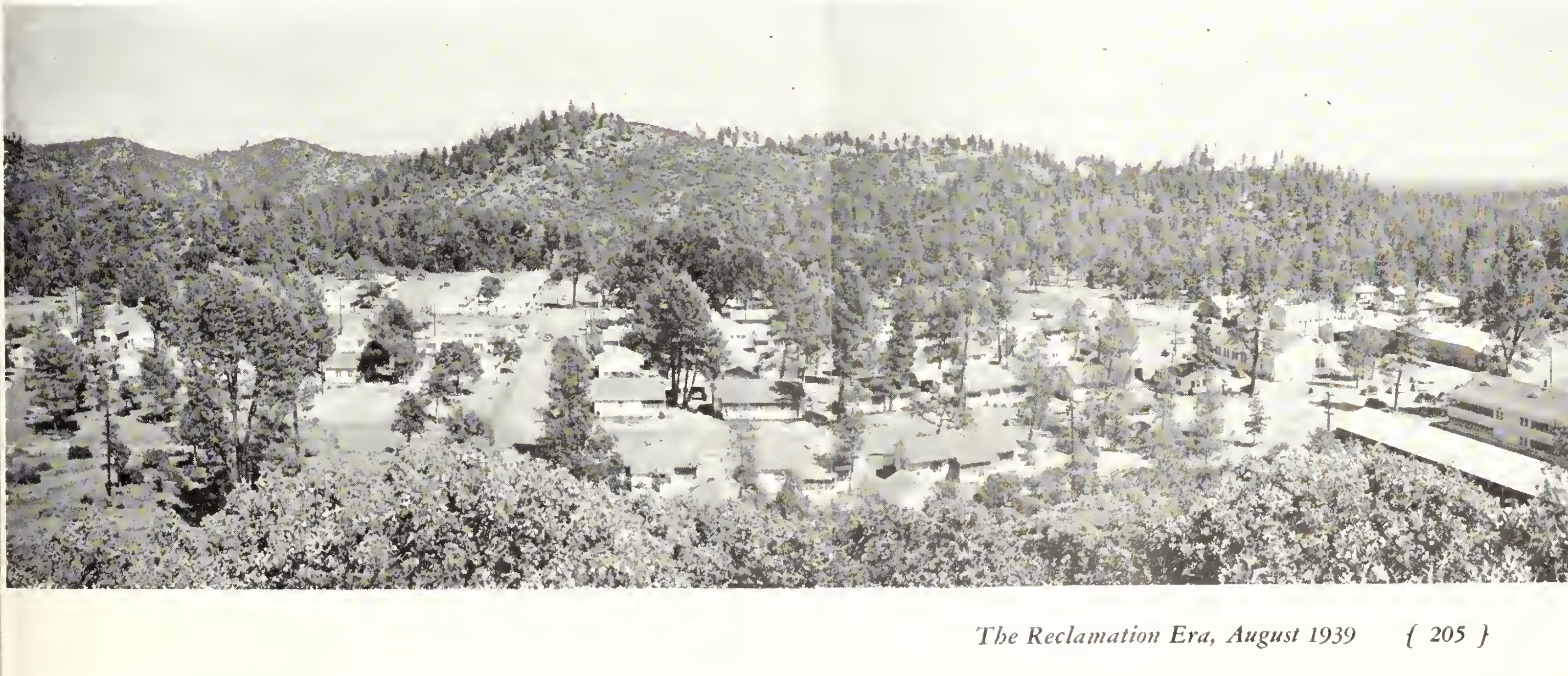
Electrical energy is purchased direct from the Pacific Gas & Electric Co. by the individual consumers. Each house at Toyon is equipped with an electric range and a 30-gallon electric water heater. Provision has been made for heating the houses by electricity, but by reason of the cost, few have availed themselves of the opportunity. Oil heating stoves are the most common method of heating, however, a few families have wood burning heaters. During the summer months, temperatures exceeding 110° F. are not uncommon. The office building and both dormitories are air conditioned and most of the residents will either buy or build some type of home-cooling device. Unlike many past Bureau camps, Toyon enjoys moderate food prices combined with a wide selection of commodities. At least three first-class markets are within a few minutes drive from camp. For amusements, a small moving-picture theatre and roller-skating rink have been constructed in the adjoining settlement of Boomtown.

School Facilities

On October 10, 1938, the Toyon grade school, constructed by the general contractor one-half mile west of camp, was opened. Previous to the opening of school the indications were that the attendance would not exceed 150 pupils. The initial building was a one-story frame structure with four rooms to which two more rooms have been added recently, and the attendance has exceeded 400 pupils. Because of the overcrowded condition at the school, it has been necessary, for this year, to utilize the Community House at Toyon for 72 first-grade pupils. High-school students are transported daily by bus to the Redding High School.

When the camp was first occupied, no work had been done with regard to the construction of sidewalks and driveways for the residences, office buildings, and dormitories, nor had any attempt been made to plant lawns, shrubs, or trees. Under the supervision of the chief landscape gardener, CCC enrollees from Camp Baird have been engaged since October 19, 1938, in constructing sidewalks and driveways and in landscaping the camp. An area around the Community House containing 2½ acres was reserved for a park area. Here it is planned to build tennis and handball courts, also benches, tables, and other facilities for picnicking. The rough grading for a softball field located just west of Toyon has

General panoramic view of Toyon



been accomplished. The camp site is overlain with a heavy red unworkable soil. In order to produce lawns, it has been necessary to cover the lawn area with a layer of sandy topsoil. All trees and shrubs have been planted and lawn planting is under way.

In September 1938 a two-company volunteer fire department was organized to provide fire protection to the camp.

The present population of Toyon is 364. All residences are occupied and a few families are living in Redding or in one of the several "boomtowns" near Toyon. To meet this need for additional housing facilities, the Bureau is providing 18 additional duplex cottages.

Contractor's Camp

The general contractor's camp is located 3 miles from Toyon, in the Sacramento River Canyon just downstream from the dam site on the east bank of the river. A post office recently has been established in the contractor's camp under the name of Shasta Dam. The camp includes an administration building for Pacific Constructors, Inc., three dormitories, a large mess hall and store with a modern electric kitchen, a 24-bed hospital, 131 family residences of 2 to 5 rooms each, and various workshops, storage buildings, and construction facilities.

1. Seamans' House as it appeared before remodeling by the Bureau
2. Development in Central Valley—a "boomtown" about 1¼ miles east of Toyon
3. The Government camp in Kennett Division; enrollees landscaping park area in front of dormitories
4. Toyon schoolhouse built by the general contractor, ½ mile west of Toyon
5. Kennett Division Government camp; CCC enrollees landscaping area near administration building

Harlan H. Barrows Heads Development of Grand Coulee Area

A UNIQUE program for the settlement and development of 1,200,000 acres, an area almost as big as Delaware, which will be irrigated in Washington by Grand Coulee Dam, was launched on July 5 by the Department of the Interior through its Bureau of Reclamation.

Harlan H. Barrows, chairman of the department of geography at the University of Chicago and a member of the Water Resources Committee, has been engaged by the Bureau as a consultant to direct the work.

Grand Coulee Dam, the world's outstanding concrete structure, has been under construction since 1933 and will be completed to form a storage reservoir 150 miles long in a little more than 2 years, if the present rate of construction is maintained. In diverting about a fifth of the flow of the Columbia River the dam will make possible the irrigation of this vast dry region to the south by pumping stored water from the reservoir into the Grand Coulee, an abandoned channel of the Columbia River formed during the last Ice Age.

Here, in what is called the Columbia Basin area or the Big Bend country, the diverted stream will be spread into thousands of miles of canals and ditches to create about 30,000 new irrigated farms. This area has been called the largest and best body of land remaining undeveloped in the United States, and possibly in the world.

For several years fundamental surveys to form a basis for the final plans for the development have been in progress. These include topographic surveys, to assist in laying out the canal systems; soil studies, to assist in developing the farms and in working out a program for future farming operations; and land mapping, to determine the size of present holdings, for under the antispeculation act the holdings must be divided into units not in excess of 40 acres in single ownership.

The fundamental objective of the planning program, as explained by Commissioner of Reclamation John C. Page, is to insure orderly development of the area as a great community of small, single-family, owner-operated farms, each adequately serviced by transportation, marketing, and educational facilities. Mr. Page said:

"The purpose of the Federal Reclamation program is to provide new homemaking opportunities, to build up the arid and semiarid West, and so to enrich the Nation. These ends have been served admirably by projects completed in the past, but these projects, for the most part, have been small and usually in areas where some comparable adjacent development has preceded them. The Grand Coulee Dam project is a great challenge, since it is almost of empire proportions and since a great and important community will be built up virtually from nothing.

"Before many decades have passed it is likely that on the farms and in the cities and towns, as yet unlocated, which will serve them, more than half a million people will live and earn their living. I am deeply interested in seeing that the job of building, which the settlers will take up where we leave off, will have a good foundation."

The advanced study is aimed broadly at determining the most logical program for developing the lands; the planning of community and transportation facilities; the outlining of sound methods of colonizing the lands which would include provisions for resettlement of some of those who have migrated from drought areas; and the determination of typical farming and marketing programs for the guidance of settlers. It will give attention to such matters as provision of domestic water supplies, assistance in laying out farm ditches, and many other items.

It is anticipated that many agencies, local, State, and Federal will participate in the planning activities which will be coordinated by the Bureau of Reclamation under the general direction of Mr. Barrows.

Surveying and Mapping

The task of surveying and mapping the 2,500,000 acres of Columbia Basin land below Grand Coulee Dam is expected to be completed in 1940.

In order to lay out the reclamation project's future canal system, more than 100 townships—an area of 3,780 square miles—must be resurveyed. About 1,200,000 acres of this land, including abandoned farms, desert land, and dry-farming areas, will be reclaimed or improved by irrigation during the coming years.

When the records are complete they will show the location, ownership, topography, and soil constituency of every 40-acre parcel of land within the Columbia Basin project area. The soil on every parcel will be sampled, carefully analyzed and classified, and the land and its improvements fairly and impartially appraised for the benefit of future settlers. About 600,000 acres of public domain are expected to be opened gradually to public settlement.

Settlers and other buyers will have access to all records, including the land appraisals, which set the maximum prices at which irrigable lands on the project may be sold after the Government enters into a contract with the landowners to build the irrigation works in order to avoid speculation.

The first step in the surveying program is "retracement," or the reestablishment of section and quarter-section corners located by contract surveyors 50 to 75 years ago. More than 10,000 metal markers in concrete settings will replace the wood stakes, marked stones, and small charcoal deposits that formerly identified such corners. Retracement has already been completed over an area of 1,750,000 acres.

The retracement survey is the basis of the Bureau's land ownership records, which will cover not only the irrigable land but also the waste land and grazing districts interspersed with the arable land. It is indispensable to the design and the purchase of right-of-way for the canal system, and complies with the provisions of the antispeculation act.

By comparison with benchmarks established by the Geological Survey and the Coast and Geodetic Survey, the relative elevations of corner monuments are determined by level parties, the second step in the surveying program. Elevations already have been determined over an area of 1,500,000 acres. They have varied from about 1,280 feet above sea level at the north end of the project to about 400 at the south end.

As the third and final step the topographic surveyors will map contour lines at 2-foot intervals of elevation on plane tables in the field. Rodmen engaged in this work have walked 50,000 miles, and still have 15,000 miles to go.

Grand Coulee Dam on Air

FOR half an hour on Monday night, June 19, the Columbia Broadcasting System put Grand Coulee Dam on the air from the dam itself. From 10:30 to 11 p. m. microphones spotted in the east vista house, the mixing plant, and on the trestle brought to the radio listeners the real sounds of flowing water and construction machinery in operation. Accurate word descriptions of the dam and the entire project were presented by the broadcasting staff and included was an interview by Don Forbes, chief announcer, with J. H. Miner, acting supervising engineer.

Six members of the Hollywood CBS staff were on the job during the broadcast which was on the air from all stations of the western network. It was the sixth in a series of on-the-spot broadcasts of man's fight for water.

Additional broadcasts in a series of radio programs on Conservation, presented by the United States Department of the Interior, will be given from time to time. Address "What Price America," Washington, D. C., for information, or making comments on the programs broadcast.

Artesian Well Water Supply for the City of Ogden from the Bed of Pine View Reservoir

Ogden River Project, Utah

AMONG the many unique features involved in the construction of the Ogden River project, Utah, the most outstanding is probably the arrangement by which the city of Ogden obtains its municipal water supply from artesian wells now covered by the waters of the Pine View Reservoir. The only available storage site on the Ogden River, the Pine View Reservoir, covers the artesian basin from which the city of Ogden receives its water supply and the utilization of this site required either that the artesian wells be abandoned and a new supply developed, or arrangements be made whereby the continued use of the artesian supply could be made possible.

The Ogden Valley in which the artesian basin is located is a fault trough partially filled by materials carried in by the rivers and by lake deposits. These materials which are roughly stratified dip downstream or to the westward. Ancient Lake Bonneville at times extended into the Ogden Valley and at one period during its existence a bed of heavy, dense clay, averaging about 70 feet in thickness was deposited on the then existing floor of the valley. This stratum is the confining bed that produces the artesian conditions.

Wells in operation with air lift prior to filling reservoir

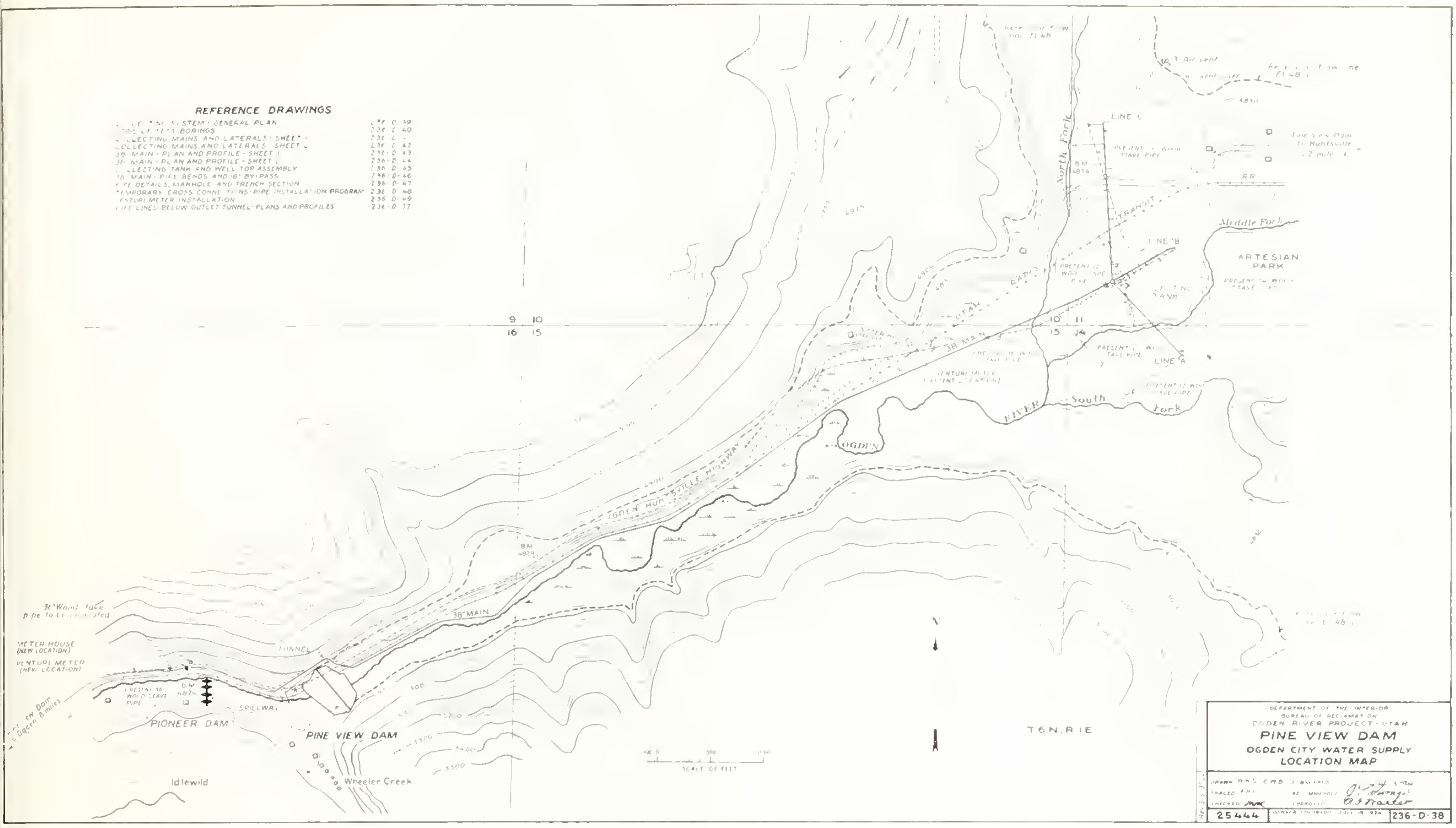
Pine View Reservoir filled

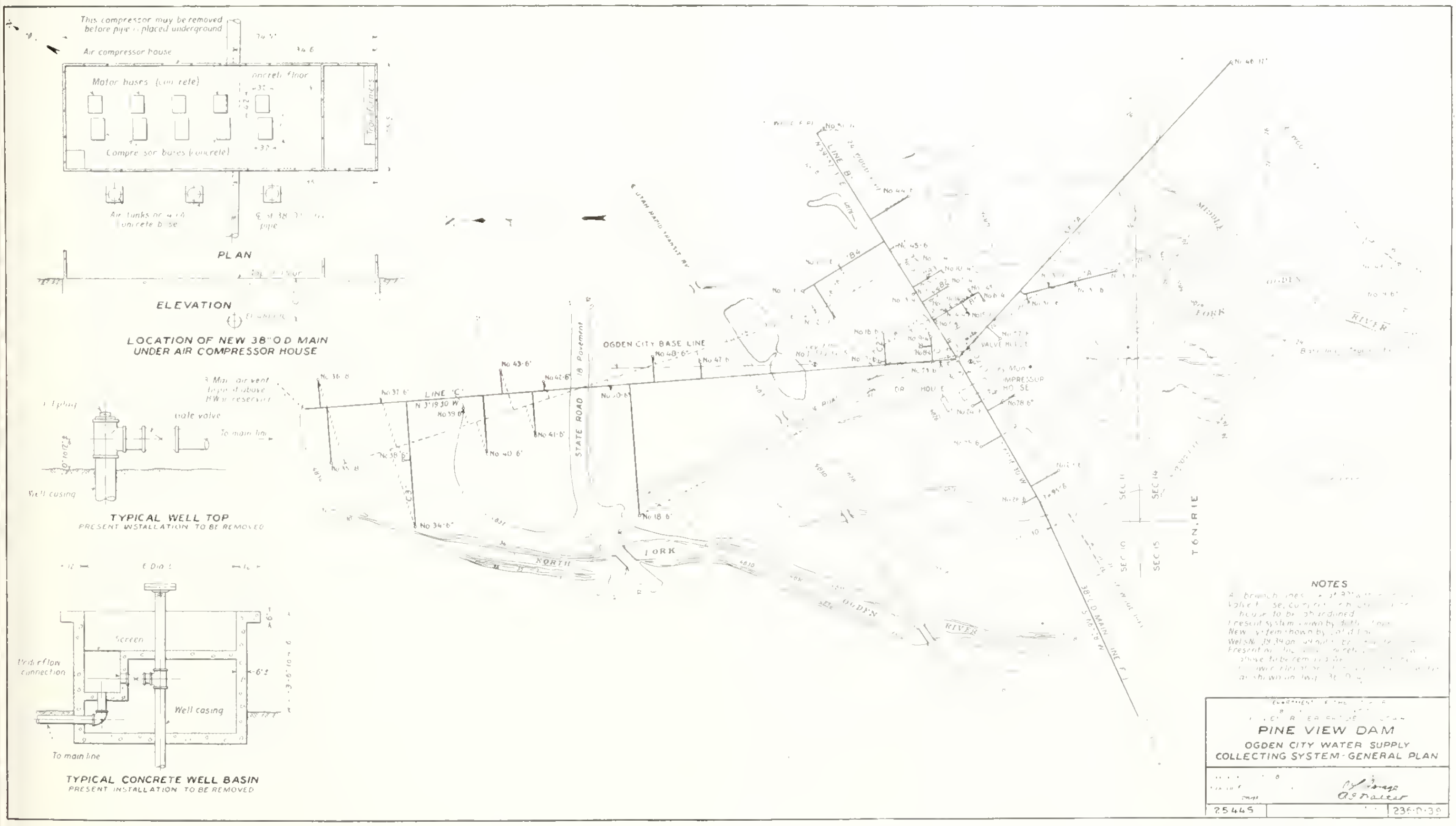
The development of the artesian possibilities of this basin was begun by the city of Ogden in 1914. In 1933, at the peak of development, 48 wells had been connected to the city supply system and about half of these had been equipped with an air-lift system. The operation of the wells so equipped is shown on the accompanying photograph. The maximum natural discharge of the 48 wells was 17¼ second-feet which could be increased to approximately 20 second-feet by the operation of the air-lift system.

The city of Ogden was justly proud of the purity of its water supply and it became evident early in the development of plans for the project that the city would not permit any substitute for its existing supply. It therefore became necessary to formulate a plan under which the artesian supply could be delivered even though the wells were covered by the waters of the proposed Pine View Reservoir. For this there was no known precedent. The details of the final plans are shown on the accompanying drawings of the Pine View Dam and appurtenant works.

Details of Plan

These plans provide for undercutting 47 of the wells at an average depth of about 9 feet below the original outlet. From the point of





undercutting, the flow of the wells passes through steel pipes to three steel pipe collector mains having maximum diameters of 20 inches which empty into a steel collector tank encased in concrete. A 38-inch O. D. welded steel pipe, 9,000 feet long, carries the artesian supply from the collector tank to a point immediately below the Pine View Dam, where it connects with the city main through Ogden Canyon.

All pipes are laid 4 to 13 feet below the bed or the reservoir. The flow from the basin is controlled by a valve on the main where it passes under the floor of the outlet tunnel of the Pine View Dam. In order to prevent the possibility of air-locking, provision is made to air vent all wells and the collector tank. The steel vent pipes are also collected underground into a single main which is laid underneath the reservoir bed to an outlet above the reservoir flow line.

After the completion of the system the flow from the artesian basin was increased to 24 second-feet which is an increase of 39 and 25 percent, respectively, over the maximum natural flow and the flow developed by means of the air lift prior to the changes described above. This is in agreement with the assurances given by the designers that construction in accordance with the proposed plan would result in increased flow from the basin. The wells have been in operation under this plan about 3 years, and for most of this time they have been covered by the water of the reservoir to a maximum depth of about 55 feet. The photograph of the close-up of the reservoir is, in general, a view of the vicinity of the reservoir under which the artesian wells are located.

Since 1932 the United States Geological Survey and the city of Ogden have cooperated in an investigation of artesian pressures and conditions. To extend the facilities afforded by existing wells, other wells were drilled in the valley and equipped with continuous recording devices to measure the artesian head and record fluctuations. One of these wells was located near the edge of the area in which the operating wells are located. As the site of this well would be flooded by the impounded water of the reservoir, an offset well, situated above the reservoir flow line, was drilled to the same stratum and the well equipped with a continuous recording device. Both wells have the same general relationship to the area in which the operating wells are located and, as simultaneous records were obtained from both wells for a considerable period before the site of the original well was flooded, a relationship between the records was determined. The differential in artesian pressures indicated in these two wells was small, and the indicated fluctuations were simultaneous.

The opponents of the proposed plan expressed the fear that the artesian supply might be polluted by overlying reservoir waters being forced into the artesian reservoir. Such pollution, however, was not considered possible as the great depth of gravel, sands, and clay overlying the artesian reservoir act as an ideal filter bed even if any movement downward through the confining beds were possible. All private wells into the artesian reservoir, of which there were a large number in the reservoir area, were capped several feet below the surface to close off all uncontrolled open channels into the artesian reservoir.

As the Pine View Reservoir was filled, the records of the offset well indicated that the artesian head increased as the reservoir filled and while the differential decreased the artesian head was always greater than the reservoir head. The net result of this is a greater artesian pressure than that which prevailed at any time under previous conditions and, as the artesian pressures are always the greater, there can be no movement of water from the overlying reservoir to the underlying artesian reservoir. That this unbalanced pressure as indicated in the offset well is not a local condition is substantiated by the records of wells in other parts of the area. At least in one case, an ordinary well situated above the reservoir flow line developed into a flowing well as the reservoir filled. No attempt is made to explain this unbalanced but desirable head in this brief article. It is, however, of distinct advantage in increasing the supply obtainable from the artesian reservoir. The revised system has been in operation for about three years and during that time has fulfilled the expectation of an increased flow. No noticeable change in the quality of the water is evident and no repairs in the system or changes in design have been necessary.

Deer Creek Dam, Provo River Project, Utah

By C. H. CARTER, *Office Engineer*

THE beginning of construction on the Deer Creek Dam in 1938, initiated development of the Provo River project which has for its purpose the storage and delivery of a supplemental water supply to farm lands and municipalities between Provo and Salt Lake City (fig. 1). This project is the largest irrigation development yet undertaken in the State of Utah, and will directly benefit more than half the population of the State.

The Bureau of Reclamation has conducted investigations to determine storage possibilities on the Provo River at various times since 1922, and in that period 10 dam sites have been tested. Following an intensive testing program and a careful study of the available engineering, economic, and geologic data, the Deer Creek site was finally chosen in 1936 as the most feasible location for the construction of a dam. Owing to the character of bedrock and other physical and engineering considerations, an earth-fill structure was selected as best adapted for this site.

Deer Creek Division

Deer Creek Dam is the principal construction feature of the Deer Creek division. The reservoir to be created by this structure will have a storage capacity of 150,000 acre-feet, and although situated on the Provo River, will obtain the greater portion of its annual storage supply from the Weber and Duchesne Rivers. To obtain this supply it will be necessary to enlarge the 9-mile Weber-Provo diversion canal from its present capacity of 210 second-feet to 1,000 second-feet, and to construct a 5½-mile tunnel, with a capacity of 350 second-feet for the diversion of surplus water from the Duchesne to the Provo River.

The Deer Creek division will provide storage water to supplement, by 25 to 50 percent, the irrigation supply of approximately 40,000 acres in Utah County and an additional 5,000 to 10,000 acres in Salt Lake County (fig. 1), which are at present irrigated by direct diversion from streams entering the valleys through canyons in nearby mountain ranges. Provo River is the most important of these streams and none has storage facilities of any consequence to insure a dependable irrigation supply after the spring run-off. The distribution of Deer Creek Reservoir storage water to lands under the Deer Creek division will be accomplished by enlarging the Provo Reservoir Canal to a capacity of 550 second-feet at the intake in Provo Canyon decreasing in size toward the Jordan Narrows, 23 miles distant, where an inverted siphon and pumping plant will be constructed to lift water from the Jordan River into the Utah Lake distributing canal.

The foregoing features comprising the Deer Creek division of the project are estimated to cost $7,600,000. A contract covering the repayment of construction costs not to exceed this amount was executed on June 27, 1936, by the United States and the Provo River Water Users' Association, the organization of subscribers for storage in the Deer Creek Reservoir. Although water for the aqueduct unit of the project will be supplied by storage from Deer Creek Reservoir, information concerning its construction will be excluded from this article for publication at a later date. The Metropolitan Water District of Salt Lake City has subscribed for 46 percent of the storage in the reservoir and will convey its supply through an aqueduct 40 miles in length, between Deer Creek Dam and Salt Lake City. A separate contract, dated November 16, 1938, was executed by the United States and the district covering the repayment of construction costs of the aqueduct unit not to exceed $5,550,000.

Deer Creek Dam

Location.—The Deer Creek dam site is located on the Provo River just above its confluence with Deer Creek, about 16 miles northeast of Provo, Utah, on highway Utah 7. When the reservoir is filled, the water will extend about 6½ miles from the dam into Heber Valley and approximately 1 mile above Charleston, the nearest town.

Construction features.—Bids for the construction of Deer Creek Dam and relocated railroad and highway under specifications No. 768, were opened February 11, 1938, and on April 11, 1938, a contract was awarded to the Rohl-Connolly Co. of Los Angeles, Calif. Thereafter the contractor began the construction of camp buildings and the assembling of plant and construction equipment, preliminary to actual construction, which was started during May, although notice to proceed was withheld until July 16, 1938.

Deer Creek Dam is the third largest earth-fill dam yet to be undertaken by the Bureau of Reclamation and will contain about 3,000,000 cubic yards of earth and rock. This volume is exceeded only by the Green Mountain Dam (4,336,000 cubic yards) now under construction on the Colorado-Big Thompson project, Colorado, and the Vallecito Dam (3,445,000 cubic yards) being constructed on the Pine River project, Colorado. Deer Creek Dam will extend 1,300 feet in length between the canyon walls at crest elevation and will rise 155 feet above stream bed with a maximum height of 240 feet above bedrock foundation. The thickness of more than 1,000 feet at the base will decrease to a minimum width of 35 feet at roadway level. The main body of the dam will consist of compacted clay, sand, and gravel of four gradations of material placed in accordance with the four sections shown in figure 3. The embankment will be protected on the upstream slope, between the berm at elevation 5,320 and the crest elevation 5,425, by a 3-foot layer of rock riprap, and on the downstream slope by a heavy rock fill increasing in thickness from the crest to the toe of the embankment. The principal quantities are estimated as 2,700,000 cubic yards of earth embankment, 182,000 cubic yards of rock fill on the downstream slope and 41,000 cubic yards of riprap on the upstream slope.

Foundation.—Exploration of the dam site disclosed a heavy overburden of sand, gravel, and boulders having a maximum depth of 85 feet. Bedrock consists principally of limestone and some sandstone which shows evidence of weathering and slight breakage but is considered entirely capable of supporting the loads to be imposed by an earth fill dam. The foundation rock can be rendered practically impervious by grouting any seams or fissures in the canyon floor or abutments. Bedrock will be exposed by excavating a trench 30 feet wide in the bottom, which will extend across the canyon a short distance upstream from the longitudinal axis of the dam. Within the trench a reinforced concrete cut-off wall, with a maximum height of 20 feet, will be constructed to prevent percolation along the bedrock surface. A secondary cut-off wall is planned for construction on the left abutment along the axis of the dam, and consideration is being given the advantages of constructing a secondary wall on the right abutment.

The excavation of 132,000 cubic yards of stripping for dam embankment, from the abut-

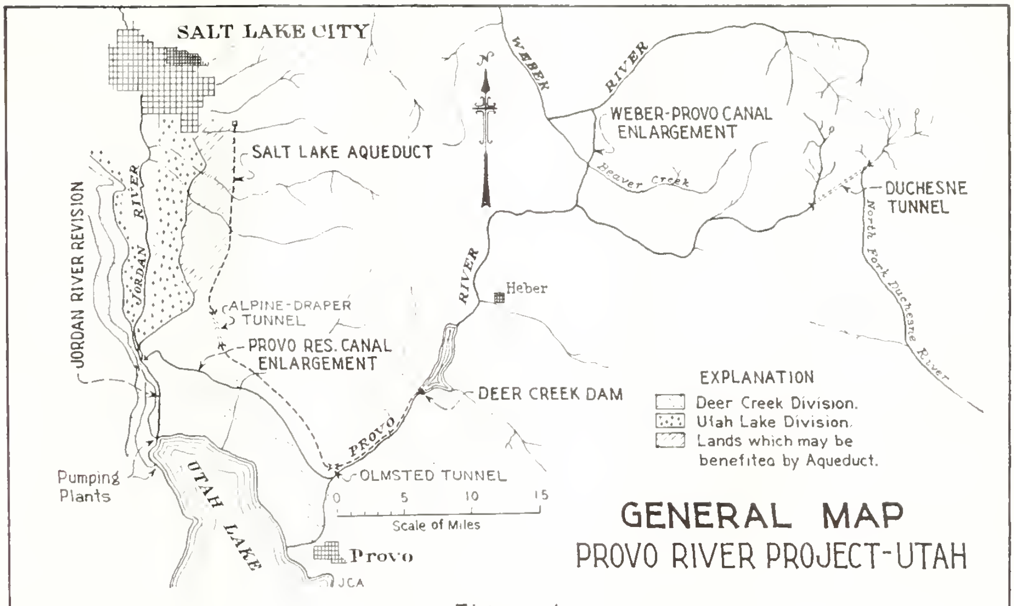
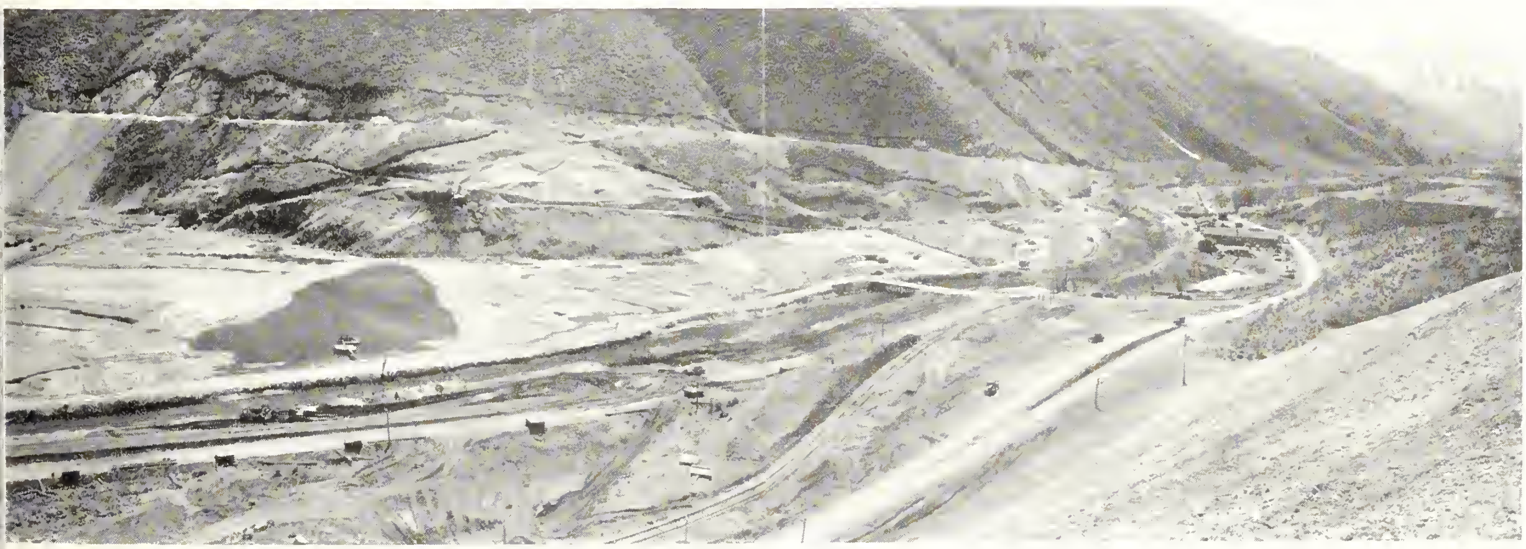


Figure 1

Deer Creek dam site from station 16+50 axis of dam. Relocated highway construction and stripping of left abutment



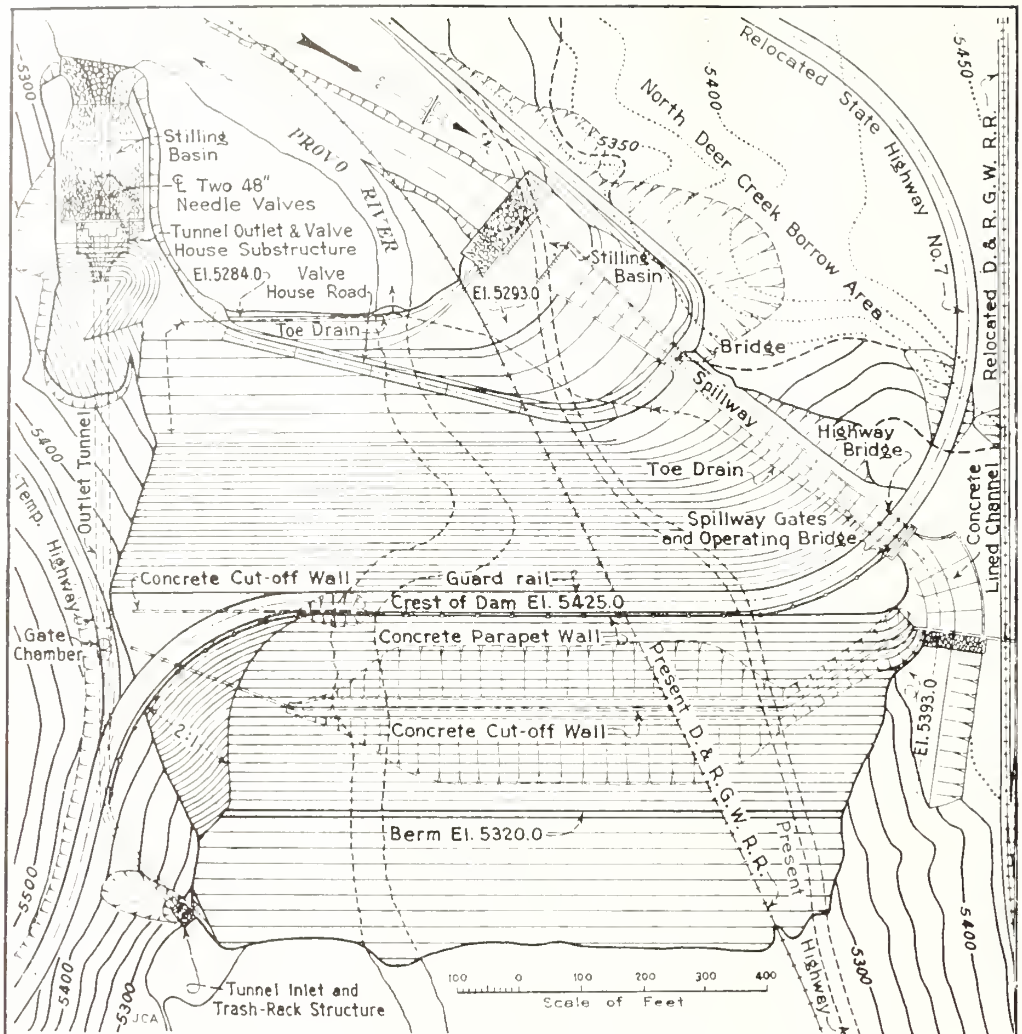


Figure 2

GENERAL PLAN DEER CREEK DAM

First Provo River water flows through intake structure into diversion tunnel

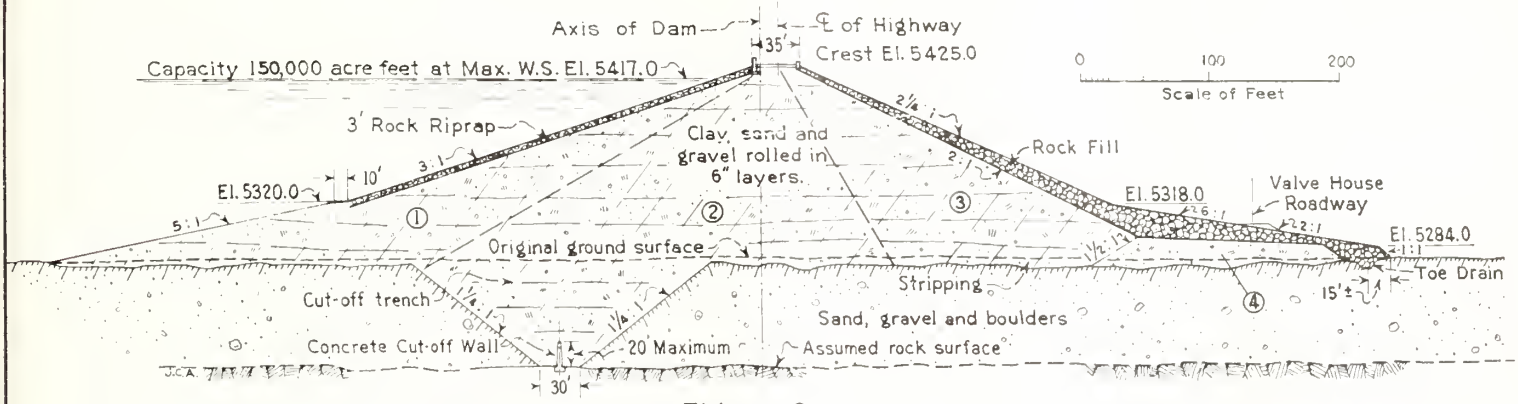
ments and the greater portion of the river bottom area (photo No. 1), constitutes the principal work accomplished in the dam site, other than completing the outlet works for river diversion, during the first year of construction. The areas exposed by the stripping operations appear to be free from any materials considered as objectionable in the foundation for an earth-fill dam. Excavation from the shallow cut-off trench, which was started in 1938, was suitable for use in the No. 4 section of the dam (fig. 3).

Outlet works.—A concrete-lined tunnel 884 feet in length has been constructed through the left abutment of the dam. Diversion of the river has been completed and the water now enters the tunnel intake structure by means of a temporary opening near the base and flows successively through the tunnel, through a concrete flume, over the floor of the valve house substructure and into the stilling basin which is downstream from the construction operations (fig. 2). Provisions have been made for the installation of outlet pipes and gates in the tunnel by diverting the river flow at low stage through a 4-foot 3-inch by 5-foot concrete-lined diversion conduit constructed under the invert of the downstream reaches of the tunnel and flume. When the outlet works are completed, water will enter the concrete trashrack structure at the tunnel inlet and be conveyed 441 feet through the 12-foot diameter tunnel to the 5- by 6-foot high pressure slide gates to be installed approximately midway of the tunnel length. The gates will be operated by hydraulic hoists from a gate chamber overhead and will control the flow of water into two 72-inch diameter steel outlet pipes in the horseshoe shaped section of tunnel which is 391 feet long, 11 feet 6 inches high, and 17 feet wide. From the tunnel outlet portal the pipes will be supported by a concrete flume to the valve house substructure where the ends of the pipes will be bulkheaded and the discharge bypassed through two 57-inch diameter branches which terminate in 48-inch needle valves. Structural provisions have been made in the designs for the valve house substructure which will permit its use as a foundation for a powerhouse in which electrical generating equipment can be installed as required.

Spillway.—A reinforced concrete spillway with a capacity of 12,000 second-feet will be constructed at the right abutment of the dam. Information available from drill holes and test pits indicates that excavation for the structure will be almost entirely in the compacted clay, sand, and gravel outwash which covers the right abutment, with few chances of encountering bedrock. The structure will be 955 feet long from the intake slab at elevation 5,393, to the lower end of the stilling basin at elevation 5,260. Protection against damage from the spillway discharge at this point will consist of a steel sheet piling cut-off and a 3-foot thickness of dumped riprap in the downstream channel. Discharge through the spillway will be regulated by two radial gates, each 21 feet long and 20 feet high which, when lowered, will permit the water surface in the reservoir to rise 20 feet to elevation 5,417, the highwater contour.

Relocated railroad.—The relocation of 10½ miles of the branch line of the Denver and Rio Grande Western Railroad connecting Provo and Heber City, is made necessary by the construction of Deer Creek Dam. The railroad has for many years operated on the present roadbed parallel to the river through the reservoir area. The location finally selected, after several lines had been surveyed, follows the shore line on the right or west side of the canyon from a point 1½ miles downstream from the dam site to a point 1½ miles beyond Charleston where the relocated line crosses the Provo River to connect with the present line.

The contract for the construction of Deer Creek Dam includes the construction of the relocated railroad. Work was started on this feature soon after the award of contract and has been continued since, except when activities were suspended during the winter. Excavation and grading of the railroad, othe



① Selected stable material. Graduated in coarseness to upstream slope.
② Impervious material.

Figure 3
MAXIMUM SECTION
DEER CREEK DAM

③ Semi-impervious material. Graduated in coerseness to downstream slope.
④ Sand, gravel and cobbles from required excavation.

than through the North Deer Creek borrow area, is about 90 percent completed; construction of cross-drainage structures and bridges is practically complete; the railroad detour near the right abutment is completed and in use; and 1 mile of track has been laid.

Relocated highway.—Approximately 8 miles of new highway will be required to replace the portion of present highway within the Deer Creek Reservoir area. The relocated line branches from the existing highway one-half mile below Deer Creek and will cross the canyon on the crest of Deer Creek Dam to the left abutment (fig. 2). From this point the relocated line follows along the east side of the reservoir to Charleston. Of the total length of highway to be constructed, only three-fourths mile is included in the contract for the construction of Deer Creek Dam. The balance will be constructed by the Utah State Road Commission and a contract covering this agreement between the commission and the United States was executed in 1938. The excavation and grading for those portions of the relocated and temporary highways included in the contract for construction of Deer Creek Dam, is practically complete. The temporary highway connecting the present road downstream with the left abutment will be used for traffic during construction operations and later serve as a stock trail to eliminate the congestion from trailing livestock on the roadway across the dam.

Rodent Control by Minidoka CCC's

RODENT control work was one of the main features carried on in June by Camps BR-27 and BR-56 on the Minidoka project, Idaho. The crews covered 18,000 acres and were successful in exterminating 30,000 squirrels and 2,000 rats in addition to other important items of work.

Prof. Rodolfo E. Ballester, Director of Irrigation of Argentina, Visits United States

ENGINEER RODOLFO E. BALLESTER, Director General of Irrigation in Buenos Aires, Argentina, visited the administrative office of the Bureau of Reclamation at Washington on July 7, en route to the Golden Gate International Exposition at San Francisco, where on Engineers Day, July 13, he delivered a paper under the auspices of the San Francisco Engineering Council of Local Sections of American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Chemical Society, and the Institute of Radio Engineers.

Mr. Ballester was present at the Third World Power Conference in Washington, September 7–12, 1936, and at its conclusion made a tour of many of our projects. His present interest is in obtaining information regarding the dams now under construction by the Bureau of Reclamation which he explains will be helpful to him in his own country, where two earthen dams will be constructed in the near future.

On his return east Mr. Ballester spent several days in the Denver office of the Bureau and arrived in Washington on August 5. On August 11 he sailed from New York for South America.

Citizens Conference on Government Management

DURING the week June 18–24 there was held at Estes Park, Colo., under the joint auspices of the Alfred P. Sloan Foundation and the University of Denver, a citizens conference on government management. General assemblies, round-table discussions, and special meetings were held throughout the week. The assemblies held in the evenings were addressed by high ranking national leaders in American public affairs. The more immediate practical work of the conference was done in a series of round-table discussions.

L. R. Smith, chief clerk of the Denver office of the Bureau of Reclamation, on invitation attended the meeting and presented a paper in connection with the discussions held on June 21, the general subject being Government Buying—Wastes in Public Expenditures and Methods of Safeguarding Economy in Government Purchases. Mr. Smith's address was on the subject Buying for the Government—Application of Sound Buying Principles.

Modern Creamery on Shoshone Project

THE Castberg Creamery has just finished the installation of 240 new frozen fruit lockers at Powell, Wyo. This installation gives the local people access to one of the most modern plants of this kind in the West. Besides these lockers there is a cold room kept at a temperature of 20° below zero for quick freezing of small fruits and vegetables. There is also a room kept at 35° above zero for storage of quarters or halves of butter.

Completion of the Tule Lake Division

Klamath Project, Oregon

By E. L. STEPHENS, *Associate Engineer*

THE first conceptions of an irrigation project in the Klamath Basin envisioned the reclamation of a portion of Tule Lake for agricultural purposes. The preliminary survey and report of John T. Whistler in 1903 mentioned the advisability of diverting the flow of Lost River—the main source of supply for Tule Lake—to Klamath River and the reclamation of lake-bed lands. The lure of the Tule Lake development evidently was a challenge to the ingenuity of the engineer to overcome the barriers placed in his way by Mother Nature.

Originally Tule Lake, situated in Klamath County, Oreg., and Modoc and Siskiyou Counties, Calif., cover an area of approximately 96,000 acres, and had a maximum depth of 28 feet. In its natural state the lake received the whole inflow of the Lost River drainage area, some 1,800 square miles, and also during years of high run-off from Upper Klamath Lake received variable amounts of water that spilled from the Klamath River through the low divide, which separates Klamath and Lost Rivers through which the Lost River diversion channel now runs.

Development of the Tule Lake division of the project was unusual in that it presented three problems: First, storage and diversion of normal run-off to permit the drying up of the lake bed by preventing inflow and establishing flood control; second, the construction of dikes within the lake bed to confine waste and overflow entering the area set aside for sump purposes; and, third, the construction of suitable irrigation and drainage works to serve the area reclaimed.

At the beginning of the project little reliable information was available on stream run-off, evaporation, and return flow. However, studies and reports made as early as 1910 estimated that approximately 40,000 acres of the lake bed could be reclaimed.

Clear Lake Dam, First Work

The first work looking toward the drying up of the lake was begun in 1909, when the construction of Clear Lake Dam was begun. This is an earth- and rock-fill dam with a crest length of 790 feet and a maximum height of 33 feet and forms a reservoir, at the head of Lost River, with a capacity of 454,000 acre-feet. Recently, in accordance with later studies and reports, 3-foot flashboard supports were installed on the crest of the spillway and the dam raised 3 feet, to provide an additional storage of about 80,000 acre-feet for flood control when needed.

The next step was undertaken in 1911 with the construction of what is known as the Lost River diversion works. These works consist of the Lost River diversion dam, a hollow reinforced-concrete multiple-arch dam 40 feet in height, with crest length of 675 feet, located on Lost River about 10 miles southeast of Klamath Falls, Oreg., and the Lost River diversion channel, a canal about 8 miles in length connecting Lost River with the Klamath River. The original channel had a capacity of 250 cubic feet a second, sufficient to carry the summer flow and a portion of the flood flow of Lost River. Later, in 1930, this canal was enlarged to a capacity of 1,200 cubic feet a second to provide more adequate flood protection for Tule Lake lands. This enlargement, owing to the depth and very low gradient adopted for the canal, made it feasible also for use as an irrigation canal during the irrigation season for diverting water from the Klamath River to Lost River, for use on the lands reclaimed from Tule Lake. The capacity of this channel when reversed is 500 cubic feet a second.

With the completion of the storage and diversion works recession of the waters of Tule Lake was rapid. By 1917 existing works on the main division of the project were extended to serve about 5,800 acres in the former lake bed.

Distribution System

Work on the construction of the distribution system for the Tule Lake division proper was started in 1921, when the Lower Lost River Diversion Dam, a concrete structure of the Ambursen type with a crest length of 324 feet, and a height of 15 feet — located about 3 miles southeast of Merrill, Oreg.—was built. Of historical interest is the fact that this dam rests on a sandstone reef, locally known as the Stone Bridge, which was used by immigrants in the early settlement of the Oregon Territory and by the Indians from time im-

Clear Lake Dam

memorial as a ford for crossing the river. At the same time this dam was being built the first 12 miles of the "J" Canal was under construction. This section of canal which diverts water from Lost River at the dam, together with supplemental laterals and drains, served an area of about 10,000 acres. Since that time work has been carried on intermittently as records and studies justified, and as funds were made available, so that on June 30, 1939, with the possible exception of puddle trenches and toe drains to prevent excessive waste, the entire distribution and drainage system serving the 33,000 acres of agricultural and 4,000 acres of grazing lands in this division, together with the system of dikes protecting these lands, were completed. In addition to the major works mentioned, other works built included Gerber Dam, a variable radius arch dam, with a height of 88 feet and crest length of 485 feet, located on Miller Creek, a tributary of Lost River, which provides maximum storage of 94,000 acre-feet, 60,000 acre-feet of which is used for flood storage for the protection of Tule Lake lands, 137 miles of canals and laterals, 193 miles of open drains, 18 miles of dikes, 6 drainage pumping plants with an installed capacity of 278 cubic feet per second and more than 1,400 minor structures.

First Public Land Opening

The first opening of lands on Tule Lake division was announced for September 29, 1922, when about 10,000 acres were made available for entry. This notice was withdrawn on January 15, 1923, after 65 farm units totaling 3,260 acres had been entered. The withdrawal was due to agitation and discontent among the settlers. Later, on January 22, 1927, public order was issued opening for entry 145 farm units totaling 8,000 acres. This was the first opening under the selective settlement law requiring capital of at least $2,000 and not less than 2 years' farming experience. Since then there have been five additional openings, the last being under public order dated September 9, 1937, when 69 farm units with a total area of 5,100 acres were opened to entry. For this opening about 3,300 copies of the public order and application blanks were mailed out to prospective entrymen and at the close of the simultaneous filing period 1,287 applications had been received for the 69 units. Present plans contemplate the opening of about 65 units totaling 4,800 acres in the fall of 1940, or sooner if conditions warrant. The remaining unentered lands in this division are of inferior quality and will not be opened for entry until their agricultural value is proved.

Alfalfa hay and potatoes are the two major products raised on these lands, the average yields of which for the season of 1938 were 4.1 tons and 377 bushels, respectively. The average gross value per acre of crops grown on the 23,955 acres of entered lands farmed during 1938 was $72.54.

Leasing of marginal lands as the lake receded and, more recently, portions of the area reserved for the permanent sump, has proven to be a profitable enterprise both for the lessees and the water users.

While the Tule Lake Unit as planned has been completed, nevertheless a great deal of work yet remains to be done before complete development of the Klamath project can be announced. Recently investigation has been made and plans worked out providing for the removal by pumping of a portion of the sump accumulation to Lower Klamath Lake for the multiple purpose of establishing a nesting and feeding ground of some 30,000 acres for migratory fowl, reclaiming for grazing and agriculture about 15,000 acres in Lower Klamath Lake and from 20,000 to 25,000 acres in Tule Lake, and at the same time removing the cause of frequently recurring dust storms that

Upper: View of Gerber Dam from right abutment
Lower: Enlarged headworks, "J" Canal, Lower Lost River Diversion Dam

Adams Ranch, main division

originate in the present dry bed of Lower Klamath Lake. This work yet to be done is perhaps the most necessary and certainly the most feasible of any so far undertaken. It awaits only authorization and funds for early completion.

Business Widespread Throughout Country as Result of Western Irrigation Development

MANUFACTURERS of the East, Midwest, and South receive $200,000,000 of business a year from federally developed irrigation areas. This estimate was based on full carload lots of goods shipped by rail into one of the Bureau's 50 irrigation developments, the Boise area in Idaho, which showed merchandise rolling into the region from 30 different non-Western States.

According to the Idaho State Planning Board, on whose survey the estimate is made, the Boise area received nearly 400 carloads of goods from the State of Michigan alone. Texas, Ohio, Wisconsin, Missouri, Pennsylvania, and Kentucky each shipped more than 100 carloads to the area, while Indiana sent 75 and Louisiana, Arkansas, and New York sent 50 each.

The purchases of the farmers and townspeople of the area were as diverse as they were widespread. Michigan manufacturers and businessmen sold them 312 carloads of automobiles and trucks, 50 carloads of electrical goods, furniture and household equipment, and 29 full carloads of cereals.

Texas industry supplied nearly 150 carloads consisting chiefly of food, which totaled 55 full carloads, and 25 carloads of gasoline and oil. Citrus fruit growers of the State shipped in 13 carloads. Miscellaneous merchandise from other Texas businessmen reached 40 carloads.

Wisconsin also came in for a goodly share of the business created by the Boise irrigation development. It sold farmers and townspeople of the area 140 carloads of farm equipment and supplies, foodstuffs, furniture, and building materials.

Ohio businessmen also shipped 134 carloads of industrial products, including agricultural implements and other farm supplies, electric refrigerators and general household equipment, building materials, and miscellaneous goods.

Michigan was not the only State to shi[p] automobiles to the Boise area residents. Automobile and truck assembly plants in Missouri also shipped 57 carloads. Other Missouri manufacturers sent more than that number of carloads of processed foods, building material, and miscellaneous articles.

From Pennsylvania industries came 114 carloads of lubricating oils and greases, processed foods, electric ranges, and steel and steel products.

Citrus fruits and fresh vegetables and canned goods came in carload lots from Florida, and foodstuffs and other supplies from Mississippi, Alabama, Tennessee, Maryland, North Carolina, and Virginia. Nearly every State in the Union participated in the business created by the demands of the farmers and townspeople of the Boise irrigation project area, the survey showed.

The Boise project covers seven counties in western Idaho near the Oregon State boundary line. Its irrigation farmers grow alfalfa hay, clover and pasture, grain, potatoes, sugar beets, apples, prunes, vegetables, and seed crops. About 15,000 persons live on its 4,000 farms and 50,000 more make a living in the towns created by those farms and dependent upon them for most of their business.

Boise irrigated farms brought their owners an average return of about $29 an acre i[n] 1937. With the average farm of about 5[0] acres, this return meant a gross income o[f] more than $1,500 for the farm family's needs of household supplies, processed foods, farm equipment and supplies, radios, automobiles, etc.

The cost to date of the Boise irrigatio[n] project has been about $16,500,000, or approximately $77 per acre of irrigable land. Abou[t] 150,000 acres of land were completely dependent, aside from the sparse rainfall, upo[n] the Bureau's diversion works for their supply of water, and a similar total received a supplemental supply.

Under the Reclamation Act which require[s] repayment to the Bureau of Reclamation o[f] the funds advanced for any irrigation development, the Boise irrigation farmers have already repaid one-fourth of the cost of th[e] development.

The Federal irrigation development areas including Boise, provide a $200,000,000 annual market for the products of manufactur[ers] and the merchandise of businessmen in th[e] East, Midwest, and South.

Carlsbad Community Developmen[t]

THE County Courthouse, a PWA project, an[d] gravel surfacing and structures on the Cav[erns]-El Paso Highway near Pine Springs ar[e] nearing completion. Other work in progres[s] on the Carlsbad project includes two grade and one high-school building and the sewe[r] system. The sewer-disposal plant was com[]pleted in June.

NOTES FOR CONTRACTORS

Specification	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
		1939						1939
843	Columbia Basin, Wash.	May 19	Diversion canal and holding ponds for Leavenworth station, migratory fish control.	Norris Bros.	Burlington, Wash	$258,296.90		July 6
842-A	Parker Dam Power, Calif.-Ariz.	June 2	Transmission line hardware	Locke Insulator Corporation	Pittsburgh, Pa	[1] 19,031.32	F. o. b. Parker, Ariz	Do.
				Hendrie & Bolthoff Manufacturing & Supply Co.	Denver, Colo	[2] 5,757.01	Discount 2 percent	June 22
				Graybar Electric Co.	do	[3] 9,142.09	do	
				Line Material Co	South Milwaukee, Wis.	[4] 1,459.67	do.	June 29
837-D	Columbia Basin, Wash.	June 16	3,500,000 barrels of low-heat cement in bulk and 162,000 barrels of modified cement in bulk.	Olympic Portland Cement Co Ltd.	Seattle, Wash	[5] 370,800.00	240,000 barrels, discount 10 cents per barrel.	June 30
				Lehigh Portland Cement Co	Allentown, Pa.	[5] 310,000.00	200,000 barrels, discount 10 cents per barrel.	Do.
				Northwestern Portland Cement Co.	Seattle, Wash	[5] 244,135.00	157,000 barrels, discount 10 cents per barrel.	Do.
				Superior Portland Cement Co., Ltd.	do	[5] 950,000.00	600,000 barrels, discount 10 cents per barrel.	Do.
				Spokane Portland Cement Co.	Spokane, Wash	[5] 450,000.00	250,000 barrels, discount 10 cents per barrel.	Do.
				Santa Cruz Portland Cement Co.	San Francisco, Calif	[5] 400,500.00	267,000 barrels, net	Do.
				Calaveras Cement Co	do	[5] 109,470.00	89,000 barrels, net	Do.
				Olympic Portland Cement Co. Ltd.	Seattle, Wash	[6] 656,305.00	439,000 barrels, discount 10 cents per barrel.	Do.
				Superior Portland Cement Co. Ltd.	do	[6] 1,295,800.00	852,500 barrels, discount 10 cents per barrel.	Do.
				Lehigh Portlaud Cement Co	Allentown, Pa	[6] 387,500.00	250,000 barrels, discount 10 cents per barrel.	Do.
				Northwestern Portland Cement Co.	Seattle, Wash	[6] 137,617.50	88,500 barrels, discount 10 cents per barrel.	Do.
				Lehigh Portland Cement Co	Allentown, Pa	[7] 41,850.00	27,000 barrels, discount 10 cents per barrel.	Do.
				Northwestern Portland Cement Co.	Seattle, Wash	[8] 202,500.00	135,000 barrels, discount 10 cents per barrel.	Do.
838-D	Gila, Ariz	June 21	Two 10- by 8-foot top-seal radial gates with operating mechanisms, float-well equipment, miscellaneous metalwork and embedded parts.	Berkeley Steel Construction Co. Inc.	Berkeley, Calif	[9] 1,880.00	F. o. b. Berkeley, discount ½ percent.	July 5
				Valley Iron Works	Yakima, Wash	[10] 3,030.00	F. o. b. Yakima, discount 5 percent.	July 6
839-D	Columbia Basin, Wash	June 22	Gantry cranes and diffusion racks and gates for the Leavenworth station.	E. T. Pybus Co	Wenatchee, Wash	4,168.73	F. o. b. Leavenworth	July 7
840-D	do	June 23	Miscellaneous metalwork for fish elevators at the Leavenworth station.	Berkeley Steel Construction Co. Inc.	Berkeley, Calif	3,330.00	Discount ½ percent	Do.
841-D	Shoshone-Heart Mountain, Wyo.	June 26	One 6- by 7-foot 6-inch high-pressure gate with frames, hoist, semi-automatic gate hanger and appurtenances.	Commercial Iron Works	Portland, Oreg	9,381.00	do	Do.
843-D	Columbia Basin, Wash.	June 28	Structural-steel framing for garage and warehouse at the Leavenworth station.	Worden-Allen Co	Milwaukee, Wis.	5,067.00	do	July 13
844-D	do	June 16	20,000 barrels of finely ground standard portland cement in cloth sacks.	Northwestern Portland Cement Co.	Seattle, Wash	48,000.00	F. o. b. Grotto, discount and sacks 50 cents per barrel.	July 8
846-D	Sun River, Mont	June 19	3,500 barrels of finely ground standard portland cement in cloth sacks.	Three Forks Portland Cement Co.	Denver, Colo.	8,750.00	F. o. b. Trident, Mont., discount and sacks 50 cents per barrel.	Do.

[1] Schedules 1, 2, 8, and 9.
[2] Schedules 4, 5, 11 and 12.
[3] Schedules 3, 6, 10 aud 13.
[4] Schedules 7 and 14.
[5] Schedule 1, item 1, f. o. b. mill.
[6] Schedule 1, item 2, f. o. b. mill
[7] Schedule 3, item 4, f. o. b. mill.
[8] Schedule 3, item 5, f. o. b. mill.
[9] Items 1, 2, and 4
[10] Item 3.

Photographic Activities Consolidated

UNDER date of July 18 Secretary of the Interior Ickes effected the consolidation of the Division of Motion Pictures with the Photographic Section under the title Photographic Section, Division of Information, Department of the Interior, with Ray B. Dame designated as Chief, reporting to Michael W. Straus, Director of Information. George A. Grant, Chief Photographer, will be Acting Chief of the Section in the absence of Mr. Dame.

The Photographic Section shall be composed of all photographic and motion picture personnel of the Department of the Interior and its bureaus, except personnel of the Miscellaneous Service Division, Geological Survey, and Bureau of Mines.

In addition to the supplies, equipment, and materials now in the possession of the Photographic Section, all supplies, equipment, and materials of the Motion Picture Section, the coloring and enlarging laboratory, and photographic equipment and supplies of the offices, bureaus, and services of this Department, except the supplies, equipment, and materials of the Miscellaneous Service Division, Geological Survey, and Bureau of Mines, are hereby transferred to the Photographic Section.

The Photographic Section shall make, develop, print, and service photographs and motion pictures for the various bureaus of the Department or other governmental organizations in accordance with established prices, or agreement between the Section and agencies requesting services.

All requests for photographic or motion picture service by the Photographic Section shall be made to the Chief of the Photographic Section and no service not approved by the Chief of the Section shall be rendered to anyone by the Photographic Section.

The Chief of the Photographic Section shall have general supervision over the distribution of materials produced by the Photographic Section and in this distribution he may operate through the bureau of origin.

The Chief of the Photographic Section shall be responsible for the supplies, equipment, and materials of the Photographic Section and under his direction all equipment and personnel of the Section may be used as directed by the Chief of the Section regardless of the origin of the request for service.

CCC Accomplishments on the Orland Project

By D. L. CARMODY, *Superintendent and Regional Director CCC*

A PERSON unacquainted with an irrigation project wonders, perhaps, what work exists that can be undertaken effectively by the Civilian Conservation Corps. In an irrigation system, canals and ditches require modernizing to meet the demands of new types of agriculture, and since the water flowing through the canals is the lifeblood of an irrigated section, and becoming more valuable as time goes on, it is not only desirable but very necessary that steps be taken to conserve every drop.

One way to conserve water is to prevent losses in transmission in the canals and laterals (small canals) that bring the water to the cultivated lands. This means the canals should be of a proper size, the banks should be high enough to prevent overflow, and seepage losses should be reduced to a minimum by sealing the waterways insofar as possible.

On a Federal Reclamation project as old as the Orland, which was initiated in north central California in 1908, there will be found a great many miles of laterals needing improvement and the type of work to be done is admirably adapted for a CCC work program. Many machine operations as well as hand work are necessary. The work is diversified enough to provide practical means of job training for the enrollees and at the same time sustain their interest. The climate of this section of California is favorable to an intensive all-year CCC construction program.

The CCC work program of Camp BR–78, located at Orland, Calif., has five major features: First, the rebuilding of earth laterals; second, the placing of concrete lining on the rebuilt laterals; third, the construction of operating roads along canals and laterals; fourth, miscellaneous small water control structure work; and fifth, weed control and eradication on Government property. The work is such that operations performed on one feature can be correlated with other features to a large extent. For instance, in rebuilding an earth lateral it is necessary to first remove all plant growth before adding additional dirt and in so doing the banks are freed from noxious weeds.

The reconstruction of laterals consisted mainly of restoring the ditches to their original shape and, in addition, raising the banks to a higher level. In the majority of cases it was necessary to haul in a good deal of material to accomplish the desired results.

One of the largest jobs undertaken was the reconstruction of 1½ miles of the canal serving the north side of the project. This particular canal which serves 6,500 acres had a section toward its head that limited the quantity of water that could be carried by the balance of the system. A study was made and it was determined that by increasing the bottom width 2 feet for the first 2,000 feet, and raising the sides on the balance an average of 12 inches, the carrying capacity could be increased from 65 to 120 second-feet. In other words, the carrying capacity was almost doubled and in an emergency the extra quantity of water carried might and probably will mean the salvation of crops which otherwise would have been lost.

In the first 11 months following the establishment of Camp BR–78 on July 1, 1938, more than 10 miles of laterals have been improved, 6¾ miles being completely rebuilt, and 3¼ miles have had the banks on both sides raised from 6 to 18 inches. In accomplishing this work, 7,500 cubic yards of excavation were made and 12,250 cubic yards of backfill were placed. The quantities seem small when compared with those on large construction jobs, but the work was scattered, the working space very limited, and the backfill was hauled an average distance of 4 miles.

Advance survey crew of CCC enrollees securing data preparatory to reconstructing and lining the canal with concrete, Orland project

Concrete Lining

Four and one-half miles of the rebuilt laterals were further improved by lining with concrete paving. The lining, 1½ inches thick, was not reinforced since frost action does not occur. Prior to placing the lining, the sides and bottoms of the sections to be paved were brought to exact line and grade, great care being taken to see that the tangents were true and that the curves were arcs of circles. The sides were brought to line by the use of screeds 1 by 4 inches on edge, spaced about 8 feet apart, being used for guides. In pouring the concrete was placed in sections between 2 by 4's laid flat. The 2 by 4's acted as guides for the screeds and insured a uniform thickness. To make a clean joint at the points where the sides intersect the bottom, 2- by 12-inch planks 20 feet long were placed on each side at the intersections and served as a form. The sides were poured first and the bottom last.

The mix used was a 1–3–5 by volume and the average slump ran from 1 to 1½ inches.

Curing was accomplished by turning in

vater on completed sections and when this was not practicable, by sprinkling. Altogether 0,000 square yards of lining were placed in ections varying from 300 to 2,800 linear feet n length.

The lining operations are a feature where he work is followed with interest by the enollees and the finished job is a credit to them.

Miscellaneous Activities

Operating roads for the use of ditch riders re built along 3 miles of laterals. The roads re constructed 8 feet wide and in the majority f cases the job is one of reconstruction rather han new work. Material to make the roadways is hauled in dump trucks and in some ases a gravel surfacing is applied.

Practically all water-control structure work s done in connection with the reconstruction f laterals and is of a minor nature. Two oncrete checks, 10 feet wide and 5 feet high nd containing 5 cubic yards of concrete piece are the largest structures built. A ood deal of the work consists of raising headvalls and widening notches in checks.

Weed eradication work is confined entirely o Federal rights-of-way along canal and lateral banks and consists of grubbing by hand nethods, such weeds as thistles, Johnson rass, and others of a noxious character. The reater portion of the work was done in conection with grading operations and areas otaling 325,000 square yards have been com letely cleared of weeds. In one instance, an rea along a concrete lined lateral paralleling he State highway between Orland and Chico vas so heavily infested with Johnson grass hat the roots extended under the lining and vere actually breaking the concrete. All roots vere grubbed out and the debris carefully colected and hauled to an isolated point for urning.

The county agriculture commission of Glenn County and their staff cooperated in every vay on weed-control work, and it is believed he practical demonstrations showing weed ontrol to be feasible will encourage the water sers to clean up their individual farms.

Organization

The technical service for which work is eing done by the Civilian Conservation Corps s responsible for the supervision and training f the enrollees when actually engaged in vork, and the Army is responsible for the ousing, feeding, clothing, and general welfare f the men at all other times.

The Bureau of Reclamation, as the techical service responsible for Camp BR-78, as a force consisting of a camp superintendnt who is in responsible charge of all operaions, four junior foremen, one subforeman, a amp mechanic, a blacksmith who is also a eneral mechanic, and a junior clerk. Each oreman supervises the work of a crew of enollees and the size of the crews varies with he number of men available and the nature f the work being done. Assisting the foremen are enrollees designated as leaders and assistant leaders. The camp mechanic makes all repairs to motive power and supervises the truck drivers and tractor operators. The camp blacksmith repairs and sharpens tools and supervises the operating of the gravel screening plant, the small gas shovel, and grader operations. The clerk, of course, takes care of all work of a clerical nature.

Canal lined with concrete by CCC enrollees to eliminate seepage and erosion, Orland project

Engineering operations are performed under the direction of the Bureau's general foreman, the field work being done by a survey party of enrollees, and the office work also by enrollees.

Job Training

The major objective of the CCC program is to return to civil life an enrollee who is better fitted to face the problems of a changing world than when he entered the Service. To accomplish this he must be instructed in better citizenship, taught to work, and to think for himself.

On the job the enrollee is taught to perform the different operations construction crews undertake and, in addition, classes giving theoretical instructions are conducted by the foremen and other qualified teachers. Practical instruction on the job perhaps counts more than any other method, and at the start of different types of work the services of men expert in their lines are secured. For instance, when concrete lining was started, two long-experienced Bureau employees worked with the CCC crews instructing the enrollees in placing and finishing operations. When the small gas shovel was placed in operation, the services of a former chief operator of the Bureau were secured and he devoted 6 weeks' time to imparting instructions to enrollees.

The survey party, composed entirely of enrollees from the chainman to chief of party, presented a somewhat different problem for all of the men lacked both experience and theoretical knowledge. An employee of the Bureau, the project's general foreman, undertook this task and by conducting classes in theory two nights each week and giving practical instruction in the field, soon developed a field party capable of functioning as a field party should.

This field party makes all preliminary surveys and stakes all work under construction by the various crews and works with a minimum of supervision. In the office, field notes are worked up, profiles drawn, and estimates of quantities prepared by enrollees.

Company 1578 is a real construction outfit and with the exception of repair work on trucks and machinery, all operations are performed by enrollees and are performed well. Enrollees operate trucks, tractors, graders, a small gas shovel, concrete mixers, a gravel screening plant, and surveying instruments and perform all operations in concrete work from placing to finishing. The work turned out speaks for itself and the experience gained by the enrollees will undoubtedly pay future dividends.

Camp BR-78 was established on July 1, 1938, when it was first occupied by CCC Company 1578. This company was transferre[d] from Camp BR-20, Tule Lake, Calif., and ha[s] been working on the Klamath Federal Recla[mation] project so the personnel were not un[familiar] with the work programs on an irri[gation] project.

Progress of Investigations of Projects

Arizona-California: Colorado River Valley surveys.—A report on the protection of Palo Verde Valley is in course of preparation; exploration and surveys of Bullshead reservoir site were continued.

California: Kings River-Pine Flat projects.—Report on the investigations is being prepared; designs and estimates were completed of Pine Flat, Piedra and Wishon Dams.

Colorado: Blue River Transmountain Diversion.—A review of the plans and estimates of the various dams was in progress.

Eastern slope surveys.—In the Arkansas Valley, land classification was completed of 47 square miles in the vicinity of Pueblo; water-supply studies were continued and control surveys were continued between Las Animas and Pueblo. A survey of silting conditions at Cucharas Reservoir was made. A report of the North Republican River investigations is being prepared, and designs for North Republican Dam have been made.

Montrose power investigations.—An examination of the Gunnison River Basin was begun for power possibilities for utilization in the Uncompahgre project area, including the towns of Montrose, Delta, and Olathe.

Western slope surveys.—Water supply studies were continued on the Collbran, Florida, Paonia, Silt, and Troublesome projects. Surveys were continued in the vicinity of the State Line dam site on the La Plata project, and designs and estimates prepared. A reconnaissance was made of routes for pipe line from Jackson Gulch Reservoir to Mesa Verde National Park. Drilling was begun at the Horse Ranch dam site on Paonia project and mapping was in progress.

Idaho: Rathdrum Prairie project.—A supplemental report of the project was completed and approved.

Boise-Payette-Weiser project.—An inspection was made of the Weiser River area, and plans made for field investigations.

Snake River Storage, South Fork.—A preliminary estimate for an enlargement of American Falls Reservoir was in progress, and estimates made of Elk Creek and Grand Valley reservoir sites. A report of the project was in preparation.

Montana: Gallatin Valley project.—Water-supply studies for the irrigated region near Bozeman were in progress.

Marias River project.—Design and estimates of cost of Shelby Dam were prepared and the report was in progress.

Montana-North Dakota: Fort Peck pumping project.—Surveys were continued of canal through Fort Peck Indian Reservation from Winota to North Dakota State line east of Medicine Lake, and on through North Dakota to the Canadian line west of Crosby. Land classification was completed on the Kabo Unit.

Nebraska: Mirage Flats project.—Preparation of the report of the project was continued and design of Box Butte Dam was nearly completed.

Nevada: Quinn Valley and Little Humboldt projects.—A reconnaissance of the Quinn Valley and Little Humboldt areas was made and a report is in preparation.

North Dakota-South Dakota: Missouri River pumping project.—Land classification in South Dakota was completed; a reconnaissance was made of area near Yankton, S. Dak.; topographic mapping of 206,000 acres out of a total of 250,000 acres in North Dakota was completed; a report on the Bismarck and Mandan units is in course of preparation.

Oklahoma: Altus project.—Plans for a tentative plan of agricultural development were being prepared.

Canton and Fort Supply projects.—Plans for divisions of the waters of North Canadian River were being worked out, and water supply studies continued.

Washita River project.—A report of the investigations is being prepared.

Oregon: Canby project.—Outline of plans for an investigation of soil and water problems was made.

Medford project.—The report was well along toward completion.

South Dakota: Black Hills project.—Preparation of a report on the Angostura project was continued.

Texas: Batmorhea project.—Water-supply studies were continued and mapping of Antelope Flats Reservoir completed, and surveys of Cherry and Big Aguja Canyons nearly completed; water rights of the area were being compiled.

Robert Lee project.—Surveys of the irrigable areas were in progress along the Upper Colorado in the vicinity of Miles and Maverick; land classification in Coke County was begun.

Woodruff and Clarkston Creeks.—Prepara[tions] are being made for drilling of severa[l] additional reservoir sites, and drilling com[pleted] at Big and Otter Creeks.

Duchesne-Sevier River projects.—Aeria[l] mapping was in progress in Sevier and Piut[e] Counties and land classification begun. Prepa[rations] for a geologic investigation of da[m] sites in Green and Yampa Canyons we[re] made.

Utah-Idaho-Wyoming: Bear River surveys.—Water-supply studies were continued; survey[s] of Pleasant Valley Reservoir site were con[tinued] and seepage studies were in progres[s].

Wyoming-Montana: Big Horn and Powde[r] Rivers.—Reconnaissance on the Lower Pow[der] River was made and land classificatio[n] completed between Broadus and Moorehead[;] surveys were continued of Custer Bench land[s].

Colorado River Basin investigations.—Lan[d] classification of 11,000 acres on the Littl[e] Colorado River were completed, and classifi[cation] of lands in Green River Basin, Wyo[.,] and San Juan River Basin, N. Mex., will b[e] commenced. In Arizona surveys were con[tinued] on the Bullshead area and diamon[d] drilling continued. A reconnaissance wa[s] made of White and Yampa River areas. I[n] Utah surveys in the Vernal-Ashley area wer[e] continued, and topographic surveys of Dewe[y] Reservoir site completed. Studies of utiliz[-] ing of Scofield Reservoir were continued, an[d] preparation of Price River-Gooseberry proj[-] ect report continued. Surveys in the Virgi[n] River and Middle Green River areas still i[n] progress. In Wyoming surveys were begu[n] in the vicinity of Lyman, Farson, and Pinedal[e] including location of canal lines and tunne[l] lines in the vicinity of New Fork, Freemon[t] and Half Moon Lakes, and geologic explora[-] tion of Willow Creek and Eden Reservoir site[s] made.

Lower Yellowstone CCC's Active

CCC CAMP BR-30, on the Lower Yellowston[e] project engaged in grasshopper control wor[k] this summer. It is estimated that 165 car[s] of sawdust, 25 cars of bran, and 16 cars o[f] arsenic which were unloaded provide[d] enough bait to cover a total of 18,000 acre[s]. Other CCC work on the project included th[e] completion of 2.5 acres in weed eradicatio[n]

Planting Willows Along Ditches to Prevent Erosion

BEFORE willows or other types of vegetation are planted along canals, laterals, and drains to prevent erosion or for other protective purposes, the officials in charge should first determine, to their own satisfaction, whether improper grades, channel alinements and cross-sections are responsible for erosion and the need for protection. Where such conditions are found to exist other corrective measures may prove to be more practical in the long run, if the expense is not too great, than to resort to such plantings.

It has been the experience on some projects that natural and planted growths of some willows and other heavier types of vegetation in close proximity to ditch and drainage courses create future problems and become obstacles to the efficient operation and maintenance of the irrigation system. This is particularly the case where such growths have spread by natural processes to locations where they are least desired and also where the necessary and repeated cleaning of channels is made more difficult and expensive because of their existence. The cleaning of canals and drains, particularly with Ruth Dredgers or other machines employing small buckets, is more difficult where willows or other heavy vegetation have been permitted to grow on the banks and slopes.

On the other hand, some of the irrigation districts on Federal Reclamation projects, and particularly on the North Platte project in Nebraska-Wyoming, have found it profitable to plant certain types of willows along the banks of their main canals to prevent erosion. Among those most popular for this kind of planting are the peach or almond leaf (*Salix amygdaloides*), golden (*S. vitellina*), and brittle or snap willow (*S. fragilis*). Other kinds are used in localities where they are prevalent. The types mentioned should not be confused with the so-called water willow which clogs the canal and becomes a nuisance.

The brittle willow (*Salix fragilis*) because of its root habits is the only variety of willow that is recommended for the prevention of erosion on canals. The use of other varieties might result in more harm than good. The fine roots of the brittle willow come out to the surface and form a perfect mat along the slope, resembling very much the common coco mat used on door steps. This willow has been used for many years on the Pathfinder Irrigation District with fine success. There are now approximately 20 miles of these trees along the Pathfinder Canal between the Guernsey (Wyo.) Diversion Dam and the district's headgates on the North Platte project.

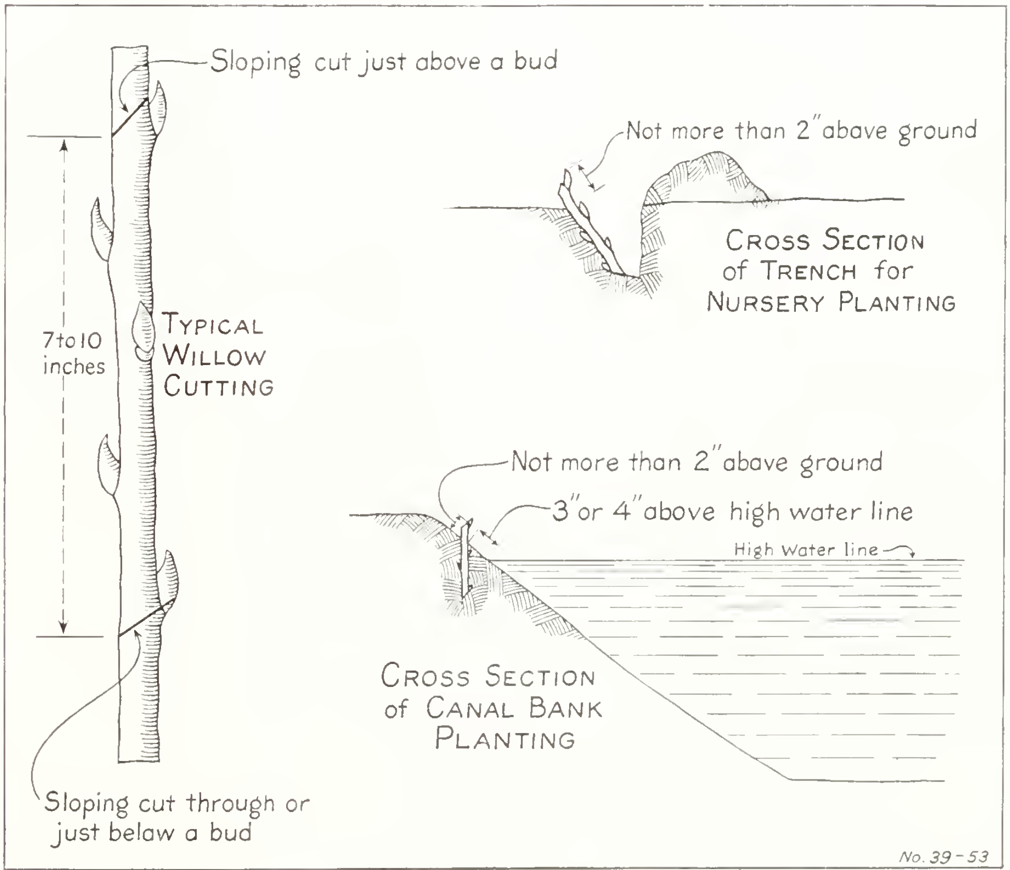
The original of these willows, which are now 30 feet high, were all started from cuttings. They were planted 6 feet apart about 3 or 4 inches above the high-water line. For miles on each side of the canal brittle willows can be seen with their mats of roots covering the slopes of the banks. This section of canal is built through the sandhills on the edge of Wyoming where water erosion is a serious problem unless some form of protection is used. The water flow is as great as 5 feet per second in some sections through the sandhills, but no erosion is in evidence where the banks are protected by these mats of roots. In a few places where the velocity is high and the channel narrow the water washes the bottom some, but the protected sides are nearly as smooth as concrete lining. And, inasmuch as the brittle willow does not produce suckers or shoots from the roots, the channel is left unobstructed and this variety can be used to reduce water erosion in canals passing through nearly any type of soil.

On some of the Federal projects, Bureau of Reclamation CCC camps have made a project of canal-bank planting. The cutting method of propagation is the one most commonly used for willows because of the ease with which this is accomplished when reasonable care is taken. Certain trees and shrubs may be propagated or grown by cutting off a section of the stem from the parent and planting it.

There are two types of stem cuttings used. The immature cuttings (sometimes called summer or half-ripe cuttings) are made by cutting the half-ripe or green-wood twigs in the summer, leaving on part of the leaves and rooting the cutting in sand under glass. This method is mentioned only to differentiate between it and the mature wood class of stem cuttings and will not be discussed here.

Mature wood (or dormant or hardwood) cuttings are usually made by cutting a straight portion of a twig of one season's growth, containing two or more leaf buds. The cut should be made with a sharp knife. The lower end is usually cut through or just below a leaf bud. Cuttings made to include a small portion of the older wood at the base of the twig, called "heel cuttings," are preferred, but have a disadvantage in that only one such cutting can be made from each twig. If such a cutting is made, it should be kept separate from the rest and planted in a location less favorable to rooting, such as higher positions on banks.

Cuttings may be made any time during the winter, but the best results are obtained by making them in January or February, as they should be kept inactive for several weeks. Wood of one season's growth, of medium size and well matured, should be chosen. Willow hardwood (or mature wood) cuttings should be 7 to 10 inches long, but should be of a uniform length in order to facilitate handling and storing.



As a rule, roots form most readily at a leaf joint, therefore it is customary to cut the lower end through or just below a leaf bud. The top end is cut a short distance above the top bud. Both the top and bottom cuts should be made on an angle as shown in the sketch.

If time or weather prohibits making the cuttings in the field, whole branches may be cut and brought in for cutting into lengths inside a building. They should not, however, be brought into a warm room until ready to be cut. If it is necessary to hold the branches over for a few days they should be packed in wet sawdust or sand, or stored in a cool, moist place such as a cellar.

The cuttings, when made, should be tied in bundles of 50 or 100 each, taking care that they are all laid one way to facilitate planting them right end up. The bundles of cuttings are packed in slightly moistened material, such as sand, and stored in a cool place where they will remain fresh. Frequently they can be kept in good condition by burying them in a well-drained place in the open ground and providing protection from excess water and from freezing. It is customary to place the butt ends up when burying.

Sometimes success has been attained without the usual storing of willow cuttings in moist sand. If the ground thaws early and cuttings can be planted at a time when they will be dormant a few weeks they may be planted directly from the branches into the ditch bank or into a nursery. However, it is usually a good precaution to store the cuttings.

The first change seen in the condition of the stored or planted cuttings is the formation of a mass of tissue on the lower or butt end, known as callus. Although roots do not ordinarily arise from the callus itself but from the tissues underneath or along the stem above it, this formation is a common preliminary to rooting. Some kinds of plants may root without any apparent callus tissue.

It is not usually necessary to plant willows in a nursery for successful ditch bank planting. However, if it is desired to have rooted trees, cuttings may be planted in trenches, cultivated and watered as a garden crop. Planting should be done before any growth starts from the buds. The cuttings are set butt-end down in a slightly inclined position with the top bud near the ground level. Not more than 2 inches should be above the ground. They should be spaced 4 to 6 inches apart in the rows. After a year's growth they can be transplanted to the canal banks.

When the cuttings are planted directly on the bank the work must be done when the ground is soft enough to allow pushing the stem into the bank to the proper distance without skinning the cutting. This should be nearly the entire length (as stated in the preceding paragraph) with not more than 2 inches showing above the ground. This type of planting should also be done as early as possible and before any growth starts from the buds. The ground should not contain any frost.

Ordinarily the outside curve of a bend in a canal needs protection most. However, in certain types of soil, erosion is encountered on other sections of the canal. This is particularly true where the water velocity is high or the channel narrow.

Cuttings should be placed 6 feet apart 3 or 4 inches above the high water line. They should be pushed in perpendicular to the horizontal plane and not perpendicular to the bank. This leaves the butt end a little nearer the surface where the warmth from the sun will start root growth earlier. The planter should firm the ground around the cutting with his heel, being careful not to skin the bark or rub off the top bud. Cuttings placed below the water line may be washed or drowned out. If placed too high on the bank they will not receive enough water to start roots and leaves. If too far out of the ground the stems will dry and not retain enough moisture to start the growing process.

When the trees are older it is not necessary to maintain a 6-foot spacing as the roots will cover a greater distance. Brittle willow roots will sometimes form a continuous mat on bank slopes when the trees are as far as 30 feet apart. Twelve to 18 feet is a good distance for most mature willows. The 6-foot spacing is necessary for smaller trees, as bank protection is attained much sooner.

The proper methods of cutting and planting willows are shown in the accompanying illustration.

(Editor's note.—The above article, with the exception of the first two paragraphs, was prepared from information on suitable types of willows and methods of preparing and planting cuttings submitted by R. B. Balcom, supervisor, forestry and demonstrational projects, Civilian Conservation Corps, Camp BR-1, Minatare, Nebr.)

Water Hemlock Eradication on the Owyhee Project

By A. N. ASHLINE, *Assistant Engineer*

WATER HEMLOCK, the most poisonous plant on the North American Continent, has for many years infested considerable areas of the Owyhee project. The county agents were concerned about the danger of this weed to the community, but as it grew along the water's edge in canals and streams, no attention had been given to it by the ranchers.

In the summer of 1936 several small boys, unaware of the poisonous nature of water hemlock, ate some of the root. All were made seriously ill and one of them died. The community was aroused to the danger of permitting this weed to grow and spread on the project and plans were considered for a vigorous campaign to destroy all water hemlock plants.

In 1937 an extensive program was inaugurated on the Owyhee project and adjacent irrigation districts to eradicate water hemlock. A survey was made of canals, laterals, and other wet areas where this poisonous weed might be growing. It was found that some canal banks were covered with water hemlock, while others had only scattered growths. One of the worst infestations was along the Advancement lateral which had been reconstructed in 1935. After only 2 years' time, sections of this lateral that had been completely rebuilt, had some of the heaviest infestations. It was also discovered that drain ditches and swamp areas were as badly infested as the canals and laterals.

Wherever water hemlock was found along a canal or lateral, eradication work by CCC enrollees was started at the head of the canal and carried to the lower end. Special efforts were made to eradicate the water hemlock from the whole length of each canal worked on, as a complete eradication was necessary in order that results might be observed the following year. It is estimated that during 1937 eradication work was completed on not less than 100 miles of canals, laterals, and drains.

The eradication procedure consisted of cutting the root of the plant as far below the crown as possible and removing root and plant to a central place to be dried and completely burned. The county agent warned that the odor from the roots attracted stock and that eating of even small pieces of the root was usually fatal to stock. Roots and plants of the water hemlock were loaded on trucks and hauled to CCC Camps BR-42, Ontario, and BR-43 near Nyssa, where the piles could be guarded from loose stock. So far as known, no loss of stock resulted from these operations. Several tons of the plant were stacked at both camps.

During the season of 1938 CCC Camps BR-42 and BR-43 covered the same canals, laterals, and drains as in 1937, using the same eradication procedure. One-half the time was

Water hemlock along Advancement lateral

equired to do this work in 1938 as in 1937. lso the amount of plant growth obtained was ess than one-half that collected in 1937.

The complete eradication of water hemlock rom the Owyhee project is a considerable roblem under present conditions. The plant found along streams many miles from the rigated areas. Seeds from upstream are ashed down to the banks of irrigation canals and laterals. The fact that the period during which the plant is growing is the same as the period when the canals are carrying an abundant water supply, probably contributes to the luxuriant growth of this weed. In spite of these conditions, however, it is believed that a yearly eradication program properly carried out can control the water hemlock within the project.

Beneficial Use of Water

By A. J. REED, *County Extension Agent, Pershing County, Nev.*

HE importance of the proper use of water irrigation was again brought before farmrs and businessmen of the Humboldt project t Lovelock, Nev., by L. H. Mitchell, irrigaon adviser of the United States Reclamation ervice, at two meetings held on June 22 and 3, 1939.

Mr. Mitchell, in a forceful, educational maner, brought home to those attending, by the se of a movie and slides, valuable lessons the use of land and water. The slides also howed the need for controlling weeds.

"The beneficial use of water is the real roblem before the irrigation farmer today," Ir. Mitchell said. "How much water to use, hen it should be applied, slope, flow, availbility, drainage, types of soil, humus, and fertility, are all important in land and water use," he continued.

The use of probes, soil augurs, and soil tubes were emphasized strongly by Mr. Mitchell at the meeting, and the probe was demonstrated in the field during the day meetings. Water-measuring devices at the headgates in each ranch another important feature which should be adopted when practical—is advocated by the irrigation adviser.

"Every legitimate means available should be used to acquaint the water user with better methods of using his water and his lands," was one of the highlights of his discussion. "Many of the ills of water users, economic and cultural, are caused by the misuse of either land or water. Water cannot be made to run up hill, neither will it efficiently irrigate improperly leveled soil," Mr. Mitchell continued. "Soil leveled properly, having the right slope, can be efficiently irrigated if head ditches which are of the right size and carrying a suitable head of water are also used," he said.

Now, we expect to see many of our ranchers using soil probes. We expect to see them more properly level their lands. The proper construction of head ditches will also receive more serious consideration, as a result of Mr. Mitchell's visit.

Attention to fertility and humus in their relationship to the water holding capacity of soil was focused graphically by the talks and movies.

"Water applied to rectify a lack of fertility and humus develops into a vicious cycle. First, because soluble salts are washed out, air forced out, and the water table is raised. Secondly, cultivated plants languish and die. Next, weeds, thus given a break, cap a general economic break-down to the detriment of the farmer, his community, the project, and the State," is another of the Mitchell axioms.

A meeting was held by the Pershing County Chamber of Commerce so that businessmen could hear Mr. Mitchell, at the suggestion of A. Jahn, president of the Pershing County Water Conservation District.

Another meeting was held by the Big Meadow Community Center at the home of Chester Anker, president of the Pershing County Farm Bureau.

Even though it was a busy season for farmers, as haying was in full swing, a good turnout greeted the speaker.

Irrigation Adviser Addresses Uintah Basin Industrial Convention

L. H. MITCHELL, Irrigation Adviser of the Bureau of Reclamation, addressed the Uintah Basin Industrial Convention held at Fort Duchesne, Utah, on August 23, 24, and 25.

More than 5,000 farmers attended the convention and Indian Fair to learn new methods of agriculture and discuss problems pertaining to their farms and communities. "Every acre to its best use through unified Basin land use planning" is the slogan adopted for the 1939 convention.

Mr. Mitchell's subject was conservation of soil and water. He illustrated his talk with colored lantern slides and a short film on the fundamentals of good irrigation practice. He also discussed improved practices in irrigation farming observed during the past summer in visiting more than 30 irrigation projects in the Western States.

Mr. Mitchell has been engaged throughout the summer in this educational work and will not return to his headquarters at Washington until the early fall.

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THE RECLAMATION ERA • AUGUST 1939

CUT ALONG THIS LINE

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif
Friant division	Friant, Calif	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo	Irvin J. Matthews	Constr. engr. [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz	E. C. Koppen	Constr. engr		R. J. Coffey	Los Angeles, Cal
Pine River	Bayfield, Colo	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr	George B. Snow	J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif

[1] Boulder Dam and Power Plant. [2] Acting. Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan
Klamath, Langell Valley [1]	Langell Valley irrigation idstrict	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.–S. D.)	Denver, Colo	W. G. Sloan	Engineer
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Medford (Oreg.)	Denver, Colo	J. R. Iakisch	Senior engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer

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ARROWROCK DAM (BOISE PROJECT, IDAHO) WITH NEW FACE AND OVERFLOWING SPILLWAY

THE RECLAMATION ERA

SEPTEMBER 1939

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VOLUME 29 • SEPTEMBER 1939 • NUMBER 9

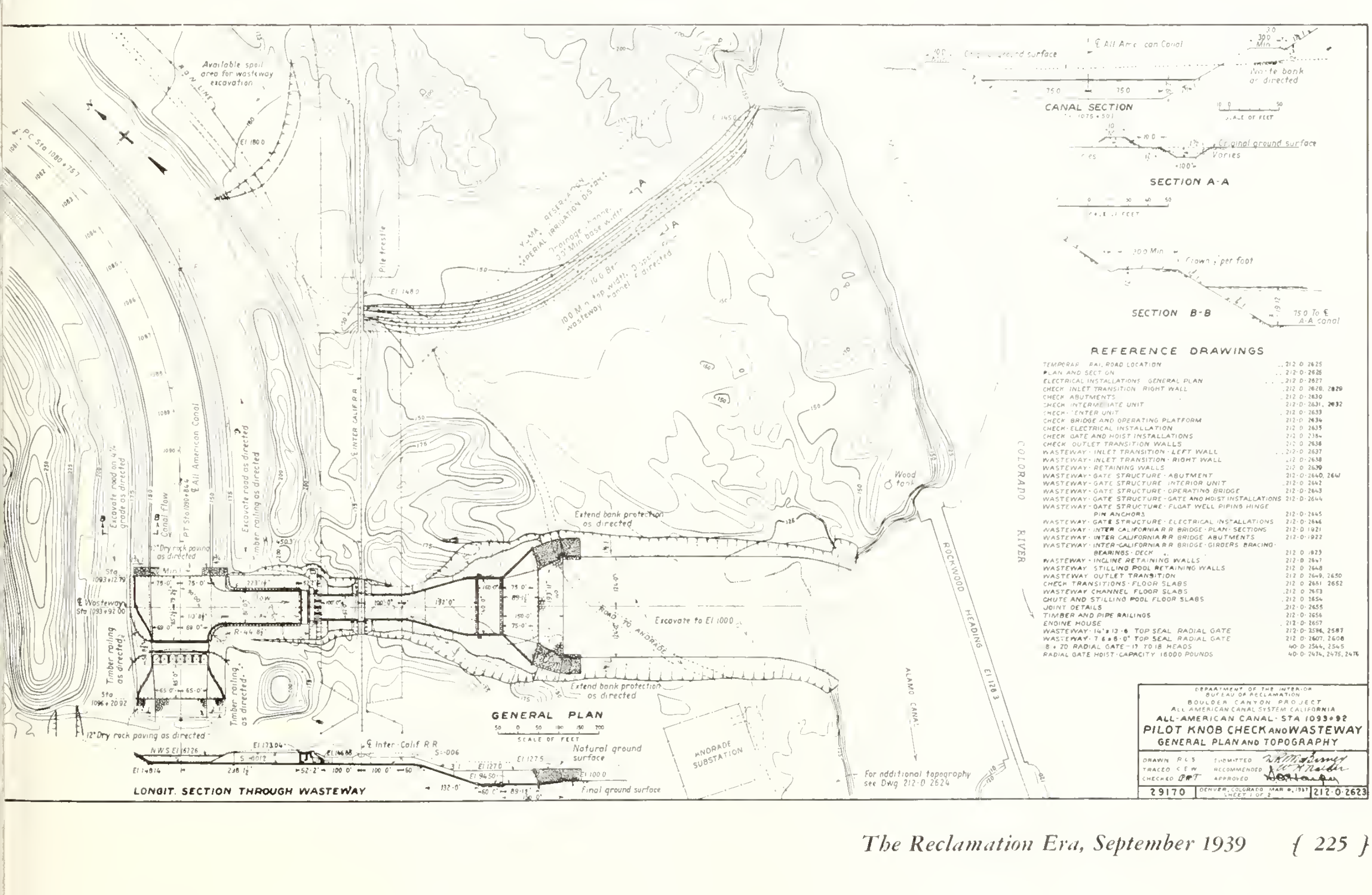
Pilot Knob Check and Wasteway All-American Canal

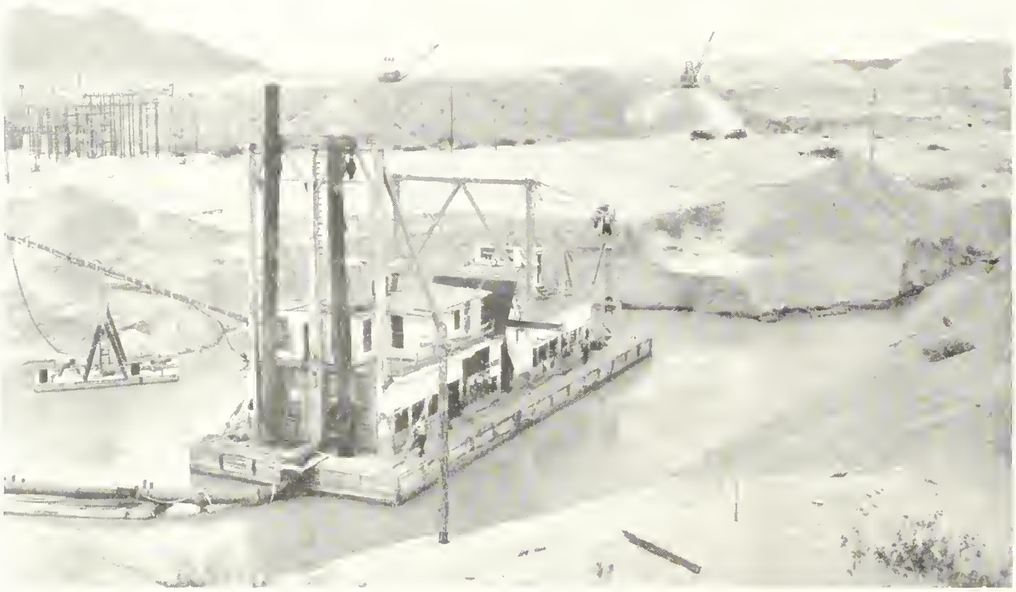
By Associate Engineer G. W. MANLY *and Assistant Engineer* L. E. CRAMER

THE design and construction of the pilot knob check and wasteway on the All-American Canal at mile 20.8, near Yuma, Ariz., presented the Bureau of Reclamation design and field staff and the contractors responsible for building it with several opportunities for the exercise of new and interesting construction methods. From a structural point of view the structure is relatively simple. However, it did present its own peculiar problems, and embodies in its design and construction certain ideas and developments not applicable to any of the other structures appurtenant to the construction of the All-American Canal System.

Purposes

The wasteway will meet a need for a thorough and expeditious means of dewatering the All-American Canal from its intake to a point near mile 36.0. Below that point the wasteway constructed near mile 71.0 will provide the needed facilities for dewatering. Quick dewatering is resorted to usually in event of emergencies resulting from breaks in canal embankments, earth movements resulting in damage to the canal, etc. The pilot knob check and wasteway will also be useful if repairs or maintenance jobs requiring dewatering become necessary downstream from it, on either the canal or its related structures since the entire flow of the canal can be diverted through the wasteway. The canal could be under normal operation upstream from the wasteway and complete interruption would be avoided. Water for the total irrigation needs of the important 62,000-acre Yuma Valley





Upper: Figure 1.—Completed Pilot Kno check and wasteway structure. Chec gate structure in right foreground; waste way gate structure in left center; Rock wood Heading of Imperial Canal i background; and beyond is Colorad River

Center: Figure 2.—Imperial Irrigatio District's hydraulic dredge "Brawley, used for excavation of wasteway channe below stilling pool

Lower: Figure 3.—Construction at Pilo Knob check and wasteway. The hy draulic dredge in background is exca vating the lower wasteway channel an discharging about 1,000 feet to the righ of channel

project will be taken from the All-America Canal, upstream from the wasteway.

Description

The structure consists of two essential parts the check section in the All-American Cana prism, and the wasteway section constructe at 90° off the All-American Canal centerlin The check section consists of a gate structur with seven electrically operated 18- by 17.5 foot radial gates and a short section of line canal both upstream and downstream fro the gate structure. The piers for the chec gates support a concrete highway bridg across the canal. The wasteway section co sists of a vertical-walled concrete chann containing four electrically operated 14- b 13.5-foot radial gates manually controlled, an two 7.5- by 6-foot radial gates under aut matic control. Power for the gate hoists i supplied by a gasoline motor-generator se The two smaller float-controlled automati radial gates are provided to maintain a co stant water surface in the All-America Canal above the check. Any water tha reaches the structure, in excess of that r quired in the canal below the check gate will be automatically wasted through thes two gates and the wasteway channel, int the Old Imperial (sometimes called th Alamo) Canal. The concrete wasteway cha nel discharges through a 3 to 1 sloping chut into a stilling pool, and thence through a unlined earth channel into the Old Imperi Canal which at present is supplying the Im perial Valley. The total length of the wast way channel, including both lined and u lined sections, is 1,600 feet.

Excavation for the entire structure totale 595,000 cubic yards and contains 13,090 cub yards of concrete.

Besides the road bridge crossing the ga structure on both the check and wasteway, railroad bridge crosses the channel just b low the gate structure (fig. 1).

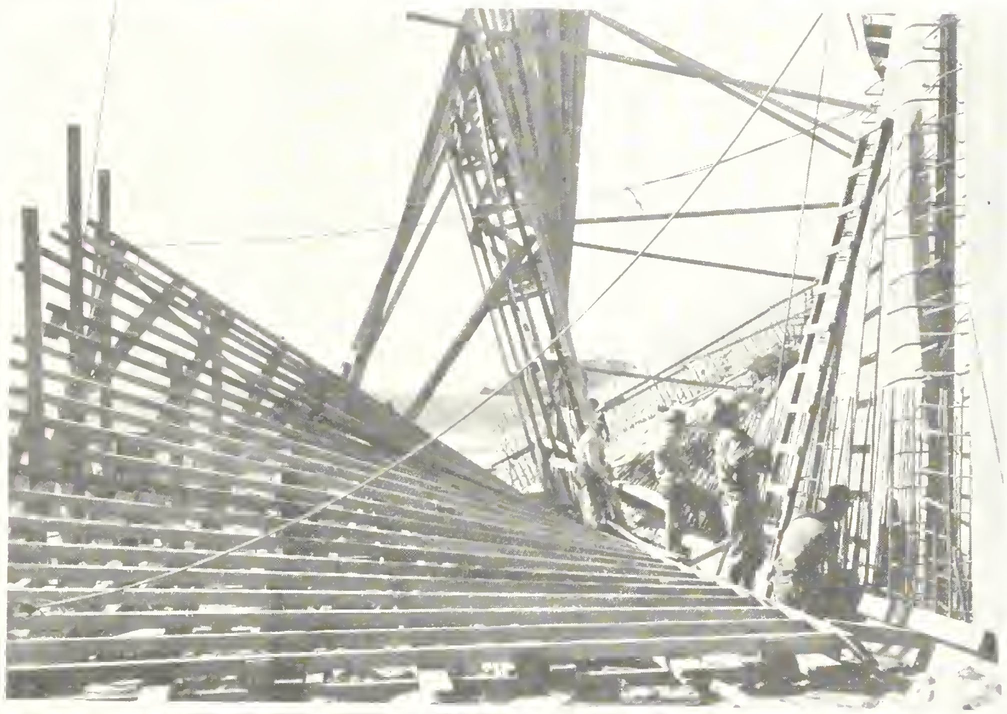
Design

This structure, because of its size and e panse, was designed and built as joint

Upper: Figure 4.—Batching plant and cement storage shed

Center: Figure 5.—Framework for inside orm of right transition wall of the check outlet at Pilot Knob check and wasteway. This framework was assembled n position and moved out and away from the back form

Lower: Figure 6.—Crane lifting completed inside transition wall forms back nto position. Note concrete spreaders n place against the back, or outside form



nits in order that expansion and contraction tresses might be reduced and the cracking f concrete minimized. Watertight but flexble joints, with rubber water stops embedded n the concrete on either side of the joint, vere provided between the various units of he gate structures, walls, and floor slabs. ll retaining walls under 16 feet in height vere designed as cantilevers, and the reaining walls up to 32.5 feet high were deigned with counterforts, with face slabs arying from 12 to 24 inches in thickness. ince the floor slabs are not restrained by he walls, percolation gradients were lowered y means of cut-off walls beneath the floors, ich that uplift pressures would not occur.

The concrete-lined wasteway channel erves to drop the water, in quantities up to 3,000 second feet, approximately 57 feet and erminates in a stilling pool so designed as o dissipate the energy in a well-distributed ydraulic jump.

Automatic float-controlled radial gates, hyraulically actuated, were designed for the asteway gate structure. These gates will perate so that the water surface in the anal above the check can be held at a preetermined elevation, and any inflow which ight tend to raise this water surface will e automatically discharged through the asteway.

Models were constructed in the hydraulic boratory in Denver for the purpose of testg flow conditions in the wasteway channel, e operation of the automatic gates, and r determining the stilling pool designs.

Excavation

Most of the excavation occurred in the asteway channel which accounted for 500,-0 cubic yards of the total excavation for e structure. Much of the material from is channel had to be moved 500 to 1,200 et. Approximately 250,000 cubic yards were cavated by power shovel and dragline and uled to the spoil area by truck. The reaining 250,000 cubic yards were removed ith the aid of a hydraulic dredge (figs. 2 d 3), which the contractor held under lease om the Imperial irrigation district, the ency operating and maintaining the existg irrigation facilities for Imperial Valley. redging was begun at the outlet end of the isteway channel, at its confluence with the existing canal, into which the wasteway will discharge. Since the wasteway channel grade was 10 feet below the water surface of the existing canal it is planned to waste into, it was possible to float the dredge into very advantageous positions and excavate all of the channel below the stilling pool by this method. Dredge equipment used included a 20-inch suction pump directly connected to a 600-horsepower electric induction motor; then 350 feet of 20-inch pipe line to an electrically operated booster pump located on the bank; then 1,000 feet of 20-inch pipe line to the dump area. The greater portion of the material dredged consisted of loosely cemented sand, but some soft sandstone was encountered which occasioned slight delays. The contractor had hoped to excavate the actual stilling pool area with the dredge also, but slow progress toward the end of the work, on account of the sandstone becoming more difficult to dislodge, caused the abandonment of these plans, and the stilling pool was excavated with a dragline feeding a truck fleet.

Aggregate and Concrete Handling

Washed and graded concrete aggregates were hauled 21 miles and placed in bunkers which were built in the form of chutes on the side slopes of the canal. Aggregate from the bunkers was fed by gravity into a skip, which, in turn elevated the load to hoppers above the batching scales (fig. 4). From the batching scales the aggregate was dumped into three-batch capacity dump trucks. The trucks then picked up cement from an adjacent storage shed and hauled the dry batches to the mixer. Mixing equipment consisted of a 1-cubic yard paver with a tower and hoist for elevating the concrete to high buggy runways for wall pours.

On all of the work above the 3 to 1 sloping chute, the mixer was spotted very close to each pour. The concrete for wall pours was delivered by means of the tower hoist to buggies operating upon runways. For concreting the chute and stilling pool, the mixer was placed at the top of the slope and concrete was delivered to buggies by means of a cable car, operating on an inclined trestle. Rubber downspouts were used on all wall pours. These proved much easier to handle than standard metal "elephant trunks," especially on thin, high walls, such as occurred in the upper portion of the wasteway channel. These particular walls were 25 feet high, 12 inches thick, and were placed in one lift. All concrete was vibrated with flexible shaft electric vibrators. "Windows" were cut in the top forms of warped transition walls to facilitate vibration of the concrete. A small part of the concrete was cured by the use of a transparent membrane curing compound. This type of curing was done as a part of a series of experiments being conducted at the time by the Bureau of Reclamation. When the experimental data had been obtained, the further use of the curing compound was discontinued, and the remaining concrete was water cured.

Forms

For typical vertical walls the standard form construction consisted of large prefabricated panels with 1- by 6-inch tongue-and-groove sheeting, 2- by 4-inch studding with plates, and double 2- by 4-inch walers. The panels were handled with a small crawler-mounted crane. There are seven warped transitions on this structure and the contractor developed rather interesting methods of forming them. The thinness of the warped walls made it practically impossible to sheet the front or top form in place. On typical transitions, the back form, including buttresses, was built complete in place, the studding for the front form was set up and properly spaced from the back form, the walers of laminated 1 by 6 inches for the front form were spiked to the studding, and the framework for the front form (studding and walers) was braced and trussed so that it would hold its shape when removed from the support of the back form. Next, the front form framework was lifted out and away from the back form (fig. 5), and the 1- by 6-inch tongue-and-groove sheeting nailed to the studding. While the front form was being sheeted the reinforcing steel for the wall was placed. The final operation consisted of sliding the front form back against spreaders placed against the rear form and tying the two forms together (fig. 6).

A variation of the above scheme was used on one transition form with unusually sharp curvature. In this case the studding was first placed on the wrong side (inside) of the front form sheeting so that the sheeting could be bent convexly instead of concavely. After the sheeting had been nailed to these temporary "inside" studs, the outside studs were nailed to the sheeting and the form was braced to hold its curvature. Next, the front form was slid out away from the rear form and the temporary "inside" studding was removed. The front form was then ready to be slid back into position.

Concrete spreaders which could be broken and left in the walls were used extensively on high thin walls. Tie rods were encased in waxed paper sleeves and completely removed when the forms were removed. All forms were shop designed and carpenter foremen were supplied with completely detailed working drawings for each form.

Subgrade Unwatering

Since the floor of the stilling pool is over 15 feet below the natural water table, the contractor was faced with a considerable unwatering problem, a situation that has not had to be contended with in the construction of the greater portion of the structures on the All-American Canal project. An earth cofferdam was left across the channel below the stilling pool when excavation w made. The drainage system was rather si ple. The reverse filter under the floor slab permanent device to intercept seepage wate after the operation of the structure) at t toe of the 3 to 1 slope was connected at bo ends to open trenches which extended alo the outside of the stilling pool retaining w footings. These trenches discharged into t sumps immediately downstream from the e of the concrete. One gasoline and one el tric-powered pump was stationed at ea sump. Water from the sumps was pump out into the unlined channel at the rate 1,500 gallons per minute.

Railroad Crossing

The Southern Pacific Railroad Compan branch line into Mexico crossed the propos wasteway channel and provision was made maintain traffic during construction by t building of a "shoofly" track around the tual site of the railroad crossing. The co tractor then concentrated his early constr tion efforts upon the completion of the brid and railroad traffic on the permanent cro ing was restored early in the job. This p mitted the completion of the wasteway cha nel without interference to train services.

The pilot knob check and wasteway str ture was completed during the summer 1938, and only awaits the coming of water the All-American Canal in order that its i portant role in the successful operation this ambitious irrigation project may beg to be fulfilled.

Friant Dam Construction Call for Bids

THE call for bids for the construction Friant Dam, second major structure of t Central Valley project, California, which w scheduled for August 23, was postponed un September 14, when, at 10 a. m., bids we opened at the office of the Bureau of Rec mation in the Old Post Office Building, Sacr mento, Calif.

Friant Dam will be constructed on the S Joaquin River just east of Fresno. It w be a concrete gravity type dam, 300 feet hig 3,430 feet long, and will require an estimat amount of 770,000 cubic yards of excavati for the foundation, and the placement 1,935,800 cubic yards of concrete. Fria Dam will create a reservoir with a to storage capacity of 512,500 acre-feet of wat of which 70,000 acre-feet will be reserved f flood reduction; and 316,500 acre-feet will useful storage for irrigation diversion. T spillway of the dam will have a capacity 90,000 cubic feet of water per second.

Roy B. Williams, former Assistant Co missioner of Reclamation, left Washington June 10 last for the Friant Dam Governme camp. He will be in charge of the co struction of the dam as construction engine

Nevada Poultry Producers, Inc.[1]

N 1927 a few farmers living near Reno, Nev., rganized in an attempt to secure better and nore stable prices for some of their products, articularly eggs. At first there was no estab- shed place of business and activities were onfined to cooperative contracts with pack- ng houses and other established firms. lthough the results were not unusual, proof as obtained that a cooperative organization ould be made to succeed and derive a real enefit for the local poultry producers, so in December 1930, the organization was ex- anded, a place of business established at 338 vans Street, Reno, Nev., and this business as continued to grow each year since, now eing the largest cooperative poultry and egg usiness in the State.

During the first year of actually established perations, a total of about $22,000 worth of usiness was handled. In 1938 this had in- reased to $283,000, which included the han- ling of 23,000 cases of eggs, 114,000 pounds of ll types of poultry, and 9,000 bags (100 ounds each) of poultry feed and other miscel- ineous produce. Improvements in the place f business present additional proof of suc- ess. The first building erected, which was nly 40 by 50 feet, has since had three addi- ons, the latest constructed in 1938 at a cost f approximately $10,000, bringing the total alue of buildings to about $25,000, all under he association's ownership. The organization as a capital of $10,000, with proposed changes n the bylaws which may increase this capital o $50,000, and thus facilitate the handling of reater and anticipated business.

From the beginning of business, the affairs f the association have been under the super- ision of the present manager, Roger Teglia. Both the outside, or field work, and the office ctivities provide employment for a yearly verage of 14 workers consisting of 2 in the ffice, 2 truck drivers, and a varying number of lant employees.

The organization has 66 actual members, all f whom are egg producers who form the nain body and are exclusive of auxiliary mem- ers who form the colored poultry and rabbit- roducer groups and the turkey growers. This year the association took in all members f the Nevada Turkey Growers' association as group and handled practically all turkeys roduced in Nevada, marketing the turkeys nder the Norbest brand. A total of about 400 armers are provided service in the way of a tabilized market for eggs, all types of poultry, abbits, and a certain amount of grain which s processed for poultry feed for member use nly. It has been reported that by maintain- ng adequate storage facilities and proper nanagement an especially effective egg price tabilization has been secured. This stabiliz- ing effect is claimed for the present season to the extent of 5 cents per dozen of eggs.

Although production has been low during the past 2 years, an improvement is said to be in evidence and the prediction has been made that a steady gain will continue to the point of normal production for Nevada within 2 years.

The association is now serving practically all of Nevada and making heavy shipments to northern California and the Lake Tahoe region. During more normal production periods the market territory is said to be considerably extended, with shipments having been made to points as far as the Hawaiian Islands.

[1] A brief statement regarding this organization vas carried in the May issue of the ERA.

Feed department

Growth of Water Storage, Federal Reclamation Reservoirs, 1907–1939

On June 30	*No. Reservoirs*	*Storage* (Acre-feet)	*On June 30*	*No. Reservoirs*	*Storage* (Acre-feet)
1907	3	154,000	1923	30	6,786,000
1908	7	192,000	1924	30	6,545,000
1909	12	1,030,000	1925	33	5,565,000
1910	16	1,331,000	1926	34	5,555,000
1911	18	2,038,000	1927	37	8,939,000
1912	21	3,594,000	1928	38	8,599,000
1913	22	3,269,000	1929	40	7,761,000
1914	24	3,980,000	1930	42	7,162,000
1915	27	5,295,000	1931	44	5,076,000
1916	27	6,362,000	1932	44	9,189,000
1917	27	7,027,000	1933	46	8,853,000
1918	28	5,115,000	1934	47	5,112,000
1919	29	4,722,000	1935	49	11,677,000
1920	29	7,734,000	1936	51	18,473,000
1921	30	7,413,000	1937	52	25,843,000
1922	30	7,409,000	1938	62	34,090,000
			1939	71	36,009,109

[1] From the data available in Washington Office.

The Upper Columbia River Country

TREASURE seekers have been great world movers—discoverers of new lands and precursors of trade and settlement. Gems, silks, and spices attracted them from Europe to the Orient, and the search for gold finally carried them all over the world.

In the days of Columbus, Portugal and Spain were the world's most formidable maritime powers and most energetic treasure seekers. Each was ambitious to inherit the earth, and Pope Alexander VI actually divided the pagan world between them. To Portugal he gave, to enjoy and possess, the exclusive right to discover, conquer, trade in, and dominate the seas and all pagan territories east of a meridian 370 leagues west of the Cape Verde Islands; and to Spain he gave seas, lands, and Pagan peoples west of that line. For that reason, Portuguese colonies and influences are found in southern Asia, in Africa, and in Brazil, and Spanish names are found marking prominent geographical features of the Americas as far north as Alaska.

Aware of the rich commerce to be developed with India, if a sea route to it could be found, both nations searched vigorously for a passage from the Atlantic to the Indian Ocean. Portugal succeeded first, by way of the Cape of Good Hope. Balboa discovered the Pacific Ocean for the Spaniards in 1513 by crossing the Isthmus of Panama, and Magellan found a connection between it and the Atlantic in 1520, and was first to circumnavigate the globe. His new-found route was so hazardous, however, that for years the west coast of the Americas was searched persistently for a better passage. That search led, in time, to the discovery of the Columbia River.

Carried away from its companions by a storm, a Spanish "frigata" drifted north along the Pacific coast of North America in 1602, and its commander, Martin Aguilar, discovered the mouth of a "rapid and abundant river, with ash trees, willows and brambles, and other trees of Castile upon its banks. In spite of his endeavors, the powerful curre prevented his entrance into the river, and h sailed away to Acapulco, "seeing that he ha already reached a higher latitude than ha been ordered by the viceroy, and that the nun ber of sick —was great."

His historian, Torquemada, supposed tha Aguilar had rediscovered a river "leading t a great city, which was discovered by th Dutch, and that is the Strait of Ania through which vessels passed in sailing fro the North Sea to the South Sea; and that th city called Quivera is in those parts."

Kettle Falls, 100 miles above Grand Coulee Dam and 50 miles below the Canadian border, the only cataracts in the Upper Columbia. Within a year they will be flooded by the backwater behind the dam and will cease to be an obstacle to navigation

Columbia Earlier Known as Rio de Aguila

Whether Aguilar saw the mouth of th Umpqua at flood season, which is likely, o the mouth of the Columbia, reports of his dis covery gave to the Columbia one of the firs of the many names by which it has bee known, the Rio de Aguilar; and the even was the basis for Spain's claim to possessio of the west coast of North America, and great stimulus to search for the great rive of the west, a mythical large city on its banks and rich savages to be plundered.

A hundred years of struggle engendered b the Reformation left Spain prostrate at th end of the Thirty Years' War and ended he barbarous policy of sword for pagans and in quisition for heretics. Struggle against th absolute monarchy of the Bourbons occu pied other nations for years, and a centur and a half passed after Aguilar's voyage be fore west coast exploration was actively re sumed, led by Spain, followed by Russia, Eng land, and France. The American revolutio soon engaged the attention and resources o England, and involved France, leaving th field of Pacific exploration to Russia an Spain.

Russia, carried along by the stimulus o Peter the Great's ambitions, had expande from the Baltic to the Pacific. In 1741 Vitu Behring explored the coast of Alaska; but though his explorations took him south to th 46th parallel, that is, into the latitude of th Washington and northern Oregon coasts, h did not discover the great river of the west Thirty years later, furs from the north wer carried into Canton by the Russians, and th extent of the Pacific Ocean was first realized

The Spanish voyager Perez, in 1774, dis covered Queen Charlotte's Island, off th Canadian coast, the Olympic Mountains i Washington, and Nootka Sound on Vancouve Island. He traded with the natives, but di not find the great river.

A year later, Bruno Heceta worked up th coast, put a boat ashore below the Strait o Juan de Fuca, only to have its crew murdere by the Indians, and withdrew southward.

On August 17, in latitude 46 degrees 10 minutes, he came opposite a great outward current which he concluded might be from the mysterious Straits of Fuca or the long lost Rio de Aguilar. Failing in his attempts to enter against the strong current, and puzzled by the currents and his unreliable maps, he named the area from which the currents issued Assumption Bay, and sailed away to Monterey.

This discovery of the mouth of the Columbia was the basis of Spanish claim to the Oregon country conveyed to the United States by treaty in 1819. Voyages of Bodega, Heceta, Arteaga, Martinez, De Haro, Valdez, and others gave Spain an uncontested title to the Pacific coast as far north as the 60th parallel, and gave now-familiar Spanish names to landmarks from Mexico to Alaska.

After 2 years in the South Seas, which gave to England many strategic points in the Pacific, Capt. James Cook turned his attention to the west coast of North America, but found neither the Straits of Juan de Fuca nor the great river of the west. Two ships, carrying furs from Nootka to China shortly after Cook's voyage, opened a new and profitable trade that stimulated anew among all nations the search for the lost great river of the west, for rivers were the highways to interior trading points. Furs were as valuable in trade as the precious metals, and Nootka Sound became a great trading point.

On July 5, 1788, John Meares, an Englishman in the employ of Portuguese traders, in search of the lost river, found what he believed to be and what apparently was its mouth; but, intimidated by shoal water and rough sea, he failed to enter the river.

Robert Gray Makes First Actual Entrance Into Columbia River

In the spring of 1792, Robert Gray, a Boston trader, commanding the Columbia Rediviva, southbound along the coast, met and reported to Capt. George Vancouver, commissioner to represent Great Britain and to find the great river and the Straits of Juan de Fuca, that he had earlier found in latitude 46 degrees 10 minutes, and for 9 days had tried to enter a powerful river. Vancouver had already concluded that Meares was right in reporting that no such river existed, and he continued on his way toward Nootka Sound while Gray proceeded with his plan to rediscover and enter the river.

On May 11, 1792, in favorable weather, he "ran in with all sails set," and ascended the river 20 miles. He named the river the Columbia in honor of his ship, and claimed it for the United States. Gray's seems to have been the first actual entrance into the river, and the first basis for a valid claim to its possession. But for this event, it is probable that the British or Spanish would have held the Pacific coast, and that the United States might never have become a great Nation.

Exploration of the Pacific Northwest began with the fur trade, and for years the economic and political history of the territory paralleled closely the histories of the great fur companies and their international relations.

Oldest and, except during a relatively short period, the largest and most famous of the fur traders was the Hudson's Bay Co. It had its origin in a charter granted in 1670 by Charles II to Prince Rupert and 17 associates. Although its losses were great during the French and Indian wars, its profits were enormous, and its growth steady.

After the ceding of Canada by the French to the British in 1763, its operations, confined previously to the rigorous countries drained by the Saskatchewan, Athabaska, and Mackenzie Rivers, were extended to the west and south. In 1793 Alexander Mackenzie reached the Pacific Ocean at a point northeast of Vancouver Island; and by 1811, representatives of the Northwest Fur Co., powerful Canadian rivals of the Hudson's Bay Co., had penetrated the Columbia River basin.

Lewis and Clarke Expedition

One of the first Americans to realize the importance of the so-called Oregon country to the United States was John Ledyard, a Yankee sailor, who in 1786 interested Thomas Jefferson. Although Jefferson had never been west of the Alleghanies, he conceived an expedition of exploration to ascend the Missouri River, to cross the Shining Mountains (the Rockies), and to descend the Columbia to the Pacific. The resulting expedition is believed by many historians to have been the greatest of all similar events in enlarging the public interest in territorial expansion, and in fixing the country's destiny.

Upon his inauguration, Jefferson urged Congress to authorize an expedition "to explore the Missouri River and such principal streams of it as, by its course of communication with waters of the Pacific Ocean, or any other river, may offer the most direct and practical water communication across the continent, for purposes of commerce." The Louisiana Purchase stimulated popular interest in exploration and emigration, and the Lewis and Clarke expedition was organized.

The party consisted of the bold and energetic Capt. Merriweather Lewis and the wise and resourceful Lt. William Clarke, 14 soldiers of the Regular Army, 9 Kentucky volunteers, 2 French voyageurs, a hunter, an interpreter, and a negro servant. As a result of a promise to the soldiers of retirement on full pay with a grant of land, seven journals in addition to those of Lewis and Clarke were kept.

Five months were spent in the journey from St. Louis up the Missouri River to Fort Mandan (N. Dak.), where the party spent the winter among friendly Indians. The following season, with the addition of Sacajawea, who had been kidnaped in childhood from a far western tribe, the journey was continued up the Missouri River to its origin at the three forks of streams named by Lewis and Clarke the Madison, Jefferson, and Gallatin, and thence up the Jefferson and across

Crown Point on the Columbia River Highway, 25 miles east of Portland, is a favorite stopping place for travelers. A magnificent view of the gorge is seen from this point

the Continental Divide. Finding the descent of the turbulent, canyoned Salmon River impossible, they worked their way north and west through and over the Bitterroot Mountains, western boundary of Montana, to the Clearwater River, a tributary of the Snake. Leaving their horses with Nez Perce Indians, they built boats and descended, in turn, the Clearwater, the Snake, and the Columbia, reaching the Pacific in the winter of 1805.

Log buildings were erected at Fort Clatsop near the site of Astoria, and the winter was spent there. The homeward journey, begun late in March 1806, followed approximately the route by which they had traveled west. Reports of the expedition created a sensation in the Atlantic States, and created new enthusiasm for westward expansion.

Expedition Financed by John Jacob Astor

Most important of the succeeding expeditions were those financed by John Jacob Astor for the purpose of establishing trading headquarters for the Pacific Fur Co. at the mouth of the Columbia, and outposts throughout the Columbia Basin. One party was sent by sea, and another by land.

The ship *Tonquin* sailed from New York, September 8, 1810, and arrived at the mouth of the Columbia in March of the following year. The trading post established on the south side of the river was named Astoria.

The land party under Wilson P. Hunt fared badly. Astor hoped to profit by the experience of the French-Canadian trappers and traders, and included many of them in his organization. The Hunt party was organized at Montreal, Mackinac, and St. Louis, and started the ascent of the Missouri in October 1810, spending the following winter on the upper Missouri. It reached the headwaters of the Snake River the next spring.

Efforts to descend the Snake River, which took them into a rough desert country of lava and sagebrush, led to extraordinary suffering from hard travel, thirst, hunger, cold, and menacing Indians. Late in January 1812, a number of members of the party, in charge of Hunt, reached the Columbia near the mouth of the Umatilla, and Astoria February 15. Three months passed before the remainder of the party arrived.

Astor's organization established a trading post at the mouth of the Okanogan River in northern Washington in September 1811 and another at Spokane House, at the junction of the Spokane and Little Spokane, in 1812.

In an effort to defeat Astor in his plan to establish the first fur-trading post at the mouth of the Columbia, David Thompson, representing the Northwest Fur Co., competitor of the Hudson's Bay Co., led an expedition across the Canadian Rockies in 1810. Inclement weather confined the party on the headwaters of the Columbia during the winter, and they reached the Pacific, July 15, 1811, to find Astor already implanted there.

The Thompson group was the first party of white men to traverse the watershed of the upper Columbia. On its journey down the river, huts were built and flags were raised to mark its occupation of the country. The Northwest Fur Co. had previously established posts in the Kootenai and Flathead Valleys.

As a result of the War of 1812, and of difficulties with his Canadian partners and employees, Astor disposed of his fur business in the northwest to his Canadian rival in 1813.

In 1821, by act of Parliament, the Hudson's Bay Co. and the Northwest Fur Co. were reorganized under the name of the former; and, thereafter, until the western section of the boundary between Canada and the United States was fixed at the 49th parallel, the Hudson's Bay Co. was the dominating force in the basin of the upper Columbia.

Furs are products of the wilderness, so settlement was not encouraged; but the westward pressure of the agricultural population of the United States quickly developed the Middle West, and, in a relatively short period, trappers, gold seekers, cattlemen, and farmers rapidly succeeded one another in occupying the Oregon country.

The Columbia River and its tributaries we[re] economically important in the early days [of] the development of the Pacific Northwest b[e]cause, then, rivers and streams were the onl[y] means of access to enormous inland area[s.] They decreased in economic consequence [as] routes for travel and transportation, as trail[s,] wagon roads, and railroads were extende[d] until commercial navigation is now almost e[x]clusively confined to the lower reaches of t[he] river through which offshore ships find the[ir] way to the ports of Portland and Vancouver.

The future economic usefulness of the grea[t] river and its tributaries is well begun. Wat[er] diverted from them already makes homes [on] otherwise desert land for thousands of people[,] and electrical energy, derived from their fal[l]ing waters, lights cities and buildings, operat[es] mines, turns factory wheels, and moves tran[s]continental trains. Some additional land wi[ll] be reclaimed with water and power from th[e] river; and, long after oil fields are pumpe[d] dry and coal beds mined out, energy from th[e] falling waters of the Columbia will be suppl[y]ing mankind with mechanical energy and wi[th] substitutes for exhausted natural resources.

Dr. Paul J. Raver Appointed Administrato[r] Bonneville Project

FRANK A. BANKS, supervising engineer of the Columbia Basin project, was recently appointed Acting Administrator of the Bonneville project to succeed temporarily the late James D. Ross. On August 21 Secretary of the Interior Ickes announced the appointment to this important post of Dr. Paul J. Raver, chairman of the Illinois Commerce Commission, who assumed his new duties in Portland, Oreg., on September 15.

Dr. Raver, born at Logansport, Ind., April 27, 1894, was graduated in civil engineering from the University of Nebraska in 1917, received a degree of master of business administration from Northwestern University in 1927, and of doctor of philosophy from Northwestern in 1933.

After serving as a lieutenant in the Eighteenth Field Artillery during the World War, Dr. Raver worked until 1927 as a valuation and estimating engineer in Chicago. During the next 6 years he served as instructor, assistant professor, and associate professor of public utilities at Northwestern University. In 1933 he became supervisor of the section of rates and research of the Illinois Commerce Commission, organizing the section and directing special research on such subjects as revenues, rates, the cost of capital, incorporate relations, rate of return, securities, and related economic and financial subjects. He also prepared expert testimony in important rate cases and supervised the handling of all rural electrification problems for the commission.

Two years ago Dr. Raver was appoint[ed] executive officer of the Illinois Commerc[e] Commission and resumed part-time teachi[ng] at Northwestern University. Although he r[e]cently was appointed chairman of the co[m]mission by Governor Horner, the Govern[or] has consented to release him in order that [he] may take up the duties of administrator [of] the Bonneville Project.

Since 1935, in addition to his other wor[k,] Dr. Raver has served as a member of th[e] Illinois State Rural Electrification Committe[e] developing rural electrification in cooperati[on] with the Rural Electrification Administrati[on] and other agencies.

"I am grateful to Governor Horner for r[e]leasing Dr. Raver from his new appointme[nt] as chairman of the Illinois Commerce Co[m]mission," Secretary Ickes said. "I feel th[at] Dr. Raver is especially well qualified as [a] result of his long and brilliant record to [do] the important job I am assigning him at Bo[n]neville. Dr. Raver has demonstrated abili[ty] to handle in the public interest the marketi[ng] of the power from Bonneville Dam."

Mr. Banks, who was drafted as acting a[d]ministrator while serving as supervising eng[i]neer of the Bureau of Reclamation, in char[ge] of the construction of the gigantic Gra[nd] Coulee Dam, will confine himself to his reg[u]lar work at Grand Coulee Dam when D[r.] Raver takes office.

"Mr. Banks has done a fine job on his te[m]porary assignment," Secretary Ickes sai[d.]

(*Continued on page 237*)

Progress of Investigations of Projects

By W. I. SWANTON, *Engineering Division*

ARIZONA: *Hassayampa project.*—Land classification of the Hassayampa River and Wittman areas was completed and water-supply studies are in progress.

Showlow (Little Colorado River).—Land classification completed and water studies being continued. Plans for geologic review of storage sites being made.

Bill Williams project.—Inspection of Date Creek and Alamo dam sites was made.

ARIZONA-CALIFORNIA: *Colorado River surveys.*—Preparation of report in regard to protection of Palo Verde Valley in progress.

ARIZONA-NEVADA: *Bullshead Reservoir.*—Diamond drilling in progress and test pits being dug.

CALIFORNIA: *Chuckawalla project.* Field reconnaissance of project made.

COLORADO: *Blue River-South Platte transmountain diversion.*—Preparation of report in progress and cost estimates reviewed.

Collbran project.—Water-supply studies in progress.

Florida project.—Land classification in progress and inspection of Upper and Lower Park reservoir sites made.

Grand Mesa project.—Reconnaissance of reservoir sites and land classification in progress.

Mesa Verde pipe line.—Preparation for survey of pipe line from Jackson Reservoir site, Mancos project to Mesa Verde Park in progress.

Montrose power project.—Reconnaissance of Gunnison River Basin streams made and surveys planned of Gunnison and Uncompahgre Rivers to determine power possibilities.

North Republican River project.—Water-supply studies in progress including reservoir operations.

Paonia project.—Topography of Horse Ranch reservoir site completed, and drilling dam site continued.

Silt project.—Water-supply studies were continued and surveys of line from Harvey Gap Reservoir in progress.

COLORADO-KANSAS: *Arkansas Valley investigations.*—Control surveys for aerial photography continued; 394 miles of traverse run; land classification and water-supply studies continued, including storage at Caddoa Dam.

COLORADO-NEW MEXICO: *La Plata project.*—Design of State Line Reservoir was in course of preparation, and plans and estimates for canal lines are nearing completion.

Animas-La Plata project.—Land classification of the area west of the La Plata River in Colorado was begun.

IDAHO: *Snake River storage, South Fork.*—The preparation of report was continued, and study of surplus water supply, preliminary designs, and estimates of enlargement of the American Falls Reservoir to capacity of 3,100,000 acre-feet made.

Weiser investigations.—Geological surveys of a number of dam sites and reconnaissances of several reservoir sites were made.

KANSAS: *Kansas reconnaissance.*—An inspection of the proposed projects in Gray, Hodgeman, Pawnee, Jewell, Republic, Cheyenne, and Gove counties was made.

MONTANA: *Canyon Ferry Reservoir.*—Reconnaissance of Canyon Ferry Reservoir and dam site was made and surveys begun.

Deadman's Basin Reservoir.—Report was in course of preparation and flood control studies in progress.

Gallatin Valley project.—Plans for study of return flow from canals being outlined.

Marias River project.—Water supply studies were continued.

Rock Creek project.—Report was in course of preparation.

MONTANA-NORTH DAKOTA: *Fort Peck pumping project.*—Field work about completed and report is being prepared.

MONTANA-WYOMING: *Big Horn Basin.*—Mapping of over 2,500 acres completed, and reconnaissance of Shell Creek Valley made.

Powder and Tongue Rivers.—Powder River land classification was completed and a total of over 37,000 acres located to date.

NEBRASKA: *Mirage Flats project.*—Report in course of preparation.

NEVADA: *Washoe project.*—Plans made for field surveys this season.

NEW MEXICO: *Shiprock project.*—Reconnaissance of project was made.

Turley project.—A reconnaissance of project was made and outline of plans for field surveys made.

NORTH DAKOTA-SOUTH DAKOTA: *Missouri River pumping.*—Field work was completed in South Dakota areas and survey of 30 pumping projects in North Dakota nearly completed.

Missouri River tributaries.—A reconnaissance of the White, Bad, and Moreau Rivers was made.

OKLAHOMA: *North Canadian Basin project.*—Water supply studies were made and determination of irrigation requirements in several areas begun.

OREGON: *Canby project.*—Survey of canal and pipe lines was in progress and data obtained for estimates of pumping costs.

Chewaucan project.—Water supply studies are in progress.

Grande Ronde project.—Studies of transmountain diversion were in progress and flood-control data assembled.

Willamette Basin.—A reconnaissance of agricultural lands in the basin was made.

SOUTH DAKOTA: Preparation of reports of Angostura and Buffalo Gap projects was in progress, and plans made for preparation of report on the Shade Hill project.

Rapid Valley project.—Diamond drilling at the Pactola Dam site in progress.

TEXAS: *Balmorhea project.*—Surveys of reservoir sites continued, land classification begun and a new district map being made.

Robert Lee project.—Land classification was begun and water supply studies continued.

UTAH: *Colorado River-Great Basin.*—Soil surveys of several areas were in progress and control surveys for aerial maps in several areas in progress. Water supply studies of Flaming Gorge site begun.

Dewey Reservoir.—Studies of power development at Dewey dam site were continued.

Price River project.—Designs and plans of dams were prepared and report of project in progress.

San Rafael River.—Water supply studies were continued and preparation of cost estimates of Cottonwood-Huntington Canal made.

Sheep Creek surveys.—A survey of Hickerson dam site was in progress and plans were made for survey of Long Park reservoir site.

UTAH: *Vernal investigations.*—Topographic survey of Tyzack Ranch Dam site was made and water supply studies continued.

Virgin River investigations.—A reconnaissance of the Virgin River Basin was made.

Utah Cooperative projects.—A drilling program on Beaver Creek was prepared; drilling on Newton Creek will be begun soon; drilling on the Woodruff project was completed; and a report of the Weber River investigations is being prepared.

UTAH-IDAHO-WYOMING: *Bear River surveys.*—Topographic mapping of Pleasant Valley Reservoir site nearly completed and a reconnaissance of streams between dike north of Bear Lake and Last Chance Canal completed; seepage studies begun.

WYOMING: *Pinedale project.*—Surveys of New Fork, Half Moon, and Boulder Lakes were completed, and surveys of Fremont Lake were in progress.

Lyman project.—Geologic examination of Willow Creek Reservoir site was made and test pits were being excavated.

Tucumcari Industrial Development

THERE has been some activity in real estate in Tucumcari, New Mex. Several new homes in the city are under construction, and remodeling of old homes and some business property continues.

Storage Reservoirs, Yakima Project, Washington

By D. E. BALL, *Associate Engineer*

SIX storage reservoirs having a maximum combined capacity of 1,063,800 acre-feet provide Yakima project lands with an adequate and dependable water supply.

These reservoirs, varying in elevation from 2,000 to 3,500 feet above sea level, are formed by dams placed at the outlet of lakes or meadows in the heavily glaciated upper portion of the watershed of the Yakima River and its tributaries on the eastern slope of the Cascade Mountains. The stored waters are released into the Yakima River system and delivered in the river channels to the various canal headworks where they are diverted and distributed to the irrigable lands.

Information relative to these reservoirs and storage dams is given in the accompanying tabulation.

The installation of flashboards on spillway crests has increased the storage capacities of Bumping Lake, Keechelus, and Clear Creek reservoirs, by 4,000, 5,080, and 530 acre-feet, respectively.

	Bumping Lake	Lake Kachess	Lake Keechelus	Clear Creek	Tieton	Lake Cle Elum
Reservoir:						
Capacity ... acre-feet	33, 800	239, 000	153, 000	5, 300	197, 000	435, 70
Surface area ... acres	1, 300	4, 540	2, 550	270	2, 540	4, 88
Drainage area ... square miles	69	64	55	60	187	21
Dam:						
Type ... / Height above stream bed ... feet	(1) 45	(2) 63	(2) 70	(3) 58	(2) 222	(2) 13

[1] Earth fill. [2] Earth and gravel fill. [3] Concrete arch.

At the time of the passage of the Reclamation Act of 1902 approximately 120,000 acres in this area were being irrigated by private canals. Under the State law, filings had been made appropriating water far in excess of needs or ability to use, with the result that there was insufficient water during the low flow period, from July to October, to supply the rapidly increasing late summer irrigation demand. Investigations by the Bureau of Reclamation resulted in a satisfactory adjustment of water rights and the beginning of the orderly construction of the storage dams and the development of irrigable lands.

The total area now irrigated in the Yakima Valley is about 420,000 acres, of which more than 319,000 acres are supplied with water from irrigation works and storage reservoirs constructed or acquired by the Bureau of Reclamation. About 101,000 acres are being irrigated from the natural flow of the Yakima River and its tributaries. Upon completion of the project, the total area under irrigation will approximate 595,000 acres. Construction of the Roza division, which contains an irrigable area of about 72,000 acres, was begun in 1936 and is now under way.

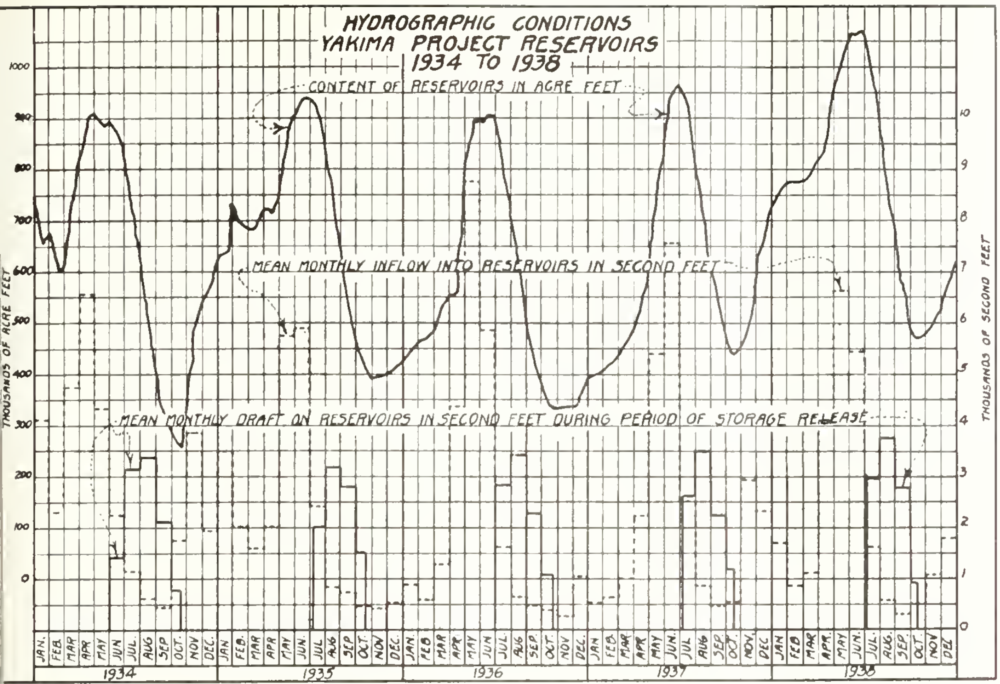
The total drainage area above the reservoirs is 585 square miles. For the period from 1925 to 1938, inclusive, this area had a maximum annual run-off of 2,590,000 acre-feet, a minimum of 1,070,000 acre-feet, and a mean of 1,633,000 acre-feet. The mean annual run-off at Union Gap, below all major tributaries, of 3,381,000 acre-feet from a drainage area of 3,550 square miles, clearly reflects the water resources of the stream.

The accompanying diagram shows the hydrographic conditions of the storage system from 1934 to 1938, inclusive. Spillway gates were installed at Cle Elum Dam in 1937, increasing the capacity of the reservoir from 360,000 to 435,700 acre-feet. The maximum reservoir content of the storage system to date was 1,069,716 acre-feet on June 23, 1938.

While constructed and operated primarily for storage of water for irrigation use, the reservoirs are operated as far as practicable for flood control. During the Yakima River flood of December 1933 the greatest on record, a peak flow of 54,300 second-feet developed at Union Gap, just below Yakima. Except for control at project reservoirs, where 28,300 second-feet were held up, the flow would have been 82,600 second-feet.

All of the project reservoirs are easily accessible by excellent highways. Because of their picturesque location in the Cascade Mountains, excellent boating, fishing, and swimming, they offer unexcelled recreational facilities to vacationists and sportsmen. An increasing number of local residents are tak-

Tieton Dam, Yakima project, completed in 1925



ing advantage of these recreational opportunities and are constructing summer cottages at several of the reservoirs.

Yakima Asparagus

A COMPILATION by handlers of returns from asparagus grown in the Yakima Valley this season indicates that growers received $367,120 for 4,685 tons of this important crop which they harvested. Canning and freezing establishments used 3,185 tons, while 1,500 tons went to fresh vegetable markets for immediate consumption. Of the above total, 2,776 tons were grown in the vicinity of Sunnyside.

Klamath Alsike Clover

WITH more than 5,000 acres planted to alsike clover on the Klamath project and with an advance in price noted, this crop seems to be in line to become one of the project's major crops.

Storage on the Salt River Project

Operated by the Salt River Valley Water Users' Association, Phoenix, Ariz.

By T. A. HAYDEN, *Assistant Engineer, Salt River Valley Water Users' Association*

OOSEVELT DAM (1905–11) was the first ajor irrigation work constructed under the National Reclamation Act of 1902.

With three other dams below it, practically omplete regulation is effected of stream flow anging from 200,000 to 300,000 second-feet. n the Salt River Valley, where once the uncontrolled river barely sufficed for the irrigaion of 100,000 acres on a one-crop-per-year asis, today 250,000 acres are cultivated, 75 ercent of which produces two or more crops er season. In addition, a partial water supply s furnished to 95,000 acres of nonproject land nder the Warren Act. By means of power enerated at these four dams, with four plants t drops on the canal system, a supplemental vater supply is made available for pumping nderground water from beneath project ands, and electricity is furnished for domestic se to every farm.

Irrigation storage is the primary and power he secondary function of Roosevelt Dam. Power is the main purpose of Horse Mesa, Mormon Flat, and Stewart Mountain Dams, uilt by the Salt River Valley Water Users' Association on the Salt River below Roosevelt and, with Roosevelt, forming a chain of akes nearly 60 miles long, each dam backing he water up to the toe of the next higher. The aggregate reservoir capacity is 1,894,800 acre-feet. Of this, 1,522,000 acre-feet (less 122,000 acre-feet of silt accumulated in 28 years' operation), is in Roosevelt.

Granite Reef Diversion Dam, 12 miles below Stewart Mountain Dam, diverts the water as released from the reservoirs into two 2,000-second-feet canals, one on each side of the river. Four miles above Granite Reef the Verde River enters the Salt. The two rivers drain 13,000 square miles of mountain watershed with a highly erratic run-off, varying from 200,000 to 300,000 second-feet in volume and from less than 300,000 to more than 5,000,000 acre-feet in mass. While the area drained is almost exactly divided between the rivers, the average yearly run-off is 567,-00 acre-feet for the Verde and 820,000 for the Salt, a ratio of 40 : 60.

Until the present time the Verde has been uncontrolled. In May 1939, Bartlett Dam was completed by the Bureau of Reclamation on the Verde, 22 miles above its junction with the Salt. This is the highest multiple-arch dam yet constructed and impounds 200,000 acre-feet of water, increasing the gross project storage to 2,094,800 acre-feet, not deducting silt.

The Indian Service owns one-fifth interest in the dam and is therefore entitled to one-fifth of the total storage, from which it is planned to develop 6,000 acres of Indian lands near the reservoir.

It is anticipated that this comparatively small storage on the Verde will save over 90 percent of flood waters now wasted, the theory being that water stored in Bartlett will be withdrawn as rapidly as economically feasible, holding Salt River storage in reserve meanwhile, thus making Bartlett again available for other floods.

Water Users Assume Project's Operation

Roosevelt Dam was dedicated by President Theodore Roosevelt in March 1911. The Government took over the project in 1907 and operated it until November 1917, when it was turned over to the Salt River Valley Water Users' Association. During this 10-year period, Granite Reef Diversion Dam was built, the canal and lateral system acquired, enlarged, and improved, hydroelectric power plants and transmission lines provided, pumping plants installed, and other work done, aggregating, with Roosevelt, a cost of $15,000,000. In 1935 additional work was undertaken by the Bureau, amounting to

$6,000,000. This program has just been completed. The main features were Bartlett Dam, $4,000,000 (exclusive of the Indian's share), and improvements to the spillways at the four storage dams on Salt River, which had been shown by studies in the Bureau's hydraulic laboratories to be inadequate for safely handling the largest floods.

Of the $21,000,000 capital investment made by the United States under the Reclamation Act, $12,000,000 has been repaid, $5,000,000 prior to 1917 and $7,000,000 since. Horse Mesa, Mormon Flat, and Stewart Mountain Dams, with other project developments made independently by the Salt River Valley Water Users' Association aggregating $22,000,000, bring the total project capital investment to $43,000,000.

The low rainfall, extreme dryness, warm climate with 12 months' growing season, and intensive farm operations result in a high use of irrigation water. This averages around 3½ acre-feet per acre per year at the farm, and over 5 acre-feet is required at the head of the canal system to produce this net delivery after deducting seepage and operating losses.

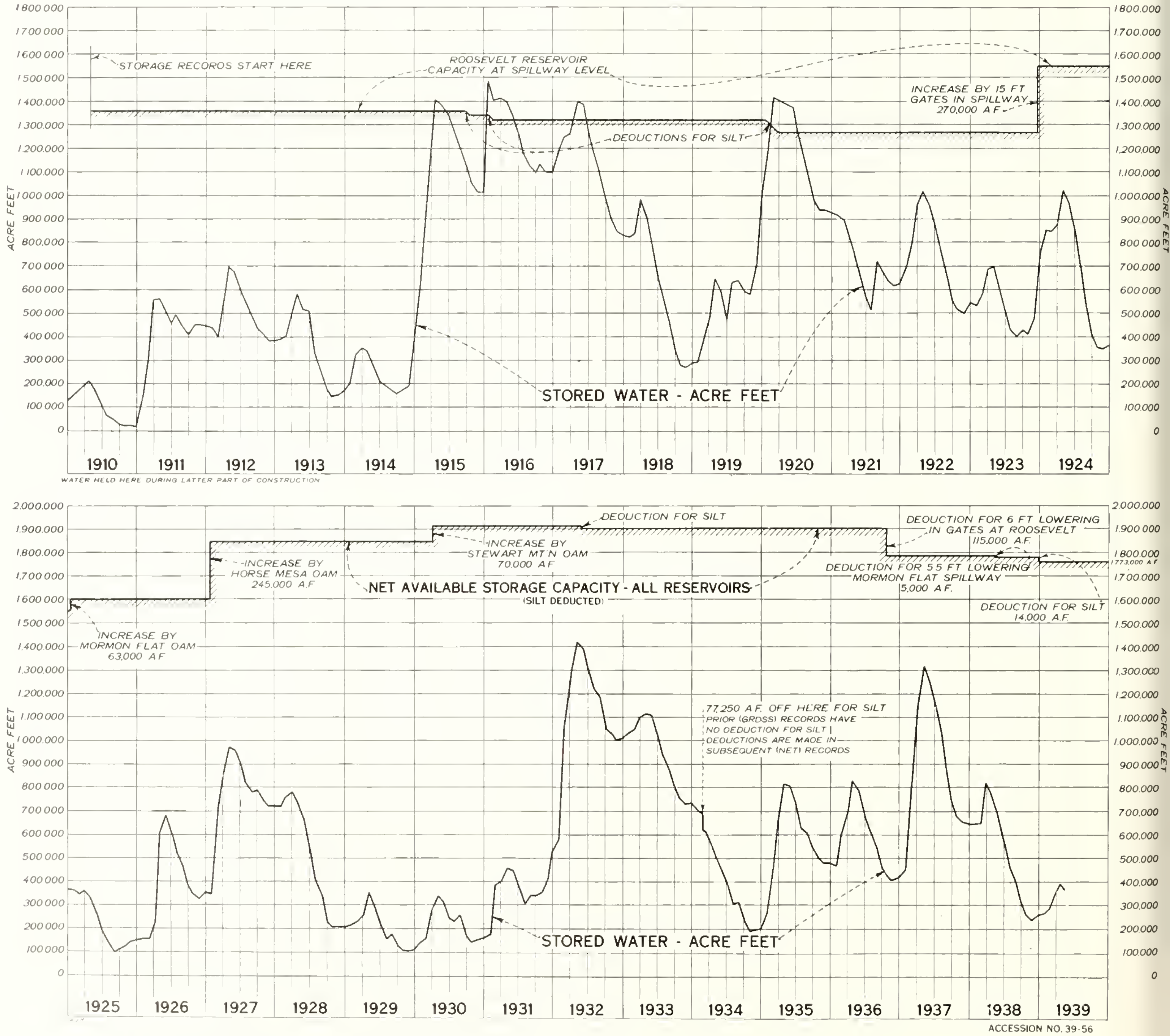
For the 14 years ending 1938, the net water (deducting evaporation) made available by storage has varied from 400,000 to 800,000 acre-feet per year, averaging 627,500 acre-feet. This is almost exactly half the total average project irrigation use of 1,235,000 acre-feet for the 14 years, and two-thirds the average use of 1,004,000 acre-feet of river water. These figures cover one 15-month period.

These bare figures understate the credit due to storage. The water from underground must be credited to storage largely because, without the added contributions to ground water due to the larger irrigation supply and use and without the cheap power created by the dams to operate the pumps, only a small percentage of the underground water would be available.

To repeat the statement made at the begin-

RESERVOIR CAPACITY AND WATER STORED ON SALT RIVER

INCLUDING ROOSEVELT, HORSE MESA, MORMON FLAT, AND STEWART MOUNTAIN RESERVOIRS AS BUILT



ing, storage means the difference between 00,000 acres producing one crop per season nd 250,000 acres producing 1¾ crops per season, or, what would be the equivalent, 440,000 cres producing one crop. This is a 4 : 1 ratio, vhich roughly may be said to evaluate the resent ratio of population, improvements, roduction, and economic structure generally o that of pre-storage days.

Data on the five storage dams and the hisory of storage for the past 28 years are iven in the accompanying tabulations and raphs.

Storage Extremes for Reservoir System on Salt River at and Below Roosevelt Dam

1910 to 1938, inclusive

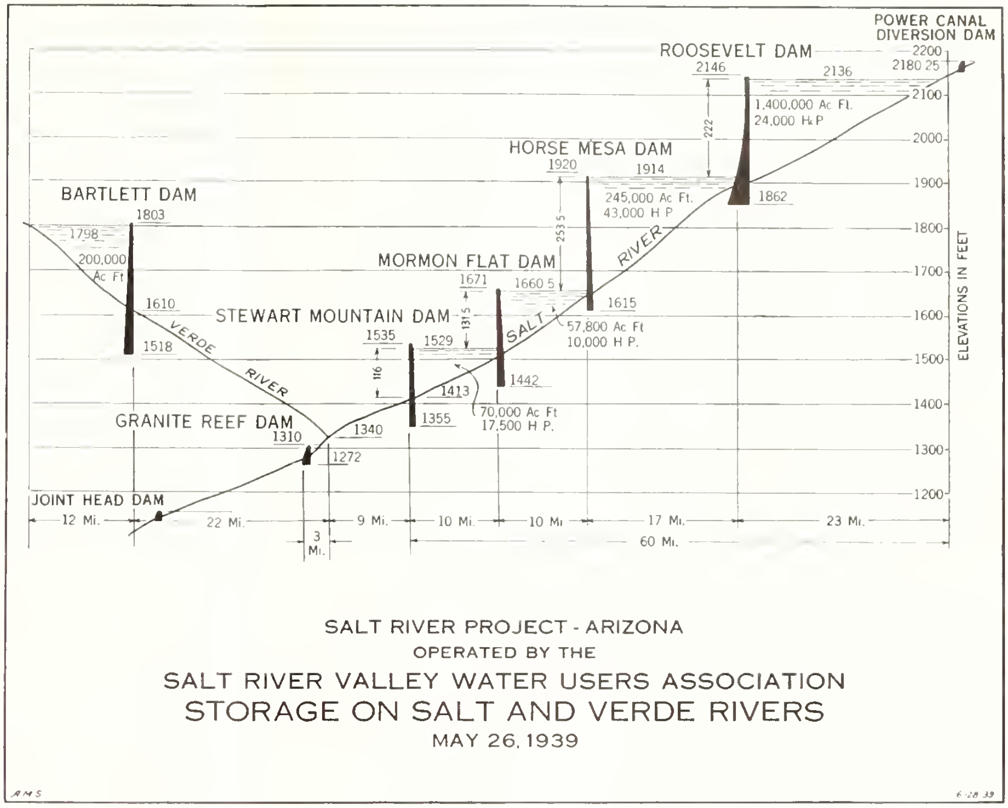
[Amounts in acre-feet]

	Maximum		Minimum	
910	May 1	211, 217	Nov. 13	16, 914
911	Apr. 15	568, 838	Jan. 1	22, 438
912	May 7	703, 218	Dec. 31	384, 644
913	Apr. 26	583, 694	Nov. 14	140, 833
914	Dec. 31	391, 924	Sept. 30	158, 535
915	May 5	1, 421, 168	Jan. 1	395, 059
16	Jan. 29	1, 563, 720	do	1, 021, 296
17	May 7	1, 401, 786	Jan. 31	828, 788
18	Mar. 28	991, 914	Nov. 14	266, 767
19	Dec. 31	1, 034, 960	Jan. 1	290, 045
20	Feb. 23	1, 496, 912	Dec. 31	934, 892
21	Jan. 1	934, 045	July 25	494, 026
22	May 1	1, 025, 302	Nov. 29	498, 570
23	Apr. 16	701, 647	Sept. 16	380, 271
24	Apr. 30	1, 031, 989	Dec. 6	317, 743
25	Mar. 15	377, 837	Aug. 23	87, 065
926	May 18	692, 646	Jan. 1	147, 086
927	May 13	975, 481	Feb. 11	350, 432
928	Mar. 19	785, 349	Nov. 29	206, 231
929	Apr. 23	364, 311	Nov. 23	98, 079
930	May 12	347, 618	Jan. 1	110, 178
931	Dec. 31	521, 017	do	160, 430
932	May 3	1, 427, 610	do	525, 281
933	May 10	1, 140, 167	Dec. 31	729, 767
934	Jan. 2	728, 709	Nov. 16	177, 464
35	May 7	823, 543	Jan. 1	198, 833
36	May 11	831, 143	Dec. 25	101, 907
37	May 3	1, 312, 245	Jan. 1	122, 075
38	Mar. 25	822, 624	Dec. 11	238, 832

Power Development Federal Reclamation Projects July 1939

Project	*Output (Kw.-Hrs.)*
alt River, Ariz.	[1] 34, 593, 880
uma, Ariz.-Calif.	779, 215
oulder Canyon, Ariz.-Nev.	199, 490, 000
rand Valley, Colo.	1, 117, 740
oise, Idaho	7, 163, 472
inidoka, Idaho	7, 508, 000
orth Platte, Nebr.-Wyo.	2, 642, 280
ewlands, Nev.	717, 150
trawberry, Utah	611, 555
akima, Wash.	1, 842, 550
iverton, Wyo.	260, 790
hoshone, Wyo.	1, 020, 000
Total	257, 746, 632

[1] Of this amount 5,566,000 by Diesel engine.



New Bonneville Administrator

(Continued from page 232)

"Good progress has been made on the construction of transmission lines and in negotiations for power contracts."

"Mr. Banks is an outstanding construction engineer, and he let me know," Secretary Ickes continued, "when I drafted him for acting administrator of Bonneville, that the completion of Grand Coulee Dam was his ambition. I respect him for this, because that dam is worthy of the best in any man. As a matter of fact, he has been loyally running two jobs, either one of which is big enough for even a big man."

Milk and Butterfat Production

COWS of the Burley-Rupert area on the Minidoka project, Idaho, included in the Twin Falls-Mini-Cassia Cow Testing Association, again took top honors for production during the month of June. The association has 454 cows. A cow owned by G. R. Congleton of Burley produced 87.6 pounds of butterfat as compared to the association's average of 31 pounds. Joe Gisler's herd of more than 20 cows, located at Rupert, yielded on an average 1,276 pounds of milk and 42.6 pounds of butterfat; while the herd of Edwin Ames, of Heyburn, with less than 10 cows, averaged 1,411 pounds of milk and 39.4 pounds of butterfat.

Concrete Poured in Grand Coulee Dam

THE concrete pour in Grand Coulee Dam for the month of July was 329,393 cubic yards, and the total pour at the end of that month was 7,027,618.

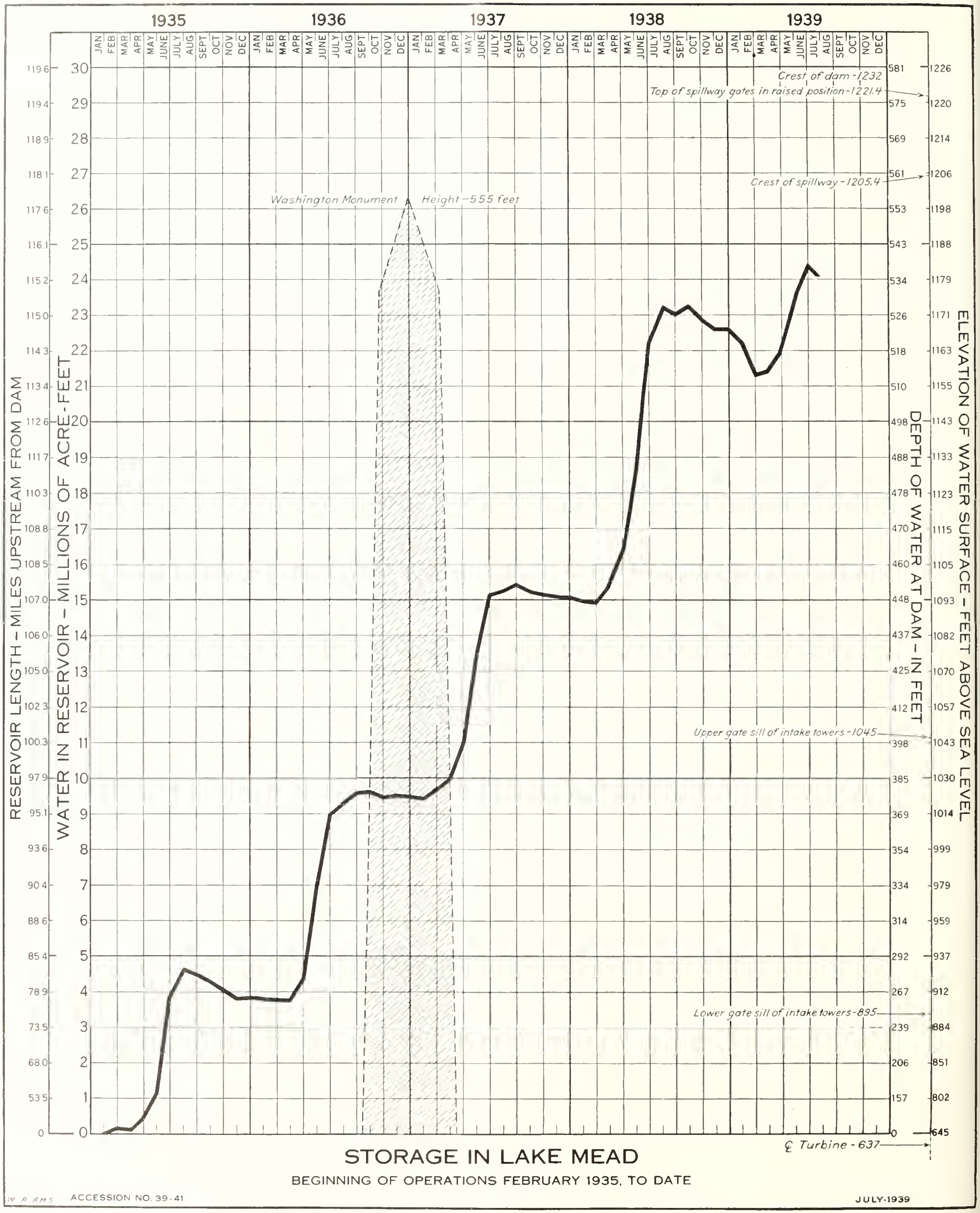
The total represents 4,500,000 cubic yards poured by Mason-Walsh-Atkinson-Kier Company under its contract for the low dam, and the balance of 2,527,618 represents concrete poured by Consolidated Builders, Inc., which has the current contract for completion of the dam.

Belle Fourche Wool Industry

THE wool industry in the Belle Fourche section of South Dakota is reaching proportions of note, with 2,800,000 pounds passing through Belle Fourche storage hou es, and 1,800,000 pounds being received at Newell. Buyers have been plentiful, eight eastern wool firms keeping representatives in the section during the season, and many other houses having field men representing them at various times.

Wedding

ON June 27, 1939, Harry E. Fitch, ranger, and Miss Katherine T. Ashlin, clerk, Boulder Canyon project, Boulder City, Nev., were married in Las Vegas, Nev. The bride was formerly employed in the Washington office of the Bureau.


1935
1936
1937
1938
1939
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
Crest of dam - 1232
Top of spillway gates in raised position - 1221.4
Crest of spillway - 1205.4
Washington Monument Height - 555 feet
Upper gate sill of intake towers - 1045
Lower gate sill of intake towers - 895
℄ Turbine - 637
RESERVOIR LENGTH - MILES UPSTREAM FROM DAM
WATER IN RESERVOIR - MILLIONS OF ACRE-FEET
DEPTH OF WATER AT DAM - IN FEET
ELEVATION OF WATER SURFACE - FEET ABOVE SEA LEVEL
STORAGE IN LAKE MEAD
BEGINNING OF OPERATIONS FEBRUARY 1935, TO DATE
ACCESSION NO. 39-41
JULY-1939

Nebraska's Program for Weed Control

By GEORGE S. ROUND, *Extension Editor, University of Nebraska College of Agriculture*

THE Nebraska noxious weed-control program, based upon education, district organization, and prevention, is getting results.

It is through such a well-rounded program that farm and city people are recognizing the dangers of weeds and becoming vividly aware of the need to do something about it. The problem is being combated by a well-established educational program, by the organization of corporate noxious-weed-eradication-districts; by encouraging the eradication of noxious weeds, using approved methods; by prevention of new infested areas through control of infested seed and livestock feed; and by precaution in the use of crop-harvesting machinery.

Boosted along was the noxious-weed control by the enactment of a weed law by Nebraska's Unicameral Legislature in 1937. This legislation was primarily aimed at field bindweed, but also makes provision for control of leafy spurge, Canada thistle, and puncture vine. Furthermore, it enables the Director of the Department of Agriculture and Inspection to designate other weeds noxious as conditions may warrant.

This law created a State weed advisory committee to assist and advise the director of the State department of agriculture in the program of control of noxious weeds. Serving on this committee are: W. H. Brokaw, Director of the Agricultural Extension Service of the University of Nebraska; Dr. F. D. Keim, Chairman of the Agronomy Department at the University of Nebraska; H. L. Wahlgren, of Elk City, President of the Nebraska Crop Growers' Association; and Harvey Raben, Nebraska City, President of the Nebraska Horticultural Society.

Educational Program

One of the most important factors in any program designed to encourage better farming operations and promote efficiency is education. The passage of the Nebraska Weed Law in itself was educational in that it showed a strong desire on the part of the majority of the people to do something about noxious weeds, and particularly field bindweed.

Although the University of Nebraska College of Agriculture and its branches has for years carried on an educational campaign against weeds, the passage of the State law added vigor to this long-established program. Educational meetings have been conducted throughout the State with farm groups, community clubs, chambers of commerce, vocational agriculture classes, schools, and other interested groups. Generally, these gatherings have been arranged by county agricultural agents.

Interesting has been the fact that many farmers and landowners did not recognize bindweed and other noxious weeds when they saw them. Thus, the meetings were very valuable in establishing identity of noxious weeds which need to be eradicated.

Another supplement to the educational program has been the production and utilization of colored movie films showing bindweed and other noxious weeds, methods of eradication, and weed conditions in all parts of the State. In addition, as a part of the educational work, weed exhibits were arranged for the Nebraska State and county fairs in 1938. Cooperating were county agricultural agents, 4-H clubs which the agents sponsor, and the department of agriculture and inspection.

Weed tours and field demonstrations sponsored by the county agricultural agents have also been a part of the educational program. Farmers seeing successful eradication work actually in operation thus have been convinced and encouraged to carry on eradication practices on their own farms.

All agencies have cooperated in this vast educational work. Much information on weed identification and eradication has been distributed to farmers and grain and seed dealers. Educational material has also been distributed to practically every school in Nebraska. The State department of agriculture has published and distributed a bulletin, "Nebraska Weeds," which has become very popular. This bulletin contains illustrations, means of identification, and methods of eradication of common weeds. In many schools this bulletin is now being used as a textbook for agricultural classes.

Still another part of the educational work during the past year has been the comprehensive bindweed survey which is now being completed. Only through the cooperation of the State and Federal crop statistician, precinct assessors of the State, the Agricultural Extension Service, and the State department of agriculture has this been accomplished.

With the assistance of the Works Progress Administration, noxious-weed-infestation maps and other informative material will be developed in the future for furthering the educational work in counties of Nebraska.

Weed Eradication Districts

Bindweed control in Nebraska is recognized as a community problem and hence the organization of legal weed-eradication districts as the second step in the Nebraska noxious-weed-control program. In Nebraska it is a well-known fact that the sale and loan value of land infested with bindweed is greatly reduced, cultivation increased, and the crop yield reduced from 10 to 90 percent. Sometimes even the land is abandoned for crop-growing purposes.

These facts have brought out the necessity for definite organization to combat bindweed. Under the Nebraska law, such districts may be established by petition of 51 percent of the resident landowners or owners of 60 percent of the land in any contiguous body of land. After a survey has been conducted by the department of agriculture and inspection to determine the feasibility of organization, a hearing is held before the county board. The board at that time determines whether an organization shall be established.

A weed-district organization assures a district-wide eradication program. A certain percent of each portion of infested land within the district is treated each year, leading to complete eradication. All roads, railroad rights-of-way, ditches, and canals must be cleared at the expense of the controlling agencies.

These districts are administered by supervisors who are elected by the landowners themselves within the area. Organized districts receive the benefit of State supervision and cooperation. The costs are borne according to benefits derived. In most of the organizations, all landowners share in the organization and administrative costs. Each landowner, however, is responsible for his own eradication. The organization and administrative costs thus far have averaged in Nebraska from ½ cent to 2 cents an acre for the first year.

At present, there are 18 areas either organized or undergoing organization procedure in Nebraska. They vary in size from 9,609 to 365,000 acres. Approximately 1,200,000 acres will be under noxious weed district organization at the close of the summer of 1939.

First organized under the State weed law was the Mitchell precinct noxious weed eradication district in Scottsbluff County, located in the North Platte irrigated valley and composed of about 29,000 acres. Landowners there are much concerned over eradication of the bindweed. This was evidenced by the fact that 95 percent of the resident landowners petitioned to establish the district. Only 2 landowners out of the 125 present at the hearing for organization were opposed.

A survey conducted by the department of agriculture and inspection shows 303 bindweed-infested areas were mapped on 85 farms in the district for a total of about 70 acres. In 1938 the district supervisors urged all landowners to eradicate as much as possible, but no eradication assessment was made on anyone.

So successful was the work that the supervisors thought it again unnecessary to make any eradication assessments in 1939. Out of the 303 infested areas, a total of 251 were treated last year, which shows the progress being made under the organization plan.

The extensive work carried on last year was probably somewhat encouraged by the demonstrational weed-control plots of the State department of agriculture and inspection, the Nebraska College of Agriculture, and the U. S. Department of Agriculture. Also a very successful weed tour of the district was sponsored by C. W. Nibler, Scottsbluff County agricultural agent.

Similar instances of progress could be cited in other districts. But more of the eradication work is being done by cultivation than by the chemical method as the infested areas are larger.

Recently the Works Progress Administration approved a state-wide project to assist the public agencies in eradicating bindweed and other noxious weeds on publicly owned property in organized weed-eradication district. The projects are now being established.

Eradication

Methods of eradicating bindweed and other noxious weeds recommended by the department of agriculture and inspection in the districts are those outlined and developed by the Department of Agronomy at the Nebraska College of Agriculture and the Nebraska Agricultural Experiment Station. Important information is also constantly derived from the Federal-State noxious-weed laboratories and particularly from the one located near York, Nebr.

Cultivation is regarded as the most practical and economical method if the infested areas are not too small. Cutting off the above-ground parts of the plant about every 10 or 12 days the first year forces the plant to continually draw upon its food reserves in the roots in the production of new growth. Fewer cultivations at less frequent intervals then are required the second year. Originally, 20 to 30 cultivations were necessary for complete eradication. Cultivating at a depth of 4 inches seems to be most practical and economical.

A duck-foot cultivator with shovels overlapping 3 to 4 inches is the best implement for eradication work. Improvised tools with long straight blades, duck-foot shovels attached to corn cultivators and other attachments have also proven satisfactory. Cultivation costs vary, depending upon the type of implement and power used. The cost of eradication averages between $7.50 and $12 an acre over a period of two years.

Past experience discloses that even after a bindweed patch is destroyed, there is still the problem of new seedlings. Bindweed seeds have been known to stay in the ground 20 years and still germinate. Plowing the ground at greater depths once or twice a season will bring seeds closer to the surface and encourage them to germinate. A frequent cultivation will then destroy the seedlings.

Sodium chlorate has proven the cheapest and most practical chemical found for bindweed eradication. Best results in Nebraska have been obtained if it is applied in the fall months when there is a sufficient supply of soil moisture to cause the sodium chlorate to dissolve and leach downward. Three pounds of sodium chlorate to the square rod are recommended for average conditions.

On rich soil containing much organic matter, larger amounts are recommended. Most landowners in the Mitchell precinct district have used 4 pounds per square rod and have secured good kills. Recent information shows that better kills are obtained if the ground is not disturbed before or after sodium chlorate is applied. The treated area should be left undisturbed the following season in order that the treatment may be fully effective. Applying the sodium chlorate in the dry form, when conditions are favorable, is preferable.

Preventive Measures

In addition to the methods described above, one other means of getting the noxious weeds is being used extensively in Nebraska—that of preventing infestation of areas. Under provisions of the State weed law, the sale of seed, livestock feed, and other material containing noxious weed seed is prohibited until it has been processed in such a way as to destroy or remove the viability of the weed seed. These regulations, along with other material, were distributed to owners and operators of elevators, mills, seed houses, and public sale barns for their information as well as to apprise their patrons.

Representatives of the department of agriculture and inspection have also interviewed owners and operators of these organizations, explaining the purposes of the weed law. There has been a marked interest on the part of farmers and elevator and seedmen in seed and feed inspection since the enactment of the weed law.

Also, in past years many new infestations of bindweed were caused by threshing machines and combines carrying weed seed from farm to farm. Under the provisions of the State law, all harvesting machinery must be cleaned before being moved from a field infested with noxious weeds. Furthermore, printed copies of these regulations must be affixed to and remain upon every threshing machine or combine during the time it is operated in the State. Inspection work is carried on during the harvest season in an attempt to secure cooperation of farmers and machine operators in carrying out provisions of the law.

Such a noxious-weed-control program, based upon education, district organization, and prevention, is bringing real and tangible results to Nebraska and will continue to do so in the future.

Reclamation Contracts Create Industrial Activity

THE self-liquidating projects of the Bureau of Reclamation are moving forward and total contracts for labor, materials, and machinery amount to $130,000,000.

Labor contracts in progress August 1 amounted to about $100,000,000 and materials on order, such as cement and steel, together with machinery, such as dam spillway gates and power-plant equipment, made up the rest.

Under contract are 32 major labor jobs, which call for an expenditure of $93,169,000, chiefly on man power.

Biggest labor jobs are the construction of Shasta Dam and its power plant on California's Central Valley reclamation development and the completion of Grand Coulee Dam on the Columbia Basin irrigation project in Washington.

Shasta Dam will not only be the second highest concrete masonry dam in the world, ranking after Boulder, but it will rank second largest, in cubic yards of concrete masonry, after Grand Coulee. Shasta's spillway will create a waterfall three times higher than Niagara.

The Shasta construction job, which was awarded to the Pacific Constructors Co., Inc., Los Angeles, amounts to $35,939,450. It will be finished in 1944.

The completion of Grand Coulee Dam, the base of which was covered under a separate contract, is scheduled for 1942, and will cost $34,442,240. Consolidated Builders, Inc., of Oakland, Calif., has the job.

Shasta and Grand Coulee together also account for a large part of the $30,000,000 of materials and machinery on order, according to the report. Shasta construction calls for 5,800,000 barrels of cement, at a cost of about $6,900,000. In addition, four generating units for the power plant have already been ordered, which amount to about $4,300,000.

Grand Coulee's completion requires about 3,500,000 barrels of cement, at about $5 209,-000, and the Bureau has already awarded contracts for three generator units in the power plant at a cost of $4,150,000.

The two generator units now on order for Boulder Dam, which will bring the number installed in its power plant to 11, with 6 still to be bought and placed in operation as the demand for electrical energy justifies the installation, will cost $2,375,000.

The self-paying aspect of Reclamation development work and the industrial activity and employment created by the program were emphasized by Commissioner Page in making his report on these contracts to Secretary of the Interior Ickes. Mr. Page said:

"This $130,000,000 of contracted work, awarded to American business and labor, is triply approvable. First, it brings desirable permanent contributions to the economy. Second, it is self-liquidating—all of it will be under contract for repayment to the United States. And third, its effects on industry and employment spread throughout the country.

"In employment alone, according to Bureau of Labor Statistics records on the labor required for Reclamation work, the Bureau of Reclamation's present contracted program of irrigation construction and development is creating more than 140,000,000 man-hours of work, both direct and indirect."

A list of major labor contracts of the Bureau of Reclamation in force as of July 20 amounting to more than $500,000 follows:

Major Labor Contracts of the Bureau of Reclamation as of July 20, 1939

State and project	Description of work	Contractor	Contract	Year started	Percent complete
California: Central Valley	Construction of Shasta Dam and power plant.	Pacific Constructors, Inc., Los Angeles, Calif.	$35,939,450	1938	26
Washington: Columbia Basin.	Completion of Grand Coulee Dam.	Consolidated Builders, Inc., Oakland, Calif.	34,442,240	1938	36
Colorado: Colo-Big Thompson.	Construction of Green Mountain Dam and power plant.	Warner Construction Co., Chicago, Ill.	4,226,206	1938	16
Utah: Provo River	Construction of Deer Creek Dam and appurtenant works.	Rohl-Connelly Co., Los Angeles, Calif.	2,190,638	1938	30
Colorado: Pine River	Construction of Vallecito Dam.	Martin Wunderlich Co., Jefferson City, Mo.	2,115,870	1938	36
Arizona-Nevada: Boulder Canyon.	Furnishing and installing generators.	Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.	1,506,665	1938	80
Washington: Columbia Basin.	Furnishing and erecting penstocks and pump inlet pipes.	Western Pipe & Steel Co. of California, San Francisco, Calif.	1,456,624	1938	51
California: Central Valley	Earthwork, tunnels, and structures, Southern Pacific R. R. relocation.	R. G. Clifford, San Francisco, Calif.	1,223,186	1939	1
Do	do	West Construction Co., Monrovia, Calif.	905,078	1938	34
Do	Earthwork and structures, Southern Pacific R. R.	Granfield, Farrar & Carlin, San Francisco, Calif.	814,816	1938	75
Utah: Provo River	Construction of Olmsted and Alpine-Draper tunnels.	George K. Thompson & Co., Los Angeles, Calif.	746,535	1938	[illegible]
Nevada-California: Truckee Storage.	Construction of Boca Dam	Geo. W. Condon, Omaha, Nebr	668,110	1937	94
California: Central Valley	Earthwork, tunnels, and structures, Southern Pacific R. R.	United Concrete Pipe Corporation, Los Angeles, Calif.	598,674	1939	56
Do	Construction of Sacramento River Bridge.	American Bridge Co., Pittsburgh, Pa.	569,100	1938	60
Washington: Yakima-Roza.	Construction of Roza Diversion Dam, bench flume and railroad bridge.	Morrison-Knudsen Co., Inc., Boise, Idaho.	531,491	1938	86

47-Mile Section of Coachella Canal Contract Awarded

MORRISON-KNUDSEN Co., Inc., and M. H. Hasler, of Los Angeles, Calif., submitted the lowest and successful bid of eight proposals received and opened at Yuma, Ariz., on June 1 last for the construction of a 47-mile section of the Coachella Canal of the All-American Canal System, this section to augment the 43-mile section which was begun about a year ago and bring under present construction 90 miles of the 130-mile canal.

Taking out of the All-American Canal just west of the sand hills in the East Mesa of the Imperial Valley, Calif., this branch canal threads northwest about 100 miles to a point past the Salton Sea, then curves fingerlike and returns south about a third of its distance through the Coachella Valley.

This second section of the canal will begin a little south of the Salton Sea, almost paralleling the sea for about two-thirds of its length, to near Dos Palmas, Calif.

The contract includes 32 siphons, 4 spillways, and 5 drainage inlets in addition to excavation work. These structures are necessary because more than 160 washes cross the canal line. These washes are dry ordinarily, but at times of heavy rain or cloudbursts, they carry floods of short duration, heavily loaded with sand and silt. It is estimated that about 90 structures will be needed to cross the washes, even though some of the washes will be grouped together by means of diversion channels and levees.

The siphons covered by this contract will have rectangular-shaped barrels.

Approximately 1,000,000 acres of rich desert lands in the Imperial and Coachella Valleys ultimately will be irrigated by the All-American Canal and Coachella Canal.

The 80-mile All-American Canal is virtually completed and probably will be put in use the early part of next year. About 500,000 acres now irrigated in the Imperial Valley will be served by this canal.

The Coachella Canal is designed to serve more than 350,000 acres of arid lands, which have not heretofore been irrigated. These lands lie in the section known as the East Mesa of the Imperial Valley between Holtville, Calif., and Yuma, Ariz., and in the southern end of the Coachella Valley north of Salton Sea. Some lands in the Coachella Valley are at present being supplied water by pumping from wells.

The All-American Canal System was authorized as a part of the Boulder Canyon project in 1928.

The present contract calls for commencement of work within 30 days after date of receipt by the contractor of notice to proceed and for completion of this section of the canal within 1,060 calendar days, 35 days less than 3 years.

Boulder Recreational Development

ON a beautifully situated spot, which gives an excellent panoramic view of Lake Mead, ground work on the Hemenway development area is progressing rapidly. The development work is being done on the new site of the projected boat docks, camp sites, resort, and bathing beach, and is under the direction of Supervisor Guy D. Edwards and his National Park Service staff.

Of special interest is the new standard gage highway, which will branch off from the Boulder City-Boulder Dam Highway to the Hemenway development area 2 miles away. The road is being built under the supervision of the Bureau of Public Roads. The highway will go to the camp sites and then to the permanent boat landings one-half mile farther north.

One hundred trees have already been planted at the camp site and are flourishing under the expert care of Park Service naturalists. Camp sites have been marked and construction work on them will be started at an early date. Modern comfort stations, electricity, water, and sewage disposal will be available to campers.

Two hundred feet above the new camp site, which is 1¼ miles from the present boat landing, are special camps for cars with trailers. Below the camp site is the bathing beach, which has already been graded and has a large quantity of sand spread over the contour of the beach. Near the camp site will be constructed a modern Spanish ranch house style resort building.

(*Continued on page 243*)

Rio Grande Project Provides Recreation Spot

By WALTER K. M. SLAVIK

ELEPHANT BUTTE Reservoir, created by Elephant Butte Dam on the Rio Grande (New Mexico) reclamation project, is becoming one of the State's most popular recreation spots. As a drawing card for visitors, it is reported second only to the well-advertised Carlsbad Caverns.

Local newspaper accounts describe the reservoir as "a blue sea of islands in the middle of a desert" and "a wonderful spot to spend the week end." Thousands of New Mexicans and Texans from El Paso and other towns go there to fish, camp, swim, boat, and picnic along its 200 miles of wooded shore line.

Once yearly the reservoir is the scene of a regatta attended by 5,000 to 6,000 spectators. Numbers of motorboat races, with hydroplanes, inboard and outboard motorboats, are held, and trophies awarded to winners. Other events include surfboard competition, swimming races, diving contests, water polo games, and casting contests.

The regatta is a community affair, with all participating in its preparation. All the organized work and control of the regatta is voluntary. Money received as admission fees is awarded to winners of races in addition to loving cups and medals.

Ninth Annual Regatta Held

Hundreds of citizens from El Paso, Tex., about 100 miles south of Elephant Butte Dam, discovered for themselves the attractions of the reservoir as a summer resort during the ninth annual regatta, held recently. Every year more vacationists wonder how they had overlooked the reservoir as a vacationing place, and add themselves to the growing number of campers.

Fishing is the favorite sport at the lake. Four long floats reach out into the lake below a dance pavilion near the dam. Crappie fishing is very popular on the floats, but other fishermen with bigger prizes in mind hire outboard motorboats and go out for the 25 black bass that have been tagged by the Federal Warm Water Hatchery below the dam. Each of these fish brings the lucky angler $50 in prize money from Hot Springs, N. Mex., businessmen. Four have been caught. The hatchery has been stocking the lake with blue gill, also.

Swimming is pleasant anywhere on the lake, but a cove near the dam draws most people. The cove has a large sandy beach with a smooth bottom and gradual slope safe even for children. The cove has a float and diving platform.

Elephant Butte Dam. Reservoir with its 200 miles of recreational shore line in background

Speedboat Rides Available

Speedboat rides are available to visitors to the reservoir. For 50 cents one can ride around Elephant Butte Island.

Provisions for overnight visitors to the lake are being developed. Lake front camping grounds have been completed, shaded by trees and green with lawn. Stones set the grounds off into units. Each unit has a stone table and benches, a stone fireplace, an electric outlet and meter for cooking and other appliances, and space for a tent or trailer and automobile. Foundations for 22 cottages have already been laid.

Rio Grande One of First Projects

The Rio Grande irrigation project is in New Mexico along the Rio Grande just above the Mexican border. It was one of the first to be constructed by the Bureau of Reclamation. Surveys were begun in 1903, actual work started in 1906 and first water delivered to irrigation farmers in 1908. Elephant Butte Dam was completed in 1916.

When the dam was built it was known that hydroelectric development was possible and six 5-foot diameter pipes were built into the dam to use later, as soon as the power possibilities might be developed. Water released to supply irrigation needs could provide only seasonal or dump power, however, for which there is little demand, until Caballo Dam was finished last year.

Caballo Dam the Regulating Reservoir

Caballo Dam is also on the Rio Grande, about 25 miles downstream from Elephant Butte Dam, in Sierra County, N. Mex. It provides a regulating reservoir for the water released at Elephant Butte. The water let out during the winter months is retained in Caballo Reservoir for irrigation use the following summer. During the summer the Caballo Reservoir is then drawn down by irrigation requirements until it is ready in the fall to receive the next winter's accumulation of water at Elephant Butte Reservoir. Thus water can be released at Elephant Butte at a uniform rate throughout the year and firm or year-round power can be generated, while irrigation farmers below Caballo are assured of a reliable supply of water for their needs.

Power Plant Under Construction

The power plant at Elephant Butte now under construction by the Bureau of Reclamation will have a total capacity of 27,000 kilovolt-amperes. Turbines driving three generators will each develop 11,500 horsepower. Three penstocks 8 feet in diameter will carry the water to the turbines. Huge manifolds will connect the three penstocks with the six 5-foot penstocks originally built into the dam.

The turbines and generators are to be of the vertical type. The turbine will be directly below the generator to which it is connected. Each turbine-generator unit will be higher than a 4-story building.

The power plant is expected to be completed sometime next year, and 115,000 volt transmission lines from the dam to Las Cruces, and to Deming by way of Silver City, are contemplated.

At least 100,000 acre-feet of storage capacity will always remain available at Caballo Dam for flood-control purposes, however, and power generation at Elephant Butte will of necessity be subordinated to flood control, for which the dam was primarily built, and irrigation requirements.

Recreational Development

(*Continued from page 241*)

On the hill, above the camp development, is being constructed a 375,000-gallon double-compartment reservoir which will be fed by a 6-inch pipe from the booster plant 1½ miles away. Pipe lines are being laid to the camp-site area and to the new boat landing.

The new boat docks, one-half mile north of the camp site, and 2 miles north of the present boat landing, are now under construction. The docks are situated in a little cove, protected from north winds by small hills. The site selected for the permanent boat docks is at the base of the peak known as Red Mountains.

Above the boat landing and in a protected area is being constructed a modern spray type sewage disposal system. Sewage pipes from the camp ground to the boat landing and then to the new disposal plant have already been laid.

A 33,000-volt power line has been constructed to carry the power to the new area. In the near future more trees, decorative bushes, and plants will be set out at the camp site and boat landing.

The new site selected will give the tourists a majestic view of Lake Mead and the highly colored foothills of Fortification Mountain.

L. S. Davis Returns to Bureau Rolls

LOUIS S. DAVIS, for the past 4 years in charge of the C. C. C. Division in the Office of the Chief Engineer, Denver, Colo., has returned to the regular rolls of the Bureau in the Denver office. Responsibility for the C. C. C. work formerly performed in the Chief Engineer's office has been divided between the Commissioner's office in Washington and the various regional directors.

Speedboats in foreground for 50 cents ride passengers around Elephant Butte Island, prominent in the distance

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been approved by the Secretary:

Appointments

Ole J. Hendrickson, junior engineer, Columbia Basin project, Coulee Dam, Wash. (by transfer from War Department).

Edward W. Fisher, associate attorney, Legal Division, Washington office (detailed to Office of the Solicitor).

Benjamin Palmer King, associate attorney, Field Legal Office, Billings, Mont.

Transfers

Carl A. Hagelin, from junior engineer, Denver, Colo., to assistant engineeer, Pine River project, Bayfield, Colo.

James H. Warner, from resident engineer, Seminoe Dam, Kendrick project, Wyoming, to senior engineer, Friant division, Central Valley project, Friant, Calif.

Chas. S. Hazen, assistant engineer, Denver, Colo., to Helena, Mont. (Secondary projects.)

Don Henry Huff, junior engineer, from Denver, Colo., to Boise-Weiser-Payette investigations, Weiser, Idaho.

Carl L. Myers, from junior engineer, Denver, Colo., to assistant engineer, Yellowstone River Basin investigations, Billings, Mont.

John E. O Fallon, junior engineer, from All-American Canal, Yuma, Ariz., to Denver, Colo.

Clifford E. Cross, junior engineer, from Denver, Colo., to Green Mountain Dam, Colorado-Big Thompson project, Colorado.

Porter J. Preston, supervising engineer, Colorado-Big Thompson project, Denver, Colo., to Estes Park, Colo.

Kent S. Ehrman, assistant engineer, from Denver, Colo., to Bend, Oreg. (Deschutes project.)

James D. Church, Jr., from assistant engineer, Denver, Colo., to same at Parker Dam, Calif.

Eugene L. Gallagher, from associate engineer, Denver, Colo., to same at Parker Dam, Calif.

Separations

Kenneth S. Brown, head photographer, Columbia Basin project, Coulee Dam, Wash., to enter private business.

Francis V. Frazier, junior engineer, Denver, Colo., to accept position in San Diego, Calif.

Herman L. Cooper, junior engineer, Denver, Colo., to accept probational appointment in War Department, Washington, D. C.

Dale B. Lamb, assistant engineer, Boulder Canyon project, to accept position at the Bonneville Dam, Portland, Oreg.

A Public Power Project in Puerto Rico

By CARL A. BOCK, *Consulting Engineer*

ON the island territory of Puerto Rico there is gradually but steadily coming to fruition a power system that is now attracting much attention from those interested in the possibilities of public power development. It had escaped from general public notice, no doubt, because the project was started more than 20 years ago as an irrigation development and not a power project.

Puerto Rico is fourth in size of the West Indies Islands, having a total area of only 3,435 square miles. It has a warm equable climate. Although it is very mountainous, with peaks rising to 4,400 feet above the sea, a considerable area of fertile coastal plains is well adapted to agriculture. Its dense population (1,825,000, or about 530 to the square mile) necessitates intensive use of the land. With this situation has developed the island's chief industry and main source of wealth, the production of sugar. The flat coastal lands are specially well suited to the growing of cane, but the crop is limited by the supply of water available for irrigation. While the rainfall is intense in some of the high mountain regions, exceeding 100 inches at one station, on some of the lowlands best suited to farming, the rainfall averages less than 35 inches.

The public irrigation law in 1908 initiated government participation in the development of water resources. The small, inefficient private systems of irrigation were entirely inadequate. The large investment required and the need for cooperative action among the landowners in order to assure the most widespread economic benefits possible under these conditions clearly indicated the need for comprehensive government development and control.

Engineering studies were undertaken soon after the passage of the law and construction was started in 1910. It was logical to seek water in the mountains and bring it to the plains. The first project for this purpose provided a storage reservoir some 2,000 feet above sea level for impounding flood runoff. While this provided only a relatively small amount of water, a fall of more than 1,000 feet to the irrigated lands made feasible the installation of a small power plant at Carite, in 1915. The power feature was quite incidental, the first plant having a single unit of only 600-kilowatt capacity.

Prior to this installation electric power development on the island was wholly in the hands of private enterprise, and service was confined mainly to the three largest cities—San Juan in the north, Ponce in the south, and Mayaguez in the western portion of the island. The San Juan franchise, however, called for extension of service over the entire central, north, and eastern region, and lines were gradually extended to serve the more populous towns. There are no oil or coal deposits on the island, and the private power plants are operated largely with imported fuel oil.

Panoramic view of the Toro Negro hydroelectric plant No. 2

Uses for Electricity Increase

The first use of the Government byproduct power was for pumping water in the irrigated districts. Soon the demand for this increased as the irrigation projects made more land and more water available. Other hydroelectric plants were added from time to time, with suitable transmission and distribution lines. Electricity thus made available, and at reasonable rates, soon was being used for various purposes in sections which had previously been without electric power.

The reliability, reasonable cost, and convenience of Government power created a popular demand to have this service extended to other areas where electric power was still lacking. Supported by 10 years of successful operation of its hydroelectric system the insular government in 1925 passed an "act for the development of water resources," which was broadened in 1927, providing for surveys and for the construction of additional power plants. Pursuant to this act, the insular executive council in 1929 adopted a resolution prescribing that the territory in the southern part of the island would constitute the area in which the Government through its utilization of water resources might distribute its surplus electric power. The resolution states that where a given portion of the area has been assigned through franchise to a public service company the utilization of water resources shall not, as a matter of policy to avoid interference with the interests of the public and of the company, sell or distribute any power directly to consumers provided the public service company meets the demand.

The general policy of the utilization of water resources with reference to the disposition of its electric power is outlined in part by the following quotation from its annual report of 1930:

"Thus organized we proceeded with the work of the year extending our transmission and distribution lines with a view to developing the territory which it is our duty to serve and providing for the gradual and natural expansion to other territory where electric service may be lacking and the use of power from our system will prove advantageous to the public. These endeavors have been directed with no desire nor purpose to interfere in any way with the interests of private enterprises which are engaged in similar work in the island . . .

"It has not been our policy to in any way attempt to compete with or invade the territory that belongs to or is claimed by privately owned public-service companies and which can be served by these companies adequately and advantageously for the public. It is gratifying to note that the incentive created by our service in the public mind toward appreciating more and more the value of electric current for all purposes and their multiplying the consumption of electricity have caused a widespread stimulus in the industry which has moved the public service companies operating in the island to decide on expanding their business and to seek interconnections."

Additions early were made to the initial Carite plant, and this development now comprises three units having a total capacity of 4,600 kilowatts. A second development has been built in the mountains of Toro Negro, in the south-central portion of the island. It has two units with a combined capacity of 10,600 kilowatts. Purchase of the Ponce steam plant in 1937 added 3,300 kilowatts, bringing the system total to 18,500 kilowats. Two other projects, Gaizas and Dos Bocas, are entering the construction stage in the west-central mountain region of the island and will have a combined installed capacity of 27,000 kilowatts. One of the projects develops a power head of 2,000 feet.

A significant addition is the Ponce Electric

Upper: View of penstock line, powerhouse, and outdoor switching structures
Lower: Guayabal Reservoir

View of Carite

Toro Negro hydroelectric plant No. 1

Toro Negro hydroelectric plant No. 2

Co.'s properties, purchased by the government last year for $1,050,000, and immediately made an integral part of the power system of the water-resources utilization. The Ponce Co. was previously one of the largest purchasers of power from the government system. The plant operates with imported fuel oil. With the acquisition of this property the government network now comprises 340 miles of transmission lines and 500 miles of distribution lines. It serves an area of more than one-third of the entire island. A total of $5,443,000 has been invested by the insular government in the hydroelectric system (not including Ponce steam plant, nor Garzas, and Dos Bocas). Revenue from the sale of power in the fiscal year 1936–37 amounted to $661,100. Operating expenses amounted to $206,600. The government's system during that year produced 40 percent of the power generated on the island. Of its present production 70 percent was used within its area of operation, and of this amount 82 percent was used for irrigation and other uses in the rural areas, and 18 percent was used for light and power in towns. The other 30 percent of its production was sold to outside interconnected systems belonging to municipalities and to privately owned public utilities.

In the development of this system by the government, interconnections have been made with the systems of operating utilities and with private industrial plants, which together now provide an interconnected system of some 45,000 kilowatts of generating capacity. The pooling of these facilities makes available enough reserve capacity to take care of, in an emergency, the load of any individual system. Through its interconnections the government has developed an economy by using the power from surplus bagasse (cane byproduct used for fuel) at two of the sugar mills. It buys the surplus power from these companies during the grinding season, January to June, which corresponds with the dry season, and sells electrical power to the same companies for their agricultural needs during the rainy season.

This government power development in the beginning was only a very incidental part but is now a part of a unified, multipurpose program for utilization of the water resources of the island. It was developed gradually in an endeavor to provide electricity for those parts of the island which had not been supplied by private enterprise. It was the policy to provide electric service where it was lacking. It was the policy to cooperate freely with privately owned public-service companies by selling them surplus power when they needed it. This policy resulted in the gradual creation of a service which because of its dependability and its availability through cooperation not only satisfied a popular demand for electric power, but created a widespread stimulus which encouraged private companies to expand their facilities and to seek further interconnection with the government system. This approach facilitated purchase of the Ponce property. It has put the insular government definitely in the power business.

Project works have been built conservatively, and have been operated with economy, under the direction of a director-chief engineer, an American graduate engineer who is qualified by training and experience to plan, build, and operate water control and hydroelectric projects. Much credit for maintaining the general plan of approach is due to Dr. Ernest Gruening, Director of the Division of Territories and Island Possessions in the United States Department of the Interior, and until last July administrator of the Puerto Rico Reconstruction Administration, who has given his full support to the development program. The Puerto Rico Reconstruction Administration, now under the local administration of Miles H. Fairbank, assistant administrator, has continued to help finance the construction. The original development and actual execution of the policies have been largely the work of Antonio Lucchetti, director-chief engineer.

Shasta Dam Aggregates Contract Awarded

A CONTRACT for one of the largest gravel processing jobs ever undertaken by the Bureau of Reclamation was awarded on August 2 for the preparation of concrete aggregates for Shasta Dam, Central Valley project, California.

The successful bid of $4,413,520, submitted by the Columbia Construction Company, Inc., of Oakland, Calif., was the lowest of four proposals received and opened on June 1 by the Bureau of Reclamation at its Sacramento, Calif., office.

An estimated 7,600,000 tons of gravel and 2,800,000 tons of sand will be required for the manufacture of concrete at Shasta Dam. This gravel and sand will be obtained from the North Kutras tract located at a bend in the Sacramento River just east of Redding, Shasta County, about 12 miles downstream from the dam site.

This contract involves clearing the areas to be stripped of all trees, brush, and other objectionable surface materials; construction of a large processing plant; excavating and processing the gravel and sand; building railroad tracks to connect with the main line of the Southern Pacific Railroad Co.; loading aggregates into cars; and transporting the material to an interchange yard on the main line. The interchange yard will be located near Middle Creek, 2½ miles above Redding.

Washed and graded aggregates will be stock piled in five sizes, one of sand and four of gravel. The gravel will vary in size from $\frac{3}{16}$ of an inch to 6 inches.

The Bureau of Reclamation will provide for transportation of the sand and gravel in steel gondola-type cars from the interchange

(*Continued on page 247*)

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or materia	Low bidder: Name	Low bidder: Address	Bid	Terms	Contract awarded
		1939						*1939*
1242-D	Deschutes, Oreg	June 27	One 25-ton, single-motor, overhead traveling crane for valve house of Wickiup outlet works.	Cyclops Iron Works	San Francisco, Calif	$3,438.00	Discount ½ percent	July 12
1248-D	Columbia Basin, Wash	July 5	Racks, rack-operating mechanisms and elevator hoists for dams Nos. 2, 3, and 4 at Leavenworth station.	Worden-Allen Co	Milwaukee, Wis	[1] 5,085.00	do	July 14
				Puget Sound Machinery Depot.	Seattle, Wash	[2] 3,045.00		Do.
1245-D	Kendrick, Wyo	June 29	Precast reinforced concrete pipe	Elk River Concrete Products Co. of Montana.	Helena, Mont	13,841.20	F. o. b. Casper, discount ½ percent.	July 22
1249-D	Columbia Basin, Wash	July 6	2 radial gates and 1 radial gate hoist for dam No. 2 at Leavenworth station.	Berkeley Steel Construction Co., Inc.	Berkeley, Calif	[1] 980.00	Discount ½ percent	July 19
				Commercial Iron Works	Portland, Oreg	[2] 1,994.00	do	July 18
1251-D	do	July 7	Miscellaneous metalwork for installation at the Leavenworth station.	Arthur J. O'Leary & Son Co.	Chicago, Ill	2,945.00	do	Do.
1253-D	Shoshone-Heart Mountain, Wyo.	July 10	Metalwork for trashrack frames and sections for the controlling works of the Shoshone Canyon Conduit.	Worden-Allen Co	Milwaukee, Wis	1,726.00	do	July 19
840	Colorado-Big Thompson, Colo.	June 7	Construction of Continental Divide tunnel.	Shasta Construction Co	San Francisco, Calif	10,759,405.00		[3]
A-38, 385-A	Columbia Basin, Wash	June 20	12 Diesel-engine-powered crawler tractors, 2 towing winches and 2 logging sulkies.	Caterpillar Tractor Co	Peoria, Ill	[4] 27,948.00	Discount $50 per unit	July 18
A-38, 392-A	do	June 26	22 stake body trucks, 5 pickup trucks, and 4 station wagons.	William O. McKay Co	Seattle, Wash	[5] 33,365.33	F. o. b. Dearborn, Mich., except stake bodies.	July 20
1252-D	Rio Grande, N. Mex.-Tex	July 7	Ventilating and air conditioning equipment for the Elephant Butte power plant.	The New York Blower Co	Chicago, Ill	[6] 264.10	F. o. b. Engle, N. Mex	July 18
				Reynolds Electrical and Engineering Co.	El Paso, Tex	[7] 503.70	do	Do.
				American Blower Corporation.	Denver, Colo	[8] 229.42	F. o. b. Detroit	July 22
				The Bishop & Babcock Manufacturing Co.	Cleveland, Ohio	[9] 60.00	F. o. b. Engle, N. Mex., discount 2 percent.	July 19
1256-D	do	July 6	5,000 barrels of finely ground standard portland cement in cloth sacks.	Southwestern Portland Cement Co.	El Paso, Tex	12,400.00	Discount and sacks allowance 50 cents per barrel.	July 21
850	Deschutes, Oreg	June 27	Construction of Crane Prairie Dam and outlet works at Wickiup Dam.	Vernon Bros. Co	Boise, Idaho	[6] 98,560.00		July 28
				C. J. Montag & Sons	Roseburg, Oreg	[7] 154,653.50		Do.
1255-D	Rio Grande, N. Mex	July 11	1 oil purifier, 1 filter-paper drying oven and 1 portable dielectric test set for Elephant Butte power plant.	The DeLaval Separator Co	Chicago, Ill	[1] 2,365.00	F. o. b. Engle, N. Mex	July 21
				Westinghouse Electric and Manufacturing Co.	Denver, Colo	[2] 138.21	do	July 25
				The Standard Transformer Co.	Warren, Ohio	[1] 195.09	F. o. b. Engle, N. Mex., discount 1 percent.	July 26
835	Boulder Canyon, Ariz.-Nev.	May 15	Hydraulic turbines for units A-1 and A-2, Boulder power plant.	Baldwin-Southwark Corporation.	Eddystone, Pa	[6] 874,800.00	F. o. b. Eddystone	Aug. 1
852	do	July 5	23,000-volt bus structures, bus structure changers, oil circuit breakers, and oil circuit-breaker changers.	Railway and Industrial Engineering Co.	Greensburg, Pa	[6] 371,100.00	F. o. b. Boulder City	Do.
				I. T. E. Circuit Breaker Co	Philadelphia, Pa	[11] 212,970.00	do	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[9] 13,463.00	do	Do.
				Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[12] 663,739.00	do	Do.
853	Columbia Basin, Wash	do	Two 72-inch diameter ring seal gates for station service penstocks, Grand Coulee power plant.	Koppers Co., Bartlett-Hayward Division.	Baltimore, Md	21,000.00	F. o. b. Baltimore	Do.
854	do	July 12	11 135- by 28-foot drum gates for Grand Coulee Dam.	American Bridge Co	Denver, Colo	609,360.00	F. o. b. Gary, Ind	Do.
855	Yakima-Roza, Wash	July 15	Earthwork, concrete lining and structures for wasteway No. 3, stations 1689 and 97.9, Yakima Ridge Canal.	H. J. Adler Construction Co	Yakima, Wash	158,966.00		Do.
861	Central Valley, Calif	July 14	Earthwork, tunnels and structures, Southern Pacific R. R. relocation, milepost 273.19 to milepost 278.36.	A. Teichert & Son, Inc., United Concrete Pipe Corporation, and Ralph A. Bell.	Pollock, Calif	1,857,567.50		Aug. 2
1247-D	Boise-Payette, Idaho	July 5	Structures H-Line Canal and laterals and D-Line Canal laterals 5.9 to 5.9-8.5-0.5.	Henry L. Horn	Caldwell, Idaho	21,265.50		Do.
27,602-C	Provo River, Utah	June 19	Cross ties and switch ties	Denver & Rio Grande Western R. R.	Denver, Colo	[13] 44,959.00	F. o. b. Deer Creek siding.	Do.
829	Colorado River, Tex	Mar. 7	Trashrack metalwork for outlet works at Marshall Ford Dam.	Joseph T. Ryerson & Sons, Inc.	Chicago, Ill	[1] 19,050.00	F. o. b. Chicago	[3]
				Treadwell Construction Co	Midland, Pa	[2] 31,680.00	F. o. b. Rutledge, Tex.	[3]
857	Central Valley, Calif	July 17	Two 2,500-kv.-a. vertical-shaft alternating-current generators for Shasta power plant.	General Electric Co	Schenectady, N. Y	52,500.00	F. o. b. Schenectady and Fort Wayne, Ind.	Aug. 9
1,250-D	Deschutes, Oreg	July 6	Two 96-inch o. d. welded plate-steel outlet pipes for outlet works at Wickiup Dam.	John W. Beam	Denver, Colo		F. o. b. Chicago, discount ½ percent.	Do.
1254-D	Boulder Canyon, Ariz.-Nev.	July 10	Line hardware and conductor fittings for 287.5 kv. switchyard at Boulder power plant.	Ohio Brass Co	Mansfield, Ohio	[6] 2,224.10	F. o. b. Boulder City	July 28
				General Electric Supply Corporation.	Denver, Colo	[7] 1,507.81	do	July 31
				Burndy Engineering Co., Inc.	New York, N. Y	58.65	do	Do.

[1] Item 1.
[2] Item 2.
[3] All bids rejected
[4] Items 1 and 2.
[5] Items 1, 2, 3, and 4.
[6] Schedule 1.
[7] Schedule 2.
[8] Schedule 3.
[9] Schedule 4.
[10] Item 3.
[11] Schedules 2 and 3.
[12] Schedules 5 and 6.
[13] Items 1 and 3.

Shasta Dam Contract

(Continued from page 246)

ard to Coram, which is just downstream rom the dam site. The graded gravel and and will be delivered at Coram to the Pacific Constructors, Inc., the general contractor now engaged in excavation operations at Shasta Dam. Pacific Constructors will manufacture and place the concrete.

It is estimated that the maximum daily delivery to be required when concrete operations at the dam reach a peak, probably in 1942, will be about 16,000 tons of gravel and 6,000 tons of sand, calling for four or five trains of about 80 cars each day.

The contractor is allowed almost 5½ years (2,000 calendar days) to make delivery of the aggregates after notice has been received to begin with the work. Deliveries will not be required before November 1, 1939.

C. C. C. Accomplishments on Federal Reclamation Projects, F. Y. 1939

By ALFRED R. GOLZÉ, *Supervising Engineer, C. C. C.*

THE C. C. C. program on Federal reclamation projects during the 1939 fiscal year was greatly augmented by a 30-percent increase in the number of camps assigned to the projects. From a total of 34 camps in July 1938, the number of camps increased to 44 in May 1939.

With the allocation of the additional camps it became possible to bring within the scope of the C. C. C. program nearly all of the Federal reclamation areas in urgent need of this type of assistance. The types of work on which the enrollees were engaged were many and varied.

The complex canal systems of the average irrigation project require many hundreds of permanent structures to control the valuable irrigation water and to release only the proper quantity to each farm. Canals passing through porous strata must be lined with concrete or clay to prevent seepage. The natural slope of valley lands requires concrete steps in the canal system to drop the water to lower elevations without erosion. Bridges, flumes, and siphons are necessary to carry the water over canyons and drainage channels. Operation roads must be constructed along the canals to permit Government operators access to the various control works and for inspections to prevent breaks due to leaks. Telephone lines between operators' headquarters are essential to the efficient management of the irrigation system.

C. C. C. on Operating Projects

Two-thirds of the C. C. C. camps of the Bureau of Reclamation were engaged on rehabilitation of the operating projects constructing permanent improvements of the above type. Outstanding achievements of the year included completion of the Stinkingwater Creek siphon on the Belle Fourche reclamation project in South Dakota. This monolithic concrete structure 200 feet long and 8 feet in diameter carries irrigation water under the creek bed by a drop of 39 feet.

On the Yuma project in southwestern Arizona C. C. C. activities reached their maximum in the winter months. This year the operation of one camp at Yuma through the summer has been successful. Concrete lining of canals, reconstruction of canals and structures, and rodent control comprise the principal features of the C. C. C. program.

On the Orland project in northern California an extensive program of concrete lining of the canal system has been undertaken by the newly established camp. Situated in a soil formation extensively porous, this conservation program will guarantee minimum waste in delivering water to the orchards and farms of this well-known project.

In western Colorado C. C. C. forces on the Grand Valley project have completed concrete lining on 2 more miles of main canals and laterals. Reduction in seepage on adjacent land is already apparent. Severe winter conditions curtailed construction of water-control structures, but more than 300 were built, principally of concrete. The assignment of an additional camp to the Uncompahgre project has expedited the project program for the reconstruction of all water-control structures and riprapping of waterways. C. C. C. enrollees from this project assisted in the construction of the Fruit Growers Dam and road improvements at Taylor Park Dam and in the Black Canyon of the Gunnison National Monument.

On the Boise reclamation project in southwestern Idaho C. C. C. enrollees completed reconstruction of the Deer Flat Reservoir, an important link in the irrigation system of this project. Principally a riprapping job of hand-placed rock to eliminate erosion on more than 10,000 linear feet of earth embankment, this work insures permanent protection to the water supply of the Boise project. The New York Canal was improved by the construction of operation roads on the banks with cattle guards to eliminate gates, and by concrete lining and blanket riprapping. Hand-placed riprapping of canals, clay lining of canals, and construction of recreational and wildlife facilities were the chief features in progress on the Minidoka project in southern Idaho.

In Montana, the temporary summer camp at Pishkun Reservoir on the Sun River project was discontinued in September 1938, being replaced by an all year camp near Augusta. The Elbow Coulee wasteway, a mile-long canyon cut 120 feet deep by waste water, has been placed under control by the construction of nine grouted-rock drops supplemented by large rock pilasters. The Willow Creek feeder canal, to bring Sun River water to Willow Creek Reservoir, was 70 percent complete at the end of the year. Near Babb, another summer camp of enrollees continued the rehabilitation of the large steel pipe siphon across the St. Marys River.

At Malta, Mont., headquarters for the Milk River project, an all-year camp was established in July 1938. Although handicapped by a record flood on the Milk River in March of this year, the new camp has accomplished many urgent improvements to the canal system. Side camps at Fresno Dam and Glasgow have facilitated extension of the C. C. C. work to all corners of the project. On the Lower Yellowstone project, in eastern Montana, permanent improvements to the canal system and revetment of the river banks were the principal features of work during the year. Similar work was in progress on the Huntley project in the southern part of the state throughout the fiscal year.

For the protection of the Newlands projec in western Nevada, C. C. C. enrollees con tinued the general rehabilitation program in progress the previous 3 years. Enrollees from one of the Fallon camps were transferred t Boca Dam in nearby California, for clearing the reservoir site and building roads. C. C. C work on the Humboldt project was termi nated on September 30, 1938, with completion of the parapet curb walls across Rye Patc Dam.

On the North Platte project in Wyoming and Nebraska a multitude of work projects were in progress by these camps. Supple menting the principal construction program of concrete lining of canals and reconstruc tion of water-control structures, were recrea tional developments at Guernsey Lake an Lake Minatare, planting of trees for erosion control, and experimental projects. Thes latter included experiments with strawberr clover, with various types of weed-competing grasses, with cotton fabric as a canal lining with weed burners and chemical weed eradi cators and with clean cultivation of weed infested areas.

On the Rio Grande project in New Mexic and Texas, rehabilitation of the project wit C. C. C. forces was continued. A side cam was established at Hatch, N. Mex., in orde that the enrollees could reach this area o the project without traveling exce.sive dis tances. As an aid to weed control, nearl 14,000 rods of fencing along ditch banks wer completed to enclose 21 miles of right-of-way furnishing pasturage for approximately 1,00 sheep. On the Carlsbad project concrete lin ing of canals was the principal activity 40,000 lineal feet being completed.

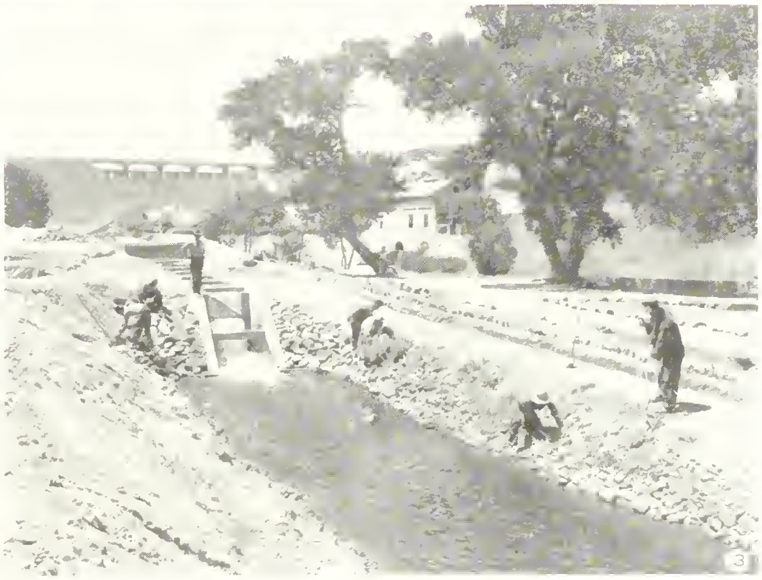
On the Klamath project in souther Oregon enrollees continued with rehabilita tion of the project distribution system, th raising of Clear Lake Dam, and the eradica

(*Continued on page 250*)

Work of CCC enrollees on Reclamation projects illustrated by recent photographs of typical activities

1. Completed flume in Grimes District, Newlands project

2. Completed turn-out and check in Old River District, Newlands project, Nevada



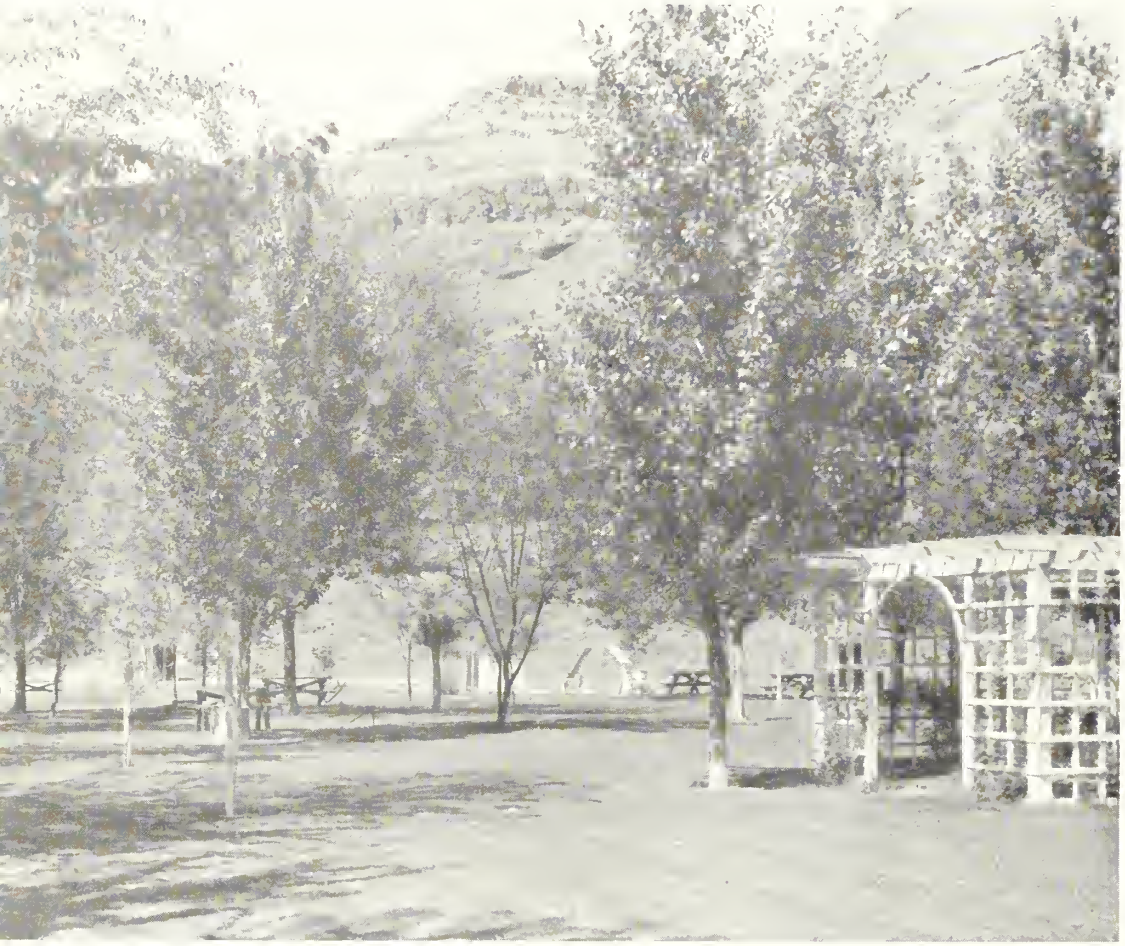
3. Completing work on chute and small drop on lateral immediately below Lahontan Dam, Newlands project, Nevada

4. Clearing Shasta Reservoir. Cleared area in background extends to high-water line of reservoir. Kennett Division, Central Valley project, California

5. Completed stretch of concrete-lined canal, Orland project, California

Johannesen Park at Owyhee Dam

By HOLLIS SANFORD, *Associate Engineer*



Johannesen Recreation Park

JIM and Buck decided there should be a park for visitors at Owyhee Dam and they made that idea a reality. Jim is J. A. Davenport, local manager for the telephone company at Ontario, Oreg., and Buck was Allen Johannesen, reservoir superintendent at Owyhee Dam, who died in 1937 after 20 years of meritorious service for the Bureau. After talking it over early in 1935, Buck agreed to help with the work if Jim would get some of the people on the project behind the scheme.

Jim first induced the Pomona Grange to sponsor the project and the grangers really did their part. They planted trees, bought grass seed, provided hose, and helped in a dozen ways. Jim next got local business houses in Ontario to provide lumber and paint for picnic benches. These materials were taken to the Ontario High School, where the manual-training class turned out 15 bench-table sets. Somehow Jim got them up to the dam, 43 miles away, part of them in his own car.

In the meantime Buck and his crew at the dam were going ahead with the landscaping. They fenced the park, built two double-unit stone fireplaces, irrigated and cared for the lawn, did some more planting, and in the end they made a really beautiful spot. When Buck died in 1937 Jim won the everlasting thanks of Buck's many friends by suggesting to the Grange that the park be called Johannesen Park.

On a Sunday in the spring of the year one will find 100 to 150 people resting and picnicking in the cool shade of the trees, comfortably out in the harsh desert but free to observe its beauties. The Owyhee Dam, less than a mile up the river, is naturally the big drawing card. The reservoir is well stocked with crappies, bass, perch, and Eastern brook trout, thanks again to Jim Davenport. In the spring fishermen usually get their limit of 30 fish. Boating is also becoming a popular sport. For the one who has a good boat and the time, the 50-mile trip up the reservoir provides rare color and scenic grandeur. Unfortunately, the abrupt, rock[y] shore line of the reservoir does not affor[d] good bathing.

Most of the visitors are settlers and towns[people] from the Owyhee project. Nyssa i[s] 31 miles and Ontario is 43 miles from th[e] dam. The park is being cared for by th[e] maintenance crew at the dam under the su[pervision] of Reservoir Superintendent Dic[k] R. Stockham.

C. C. C. Accomplishments

(Continued from page 248)

tion of noxious weeds. On the Vale projec[t] in eastern Oregon reconstruction of the proj[ect] distribution system continued. At th[e] end of the year a detachment of enrollees ha[d] nearly completed construction of the para[pet] wall on Agency Valley Dam.

Aiding in the development of the Owyhe[e] project, adjacent to the Vale project, C. C. C[.] enrollees have constructed laterals and water[-]control structures to regular Bureau of Rec[lamation] standards under the direction o[f] the regular service engineers and inspectors[.] Salvage of the old construction railroad t[o] the Owyhee Dam was completed and th[e] right-of-way improved sufficiently for tem[porary] use as a highway. A detail was sen[t] to the Unity Dam on the Burnt River proj[ect] to construct a parapet wall and mak[e] other finishing touches to the structure.

Two new camps have been established o[n] the Shoshone project. The camp at Powell[,] Wyo., is engaged on a miscellaneous con[struction] program on the Garland and Will[wood] divisions. The new camp near Cody i[s] aiding in the development of the Heart Moun[tain] division. The camp, which was opene[d] in 1935 at Deaver, continued its rehabilita[tion] of the Frannie division.

In eastern Utah enrollees completed th[e] parapet wall on the Midview Dam; con[tinued] work on the Yellowstone Feeder Cana[l] and the Duchesne diversion dam for th[e] Moon Lake project. Clearing operations wer[e] continued in the Deer Creek reservoir sit[e] on the Provo River project, fences were buil[t] along the railroad right-of-way, and change[s] were made to remove a highway from th[e] future inundated area.

Near the beginning of the fiscal year tw[o] all-year camps were established on the Yak[ima] project for general rehabilitation and im[provements]. Reconstruction of 2,000 feet o[f] the Mabton siphon and improvements to a number of important canal structures hav[e] been completed. Clearing of dead timbe[r] from Lake Kachess, which had been sus[pended] in 1936, was resumed in the spring o[f] 1939.

On many of the operating projects demon[stration] programs for the control of noxiou[s] weeds were continued with increasing suc[cess] in their aim to educate the water user[s] to the best means to destroy this menac[e] that threatens their farms and the Government investment in the irrigation system.

C. C. C. on New Projects

With the materialization of the additional camps allocated to the Bureau of Reclamation, construction of the Deschutes reclamation project in central Oregon was inaugurated by the assignment of three C. C. C. camps. This project is designed to save, through irrigation, a well-developed dry-farming community of about 50,000 acres now threatened with extinction through successive droughts.

Two new C. C. C. camps have been constructed near Baird, Calif., north of Redding, and enrollees from these camps are clearing timber and brush from the reservoir area to be inundated by the Sacramento River water when caught and stored behind Shasta Dam, now under construction. Landscaping of the Government-built town of Toyon, headquarters of the Kennett division of the Central Valley project, was commenced by enrollees from these camps.

Recreational developments at irrigation reservoirs in areas remote from the resort section were continued with the aid of the C. C. C. The large development at Elephant Butte Reservoir on the Rio Grande in central New Mexico made excellent progress. A 12-pond hatchery has been constructed below Elephant Butte Dam to provide fish for stocking the reservoir, fishing being the principal sport at this recreational area. The development of a new recreational area in central Wyoming on the Kendrick reclamation project was begun at the Alcova Dam recently completed by the Bureau of Reclamation. Boating and camping facilities are being provided at the reservoir and a park road system constructed. Preliminary work for a similar development at the Alamogordo Reservoir near Fort Sumner in New Mexico was begun with the establishment of a side camp at Alamogordo Dam.

The educational training of the C. C. C. enrollees was improved through the year by the development of new visual teaching aides and reference material particularly adaptable to a construction program of the reclamation type.

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By W. I. SWANTON, *Engineering Division*

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Sir: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to The Reclamation Era.

Very truly yours,

September 1939. (Name)...................................

(Address)...................................

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief Clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif.	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev.	Chas. S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo.	Irvin J. Matthews	Constr. engr.[2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz.	E. C. Koppen	Constr. engr	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo.	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.[2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Rosa division	Yakima, Wash.	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent		R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo.	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.–S. D.)	Denver, Colo.	W. G. Sloan	Engineer.
Canton and Fort Supply (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Black Hills (S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Associate engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex.	E. A. Moritz	Construction engineer.

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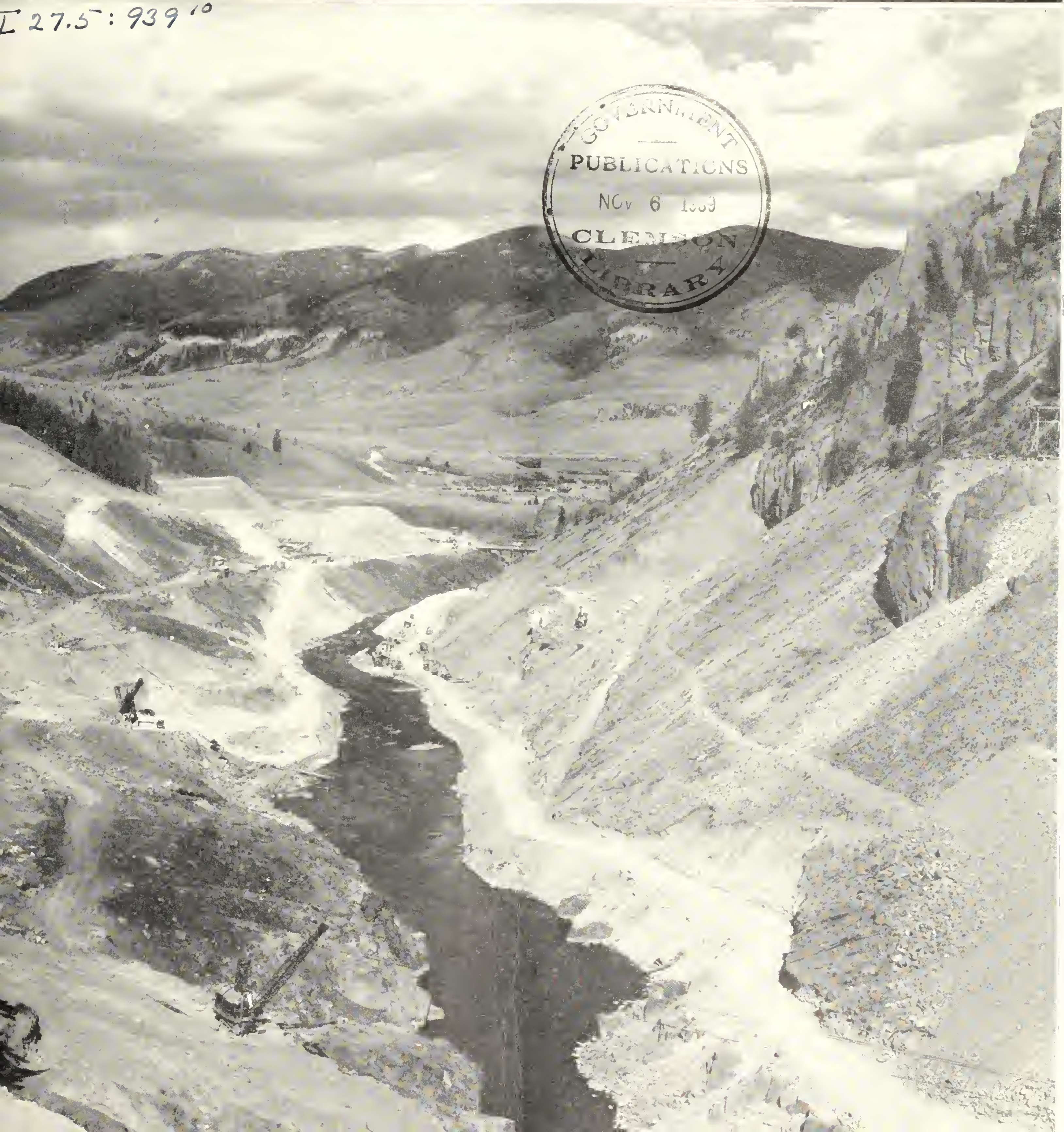
CARROTS GROWN UNDER IRRIGATION

THE RECLAMATION ERA

OCTOBER 1939

GREEN MOUNTAIN DAM SITE, COLORADO-BIG THOMPSON PROJECT, COLORADO—DOWNSTREAM VIEW



National Reclamation Association

THE Eighth Annual Convention of the National Reclamation Association will be held in Denver, Colo., November 14–16.

The selection of this place for the convention is considered a particularly happy one because it is the construction headquarters of the Bureau of Reclamation, and the Chief Engineer of the Bureau and his staff are available for consultation on Federal reclamation problems. Every possible assistance that can be rendered by the Chief Engineer's office will gladly be given and a representative group of the Bureau of Reclamation from the Washington and field offices will be in attendance.

The Bureau in many instances looks to the association for expression of water users' views, and it is hoped there will be a good attendance at this meeting in order that the problems brought up for discussion will broaden the viewpoint and result in representative conclusions.

The National Reclamation Association has 982 individual members and 380 organization members, which represent in excess of 100,000 people throughout the reclamation sections of the 15 Western States. Among these organization members are irrigation districts, water users' associations, farm, civic, and commercial organizations, corporations, city, county, and State governments.

In commenting on the association, Hon. Harold L. Ickes, Secretary of the Interior, said:

"The work of the National Reclamation Association has commanded wide attention and support in the West among those interested in the conservation of water and soil resources. Since it is the most articulate western organization sponsoring water conservation, it has influenced much of the thought on the subject in all sections of the Nation."

John C. Page, *Commissioner.*

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 29 • OCTOBER 1939 • NUMBER 10

Green Mountain Dam and Power Plant

By S. F. CRECELIUS, *Construction Engineer*

IN ORDER to protect water users in the Colorado River Basin against the depletion of their water supply resulting from the transmountain diversion of the water of the upper Colorado River, the United States Bureau of Reclamation is building a dam on Blue River, in Green Mountain Canyon, to be known as Green Mountain Dam. More than 80 million kilowatt-hours of electrical energy will be developed yearly in one power plant immediately below the dam. It is expected that power will be available at this plant in 1943. This plant will furnish power for driving the Continental Divide Tunnel from that time until completion. After the entire project is completed the power line will be used for pumping water from Granby Reservoir into Shadow Mountain Lake, as well as supplying a commercial market.

Description of the Dam

Green Mountain Dam will be an earth and rock fill embankment constructed of selected materials passing a grizzly with 3-inch openings. The dam will be 270 feet above stream bed and will form a reservoir with a capacity of 152,000 acre-feet. The dam will be built in two parts—the permanent cofferdam and the main dam embankment. The upstream slope of the dam will be 3:1 from the crest at elevation 7,960 to the crest of the permanent cofferdam at elevation 7,780, where there will be a 40-foot berm, and the slope from this berm to bedrock will be 3:1. The upstream slope will be blanketed with 3 feet of dumped riprap. The downstream slope will be $2\frac{1}{2}:1$ from the crest of the dam to elevation 7,770, and below this level 5:1. The downstream section of the dam will be constructed of cobbles recovered from embankment material passing over a grizzly with 3-inch openings. The volume of the cobbles or rock fill is expected to be about 22 percent of the total volume of the embankment.

The slopes bounding the various classes of material in the section of the dam are variable and will be adjusted to agree with the volumes of the various materials available.

SAMUEL F. CRECELIUS
Construction Engineer

The foundation of the dam will be on Morrison shale, Dakota sandstone, and porphyry. Four cut-off walls will be placed under the dam. Excavations for concrete cut-off walls will be made at least 3 feet into bedrock, and the walls will extend an average of 10 feet above bedrock. Grout-formed curtains will be placed under cut-off walls, and blanket grouting of the foundation will be done if found necessary.

Spillway

The spillway, with a capacity of 25,000 cubic feet per second, equivalent to 40 cubic feet per second per square mile of the 624 square miles of drainage area, is located at the left abutment of the dam. The maximum discharge rarely has exceeded 10 cubic feet per second to a square mile. The maximum discharge for the past 39-year period was that of 1912, which was 287,000 acre-feet. The spillway entrance has a flat bottom at elevation 7,924. The base of the left slope of the inlet is a segment of a circle with a radius of about 400 feet starting from the left abutment of the spillway bridge and with its center on the axis of the dam. The slope of this side is $1\frac{1}{2}:1$ except where it intersects a vertical concrete wall with a 50-foot radius starting from the left abutment of the spillway bridge and with its center on the axis of the dam. The base of the right bank of the spillway entrance is a segment of a circle with a 116-foot radius, and this bank is a warped surface starting from vertical at the right abutment of the spillway bridge abutment and ending in a 3:1 slope where it meets and becomes tangent to the upstream face of the dam embankment. The spillway entrance will be lined with concrete from the spillway bridge to a point about 140 feet upstream.

The spillway is controlled by means of three 25- by 22-foot radial gates placed under the spillway bridge and provided with both electric-motor-driven hoists and automatic-float mechanism control. The spillway will have vertical cantilever walls from station 10+42.5 to station 14+22.19. From station 14+22.19 to station 15+94.13 there is a transition from vertical to $\frac{1}{2}$ to 1 side slopes, which slope continues to station 19+53. The floor grade of the spillway is a series of vertical curves with its lower end at elevation 7,700.

Diversion Tunnel and Outlet Works

The outlet works consist of an inlet approach channel, an 18-foot circular diversion tunnel, a $15\frac{1}{2}$-foot circular inlet shaft, a trashrack structure over the inlet shaft containing a floating bulkhead, an 18-foot circular outlet tunnel from the inlet shaft to the gate chamber, a gate chamber, two 102-inch ring-seal gates, a 20-foot diameter gate hoist shaft, a 15-foot 9-inch by 23-foot 3-inch modified horseshoe outlet tunnel containing two 102-inch diameter plate-steel penstocks, an outlet channel (to be backfilled after completion of the power plant), two 102-inch diameter plate-steel penstock tubes extending from the downstream tunnel portal to the turbines in the powerhouse, and two 42-inch interior differential needle valves connected to the penstocks by means of two 50-inch diameter inlet tubes. Diversion discharge with 15 feet free board on the cofferdam is 10,000 second-feet, approximately twice the recorded discharge. The minimum thickness of the circular tunnel concrete lining will be 18 inches and that of the horseshoe tunnel 24 inches.

Upper: Green Mountain Dam with Elk Mountain in background. Note conductor cable reels mounted on rubber-tired cable carts

Lower: Transmission line, Green Mountain Dam to Grand Lake. Contractor's camp site in left center

The thickness of the concrete lining of th inlet shaft will be 18 to 24 inches. The linin of the gate hoist shaft will be from 18 to 3 inches. The tunnel lining will be reinforce wherever the character of the rock throug which it is excavated is poor.

A concrete plug will be placed in the diver sion tunnel just upstream from the inle shaft previous to placing the gates, gate plug and penstocks.

Powerhouse

A reinforced-concrete powerhouse 67 fee wide by 97 feet long will be constructed o the right bank of the river immediatel downstream from the dam. This work wil be done by contract. The installation of ma chinery and electrical equipment will be per formed by Government forces. The hydro electric plant will consist of two 12,00 kilovolt-ampere vertical-shaft generator unit each with direct-connected exciters and eac driven by a 14,100-horsepower turbine. Th transformers and oil circuit breakers will b located in a switchyard adjacent to the powerhouse. The plant will be operate under a variable head, probably averagin about 225 feet, and will develop abou 80,000,000 kilowatt-hours annually.

Local Materials

No suitable concrete aggregate could b found in the vicinity of the dam, but an ex cellent pit was found at Kremmling, a dis tance of 18 miles by road from the dar site.

The embankment is to be built with mate rials to be taken from required excavation and from a borrow area lying south of th dam site and at a higher elevation. Th greater part of the material from require excavations and all of that from the borrov area is glacial drift containing clay, sand gravel, and boulders. Tests indicate that th ¼-inch material from these sources has a average density of 131 pounds per cubic foo optimum moisture of 9 percent, and an aver age percolation rate of 0.113 feet per year The available amount of semipervious mate rial is small and is found in the outlet char nel and powerhouse area and talus coverin the right abutment.

Mechanical analyses of material from th borrow area and from required excavation indicate that there will be approximately 2 percent by weight of cobbles that will be hel on a grizzly with 3-inch openings. The col bles will be used for the downstream roc fill.

Rock excavated from the outlet channe and powerhouse areas will be used for ripra on the upstream slope of the dam.

Power Line

A 115,000-volt transmission line was cor structed by Government forces from the sul station of the Public Service Co. of Colorado at Dillon, Colo., to Green Mountain Dam, a distance of 26.79 miles; and a substation was constructed at Green Mountain Dam to deliver 2,300-volt, 3-phase, 60-cycle current to the contractor and to the Government camp during the construction period.

A contract dated November 15, 1938, was entered into with the Warner Construction Co., of Chicago, for the construction of Green Mountain Dam and Power Plant.

Construction

Tunnel camp.—A part of the contractor's organization arrived on the site on December 1, 1938, and work was started immediately on a camp to accommodate the tunnel workers. This camp was placed on the left bank of the river about 1,200 feet upstream from the upstream toe of the dam and about elevation 7,790. (Permanent cofferdam elevation, 7,780.) The camp consists of a large building housing a commissary, store, kitchen, and two dining rooms; 25 eight-man bunkhouses; a time office; a compressor house; an oil house; a bathhouse; and a toilet. At the intake portal of the tunnel a field office was constructed for the engineers, an ambulance house, a blacksmith shop, a powder-make-up house, and an oil-storage house. The M. H. Peck Co., of Denver, Colo., was given the concession for housing and feeding the contractor's employees.

Headquarters camp.—In addition to the above-described camp the contractor constructed another camp on the left side of the river about 1,000 feet upstream from the southwest end of the axis of the dam and above elevation 7,975. This camp consists of an office building, a machine shop, a carpenter shop, a dormitory, and about 50 two-, three-, and four-room residences.

Trailer camp.—In addition to living quarters provided by the contractor for his employees, many small houses and trailers were scattered over the reservation. In order to provide proper sanitation facilities and an orderly arrangement, the contractor constructed gravel streets, installed water and electric-lighting systems, sanitary facilities, and arranged for the disposal of garbage, and the assembling of trailers and temporary houses in an orderly manner in a confined area.

Tunnel excavation.—On December 9, 1938, excavation was started at the upstream portal of the tunnel, and the tunnel was holed through on May 15, 1939.

The materials encountered in excavating the tunnel consisted of Morrison shale and porphyry. Steel supports consisting of six-inch I-beams were required in the greater part of the tunnel, and a few instances when bad ground was encountered, liner plates bolted to I-beams were installed.

Drilling in the heading was usually done in 8-foot rounds, using drills mounted on a jumbo moving on a track. Mucking was done with a 50-horsepower, electrically operated Sullivan scraper. This machine was mounted on small trucks running on a 3-foot-3-inch-gage track and was moved by Diesel trucks used for removing muck. The scraper bucket was moved back and forth by cables passing through tackle blocks. The bucket was dragged back and up an incline or ramp under which stood a truck. The bucket was bottomless and discharged at the end of the ramp into the truck, which carried the muck from the tunnel.

Concrete plant.—While tunnel excavation was in progress, a concrete plant was erected. The plant consisted of storage bins for the various sizes of aggregate placed on a level area on the downhill side of a steep hill. Aggregate was delivered to the bins from a haul road located above the bins, dumped into baffled chutes, and delivered to the bins without segregation. The aggregate was picked up with a clamshell bucket operated by a stiffleg derrick and deposited in hoppers located over the mixing plant, which was on the downhill side of the derrick. The aggregate passed from the receiving hoppers to weighing hoppers and then to two Koehring 28 S nontilt mixers set on the same level with a cement-storage shed. Mixing water was controlled by calibrated hand-operated tanks. Concrete was mixed 1 minute 45 seconds after all ingredients were in the mixer, dumped into 1½-ton Ford V-8 dump trucks covered with canvas, and hauled to the point of placement.

Tunnel concreting.—Tunnel concreting was begun on June 1, 1939, and it is expected that all concrete in tunnel and shaft linings will be completed by October 1, 1939.

The tunnel invert in the circular section was placed in the first operation to an elevation of 2.626 feet above invert grade and in the modified horseshoe section to 2.02 feet above invert grade. Guide forms were set to line and grade and securely anchored in place on both sides of the tunnel at the contact between the invert and arch. Concrete was hauled from the mixing plant to the tunnel in trucks. In that part of the tunnel where there was no steel in the invert, concrete was dumped close to its final location, shoveled to place, and vibrated and brought to the designed section by means of a template moved by hand on the guide forms. In portions of the tunnel where the invert was reinforced, trucks delivered concrete to a Barber-Greene portable conveyor, which discharged into a Rex pumpcrete machine (model 200, single action, 300 horsepower) set up in the tunnel which pumped the concrete to place through an 8-inch pipe line. After vibrating, a heavy wooden screed or boat template about 10 feet long moving on guide forms was dragged over the newly placed concrete by means of an air winch. This was followed by a light hand-operated template to form the surface true to invert shape and grade. Finishers followed the template, working from a platform suspended from and moving on the guide forms.

When the concrete in the invert had set sufficiently, a straightedge was applied to the line of contact of the invert concrete with the arch, and high spots were ground down preparatory to setting the steel form for the arch. A track was laid in the invert upon which to run the steel form-carrier. The forms for the circular section and the horseshoe section were both constructed with hinges for the bottom portions of the forms. The forms could be raised and lowered on the carriers. Removal of forms was accomplished by unbolting the lower sections and folding them inward on hinges and then lowering the whole form before moving.

Concrete for the tunnel arch was delivered to a Barber-Greene portable conveyor, then discharged into the pumpcrete machine, which pumped the concrete into the steel

(*Continued on page 277*)

Green Mountain Camp

Shadow Mountain Camp

Government Headquarters for Western Division Colorado-Big Thompson Project

PORTER J. PRESTON
Supervising Engineer
Colorado-Big Thompson Project

M. E. BUNGER
Principal Assistant to
Supervising Engineer

BIDS were opened publicly by the supervising engineer at 10 a. m., May 24, 1939, under Specifications No. 1227-D, covering the construction of two duplex cottages at Shadow Mountain Camp on the Colorado-Big Thompson project. Of six bids submitted John A. Bell, of Berthoud, Colo., was awarded the contract on May 27, with the low bid of $8,110. Mr. Bell was previously awarded a contract for the construction of a 12-room dormitory at Estes Park, Colo.

Bids on the major part of construction on the Shadow Mountain Camp, for furnishing labor and materials and performing all work for the construction of two 5-room, two 4-room, and two 3-room residences, were opened publicly by the supervising engineer at 10 a. m., May 26, 1939, under readvertisement of Specifications No. 1215–D, dated May 15, 1939. There were five bids submitted. John A. Bell submitted the low bid of $34,545. Shadow Mountain Camp is located about 10 miles northeast of Granby, Colo., on the shore of the proposed Shadow Mountain Lake which will be more than 2½ times the size of Grand Lake, adjoining it by means of the present outlet. It is expected that this construction will add to the appeal this area already has for tourists and vacationists.

All the residences will be built of similar materials and will be of the Colonial type and wood-frame construction. They will be of modern construction and will harmonize with the scenic beauty of the surrounding area.

The Shadow Mountain Camp will serve as headquarters for the Granby division and other construction activities of the Colorado-Big Thompson project in the vicinity of Grand Lake and Granby, Colo.

Public Land Openings

AN OPENING of public land on the Greenfields division of the Sun River project, Montana, consisting of 81 farm units, an area of 6,836 irrigable acres, was announced by the Secretary of the Interior to occur on October 25, 1939, and an opening of a tract of 39 farm units, or 2,826 acres, on the Riverton project, Wyoming, is scheduled to occur on November 16.

In accordance with present legislation, ex-service men are granted a 90-day prior right of entry at each of these openings, which on the Sun River project will expire on January 23, 1940, and on the Riverton project on February 14, 1940.

Descriptive printed material and farm application blanks may be obtained by addressing the Commissioner, Bureau of Reclamation, Washington, D. C., or the Superintendents at Fairfield, Mont., and Riverton, Wyo., respectively, of the Sun River and Riverton projects.

CCC Activities on the Milk River Project

MONTANA

By WILLIAM MAXEY, JR., *Assistant Engineer, CCC*

FROM an operation viewpoint, the Milk River project is divided into two separate units, namely, the St. Mary storage unit, the source of water supply, and the project unit, comprising the Chinook, Malta, and Glasgow divisions. The original storage plan provided for the impounding of water in Sherburne Lake, its diversion from the St. Mary River through an 842-cubic-feet-per-second canal 28.8 miles long, across the Hudson Bay Divide to the North Fork of Milk River, and thence down the river 300 miles to Chinook, Mont., where the first diversion dam for the Chinook division is located.

Through the operation of this project during the past 25 years, it has become increasingly evident that a regulating and supplemental storage reservoir was needed near the head of the irrigable area. Accordingly, investigations and preliminary surveys were made, and in 1934 final plans were prepared and contracts were awarded for the construction of the Fresno Dam on the Milk River about 15 miles west of Havre, Mont.

The irrigable area of this project lies along both sides of the river from Chinook to its mouth near Nashua, a distance of about 160 miles. At Dodson, 46 miles below Chinook, the Dodson Dam diverts water into the Dodson North and South Canals for the irrigation of the Malta division. The Dodson South Canal (capacity 500 cubic feet per second) irrigates about 20,000 acres of land on the south side of the river and discharges into Nelson Reservoir, an inland reservoir located 18 miles northeast of Malta. Early spring run-off and return flow are thus stored in the Nelson Reservoir and later released back to the river to be diverted by the Vandalia Dam and used for the irrigation of the Glasgow division.

The difficulties of operating this project successfully, due to the great distances and difficult terrain involved, have long been recognized by the Bureau of Reclamation. In 1935 CCC Camp BR–32, near Babb, Mont., was established for the purpose of improving the St. Mary storage unit to safeguard the project water supply. This camp did such good constructive work that the project was allotted another camp to accomplish construction and improvement work which was urgently needed within the Malta and Glasgow divisions, and thus Camp BR–69 at Malta was constructed in July 1938.

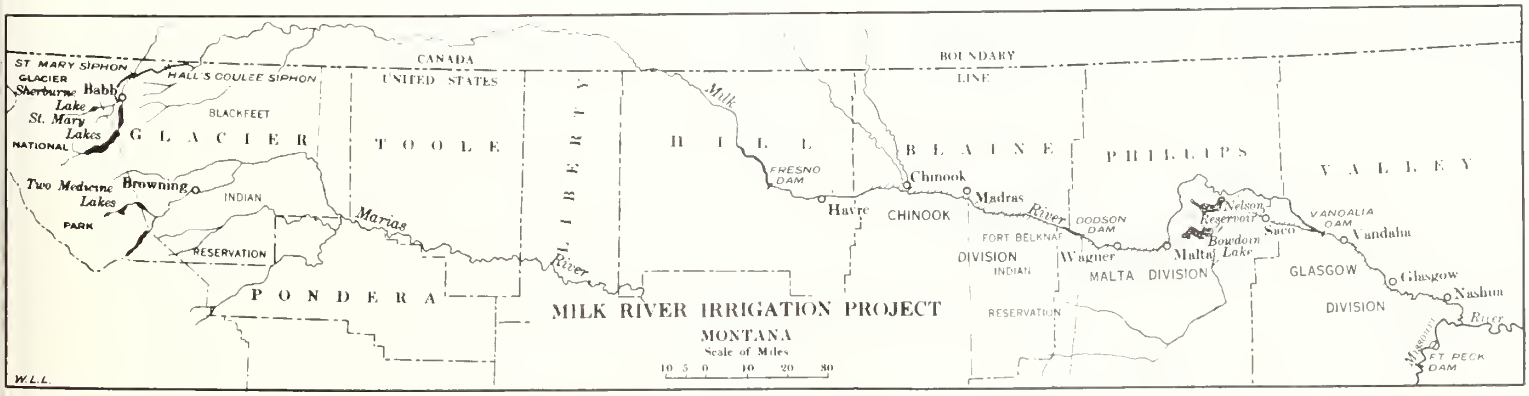
Camp BR–32—Babb

Camp Babb is located on the St. Mary River at Camp 9, the Bureau of Reclamation operation and maintenance headquarters camp for the St. Mary storage unit, about 9 miles below the intake of the St. Mary Canal. Inasmuch as it is only a summer camp, the enrollees are housed in tents, the only permanent buildings being the mess hall, bathhouse, and lighting plant. A few of the buildings, constructed in connection with the original Bureau camp, are utilized for Army headquarters, foremen's quarters, storehouse, etc.

During the summers 1935–38 this camp was principally engaged in the improvement of the St. Mary Canal siphon crossing the St. Mary River Valley. The camp was reoccupied on April 27, 1939, by CCC Company 258, and the work program for the season was resumed. This work is now about 90 percent complete. After completion of this work the improvement of a similar siphon, about 1,300 feet in length, will be undertaken at Hall's Coulee, 10 miles down the canal.

The St. Mary siphon is a two-barrel, 7 feet 6 inches diameter, riveted, steel-pipe structure 3,000 feet long, working under a maximum head of approximately 200 feet. The two barrels were constructed independently of each other, the second about 10 years after the first. The first barrel was laid on an earth foundation and buried without provision for drainage. After about 18 years of operation, excessive deterioration in the nature of rust pits began to appear throughout the bottom section of this pipe, indicating the need for major repair. The second pipe was supported on concrete pedestals entirely above the ground and has shown no sign of rust or decay, as adequate maintenance is simple. As it was necessary to completely uncover the original pipe to accomplish the needed repair, it was decided to support the pipe on concrete pedestals also and leave it uncovered to facilitate future maintenance by the Government.

The work begun in 1935 has been continued this summer. As the operations can be carried on only during the irrigation season, no movement of the pipe can be permitted. All earth, therefore, is moved from around the pipe by means of slip scrapers and a small tractor, in alternate sections large enough to accommodate the supporting pedestal forms to a depth of approximately 2 feet below the pipe. Concrete pedestals, each containing about 2.5 cubic yards of concrete, are then placed at about 20-foot intervals under the pipe to support it in place, and the remaining earth sections between pedestals afterward removed. Since the second pipe is located about 10 feet above the original pipe the pedestals of the two structures are joined, where deemed necessary, with heavily reinforced arms to avoid any slipping of the higher pipe into the lower trench. Anchor piers completely surrounding the pipe, each containing about 20 cubic yards of concrete, are constructed where required. A rock drain



is laid throughout the entire length of the pipe to provide adequate drainage, and the walls of the trench are paved with rock where excessive erosion is liable to occur. The metal is thoroughly cleaned by sandblasting and treated with three coats of protective material applied with a paint gun. The air for both sandblasting and painting operations is supplied by a 315-cubic-foot capacity compressor, permanently situated near the center of the conduit from which a supply line, with frequent outlets, extends in each direction. In this manner both cleaning and painting can be carried on either separately or coincidently as conditions require, for the most efficient prosecution of the work. All operations around the pipe are particularly difficult owing to the close working conditions and the excessive amount of water encountered. It was believed at one time that this difficult work could not be successfully carried on by inexperienced CCC forces, but experience has proven the contrary and an excellent job is being obtained with scarcely any accidents.

In addition to the work on the siphon, Camp BR-32 has cleared and burned 50 acres of timber along the shore line of Sherburne Reservoir, located in Glacier National Park; constructed approximately 4 miles of road to make the camp easily accessible from the State highway system; lined about 5,000 feet of bank on the St. Mary Canal with oversize pit-run river gravel; placed 12,000 square yards of field stone riprap at necessary points along the canal; cleared heavy brush and timber from about 5 miles of canal right-of-way; and improved the ditchriders' roadway along 10 miles of canal bank.

It is evident there is enough necessary work available on the Milk River storage system to keep this camp well occupied for several years. In addition to the Hall's Coulee siphon repair, several large structures are urgently needed to facilitate operation; about 5 miles of the canal should be lined to prevent excessive seepage; a great portion of the canal bank should be protected against erosion, and numerous other improvements should be made which will be beneficial to the operation of the canal system and safeguard the Federal investment in the Milk River project. All this work is well adapted to CCC accomplishment and will provide excellent job training for enrollees.

Forest Fire Control

Camp BR-32, with other CCC companies, has been called upon frequently to assist the Forest Service and National Park Service in the control of forest fires within Glacier National Park. In 1936 practically the entire company was engaged for about 2 weeks in the suppression of disastrous fires which caused great damage to particularly scenic portions of the park. Fire training of enrollees is conducted in camp by experienced foresters and fire fighting is carried on under the supervision of the Glacier National Park organization in accordance with the provisions of an approved form of agreement entered into between that agency and the Bureau of Reclamation.

Camp BR-69—Milk River

Camp Milk River is situated near the center of the irrigable area of the Milk River Project. The camp site is located on the south bank of the Milk River in an area devoted to park purposes at the outskirts of Malta, Mont. Considerable work was necessary to grade the grounds, streets, and walks to provide a suitable camp area. Beautification of the camp was continued this spring with the planting of trees, shrubs, and grass. Side camps have been operating at both Fresno Dam, now under construction, and near Glasgow for the improvement of the Glasgow division of the project.

Camp BR-69 is on United States Highway No. 2, adjacent to an auto camp, and is easily accessible to auto travelers. A short visit to this camp furnishes an excellent demonstration of what the CCC is doing for the young men of the country and what these young men can do for themselves if given an opportunity.

Work Program

During the short time available for fieldwork in 1938 before the winter set in, the canal and lateral systems were improved by the construction of 2 large concrete and steel checks, 130 linear feet of concrete lining of the Dodson South Canal, one 15-foot weir in the wasteway of Bowdoin Lake Bird Refuge, 1 combination turn-out and bridge, and the excavation for 1 drop and wasteway of 50-cubic-feet-per-second capacity. During the winter approximately 60 acres of brush were cleared from the Fresno Reservoir, 2,500 linear feet of canal bank were sloped for riprap, 2 log and rock jetties were constructed in the Milk River preparatory to the placing of willow mats for protection of the lateral system against river erosion, 3 acres of heavy timber and brush were cleared in connection with a river channel change below Dodson Dam, and a considerable amount of canal and lateral clearing was done preparatory to riprapping canal banks and constructing operating roads. Approximately 250 cubic yards of sand and gravel were screened and hauled to stock piles at the camp for later use in the construction of concrete structures. The Fresno Dam side camp operated during the months of February and March, completing the clearing of the Fresno Reservoir. On April 1 this force was moved to the Glasgow side camp for work on the Glasgow division.

Milk River Flood

The contemplated spring work program of the camp was seriously interrupted by a flood of the Milk River occurring from March 21 to 25, 1939. Although the Milk River Valley is subject to frequent floods, this, the most serious of the past 40 years, inundated the greater portion of the lower project area including the site of the main camp at Malta, which was under about 5 feet of water for 1 week. Due to the excellent work of the entire company during the flood period, property losses were almost negligible. The floors of camp buildings suffered the only serious damage. The true CCC spirit was remarkably displayed during this catastrophe, and there was no confusion or complaint, although it was necessary for enrollees to work almost continuously for 2 days, first in attempting to protect the camp and later in the evacuation of equipment, supplies, and records ahead of the rapidly rising waters. Through the courtesy of the city of Malta, the entire company was quartered in the auditorium of the city hall for about 10 days, and mess was furnished from a temporary field kitchen. During this period no dissatisfaction over the hardships incurred was evident and work proceeded in an orderly manner.

Following the flood, enrollees were released whenever necessary, and through special authority CCC facilities were made available during the emergency period to assist in clean-up, particularly in sanitation measures to prevent the spread of disease. Subsequently almost the entire camp was engaged in emergency repairs to the canal system on the Malta and Glasgow divisions in order that the great amount of work required might be accomplished before the demand for spring irrigation water. Approximately 1 month was required to restore the camp to its normal condition.

CCC Work Program

This camp rehabilitation and emergency repair work to the canal systems necessitated a major change in the work program outlined for 1939, and will result in a materially decreased accomplishment on the project for the season.

The work anticipated for this camp is well under way and enough work remains to provide a well-rounded program for several years to come. This includes the construction of numerous small concrete structures to replace the original timber structures now deteriorated, and to provide for an improved service necessitated by an increasing number of small intensively cultivated farms, which are replacing the old type of extensive agriculture on the project. Revetment work will be accomplished on several sections of river bank to protect the canal system from erosion. A considerable amount of concrete lining to prevent seepage and rock riprap to control erosion will be accomplished on the canal and lateral systems. About 75 miles of ditchriders' roadway should be constructed to facilitate operation. All these things can be accomplished readily and will result in a great improvement to the project as well as in the training of enrollees for many different jobs.

Work of an experimental nature also is receiving attention on this project. During the fall of 1938 a plot of Government-owned ground was laid out to study the eradication of Russian Knapp weed with various chemicals. It is contemplated that information will be derived from this experiment to indicate the best chemical to use and the most economical amount to apply per acre to effectually control this particular weed. Similar experiments have been carried on during the 1939 season to include other weed varieties. Future experimental control work will embody also eradication by the clean cultivation methods.

Local Assistance

During the early spring of 1939, it became evident that a grasshopper infestation was imminent which threatened the entire season's crop over several counties of eastern Montana. Glasgow was designated as the bait-distribution center for an intensive control campaign in three large counties. All available CCC forces were enlisted to assist the Bureau of Entomology and Plant Quarantine and the State Extension Service in control work. From April 15 until July 15 the Glasgow side camp, with all its available transportation facilities, was devoted almost exclusively to the unloading, transportation, and distribution of poison-bait material, the mixing and spreading being carried on by Work Projects Administration and county forces. The results of the work cannot be definitely determined, but it is evident that damage was not as great as had been anticipated, as good crops are now being harvested over the area most seriously affected.

Prairie or grass fires have been very frequent over the grazing area adjacent to the Milk River project during the months of July and August. These fires as a rule occur in very sparsely settled districts and, if not controlled, result in great damage to the range. Local facilities are not available for the suppression of such fires and several calls have been answered by the camp. The enrollees have been trained in the control of this type of fire, and with a large force available such fires can be extinguished rapidly, and without danger to the fighters. The company has been able to make immediate response to all fire calls and as a result several fires have been suppressed which might otherwise have cause widespread damage to the range and in some cases to farm property.

The material assistance which is rendered so promptly and efficiently by the enrollees is fully appreciated by the locality as a whole. Through this work and the general excellent conduct of the men both on and off the job, the CCC has gained for itself a position of high esteem in the community.

CCC enrollees rehabilitating St. Mary Siphon

Job Training

Enrollee job training is being carried on very well in these camps under the direction of the Bureau of Reclamation foremen. An effort is being made, through the use of models, relief maps, and project plans, to instruct the enrollees not only in the use of tools and equipment, but also in the history and need of irrigation in the West, the irrigation plan of the Milk River project, and the need and use of each particular structure. The work in progress offers an excellent opportunity for the development of skilled, careful, truck drivers, tractors, and other heavy machinery operators. The theory and practice of concrete construction comprise a major feature of the training program. Safety practices at work and in camp are stressed, and a safety consciousness is being developed by the enrollees which will tend to minimize future accidents. All these features are given the continuous and careful attention of an experienced supervisory staff. These camps, aside from conducting work programs of permanent benefit in the conservation and utilization of national resources, provide excellent training for the young men in useful pursuits that will aid them in becoming self-supporting citizens after they leave the Civilian Conservation Corps.

Grand Coulee Concrete

THE first week in the month of August the 3,000,000th yard of concrete was poured in the dam by the contractor, Consolidated Builders, Inc. The record pour under this contract was 395,945 cubic yards during 1 month. This was surpassed for the month of August when 397,994 cubic yards were placed.

Belle Fourche Products Shown

THE Butte County Fair at Nisland, August 24 to 26, featured irrigated products and a full showing of well-bred livestock. The Horse Creek community was awarded first prize on agricultural exhibits, the Nisland Women's Club was first in textiles, and the Fruitdale Women's Club received the blue ribbon for baked and canned products.

Expenditure at Dam Pays Water Users[1]

IT IS unusual for an investment of $300,000 to pay itself out over 15 months—but the Salt River Valley Water Users Association made one in 1938 that has done that.

It was the money spent on repairing the diversion dam and canal above Roosevelt, by which the normal flow of the Salt River can be led along the edge of the reservoir to the top of the dam and then dropped 190 feet down to the turbines.

Of course, the reason the investment was returned to the association so promptly was the unusual drought, which dropped the level of Roosevelt lake to a point where it no longer would operate the hydroelectric generators efficiently, if the water came to them from what would be almost the bottom of the dam.

Lost Revenue in Idleness

Long periods of stilled machinery would have resulted while the engineers waited for the water level to rise to a point where the turbines could be operated—and every minute the turbines do not turn over and produce electricity means lost revenue to the association.

There were many years in the past 33 when the canal was not used by the association, because it was not needed, and there will be many years in the future when it will lie idle. But when the lake is low, it is invaluable—and this is one of those years.

The canal had its genesis in Roosevelt Dam. When the United States Bureau of Reclamation engineers prepared to build the giant structure in 1906, they needed power and lots of it. Diesel generators still were to come. Steam would have been very expensive, with a long haul for fuel, either coal or wood.

Power Dam is Built

Since the dam was to generate electricity after it was built, engineers reasoned, why not generate some before that time, since the source of power was at hand?

So they went upstream to a point where they could build a diversion dam at not too great expense and started a canal from that point down to the dam site. The diversion dam is approximately 20 miles up the Salt River from Roosevelt Dam. If you have occasion to drive over the Globe-Young Highway, you will ford the river just below the dam and cross and recross the canal several times before arriving at the ford.

The first dam was constructed of boulders, brush, and dirt, after the canal had been built. It served to divert the flow of the stream satisfactorily during the summer and early winter months, but almost annually a spring freshet would wash away a portion of the obstruction or a regular flood would sweep the whole thing clean from bank to bank.

Washed Out Seven Times

In 1916, a flood on the Salt River washed out the entire center section of the dam. It remained unrepaired until 1925, when the brush and gravel filling of the dam was renewed to meet a low-water emergency similar to the present one. In the next 7 years, this makeshift dam was washed out seven times.

By that time it was recognized that the Water Users Association might just as well build something more substantial as to be continually repairing the temporary dam. The work finally was undertaken in 1937, with the Bureau of Reclamation supervising the construction. Now a concrete structure stems the stream, sending all water into the diversion canal, or allowing it to follow the original stream bed as is desired.

In time of flood, the river pours over the top of the dam and continues its way to Roosevelt lake. The dam height is such that any excess of water over the amount the canal will carry will pass down the stream; or the canal can be shut off entirely, so that all water will run downstream and into the lake.

Saves $590,000

One of the impelling reasons for construction of the canal in the first place was the fact that the Reclamation engineers felt the price of cement, delivered at the dam site, was far too high. They wanted the power to operate a cement mill in connection with the dam building work.

The canal and diversion dam when first built cost $1,346,000. Figures showed later that the Government got back a saving of $590,000 on 338,000 barrels of cement, which it manufactured on the spot with aid of the power derived from the hydroelectric energy developed by the canal.

The canal runs along the south bank of the river, following the shore curvatures of the lake. It has 20 tunnels with a total length of approximately 9,500 feet, 2 concrete flumes with a length of 170 feet, 20 storm water culverts, and 5 siphons with a length of 3,000 feet. It starts from stream level but "climbs" in comparison with the old bed of the Salt River as it proceeds to the top of the dam. Actually, there is just enough drop in it to carry the water along at a rapid rate and still come out 190 feet above the water wheels of the turbines at the base of Roosevelt Dam.

Considerable Power

It carries 200 second-feet of water, sufficient to operate a 950-kilowatt generative unit, which is considerable power, particularly at this time.

In repairs made 2 years ago, two of the tunnels were rebored and relined with concrete. Seven washed-out spots were repaired as the canal was concrete lined. Two new siphons were built—one to carry the canal under a wash and the other to replace a flume.

It was a considerable engineering feat when first constructed and considerably more "smart" engineering was shown in making it a permanent adjunct of the water users' operating resources. All of the work was done by private contract, under supervision of E. C. Koppen, engineer for the Bureau of Reclamation.

No one foresaw in 1937, however, how valuable the canal was to be 2 years later.

[1] Extracted from Arizona Republic, Phoenix, Ariz., September 4, 1939.

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been approved by the Secretary of the Interior:

Appointments

J. Philip McClure, junior engineer, Denver, Colo. (vice Charles S. Hazen).

Edward P. Martin, junior engineer, Denver, Colo. (vice Archie K. Hill).

Byron N. Souder, junior engineer, Denver, Colo.

Verney W. Russell, engineer, Columbia Basin project, Coulee Dam, Wash.

Wayne W. McWhorter, junior engineer, Provo River project, Utah.

Transfers

Melville S. Priest, from junior civil engineer, War Department, Rock Island, Ill., to junior engineer, Denver, Colo.

Harold D. Hafterson, junior engineer, from secondary investigations, Bismarck, S. Dak., to same at Denver, Colo.

Odin S. Hanson, junior engineer, from secondary investigations, South Dakota, to same at Denver, Colo.

Leslie M. Alexander, from assistant engineer, Denver, Colo., to same at Phoenix, Ariz.

George Young, from supervisor of labor relations, Kendrick project, Casper, Wyo., to same at Colorado-Big Thompson project, Estes Park, Colo.

Separations

Joseph M. Buswell, assistant engineer and Harold B. Houston and John H. Ludwig, junior engineers, Denver, Colo., resigned to accept positions with War Department.

Eighth Annual Convention National Reclamation Association

PRESIDENT O. S. WARDEN, in announcing the annual convention of the National Reclamation Association to convene at Denver, Colo., November 14, 15, and 16, promises an interesting program of problems vital to every water user on a Federal reclamation project. Sessions will be held in the Shirley-Savoy Hotel.

Needs Cited

The organization of the association followed an expression of its need by the late Dr. Elwood Mead, Commissioner of Reclamation, who believed that an official group, who could speak for the water users, was needed in Washington for consultation by Bureau officials, Members of Congress studying their problems, and the general public to better understand what is involved in the Federal reclamation policy.

Association Organized in Utah

Organization was effected by the Governors of the Western States and a call for the first meeting sent out by the late Governor Dern, of Utah. A representative of each of 11 States in Reclamation territory was placed on the Board of Directors and on committees. This State representation has since been increased to 15. Its first president was Marshall N. Dana, of Portland, Oreg., who served for 4 years, and his successor, the present incumbent, is O. S. Warden, of Great Falls, Mont., who also has served 4 years.

Organization Serves Effectively

Since the organization of this association 8 years ago, it has rendered a very helpful service not only to the irrigation districts and water users' associations which it directly represents, but to the Federal Bureau of Reclamation, which has as its responsibility operations under the Federal Reclamation policy; and to the Legislators in Congress who deal with legislation affecting these operations and the appropriation of funds to carry on its work. Its educational material has created good will and understanding.

The association also acts in a helpful capacity to the agencies which are in a position to further the interests of its constituent group, and tangible results are reflected not only in the congressional authorization of increased activities, but in the appropriation of sufficient funds that afford an opportunity for orderly development of a long-term program. This involves supplemental water storages on projects with an insufficient water supply; the development of hydroelectric power on projects, making of them more complete economic units; the inauguration of multiple-purpose projects affording facilities for flood control, navigation, and irrigation, thus making a fuller use of available water supplies of the West.

By its service and activities the National Reclamation Association has invited the confidence of those which it directly represents and the persons and groups with which it must deal in getting the best possible results. Mr. Floyd O. Hagie, secretary-manager of the association, with headquarters in the National Press Building in Washington, is tireless in his effective service on behalf of those whom he represents.

Praise for National Legislature

The territory in which Federal reclamation projects are located (all west of the 100th meridian) is fortunately represented in the Senate and House of the National Legislature by very able, level-headed men who have succeeded in securing for reclamation a prominent place in the conservation and long-term development of natural-resources projects.

Laudatory Comments

Comments by members of the House and Senate of the National Legislature and others sent to the National Reclamation Association attest to the helpfulness of the association.

Program Tentatively Outlined

The tentative program for the annual meeting provides for registration at the Shirley-Savoy Hotel on the first day of the convention, November 14; meeting of State groups; address of the President; reports of officers of the association; and round-table discussion of Problems of the Water User.

The second day, November 15, provides for discussion of the following subjects:

Reclamation Project Act of 1939—Its Provisions and Aims. New Water Laws Needed in the West. The State's Place in Water Conservation. Water Conservation Procedure in the Great Plains. Reclamation in the Multiple-Purpose Project. Contribution of the Army Engineers to Reclamation. Flood Control and Its Assistance to Reclamation. Soil Conservation and Resettlement.

On that day and in the evening, a personally escorted trip is planned through the Denver offices of the Bureau of Reclamation, which is designed to acquaint delegates with the activities of the Bureau of Reclamation carried on under the supervision of its Chief Engineer.

On the third and last day of the convention, November 16, there is planned discussion of the the following subjects:

Sugar Beet Expansion—Legislation Needed. Sugar Beet Acreage on Reclamation Projects. The Domestic Sugar Problem. The Sugar Factory and Reclamation. Discussion of Open Questions. Steps to Insure Continued Development of West by Reclamation.

Reports of the auditing, budget, legislative, and resolutions committees will be received, following which the first meeting of the newly elected Board of Directors will be held. The convention will close with a banquet and entertainment in the evening.

Attendance Urged

Not too much emphasis can be placed on the desire that there will be complete representation at this annual convention. This would effect discussion of problems that would be more representative of the vast territory the association represents.

Oregon Reclamation Association Meets

ON September 11 and 12, the twenty-ninth annual meeting of the Oregon Reclamation Association was held at Clatskanie. The annual address was given by President Frank T. Morgan of Nyssa. Marshall N. Dana, editorial page editor of the Oregon Journal, was the principal speaker at the banquet on the opening night.

On the second day a big free barbecue was held and an address was given by Governor Charles A. Sprague. Reports were made at the closing sessions, including the following:

Flood Control and Drainage in Western Washington, by Lars Langnoe, Washington Department of Public Works; The Flood Control Program, by Col. John C. H. Lee, District U. S. Engineer; Pending Irrigation Projects, by Percy A. Cupper; Distribution and Sale of Bonneville Power, by Horace E. Bixby, Bonneville Power Co.; The Willamette Basin Project, by Senator Douglas McKay, Chairman, Willamette Project Commission; Improvement and Cropping of Reclaimed Land, by H. D. Howell, Superintendent, Astoria Experiment Station; Highway Problems on New Projects, by Judge Guy Boyington, Astoria; A Weed Control Program, by George A. Nelson, Columbia County Agent.

History of Reclamation in the State of Washington

JOHN BROOKE FINK, director of the department of conservation and development in the State of Washington, in his ninth biennial report, prints interesting facts about the history of reclamation development in the State of Washington. It is interesting because he claims records in his department show irrigation development started about 100 years ago. His statement follows:

Irrigation—Private Development

The first reclamation of arid lands in this State by irrigation probably occurred about 100 years ago. Records of this department show that Dr. Marcus Whitman constructed a ditch in 1846 to divert water from Doan Creek for irrigation of lands of the Whitman Mission Donation Land Claim, located 6 miles west of the City of Walla Walla. Although Dr. Whitman's settlement had been established 10 years previous to that time and it is understood that agricultural crops were produced during that 10-year period, such crops undoubtedly obtained moisture from subirrigated lands.

Our next record of early irrigation development was on Ahtanum Creek in the Yakima Valley. In 1847 the Oblate Fathers established a mission on that stream and prior to 1852 constructed a ditch to divert water from Ahtanum Creek for the irrigation of the mission's lands.

In north central Washington we find that Hiram (Okanogan) Smith settled on Osoyoos Lake in Okanogan County and in 1858 constructed a ditch to divert water from Nine Mile Creek to irrigate lands on which 1,200 apple trees had been placed. This was probably the first irrigated orchard in the State.

From this period to the early nineties the practice of irrigation was developed by individuals and small groups, diversions being for the most part from creeks and small streams, with a few from the various rivers. Such systems were easily constructed and comparatively inexpensive. The peak of this type of development was reached during the eighties. By the early nineties most of the waters of the small streams in central and eastern Washington had been appropriated and those irrigation systems most easily constructed had been built. Attention was, therefore, turned to the larger enterprises, the construction of which was necessarily undertaken by corporations and irrigation districts. The first irrigation district law was enacted in 1890.

Most of the larger projects were promoted by private groups and corporations often principally for land-promotion purposes. In such cases, the irrigation works were likely to be flimsy, constructed with cheap materials, and consequently short-lived. As soon as the raw lands had been sold, frequently at fabulous prices, the promoters sold the irrigation system to a water-users' association or irrigation district organized for that purpose. In some cases the capacity of the ditch was inadequate to serve all the lands under it; in others, the available water supply was insufficient for the lands on the project. The settlers on these projects, after taking over the irrigation works, were immediately confronted with the necessity of constructing adequate and more lasting irrigation works. This cost, added to their investment in unimproved lands, the cost of land development, and the obligation incurred in the purchase of the original inadequate irrigation system and water rights, totalled more than much of the land could bear. The settlers were unable to pay their assessments, and consequently some lost their total investment, a condition which was sufficiently prevalent to reflect severely on the economics of irrigation farming for many years.

In the year 1917 the State water code was enacted, giving central authority over the water resources of the State to the supervisor of hydraulics and providing a means of establishing definite water-right titles, so necessary for the successful operation of irrigation projects.

Today there are 99 irrigation districts and 43 incorporated irrigation ditch companies in the State, very nearly all of which are in good financial condition, as the conditions above described have been corrected by refinancing and other adjustments. The area reclaimed under the canals of these districts and companies, together with lands reclaimed under private and partnership ditches, is estimated to be 600,000 acres. According to the United States Census Reports, there were 15,949 irrigated farms in the State in 1930, having a value of $208,738,027.

Irrigation—Federal Development

In 1893 the United States Geological Survey established the first gaging stations in the State of Washington, located on the Yakima and Naches rivers. These stations were installed principally for the purpose of determining the quantity of water available for irrigation projects.

In 1902 the Federal Reclamation Act was passed, providing for the appropriation of receipts from the sale and disposal of public lands in certain States and Territories into a special fund, to be reserved for survey, construction, etc., of irrigation systems for the reclamation of arid lands in those States. In 1903 preliminary investigations were commenced by the United States Reclamation Service on the Okanogan, Yakima, and Palouse projects. The construction of the Sunnyside (enlargement of the then existing canal) and Tieton units of the Yakima project was authorized by the Secretary of the Interior in 1905. The Sunnyside Canal was purchased in 1906, following the enactment in 1905 of State legislation withdrawing from appropriation all waters of streams which would supply projects under investigation by the U. S. Reclamation Service, and reserving water for such projects if they proved feasible. By the same law, State lands were reserved for use in connection with such projects, in the event they should be required. Congress in 1924 appropriated the first funds for construction of the Kittitas unit of the Yakima project, to reclaim 70,000 acres, completed in 1929.

To date, $32,100,000 has been expended by the Federal Government through the Bureau of Reclamation for completed irrigation systems in the State of Washington. In addition, $7,000,000 has been appropriated for the Roza project, now under construction, and approximately $8,000,000 more will be required to complete it. These figures do not include any Federal expenditures for the Grand Coulee Dam and Columbia Basin project.

It is of interest to note what might be termed the first move in behalf of the Columbia Basin development. Our first State legislature, during the winter of 1889–90, sent a memorial to Congress requesting an appropriation of $50,000 to drill artesian test wells in Yakima, Klickitat, Douglas, Adams, and Walla Walla Counties, in the hope of finding an adequate water supply for irrigation. The following is quoted from the memorial, "And should said wells prove successful, this vast domain which is now but sparsely settled, would in a few years be thickly studded with large fields of grain, with a thousand orchards bearing nearly every kind of fruit, and many a happy home."

The first investigation of the project was made by the U. S. Bureau of Reclamation in 1903.

During Governor Lister's term of office, beginning in 1918, the State made the first complete surveys and studies of both the gravity and the pumping project, the plan most favorably considered at that time being a gravity system, with water to be diverted from the Pend Oreille River for irrigation of basin lands.

The U. S. Corps of Engineers, in 1929, began an exhaustive investigation of the proposed Columbia Basin project and completed their report in 1931. By this investigation, the feasibility of the Grand Coulee pumping project was determined and the Army report recommended that plan rather than the gravity plan. In 1934 Congress set aside $63,000,000 for the beginning of construction of Grand Coulee dam, to be expended under the direction of the Bureau of Reclamation. This amount has been expended and further appropriations made for the continuation of the project, which, in addition to its power, navigation, and flood-control features, will provide water for the reclamation of 1,200,000 acres of arid land in the State.

Diking and Drainage

Diking and drainage systems have also played an important part in land reclamation in the State of Washington. Reclamation of this class of land undoubtedly began with the early settlement of the State, particularly west of the Cascade Mountains. Laws were enacted as early as 1890 relating to the construction of dikes for protection of lands against overflow from tidal waters and river freshets, and in 1895 the first diking and drainage district laws were enacted.

A large portion of this type of reclamation works is located west of the Cascade Mountains, and a greater part of the acreage so reclaimed is along Puget Sound and the Columbia River in southwestern Washington. Practically all of the lowlands on rivers and tidal waters are diked against overflow, most of the districts west of the Cascade Mountains being provided with drainage systems, including pumping plants, for the purpose of lifting water from the low-lying drainage ditches inside the dikes. In eastern Washington most of the diking and drainage systems are located along the Colville and Pend Oreille Rivers.

Drainage of lands has been an important feature on irrigation projects, also, as drainage of irrigation seepage water is essential to the preservation of developed lands for agricultural purposes. The U. S. Census Reports for 1930 indicate that 172,039 acres of this type of land are drained. Seventy-eight drainage districts have been established for this purpose and have constructed and are maintaining drainage systems.

There are a total of more than 200 diking and drainage districts in the State, including those on irrigation projects. According to 1930 Census Reports, the capital outlay invested in diking and drainage works in the State is $4,637,576 and the area of land in such enterprises is 367,242 acres. No records are obtainable of the area of land reclaimed by diking and drainage through individual or community efforts, but a great area has been made suitable for agricultural purposes, particularly west of the Cascade Mountains, through such efforts.

The State Reclamation Act

During the World War and the years immediately following, farm products brought high prices, and consequently farming and reclamation development were stimulated. But the time had arrived when all the most easily developed projects had been constructed, largely by private capital, leaving the more costly projects which could be financed only with Federal or State aid. In addition to new projects, extensions, improvements, and refinancing were found necessary for existing projects that had originally been financed by private capital. But little or no money was available from that source for this need. In order to promote further reclamation of lands and to save existing projects and wealth created under them, it was found desirable to enact a State reclamation law, chapter 158, Laws of 1919, which provided for the creation of the State reclamation board and the establishment of the reclamation revolving fund, revenue for which was to be derived from an annual general tax of one-half mill, to be used, in accordance with the law, for reclamation purposes. This tax was levied from 1919 to 1925, but each legislature since that time has suspended it. The amount collected from it totaled $3,994,173.19 as of September 30, 1938. Since the reclamation revolving fund was established, approximately 80 irrigation, diking, and drainage districts have received financial assistance from it, in the amount of $5,459,685.56.

Although the reclamation act provides that moneys from the reclamation revolving fund shall be used for the purpose of assisting reclamation districts in their construction, improvement, and refinancing problems, each legislature appropriates money from that fund for other purposes, such as seed wheat, the soldiers' settlement at White Bluffs, forestry, and interstate water suit, cooperative activities with the U. S. Geological Survey, and the Columbia Basin project. Nearly $1,000,000 has been expended from the reclamation revolving fund for such miscellaneous purposes, and very little of it has been repaid to the fund.

Probably the greatest benefit which has come from the reclamation act is the financial aid that the State has given to reclamation districts during the several recent depression years, the refinancing of the districts making it possible for many farmers to remain on their land and retain their independence who would otherwise have become relief charges. The expenditures for such purposes are in the form of loans to reclamation districts and are secured by bonds, payable over a period of years, issued by the districts and delivered to the Department of Conservation and Development.

Engineering Labor Methods Compared

SEVEN thousand donkeys and 43,000 men would be doing the job if the Grand Coulee Dam were being built in India, according to A. N. Khosla and Kanwar Sain, designing and constructing engineers of the irrigation service, Punjab, India, now visiting works under construction by the Bureau of Reclamation.

Until the Boulder Dam was built, India boasted the biggest dam in the world. The proposed Sutlej Dam will be nearly as big as Boulder. Speaking of the Grand Coulee Dam, Mr. Khosla said, "We read in India about your large dam here, but we had no idea it was as big as it really is."

"We use very little power and machinery—mostly the labor of men and donkeys, consequently we have fewer accidents. About the only time we lose a man is when a worker falls asleep during lunch hour, with his head on a tram rail, and is run over. During the construction of our large dam, only six men lost their lives."

India has practiced irrigation from prehistoric times. It now has under irrigation 30,000,000 acres—10 million more than the United States, and as much as the 11 Western States ever can have.

People Want More Electricity

AN insatiable appetite for the products of power, goods as well as services, will, in the opinion of Morris L. Cooke, internationally famous management engineer, create a market for the electrical energy to be generated at the Grand Coulee Dam. Mr. Cooke, formerly the head of the Rural Electrification Administration, is making a tour of large western hydroelectric projects.

"I have faith that there will be a market available," he declared. "Our experience in REA will show you why such faith is justified.

"Authorities on public utilities told us our undertaking was far too ambitious, that even if a market for more power existed, we couldn't get poles enough to cover the territory we hoped to serve. We got plenty of poles, and in a few years the consumption of electrical energy was increased 32 percent.

"And what's more, the great bulk of the increase, probably two-thirds of it, was made by the private companies themselves. The Government showed them what could be done.

"Indescribable, it leaves me speechless," was Mr. Cooke's comment on the structure, and on the activities at the Coulee Dam. After seeing the so-called construction model used in explaining to tourists the changes that have taken place and the purposes of the dam, Mr. Cooke suggested that some toy maker ought to make up a set of blocks so that children could build models of the dam for themselves. "Couldn't a healthy youngster get a kick out of that?"

Field Officers in Washington

CHIEF ENGINEER R. F. Walter from Denver, Supervising Engineer Walker R. Young from Sacramento, and District Counsel J. R. Alexander from Salt Lake City were in Washington during the month of October on administrative assignments.

Ogden River Project, Utah, 1939

By N. T. OLSON, *Engineer*

THE Ogden River project is located along the western foot of the Wasatch Mountains from Ogden to Brigham City in the northern part of Utah. The primary purpose of the project is to augment the water supply of lands already under irrigation but on which drought losses are frequent because of the absence of late water. The water supply is obtained from the floodwaters of Ogden River which are stored in the Pine View Reservoir—a reservoir with a capacity of 41,838 acre-feet, located in the mountains 9 miles east of the city of Ogden.

To date, construction on the Ogden River project has secured the completion of the Pine View Dam and Reservoir; a 75-inch wood-stave pipe line from the dam to the lower end of Ogden Canyon; the Ogden-Brigham Canal; a steel siphon across Ogden Canyon; and the South Ogden Highline Canal, all of which work was completed under Government contracts in 1937. In addition, since that time, distributing systems to convey water from the Ogden-Brigham Canal to existing ditches below have been constructed by interested water users.

There remain to be completed a parapet wall at Pine View Dam, four wasteways along the Ogden-Brigham Canal and a distributing system for lands under the South Ogden Highline Canal. CCC forces are now constructing the parapet wall and at its completion contemplate starting work on the wasteways. The distributing system is to be constructed by a combination of contract and Government forces.

Under the South Ogden Highline Canal considerable land has been included in the district which never before enjoyed the benefits of irrigation, together with lands which have received water from small mountain streams for more than three-quarters of a century. At present there are 1,534 separate units representing a total of approximately 2,000 acres of land all lying within a few minutes' drive from the business district of Ogden, a city of 45,000 population.

Many different classes of ownership are represented in the list of water users. For example, there are represented residential property, school and church property, a golf course, a cemetery, and farm and orchard lands, as shown by the accompanying photographs, each presenting a demand for water based on its own individual requirements. Farm and orchard lands take water on a 24-hour delivery basis; the golf course requires continuous service with a fluctuating demand calling for the maximum delivery between midnight and midmorning; a continuous uniform flow is needed for the cemetery throughout the season; and the residential property needs continuous service with peak loads in the morning and evening.

In order to meet all of the varying demands for water in the district, two systems of distribution have been designed: A low-pressure pipe system which supplies farm and orchard land; and a high-pressure pipe system which supplies the residential area. In addition to these, a combination high- and low-pressure system is used in which the high-pressure line acts as a feeder for several low-pressure lines as well as supplying the golf course and some residential property.

High-Pressure Systems

Because of the fluctuating demand for water in a residential section, it is necessary to have an equalizing reservoir between the source of supply in the main canal and the high-pressure lines serving the area. This equalizing reservoir is designed to have a capacity equal to 1 day's requirements for the system and will receive its supply from the main canal at a uniform rate throughout the 24 hours. The reservoir is located adjacent to the main canal and at such an elevation that, when filled, additional flow returns to the main canal, thus eliminating other wasteway requirements. Actual delivery of water to the reservoir is recorded by a water meter in the line between the canal and the reservoir.

From the reservoir a network of pipe mains and laterals bring water under pressure to the lot line of each unit under this system. The pressure is supplied to the line by the natural fall of the ground between the canal and the lands being served. The delivery heads range from 80 feet to a maximum of 325 feet. Each individual tract is given water service by permitting a tap on the high-pressure line. The size of the tap for any individual tract is determined by the pressure head available at that point.

Distributing pipe lines are located in the streets and alleys with most of the lots being served from the alley line. Gate valves control the flow of water into branch lines and air and vacuum valves are placed where necessary. Pressure reducers are not needed, as the water is for irrigation only and high heads are desirable where sprinkling systems are used.

Provision is made for draining the entire system at the end of the irrigation season.

The low-pressure systems serving the farm lands take the water directly from the canal and as they are served on a 24-hour basis no reservoir between the canal and the pipe system is necessary. Low-pressure concrete pipe for working heads of 30 feet is used, and the regulation of pressure and discharge in the pipe is accomplished through the use of gate valves and air risers. The actual delivery of water to the separate units is accomplished through an orchard-type valve in the pipe.

The efficient operation of the low-pressure systems requires the use of water meters in the line, but because of the great number of units involved it was not feasible to install one for each individual user. Several tracts of land each having small allotments of water have been combined under 1 meter. This has been accomplished by choosing a usable irrigation head for these small tracts and with that as a basis the amount of rotation between tracts required to keep that capacity in the pipe is determined. Seasonable and crop changes will vary this requirement, but the lines have all been designed with some extra capacity.

Development

The soil is fertile and the climatic conditions are favorable to the production of orchard and garden crops. Apples, cherries, apricots, pears, peaches, berries, celery, beans, peas, and tomatoes are all grown commercially on some of these and adjoining tracts.

All of the lands under the project are privately owned. Approximately 2 miles of the main highline canal is within the city limits and considerable of the land to be irrigated is residential city property which is now experiencing a building boom, where residences costing from 5 to 30 thousand dollars are being constructed—each designed with a sprinkling system to connect with the high-pressure line.

Beyond the city limits, but close to the business district, a movement has already started for the construction of moderately priced homes on acre tracts, where wage earners, with the assured supply of irrigation water, can supplement the family larder with fruit and vegetables from the back yard. Owners of the larger tracts on the project have already started acre subdivisions, and with the completion of the distributing system it is anticipated that this movement which is just starting will gain such momentum that ultimately the entire area will be suburban acre tracts where gardening for the family larder will be an avocation of the wage earner.

Upper: A supplemental irrigation supply will be provided for this 2-year-old peach orchard by the proposed distribution system
Center: New houses being built on lands proposed for inclusion in the South Ogden Conservation District
Lower: Houses recently constructed in area to be irrigated from the distribution system

Wilt-Resistant Alfalfa in Nebraska

IN the North Platte Valley in western Nebraska many acres of sandy soil now made useless to farmers through wind erosion, may be on the road to definite reclamation in the next 2 or 3 years. Lionel Harris, superintendent of the Scotts Bluff experiment station, and T. W. Parry, manager of the Pathfinder Irrigation District, believe that wilt-resistant alfalfa will go a long way toward solving the erosion problem.

Wilt-resistant alfalfa, once not much more than a scientist's dream, is becoming an actuality. Experiment station workers gleaned a pound of seed last summer from a plat containing a resistant strain, developed by Dr. H. M. Tysdal, Federal agronomist who works between the station and Nebraska Agricultural College at Lincoln.

This pound of seed, planted at the station this spring over an acre tract, has surprised observers at the rapidity with which it is producing more seed. Mr. Harris believes the sparsely sown acre may yield 40 pounds of seed, enough to plant 10 acres under ordinary field conditions. The 1 pound was planted in rows and spread over the area in order that experimenters might scrutinize it more closely and weed it carefully. Farmers plant about 10 pounds of seed to the acre.

The seed will next be distributed to valley farmers who promise to prevent crossing with common alfalfa. It is necessary that the wilt-resistant type be isolated by the growers, since any crossing would definitely lower resistance of future seed. Before the seed is disturbed, samples will be sent to Dr. Tysdal in Lincoln for further wilt-resistance tests.

If seed is increased at the present rate, Mr. Harris says, it may be made available to farmers on a large scale in 2 or 3 years. He wants to make clear, however, that even the best of the wilt-resistant varieties now under consideration have not reached the stage of perfection. Experimentation will go on, even though the 40 pounds of seed harvested this summer lives up to expectations.

One of the chief objects of the search for a resistant variety has been the reclamation of the valley's sandy soil. Irrigation water is available for much of this acreage, but the value of both the water and the land is negligible when crops cannot be grown.

Wilt, Harris says, usually kills the ordinary alfalfa plant in 5 or 6 years. The chief consideration now, he thinks, is to maintain the purity of the strain through the prevention of cross breeding.—*Scottsbluff Star Herald.*

World's Record Broken

IN the mass placement of 8,000,000 cubic yards of concrete in the Grand Coulee Dam, world's records have been continually smashed. The total placement for the month of September was 449,689 cubic yards.

Asphaltic Concrete Lining—Central Valley Project

CALIFORNIA[1]

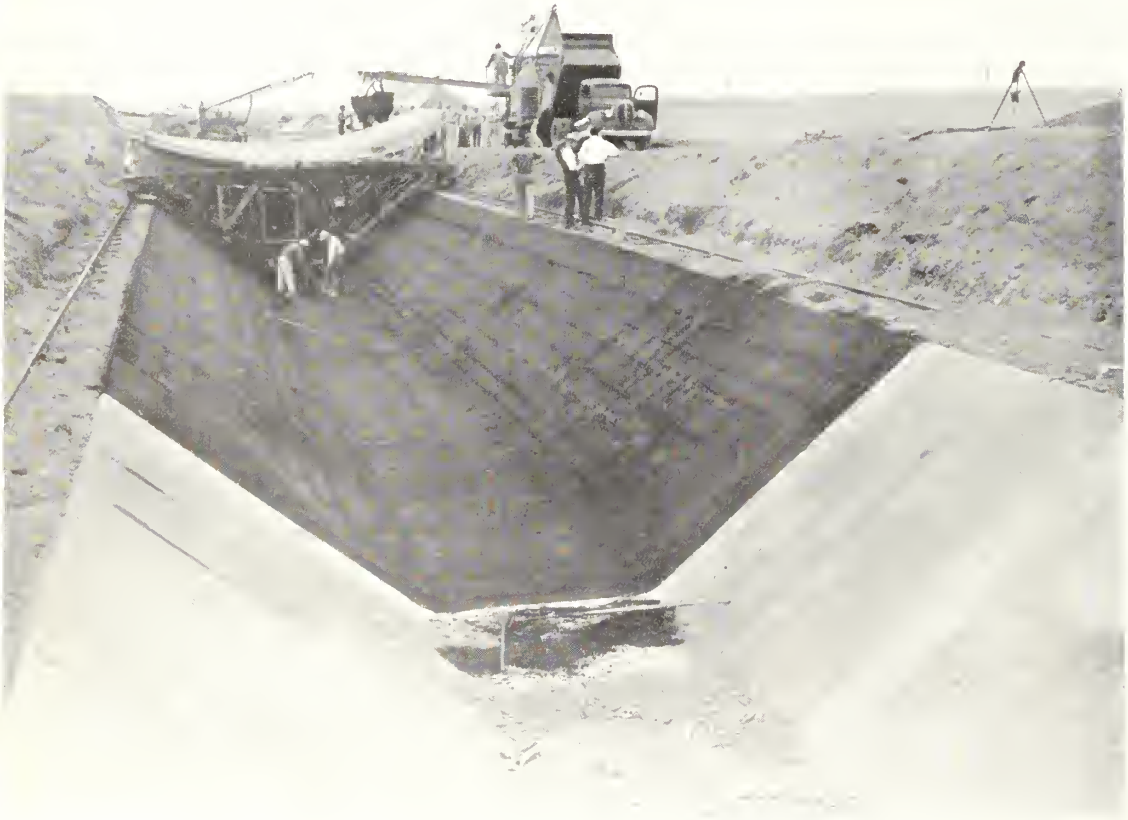
THE Contra Coastal Canal, 46 miles in length, with a pumping diversion capacity of 350 cubic feet per second, is a feature of the Delta Division of the Central Valley project, California, now being constructed by the United States Bureau of Reclamation. This canal will provide a supplemental supply of fresh water for the industrial and agricultural areas which lie south of the Suisun Bay between Martinez and Oakley, and will also furnish some water for certain municipalities in the same general locality. Water will be released from the reservoir to be impounded behind Shasta Dam into the Sacramento River, and carried across the Delta of the Sacramento and San Joaquin Rivers to assure the quality of the supply for this canal and other features of the Central Valley project. The Contra Costa Canal, except for its first 4 miles, is being constructed as a concrete-lined canal.

[1] Article prepared by Engineer Garfield Stubblefield in collaboration with Junior Engineer Oliver Folsom and Inspector A. Kalal under the direction of Division Engineer O. G. Boden.

An experimental section of asphaltic concrete lining 308 feet in length was placed in the Contra Costa Canal near Antioch, Calif., on May 25, 1939. The canal section at this location has a bottom width of 7 feet, lining height of 7½ feet and 1¼ : 1 inside slopes. The purpose of the test section is to provide information for determining the relative costs of asphaltic concrete lining and portland cement concrete lining and to indicate the feasibility of utilizing asphaltic concrete lining on projects where local aggregates are of inferior quality or the severity of sulfate conditions are hazardous to portland cement concrete.

The subgrade was accurately shaped by a trimming machine which spanned the canal and was supported on accurately alined rails, one on each side of the canal, which also supported the lining machine during its operations. The subgrade was sterilized to prevent weed growth by spraying with creosote and by depositing sodium chlorate salt into 1-inch diameter holes. These holes were placed on 2-foot centers in a row near the top of the sides of the canal in cut section and on 2-foot centers in each direction in the fill section.

Placing experimental strip of asphalt lining in canal section. Completed lining seen downstream



The asphaltic concrete mix was designed and placed with the cooperation of the Pacific Coast Division of the Asphalt Institute, which was represented by A. H. Benedict, technologist. The mix contained approximately 6.9 percent of 151–200 penetration asphalt, gave no slump, and retained its position as placed. Aggregate was composed of 8.4 percent limestone dust passing a 200-mesh sieve, 49.8 percent of well-graded sand, and 41.8 percent of 3/16- to 3/4-inch gravel.

The asphaltic concrete was hauled 50 miles by truck from a mixing plant in Oakland. Temperature of the mix at the plant ranged from 300° to 350° F. and the placing temperature averaged about 250°. Trucks dumped into a 27-E Multi-Foote paver, which remixed the asphaltic concrete and delivered it into the receiving hopper car of the Clyde Wood slip form lining machine. The mix dropped from the car to the front side of the machine which consolidated it by means of tubular vibrators and its own weight. A minor difficulty was encountered with this "no slump" material. Part of the vibrators and separating rubbers extended below the surface of the lining and left grooves which had to be filled by finishers working behind the slip form. A jumbo having steel screed plates was dragged behind the slip form and served to partially smooth out rough places on the sides of the canal. The rate of placement was not materially different from that for portland cement concrete.

A hot iron, back of the finishing jumbo, was used to smooth out rough spots on the surface. Cracks appeared after the lining had cooled, with the same frequency as the joints of the wire mesh reinforcement which was laid on the subgrade in 6-foot sections fastened together to form a mat. This wire mesh was made of No. 9 wire with 2- by 4-inch spacing. It was raised in front of the lining machine so that it would be embedded close to the middle of the 3-inch lining.

After a 4-day curing period a seal coat using about 0.1 gallon of emulsion per square yard was applied by spraying from the banks of the canal. A light coat of white sand was dusted in to approximately match the color of the portland cement concrete. The lining is not as smooth as well finished concrete, and the top edges of the lining are not as evenly finished as the edges of the regular concrete lining. One month after placing, a slight settlement was noted, in comparison with adjacent sections of portland cement concrete lining which showed no apparent settlement.

Health Officers Appointed for Boulder City

DR. DANA D. LITTLE and Miss Frances R. Brewington were appointed September 13 city health officer and city health nurse, respectively. In these capacities they serve gratuitously. Dr. Little is a practicing physician in Boulder City and Miss Brewington serves as school and public-health nurse under the general supervision of the State board of health.

These officials will protect the health of the residents of Boulder City, taking necessary preventive measures and also protecting the residents from the spread of disease.

Geological Division Established in Denver

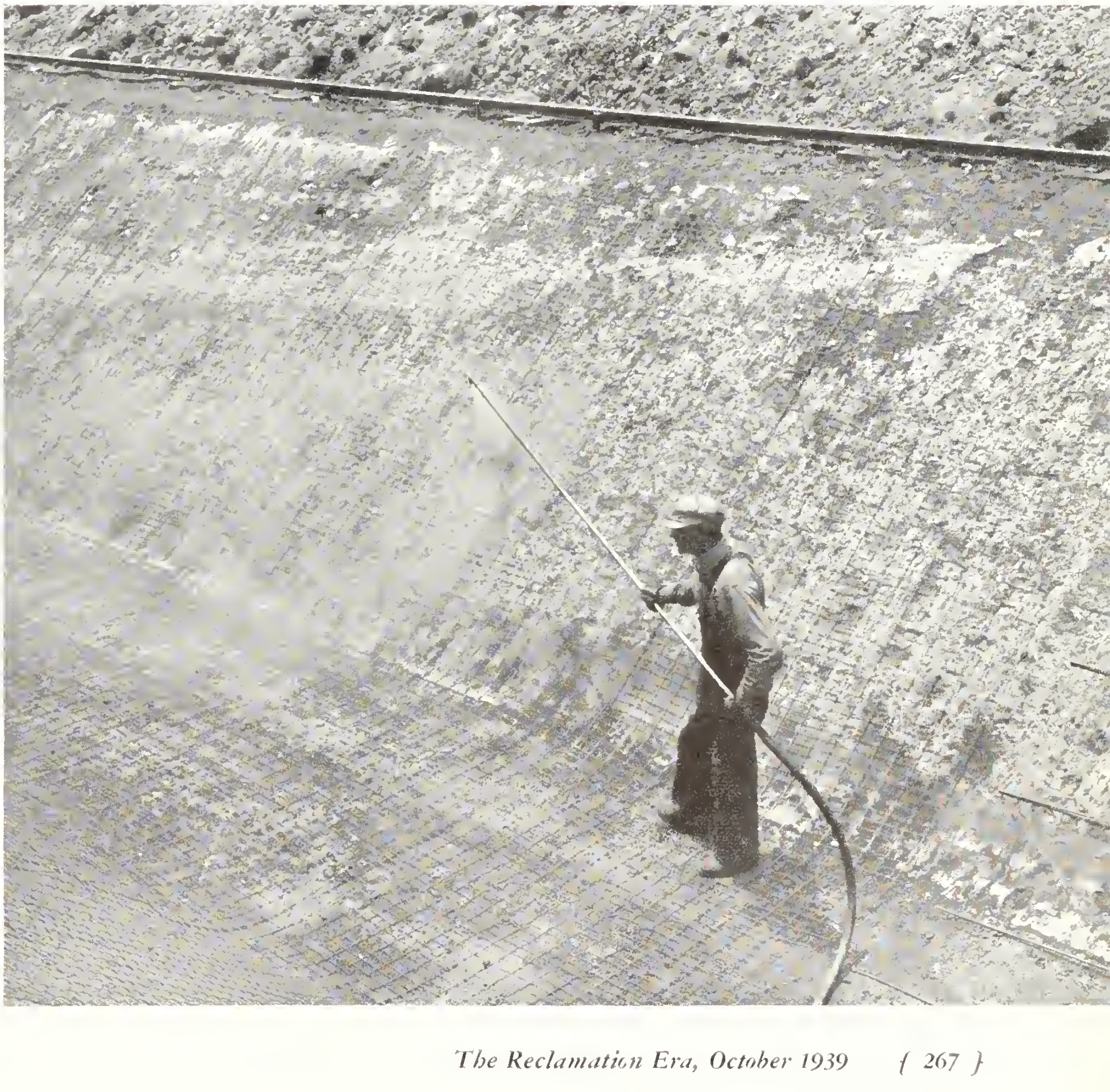
IN accordance with a general order issued on September 7 by Chief Engineer R. F. Walter, a technical geological division has been formed in order that centralized direction may be given by the Denver office to geological personnel on construction projects and in the designing section of the Denver office.

The new division will be in charge of F. A. Nickell as "head geologist", who will report to the chief designing engineer and will direct the geological work in the designing section of the Denver office and have advisory direction, through normal project channels, of all geological work on construction projects.

Administrative supervision of field geological personnel will remain under the project heads.

Yakima Fruit Growers Organize

IN AN effort to improve marketing conditions within the fruit industry, to the mutual advantage of both grower and shipper, an organization of Yakima shippers known as United Marketers, Inc., has been formed.



Upper: Operations from downstream side of rig

Lower: Detail of wire mesh reinforcement and workman applying creosote spray to prevent weed growth

Contracts Awarded, Crane Prairie Dam Deschutes Project, Oregon

Crane Prairie Reservoir.—This structure is located on the Deschutes River near its head. It is an old reservoir built in 1922 for a proposed Carey Act irrigation project which was never completed. It has since been used by three old irrigation districts. A temporary timber crib and rock-fill dam was constructed for economy and also in order to test out the tightness of the reservoir basin which was questioned. The dam was constructed to a storage capacity of 50,000 acre-feet.

The three districts using this reservoir have recently entered into a Warren Act repayment contract with the Bureau for the reconstruction of the dam to its present storage capacity, and for the clearing of the reservoir site, to a combined estimated cost of not to exceed $400,000.

Wickiup Reservoir.—This is a proposed reservoir, required for the use of the "North Unit" (50,000 acres) of the Deschutes project, now under construction. This reservoir also is located on the main upper Deschutes River, a few miles below the Crane Prairie Dam. The storage capacity proposed is 180,000 acre-feet, which will require a main dam across the Deschutes River to a height of 84 feet above river level and with a long low left wing extending for a total dam length of approximately 2¾ miles. A secondary dike (East Dike) is also required to cross a saddleback of Wickiup Butte. This is approximately seven-tenths of a mile in length and the maximum height is 27 feet. The type of dam proposed is a rolled-earth and gravel embankment with rock faces, similar to that proposed for Crane Prairie. The spillway will be around the left end of the East Dike, through an uncontrolled rock cut, and discharging into a ravine which leads back to the river. Owing to the very constant flow of the Deschutes River it is expected that the usual flood will be taken through the outlet gates, and that the spillway will be used but seldom, if ever.

The reservoir submerged area is some 11,300 acres, nearly all of which is heavily timbered with commercial Ponderosa pine and with lodgepole pine. A local lumber company has now removed the commercial timber and the balance is to be cut and burned.

The preliminary estimated cost of the Wickiup Reservoir is $2,422,000. The construction of the reservoir, except for the outlet works, has been approved as a CCC project, augmented by some Bureau force account work, and the building of the wing of the main dam and the clearing of the reservoir is now under way. The CCC work will greatly reduce the cost of the reservoir to the project water users.

Letting of contracts.—Invitation for bids covering the construction of Crane Prairie Dam and the outlet works of Wickiup Dam was issued by the Commissioner on May 27, 1939. Bids were opened at the project office on June 27. Seven contractors submitted bids on one or both schedules. The successful bidders were: Schedule 1 (Crane Prairie), Vernon Bros., Boise, Idaho, $98,560; schedule 2 (Wickiup), C. J. Montag & Sons, Portland, Oreg., $154,653.50. Telegraphic notice of award of contract was sent by the Chief Engineer to Montag & Sons on August 1 and to Vernon Bros. on August 9. The latter was delayed pending the signing of the "repayment contract" by the three private irrigation districts interested, covering the repayment of the cost of construction of the Crane Prairie Dam.

Regarding the time for commencement and completion of work, the specifications provide:

"The contractor shall begin work within thirty (30) calendar days after date of receipt of notice to proceed, shall complete all of the work under schedule No. 1 within three hundred (300) calendar days, and shall complete all of the work under schedule No. 2 within four hundred and fifteen (415) calendar days from the date of receipt of such notice."

These limitations of time, especially in the case of schedule 1, and also because of the lateness of the season in letting the contracts and the severity of the winters in this locality, make it necessary for the contractors to get started as soon as possible and that they work on a rush schedule.

The Government is to furnish all materials that will become a part of the completed construction work, such as outlet gates and fixtures, reinforcing steel, cement, concrete aggregates, etc. These materials are being purchased by the Chief Engineer's office, and the gates and fixtures and reinforcing steel have now either been purchased or proposals have been submitted for early delivery.

Crane Prairie Dam.—This dam is to be a rolled earth and gravel embankment with a riprapped upper face and a rock-fill lower face. The height above water surface is approximately 30 feet and the crest length is 285 feet. The outlet structure is a twin 7-foot diameter horseshoe conduit through the right abutment, controlled by two 4.8 by 6 feet cast-iron slide gates, and provided with a fish screen at the inlet and a stilling pool at the outlet of the structure. The spillway is an unlined rock cut around the left abutment, 80 feet in bottom width and extending for a length of some 400 feet downstream from the axis of the dam. The spillway is controlled by an open concrete weir, 80 feet in length and at an elevation 10 feet below the crest of the dam. The axis of the dam is 230 feet downstream from that of the old structure.

Wickiup Dam—outlet works.—The outlet structure is located in an open cut in the right abutment of the dam near the river bank. It will be founded on bedrock. The structure is a double 9-foot diameter, horseshoe, concrete pressure conduit leading to the concrete gate shaft, located near the axis of the dam. At this point the conduits are controlled by two 96-inch "ring follower" gates, set in concrete-imbedded cast-steel pipe of the same diameter. Below the gate chamber the outlet is a double 96-inch diameter steel pipe resting on cradles inside of 11-foot diameter, concrete horseshoe conduits. At the lower toe of the dam the conduits are again controlled by two 90-inch "tube valves," set in a concrete valve house. These valves discharge into a concrete stilling basin. The inlet of the conduit is provided with a trashrack structure.

Boom Across Columbia Serves Dual Purpose

A PARTY of seagoing rattlesnakes had their voyage cut short when workmen destroyed them on logs and debris accumulated at a boom stretched across the Columbia River above the Grand Coulee Dam.

A group of waterfalls, now 50 feet high, and still growing, has been created at the dam. The boom across the river serves the double purpose of protecting pleasure boats from possible destruction in the falls, and of collecting logs and floating trash that would otherwise accumulate in quiet areas of the forebays. Much of the wood is salvaged by residents of the vicinity, and cut up for fuel, but it is necessary to open the boom from time to time and allow the remainder to go on downstream.

Coulee Dam Model

LIKE the mountain that was brought to Mahomet, Coulee Dam is brought to many interested people who are unable to visit the dam. A portable model, made by the Bureau of Reclamation, is exhibited at various points in the northwest by the Office of Government Reports. Now, it is doing the fairs. During the past school year, it was shown by a lecturer at numerous high schools and service clubs under the sponsorship of local organizations.

Construction of Seminoe Dam and Power Plant, Kendrick Project, Wyoming

By J. H. WARNER, *Resident Engineer*

SEMINOE DAM and power plant were completed on July 1, 1939, after 3½ years of intensive and continuous construction work in the Black Canyon of the North Platte River 37 miles north of Parco, Wyo.

This dam, serving the dual purpose of providing irrigation storage and power development for the Kendrick project of the Bureau of Reclamation, was built by a combination of Morrison-Knudsen, Utah Construction, and Winston Brothers, while all power plant machinery and equipment was installed by Government forces.

Reconnaissance surveys and preliminary studies indicated that the most feasible site from the standpoint of economy, geology, and storage possibilities was located in the Seminoe Canyon. The dam site upon which the final studies were concentrated is at the extreme upstream end of the granite canyon, a point where the river, after following the soft sandstone in a westerly direction, turned due north cutting through the granite.

Prior to awarding the contract 1,800 feet of diamond core drilling and 175 feet of vertical shafts were completed in the foundation, and 235 feet of horizontal drifts were driven into the abutments. Additional drilling and about 500 feet of drifts were excavated to further prove the suitability of the canyon floor and the abutments after the contractor had excavated the diversion tunnel.

Contract Designs

After preliminary designing of straight gravity type and constant angle arch type of dams with the powerhouse in various locations, the final contract designs incorporated the thin arch type with a vertical upstream face on a radius of 290 feet, a theoretical crest width of 15 feet, and a base width of 85 feet, the powerhouse filling the width of the canyon at the toe of the dam and the spillway and diversion tunnels through the right abutment.

The variable radii of the downstream face which provide horizontal sections thicker at the abutments than at the crown of the arch, were later revised to incorporate still greater bearing surface at the abutments by adding fillets of 50 feet radius. The addition of fillets and the moving of the left end of the dam upstream approximately 30 feet were the major changes in the design of the dam considered necessary as the uncovering of the site proceeded.

Changes in the appurtenant structures considered advisable in the construction drawings incorporated lining of the diversion tunnel, a cut and cover section at the downstream portal of the spillway tunnel, a grouting and drainage tunnel in the right abutment, a road to the top of the dam on the west side of the river instead of one contemplated on the east side, a road out of the canyon on the east side for the purpose of constructing and maintaining the 115,000-volt transmission line to Cheyenne, and a concrete stilling basin for the needle-valve discharge of the outlet works.

Construction Design

General.—The construction design includes many of the proven features of other Bureau of Reclamation concrete dams and some departures and new methods that are considered an improvement on the construction of a thin arch concrete structure.

The dam is divided into full radial blocks approximately 50 feet wide, measured along the axis, deviation from these widths being necessary in order that the penstock and outlet pipes be kept in individual blocks with no pipe crossing a radial joint.

The rock abutments are designed and excavated to provide for a full radial abutment on the right and half radial on the left. Had the left abutment been full radial, the excavated-rock quantities would have been excessive.

Cooling.—Cooling and shrinking of the concrete was considered advantageous even in the thin section of this dam, one advantage being the averting of a high temperature gradient between the center of the concrete mass and the exposed surfaces, another being the reduction of the temperature early and uniformly to a point below the mean annual temperature in order to obtain a maximum joint opening so grouting of the joints could proceed with the first filling of the reservoir.

To provide for cooling, tubing of 1-inch outside diameter was laid in horizontal coils on 5½-foot spacing, one to each block and at 5-foot vertical spacing to conform to the 5-foot concrete lifts. These coils were assembled after the final cleanup and just previous to the placing of the next 5-foot lift. The pumping of river water was started through each new coil before concrete placement started, and it flowed uninterrupted until the concrete temperatures had dropped to 5° above the river temperature. Pumping was discontinued in the older coils until fall, when the river water had cooled to a point below 50° F. Then pumping was resumed and secondary cooling was in progress until the entire structure had assumed a temperature of between 35° and 40°. Ordinarily, cooling water was circulated at a velocity of not less than 2 feet per second or a flow of about 4 gallons per minute per coil.

Grouting.—The grout curtain, as designed for Seminoe Dam, is similar to many of the Bureau structures of this type. Alternate 100- and 50-foot holes at 5-foot centers and 1¾ inches in diameter were diamond drilled into the floor of the canyon and normally into the abutments from pipes set in the concrete and protruding from the upstream face. Grouting pressures from 50 to 250 pounds per square inch were used, and grout having a water cement ratio varying from 1 to 5 was pumped into the cracks depending on take of the holes. Departing from the designed "A" line grout curtain just mentioned, considerable drilling and grouting was performed from the foundation treatment galleries, later described under "Mining," and in the grouting and drainage gallery in the right abutment.

After all foundation grouting was completed, 4½-inch drainage holes on 10-foot centers were drilled through 6-inch steel pipes set in the concrete. These drain holes were located 5 feet downstream from the "A" line grout holes and were drilled 30 feet into the rock. A connection was made from the 6-inch pipe to the 8-inch headers that carry the drainage to the downstream face of the dam. Three-inch porous concrete drain tile at 10-foot centers, set vertically 5 feet downstream from the face of the dam, collect any internal drainage water and discharge it into the drain headers.

Construction Features

Spillway and diversion tunnels.—Excavation for the 30-foot diameter concrete lined spillway tunnel was started in the spring of 1936 by removing the top half to the junction of the inclined spillway tunnel and the diversion tunnel. After reaching this point, the tunneling was attacked from three locations. Crews started from the upstream portal of the diversion, others drifted up the center line of the inclined tunnel with a pilot raise, and the third set of miners removed the lower half of the horizontal spillway tunnel. Fairly sound granite was encountered in the entire spillway tunnel except at the downstream portal where steel sets were required. However, serious difficulties were met in 200 feet of the diversion tunnel. The contractor had elected to construct an unlined 26-foot horseshoe section and started removing this from a full heading, but on reaching disintegrated caving material, the plans were changed to a heavily timbered section. The following spring when concrete lining was started the diversion tunnel was lined throughout as a 24-foot horseshoe.

Concrete lining of the horizontal spillway tunnel and the diversion tunnel was carried on from April to July 1937, and after low pressure grouting of the spillway section, the river was diverted early in August 1937. Following this, the lining of the inclined spillway tunnel and the placing of concrete in the spillway gate structure to the roadway, required the remainder of the season or until December 1. While movable jumbos were used throughout for concrete forms in the horizontal tunnels, it was necessary to form in place the lining of the inclined tunnel due to change in shape and size for its entire length.

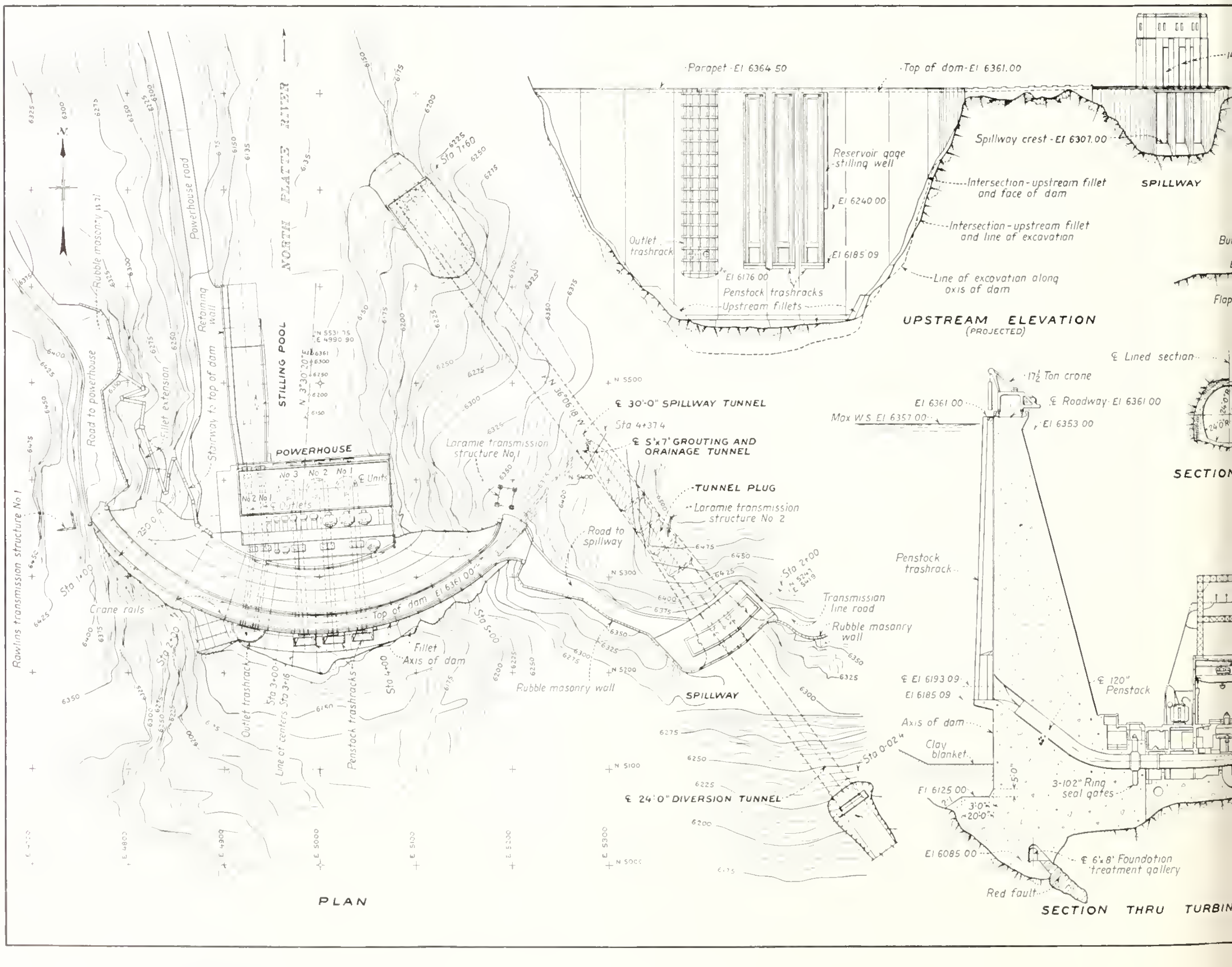
All concrete for the tunnels and gate structure was placed by a pumpcrete machine, located on the right side of the river.

A 12-ton movable cableway served the pumpcrete machine from the mixing plant on the left abutment. Maximum distances pumped were a thousand feet, and maximum size aggregate pumped through the 8-inch discharge pipe was 3 inches.

Excavation—Dam and power plant.—While the river was still flowing through the dam site, much of the stripping of canyon walls and rock excavation for the contractors cableway benches and for the dam was in progress. This work continued uninterrupted in 1936 and 1937 except for a few weeks when exploratory drifts were being excavated in the right abutment. The test drifts were considered advisable to prove the deep rock in the right abutment after disintegrated material was encountered in the diversion tunnel.

The office and field control of the abutment excavation was novel, in that neither rod nor chain were used. Office computations were made of controlling excavation points for each 5-foot contour, using two known triangulation points. The field party consisted of two transitmen with telephone head sets, a recorder, and one rodman attached to ropes with a life belt. The rodman's only equipment was a 3-foot stick. The transitman, in constant communication, read horizontal angles to a predetermined point, thereby spotting the rodman at the intersection. One transitman with a known height above sea level read the vertical angle, computed the elevation, and signalled the rodman the cut to paint on the cliff.

After diverting the river and unwatering the site, power shovels and trucks removed



about 30 feet of overburden, much of which was exceedingly large rocks toppled from the cliffs for ages past. When the floor of the canyon was excavated to the designed base of the dam, one-third of the area was still covered by disintegrated material. Excavating an additional 30 feet revealed two fault zones. One crossed the canyon floor near the axis dipping 48° downstream, the other had a strike up and downstream dipping 70° under the left abutment. As it was unsafe to continue down the seams using open cut methods, it was decided to form galleries and shafts in the base of the dam attacking the seams by mining methods.

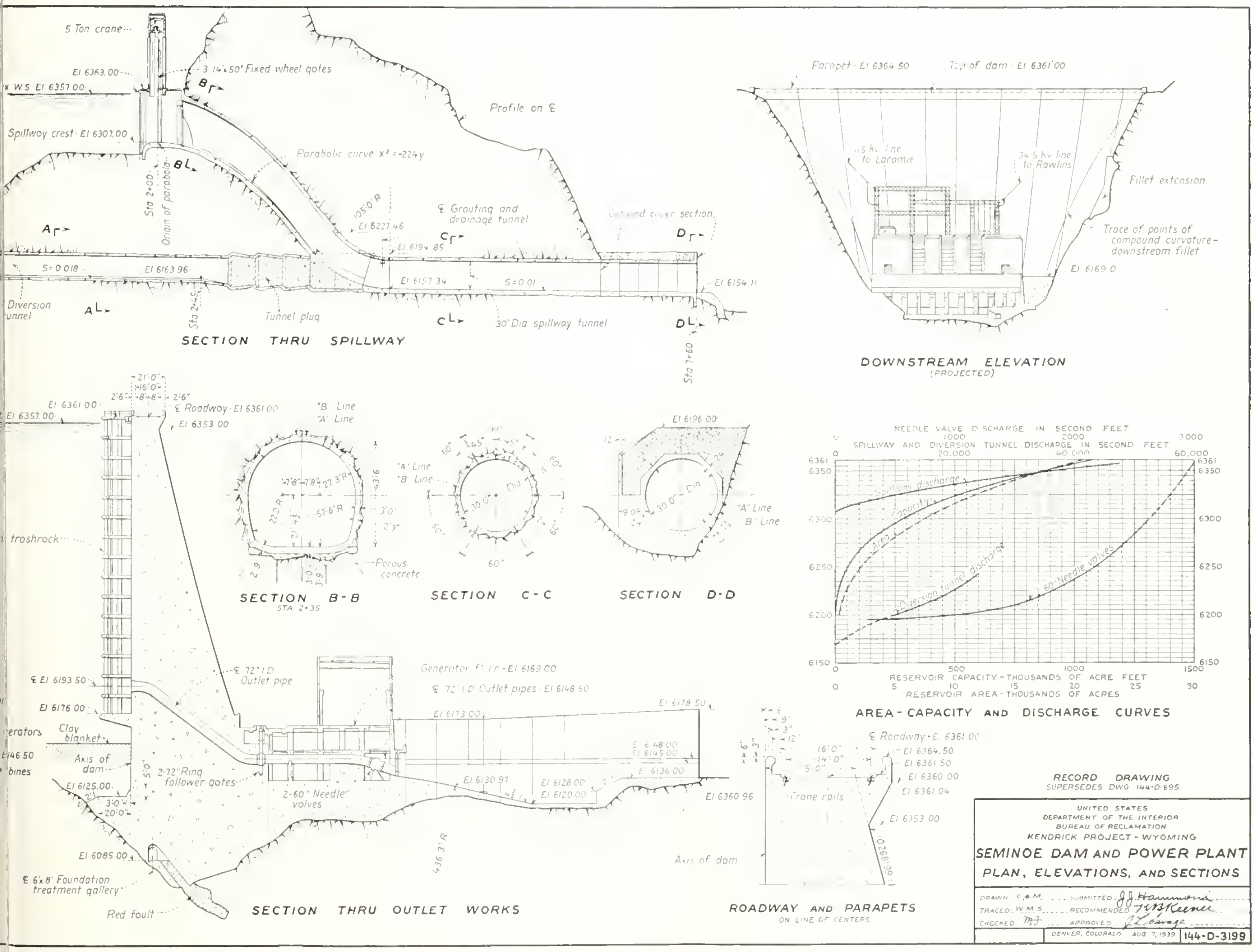
Excavation of tailrace.—The deepening of the river channel for 2,200 feet downstream from the powerhouse was an extremely difficult piece of excavation. The meandering channel following the river is 70 feet wide on the bottom with 1 to 1 side slopes and maximum excavated depths of 25 feet. Excavation was carried on during two fall seasons when the flow of the river was at a minimum. A dragline with an 80-foot boom and 5-yard bucket was used in loading trucks which hauled the material to a side canyon. While only 15 percent of the excavated material was over 1 cubic yard in size, many of the rocks had to be drilled and shot under water to be loosened. The final removal of the downstream cofferdam and tailrace close to the powerhouse was not completed until the gates in the dam were closed.

Concrete—Dam and Power Plant

All the aggregate for concrete was excavated by draglines from bars within the river channel 2½ to 4 miles upstream from the dam. Removal from the river bottom was necessarily carried on only in the low-water months in the fall of 1936, 1937, and 1938. The raw aggregate was stock piled at the screening plant which was located in the reservoir area 2½ miles from the dam. The material was washed and screened into four sizes of gravel, the maximum being 3- to 6-inch cobbles, and transported by an aerial tramline to the mixing plant. The location of the mixing plant was on the canyon wall upstream from the dam. It included one 4-cubic-yard mixer, batching equipment for aggregate, water and modified bulk cement, and a combined recorder registering the weights of each ingredient and the consistency of the concrete. Two and one-half minutes mixing time was the minimum allowed, and the average slump attained in the mass concrete for the dam was 1¾ inches at the forms. This dry mix was easily handled in 4-yard bottom dump buckets which placed the concrete in any block of the dam or any location of the powerhouse, where it was vibrated into place. Transportation from the mixing plant to the forms was by a shuttle train and a 12-ton traveling cableway.

Seminoe is the only dam of this size built under rigorous climatic conditions where the placing of concrete was completed in one season.

This was made possible by the concrete operations starting on January 19, 1938, in a



deep trench about 125 feet wide with cables strung across to support many thousand square feet of canvas.

Distillate burning orchard heaters raised temperatures sufficiently to continue concrete operations in weather considerably below freezing. By the time the spread footing was completed and forming of the faces of the dam started, good weather prevailed which continued all summer. The final work on the parapets was completed on November 28, 1938, after a 17° mean minimum month of working under canvas and steam heating of the concrete. From the rock foundation to the top, vertical contraction joints divide the dam into 10 blocks approximately 50 feet wide for convenience in construction and to provide for the contraction of the concrete. All joints were formed with the standard sloping keyways incorporating a complete grouting system with copper seals on both faces of the dam, at top and bottom of each 50-foot lift.

Alternate blocks were built from two to three 5-foot lifts higher than the adjoining ones. The rate of placing concrete was regulated by the minimum requirement of a 5-foot lift each 72 hours and the ability to raise forms and clean the horizontal concrete surfaces.

Flexible panel forms, about 56 feet long constructed of 1¼-inch vertical grain tongue and groove fir flooring with no steel facing, were used entirely for the faces of the dam. The horizontal construction joints were cut with air and water jets during the hardening process, usually between 12 and 16 hours after placement.

The bulk modified cement was shipped by rail from the Monolith Portland Cement Co. at Laramie to Parco, where it was unloaded by pumping and transported to a silo at the dam site by trucks. One barrel of cement per cubic yard of concrete prevailed in the mass mix for the dam. The mix by weight, cement to aggregate, was 1:9.61, a gravel to sand ratio of 2.4, water cement ratio of .54, slump 1¾ inches, and a resulting 28-day strength of 5,000 pounds per square inch for all test cylinders broken.

After spreading a layer of grout on the 3-day-old surface, the concrete was dumped from 4-yard buckets using either three or four layers, for the 5-foot lift depending upon weather conditions or the ability to spread and vibrate the concrete without resulting cold joints.

The powerhouse, a reinforced-concrete structure with steel-girder roof framing located at the toe of the dam, is separated from it only by a ¾-inch cork joint. The substructure of this building was constructed in a series of convenient blocks with stainless-steel sealing strips for water stops. The superstructure above the generator floor was placed continuously in 8-foot lifts using 4-yard side-gate buckets discharging into hoppers and elephant trunks. Four-inch tongue and groove flooring was used for exterior forms and the interior was paneled, using 4- by 8-foot sheets of ⅝-inch plywood and ½-inch V strips at the plywood joints. This arrangement relieved the plainness of the interior walls, and after the she-bolt holes were dry-packed and the airholes filled by sack rubbing, a very pleasing surface was obtained.

The power plant houses three vertical-shaft hydraulic turbines built by the Pelton Water Wheel Co. Each of these units has a capacity of not less than 7,000 horsepower at full gate opening when operating at 225 revolutions per minute under a net effective head of 113 feet. As this head increases the turbine output increases to a maximum of 15,000 horsepower at full gate opening under a net effective head of not more than 171 feet. The scroll cases are of ¾-inch plate steel fully assembled on the job with all holes reamed, countersunk, and riveted with 1⅛-inch rivets. The three alternating-current generators were built by the Allis-Chalmers Manufacturing Co. with the following rating for each: 12,000 kilovolt-ampere capacity; 90 percent power factor; 60-cycle frequency; 3-phase; 6,900 volts, and a speed of 225 revolutions per minute.

All the hydraulic gates are located in the basement of the powerhouse. Three types are installed, the motor operated 102-inch ring seal gates in the penstocks, the 72-inch oil pressure operated piston type ring follower gates in the two outlet pipes and the 60-inch balanced needle valves discharging into the stilling basin downstream from the powerhouse.

A well-equipped machine shop, oil storage room, oil filter room, electrical bay with switch gear, station power transformer room, storage battery room, and compressor room all occupy the turbine floor. The main control switchboard alone is located in the control room at the east end of the building on the generator floor.

Three banks of step-up transformers serving the Rawlins, Casper and Cheyenne lines occupy the platform between the dam and powerhouse.

Mining and backfilling of seams under the dam.—Probably the most interesting and unusual feature in connection with the construction of Seminoe Dam was the removal by mining methods of faulted areas under the dam and the healing of these seams with concrete and grout.

As this work was unforseen and not provided for in the contract and as the extent of it was uncertain an order for changes was signed to execute this work on a cost plus basis. As certain concrete adjacent to the power plant had to be in place before removal of muck from the mine could start, the work was delayed until July 1938 or not until the concrete in the dam was 150 feet above the foundation.

The main hoisting shaft, 100 feet deep, was formed near the toe of the dam and close to the left abutment. Two 6- by 8-foot galleries were formed in the base of the dam from 10 to 15 feet above the foundation rock and paralleling the seams at a distance from them to give access to the seams through adits sloping similarly to the dip of the seams. The adits, 5 feet high and 7½ feet wide, were spaced on 25-foot centers.

The seams named after the color of the red gauge material in one and the black chloridic schist in the other, are confined between fairly sound hanging walls and foot walls. The red seam varied in thickness in places from 15 feet thick near the base of the dam to only 3 or 4 feet wide 40 feet below where excavation was discontinued for lack of working room. The black seam which dipped 70° under the left abutment was quite constant in its thickness of 5 feet. This seam which was offset at the foot wall of the red seam was followed down to this point with resulting depths varying from 10 to 87 feet deep.

The mining procedure was to sink shafts in alternate adits to where the seam pinched to a narrow thickness, then to drift from the bottom of the shaft along the seam halfway to the adjoining shafts and backfill this area with concrete. The height of each drift was approximately 8 feet. This process was repeated until all the disintegrated material was removed from under the dam and backfilled with concrete. Timber sets 8 by 8 inches spaced on 5-foot centers were placed while sinking the shafts and occasional stulls were set in the drifts. Many of the supporting timbers were left embedded in the concrete but lagging was removed as concrete was placed.

The procedure in the black seam was altered due to the steeper dip, crumbly material, and excessive water. After the shafts were sunk, drifting along the seams started immediately under the dam and filled with concrete by bulkheading at the sides of the shaft. This same procedure was followed on down and finally the shafts filled.

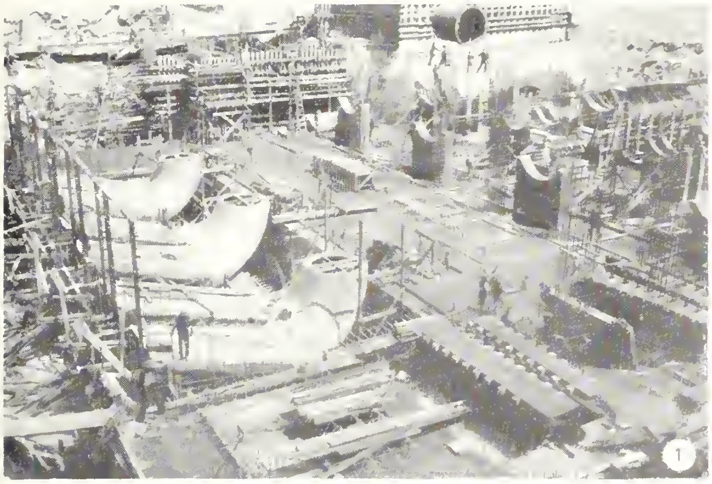
Air tools and equipment were used exclusively in the excavation and no explosives were allowed or found necessary as only such material was removed as could be excavated with paving breakers.

Where concrete could not be placed by means of elephant trunks, it was blown into place by a specially designed gun and then vibrated.

To provide a suitable cut-off in the red seam under both abutments the red-seam gallery was extended in 10-foot sections, setting 7-foot diameter forms with the back end bulkheaded, and pumping in the concrete through 8-inch diameter pipe set in the arch forms. In this manner the circular tunnels were advanced 80 feet under the left abutment and 50 feet under the right abutment.

Grouting systems were installed on the hanging wall of both seams previous to backfilling with concrete. After the concrete had cooled, approximately 4,000 sacks of cement were pumped into the lines providing a foundation with all faults, seams, and crevices well

(*Continued on page 278*)



1. Seminoe Dam and power plant—start of draft tubes and penstocks

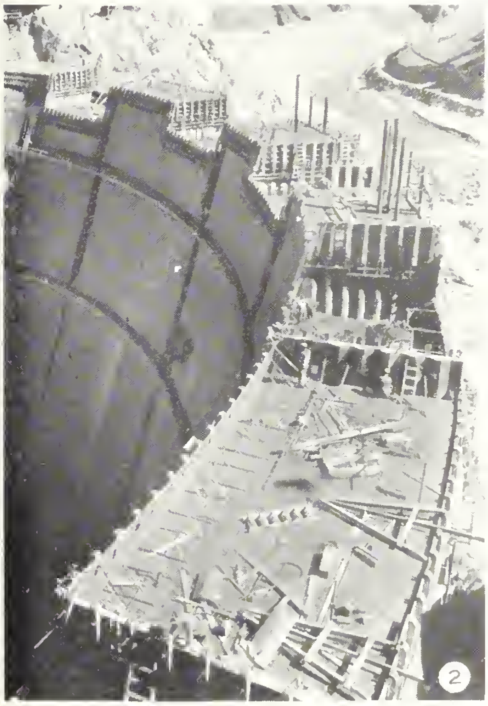
2. Type of forms—dam as it appeared October 1, 1938

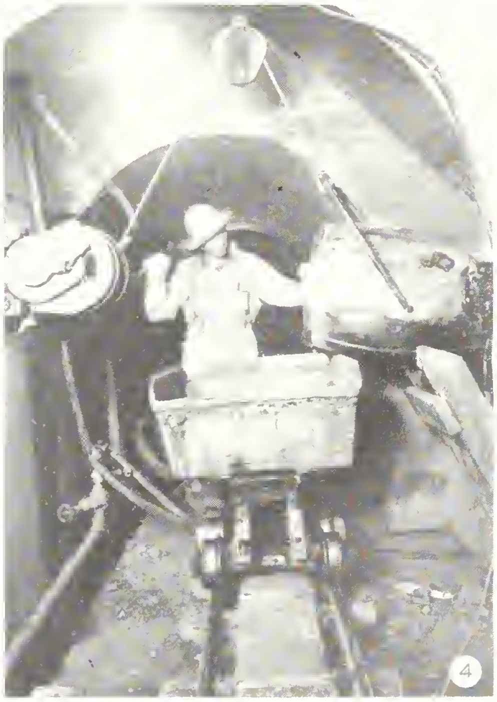
3. Placing and vibrating 1¾-inch slump concrete

4. Equipment used in mining under the dam

5. Downstream view of dam, power plant, and spillway tunnel

6. Upstream view showing spillway gate structure and reservoir within 65 feet of high water level





The Coachella Branch of the All-American Canal

By L. E. CRAMER, *Assistant Engineer*

THE application of irrigation water upon the former desert region now known as Imperial Valley was first effected in 1902, and the All-American Canal, now under construction by the Bureau of Reclamation, will replace a canal system begun at that time, which has since become almost wholly inadequate. The new system, as did the old one, will take water from the Colorado River near Yuma, Ariz. The All-American Canal will allow for a greater conservation of water than has been possible in the past, and the supply will be ample to irrigate 483,000 acres of desirable lands not now served by the existing facilities. The gross irrigable area within the confines of the present system in Imperial Valley is 515,000 acres.

Of the additional acreage to be brought into the range of influence of the All-American Canal 152,000 acres are in the Coachella Valley in southern California.

To supply the Coachella Valley region with Colorado River water requires the building of a 134-mile branch canal, from the main 80-mile All-American Canal. The Coachella Valley has been brought to an exceedingly intense, but only partial state of development, by the use of natural underground water supplies for crop irrigation. Slightly in excess of 16,000 acres are under cultivation in Coachella Valley at this time. The leading crop is dates, but citrus fruits and winter vegetables are also important sources of revenue. As is usual in regions experiencing a limited annual precipitation, and depending upon naturally stored water for their development and growth, the expansion permissible is directly proportional to the water that can be obtained from such sources.

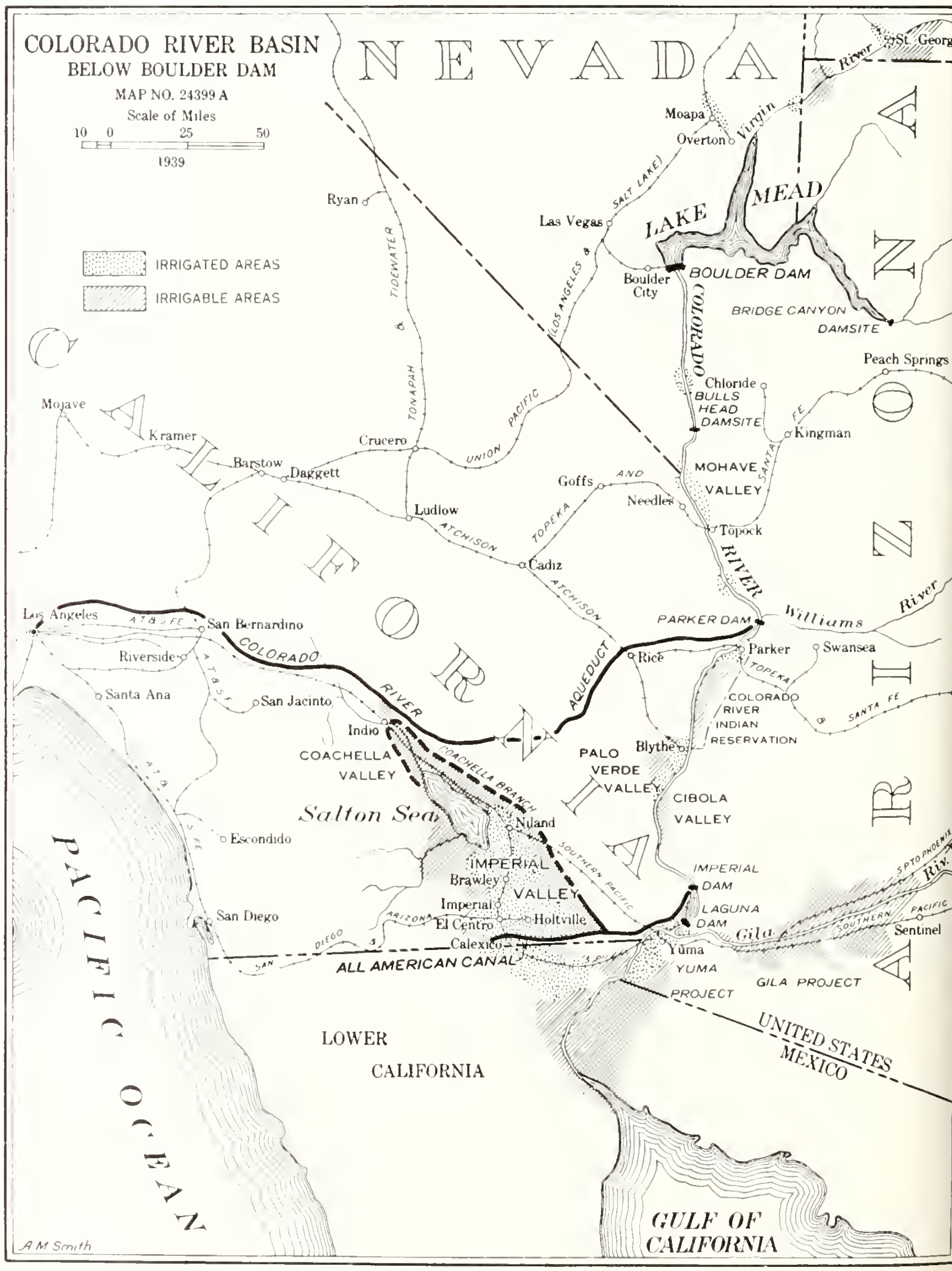
It took vision and foresight to develop the desert regions of southern California. Much of the territory has long been noted for its low annual rainfall. The construction of a canal to transport Colorado River water into Coachella Valley is the culmination of a plan conceived many years ago to meet the definite need for an increased water supply of a rapidly developing section of the country.

Irrigation in Coachella Valley

The first known use of water for a strictly development project carried on in the desert itself was made by the early Indian inhabitants who found that the digging of a well locally eliminated the necessity for long trips into the mountains in search of water. These first wells were located in the northern end of the valley at a point now known as Indian Wells. The "well" was really only an incline, dug by hand to a depth of about 20 feet. Surface water was encountered at that depth and a plentiful supply was available for carrying it up the incline.

The first water to be pumped by mechanical means in the Coachella Valley was obtained in the southern end, where water was within a few feet of the surface, by inserting perforated well points of about 2 inches in diameter down to surface water and a taching a hand suction pump at the top.

For many years before the increase in de mand reduced the flow, the Coachella Valle was famous for its abundance of artesia water. Farming operations were commence in 1885 in the districts favored with artesia supplies, and as the population increased, de velopment was forced gradually to highe ground, where pumping became necessary.



The Need for Water

Whether this region is to maintain its present state of development and values and, in addition, enjoy continuing growth depends entirely upon the provisions made for the development of additional water supplies. The Coachella Valley is a naturally arid region, and its past growth has necessitated the drawing of more water from the natural underground basins than is being replenished.

This has been accomplished by pumping down into the depths of the underlying gravels and extracting the waters which have accumulated in the past before the development of the modern and efficient deep-well turbine pump. The steady year-by-year improvements in the design and construction of this type of pump has permitted the economical lifting of water from greater depths, and this fact has tended, in recent years, to develop the outlying districts. A good well in the lower portions of the valley now has to be 600 feet in depth to obtain the larger flows and pressure heads. The main source of supply to the underground basins comes from the Whitewater River, which accounts annually for an estimated 54,000 acre-feet of the impounded waters.

That the use is exceeding the inflow is evident by remembering that only a very few years ago supplies of ground water were available over most of the valley at reasonable depths. In some portions of the area water flowed from wells under artesian pressure. Artesian flow has now practically ceased. The average water level throughout the valley has fallen at the rate of almost 12 inches per year for the past 30 years, and so it is not difficult to see that some increase in water supply will soon be needed. The only remaining water source economically capable of maintaining present requirements and of meeting future needs is the Colorado River. The Coachella branch of the All-American Canal has been planned to make this water source available. The branch canal will also be of sufficient capacity to serve 195,000 acres of unimproved desert lands through which it must pass to reach Coachella Valley.

Surveys

Investigations, preliminary surveys, and cost estimates for the Coachella Canal were begun during early summer in 1929, and were conducted jointly with similar surveys for the main All-American Canal. Investigations for both canals were made by the Bureau of Reclamation, and under the direction of H. J. Gault, who rendered a formal report in May 1931, which indicated that gravity-canal routes to both the Imperial and Coachella Valleys were feasible from an engineering point of view. This report summarized the results of preliminary studies and surveys, and recommended definite general routes for both canals.

In the latter part of 1933, when the All-American Canal field office was opened at Yuma, Ariz., work was commenced upon final surveys and the preliminary investigations previously made were considerably enlarged upon.

There is no general system of main or lateral ditches in Coachella Valley, consequently special surveys and studies, leading to the final location of these laterals, have been commenced. Work on this phase of the project has not yet been concluded, although a great mass of information has already been accumulated as to costs of construction, pumping, and operating the canal. Also topographical maps of the entire irrigable area of 152,000 acres are being made. The results of this work will then be coordinated and studied and the best routes for lateral ditches selected.

16-cubic yard capacity dragline, equipped with walking traction, roughing-out Coachella section

Canal capacity

A diversion of 2,500 cubic feet per second will be made from the All-American Canal at a point 21 miles west of Yuma, Ariz. The branch canal will then proceed northwesterly to the north of the Salton Sea, along the east edge of a region that has a potential irrigable area of 195,000 acres. Approximately 1,200 cubic feet per second will eventually be taken from the canal between Miles 0.0 and 40.0 to partially provide for the needs of the above area, and the balance of 1,300 cubic feet per second will be available to the Coachella Valley proper.

The new canal will be of trapezoidal section, and from its intake to Mile 86.0 will have side slopes of 2 to 1 and will be unlined; from thereon side slopes of 1½ to 1 are planned. To reduce canal losses and hence to conserve water, to eliminate excessive right-of-way requirements, and to obviate the construction of expensive drainage facilities in cultivated areas, the canal from Mile 86.0 to the end, a distance of 48 miles, will be lined with a 3-inch thickness of concrete. The prism will begin with a bottom width of 60 feet and a water depth of 10 feet.

Construction work now underway

Construction work on the Coachella Branch Canal has already been started, and to July 1939, excavation for the first 19 miles had been completed. The excavation work on the first 40-mile reach of canal is scheduled for completion in the summer of 1940, by which time work will have been started on the excavation and the building of structures on the second 40-mile reach. It is expected that the remaining section of 54 miles will be placed under construction by 1941. The last 16 miles will be built through territory that is partially improved.

A location map which indicates the canal route and the ultimate irrigable areas in the Coachella Valley was reproduced in the July 1939 issue of the RECLAMATION ERA, with an article entitled "The All-American Canal."

Washes

There are more than 160 washes crossing the Coachella Canal between Mile 40.0 and the end at Mile 134.0. These are channels that are normally dry except at times of heavy rains or cloudbursts, when they carry sudden floods of short duration, heavily laden with boulders, sand, and silt. The plan of crossing is to pass the canal under the flood channels by the use of double-barrelled rectangular inverted siphons. These siphons are placed at intervals determined by the character and the size of the area contributing to the run-off. Many of the washes will be combined in groups of two or more and concentrated into one channel by training levees and diversion channels. By this method the number of siphons required will be reduced. Approximately 90 such structures are planned for the complete canal. The flow of smaller washes that cannot be conveniently combined with others leading to a crossing structure will be taken into the canal over a paved spillway built into the canal side slope.

The reach of canal between Miles 40.0 and 80.0 is the only portion upon which final structure designs have been completed, and this section will contain 32 siphons and 5

(*Continued on page 286*)

Grand Coulee Dam—Kibitzers' Paradise

The west Vista House affords fine view of construction on dam

Seeing Grand Coulee Dam

GEOGRAPHICALLY unbalancing the World's Fair distribution this year, and competing almost on an equal footing with both in spectacular appeal, Grand Coulee Dam was visited in July by 53,700 persons, representing every State of the Union, the District of Columbia, 4 territories, 8 Canadian Provinces, and 26 foreign countries.

The job is the thing. Unique—never in the world has anything else of its size been undertaken; dramatic—man subduing the second largest river in North America; interesting—never a dull moment as thousands of men work around the clock, their jobs as finely synchronized as a regimental maneuver.

The Bureau of Reclamation which is building Grand Coulee Dam, recognizes the fitness of this human urge "for to admire and for to see" and welcomes the interest of the sidewalk superintendents who honor it by dropping by.

Grandstands have been built on either side of the Columbia River at the dam site—the east and west vista houses—where about 400 persons can sit comfortably and watch how it is done. A guide points out the items of interest, and explains how and why and whence. His voice is amplified to reach the parked cars whose occupants may be observing from beyond the grandstands.

"More concrete below the water surface than in Boulder Dam, and more masonry in sight than in the biggest pyramid," they learn. Fifteen waterfalls, each 50 feet wide and now about 50 feet high they see as the summer flow of the Columbia sweeps through the center spillway of the dam. (The height of the waterfalls will increase with the height of the dam.) Locomotives pulling cars of concrete buckets, full then empty, back and forth they go across the trestle from the mixing plant on the east side to the portion of the almost-a-mile-long dam where concreting is in progress. In July they watched the powerhouse on the west side grow—the plant where 108,000 kilovolt-ampere capacity generators will operate, generators almost a third larger than those at Boulder, the champions of today.

These ringside seats at the biggest show on earth are free. The crowds are kept moving along at a reasonable pace by the lecturer who, his story told, suggests that they adjourn to the room below for a look at the model of the dam.

Grand Coulee Dam Models

The past, the present, and the future of Grand Coulee Dam are shown in two ingenious models, one in each vista house. In one is shown the dam site. First, 5 short years ago, just a mighty river flanked by the arid hills, in the vicinity four lonesome dry-farm iomes, and a current-driven ferry. Out of he model then is lifted a section representng 20 million cubic yards of material excaated from the 100-acre area. Finally a nodel of the dam, powerhouses, and pumping lant is set in; and, in a period of minutes, he visitors see and hear about a change that as already required the efforts of several housand men over a period of 4 years.

The other model shows how the yearly ycle of the Columbia River's flow affects he project of which Grand Coulee Dam is he dominant feature. Clearly shown are the rrangements by which the dam will raise he water 350 feet and a huge pumping plant ill lift it 280 feet higher to an open canal, rom which it will flow to desert and dry arm lands to be reclaimed during the next everal decades.

Close by to the free parking space for isitors is an air-conditioned restaurant hich serves employees of the project as ell as visitors. It and an oil station are the nly two concessions in the Government own, Coulee Dam. Hotel accommodations ay be had at Mason City, the contractors' amp on the east side of the river. Picnic rounds along the Columbia, below the dam, ere leveled and landscaped by CCC orkers formerly located in a nearby camp.

This construction job that is going on there n the Columbia River in eastern Washingon is ticking along to completion as fast as 034 men working a three-shift schedule with aterials and machinery that twice as many ore men throughout the rest of the country re producing can accomplish. The picture anges by the month, and it is expected the mpleted dam will be coming up sometime in 1941. Until then, to all side-line engineers whose eyes are arrested by a steam shovel broadening a thoroughfare or extending the county road, the Bureau says "Grand Coulee, the biggest job on earth, is your dam. Come and watch it grow."

Model of Grand Coulee Dam viewed by visitors

Green Mountain Dam and Power Plant

(*Continued from page 255*)

ch form through an 8-inch pipe line enterg the form at the crown of the arch. Conete was worked into place by men in the rm, and vibration was accomplished rough doors in the forms. Forms were moved in 18 hours after placing, and conete was kept wet for 14 days after placing. ood forms were used for special sections of e tunnel.

Stripping foundation for the permanent fferdam.—The left abutment of the pernent cofferdam is located in an ancient de area. Excavation was started at the er and progressed toward the abutment. was soon noticed that cracks were open at intervals between the river and the utment, indicating that the old slide had umed movement toward the river. The avation was carried down to a sound atum of blue shale upon which the slide appeared to move. This stratum was covered with a thin clay seam into which water from springs had penetrated, making it a perfect lubricant. Excavation was carried along the surface of the blue shale to a point in the abutment where the overlying shale was not shattered, indicating that the limit of movement had been reached. Water from springs in the left abutment was collected at a sump and carried to the river at a point above the permanent cofferdam, and it is believed that this will prevent movement in the abutment now exposed.

Grouting under permanent cofferdam.—A grout curtain is being formed under the cut off wall in the permanent cofferdam foundation with holes spaced 10 feet on centers. Every third hole under a short piece of this wall will be drilled 25 feet deep and grouted, using a pressure of 30 pounds per square inch; then one hole between each pair of these 25-foot holes will be drilled 50 feet deep and grouted; then the remaining holes in this space will be drilled 100 feet deep and grouted.

It is believed that any existing conditions requiring grouting will be discovered in grouting these test holes, and that a safe cutoff grouting plan can then be adopted.

Winter construction program.—The average annual working season at Green Mountain Dam is from 6 to 7 months.

The contractor's schedule has been seriously interrupted by labor trouble, and in order that he may be in a position to take the best advantage of the working season of 1940 he may adopt the following as a minimum work program for the coming winter:

Complete concrete lining in tunnel; complete excavation of intake shaft; complete concrete lining of intake and gate hoist shafts; grout tunnel and shafts; construct temporary cofferdam; divert river; strip right abutment, river bed, and left abutment well back from river; put in foundation of permanent cofferdam cut-off wall, and place grout curtain under same, and start powerhouse excavation.

Government camp.—The Government camp consists of an office and laboratory building, a 12-stall garage and shop building, a large warehouse, a 12-man dormitory, 10 permanent single residences, 4 duplex units, and 11 small temporary residences. The camp water supply is piped from a large spring to a concrete tank with a 17,600-gallon capacity and from the tank to the camp. The camp is provided with sewers, sewage disposal, gravel streets, telephone service, and electric power. A steel arch bridge with a concrete deck and a span of 170 feet was constructed over Blue River at the camp site to provide access from the warehouse to the powerhouse site.

Completion of Construction Contract Boca Dam, Truckee Storage Project

ALL work under contract for the construction of Boca Dam was completed August 23, 1939. The latter part of the work was accomplished by subcontractor Lord & Bishop, of Sacramento, Calif., after the contractor, George W. Condon Co., of Omaha, Nebr., closed his office at Boca Dam on June 22, 1939.

As the final contract work was being done the controls for the outlet works were tested and found to operate perfectly on August 19, as were the spillway gate controls so tested on August 22. These tests were considered particularly satisfactory as the reservoir at the time contained stored water in the amount of approximately 28,300 acre-feet, the capacity of the reservoir being 40,800 acre-feet.

Boca Dam is now ready for operation with the exception of the placing of rock riprap in the outlet channel, which work is expected to be accomplished in the near future by Government forces. In addition to this work further improvements in the form of landscaping, road construction, stream-gaging-station installations, and general betterment work, are intended to be completed by continuing the work now being done by forces of the CCC camp established near the dam.

Project Schools

A NEW grade-school building was ready for occupancy on the Shoshone project, Wyoming, when school started on September 6.

Two new grade schools were ready for occupancy for children on the Carlsbad project, and good progress is being made on a new high school building.

New Union High Schools at Adrian and Nyssa opened for the first time during September to serve children of the Owyhee project, Oregon-Idaho.

Olive-Oil Plant

A NEW plant for pressing olives with a capacity of about 240 gallons per day is in operation this season on the Orland project, California. It requires 6 tons of olives to make this amount of oil.

Boca Dam, Truckee storage project, Nevada

Construction of Seminoe Dam and Power Plant, Kendrick Project, Wyoming

(*Continued from page 272*)

filled with concrete and grout where before 3,500 cubic yards of soft yielding material occupied the seams.

After completing all grouting in the galleries, drainage holes were drilled and the amount of inflow measured, with the water surface in the reservoir at a point 200 feet above, was only 5 gallons per minute.

Major Quantities and Units

Height of dam_______________feet__	29
Length of dam_______________do____	52
Thickness of dam at base______do____	8
Excavation—common and rock for dam and power plant__cubic yards__	265,00
Total concrete in dam_________do____	180,00
Cement per cubic yard of concrete in dam_______________barrel__	1
Slump of mass concrete_____inches__	1¾
Maximum temperature of concrete degrees__	10
Minimum temperature of concrete after cooling______________degrees__	3
By secondary cooling—amount of water circulated per cubic yard of concrete _________________gallons__	30
In grouting—cement used per lineal foot of hole drilled_________sack__	0.7
Storage capacity of reservoir acre-feet__	1,020,00
Average annual production of firm power will be_____kilowatt-hours__	130,000,00
Average secondary power_____do____	30,000,00
Capacity of spillway____second-feet__	50,00

A Tribute

MRS. MARJORIE ELLIS, wife of one of th engineers assigned to the Salt River projec Arizona, has written Tribute to a Ghost Tow and this article nicely illustrated, appears i the October issue of Arizona Highways. He article is a simple, interesting, and very rea able account of life in the camp which wa the operating base for workers on Bartle Dam.

Mostly everything that has been writte during the construction period has been a technical nature. This account differs i that respect and describes life in the cam from its establishment to the date of dese tion when the working crews completed th job. The reading of her story is recommended.

Ladino Clover, Owyhee Project

IT IS estimated that a bumper crop of 30,0 to 40,000 pounds of this clover seed, whic is about four times that of any previous ye in Malheur County, will be harvested.

Power Developments on the Riverton Project

By S. T. LARSEN, *Assistant Engineer*

ALL power and irrigation water used on the Riverton project is diverted from Wind River into the Wyoming Canal at the Diversion Dam. Pilot Butte power plant and reservoir are located about 9 miles down the Wyoming Canal from the point of diversion. Water passing from the canal to the reservoir drops about 100 feet in elevation and in so doing provides a head for power development at the Pilot Butte power plant.

The Pilot Butte power plant was first operated in 1925, principally for the purpose of supplying electric power for the Government draglines which were working on canal excavation. About a third of the first year's production was sold as commercial power. The original installation consisted of one 1,000 kilovolt-amperes generating unit and a 1,000 kilovolt-amperes bank of transformers. Four years later a second generating unit, identical with the first, was installed to take care of the increasing commercial load and to provide stand-by power; the transformer capacity was not increased, however. As heavy construction work on the project was reduced, Government use of power decreased accordingly so that in later years about three-fourths of the power generated has been sold commercially.

Market for Electrical Energy

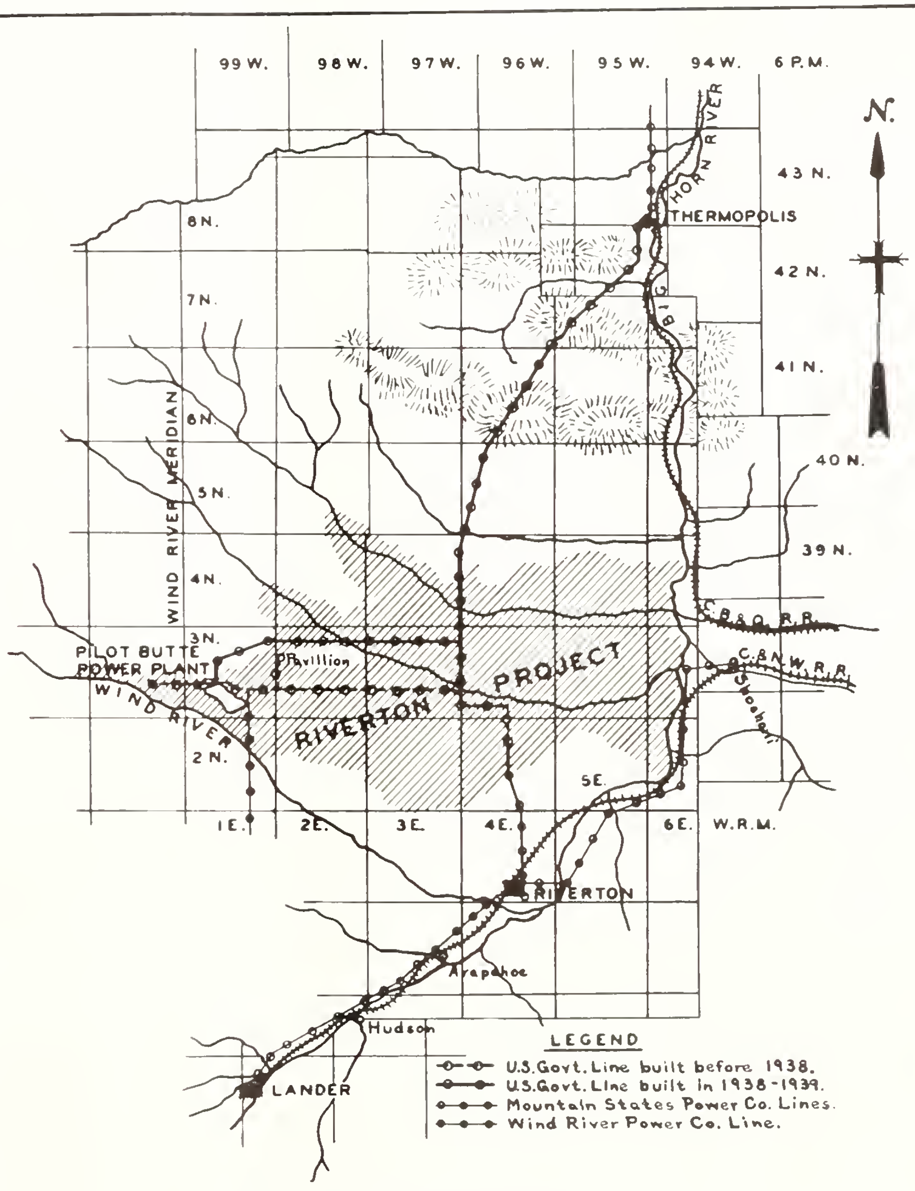
At the end of 1938 wholesale electrical energy was being sold to three customers—the Mountain States Power Co., the Wind River Power Co., and H. K. Burch. The Mountain States Power Co. serves the principal towns of Fremont County and the Big Horn Basin. Energy for their Fremont County business was furnished principally by the Pilot Butte power plant while energy for their Big Horn business was furnished by the Shoshone project plant at Cody. The Wind River Power Co. serves the town of Ethete and some rural customers in the vicinity of Fort Washakie. The energy sold to H. K. Burch is used by the purchaser in the operation of the Pilot Butte oil field.

Early in 1938 the desirability of a connecting line between the Big Horn Basin transmission system and the Riverton project system became evident due to the closing down of the Gebo coal mine plant which had served as a power source and regulator for the south end of the Big Horn Basin system. Consequently an item of $125,000 for the construction of a transmission line by the Riverton project from Pilot Butte power plant to Thermopolis, Wyo., was included in the Second Deficiency Act, fiscal year 1938.

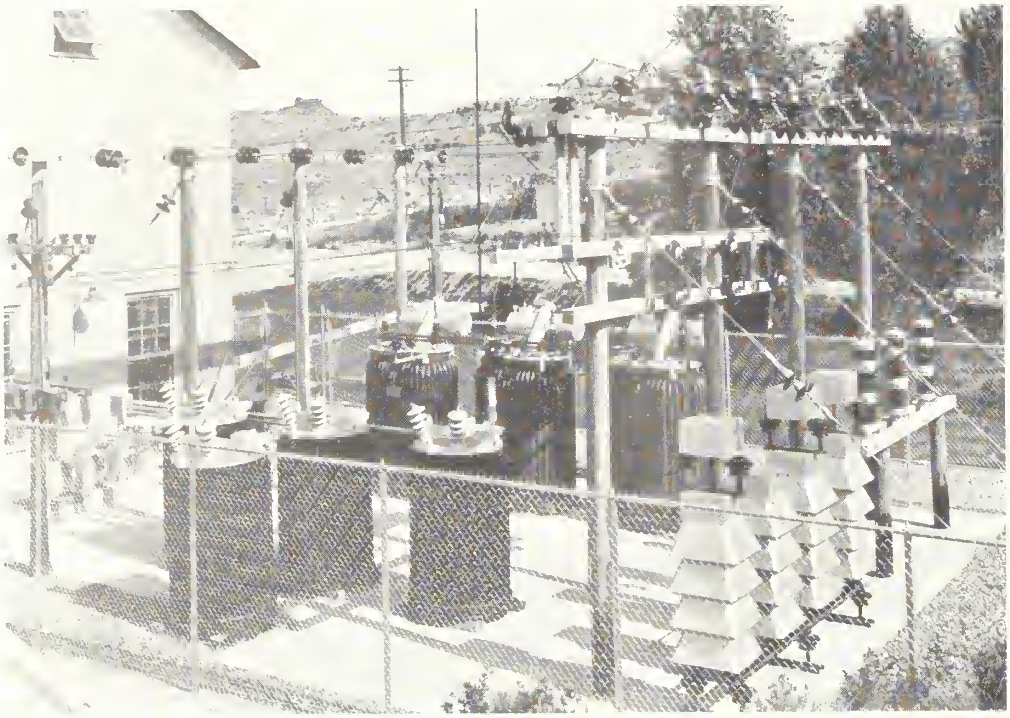
As soon as funds were available the work of locating the line was undertaken and the survey data was transmitted to the Denver office, where designs were prepared. These designs embodied the latest improvements in transmission-line design, thereby insuring a first-class line as dependable and trouble-free as was possible to secure.

The conductor used was No. 1/0 stranded aluminum reinforced with steel; wood cross-arm braces and wood guy strain insulators were used. The line was designed to carry 33,000-volt, 3-phase current on a single circuit. Except on long spans single-pole structures were used with the length of poles ranging from 30 to 60 feet, the majority of the poles being of the 35- and 40-foot lengths.

Actual construction work on the line was started in August, when the hole-digging crew went to work. A contract was let for the hauling of poles, but all other work was done



RIVERTON PROJECT
POWER TRANSMISSION SYSTEM



Pilot Butte power plant transformer yard

by Government forces under the direction of the project power foreman. Considering the natural difficulties that had to be overcome in building the 53 miles of line, much of which was over rugged, mountainous country, very good progress was made with the work. Some delay in completion of the line was caused by the failure of materials to arrive on schedule and by right-of-way complications, but the final connection was made and service established on January 27, 1939.

In order to provide sufficient transformer capacity to serve the Big Horn Basin in addition to the Fremont County load it was necessary to purchase a new bank of transformers. It was considered advisable to install transformers of sufficient capacity to carry the entire output of the plant, so bids were received for three transformers of 667-kilovolt-ampere capacity each. The Kuhlman Electric Co. was low bidder and furnished this equipment. The work of installing the new transformers included the placing of conduit and the extension of the concrete slab in the transformer yard to form a base for the new equipment. Five-inch-diameter conduit was placed to carry the 2,300-volt feeders from the oil circuit breaker in the plant to the transformers. Conduit of smaller sizes was installed to carry the temperature alarm circuits and the lighting circuits for the transformer yard.

In the old arrangement the 33,000-volt busses above the old bank of transformers were strained into the framework of the powerhouse. Inasmuch as the building was not designed to take this stress it was deemed advisable to support these wires in some other manner. A plan was evolved for placing both banks of transformers far enough away from the powerhouse so that a pole structure could be installed to carry the busses, this pole structure being guyed into the powerhouse foundation. This plan worked out very well, and the space afforded next to the building was utilized to place the transformers that serve the 2,300-volt lines leading from the plant. The work on the transformer yard was completed with the installation of a chain-link fence 8 feet high with the posts set in a concrete curb.

Interior of Powerhouse

Inside of the powerhouse it was necessary to install switchboard apparatus and instruments for the operation of the new bank of transformers. An oil circuit breaker, similar to the types already in service at the plant except that the capacity was increased, was installed between the 2,300-volt-generator busses and the new transformers. Demand and watt-hour meters were installed to measure the energy delivered to or received from the Thermopolis line. A meter for measuring reactive volt amperes, a wattmeter, and ammeters for measuring line and ground current were also installed, together with the necessary ammeter and shunt switches. The switchboard installation was completed with the installing of a contact clock, relays, indicating lamps, potential and synchronizing receptacles, and test links and terminals.

The old 33,000-volt transmission line to Riverton bears slightly south from the power plant and then goes directly east along section lines for 16 miles before it again bears south toward Riverton. In locating the new line to Thermopolis it was considered advisable to build the new line directly into the power plant rather than use the first 16 miles of the old line to carry both the Riverton and Thermopolis loads. So the new line was located due north from the power plant for about 1 mile, then northeast for 5 miles and then due east for 12 miles before going north again toward Thermopolis. At the point where the Thermopolis line turns north a tie line was extended 3 miles south to connect with the old 33,000-volt line to Riverton. Under normal operating conditions the tie line is left open; the Riverton line is fed through the old bank of transformers, and the Thermopolis line is fed through the new bank of transformers. In case either line fails between the power plant and the tie line the other line may be used to carry both loads, the total load being limited by the capacity of the transformers on the line in operation. By using the tie line it is also possible to bring energy from the Big Horn Basin into Fremont County. In this way the Big Horn Basin system serves as stand-by for the Riverton project system.

Due to its relatively small size and to the high cost of winter operation, the Pilot Butte power plant will never set any record for cheap production of power but the plant does have an important place in the plan of the construction and development of the Riverton project.

Annual Meeting South Dakota Reclamation Association

ON November 1, the second annual meeting of the South Dakota Reclamation Association was held in Rapid City, S. Dak. Representing the Bureau of Reclamation on the program was Engineer W. G. Sloan, who lead the discussion on the Place of Reclamation in the Conservation of Our Resources.

Other subjects assigned for discussion were:

Water Conservation and Development Through Federal and State Agencies, by Ross D. Davies, State coordinator.

Experience of Irrigation on the Indian Reservation, by Carl Aamodt, Agricultural Extension Agent, Rosebud Agency.

Advantage of Domestic Sugar Production by W. J. O'Bryant, Manager of the Utah-Idaho Sugar Factory, Belle Fourche.

Brief Address by O. M. Browne, Associate Engineer, Office of Indian Affairs, Department of the Interior, Washington, D. C.

Boulder Dam Visitors

AT THE end of August the visitors to the Boulder Dam powerhouse numbered so far this year 246,571. A comparative figure for the same period last year is 213,520.

Columbia Basin Land Survey

"I WANT to know more about the land to be reclaimed" is the substance of many letters received by the Bureau of Reclamation and by newspapers and chambers of commerce in the vicinity of the Grand Coulee Dam.

One of the most interesting chapters of the story of that land deals with surveying on a grand scale—covering and recording the characteristics of 2 million acres of land in minute detail. There are reasons for doing it.

Thirty to seventy-five years ago the public domain was surveyed by contract land surveyors, extending the pattern of sections and townships into the arid and semiarid districts of central Washington. Learning that grain could be grown by dry-farming methods on enormous areas formerly used only for grazing, settlers homesteaded the land. A quarter section, adequate in a humid climate, proved to be too small to support a family by dry farming, so many failed and moved away. Those who remained in the areas of greatest rainfall built big wheat ranches out of the abandoned small farms, and fences, surveyors' stakes and monuments, and other landmarks disappeared in enormous fields.

Droughts, continuing year after year, drove many settlers out of districts where dry farming had been successful for a few years, and more boundary markers were lost in desert. Now Uncle Sam must know where they ought to be, because he must administer the Antispeculation Act as water from the Grand Coulee Dam is being made available.

The act was designed to protect settlers from speculative land prices and to insure homemaking opportunities for many families. Briefly, it provides that one person may hold only a limited acreage, if he hopes to obtain any water from the Coulee Dam, and that those owning more land must offer it for sale at its unirrigated value as appraised by the Secretary of the Interior. So the Government must know the owner, location, character, and value of every piece of land in an area roughly 60 miles wide and 85 miles long. Finally it will have all of that information with respect to the million-odd acres to be irrigated, and it will be available to prospective settlers, free.

The surveying task includes recovering the sections and quarter-section corners in a 2½-million-acre area, and marking them with permanent monuments of concrete and metal. Some of the points, once marked with small deposits of charcoal where stones or wood stakes were not available, were long ago plowed under or trampled beyond recognition. Their proper locations are redetermined according to the laws and customs governing land surveyors. These "retracement" surveys have covered, already, more than 2,000,000 acres.

For the purpose of laying out irrigation canal systems and as a means of determining the value of land, the topography of the land must be known. It is represented graphically on those maps that are covered with wavy lines, each running through all points of the same elevation.

Level parties, starting from bench marks established in the territory by the Geological and the Coast and Geodetic Surveys, determine the elevations of all section and quarter-section corners. That work has been done on more than 1,500,000 acres of land by Bureau surveyors.

Men with plane tables, drawing boards on tripods, follow. Through their telescopes, they determine both the distance and direction from their own locations to the various positions occupied by a rodman, while he is kept by a levelman always at the same elevation. Plotting the positions at which a rodman was observed, and drawing lines through such points, the topographic map is made right in the field.

Over a hundred men are engaged on the project land survey. One of them with a taste for statistics estimates that the rodmen have already walked 55,000 miles and have about 15,000 miles to go before the topographic mapping is completed.

Appraisal, Tucumcari Lands

PREPARATORY to construction of the Tucumcari project, N. Mex., it was necessary to have an appraisal made of all lands of the project consisting of 81,000 acres, gross area.

The process of setting up an appraisal was delegated to a board of one man who was tentatively selected by the Arch Hurley Conservancy District, and one man selected by the Department, who together selected a third man for a three-member board. On January 30, 1939, approval was made by the Secretary of the Interior of all members and work was initiated on February 7, 1939.

As a basis for appraisal, sheets were prepared for each 160-acre tract, segregation was made, and values were set up on each 40-acre legal subdivision. The lands previously had been classified during the investigation period in 1936–37, at which time the main canal and principal laterals were preliminarily located, serving to form the tentative upper limits of the area susceptible of irrigation. The appraisal sheets set out the various standard classifications of land in acres, which aided the appraisal Board materially. Instruction to the appraisal board constituted only a general outline which called for a present market value of land and improvements, not considering potential benefits from future irrigation.

On the 81,000 acres, gross area, there were 220 landowner contracts, of which 74 were excess land ownerships and 146 were nonexcess landowners. Excess landowners were those having more than 160 acres for a single person, or more than 320 acres for man and wife. There are 5,215 acres of State, school, and Government land and 75,785 acres owned by individuals and corporations. Practically all of the land had been homesteaded between 1900 and 1910 and, being west of the 100th meridian, is subject to the reclamation law. A number of the original homesteaders still own their land, but most of them and approximately 40 percent of the landowners are nonresidents. The majority of the landowners having excess lands are residents, with a few exceptions. Most of the large holdings had been accumulated through purchase from the original homesteaders, using the land for stock ranch purposes.

The Appraisal Board completed its appraisal and a report was made to the Commissioner of Reclamation on March 8, 1939. The report was approved by the Secretary of the Interior on April 3, 1939.

Negotiation of excess land agreements and incremented value contracts.—With special request from the conservancy district to negotiate the contracts and agreements, the Department instructed the project office to carry on this work, to be later chargeable to the project cost. The work of securing contracts was begun on April 4, 1939, and has proceeded satisfactorily. The local people have decisively expressed their faith in favor of the project.

This is the first instance in the State of New Mexico whereby a conservancy district has entered into a contract with the United States Government to construct an irrigation project. Usually a conservancy district, established by the landowners, votes bonds for construction purposes. In this instance, by an act of the State legislature, legal machinery was set up eliminating the necessity of a vote of the landowners and making it possible for a conservancy district to enter into such a contract. The result was that the expression of the people was received principally through negotiation of their contracts.

Rock Cuts on the All-American Canal

By L. E. CRAMER, *Assistant Engineer*

IN locating the route of the 80-mile All-American Canal from Imperial Dam on the Colorado River near Yuma, Ariz., to the Imperial and Coachella Valleys in California, it was realized that portions of the route must pass through several rocky ridges or spurs. The route finally selected passed through three such ridges, involving a total length of rock cut of 3,200 feet and a total rock excavation of 1,303,600 cubic yards.

The first rock cut of 1,500 feet in length was encountered at Mile 4.3 from Imperial Dam and the excavation at this point amounted to 688,600 cubic yards. The second and third cuts are at Mile 21.6, 750 feet in length, and at Mile 22.0, 950 feet long. The total rock excavation at these last two amounted to 615,000 cubic yards.

A comparison of the main features of the three rock cuts is given in the following table:

	Rock cut No. 1	Rock cuts Nos. 2 and 3
Bottom width.................feet..	94.0	69.0
Water depth.................do....	22.75	20.13
Quantity...cubic feet per second..	15,155	10,155
Velocity..........feet per second..	6.0	6.0
Kutters "n" [1]........................	.035	.035

[1] Coefficient of roughness.

Preliminary geological surveys conducted prior to excavation indicated a decided lack of uniformity in the character of the rock, and it was also evident that earth disturbances in the past had altered the formations. Much of the formation was badly shattered and full of small seams. Some of the apparent intrusions were very hard and proved difficult to excavate to a designed slope. Other parts were soft and could be more easily worked.

Original designs called for side slopes of ¾ to 1 which it was felt was the steepest these cuts could be expected to withstand without slides occurring; however, the undetermined stability of the material to be excavated made it desirable during the progress of the work to vary the side slopes and the dimensions dependent thereon. The rock cut at Mile 4.3 had a final cross section that conformed very closely to the ¾ to 1 slope as designed (fig. 1), but the cuts at Miles 21.6 and 22.0, although they were originally excavated at a slope slightly flatter than ¾ to 1 (figs. 2 and 3), later exhibited slide tendencies and the side slopes were flattened further (figs. 4 and 5).

Transitions between the rock section and adjacent earth section were provided at both upstream and downstream ends of each rock cut, the upstream transitions being 100 feet long and the downstream transitions 130 feet long.

Consideration was given, at one stage in the design studies, to lining the canal through these rock sections, but such plans were later abandoned when it was found that a previously built canal, the Yuma Main, had never shown evidences of being subjected to excessive losses during its passage through similar geological formations.

The maximum depth of cut at Mile 4.3 was 85 feet, and at Mile 21.6 and Mile 22.0 the maximum cuts were 90 and 100 feet, respectively. Most of the rock in all three cuts was mica schist, and granite containing gneiss. Some diorite and quartzite occurred in the cut at Mile 22.0. From the right side of this cut, layers of rock separated by mud seams, dipped downward on a slope of approximately 1 to 1 toward the center line of the canal. This condition caused slides on the right side of the canal during construction, and was also responsible in some measure for two slides that occurred subsequent to the completion of the original excavation contract.

The methods used for excavating all cuts were essentially the same. The material was drilled and blasted in a series of horizontal layers or lifts. Drilling was done with jackhammers and wagon drills, supplied with air from a stationary, electrically driven compressor. The holes were sprung with dynamite and blasted with black powder, and in one instance with TNT. Powder consumption approximated 1 pound per cubic yard. Rock disposal at the Mile 21.6 and Mile 22.0 cuts was handled by a 2-cubic yard power shovel which loaded the rock into 20-cubic yard "buggies" drawn by crawler tractors. The contractor on the cut at Mile 4.3 used an electrically powered shovel feeding a fleet of 8-cubic yard Sterling trucks.

Seven months after the completion of the contract involving excavation in the cut at Mile 22.0, a rather serious slide of nearly 5,000 cubic yards occurred on the right side of the canal (fig. 4). Study revealed the existence of several caves in the bank of the canal, which left some large overhanging portions of rock which it was considered desirable to have removed, in order that possible future slide tendencies would be reduced to a minimum. Consequently, a further contract was let which provided for the removal of the loose material in the slide, and the further excavation of the side slopes to stable lines. This work occupied the contractor 6 months, and the right side was flattened to a 1 to 1 slope. The repair work on the lef side was confined to flattening the slope to ward the top of the cut in soft and blocky material. Detached rocks that had loosenec were scaled.

The excavation methods on this new con tract followed closely those used in the origi nal work, drilling being done by jackhammer and wagon drills. Compressed air was fur nished by a stationary, electrically driven ai compressor. The holes were loaded rathe lightly to minimize the shattering of the roc beyond the required lines of excavation. Th rock was loaded by a 2-cubic-yard gasoline powered shovel, and hauled to the wast dump by a temporary industrial railroad powered by a gasoline locomotive (fig. 5).

Approximately a year after the completio of the above-described work, another smal slide occurred in the same cut and near th location of the first slide, on the right side o the canal. The loose material in this slid was subsequently removed from the canal b a Government force account crew. The righ side in this vicinity was also further flat tened at several points where overhang oc curred. During this slide repair work a effort was made to trim the right slope alon the line of the mud seams previously men tioned. The sloping layers of rock wer then benched at stated elevations and furthe excavation then made in the underlyin seam, which was followed until the forma tion of another bench became desirable. Thi method provided small berms or shelve which will prove useful in impeding th progress of future slides, if they occur, an to prevent loose material from falling int the canal water prism.

A considerable quantity of the materia excavated from the rock cuts has been use by the structure contractors on the Al American Canal system, for riprap prote tion in the vicinity of wash overchute bridges, etc., and for dry-rock paving pr tection at the inlets and outlets of othe structures. Also, the embankment section c the canal from Mile 2.7 to Mile 4.3 was face on the outside slope with rock from the cut a Mile 4.3. The bank along this section c canal is built on ground that was formerl (before the completion and operation c Boulder Dam) subject to overflow durin flood periods of the Colorado River. Th embankment is therefore, in effect, an eart dam 8,400 feet long. The balance has bee placed in designated accessible waste pile adjacent to existing roads, from which it wi be possible in the future, if necessary, t obtain large quantities of good-quality roc for canal-maintenance purposes.

Figure 1.—All-American Canal rock cut—looking upstream

Figure 5.—Downstream view through rock cut; slide material being removed by temporary industrial railroad

Figure 4.—Rock slide in canal

Figures 2 and 3.—Excavating rock section in canal

A shot of 26,000 pounds of TNT, in rock cut

Railroad Construction at Shasta Dam

ONE of the largest railroad building jobs in the United States in recent years is under way in northern California as a result of construction of mighty Shasta Dam by the Bureau of Reclamation. Twelve tunnels and 8 major bridges are included in the 30 miles of new main line of the Shasta Route of the Southern Pacific Co. being constructed around the site of the future Shasta Reservoir. Contracts for railroad relocation totaling more than $7,000,000 have now been awarded, covering all of the 30 miles of the roadbed grading, 12 tunnels and 5 of the bridges.

Bids have been received by the Government for erecting two more bridges. The only feature of the relocation yet to be advertised for construction is the huge double-deck Pit River Bridge which will carry both the railroad and United States Highway 99 over an arm of the reservoir. Bids are expected to be called for the Pit River Bridge this fall.

Main line railroad traffic between California and the Pacific northwest now passes under, instead of across, an abutment of th Shasta Dam site in the Sacramento Rive Canyon 12 miles north of Redding. Souther Pacific trains which formerly crossed the da site near its base on the west bank of th river were diverted through a temporar 1,820-foot bypass tunnel on June 26. Co pletion of the tunnel will permit excavatio to proceed for the base of Shasta Dam wit out waiting for completion of the permane 30-mile railroad relocation around the enti reservoir site.

First train passes through Shasta Dam Tunnel—Fast freight bound from California to Oregon

Officials of the Bureau of Reclamatio the Southern Pacific Co., the Colonial Co struction Co., Shasta County, and the cit of Redding participated in a dedication cer mony at the south portal of the tunnel. section gang tamped the last ballast unde the track early in the afternoon and th first train, a fast freight bound from Oa land, Calif., to Portland, Oreg., passe through the tunnel at 2:55 p. m. Amon those taking part in the dedication wer Ralph Lowry, construction engineer of Shast Dam; W. H. Kirkbride, chief engineer of th Southern Pacific; C. H. Ludberg, preside of the Colonial Co., tunnel contractor; an Roscoe J. Anderson, president of the Shast County Chamber of Commerce.

Connecting California with the Pacif northwest, the present line of the Souther Pacific, built in 1884, winds up the Sacr mento River Canyon out of Redding, pa the dam site and through the reservoir are Thirty-seven miles of this line between Re ding and Delta Station, Calif., are being r placed by 30 miles of the new line now und construction around the reservoir site at a elevation above the future high-water leve The new line will be 7 miles shorter an will have 5,000° less curvature.

When the new 30-mile railroad is co pleted and opened to traffic, probably abo September 1941, the existing canyon line wi be abandoned and the bypass tunnel at t dam site will be available for river diversi while concrete is being raised in the 56 foot dam. For this contingency the bypa tunnel has been lined throughout with co crete. It is a horseshoe-shape bore, 28 fe high and 26 feet wide, and passes under t dam site a lateral distance of 725 feet fro the river.

As the first construction at the Shasta Da site, work was started on the tunnel in Ju 1938 under a contract awarded to the C lonial Construction Co. of Spokane, Was The bore was driven from both ends. Co siderable soft rock was encountered near t portals, necessitating the use of steel su ports and liner plates for sections of sever hundred feet. The rock under the dam si was found to be sound The tunnel w holed through on March 4, 1939, by a dyn mite charge which blasted a 3-foot opening between the north and south headings. The last barrier of rock was soon mucked out to leave a horseshoe-shape bore about 28 feet high and 26 feet wide, passing through the west abutment of the dam site a lateral distance of 725 feet from the river. Because of its prospective use later as a water diversion conduit, the tunnel was lined its entire length with concrete from 18 to 21 inches thick.

Contract work was completed on June 12, after which Southern Pacific crews laid the track through the tunnel on ballast taken from slag piles of the old Mammoth Copper Mine at Kennett a few miles upstream from the dam site. As soon as the tunnel was opened to traffic on June 26, the bypassed section of track along the river at the base of the dam site was removed and the way cleared for Pacific Constructors, Inc., general contractor on Shasta Dam, to extend large-scale excavation operations to this area.

The first unit of the permanent railroad relocation—a four-fifths-of-a-mile bridge across the Sacramento River at Redding—is almost completed. About 6,000 tons of structural steel were shipped west from Gary, Ind., for this bridge.

Several miles of the roadbed have been graded in different sections. Two of the 12 tunnels have been holed through and men are boring underground in three others, two of which are a half mile each in length. The entire railroad relocation involves almost 4,000,000 cubic yards of excavation, driving 19,000 feet of tunnels, erecting 20,000 tons of bridge steel, and laying 6,000 tons of rails.

Annual Agricultural Tour Cache County, Utah

A RECORD crowd attended the thirteenth annual agricultural and sugar-beet tour of Cache County, Utah, on August 23, visiting a large number of local farms, the agricultural experiment station, and Utah State Agricultural College.

Farmers declared it "the best excursion yet." Asked why he considered it the best tour in the history of Cache County, one farmer replied, "Because we had fine demonstrations, the greatest interest shown by farmers, and the largest crowd." He added, "I believe farmers are beginning to realize that they must put into practice these new things developed by our experiment stations if they expect to succeed in the farming business."

Leaving Cache County courthouse at 9 o'clock the tour party visited farms in the vicinity of Logan. There an explanation of the county weed-control program was given. Land on which clean cultivation was carried on last year was found producing a good crop of beets. Results of spraying to destroy perennial rootstock weeds were also observed.

Proper crop rotation systems were discussed at the next stop on the tour. The results of a well-planned rotation were observed in a field of beets which showed promise of a better than 20-ton crop.

On another farm was seen a typical case of the ravages of alfalfa wilt. Dr. R. J. Evans, agronomist of Utah State Agricultural College, pointed out affected and dead plants adjacent to vigorous healthy alfalfa and explained effective methods to control this disease.

Injury to beets from nematode was observed on a farm in Wellsville. Last year this land produced 24 tons of beets, following alfalfa and wheat in a rotation. This year because of the injury from nematode probably not more than 8 to 10 tons an acre will be produced. Some of the crop has been so badly damaged it will not be harvested. Measures to prevent nematode infestation were discussed.

At the college experiment farm in Providence fields, Mr. Wesley Keller, United States Department of Agriculture Associate Geneticist in charge of forage crop investigations, explained the Department's important work in the development of grasses for reseeding the ranges. Following this, Dr. Evans pointed out a demonstrational plot on which weeds had been eradicated by the use of carbon bisulphide. He also gave a short talk on the experiment station work with varieties of alfalfa in an effort to develop wilt-resistant strains.

At noon, lunch provided by the Amalgamated Sugar Co. and the Cache Sugar Beet Association, was served to 250 people on the south lawn of the college campus.

The high point of afternoon events was an educational program at the college engineering auditorium featuring addresses by community leaders and agricultural specialists.

An address by Saul E. Hyer emphasized the value of obtaining and utilizing the best information on successful farm practices.

J. W. Randall, district manager of the Amalgamated Sugar Co., gave a talk on the importance of keeping records. He said that a lot of records showed the cost of producing a ton of beets varied from about $3.75 per acre to more than $8. The low cost was on a 24-ton crop and the high cost on less than 10 tons per acre. Mr. Randall also pointed out the relationship of yield to fertility. He said the more manure used on the farm, the lower the relative cost of production, due to increased yields of beets.

County Agent R. L. Wrigley, summarizing the many helpful points observed on the tour, urged farmers to put the improved practices into use and then to pass the information on to their neighbors. He emphasized the importance of crop rotation and the need of planting beets on land reasonably free from nematode. Mr. Wrigley said the county planning committee had set a standard of 14 tons of beets per acre and looked to every farmer to cooperate by the adoption of proper methods to bring the average tonnage of beets to that figure. He called attention to the value of the hay crop on Cache County farms and recommended plowing hay when fields become infested with wilt. Stressing the accomplishments of the weed-control program, he asked farmers to be on guard against all infestations of noxious weeds and to do everything possible to eliminate these pests.

Coulee Dam Pictured in French Publication

THE freedom with which information is given to visitors by the Government and by American business firms is regarded as an outstanding feature of the United States by Robert Decat, of Le Petit Parisien, recent visitor to the Grand Coulee Dam. Hard hats, signs, and other safety devices were featured by Monsieur Decat in the photos he took for his publication. America leads in its efforts to protect its workers from injury, says this world traveler and observer.

Damming the Columbia

LITTLE journeys, equivalent to nearly 20 trips around the world at the equator, will have been made on the Grand Coulee Dam by 20 small Diesel-electric locomotives before the structure is completed. Most of them haul concrete from the mixing plant on the east canyon wall to various points on the dam. Others handle freight cars of materials and supplies.

The grand central terminal for this miniature railroad system is busier than any metropolitan railroad station. A loaded train leaves every 10 seconds—a thousand trains a day—when concrete pouring is active. Fifteen million tons of freight, in the form of fresh concrete, have already been handled, in addition to thousands of tons of reinforcing steel and mechanical equipment.

Visitors to the project frequently remark that, when first conceived, the scheme of damming the Columbia was just a fantastic dream. It could not have been done in those horse-and-buggy days. Power and its offspring, machinery, are opening up a new frontier in America.

Progress of Construction on the Provo River Project, Utah

THE Secretary of the Interior on August 28, 1939, approved the award of contract for the construction of the first schedule of the Salt Lake Aqueduct to the Utah Concrete Pipe Co. of Salt Lake City, Utah, on its low bid of $522,353.27. Eleven other bids, ranging as high as $861,197.85, were submitted to the Bureau of Reclamation at the opening on July 31, 1939, from contracting firms and pipe manufacturers representing California, Idaho, Oregon, and Utah. The principal items of work are the manufacturing and laying of approximately 8 miles of 69-inch diameter concrete pipe involving trench excavation and backfill and the construction of numerous structures and other related work along this section of aqueduct for which 500 calendar days have been allowed to complete, following the receipt of notice by the contractor to proceed.

The Salt Lake Aqueduct, designed for a capacity of 150 second-feet, comprises some 36.5 miles of pressure pipe line, a 3,600-foot tunnel, and a 15,000-foot tunnel, all required to convey an irrigation and domestic water supply from Deer Creek Dam to the Salt Lake Metropolitan Water District area.

The section for which a contract has been awarded will be made up of precast reinforced concrete pipe units, the length of which is at the option of the contractor. The pipe, which will have an inside diameter of 69 inches, and a wall thickness of 7½ inches, will embody a joint designed expressly for the aqueduct by engineers in the Denver office of the Bureau of Reclamation.

Since the award of contract on December 3, 1938, to George K. Thompson & Co. of Los Angeles, Calif., work has progressed satisfactorily on the Alpine-Draper and Olmsted Tunnels as the first construction features of the Salt Lake Aqueduct. Both tunnels will be 6½-foot diameter concrete-lined horseshoe sections when completed. Excavation in the 3,600-foot Olmsted bore has been completed and concrete lining operations have started, which it is anticipated, will require about 60 days to complete. Excavation on the 15,000-foot Alpine-Draper Tunnel is being carried on from both portals with the result that 30 percent of the total length has been completed despite the heavy ground which was encountered at the outlet heading. Approximately 33 percent of the contract bid price for both tunnels has been earned, while 37 percent of the 650-day contract period has elapsed.

Construction of the Deer Creek Dam and relocated railroad and highway has been carried on since early in 1938 by the Rohl-Connolly Co. of Los Angeles, Calif. During 1938 work was concentrated on the outlet works through the left abutment, consisting of a 12-foot diameter concrete-lined tunnel and a foundation structure for a powerhouse. The principal work done in the foundation of the dam consists of stripping some of the river bottom area and portions of both abutments upstream from the axis. Part of the cut-off trench was excavated to a shallow depth and the excavated material placed in the sand, gravel, and cobble-fill portion of the embankment next to the left abutment.

Excavating and grading of the relocated railroad around the Deer Creek Reservoir area is roughly completed, except through the North Deer Creek borrow area, and the laying of track is in progress. Construction of the relocated and temporary highways is already complete and traffic is being routed over them.

From early in June, when the river was diverted through the outlet works, to the latter part of August, preparations for the foundation of Deer Creek Dam proceeded rapidly. At the later date foundation stripping and the excavation of the cut-off trench to bedrock had been completed, and construction of the concrete cut-off walls and the grouting of bedrock was in progress, the completion of which will permit the placement of earth fill in the dam. Embankment materials will first be obtained from required railroad excavation through the borrow area, which work is necessary for the completion of the relocated railroad and the abandonment of the present railroad detour through the construction area.

It is anticipated that the amount of embankment placed before cold weather, together with that which can be done next spring, will raise the embankment sufficiently high to be safe from damage by spring floods. The placing of embankment will be the major activity during 1940 and 1941, although construction of the spillway structure and completion of the outlet works will be carried on simultaneously until completed.

Approximately 38 percent of the bid price has been earned by the contractor in 30 percent of the construction period of 1,350 days allowed under the contract.

The Coachella Branch

(Continued from page 275)

drainage inlets. Four of the siphon crossings will have integrally-built automatic spillways or wasteways, constructed with them. These will serve to maintain specified constant flows in the canal, and to provide regulation in event of canal damage by seismic, or other influences.

At vulnerable points at structure sites, such as at the inlet and outlet walls of
siphons, around bridge piers, and at select
points along drainage channels, rock ripr
will be placed to prevent erosion of the so
alluvial materials. This will be placed
the form of a rock blanket, of a thickness
be determined as the local conditions wa
rant.

Excavation

The excavation for the complete canal w
be predominately in alluvial material whic
can be dug readily with standard equipmen
It is expected that small patches of sha
tered granite rock and detrital material w
be encountered in a few places where th
canal route crosses ridges coming off th
Chocolate and Orocopia Ranges, which th
route will skirt for 60 miles of its length.

The contractor engaged on the excavatio
of the first 40-mile reach of canal is using
large dragline built for handling buckets
10 to 16 cubic yards in capacity, and
smaller 2½-cubic-yard dragline for trimmin
after rough excavation has been made by th
larger machine. The larger machine
equipped with walking traction and rough
out half of the cross section to the center lin
for a distance of about 2,000 feet, and the
walks back to excavate the second hal
Operators have become very skillful in mak
ing the entire rough excavation to within
few inches of the finished grade. Tracto
operated bulldozers are used in grading ahea
of the draglines to facilitate walking the
Both dragline machines are powered by Di
sel engines. A construction roadway para
leling the canal alignment is prepared in a
vance of the excavation equipment, and o
account of the flat terrain, a few passes wi
a bulldozer usually suffice for this phase
the work.

Excavated material is used to build a
embankment on both sides of the canal, an
these have a minimum top width of 24-fee
Consolidation of similar embankments on th
All-American Canal proper has been goo
and after a few months they usually hav
attained a state of compaction sufficient
permit the driving of cars along the top.

The large dragline operates continuous
with four 6-hour shifts, and requires fou
men per shift. Excavation during the hou
of darkness is carried forward by using re
reflectorized metal cut stakes. The boo
light shines on these in a manner similar
that of automobile headlights upon the r
flector signs in use on some highways.

The maintenance upon the contractor's m
chines is done in the field, and a movable fiel
office, toolroom, and repair shop, all bui
upon broad wooden runners, have been erecte
at the scene of the work. As excavatio
progresses the buildings are skidded ahead t
new positions.

The utilization of the previously unuse
flood waters of the Colorado River presage
a new era in the life of the desert, and wi
provide a security for its residents that her
tofore has not been possible.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1939						1939
851	Columbia Basin, Wash	July 20	Two 350-ton traveling cranes for Grand Coulee power plant.	Whiting Corporation	Harvey, Ill.	$167,750.00	Net	Aug. 15
856	Boise-Payette, Idaho	July 17	Earthwork and structures, tunnel No. 2 wasteway and tunnel No. 7 wasteway, Black Canyon Canal.	Henry L. Horn	Caldwell, Idaho	119,842.75		Aug. 30
858	Rio Grande, N. Mex.	July 18	4 transformers, 2 oil circuit breakers, 14 disconnecting switches, 1 lightning arrester and 1 Petersen coil for Elephant Butte power plant.	General Electric Co.	Schenectady, N. Y.	[1] 79,500.00	F. o. b. Engle, N. Mex. Shipping points Pittsfield, Mass. and Port Richmond, Calif.	Aug. 25
				Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	[2] 31,364.00	F. o. b. Engle, N. Mex. Shipping points Hyde Park, Mass., and Port Richmond, Calif.	Do.
				National Electric Co.	Birmingham, Ala.	[3] 5,390.00	F. o. b. Engle, N. Mex. Shipping points Birmingham, Ala., and Barberton, Ohio.	Aug. 28
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[4] 3,105.00	F. o. b. Engle, N. Mex. Shipping point E. Pittsburgh, Pa.	Do.
859	do	July 21	Main control equipment, excitation cubicles with voltage regulators, station-power control equipment, and metal-clad switchgear with instrument transformers for Elephant Butte power plant.	The Wolfe & Mann Manufacturing Co.	Baltimore, Md.	[5] 21,551.00	F. o. b. Baltimore	Aug. 25
				General Electric Co.	Schenectady, N. Y.	[6] 20,000.00	F. o. b. Engle, N. Mex.	Do.
860	Provo River, Utah	July 31	Pipe line and structures, Salt Lake Aqueduct, stations 540+81.58 to 800 and 880 to 1040+15.	Utah Concrete Pipe Co.	Salt Lake City, Utah.	522,353.27		Aug. 28
866	Columbia Basin, Wash.	Aug. 1	Pipe, fittings, valves, and appurtenances for emergency gate air-inlets and drum-gate control at Grand Coulee Dam.	American Radiator and Standard Sanitary Corporation.	Denver, Colo.	[7] 185,660.00	F. o. b. Odair, Wash. Shipping point Pittsburgh, Pa.	Aug. 22
				Lynchburg Foundry Co.	Lynchburg, Va.	[2] 15,213.00	F. o. b. Radford, Va.	Do.
				George B. Limbert & Co.	Chicago, Ill.	[3] 8,726.00	F. o. b. Chicago and Odair	Aug. 11
				Crane-O'Fallon Co.	Denver, Colo.	[4] 2,819.00	F. o. b. Odair.	Do.
869	Boise-Payette, Idaho	Aug. 18	Earthwork and structures, A-Line Canal, stations 1040+00 to 1757+25 and D-Line Canal, stations 1284+81 to 2043+12.5.	Ray Schweitzer	Los Angeles, Calif.	56,302.40		Sept. 1
864	Shoshone-Heart Mountain, Wyo.	July 27	Shoshone Canyon conduit controlling works and tunnels.	Utah Construction Co.	Ogden, Utah.	217,174.00		Aug. 23
871	Central Valley, Calif.	Sept. 12	86-inch ring-seal gates and conduit lining for river outlets at Friant Dam.					([illegible])
1258-D	Riverton, Wyo.	Aug. 1	1 ditch-cleaning and excavating machine of the crawler-traction and endless-chain, bucket-digging-unit type.	Bucyrus-Erie Co.	South Milwaukee, Wis.	17,525.00	F. o. b. So. Milwaukee. Discount 2 percent.	Aug. 21
1259-D	Kendrick, Wyo.	Aug. 2	One 6,900-volt, outdoor-type, starting auto-transformer; two 7,500-volt, outdoor-type oil circuit breakers; and nine 7,500-volt, outdoor-type disconnecting switches for the Gering substation.	Graybar Electric Co., Inc.	Denver, Colo.	[9] 2,794.18	F. o. b. Gering, Nebr. Shipping points Pittsfield, Mass. and Melrose Park, Ill.	Aug. 9
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif.	[2] 1,295.00	F. o. b. Gering, Nebr. Shipping points San Francisco and Whiting, Ind.	Do.
1260-D	Boise-Payette, Idaho	July 26	20,000 barrels of finely ground standard portland cement in cloth sacks	Oregon Portland Cement Co.	Portland, Oreg.	52,000.00	F. o. b. Lime, Oreg. Discount and sacks 50 cents per barrel.	Aug. 10
1261-D	Colorado-Big Thompson, Colo.	Aug. 4	1 oil-purifier, 1 filter-paper drying oven, and 1 portable dielectric testing set for the Green Mountain power plant.	The Mine & Smelter Supply Co.	Denver, Colo.	[7] 2,257.50	F. o. b. Kremmling, Colo. Shipping point Seneca Falls, N. Y.	Do.
				Graybar Electric Co., Inc.	do	[2] 138.50	F. o. b. Kremmling, Colo. Shipping point Pittsfield, Mass.	Aug. 11
				The Standard Transformer Co.	Warren, Ohio	[3] 180.04	F. o. b. Kremmling, Colo.	Do.
1263-D	Boulder Canyon, Ariz.-Nev.	Aug. 9	Structural steel for two transmission towers for City of Los Angeles transformer circuit No. 3 at Boulder switchyard.	Tulsa Boiler & Machinery Co.	Tulsa, Okla	5,529.00	F. o. b. Birmingham, Ala. F. i. t. Tulsa. Discount ½ percent.	Aug. 19
1265-D	Kendrick, Wyo.	Aug. 8	15,000 barrels of sulfate-resisting portland cement in cloth sacks.	Colorado Portland Cement Co.	Denver, Colo.	29,850.00	F. o. b. Boettcher, Colo. Discount and sacks 50 cents per barrel.	Aug. 25
1266-D	Shoshone-Heart Mountain, Wyo.	Aug. 21	One 10-foot cylinder gate, complete with scroll case, gate guides and accessories.	The Stearns-Roger Manufacturing Co.	do	16,988.00	F. o. b. Denver	Sept. 1
1268-D	Uncompahgre, Colo.	Aug. 24	Gate frame for fixed-wheel gate for inlet replacement, Gunnison Tunnel.	Worden-Allen Co.	Milwaukee, Wis.	1,252.00	Discount ½ percent	Aug. 25
1237-D	Columbia Basin, Wash.	Aug. 18	100,000 barrels of low-heat cement in bulk.[10]	Three Forks Portland Cement Co.	Denver, Colo.	131,250.00	F. o. b. Trident, Mont. (87,500 barrels).	Aug. 19
				Pacific Portland Cement Co.	San Francisco, Calif.	44,625.00	F. o. b. Redwood Harbor, Calif. (37,500 barrels).	Do.
33,308-A	Central Valley, Calif.	Aug. 17	Galvanized fittings for plain-end thin-wall tubing.	Graybar Electric Co., Inc.	Denver, Colo.	25,837.36	Items 1 to 7 and 9 to 15, f. o. b. Elizabethport, N. J.	Sept. 1
							Item 8, discount 5 percent, f. o. b. Coram, Calif. Shipping point Economy, Pa.	Do.
A-38,444-A	Columbia Basin, Wash.	Aug. 15	Cast-iron pier grating and draft-tube drain valves.	The Stearns-Roger Manufacturing Co.	do	11,101.00	F. o. b. Denver, Colo.	Aug. 30
33,301-A	Central Valley, Calif.	Aug. 8	Reinforcing steel 2,674,900 pounds	(11)				
B-42,291-A	All-American Canal, Calif.	July 10	Reinforcing steel 1,800 tons	Columbia Steel Co.	San Francisco, Calif.	89,126.00	F. o. b. Niland, Calif. Shipping point Pittsburg, Calif. Discount ½ percent.	Aug. 22

See footnotes at end of table.

NOTES FOR CONTRACTORS—Continued

Specification No.	Project	Bids opened	Work or material	Low bidder: Name	Low bidder: Address	Bid	Terms	Co av
3,284 A	Central Valley, Calif	1939 July 24	Track materials	Colorado Fuel & Iron Co	Denver, Colo	[12]$185,118.36	F. o. b. Minnequa, Colo. Discount ½ percent on schedules 2, 3, 4, and 5.	A
				P. & M. Co	Chicago, Ill	[13]12,744.12	F. o. b. Smithson, Calif. Discount ½ percent. Shipping point Johnstown, Pa.	
				Pettibone Mulliken Corporation.	do	[14]10,920.15	do	
				The National Lock Washer Co.	Newark, N. J	[6]1,046.10	F. o. b. Newark, N. J. Discount 1 percent.	At

[1] Items 1 and 5. [2] Item 2. [3] Item 3. [4] Item 4. [5] Schedules 1 to 5, inclusive. [6] Schedule 6. [7] Item 1. [8] Specifications canceled. [9] Items 1 and 3. [10] Additional cement under original specifications. [11] All bids rejected. [12] Schedules 1, 2, 3, 4, 5, and 11. [13] Schedule 7. [14] Schedule 8.

CONTENTS

THE RECLAMATION ERA • OCTOBER 1939

CUT ALONG THIS LINE

COMMISSIONER, (Date). . . . .

Bureau of Reclamation,

Washington, D. C.

SIR: I am enclosing my check[1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

October 1939. (Name) . . . .

(Address) . . . .

. . . .

[1] Do not send stamps.

177842 U. S. GOVERNMENT PRINTING OFFICE: 1939

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	C. C. Fisher	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Constr. engr. [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz	E. C. Koppen	Constr. engr		R. J. Coffey	Los Angeles, Cal.
Pine River	Bayfield, Colo	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	Samuel A. McWilliams	Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz	E. C. Koppen	Constr. engr	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation idstrict	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Colo	W. G. Sloan	Engineer.
Canton and Fort Supply (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Arkansas Valley (Colo.-Kans.)	Denver, Colo	A. N. Thompson	Engineer.
Black Hills (S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.

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GREEN MOUNTAIN DAM SITE - UPSTREAM VIEW

THE RECLAMATION ERA

NOVEMBER 1939

THANKSGIVING CROP ON A RECLAMATION PROJECT

THANKSGIVING DAY—1939

By the President of the United States of America

A PROCLAMATION

I, FRANKLIN D. ROOSEVELT, President of the United States of America, do hereby designate Thursday, the twenty-third of November 1939, as a day of general thanksgiving.

More than three centuries ago, at the season of the gathering in of the harvest, the Pilgrims humbly paused in their work and gave thanks to God for the preservation of their community and for the abundant yield of the soil. A century and a half later, after the new Nation had been formed, and the charter of government, the Constitution of the Republic, had received the assent of the States, President Washington and his successors invited the people of the Nation to lay down their tasks one day in the year and give thanks for the blessings that had been granted them by Divine Providence. It is fitting that we should continue this hallowed custom and select a day in 1939 to be dedicated to reverent thoughts of thanksgiving.

Our Nation has gone steadily forward in the application of democratic processes to economic and social problems. We have faced the specters of business depression, of unemployment, and of widespread agricultural distress, and our positive efforts to alleviate these conditions have met with heartening results. We have also been permitted to see the fruition of measures which we have undertaken in the realms of health, social welfare, and the conservation of resources. As a Nation we are deeply grateful that in a world of turmoil we are at peace with all countries, and we especially rejoice in the strengthened bonds of our friendship with the other peoples of the Western Hemisphere.

Let us, on the day set aside for this purpose, give thanks to the Ruler of the Universe for the strength which He has vouchsafed us to carry on our daily labors and for the hope that lives within us of the coming of a day when peace and the productive activities of peace shall reign on every continent.

In witness whereof, I have hereunto set my hand and caused the seal of the United States of America to be affixed.

Done at the City of Washington this 31st day of October, in the year of our Lord nineteen hundred and thirty-nine, and of the Independence of the United States of America the one hundred and sixty-fourth.

[seal] Franklin D. Roosevelt.

By the President:

Cordell Hull,

Secretary of State.

PRICE ONE DOLLAR A YEAR

THE RECLAMATION ERA

VOLUME 29 • NOVEMBER 1939 • NUMBER 11

Friant Dam Construction Started

Central Valley Project, California

By HON. HAROLD L. ICKES, *Secretary of the Interior*[1]

HERE, along the Pacific coast, America is building a Maginot Line that is uniquely American. It is not a line of death, but a life line to preserve and enhance our American civilization. From this line there will issue no terrors of destruction; on this line human beings will not be impaled and torn to shreds. This is a line of creation, built to unlock the fertility of the rich soil, to resist drought, to overcome floods, to provide outdoor recreation, and to generate cheap power that will lighten the labors and improve the living conditions of millions of our citizens.

This life line extends from the All-American Canal, far down in the southern part of California, here to Friant Dam and thence to Boulder Dam, to Shasta and Bonneville and Grand Coulee. Link by link we are forging the most breath-taking series of projects that have ever been conceived and carried out in recorded history. In addition to these great bastions of our Maginot Line, and constituting an integral part of it, are such projects as Yosemite National Park, Sequoia, Mount Rainier, and Olympic, to which, I hope, will soon be added the Kings Canyon-John Muir National Park. All of these will contribute to the beauty, as they will add to the wealth, both of this region and of the Nation.

In recent years we have developed a new attitude toward our national resources, the wells from which our riches are drawn. If this were not so, we probably would not be gathered here today to commemorate the beginning of work on the great Friant Dam while, at the same time, taking stock of what the conservation of the Sacramento and San Joaquin Rivers means, not only to the Central Valley and to California, but also to our country which grows more precious to us as we witness what can happen in less fortunate lands.

[1] Address delivered November 5, 1939, at Friant Dam celebration.

Conservation a National Policy

Conservation is no longer a slogan; it is a national policy. At long last, after years of exuberant squandering, our people are insisting that our public lands, our forests, our water, our soil, our metals and minerals, our wildlife, and our natural recreational assets be used without waste. We want to enjoy our national riches, but we also want to preserve them for the use of generations to come. We must not let our purposes be diverted by wars in Europe and Asia, or halted by any mobilization for unjust profits at home. The gains already made must be preserved. When the present black-out of European civilization shall have been dispelled by the light of peace, the water stored and the power generated here will still be needed; the Central Valley, with its 2 billion dollars worth of improvements, will still be creating wealth for the people. Our Maginot Line of peace will stand as an impregnable fortress against alternating droughts and floods, while under its protection you and your children may confidently work and build and achieve.

President Roosevelt a Conservationist

Under the exceptional leadership of President Franklin Delano Roosevelt, whom it is my opinion that history will rank as the foremost conservationist, a comprehensive pattern for the development of our resources has been prepared for the first time. On the lines of this pattern I should like to sketch for you an ideal American valley such as yours, when conservation principles have been fully applied.

The tracing that I want to draw is not the product of some visionary mind, but a practical reality that is already taking shape so that definite outlines are visible. Here are forests in prudent use, protected and maintained by scientific practices. Yonder are unique mountain valleys and ranges set aside as parks for public enjoyment. We note that the grasses of the uplands are no longer being destroyed by greedy misuse. Upon the range graze herds and flocks that are sufficiently limited so as not to exceed the carrying capacity. Around the valley, on the contours, the hilly, dry-farmed lands are tilled without soil wastage. Where the mountain waters emerge through the foothills in the valley, storage dams stand ready to receive the precious spring floods which are later used for irrigation and power. Stream flow is regulated, floods are held in beneficent chains, channels are navigable, running waters are clear and fresh for fish. Wildlife is protected in specified areas. In the Valley itself the best irrigation methods are practiced. Neighboring cities observe the golden rule by refraining from polluting with their sewage the streams on which others rely for water for domestic purposes and for recreation.

I have referred to the comprehensive and intelligent planning for which President Roosevelt is entitled to full credit. But he has done more than plan, he has achieved. Some men have the endowment that enables them to dream great dreams that a future generation will cause to come true. Others, lacking the planning faculty, have the capacity to build on a large scale. It is not often that in one man is combined both of the abilities without which such undertakings as we have here in the Central Valley would not be accomplished at all, or, if accomplished, would fail to fit into that large and comprehensive pattern that will ensure the maximum results from the resources at hand.

From the first days of my association with him as a member of his Administration, I have never ceased to be astonished at President Roosevelt's personal interest in, as well as his comprehensive grasp of, different projects in various parts of the country. He is never satisfied merely to take the recommendation of a Cabinet officer that certain engineering plans be carried out. He studies those plans with the eye of an expert. He wants to know about costs and benefits and the relationship of one project to another. And when he gives the word to go ahead, he keeps personally in touch with the progress of the work. If there is a lag anywhere, a threatened break-down or confusion of counsel, it is he who can always find a way out of the difficulty.

I wonder if the people of California have not come to take the Federal Government too much for granted. One breath-taking public work has followed another in such rapid succession that it would not be surprising if, at times, you should overlook what has already been accomplished because you are so interested in what is being done. Even those of us in Washington who are responsible for carrying out the President's orders sometimes lack comprehension of the mighty sweep of his program. It may safely be said that no Administration in our history, perhaps even no two or three Administrations, has wrought in our land physical improvements comparable in worth, variety, and magnitude to those that have been and are being built under the present one. If the citizens of California who are kept busy moving from one such celebration as this to another would sit down with pencil and paper and strike an account of what the Federal Government has done with and for this great State, I venture to say that they would be amazed.

Central Valley Farmable Agricultural Area

Central Valley is an inland empire almost 500 miles long and nearly 50 miles wide. It is, as you know, semiarid, but its soil is as rich and its climate as favorable as any agricultural area in the world. The valley is surrounded by mountains, except for the narrow gap in the west wall through which the two great rivers, the Sacramento from the north and the San Joaquin from the south, merge to flow into San Francisco Bay. Irrigation has made this valley the granary of the West and one of the fruit baskets of the world. Its oranges roll into the world's markets. Four-fifths of the raisins grown in this country come from here. Here almost a million people have their homes.

Nature has, indeed, blessed this valley and has provided an abundance of many things. Only sufficient water is lacking. Two-thirds of the available water comes from the mountains of the north, and two-thirds of the irrigable lands lie in the valley of the south. To add to the paradox, about two-thirds of the water falls as rain and snow in the winter when it is least needed, while comparatively little comes from the heavens in the summer and autumn when the crops are thirsty.

Purpose of Friant Dam

The basic problem for this great valley, therefore, is so to redistribute the waters as to carry them where, when, and as they are needed. On the upper Sacramento River a great dam, the Shasta, is being built. This will regulate that river and will store the spring floods so that water not needed in the Sacramento Valley can be brought into the San Joaquin basin during the summer and autumn. At the same time, the Friant Dam here will hold back the waters of the San Joaquin in order to supplement the diminishing supply of this vast southern irrigated area. Excess water from the Sacramento River will be pumped into the northern part of the San Joaquin Channel as a substitute for that which will be taken out here. Concurrently, this twofold redistribution of water between seasons and between river basins will serve many collateral purposes. It is as simple as that, once human ingenuity and enterprise—plus a not inconsiderable sum of money—have set themselves to the task.

The Shasta Dam, moreover, will flush from the rich delta of the two rivers the salt water which now encroaches from San Francisco Bay in seasons of low flow. It will hold floods in leash and restore and make it possible to extend navigable channels. It will provide a dependable fresh water supply for the farms, industries, and cities along the Contra Costa County shore, and, in addition, through the construction of a power plant at its base, it will be able to supply an annual production of a billion and a half kilowatt-hours of low-cost hydroelectric energy.

I wonder how many realize that more than half a century of planning had gone into this Central Valley project prior to 1935 when it was finally adopted by the Bureau of Reclamation. Few people are aware what a tremendous amount of study and painstaking negotiations have been necessary since 1935 to work out the engineering problems and legal preliminaries in order to make it possible for us to begin this dam today.

Tribute to Bureau of Reclamation

In this connection I should like to say a word about the Bureau of Reclamation of the Department of the Interior. I regard the Bureau of Reclamation as a veritable Aladdin's lamp and its chief, Commissioner John C. Page, as Aladdin himself redivivus. A finer engineering and administrative agency has never existed and you know from your personal contacts with Commissioner Page that the Bureau, although it has not lacked able men, has never had one more competent, more skillful or fairer in his dealings with the public. There are those in the Government service whose envy of the accomplishments of the Bureau of Reclamation has led them to try to encroach upon its field of activity. You will agree with me, however, that when work is best done i[t] cannot be better done.

I would also pay tribute to the splendi[d] work of our Reclamation engineers. The[y] are, I may say without exaggeration, amon[g] the best in the world. Their fame is suc[h] that foreign countries often consult the[m] about irrigation and power problems. Thes[e] engineers have built, and continue to buil[d] the greatest man-made structures in histor[y]. They are doing their work with as high [a] degree of modesty as of skill. In view [of] their accomplishments, I must regretfull[y] admit that they are grossly underpaid. The[y] receive salaries from a not too generous gov[-]ernment that a private corporation would b[e] ashamed to offer. One must admire th[e] loyalty and disinterested patriotism of [a] brilliant engineer who will work for his gov[-]ernment for $6,000 to $10,000 a year when h[e] could earn from five to ten times as much i[n] private industry. Recently one of our grea[t] engineers who is building a project that wi[ll] be a permanent landmark in engineerin[g] history, refused a $10,000 a year job that [was] offered him. He wanted to finish what h[e] was doing at $7,500 a year.

Projects Self-Liquidating

On account of certain misconceptio[ns] which exist in some parts of the country, a[l]though they are rapidly being allayed, pe[r]haps I should say a few words about th[e] financing of water conservation projects. Al[-]though the initial investment is necessaril[y] made by the National Treasury, such projec[ts] will ultimately pay for themselves throug[h] charges collected for the use of water an[d] power, although the rates for the latter wi[ll] be low indeed when compared with the price[s] that private utilities exact from the people i[n] all too many instances. Projects of this ty[pe] are too vast to be undertaken by priva[te] enterprises no matter how much initiative [they] may have. In other words, the Nation make[s] possible an abundant supply of cheap powe[r], makes productive vast areas of fertile lan[d], checks destructive floods, holds salt water [in] the sea where it belongs, and gets its mone[y] back in the end.

Let me add that I am happy to have ha[d] the chance to be of some service to th[is] area, as well as to the entire Pacific coa[st] region, both in my capacity as Secretary [of] the Interior and, until recently, as Publ[ic] Works Administrator. I am proud of th[e] fact that, during my tenure of these tw[o] offices, such remarkable projects as the A[ll-]American Canal, and the dams at Friar[t], Shasta, Bonneville, Grand Coulee, a[nd] Boulder, to select a few outstanding on[es] that have been started or finished, have bee[n] made a towering reality.

There is one more day for jubilation [in] California. There have been similar occ[a]sions in the past and there will be others [in] the future. You people of the San Joaqu[in]

(*Continued on page 305*)

REUNION AT FRIANT

By JOHN C. PAGE, *Commissioner of Reclamation* [1]

IT IS a real thrill for me to stand here and help celebrate with you today the start of construction of Friant Dam. There has been no occasion of greater significance in all the history of the Central Valley project. Primarily this is a great public celebration, a day of rejoicing for you people of the San Joaquin Valley who see here physical evidence of the approaching fulfillment of one of your fondest dreams—that of an improved irrigation supply for the lands upon which you have staked your life investments.

But this is more than a celebration. I view it, also, as a happy reunion. Participating here are representatives of three related groups most vitally concerned with the Central Valley project:

First, the *people of the valley* who have fought so hard for so many years to make the project a reality—the people who are to use and pay for the water and power.

Second, the *State of California* which originally planned the project and constantly has maintained a profound interest in its development.

Third in this family circle, *the Federal Government*, represented by the Secretary of the Interior and the Bureau of Reclamation, charged with the direct responsibility of constructing and operating the project.

We, all three, have a broad common objective in the stabilization and perpetuation of the Central Valley's vast agricultural empire. Together, we constitute a strong combination in the struggle for attainment of that objective with work for all to do.

Central Valley, 100 Percent Federal Project

With construction starting on the Friant Division, in the wake of heavy construction already under way at Shasta Dam and on the Contra Costa Canal, the situation appears to call for a clear-cut outline of the legal and financial status of the project. I want to emphasize that the Central Valley project now stands as a 100-percent Federal reclamation undertaking. In the light of its multiple purposes, several of which are of major national interest, it is entirely logical that the project should be and remain such. On the strength of its recognized benefits in the form of improved inland navigation and flood control, as well as its values with respect to irrigation, salinity control, and electric power generation, the Central Valley project has been fully authorized by the Congress. The project is being financed by direct appropriations of the Congress. Funds made available to date total $44,600,000, all reimbursable without interest to the United States Treasury. The Secretary of the Interior is in full charge of the administration of the project.

Under the existing plan the Bureau of Reclamation, which has had 37 years' experience in building and operating irrigation and power projects all over the West, is to build the Central Valley project and to operate its major features. No new administrative machinery is required to complete and operate these features.

The facts that the project has been fully authorized and is well into construction, however, do not mean that the people of the valley should become indifferent to the many problems yet to be solved in connection with the distribution of the water and power, and the fact that the State Government has no direct voice in the administration of the main Central Valley project does not mean that the State should have no further interest in its development. I believe the State has a real responsibility toward the project, particularly with respect to carrying it beyond the limits of the existing Federal undertaking and extending it to the point of maximum benefit to the people. This covers a broad field, including possibly such matters as assistance in the organization of distribution units, promotion of improved irrigation practice, and regulation of the development and use of underground waters. The Bureau of Reclamation is extremely interested in having the State prepare itself to help as it alone can.

Distribution Facilities

It is appropriate at this time to discuss further the distribution facilities of the project. It is obvious that the major project features previously outlined do not constitute in themselves an absolutely complete system. Additional works are necessary, for example, to convey water from the main canals to individual farms. The Central Valley project as now set up does not provide for the construction of lateral canals by the Bureau of Reclamation. Under the existing plan it is contemplated that water will be sold at the side of the main canals to those who contract for its purchase, such as organized irrigation and water storage districts. There are a number of operating districts in the valley which are in position to contract for a supplemental water supply from the Central Valley project. Several new districts are being organized along the route of the Friant-Kern Canal. In some areas there has as yet been no organization of prospective water users. The Bureau of Reclamation has not as yet urged the establishment of any particular types of districts, anticipating that as soon as we are in a position to negotiate contracts with water users, we will take an active part in the formation of appropriate organizations and in the adaption of existing organizations to Federal requirements.

In this connection, I appreciate that you would like to know what the water is to cost. I regret that it will not be practicable to determine the price to be charged for irrigation water until more is known about the final costs of the project works, the probable returns from the sale of electric power, and other factors. The Bureau of Reclamation has been working on this question for some time, but much still remains to be done before the question can be answered. Our aim has been to plan the project so that an adequate supply of water may be delivered to the users at the least possible cost, through structures built for permanency according to high engineering standards. It is suggested that when the charges for water are finally determined, it will devolve upon each district to decide for itself whether it can pay for project water and at the same time pay the costs of its own organization and operation. Careful thought should be given to the economic size of operating units, the kind of crops to be grown, the amount of supplemental water needed, and the nature of distribution works required.

With respect to the construction of the distribution systems, many of you know that certain proposals have been made for additional Federal assistance in this direction. Favorable consideration was given at the last session of the Congress to legislation under which it was contemplated that lateral canals taking off from the main project works would be constructed by the Bureau of Reclamation as a Federal undertaking supplementary to the Central Valley project. The legislation failed of enactment through a veto which was directed against unrelated features of the same bill. It has been announced that the lateral canal measure will be proposed in Congress again. In the event that it is enacted, it will afford the water users of this project an opportunity to have their distribution systems built with interest-free money. In the event this proposed Federal legislation is not consummated and construction of the distribution systems is not undertaken by the Bureau of Reclamation, it will be necessary

[1] Address delivered at Friant Dam, California, November 5, 1939, in connection with ceremony commemorating the start of work on the dam, the second major structure of the Central Valley project, California.

of course for the lateral canals to be financed by local or State interests.

Economic Importance of Project's Power

Those of you whose interest in the Central Valley project is primarily in the irrigation phases—and I realize that that includes the majority of the people in the San Joaquin Valley—should not lose sight of the substantial benefits to be derived from the incidental hydroelectric power development at Shasta Dam. First of all, power is to be required for the operation of some of the project featutres, such as the Contra Costa Canal and the San Joaquin pumping system. Secondly, anticipated revenue from the sale of power is an important factor in the determination of the economic feasibility of this huge project.

Power must carry its fair share of the cost of construction before cheap water can become a reality for the irrigators, and the possibilities of achieving a successful project will be enhanced if the power can be promptly and advantageously sold. In this connection it always has been the policy of the Bureau of Reclamation to give preference, in the disposal of power, to public agencies. It is hoped that public outlets will be available for Shasta power. This presents a big opportunity for local and State assistance to the Central Valley project. Possibly new State legislation may be found desirable. I should look with favor upon some legislation, drafted with consideration for the interests of all those involved, which would enable the State, through the existing Water Project Authority, to function in relation to the project in any capacity found mutually desirable by the State and the Federal Government.

Many milestones have been passed in the Central Valley project. This celebration today is made possible by the successful conclusion of certain prolonged negotiations involving the most complex water rights problems ever encountered by the Bureau of Reclamation. Several big hurdles have been cleared. Others, however, remain, and I want to give assurance at this time to those with whom agreements are yet to be consummated that their rights are to be given full consideration. It is only logical that we should have dealt first with those having control of the larger volumes of water. But that does not mean that we have any intention of ignoring others. In a region so highly developed as this valley, one where water is far more precious than the land, the working out of satisfactory water-right arrangements, fair to all parties concerned, is difficult and time consuming. It is gratifying that so far it has not been necessary to litigate water rights for the Central Valley project. I sincerely hope that we may continue to reach amicable agreements with the others with whom we will negotiate.

Today's celebration gives me great satisfaction, as it must also you, the people of the valley whose very existence depends upon an adequate supply of water. Tremendous benefits will flow from the work here started. No more worthy project ever has been undertaken by the Bureau of Reclamation. Let us all resolve now to devote our collective energies to the completion of this magnificent job.

on various features of the Central Valley project. With the award of contract on October 11 for construction of Friant Dam near Fresno, this program will be materially expanded.

Central Valley is a multiple-purpose project for navigation improvement, flood control, supplemental irrigation, salinity control, and electric-power generation. Like other Federal Reclamation projects, the Central Valley project is being constructed as a self-liquidating project, power and water payments to reimburse the United States.

CVP on Coast-to-Coast Broadcast

Walker R. Young, supervising engineer of the Central Valley project, and Frank T. Crowe, superintendent for Pacific Constructors, Inc., general contractor on Shasta Dam, participated in a radio dialogue on the project which was broadcast over a coast-to-coast network by the National Broadcasting Co. during the recent convention of the American Society of Civil Engineers in San Francisco. On the same program, which originated at the Golden Gate Exposition on Treasure Island, Guy F. Atkinson, of Consolidated Builders, Inc., general contractor on Grand Coulee Dam, discussed the work under way at Grand Coulee.

Central Valley Construction of National Economic Value

DIRECT benefits from the construction in progress on the Central Valley project are derived not only by California, in which the project is located, and its neighboring Western States, but throughout the East.

In all, 36 States have participated in furnishing materials and supplies and the majority of these States lie east of the Mississippi River. California, the home State, naturally has received the largest share of business, but Indiana is second, Michigan fourth, and Ohio fifth. Others among the leaders are Oregon in third place, Colorado sixth, followed in order by Illinois, Alabama, Pennsylvania, District of Columbia, Washington, Wisconsin, New York, New Jersey, and West Virginia.

Walker R. Young, supervising engineer of the Central Valley project, reports that disbursements to the end of the 1939 fiscal year totaled $18,337,000. Most of this is in payments to contractors for work done on Shasta Dam north of Redding, the 30-mile railroad relocation around the Shasta Reservoir site, and the Contra Costa Canal in the vicinity of Antioch. Contracts have been awarded in excess of $60,000,000 calling for progress payments as the work advances.

Expenditures by the Bureau of Reclamation for project materials and supplies, such as structural and reinforcing steel, cement, sand and gravel, pipe, metalwork, and machinery, to July 1 last, aggregated $1,739,000, distributed among three-fourths of the States of the Nation. For the first three States, California's share was $677,000, or about 39 percent; Indiana's $408,000, or 24 percent; and Oregon's $155,000, or 9 percent.

Although heavy construction is just beginning, more than 3,000 persons now are engaged by the Government and its contractors

Central Valley Project Report of Purchases To June 30, 1939

State	Cement	Steel	Machinery	Miscellaneous	Total
Alabama		$39,526		$1,069	$40,5
California	$143,898	79,251	$92,506	362,190	677,8
Colorado		5,701	12,426	42,419	60,5
Connecticut				1,116	1,1
Dist. of Col				39,346	39,3
Georgia				39	
Illinois		29,791		19,273	49,0
Indiana		395,901	4,264	8,243	408,4
Iowa			1,030	27	1,0
Kansas				339	3
Kentucky				6	
Maine				254	2
Maryland				1,177	1,1
Massachusetts				3,123	3,1
Michigan			14,833	60,593	75,4
Minnesota				659	6
Missouri		6,110		3,899	10,0
Nebraska		116			1
Nevada				47	
New Jersey			6,872	4,516	11,3
New Mexico				473	4
New York			236	23,527	23,7
Ohio		23,291	5,644	45,228	74,1
Oklahoma				123	1
Oregon	108,924	3,631	1,650	41,580	155,7
Pennsylvania		24,410		15,341	39,7
Rhode Island			1,481	251	1,7
South Dakota				55	
Tennessee				1,512	1,5
Texas				304	3
Utah				238	2
Vermont				50	
Virginia				12	
Washington			18,104	7,090	25,1
West Virginia				11,153	11,1
Wisconsin		21,180		3,303	24,4
Total	252,822	628,908	159,046	698,575	1,739,[illegible]

Friant Dam Contract Awarded

An artist's conception of Friant Dam

ON October 11, 1939, Secretary of the Interior Ickes announced the award of contract for the construction of Friant Dam, which will be the fifth largest concrete dam in the world as well as the first major engineering feature in the southern part of the Central Valley project, California.

Griffith Co. and Bent Co. of Los Angeles, the low bidders, will construct the dam under the direction and supervision of Bureau of Reclamation engineers. Their bid of $8,715,358.50 was lowest of five received and opened by the Bureau of Reclamation at its Sacramento, Calif., office on September 14, 1939.

The winning contractors have offices at 418 South Pecan Street, Los Angeles. Their bid was only $390,000 below the second bid, but nearly $4,000,000 under the highest proposal. The Shasta Construction Co., a combination made up of McDonald & Kahn, General Construction Co., H. J. Kaiser, and J. F. Shea, bid second with $9,105,760. The third combination, bidding $9,197,169, included Bevanda, Jahn & Bressi, Dowling and R. G. Clifford. Another combination including Winston Bros., Arundel Corporation, Dave Thurston, American Concrete & Steel Pipe Corporation, and L. E. Dixon, bid $12,368,660. The high bid of $12,483,173 was submitted by Friant Construction Co., a three-firm group headed by Guy F. Atkinson.

The Los Angeles contractors must start work within 30 days and will be allowed about 3 years and 3 months to finish the job. They will perform all work and supply labor and equipment, but the Government will furnish the materials for the structure such as cement, steel, and machinery, bought through competitive bidding.

The contract calls for the excavation of 770,000 cubic yards of earth and rock to prepare the dam site foundation and stripping 600,000 cubic yards of earth at present covering the sand and gravel deposit from which 1,600,000 cubic yards will be removed for the manufacture of 1,907,000 cubic yards of concrete.

The contract also calls for the installation of 3,300,000 pounds of steel reinforcement bars, 3,800,000 pounds of gates and valves, 3,440,000 pounds of tubing and fittings, and 3,000,000 pounds of pipe, machinery, and other metalwork.

Location

Friant Dam will be located on the upper San Joaquin River about 20 miles north of Fresno and 21 miles east of Madera, Calif.

Friant dam site. One shoulder of the dam will rest against the right abutment as outlined in white

It will be approximately 300 feet high and 3,430 feet long and will create a reservoir with a gross storage capacity of 520,000 acre-feet, or more than 165,000,000,000 gallons of water.

The San Joaquin River waters impounded at the reservoir will be distributed for irrigation throughout the San Joaquin Valley chiefly by means of two great canals. The Friant-Kern Canal will extend 160 miles to the Kern River west of Bakersfield and the Madera Canal 40 miles to the Chowchilla River.

The Great Central Valley reclamation project in its entirety will provide cheap power, strengthen flood control, improve navigation, and prevent the loss of tens of thousands of acres of highly productive lands in California from reversion to waste land because of salt water invasion at the Sacramento Delta and falling water tables in the San Joaquin Valley, by the additional water storage planned.

Excavation for Shasta Dam, great storage structure in the northern part of the valley, is well under way. Though somewhat smaller, Friant will be Shasta's Siamese twin in the south, for both dams will work together to achieve the widespread beneficial results anticipated from the construction of the reclamation project.

In connection with the award Commissioner of Reclamation John C. Page said:

"The award of contract on Friant Dam, focal unit of the San Joaquin Valley section of the Central Valley project, means full speed ahead for this great reclamation undertaking in California. It will be a real satisfaction for the Bureau to swing fully into this job which will bring so many benefits to California as well as the rest of the country.

"I want to assure all holders of valid rights in the San Joaquin region, however, that the Bureau is undertaking this construction work with well-planned deliberation and without undue haste. Although it will go forward with all speed, their claims are receiving and will receive every possible consideration. I have already assigned a staff of engineers to investigate these rights."

Friant Dam Celebration

A public celebration of the start of con struction on Friant Dam, important feature o the Central Valley project, was held Sunday November 5, at Friant which is 20 miles nort of Fresno, Calif. The Central Valley Projec Association, with James R. Fauver, of Exeter as chairman of arrangements, was sponso of the observance with the cooperation of th Bureau of Reclamation and other public an civic organizations.

Success on the Diamond

The bureau of Reclamation softball tea of the Kennett Division, Central Valley proj ect, is having another successful season i the Redding Softball League. The Reclama tion team finished the first half of a spli season in a tie for first place, and is unde feated to date in the second half schedule.

Boulder and Grand Coulee Dams Attract Tourists

AN endless stream of sightseers, passing at the rate of one every 20 seconds, hour after hour and day after day throughout the entire year, visits Boulder Dam, the highest dam in the world, 600,000 visitors having seen the dam during the 12 months ending September 30, an average of 50,000 a month and well over 1,500 daily.

The universal appeal possessed by one of the great engineering achievements of all time drew sightseers from every walk of life, from European royalty to the humblest citizen. They came from all parts of the United States and abroad as far away as India and China, and arrived by train, airplane, automobile, bus, bicycle, and on foot.

Nearly 200,000 automobiles brought steady daily floods of visitors to the dam during the past 12 months, and more than 2,000 huge busses and nearly 1,500 airplanes added to the total.

Boulder's great power plant, the largest operating in the world, was the focal point of attraction to visitors. Approximately a quarter of a million people rode down the 44-story elevators inside the dam to gaze at the whirring 1,000-ton generators, each powerful enough to supply a million homes with all lighting needs.

The appeal of Boulder Dam to the average sightseeing citizen is growing constantly. When the dam was still in the excavation stage it drew 100,000 visitors yearly, the number growing month by month until it reached 300,000 yearly before the dam was finished. Last year the visitors totaled more than 500,000, and during the 12 months ending September this year they reached 601,261.

The flood of visitors has impelled the Bureau of Reclamation to take precautions for their comfort and safety. Roadways have been widened, protective walls built, and special guides provided. A visitor's building which will house an elaborate model of the entire Boulder Canyon Reclamation project is planned.

The Bureau's experience with the swarms of interested visitors to Boulder presaged what could be expected at Grand Coulee Dam, still under construction in Washington, and recent figures on sightseers have borne out expectations. Already the yearly total of visitors has approached 300,000, although construction still has about 2 years to go.

Having learned by Boulder's experience, the Bureau is taking care of the public's avid interest at Grand Coulee. It has erected a grandstand capable of seating 400 so-called "sidewalk superintendents," who can not only see "the biggest thing on earth" while it is being built but hear all about it at the same time from a lecturer with an amplifying system.

The same kind of kibitzer's accommodation is scheduled for Shasta Dam in California, the second most massive masonry dam in the world. Even though the dam is still in the excavation stage, with men and machines crawling around in a yawning hole acres in extent, an estimated 80,000 people during the past 12 months have visited it, to gape and gape again.

At Boulder Dam, the record shows tha the monthly total of visitors swings from a low of 20,000 in midwinter to a virtual land slide of nearly 100,000 in the summer months In July and August guides have to take car of more than 3,000 eager, interested sight seers every day, an average of one every 1 seconds. And on some days, like Labor Day the endless queue passes at the rate of on person every 3 or 4 seconds, hour after hour throughout the 9-hour sightseeing day.

The monthly figures on visitors to Boulde Dam from October 1938, through Septembe 1939, are reported as follows: 1938—Octobe 38,398, November 30,922, December 29,918 1939—January 28,078, February 19,432, Marc 28,758, April 42,035, May 45,643, June 78,73 July 94,444, August 99,074, September 65,82

Superintendent Hayden Represents Bureau

B. E. HAYDEN, superintendent of the Klam ath project, attended the twenty-ninth annua session of the Oregon Reclamation Congres at Clatskanie, Oreg., on October 11 and 1 and led a discussion on the problems in volved with operation and maintenance While in the North Mr. Hayden conferre with the United States engineers in regard t irrigation investigations carried on in th Willamette Valley and Jackson and Jose phine Counties.

Program of National Reclamation Association

Denver, Colorado, November 14–16, 1939

Tuesday, November 14

8:30 a. m. to 1 p. m.: Registration of delegates, Shirley-Savoy Hotel.

10 a. m.: State caucuses:
- To elect member of legislative committee; member of resolutions committee; State director; and to discuss State reclamation problems.

1:30 p. m.: Convention convenes, Lincoln Room, Shirley-Savoy Hotel:
- Call to order: Pres. O. S. Warden.
- Invocation: Rt. Rev. Fred Ingley, Bishop of Colorado, Denver.
- Welcome to Denver: Mayor Benjamin F. Stapleton, Denver, Colo.
- President's address: O. S. Warden, Great Falls, Mont.
- Reports of State caucuses: By director from each State.
- Treasurer's report: J. A. Ford, Spokane, Wash.
- Secretary-manager's report: F. O. Hagie, Washington, D. C.
- Announcements.

Tuesday evening

Problems of the Water User: Round-table discussion; motion pictures and slides.

Ora Bundy, vice president, Odgen, Utah, presiding.

New Ideas in the Use of Water: L. H. Mitchell, Irrigation Adviser, Bureau of Reclamation, Washington, D. C.

Discussion led by George D. Clyde, dean of school of engineering, Utah Agricultural College, Logan, Utah, and Floyd Brown, irrigation specialist, Colorado State College, Fort Collins, Colo.

Methods of Weed Control: C. L. Corkins, State entomologist, Powell, Wyo.

Discussion led by H. D. Finch, county agent, Grand Junction, Colo., and D. D. Harris, manager, Weber River Water Users Association, Ogden, Utah.

Improved Methods in Canal Maintenance: W. H. Robinson, manager, Gem Irrigation District, Homedale, Idaho.

Discussion led by T. W. Parry, manager, Pathfinder Irrigation District, Mitchell, Nebr.; M. J. Dowd, engineer, Imperial Valley Irrigation District, El Centro, Calif.; and George O. Sanford, Superviser of Operation and Maintenance, Bureau of Reclamation, Washington, D. C.

Announcements.

Wednesday, November 15

9:45 a. m.—Reclamation 1939, Robert W. Sawyer, Vice President, Bend, Oreg., presiding.
- Reclamation Development in the Multiple-Purpose Project: John C. Page, Commissioner, Bureau of Reclamation, Washington, D. C.
- Contribution of Army Engineers to Reclamation: Maj. Gen. Julian L. Schley, Chief of Army Engineers, Washington, D. C.,
- Land Use, Soil Conservation, and Water Facilities: E. H. Wiecking, Associate Coordinator of Land Use, United States Department of Agriculture, Washington, D. C.
- Flood Control and Its Assistance to Reclamation: Hon. Dewey Short, president, National Rivers and Harbors Congress, Galena, Mo.
- Announcements.

12:15 p. m.—Luncheon and music, Hon. Lawrence Lewis, Member of Congress from Colorado, presiding; Hon. Edwin C. Johnson, Senator from Colorado.

2:00 p. m.—Afternoon session, President O. S. Warden, presiding.
- Reclamation Legislation in Congress: Hon. Compton I. White, Member of Congress from Idaho.
- The Repayment Law—Its Provisions and Aims: J. M. Lampert, chairman, legislative committee, Boise, Idaho.
- Comments from the floor and Answers to Questions by Commissioner John C. Page, Bureau of Reclamation; Chief Counsel J. K. Cheadle, Bureau of Reclamation; Charles A. Lory, president, Colorado State College, Fort Collins; R. O. Chambers, president, Federal Irrigation Congress, Minatare, Nebr.; George Grebe, Kuna, Idaho.
- New Water Laws Needed in the West: A. E. Chandler, chairman, subcommittee on State water law, water resources committee of National Resources Planning Board, San Francisco, Calif.
- What the State Ought To Do for Reclamation in Planning and Cooperation: Clifford H. Stone, director and secretary, Colorado Water Conservation Board, Denver.
- Announcements.

4 p. m. to 8:30 p. m.
- Trip through Denver headquarters, Bureau of Reclamation, by groups of States according to announcements starting at 4 o'clock—R. F. Walter, Chief Engineer, and staff as hosts.

Thursday, November 16

9:45 a. m.—Morning session, Pres. O. S. Warden, presiding.
- The Domestic Sugar Problem: Charles M. Kearney, president, National Beet Growers Association, Morrill, Nebr.
- Sugar Beet Acreage on Reclamation Projects: Hon. James F. O'Connor, Member of Congress from Montana.
- Sugar Beet Expansion—Legislation Needed: Hon. Fred Cummings, Member of Congress from Colorado.
- A National Planning Board—How It Should Be Constituted: L. Ward Bannister, Denver, Colo.
- Drainage and Clearing—Desirability and Method: Wm. E. Warne, Information Director, Bureau of Reclamation, Washington, D. C.
- Announcements.

12:15 p. m.—Luncheon and music, Hon. John A. Martin, Member of Congress from Colorado, presiding; Hon. Alva B. Adams, Senator from Colorado.

2 p. m.—Final session: Pres. O. S. Warden, presiding.
- Water Conservation Possibilities on the Northern Great Plains: Dr. Harlan H. Barrows, National Resources Board, Chicago, Ill.
- The Great Plains Program in Congress: Hon. Francis Case, Member of Congress from South Dakota.

Business session

- Report of auditing committee.
- Report of budget committee.
- Report of legislative committee.
- Report of resolutions committee.
- Choice of next convention city.

4 p. m.—First meeting of new Board of Directors.

Thursday evening

7 p. m.—Annual banquet, music and entertainment.
- Toastmaster: Hon. Ralph L. Carr, Governor of Colorado.
- Messages from friends: Pres. O. S. Warden.
- An appreciation of Congressman Edward T. Taylor.
- Address: Hon. Joseph O'Mahoney, Senator from Wyoming.

Secretary Ickes Signs Water Contract With City of San Diego

BY contract dated October 16 with the city of San Diego, Calif., the city agrees to repay approximately $400,000 of the cost of the All-American Canal, from which eventually the city will take a portion of its water supply.

Hon. Phil D. Swing, former Member of Congress from California, represented the city as its special counsel on water matters at the signing of the contract. It will be remembered that Representative Swing and Senator Hiram Johnson were co-authors of the Boulder Canyon Project Act which authorized the construction of the Boulder Canyon project, including the All-American Canal. High officials of the Bureau of Reclamation, John C. Page, Commissioner; R. F. Walter, Chief Engineer; and Walker R. Young, now Supervising Engineer of the Central Valley project in California, but formerly Construction Engineer of Boulder Dam, also were present.

Under a contract signed several years ago, San Diego agreed to pay for 112,000 acre-feet of water each year from the Colorado River, as a part of California's share in the division of the river's waters as controlled by Boulder Dam. Last April, by a vote in excess of a two-thirds majority, the people of San Diego approved the contract signed on October 16.

The city is agreeing to repay the cost of the All-American Canal proportionate to its use of the great ditch in transporting its water from the Imperial Dam to a point near the end of the irrigation system, from where it is proposed, in the future, to build an aqueduct to carry the water to the coast.

The All-American Canal's principal assignment will be to transport irrigation water across the east mesa desert for use in the Imperial and Coachella Valleys.

At the conclusion of the ceremony at which the contract was signed, Secretary Ickes presented the pen he had used to Mr. Swing as a memento of the completion of another important step in the progress of the Boulder Canyon project.

Secretary of the Interior Harold L. Ickes (sitting) signs contract with the city of San Diego. Standing (left to right): Walker R. Young, Supervising Engineer, Central Valley project; Hon. Phil D. Swing, representing the city of San Diego; R. F. Walter, Chief Engineer, Bureau of Reclamation, Denver, Colo.; E. K. Burlew, First Assistant Secretary of the Interior; John C. Page, Commissioner of Reclamation

Grand Valley Cold Storage Plant

A NEW cold storage plant, called Curnow's Frozen Food Lockers, built in Grand Junction, Colo., at a cost of $30,000, was opened for inspection at the close of September. This plant provides for the rental of 1,010 temperature controlled lockers for the storage of meats, fruits, or vegetables. The concern also provides facilities for custom killing of livestock and for their skinning, dressing, and packaging.

Conference of Bureau Supervisory Officers

FOLLOWING the 3-day session of the National Reclamation Association Convention November 14-16 at the Shirley Savoy Hotel, Denver, Colo., a 4-day meeting of most supervisory officers of the Bureau was held November 17-20. A large representation from all field offices headed by a small group of the Washington office was in attendance. Commissioner Page, Chief Counsel Cheadle, Supervisor of Operation and Maintenance Sanford, Irrigation Adviser Mitchell, Chief Accountant Kubach, Information Director Warne, and Miss Gallagher, Secretary to the Commissioner, constituted the latter group.

Commissioner Page left Washington October 31 to attend the ground-breaking exercises at Friant Dam, Central Valley project, California, coming to Denver in time for sessions of the National Reclamation Association and the Bureau Conference.

The program of the Reclamation Conference was not completed as this issue goes to press, but there will be discussions of pertinent questions, including repayment contracts under the Reclamation Project Act 1939; labor problems; finance and accounts; Civilian Conservation Corps; and general operative and administrative questions brought to the meeting by those in attendance.

Concrete Aggregates for the Gila Project

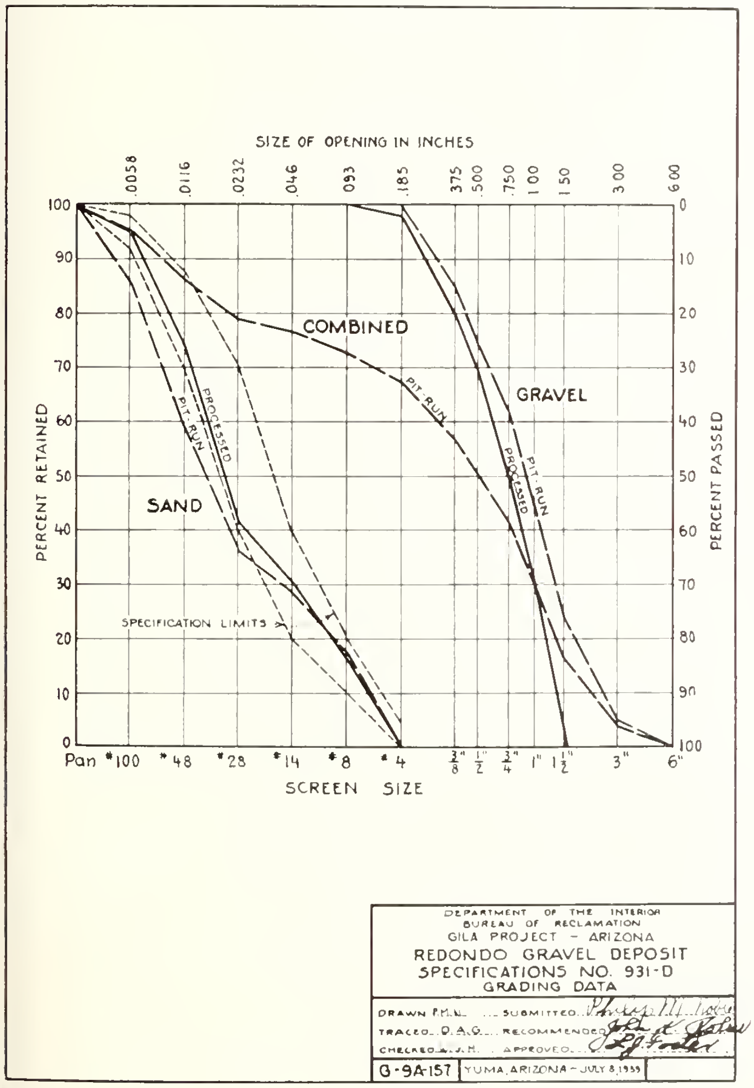
By PHILIP M. NOBLE, *Associate Engineer*

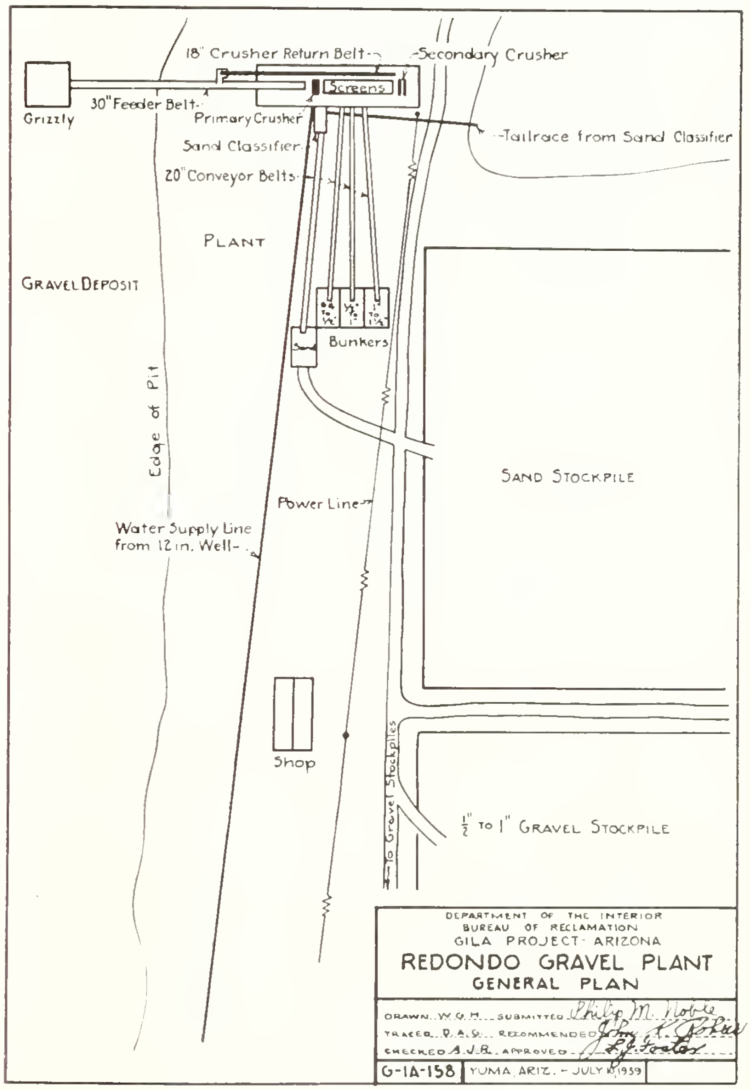
IN southwestern Arizona there is now under construction the Gila project which will eventually bring under cultivation a large area of desert land along the lower Gila River. Water will be diverted from the Colorado River at Imperial Dam about 18 miles northeast of Yuma, the initial development calling for a diversion of about 2,000 second-feet. The Main Gravity Canal follows the edge of the mesa on the Arizona side of the Colorado River for a distance of about 6 miles where it enters the first of two 20-foot concrete lined tunnels through the Laguna Mountains. Emerging from the tunnels the canal follows a generally south and easterly direction to a point about 15 miles east of Yuma where a 19-foot 6-inch diameter concrete siphon, 2,000 feet long has been built to carry the canal under the Gila River. From the Gila River Crossing the canal follows the south side of the Gila Valley to the edge of the Yuma Mesa where a pumping plant is to be built to lift the water to lateral canals. The total distance from Imperial Dam to the pumping plant is 20.85 miles. Power for pumping the water is to be obtained from Parker Dam over a transmission line which will be built this year. Excavation of the main canal and construction of the principal structures along the canal have been practically completed for the Gila Division west of the Fortuna Mountains; and more than 50,000 cubic yards of concrete had been placed prior to July 1939.

Prospecting for concrete aggregates was started in the spring of 1936. Although large areas of this desert region consist of sand and gravel or bare rock, deposits of materials which will satisfy present standards for concrete aggregates are exceedingly rare. Much of the sand and gravel of local origin is the result of decomposition of the granites, gneisses and schists composing the local mountain ranges. Such materials are usually quite friable and badly shattered. Other gravel deposits along the Colorado and Gila Rivers are cemented with calcareous materials which render them unfit for use.

Acceptable Deposit Located

A deposit of acceptable material containing sufficient quantities of sand and gravel was located near the old Redondo Ruins about 13 miles east of Yuma. These ruins are a relic of earlier days when the Gila River contained water throughout the entire





Carry-alls hauling gravel

year. Evidences of an old irrigation canal are still visible along the river bank. Since the storage and irrigation developments on the Salt and Gila Rivers further upstream were built, the lower Gila has dried up entirely except for occasional floods. The valley fill consists of 90 to 100 feet of fine sand and silt overlying coarse gravel. The first evidence of gravel near the surface in this vicinity was found around an old well which had been completely filled in, but still showed some gravel on the waste pile from the excavation. A test pit was put down near this well through 8 feet of silt, but no gravel was encountered. At the time, this was considered to be a too heavy overburden and the pit was abandoned. After several weeks of prospecting on the Yuma Desert, southeast of Yuma, this pit was deepened and gravel struck at a depth of 8.8 feet. Further investigation revealed a deposit of excellent gravel underlying 4 to 20 feet of silt and covering an area of 10 or 12 acres. The depth of the gravel deposit was 10 to 18 feet.

In exploring the Redondo deposit 3- by 4-foot test pits were dug at about 200-foot intervals, but a number of 8-inch auger holes were put down through the overlying silt to locate the top of the gravel and to determin the extent of the deposit and depth of over burden. A good many other auger holes wer put down at random over a large part of th adjoining river bottoms but no other grave deposit of any size was located.

In all investigations in the river bottom and on the mesa to the southeast, 144 tes pits and 245 auger holes were dug totalin 1,436 and 3,461 feet, respectively. Grave from the test pits at the Redondo deposit wa carefully screened to determine the pit-ru grading, and samples of the material wer shipped to the Bureau's laboratory in Den ver for physical tests and trial mix investiga tions.

This material was deposited by the Gil River and is very similar to that obtaine from the Salt River in the vicinity o Phoenix. The gravel consists of very har clean, well-rounded particles of igneous an metamorphic origin, containing large pe centages of quartzites, felsites, and granite Very little cemented material was observe but a pronounced coating of black manga nese oxide was encountered in small area Tests indicated no loss of strength due t this oxide coating and most of it washe off easily in the processing plant.

On June 17, 1937, bids were received a Yuma, Ariz., for the preparation of 261,00 cubic yards of concrete aggregates from th Redondo deposit. Ten bids were received wit the unit prices ranging from $0.48 to $0.6 per cubic yard. The contract was awarde to the George Pollock Co. in September 193 Erection of the processing plant was complete early in December and practically all of th stripping was completed before starting ope ation of the plant.

The anticipated work was scattered ove an area of some 150,000 acres and a distanc of 40 to 50 miles. Aggregates from this d posit were to be used over a period of 4 or years. These conditions meant that larg stock piles of material would be required an that the material would probably have to b handled several times before being placed i the structures. As a result of successful e perience under similar conditions on the Al American Canal, the gravel was separate into three sizes: number 4, ½ inch, ½–1 inc and 1–1½ inches. This meant that an extr size of aggregate would have to be handle throughout all operations. However, the d crease in segregation troubles with the r sultant improvement in control and workabi ity entirely offset any increase in cost ove the conventional practice of using two size number 4, ¾-inch and ¾–1½ inches. O centralized work, where the manufacture o concrete is largely a continuous process, th use of the conventional two sizes would pro ably be more economical.

Processing the Gravel

The contractor's plan of operation was t strip all of the overburden from the grav

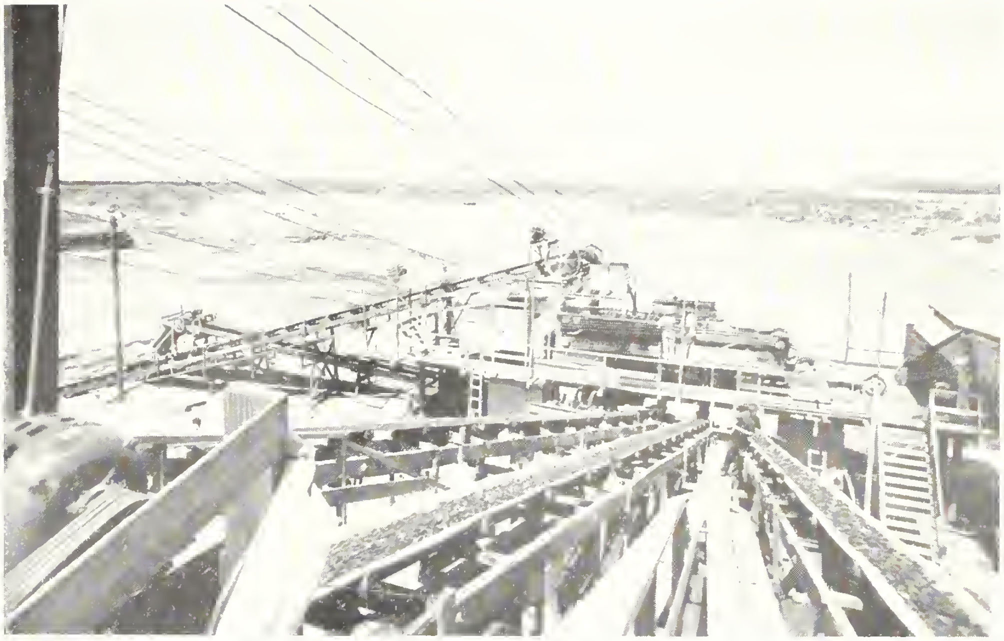
Layout for operations as viewed from ½- to 1-inch gravel stock piles

during the time the screening plant was being erected. This work was done with 13-cubic yard carry-alls and caterpillar tractors. By completing the stripping before starting to process the gravel, it was possible to use the same equipment to haul the pit-run gravel to the plant. The use of carry-alls was considered by the contractor to be very economical. However, because of the stratified character of the river-borne gravel, the materials were not as thoroughly mixed as would have been possible with shovel operation and truck hauling. Although loading of the carry-alls was done on a slope there was a tendency to pick up the entire load from a single layer or lense of material. This, of course, made it difficult to control the uniformity of the product and at times necessitated wasting sand which was too fine or too coarse to meet the specifications.

The screening plant was erected on the waste stripping pile near the center of the east side of the deposit. During the stripping operations a pit was dug to the bottom of the gravel to provide a place to erect the grizzly and feeder. A 30-inch conveyor belt carried the gravel to the screening plant, which consisted of a 2½-deck horizontal vibrating screen. The finished products were then elevated to timber bunkers from which the trucks were loaded for hauling to the stock piles immediately adjacent to the screening plant.

The main feeder belt discharged over a small grizzly with bars spaced at 1½ inches, the oversize going to an 18- by 36-inch jaw crusher; the crusher product was discharged onto an 18-inch conveyor belt which returned it to the main feeder belt. The undersize from the grizzly passed directly to the top deck of a 4- by 20-foot horizontal vibrating screen where it was washed by seven rows of sprays. A plentiful supply of water was obtained from a 12-inch well located about 800 feet from the plant. The well was drilled to a depth of 100 feet to good river gravel and had a capacity of about 600 gallons per minute. Since the gravel was unusually clean the primary purpose in washing was to aid in the separation of the sand and to carry away an excess of fine sand.

The vibrating screen consisted of 2½ decks with screens arranged to separate the material into sand (passing the 3/16-inch screen) and the three sizes of gravel (3/16–½ inch, ½–1 inch, and 1–1½ inches). The top deck consisted of 10 feet of 15/16-inch square mesh screen followed by 10 feet of 1⅝-inch square mesh. The +1½ inches from this screen went on through a secondary jaw crusher and was returned to the main feeder belt by the same return belt which served the primary crusher. The intermediate deck consisted of 10 feet of ½-inch square mesh followed by 8 feet of 15/16-inch square mesh. The +1 inch rejects from this screen dropped into the 1–1½-inch bin directly over the discharge conveyor belt. The −1 inch from this screen fell into the ½–1-inch bin, the



Screening plant viewed from top of bunkers

−½ inch having been removed by the first 10 feet of ½-inch wire mesh. The lower deck or sand screen contained 8 feet of 3/16-inch wire mesh and was directly below the ½-inch screen. The +3/16 inch from this screen passed onto the 3/16–½-inch belt and the −3/16 inch went directly into a 48-inch double reciprocating rake sand classifier.

Changes in Mixing Plant

Minor changes were made in the plant from time to time to take care of pit changes as well as to obtain maximum possible production and to improve the quality of the processed materials. The 1⅝-inch screen was originally 1½ inches but was changed to 19/16 inches and finally to 1⅝ inches to increase the proportion of 1–1½-inch gravel. The amount of oversize which went to the secondary crusher was reduced by the larger screen without appreciably increasing the percent of oversize in the 1–1½-inch gravel or the maximum size of the gravel. In the first section of the top deck, 15/16-inch, 1-inch and 11/16-inch square mesh screens were used without much noticeable change in the grading. In order to reduce the undersize in the ½ to 1-inch gravel, the last 2 feet of the ½-inch screen was changed to ⅝-inch square mesh. The 1-inch screen on the intermediate deck was changed to 15/16-inch to lower the percent of oversize in the ½–1-inch gravel without appreciably increasing the undersize in the 1–1½-inch gravel.

Although the gravel from this pit had a grading very closely approaching the ideal, the sand grading was far from satisfactory, there being only about 11 percent of the No. 28 size in the finished product, and an excess of the smaller sizes. This peculiarity was aggravated by variations in the amount of fines in the pit-run material.

Adjustments were made by mixing materials in the pit when possible and by regulation of the amount and sizes of materials wasted by raising or lowering the waste gate on the sand classifier or by regulating the quantity of water. Mixing in the pit was accomplished by excavating on the slope with the carry-alls. In most places, the gravel was underlaid with fine sand and care had to be used to avoid cutting into this. Some pockets of coarse sand were spread over the rest of the pit to improve the sand grading. Any sand rejected was returned to the pit and spread over the deposit. A second washing usually improved the grading. Frequent samples were taken in the tailrace to insure that none of the No. 28 size was being wasted. By observation of the action of the sand on the discharge conveyor belt, the inspector was usually able to tell whether or not the sand grading was satisfactory. Even with these adjustments, it was difficult to keep the percent retained on the No. 28 screen up to the specification requirements. The use of a shovel and trucks in the deposit instead of the carry-alls might possibly have eliminated part of this trouble as a better mixing of the stratified materials would have resulted.

Processed sand and gravel were taken from below the screens and from the sand classifier by four 20-inch conveyor belts. Each belt conveyed its finished product to the top of a 40-cubic-yard storage bunker. Materials were discharged off the end of the belt and no rock ladders were used. Each bunker was equipped with four gates located symmetrically in the bottom of the bin. In discharging material from the bins, two gates were opened simultaneously. This arrangement mixed the [illegible] more satisfactorily than would have been done with a single gate at the center of the bin.

Stock piles of sand and gravel were built on the east side of the deposit as near as possible to the bunkers. Some idea of the quantity of aggregates produced is given by the sizes of the four stock piles which varied from 600 by 120 feet for the sand to 975 by 50 feet for the two larger sizes of gravel. Stock piles were built to a height of 20 to 25 feet in two lifts, the lower lift being about 3 or 4 feet high, the height of one truck dump. The rest of the pile was taken up in one lift. Timber ramps were laid on the top of the piles and the trucks were backed over these ramps and dumped. When the stock piles were completed, the ramps were taken up and the chips and fine material which had accumulated were carefully cleaned up. The accumulation of fine material along the ramps is the greatest objection to this method of stock piling. Long timbers laid lengthwise of the piles were more satisfactory for ramps than "ties" or mats of short planks laid crosswise as fewer wood chips were torn off by the trucks. Another objection to this method of stock piling is the tendency of the material to segregate when dumped off the end of the piles. This tendency was considerably reduced on this job by screening to three sizes instead of the conventional two sizes.

Work Shifts

The plant operated two shifts a day, 6 days a week, from December 16, 1937, until June 17, 1938, with the exception of a few minor shut-downs. The normal operating time for this period was 2,496 hours, but delays cut this to 2,134 hours. During this time 312,878 cubic yards of sand and gravel were produced. Average production for the actual operating time was 147 cubic yards per hour. In general, delays due to mechanical trouble with the plant or equipment were of short duration. At one time it was necessary to shut down for several days while additional gravel was being stripped. Considerable time was lost during March 1938, because of power interruptions due to floods in the Los Angeles region, nearly 300 miles away, as power at present is transmitted from plants in the high Sierras and Metropolitan areas. Delays because of weather, power interruptions, and stripping operations amounted to 50 percent of the total time lost.

Mechanical analyses were made on the sand at about 2-hour intervals and on each size of gravel at least once during each shift. Other tests such as specific gravity, silt, and organic impurities in the sand were made only occasionally. Because of the peculiar sand grading frequent tests were made of the waste material from the classifier to insure retaining all of the No. 28 size. Although an attempt was made at all times to keep the sand within the specification requirements, it was also desirable to save as much sand from the deposit as was possible, since the proportion of sand produced was considerably below the expected production. This meant that the fineness modulus of the sand had to be kept as low as was compatible with maintaining the required grading limits. Ten-day averages of the fineness modulus varied from 2.53 to 2.62 with the exception of the first two 10-day periods. Between 80 and 95 percent of the tests for each period were within 0.15 of the 10-day average. Of a total of 1,063 mechanical analyses made on the sand during the 6 months' operation, 81 percent were within 0.15 of the job average of 2.58.

Sand grading, Redondo deposit, Gila project

Screen size	Cumulative percent retained		
	Pit average (test pit data)	Specification limits	Job average (processed)
No. 4 (3/16 inch)	0	0 – 5	0
No. 8	18	10 – 20	16
No. 14	28	20 – 40	31
No. 28	36	40 – 70	42
No. 48	59	70 – 88	74
No. 100	85	92 – 98	95
F. M.	2.26	2.50– 3.00	2.58

Control tests on the three sizes of gravel were essentially undersize and oversize tests. However, since preliminary investigations were based on the standard screens (3/16-, 3/8-, and 3/4-inch), these screens were used in addition to the 1/2-, 1-, and 1 1/2-inch screens. From these results, a weighted grading for the entire job has been computed and plotted on the accompanying grading chart. The pit-run gradings as determined by the test pit investigations, and the job average gradings for finished sand and gravel are also given. The composite grading for the finished gravel approaches very closely the ideal grading for 1 1/2-inch maximum siz[e] aggregate.

Because of the rapid developments on th[e] Gila project and the failure to locate othe[r] satisfactory deposits of aggregate, it wa[s] deemed advisable to increase the quantitie[s] under this contract as much as possible. Ad[-]ditional material was available beyond th[e] limits originally set, but it was necessary t[o] increase the depth of stripping. The orig[-]inal contract quantities and the final quan[-]tities are given in the accompanying table.

Aggregate quantities, specifications no. 931–[D], Gila project

Item	Quantities (cubic yards)		Unit price	Cost
	Original contract	Final		
Stripping	150,000	246,760	0.15	$37,014.
Sand	88,000	76,432	.48	36,687.
Gravel No. 4, 1/2 inch	52,000	70,054	.48	33,625.
Gravel 1/2 1 inch	64,000	86,596	.48	41,566.
Gravel 1–1 1/2 inches	57,000	79,796	.48	38,302.
Total aggregate	411,000	559,638	------	[1] 187,195.

[1] Total cost.

Because of the necessity of wasting suc[h] a large proportion of the fine sand to mee[t] the grading requirements, the quantity [of] sand fell considerably below the expected pro[-]duction. With the additional gravel pro[-]duced under the extended contract, this shor[t]age is even more pronounced. Fortunatel[y] the gravel deposit near Imperial Dam on th[e] All-American Canal contained a considerab[le] excess of sand. Rather than to waste th[is] material, the excess was properly processe[d] and stock-piled and will be available for us[e] on the Gila project in case no more econom[i]cal source of materials is located.

Wallace B. Evans Dies

EMPLOYEES on the Boulder Canyon project were saddened to read of the death of a former Bureau of Reclamation employee, Wallace B. Evans, while on duty at the island of Haiti.

A news item reports that three men, two of them Americans, were killed and another American was injured Wednesday, October 11, when a plane, chartered by the J. G. White Engineering Corporation of New York, crashed into the sea when taking off from Jacnel, Haiti, on an exploration trip. Wallace B. Evans was listed as one of the passengers fatally injured.

Mr. Evans first entered the Bureau of Reclamation in January 1917, as a rodman, and, with the exception of a few months service in the Army in 1918, was employed during four different periods from 1917 to 1923 on the Yuma project. From 1923 to 1934 he was employed on various construction projects throughout the world, including employment at Port Jerome, S. I. France, as chief engineer of construction of an oil r[e]finery for the J. G. White Engineering Co[r]poration. In 1934 he again entered the ser[v]ice of the Bureau of Reclamation as an i[n]spector on the Boulder Canyon project, an[d] on April 15, 1936, was promoted to the pos[i]tion of associate engineer, from which offi[ce] he resigned September 6, 1937, to reenter th[e] service of the J. G. White Corporation an[d] was stationed at Venezuela for some tim[e]. At the completion of that project, he wa[s] transferred to the island of Haiti where h[e] was employed at the time of his death.

Students Visit Boca Dam

ON October 28 a class of students, under th[e] leadership of Louis Titus, associate professo[r], College of Agriculture, University of Nevad[a], visited Boca Dam, Truckee storage projec[t], the visit being intended to supplement the[ir] irrigation studies.

Reclamation Water Storage

WATER storage on Federal Reclamation projects during the past 6 years has increased more than fivefold. This storage serves purposes of irrigation, flood control, city water supply, and generation of power.

Since 1933, when 46 Reclamation reservoirs held 7,000,000 acre-feet of water, storage has risen until it is now well over 35,000,000 acre-feet or 11,000,000,000,000 gallons.

The tremendous increase is largely the result of 24 new reservoirs, including Lake Mead on the Boulder Canyon project, the largest body of water ever stored behind concrete by man. Boulder Dam was completed in 1936. It now holds back nearly 25,000,000 acre-feet of water.

Aside from Boulder, the largest amounts of water stored on Reclamation projects at this time are at the Minidoka irrigation development in Idaho where 3 reservoirs hold 2,300,000 acre-feet; the Rio Grande development in New Mexico-Texas, where 2 reservoirs contain 1,150,000 acre-feet; and the Yakima development in Washington, with 5 reservoirs and 1,000,000 acre-feet.

Conservation of the country's water resources has shown constant growth since establishment of the Bureau of Reclamation by the Congress 37 years ago. In 1907, 5 years after the Federal conservation policy was put into action, Reclamation water storage amounted to only 154,000 acre-feet contained in 3 reservoirs, but 2 years later it exceeded 1,000,000 feet in 12 reservoirs.

The storage continued to grow at the rate of almost a million feet a year until the entry of the United States in the World War, in 1917, when 27 reservoirs held approximately 7,000,000 acre-feet.

The war and set-backs from drought years kept Federal water storage fluctuating between 9,000,000 and 5,000,000 acre-feet until 1934, even though the number of reservoirs increased to 47. In 1935 water storage went over the 11,000,000-acre-foot mark to show large gains every year since.

In 1936 water storage rose to 18,000,000 feet, in 1937, 25,000,000 feet, in 1938, 34,000,000 feet, and on July 1 of this year, just under 36,000,000 acre-feet.

The striking progress in Federal Reclamation storage since pre-World War years is illustrated by the attention attracted by the water storage of Pathfinder Dam on the North Platte irrigation project in Nebraska-Wyoming in 1912.

On July 8, anticipating heavy demands from irrigationists, the Pathfinder Dam had accumulated more than a million acre-feet of water. It was the first time any single structure had artificially stored this amount of water in the United States.

Today Boulder Dam's Lake Mead contains 25 times that amount, and a half dozen other Reclamation reservoirs have at one time or another held more than that amount, while still others have a capacity above 1,000,000 acre-feet.

Growing steadily is the lake forming behind Grand Coulee Dam in Washington, one of the 16 dams now under construction by the Bureau. Now already 30 miles long, the lake holds about 200,000 acre-feet. While this storage is still relatively insignificant it is expected to show rapid growth. By next summer the lake will be much wider and longer, and 100 feet deeper, and by 1941 it will be 150 miles long, stretching to the Canadian border. A 300-mile boat trip from the dam will be possible—150 miles to the border and 150 miles more into Canada as far as the Arrow Lakes. Storage capacity will be over 10,000,000 acre-feet.

Grand Coulee Lake now 40 Miles Long

UNITED STATES cartographers are clearing off white space on their maps to add a great lake to the visible assets of mankind. Three years ago the map makers had to make room for Lake Mead, the 115-mile reservoir created by Boulder Dam, highest concrete dam in the world. Now they have a new lake to cope with as Grand Coulee Dam in Washington piles back the waters of the Columbia River.

On October 29 the lake which is being impounded by the building of this dam had reached a length of 40 miles, and, at the present rate of construction, it will stretch to the Canadian border, a distance of 151 miles, in about 2 years, exceeding the length of Lake Mead by 36 miles. Vessels can travel over the new lake for its entire distance and sailors can make their journey international if desired by continuing on into Canada as far as the Arrow Lakes.

The Columbia River system dominates the Northwest. Its branches reach out from Washington and Oregon into Idaho, Montana, and Canada, and Grand Coulee Dam in turn will dominate the river system, so rich in present and future economic usefulness.

Treasure seekers for centuries have vaguely felt the potential promise held out by the great Columbia River, records reveal. After a Spanish "frigate" discovered, in 1602, the mouth of a "rapid and abundant river, with ash trees, willows, and brambles, and other trees of Castile upon its banks," and was prevented from entering it because of its powerful current, explorers never ceased their efforts to bring the river under man's sway.

Almost 200 years later, on May 11, 1792, a Boston trader commanding the Columbia Rediviva "ran in with all sails set," and ascended the river 20 miles. He named the river the Columbia in honor of his ship and claimed it for the United States.

But for this event, the Spanish or the English might have held the Pacific coast, and the United States might never have become as great a nation.

Inland exploration of the Pacific Northwest began with the fur trade, and for years the economic and political history of the Territory paralleled closely the fortunes of the great fur companies.

One of the first Americans to realize the importance of the so-called Oregon country was John Ledyard, a Yankee sailor who in 1786 interested Thomas Jefferson in an expedition to ascend the Missouri River, to cross the Shining Mountains (the Rockies) and to descend the Columbia to the Pacific.

The expedition is believed by many historians to have been outstanding in fixing the public interest on territorial expansion, and in determining the country's destiny.

Furs are products of the wilderness, so settlement was not encouraged, but the westward pressure of the agricultural population of the United States quickly developed the Middle West, and in a relatively short time trappers, gold seekers, cattlemen, and farmers rapidly succeeded one another in occupying the Oregon country.

Now, 300 years later, the treasure seekers are finding the new wealth that is in the Columbia—its potential power for the benefit of man existing in rippling waters and in the earth they serve. And increasingly, in the future, that earth will be made to serve man more and more, by reclamation developments.

The economic usefulness of the great river and its tributaries is well begun. Water diverted from them already transforms lonely desert wastes to flourishing farms—real homes, offering security and happiness. Electrical energy created by their falling waters lights cities and operates factories and mines.

Grand Coulee Dam, largest man-made structure in the world, will store waters enough for the ultimate irrigation of 1,200,000 acres, as well as being the largest single source of electrical energy, when fully developed. It will provide homes and livelihood for scores of thousands of American families in the Big Bend country of Washington.

Yakima Strawberry Clover

YAKIMA VALLEY growers of strawberry clover have recently organized a cooperative seed marketing organization and have arranged for leasing a warehouse to care for disposition of the crop. The seed will be inspected and tagged by State inspectors. It is estimated that 40,000 pounds of strawberry clover seed will be threshed this fall. The strain grown in the valley is said to be one of the best and is sought by growers in other countries, particularly Australia.

Storm-Drainage Structures on the All-American Canal

By GORDON W. MANLY, *Associate Engineer*

FOR the first 21 miles, the All-American Canal is located along the western edge of the Colorado River flood plain, on the slope between the river bottom land and the mesa. The drainage from an area of about 153 square miles to the west and north of this portion of the canal is carried by numerous watercourses crossing the canal alinement at approximately right angles. Although the lower Colorado River Valley is a region of very low rainfall, it is not uncommon for half, or more, of the total annual rainfall to occur in one storm of cloudburst proportions. At Yuma, as much as 1.85 inches of rain have fallen in 1 hour. When such storms occur, the normally dry watercourses carry large flash floods. To provide for carrying the flow of these watercourses, or washes across (or where practicable into) the canal, was one of the major problems in the construction of the All-American Canal.

About two-thirds of the drainage area of the washes is a mesa, which has a general slope toward the canal of 1 to 2½ percent. The soil of the mesa is, for the most part, rather porous, and the rate of run-off from this area comparatively low. The remainder of the drainage area is composed of numerous ranges and spurs of precipitous, almost completely barren, mountains with a very high rate of run-off. In general, the larger washes obtain considerable water from the mountainous area beyond the mesa, whereas the watersheds of the smaller washes are confined to the mesa area. There are 10 washes with drainage areas in excess of 2,000 acres. The estimated maximum discharge of these washes varies from 600 cubic feet per second for "945" Wash, which has a watershed of 2,100 acres of rather flat mesa, to 15,000 cubic feet per second for Picacho Wash, with a watershed of 27,400 acres, a considerable portion of which is mountainous.

The large discharge and heavy suspended and bottom load of solids, carried by the washes in flood, made it impracticable to consider discharging any but the smaller washes into the canal. The plan evolved for providing for storm drainage was briefly as follows:

1. So far as practicable, concentrate the flow of the washes by constructing dikes and channels to divert the smaller into the larger washes.

2. For the 10 major washes, provide siphons for carrying the flow of the canal under the washes, or overchutes for carrying the flow of the washes over the canal.

3. For the remaining 17 minor washes, provide drainage inlet structures for carrying the flow of the washes into the canal.

The largest diversion was that of "454" Wash, with a drainage area of 6 square miles into "424" Wash. This was accomplished with a channel requiring about 30,000 cubic yards of excavation. Numerous small washes were diverted into the larger washes. The total excavation for diversion channels and dikes amounted to approximately 300,000 cubic yards. Most of this excavation was done with draglines and bulldozers by the contractor for the earthwork on the upper portion of the canal, the W. E. Callahan Construction Co. and Gunther & Shirley.

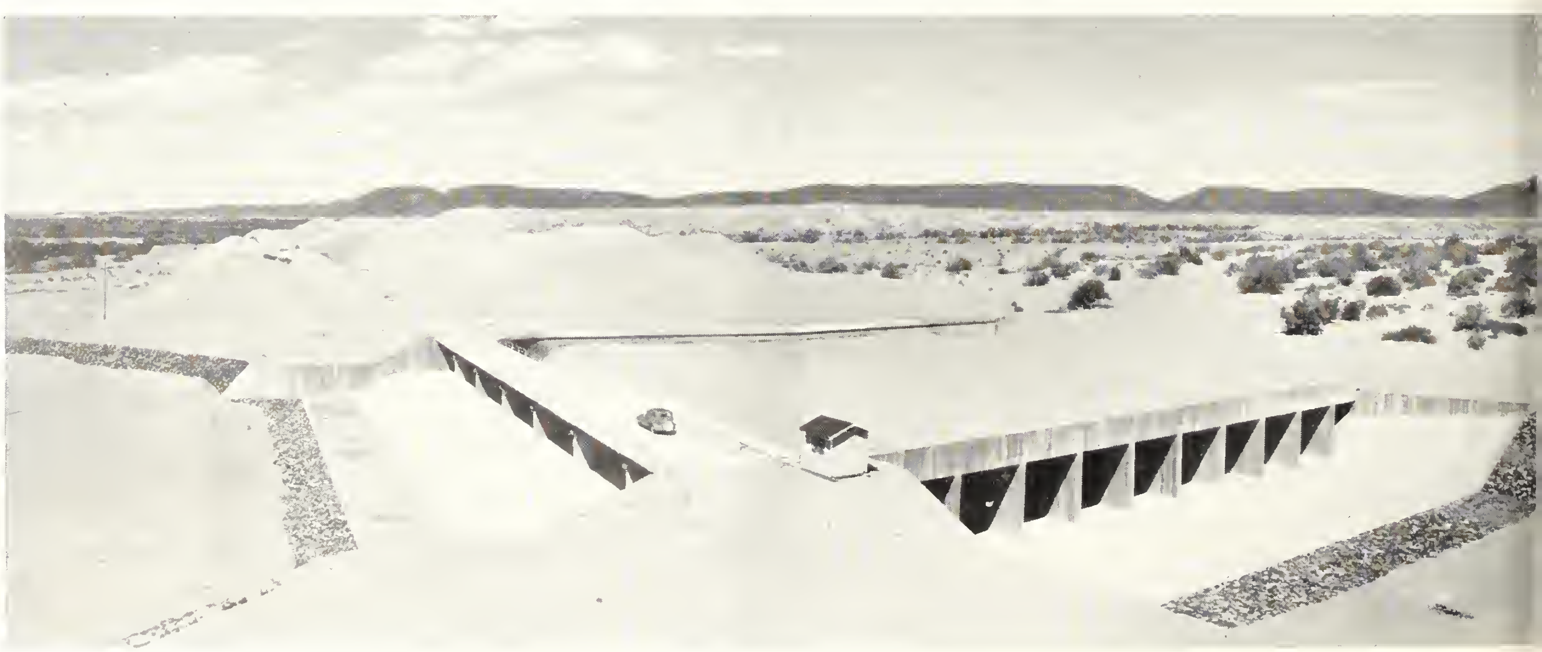
Wash Siphons

The 4 largest washes cross the canal from 2 to 13 miles below Imperial Dam. Their drainage areas and estimated maximum discharges are shown below:

Wash	Drainage area	Estimated maximum discharge
	Acres	*Cubic feet per second*
Picacho	27, 400	15, 000
Unnamed	22, 600	13, 000
424	9, 850	4, 700
120	6, 240	3. 630

The structures designed for these washes are reinforced-concrete siphons, almost identical except for width of wash crossing. Each structure consists essentially of a multiple barreled siphon, with the top slab of the siphon forming the floor of the wash flow-way across the canal. The length of the siphon barrels, which was determined by the required wash flow-way width, varies from 82 feet for "120" Wash, to 302 feet for Picacho Wash. The bottom slab of each siphon is level parallel to the canal centerline. Transversely, the bottom slab is level for the width

Unnamed Wash Siphon, looking upstream from left bank of canal



of the canal bottom. From the lines of the toes of the canal side slopes, the bottom slab is extended upward on a 1:1 slope to meet the top slab. On all of the siphons, except "120" Wash, support is provided under the bearing of the top slab, upon the sloping portion of the bottom slab, by concrete bearing piles 23 feet long. Vertical division walls divide the siphon into 8 rectangular and 2 triangular barrels. At both ends of the barrels the top slab slopes downward toward the centerline of the wash to about 5 feet below the normal water surface of the canal. Vertical walls, extending across the canal at the upstream and downstream ends of the barrels, form the sides of the wash flow-way. Floor slabs extend 45 feet upstream and 55 feet downstream from the ends of the siphon barrels. The transitions from the 1:1 slopes of the outside siphon barrels to the $1\frac{3}{4}:1$ side slopes of the canal are made with warped side walls of the same length as the floor slabs. A short rectangular concrete channel, terminating in warped transitions, is provided at the wash inlet. At the wash outlet of the structure the flow is carried down a sloping chute of rectangular cross section into a stilling pool. Warped transition walls connect the stilling pool with the wash channel below the structure.

Two concrete girder bridges are incorporated in each of the wash siphon structures. One bridge crosses the canal at the upstream end of each siphon, and is supported by piers formed by the extension of alternate division walls. The other bridge carries the canal operating road across the wash chute. It is supported by piers extending through the floor of the chute. A cut-off of steel-sheet piling 10 feet long is provided at the end of the wash outlet transition of each of the siphons. At "120" and "424" wash siphons, an arc of sheet piling extends across the outlet channel of the wash some distance beyond the stilling pool. The outside slopes of the canal embankments adjacent to the wash inlets of the structures, and the bottom and side slopes of the wash channels below the structures, are protected from erosion by a 2-foot thickness of dumped riprap. A strip of dry-rock paving, 12 inches thick, extends across the bottom and up the side slopes of the canal immediately downstream from the siphon outlet transition.

The contract for the construction of the four wash siphons was awarded to the Frazier-Davis Construction Co., of St. Louis, Mo. The major quantities of work required were:

Excavation__________cubic yards__	166, 465
Backfill __________________do____	23, 800
Concrete__________________do____	32, 534
Reinforcing steel ________pounds__	6, 482, 000
Riprap ______________cubic yards__	19, 500
Dry-rock paving___square yards__	2, 750

In addition to that required for the structures, a considerable quantity of excavation was necessary in grading the wash channels adjacent to the inlets and outlets of the structures, and in completing the canal excavation. The latter work consisted of the excavation after the completion of the structures of the plugs, or unexcavated sections of the canal, which were left to carry the flow of the washes across the canal during the construction of the siphon structures. The material encountered in the structure, wash channel, and canal excavation was mostly rather loose sand and gravel. The excavation was done with draglines and tractor-drawn scrapers.

The concrete mix used on all of the wash siphons had a maximum aggregate size of $1\frac{1}{2}$ inches, and contained approximately $5\frac{1}{2}$ sacks of cement per cubic yard. Aggregates for concrete were hauled by truck from the screening plant at station 90 to stock piles at the structure sites. A crane with a clamshell bucket was used to lift the aggregates from the stock piles to the batching hopper. From the hopper, the material was fed by gravity to a stationary 1-cubic yard electrically driven mixer. At all of the siphons, except Picacho, the mixer was located on the left canal embankment as close as practicable to the structures. In order to complete the siphons within the required time, the contractor found it necessary to start concrete placing at Picacho Wash before the completion of the concrete at Unnamed Wash. For some time, the mixer at Unnamed Wash supplied the concrete for both structures, and after the completion of Unnamed Siphon, the mixing plant was left at that location for the remainder of the concreting at Picacho Wash. The concrete was hauled from Unnamed to Picacho Wash (a distance of about $1\frac{1}{2}$ miles) in dump trucks carrying 2 cubic yards. It was found that the loss of slump in transit was less for 2-cubic-yard than for 1-cubic-yard loads, possibly because of the smaller ratio of exposed surface to volume for the larger loads. No serious loss of slump or segregation resulted from the dump-truck transportation of the concrete. A concrete pump was used in placing a large part of the concrete on the siphons. The remainder of the concrete was transported from the mixer to the forms with trucks, buggies, and cranes. Flexible shaft, electrically driven internal vibrators were used on all of the concrete placing. Curing was accomplished by sprinkling the walls, and flooding, or placing a covering of damp earth on the slabs. Steel forms were used for the division walls of the siphon barrels, and for the 1:1 sloping slabs. The forms for the sloping slabs were fitted with doors through which the placing and vibration of the concrete was done. To resist the uplift pressure of the concrete against the forms on the sloping slabs, large concrete weights were placed on the forms. Reinforcing steel was cut and bent at the structure sites.

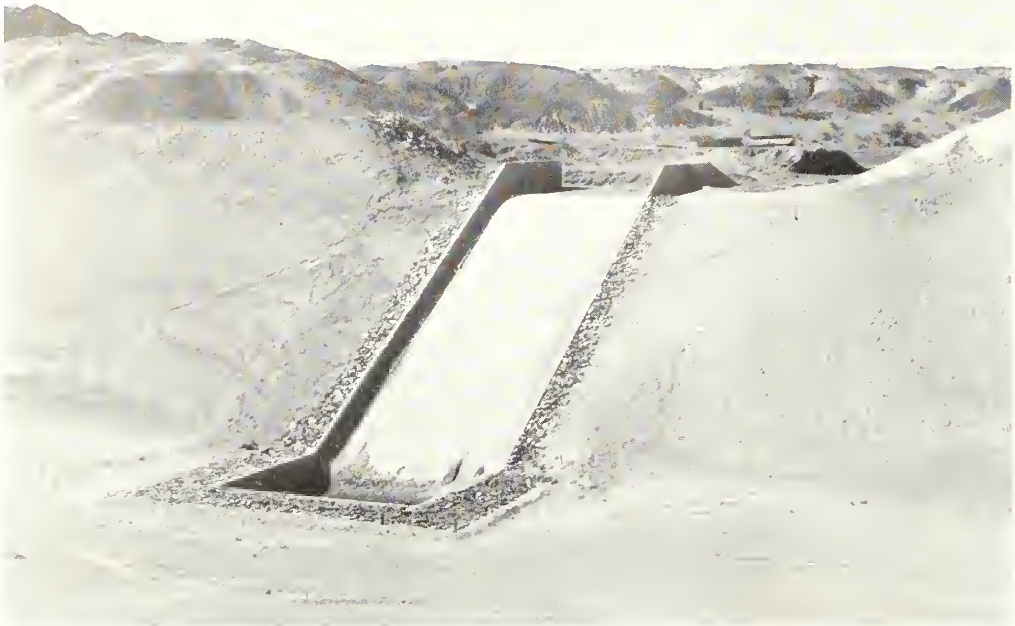
Both the concrete bearing piles and the steel sheet piles were driven with a double-acting hammer operated by compressed air. In driving the concrete bearing piles, an outside jet using both water and compressed air was used to supplement the center jet. Stone for the riprap and dry-rock paving was obtained from natural deposits of boulders on the slopes of the hills along the upper part of the canal.

Construction of the wash siphons was started in January 1936 and completed in September 1937.

Wash Overchutes

Six reinforced concrete overchutes, all similar in design but varying considerably in wash crossing width, were constructed to carry the flow of washes with estimated maximum discharges of 600 to 3,500 cubic feet per second over the canal. The major feature of each of the overchutes is a concrete flume of rectangular cross section for carrying the wash flow over the canal. The flume is supported by thin piers or division walls, which rest on a continuous slab extending across the bottom and up the side slopes of the canal. An apron and transition walls connect the flume with the wash channel at the inlet of the structure, and at the outlet, the flume discharges through a sloping chute into a stilling pool. The stilling pool is 20 to 30 feet below the floor of the flume, and usually about 7 feet below the ground surface of the wash outlet channel. Warped transition walls are provided between the stilling pool and the wash channel below the structure. As in the siphons, the canal operating road is carried across the wash outlet chute on a concrete girder bridge. The width of the flume varies from 20 feet for "945" Wash Overchute to 90 feet for Araz Wash Overchute. The side walls of the flumes are 8 feet 6 inches high, but 12-inch high baffles extending transversely across the flume floor reduce the effective depth of the flume flow way to $7\frac{1}{2}$ feet.

In all of the overchutes except that at Araz Wash, the elevation of the natural wash channel adjacent to the inlets of the structures is below the normal water surface elevation of the canal. Since the floor of the flume is above the normal water surface of the canal, considerable pondage must occur behind the right bank of the canal before the water can flow over the overchute. In general, the overchutes and siphons are similar in thickness of sections, size, and spacing of reinforcing steel. The flume floor varies from 11 to $17\frac{1}{2}$ inches in thickness, the division walls from 15 to 16 inches, and the side walls of the flume from 10 to 16 inches. Typical reinforcement consists of $\frac{3}{4}$- and $\frac{7}{8}$-inch bars at 12-inch centers in both directions in the division walls, and $\frac{3}{4}$- and $\frac{7}{8}$-inch bars at $4\frac{1}{2}$- to 10-inch centers in the floor of the flume. All of the overchutes except that at Araz Wash are provided with 4 sheet steel piling cut-off walls. A cut-off with 10-foot piling is at the end of the inlet transition, one with 10- to 28-foot piling in



Drainage inlet at station 1068, showing structure completed except for backfill and riprap at the inlet end

chutes, the concrete was mixed in portable 2-sack mixers and placed with a $\frac{1}{3}$-cubic-yard bucket, handled by a small crawler-mounted crane. Aggregates were carried from the stock piles to the mixer in wheelbarrows and buggies and weighed on platform batching scales. Internal vibration by electric and gasoline-driven flexible-shaft vibrators was used in placing all of the concrete in the overchutes. Both of the contractors on these structures used form panels made of 5-ply plywood backed by 2-by-4-inch studding and plates. A small portion of the concrete was cured with clear membrane curing compound. The remainder of the concrete was water-cured.

On the five smaller overchutes, the sheet piling for the cut-offs was driven with a drop hammer without jetting. Considerable difficulty was experienced in driving some of the piling, particularly at "810" Overchute where the formation consisted of cemented sand, with thin layers of sandstone. The sheet piling at Araz Wash Overchute was driven with a steam hammer. Riprap for the overchutes was obtained from the waste dumps of the All-American Canal rock cut at Pilot Knob.

Construction of the overchutes was started in October 1936 and finished in March 1938.

the left canal embankment at the outlet end of the flume, and cut-offs with 10-foot piling at the end of the outlet transition, and in an arc extending across the outlet channel of the wash. Only the last two mentioned lines of sheet piling are used at Araz Wash. Riprap and dry-rock paving similar to that on the wash siphons is provided for each of the overchutes.

The contractor for Araz Wash Overchute was the David H. Ryan Construction Co. of San Diego, Calif., and for the other 5 overchutes, the Peterson Construction Co. of Minneapolis, Minn. The principal quantities required in the construction of the six overchutes were:

Excavation	cubic yards	72,000
Backfill	do	30,700
Concrete	do	15,100
Reinforcing steel	pounds	3,055,000
Steel sheet piling	do	690,500
Riprap	cubic yards	13,600
Dry rock paving	square yards	5,200
Compacted earth lining	cubic yards	10,200

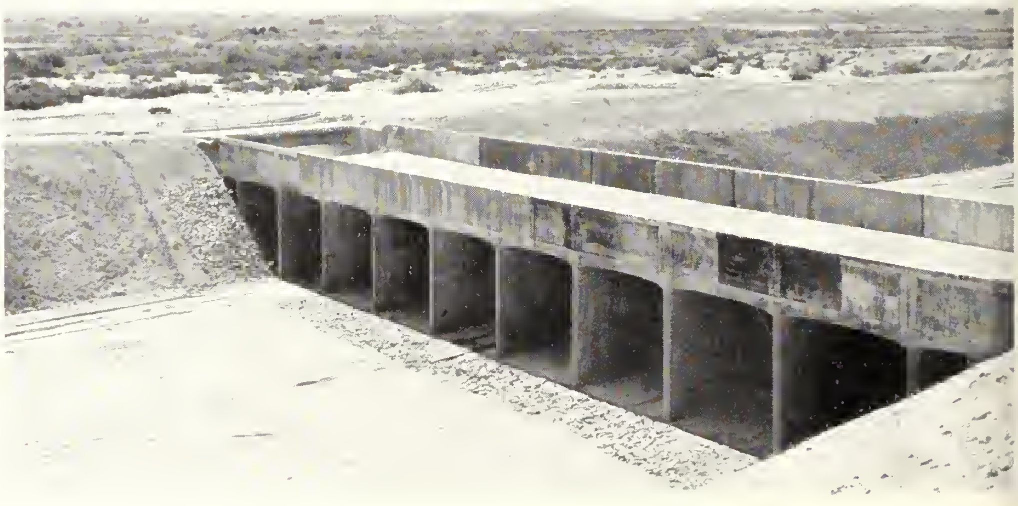
The earthwork required in connection with the overchute structures consisted of structure, wash channel, and canal plug excavation, backfill, and compacted earth canal lining. The excavation was done with draglines and tractor-drawn scrapers. The compacted earth canal lining, 19 to 24 feet thick, was placed along the lower or left canal embankment across the wash channels adjacent to the structures, where the height of the embankment and the porosity of the material made such protection against leakage necessary. The material for the lining was obtained from borrow pits near the canal. Compaction was accomplished with sheep's-foot rollers. Careful control of the borrow-pit excavation and moistening of the material were exercised.

At Araz Wash Overchute, the contractor used an electrically driven, stationary 4-sack mixer, located on the left canal bank, and transported the concrete from the mixer to the forms in pneumatic-tired buggies operated on elevated runways. On the other over-

Drainage Inlets

The small washes, which could not be diverted into the larger washes economically, were carried into the canal by means of reinforced concrete drainage inlet structures. Each of these structures consists of a concrete chute of rectangular cross section, designed to carry the wash flow through the right or upper bank of the canal and thence

General view of "810" Wash Overchute, looking downstream from right bank of canal



parallel to the side slope of the canal into a stilling pool in the bottom of the canal. The drainage inlets vary in width from 6 to 40 feet. Undermining of the chute by erosion of the canal side slopes is prevented by cut-off walls and by a 12-inch-thick layer of dry-rock paving along the sides of the chute. The outside slopes of the right canal embankment adjacent to the inlets are protected from erosion by dumped riprap, or in some cases by boulders held in place by fences made of railroad rail posts and heavy woven wire.

Eleven of the drainage inlets were built by Government forces and the remainder by contract.

The principal quantities required for the construction of the drainage inlet structures were:

Item	Structures built by Government forces	Structures built by contract
Excavation	5,000 cubic yards	3,200 cubic yards.
Backfill	4,850 cubic yards	1,500 cubic yards.
Concrete	1,050 cubic yards	600 cubic yards.
Reinforcing steel.	103,050 pounds	57,550 pounds.
Riprap	650 cubic yards	1,000 cubic yards.
Dry-rock paving.	1,700 square yards	1,300 square yards.

Construction methods used by the Government forces and the contractors on these structures were similar. Concrete was mixed in portable two-sack mixers, which usually were stationed on top of the right canal embankment. Buggies and chutes were used for placing the concrete. The rail posts for the riprap fences were driven with sledge hammers used in conjunction with a compressed-air jet.

No appreciable storm run-off has occurred since the completion of the wash siphons and overchutes. However, a rather violent rainstorm in March 1937 produced large flows across the wash plugs and demonstrated rather forcefully the necessity for the structures. Service on the Yuma Canal was interrupted for several days by damage done by some of the washes which cross that canal a short distance below the All-American Canal. At Picacho Wash Siphon the floodwaters broke through the dikes of the plug and flowed into the canal, carrying a large amount of earth into the canal and causing considerable damage to the structure contractor's materials and equipment. Before the storm the drainage inlet structure at station 1068 was completed except for the backfill around the inlet of the structure and the placing of riprap protection. The water ran into the canal along one side of the inlet, rather seriously undermining the chute and carrying several thousand cubic yards of earth into the canal. The damage to the structure was repaired by replacing the washed-out material with puddled backfill and filling any remaining voids under the chute floor with grout, injected through holes drilled in the slab.

Wyoming Reclamation Association Meeting

THE annual meeting of the Wyoming Reclamation Association was held at Riverton October 23–24, attended by 50 or 60 delegates. The meeting was generally considered to have been successful and of material value in promoting conservation of the water resources of Wyoming. Interesting resolutions passed were summed up as follows:

The association goes on record as—

1. Favoring and urging the various Federal and State agencies engaged in water conservation activities to develop and adopt some program that will provide supplemental water to lands already under irrigation, but which have an inadequate water supply;

2. Urging the adoption of a policy of early and effective action looking toward the consummation of interstate compacts with adjoining States in order to conserve Wyoming's water resources for Wyoming's own people;

3. Urging the State engineer and other interested agencies to prepare a plan for the investigation and study of Wyoming's underground water resources;

4. As commending the Bureau of Reclamation, the United States Engineers' office, and other Federal agencies for their work in connection with water conservation investigations in Wyoming, and urging that the work be carried on to completion;

5. Urging the Public Works Administration, through the Wyoming Congressional Delegation, to complete investigations on all pending supplemental water supply applications to the end that all necessary alterations, corrections, or additional data may be submitted for final approval or disapproval, and requesting that as each project receives approval, it have a perfected status for the first funds made available from any source;

6. Commending the liberalized policy of Federal agencies looking forward to the higher protection and development of Wyoming's natural resources, and recommending that this cooperation be extended to other agencies and organizations.

7. Being in favor of requesting the Wyoming Congressional Delegation to use every effort to secure a sufficient appropriation at the next session of Congress to complete the reconnaisance survey by the Bureau of Reclamation of the Yellowstone watershed.

Shoshone Future Farmers Prize Winners

POWELL Future Farmers won nearly all of the prizes at the Wyoming State Fair at Douglas, bringing home the sweepstakes ribbon for the best exhibit, also the grand champion ribbon and two champion reserve ribbons for baby beef. They brought home 47 blue ribbons for firsts, 33 red ribbons for seconds, and 15 white ribbons for thirds, and 2 fourth place ribbons for their entries.

Three boys from the Willwood division exhibited Aberdeen Angus calves purchased from Homer Mann, a local attorney who has a fine herd of this breed on the Willwood division. Richard Schmidt, a Future Farmer member, won first and grand championship for all breeds in the Future Farmers division. Later his calf was crowned reserve champion over all breeds competing, all divisions and classes competing. The calf belonging to Junior Carter, a 4–H boy, won first in the weight class of more than 1,000 pounds. The calf was later made reserve grand champion over all breeds in the 4–H division. He sold his calf at the beef sale after the show for 16 cents per pound, netting him $172. This was the highest price paid at the sale. Wayne Pearson won first in the medium-weight class in the 4–H division for Angus calves.

Friant Dam Construction Started

(Continued from page 290)

Valley especially are to be congratulated. Friant Dam is being started. Soon the canals that will carry the precious stored water from here to lands north and south will be begun. Within a few years we will be ready to arrest the creeping paralysis which has seized upon your agriculture and we will be able to grow good tissue on the scars. The 50,000-odd acres that today are desert because of the exhaustion of underground water will again be fruitful. A million acres of orchards, vineyards, and farms, now threatened by a similar catastrophe, will be saved. Your cities will remain great and will continue to flourish.

What has been accomplished here in California, and elsewhere, in the way of great public works illustrates the value of intelligent cooperation between the National, State, and local governments. Fortunately here in California you now have a resourceful and enterprising Governor whose thoughtful but practical liberalism takes the form of cooperating with the Federal Government in the conservation of our natural resources for the benefit of the people of his State. Your Chief Executive possesses both vision and the quality of leadership. Like President Roosevelt, Governor Olson knows that real conservation means neither the locking up nor the squandering of our resources. I am sure that his definition of conservation might be expressed something like this: Prudent use for the present generation while saving all that we can for those who are to come after us.

No public-spirited citizen who has the well-being of his country at heart can fail to agree with such a sentiment.

Construction of Drop No. 1 and Coachella Turnout, All-American Canal

By GORDON W. MANLY, *Associate Engineer*

BETWEEN the sand hills and the Imperial Valley, the slope of the ground surface along the All-American Canal is much steeper than the maximum permissible slope of the canal for the unlined earth section which was used. Consequently, in this portion of the canal, there is available a total head of 129.5 feet in excess of that required to maintain the flow in the canal. In order to fit the canal profile well to the ground, it was necessary to absorb this head in five drops.

The Coachella Canal (which has been described in the October 1939 issue of the RECLAMATION ERA) branches from the All-American Canal a short distance west of the sand hills. Since the logical locations for the first drop in the All-American Canal, and for the Coachella Turnout practically coincided, the two structures were combined in one reinforced concrete structure, located approximately 36 miles downstream from Imperial Dam. Drop No. 1 differs from the other drops in that the drop in the canal grade is much smaller (9.7 feet), and that no provision has been made for future power development.

The drop structure is designed for a discharge of 7,600 second-feet. The drop is accomplished by means of a 2.7:1 inclined chute with vertical retaining walls, discharging into a stilling pool. The bottom of the stilling pool is 15.7 feet below the bottom grade of the canal upstream from the drop, and 6 feet below the bottom grade of the canal downstream from the drop. From the bottom of the stilling pool, the floor of the structure slopes upward to the bottom grade of the canal, and is continued as a horizontal slab for 65 feet downstream from the stilling pool. Warped walls form the transition from the vertical retaining walls of the chute to the 2:1 side slopes of the canal. Energy dissipators are provided, in the form of high dentated steps on the downstream slope of the stilling pool floor, and a dentated sill at the downstream end of the outlet floor. Near the top of the chute is a check gate structure, in which five piers, connected by seal walls, divide the canal flow-way into four 16-foot 7-inch by 5-foot and two 14-foot by 5-foot openings. These openings are provided with four manually controlled, and two hydraulically controlled automatic, top seal radial gates. The center pier contains the float and weir wells for the automatic gates. The check gate structure piers support an operating road bridge across the canal, and a gate operating platform, on which are located the gate hoists. Power for the gate hoists is supplied by a motor generator set. The drop inlet transition extends 150 feet upstream from the check gate structure.

The Coachella Turnout provides for the diversion of 2,500 second-feet from the All-American Canal at a point immediately upstream from the drop-gate structure. The turn-out consists essentially of five 9-foot 6-inch by 10-foot rectangular barrels, extending through the right embankment of the All-American Canal. Top seal radial gates are provided at the inlet ends of the barrels. At the outlet of the turn-out, short warped walls form the transition to the normal Coachella Canal section. Adjacent to the downstream barrel of the Coachella Turnout is a rectangular barreled lateral turn-out with a capacity of 100 second-feet.

A cut-off wall of 36-foot steel sheet piling is provided at the upstream end of the drop inlet transition, and a similar cut-off of 10-foot steel sheet piling is used at the end of the drop outlet transition. Riprap blankets, 2 feet thick, protect the bottom and side slopes of the All-American Canal at the outlet of the drop, and of the Coachella Canal, at the outlet of the turn-out. At the inlet of the drop, the side slopes of the canal are protected by a 10-foot wide strip of dry-rock paving.

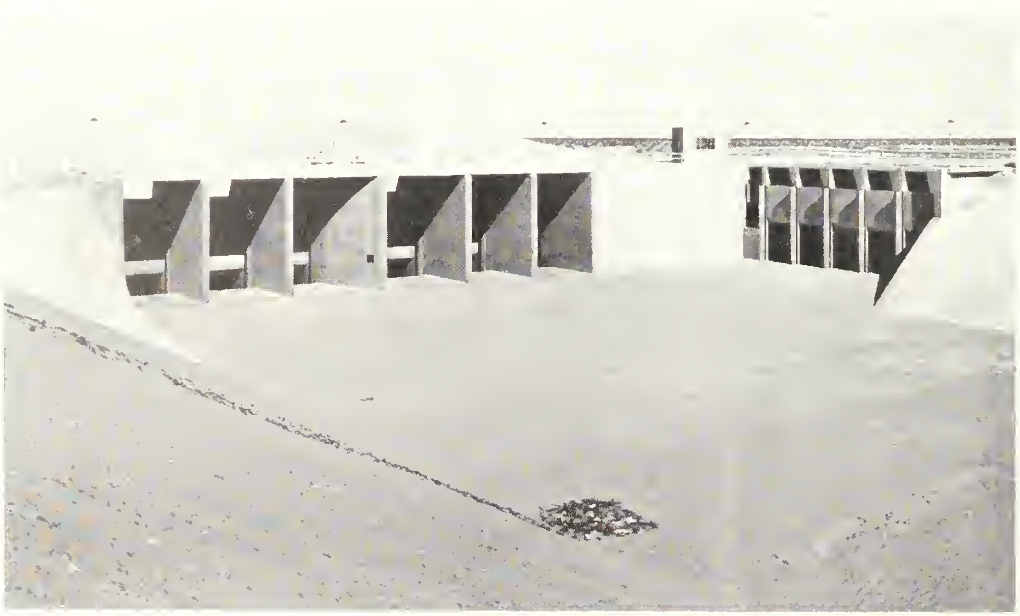
Horizontal reverse filters for the relief of uplift pressure are provided under the floor of the structure at the outlet of the turn-out barrels, at the drop stilling pool, and at the end of the drop outlet. Vertical reverse filters are used behind the retaining walls of the drop stilling pool and behind the outside walls of the turn-out barrels.

Throughout the structure, in both walls and floors, water seal expansion joints are used at rather frequent intervals. In these joints, the adjoining sections of concrete are separated by sponge rubber filler pieces, ½ to 1 inch thick, and the water seal is provided by molded rubber strips 6 and 9 inches wide, with half of the strip embedded in the concrete on each side of the joint.

The contract for the construction of Drop No. 1 and Coachella Turnout was awarded to the Lewis-Chambers Construction Co., of New Orleans, La. The principal quantities involved were:

Excavation	cubic yards	15, 440
Backfill	do	21, 159
Compacted embankment	do	1, 456
Compacted subbase	do	1, 369
Concrete	do	4, 969
Reinforcing steel	pounds	733, 723
Installing gates	do	79, 703
Driving steel sheet piling	do	251, 728
Installing metal pipe	do	56, 364

Inlet transition and drop and turn-out gate structures



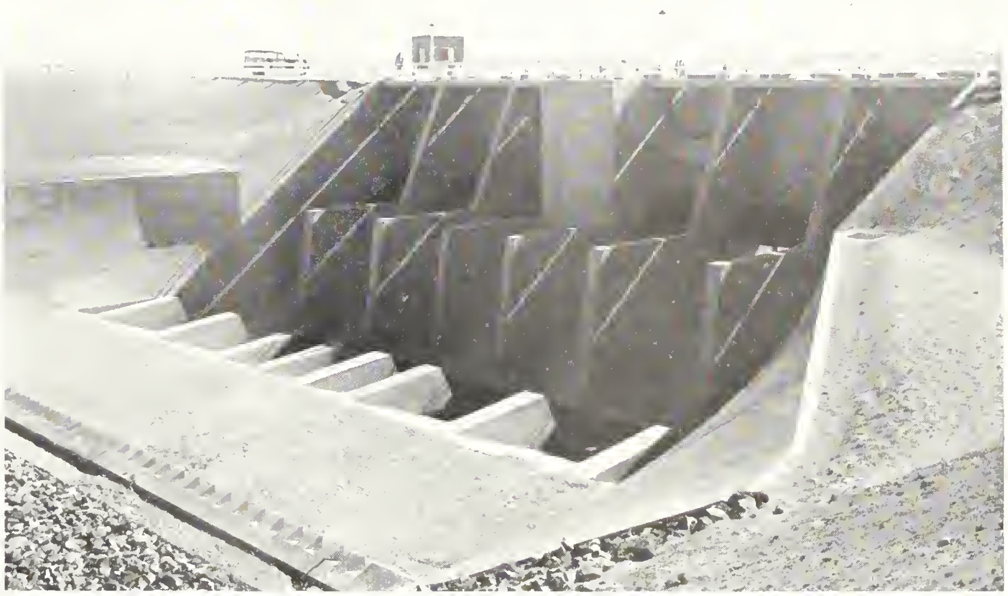
The excavation of the canal at the structure site was done under a previous contract. The remaining excavation required for the structure was done with draglines and bulldozers. The material was composed of loose sand, with occasional pockets of fine gravel. On other canal structures built on similar practically cohesionless material, considerable difficulty was encountered in preparing the subgrade, and in placing the reinforcing steel and concrete in the floor slabs and footings. To facilitate the placing of sound, well supported concrete in the slabs and footings of this structure, the specifications provided for the placing of a compacted earth subbase of 9-inch thickness on all excavated surfaces below original ground surface, upon which concrete was to be placed.

The material for the compacted subbase was a mixture of sand and clay, obtained from a borrow pit on the Pilot Knob Mesa, about 10 miles from the structure site. The dry material was hauled to stock piles at the structure site, and moistened in the stock piles. Compaction was obtained by tamping the material in two layers with pneumatic pavement breakers, equipped with circular tamping feet. Field tests showed that a density of about 120 pounds per cubic foot was obtained.

The compacted subbase provided a solid, stable subgrade, which could be trimmed accurately to grade, and which was not easily disturbed before or during the placing of concrete. Much work which the contractor would ordinarily have had to do in smoothing up, and regrading a sand subgrade which had been disturbed during the placing of reinforcing steel, and other operations subsequent to the original fine grading, and prior to the placing of concrete, was eliminated. The use of the subbase prevented the possibility of having areas of loose, bulked sand immediately under the concrete slabs. With sand subgrade, the concrete blocks, ordinarily used for supporting the reinforcing steel, tend to sink into the sand. The better support for the blocks provided by the subbase made it possible to place the reinforcing steel accurately to grade, with the assurance that it would remain at the proper elevation before and during the placing of concrete. It was also found that the subbase facilitated better vibration of the concrete, since the vibrator could be operated down to the bottom of the slab without danger of disturbing the subgrade. All of the difficulties ordinarily encountered in working on a sand subgrade are accentuated on sloping surfaces, and hence the subbase was found to be particularly valuable in such locations.

Concrete

The standard concrete mix used on the structure had a maximum aggregate size of 1½ inches and contained about 5½ sacks of cement per cubic yard. The average slump was about 3 inches. For especially thin, or inaccessible sections, a somewhat richer and wetter mix was used.



Stilling pool and outlet transition of Drop No. 1

The contractor's concrete plant consisted of a stationary 1-cubic-yard mixer and a gravity-feed batcher placed directly above the mixer. Aggregates were lifted into the 4-compartment batching hopper by a crane equipped with a clamshell bucket. The concrete was transported from the mixer to the forms by dump trucks and a crane using a 1-cubic-yard bucket. Rubber downspouts were used for placing the concrete in most of the walls. All of the concrete was internally vibrated with pneumatic or gasoline-driven vibrators. Forms were built of 1-inch sheeting, with 2 by 4 or 2 by 6 studding and walers. For all exposed surfaces the forms were lined with three-ply veneer.

The steel sheet piling was driven with a steam hammer. Considerable difficulty was encountered in driving the 36-foot piling in the bottom of the canal. Some jetting was attempted on these piles, but the contractor's water supply was inadequate for efficient jetting.

Stone for the riprap and dry-rock paving was obtained from natural deposits of boulders on the slopes of hills about 15 miles northeast of the structure site.

The construction of Drop No. 1 and Coachella Turnout was started in August 1938 and completed in July 1939.

Marshall Ford Contract Amended

BY ORDER of August 28 last, the contract for the building of Marshall Ford Dam, Colorado River project, Texas, was amended by Secretary of the Interior Ickes to provide for the commencement of the second stage of construction of a high flood-control dam.

The original contract, awarded December 3, 1936, called for construction of the so-called low dam at Marshall Ford, the first stage, a structure with a maximum height of 190 feet, which now is virtually completed. It was planned ultimately to enlarge the dam by widening the base and bringing the crest up to a maximum height of 270 feet above the foundation. This would provide a reservoir of a capacity of 3,120,000 acre-feet. Prior to completion of the low dam, the Congress last spring appropriated $5,000,000 to continue the work, looking toward completion of the second stage without interruption.

The Bureau of Reclamation, which is in charge of the dam, after considering all elements of the problem, recommended increasing the quantities of various items of work specified in the original contract in order to have the present contractor, who has the necessary plant and equipment on the ground, bring the full base of the high dam to elevations approximately the same as the crest elevations of the low dam. The principal additional work provided in the change order involves the pouring of about 325,000 cubic

(*Continued on page 317*)

Building Bartlett Dam

By E. C. KOPPEN, *Construction Engineer*

BARTLETT DAM on the Verde River, near Phoenix, Ariz., was finished on schedule last May after a 1,000-day construction period. Completion of this dam marks the culmination of the original plan for storage control of all streams tributary to the Salt River project. Other works of the Bureau consist of the Roosevelt Dam and power plant on the Salt River, diversion dams, hundreds of miles of canals, and a great multitude of structures for the irrigation of some 242,000 acres. This project is on the site of ancient irrigation developments conceived by pristine engineers and built with tools of stone. From the ashes of the old has sprung a new civilization.

Storage at Bartlett on the Verde brings a new stream into the picture. The capacity will be about 200,000 acre-feet. In operation, storage released from Bartlett or from the Roosevelt and other reservoirs on the Salt River will be diverted into the project canals at Granite Reef diversion dam, which is some four miles below the junction of the two streams.

Bartlett Dam is the highest multiple arch dam in the world. It has a maximum height of 286.5 feet and a total length of 800 feet, excluding the spillway. There are 9 hollow buttresses, 10 arches, and a short gravity section at each end of the dam. The spillway around the right end has a capacity of 175,000 cubic feet per second and consists of a curved and heavily banked, concrete-lined channel 170 feet wide and 550 feet long with 3 Stoney gates 50 by 50 feet along the crest at the upper end. Storage release at the higher levels will be through two 66-inch needle valves; river level release will be through three 6 by 7.5 feet slide gates. The total estimated cost of Bartlett Dam is $5,000,000. Work was begun in August 1936 and completed in May 1939.

Eighty percent of the construction cost and storage use is assigned to the Salt River Valley Water Users' Association and 20 percent to the Salt River Indian Reservation. Repayment under the 40-year plan is provided for by special contract between the United States and the association.

Bartlett Dam was built by the Barrett & Hilp and Macco Corporation of Los Angeles, who were the lowest of eight bidders. Serious delays were experienced from record-breaking floods in 1937 and 1938. A multiple arch dam is complicated indeed and poorly adapted to fast construction or the making up of lost time. However, the contractor finished the job on schedule and is to be highly commended for this and also for doing a fine job.

Bartlett Dam, Salt River project, Arizona, completed in May 1939

Topography and geology of the region.—Bartlett Dam is situated near the southern and lower limit of a mountainous region which extends some 200 miles to the north, approximately to the main east-west line of the Santa Fe Railroad. This region is traversed by the Verde River and numerous smaller tributaries. Most of the upper watershed is 4,500 to 7,000 feet or more above sea level. Nearer the dam the elevations range from 2,500 to 4,500. Below the dam the rough topography continues for some 10 miles, terminating abruptly in the flat-lying lands of the Salt River Valley.

Upstream from the dam for about 15 miles and especially within the reservoir area, the topography is roughly rolling with occasional steep cliffs near the river. The principal rocks in this area are the granites; higher up the principal rocks are the lavas and breccias. Here and there are scattered beds of gravel and conglomerate which were deposited by the river when flowing at higher levels.

The surface of the reservoir area and much of the adjacent country consists mainly of disintegrated granite with scattered, small areas of thin soil. Disintegration, or the breaking down of rocks, is common to the entire region and it is likely that these forces have penetrated to substantial depths. These conditions should be essentially favorable for a reasonably tight reservoir.

Geologic features.—The rock consists of two types of granite, fine and unusually coarse grained. The foundation for the dam, however, is contained almost entirely in the fine grain rock. The fine grain rock has a thickness of 400 feet or more and overlays the coarse rock. Above river level, disintegration is common to both the fine and coarse grain formations although it has progressed to greater depths in the coarse variety. Below river level a gorge has been eroded for a maximum depth of 70 feet in hard, sound rock. Here the river has cut through the fine grain rock and into the coarse formation.

In the foundation area the contact between formations is below river level and has a dip of about 27° in an upstream direction. The contact is tight and on the order of a fuzed zone some 2 to 4 inches thick. There are two principal fault zones which extend crosswise with the river; they are about 170 feet apart, roughly parallel, and both are nearly vertical. The presence of the downstream fault was known prior to construction, and it was suspected that there would be others in the buried river channel. From the early explorations it was concluded that there had been only slight, if any, movement along any of these faults; this was verified during construction.

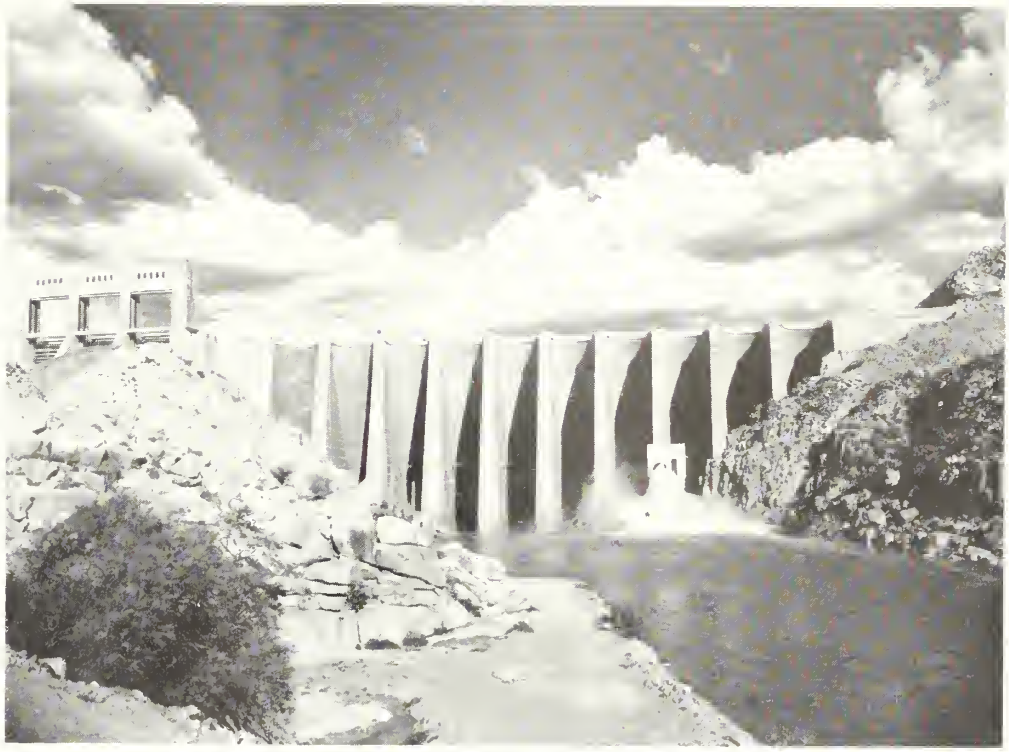
Fine grain granite.—In the footings for buttresses and arches, this is a hard, dense, mainly pinkish to grey colored rock with some evidence of slight alteration. The principal jointing dips about 70° to the left with strike nearly parallel to the river. The principal joint planes occur at intervals of 3 to 6 feet; they are mainly close-set and continuous for 20 to 40 feet or more. Cross jointing is common with some fracturing in the more weathered patches. Near-level jointing with dip of 8° to 10° downstream was encountered in the deeper part of the canyon. At higher levels and extending to perhaps 30 feet above river level are several slip planes which dip downstream at an angle of about 8°. Thinly sheethed rock and some crushed material was observed along parts of these planes, but there has been only slight, if any, movement.

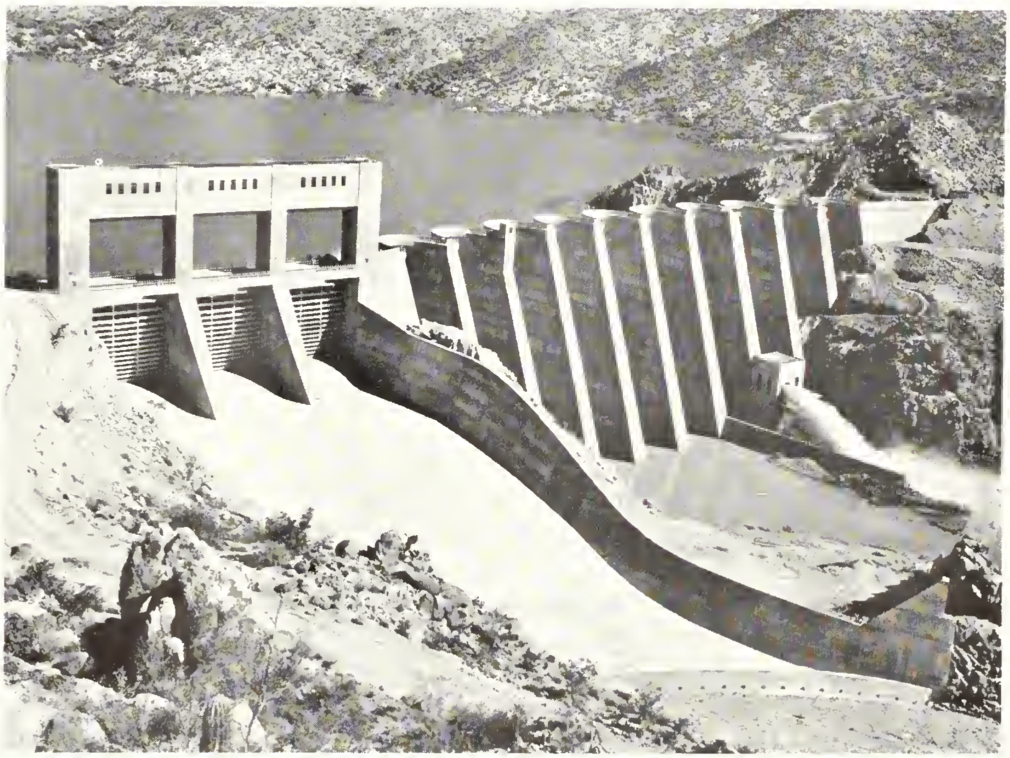
In the footings the fine grain rock is hard and sound, but there is some slight alteration—especially along the close-set joints, with thin stringers or fillings of gritty, altered products. There is also a tendency of the rock to break along incipient joint planes and here and there are small patches of closely fractured rock. Judging from the drill cores from the grout holes, however, this slightly altered condition disappears at some depth, the rock grading into the hard, fresh greyish granite.

Coarse grain granite.—Beneath the fine grain granite and also in the deeper part of the canyon, this is a hard, dense, greyish rock. It is structurally massive with widely spaced joints. It is an unusually coarse grain rock with large 1- to 2-inch phenocrysts of orthoclase and quartz. The down-river ends of buttresses 5 and 6 are based on this rock. Elsewhere, that is away from the deeper part of the canyon, the coarse grain granite has been appreciably altered and softened. It hardens some with depth but breaks up into small fragments when blasted.

Development of Foundation and Treatment

Location of dam.—The preliminary office lay-out for the dam was staked in the field during the exploratory work in the latter part of 1935. This location was shifted only slightly, the controlling points aside from the topography being the contact of the two rock formations on the left, the up-river rock promontory, and on the right side the fitting in of the down-river ends of buttresses and also the right gravity block with the foundation rock and also the topography. Some special fitting was required also for the spillway.





Bartlett Reservoir at elevation 1,728

Excavation.—An unusual amount of study and office development work was necessary to plan the lay-out for buttress and arch footings, particularly at the sides of the canyon. Fourteen to twenty lay-out drawings were required for each of the 10 arches. Excavation to sound rock was generally much deeper than expected. The deepest excavation is along the upstream cut-off. All of the arch footings were extended below closely fractured and appreciably altered rock. Footings for both arches and buttresses were shaped to roughly uniform slopes, steps and benches being avoided throughout. Some special shaping was done also for the right gravity section.

A large amount of excavation was required to shape the footings for the buttresses on the right side of the canyon. The situation here was complicated by the steep jointing of the rock with direction nearly parallel to the buttresses; also the need for maintaining approximately equal differences in elevation between the downriver ends of buttresses.

Storage in Bartlett Reservoir, 52,000 acre-feet

The precise limits of the excavation for upstream footings were often difficult to fix. There was not only the question of depth to suitable rock, but also the upstream limit of the excavation as governed by the sloping face of the dam. And adding to the difficulty was the requirement for uniformly sloping footings for the arches and also the need for certain minimum depths of arch footing concrete against the sides of the excavation. As the excavation approached final limits, the trimming was done by light shooting and by breakers and wedging. Prior to concreting, the rock surfaces were cleanly washed with water under pressure. Joint faces required sand blasting to remove the thin coating of gritty, mudlike altered products.

Faults.—The upstream fault was buried beneath the river fill and its presence was therefore not disclosed prior to construction. This fault traverses the footings for the eight arches to the left of the deep part of the canyon just upstream from the springing line. This fault dips about 70° in an upstream direction; the average width is about 24 to 30 inches. At the right end, however, it pinches to a width of about 3 inches and terminates in a similar 2-inch cross seam in the deepest part of the canyon.

The downstream fault is about 170 feet below and roughly parallel to the upstream fault; it has a dip of about 80° in a downstream direction. This fault passes out of the foundation area beneath the upside of the right gravity section, to the left it traverses all except the last two buttresses. This fault varies from 24 to 48 inches in width.

The faults are much alike. Commonly, the sides are roughly parallel, smooth and even and on the order of joint planes, but in places the rock at the sides is crushed. The filling consists of 1- to 4-inch sheeted rock. Near the surface the sheeted rock is broken and appreciably altered with occasional 1- to 2-inch sheets of mud; with depth the fault filling grades into firm, sound, unbroken sheeted rock with close-set joints filled with compact altered products.

There has been no special concern about these faults as regards future movement or with respect to support for the dam. They have, however, been a special problem as regards the prevention of leakage. In the footing areas the fault was commonly excavated 3 to 5 feet below footing level with breakers, the bottom of the excavation always being down to sound and unbroken, closely sheeted rock. Pipe for grout holes was placed at intervals of 5 feet along the upstream fault. These were later drilled and grouted to a depth of 25 feet. Where they passed out of the foundation area, shafts from 18 to 37 feet deep were dug into the faults and backfilled with concrete. Beneath the bottoms of these shafts the faults were grouted to a depth of 25 feet.

Primary grouting.—The principal avenues of possible water or grout travel are the joints in the foundation rock which have heretofore been described. Practically all of these joints are relatively close-set and more or less compactly filled with altered products; in other words, nature had already done a fair job of grouting. The faults, especially where they leave the foundation area, have likewise been viewed as avenues of possible water travel. In approaching the task of grouting, special consideration was given to the short contacts of concrete on foundation rock, the need for extreme caution in connection with the arch type of construction, and the steep, principal jointing at the sides of the canyon.

Primary holes were spaced at intervals of 5 feet along the upside of the arch footings and drilled fanwise, normal to the footings. Adjacent to the fault the grout holes were inclined upstream, the purpose being to place the grout curtain in front of the fault. Grout holes were drilled through 2½-inch pipe which had previously been spudded some 2 feet into foundation rock and extended through the concrete footings.

Grouting in arch footings was begun a few days after the footings had been poured and special efforts made to complete it before arch construction started. The grouting program was usually well along, the more important part always being finished, but commonly some part of the intermediate holes and occasionally the last stage on the alternate holes were not completed until after some progress had been made on arch construction. On the gravity sections grouting was done after concreting was well along. Across the spillway, grouting was done after the cut-off was poured but before the crest slab was placed. On the right end of the spillway gate structure, grouting was done before concreting, the outer slabs of sheeted rock being first pinned together with 1⅛-inch square steel dowels, 8 to 12 feet long.

Primary grouting was done in stages. In a group of holes, usually those for one arch, the plan was to first drill and grout alternate and intermediate holes to a depth of 12 to 15 feet. In the next step, alternate holes were drilled and grouted in three stages to 40, 70, and 100 feet, or to lesser depths at the sides of the canyon. Subsequently the intermediate holes were drilled and grouted to full depth in one stage.

Grout holes were 1⅜ inches in diameter and were drilled with diamond rigs. All drilling was done under subcontract by the Diamond Drill Contracting Co. Core recovery was good and gave much essential information. All holes or stages were tested with water prior to grouting; no special attempts were made at washing. Standard cement was used throughout; grout mixtures ranged from one part of cement to 1 to 5 parts of water by volume. Grouting was done with a duplex piston displacement pump with 3½-inch pistons and 10-inch stroke. Pressures during the feeding of grout were maintained as uniformly as possible by controlling the power input to the pump; variable resistance to the travel of grout, therefore, caused merely a slowing or speeding in the rate of pumping. Feeding pressures ranged from 125 to 175 pounds with final maximum pressures of 250 to 350 pounds; the latter pressures, however, were on for only a few minutes.

There are 351 primary holes with total length of 25,680 feet and consumption of 20,230 sacks of cement. About two-thirds of the holes required less than one-half sack of cement per foot, 44 holes required from one-half to 1 sack, and 72 holes required from 1 to as high as 10 sacks per foot. The more open holes are in the deeper part of the canyon. A level party was in constant attendance during grouting to keep a careful check for uplift. This was good insurance; no appreciable uplift occurred anywhere on the job.

Secondary grouting.—The secondary holes were directed toward consolidating the rock at the arch groins and also the sheeted rock in the faults. Others were interspersed with the primary holes and drilled into prominent seams or areas of close sheeting. There are 302 of these secondary holes with total length of 8,010 feet and cement consumption of 4,220 sacks.

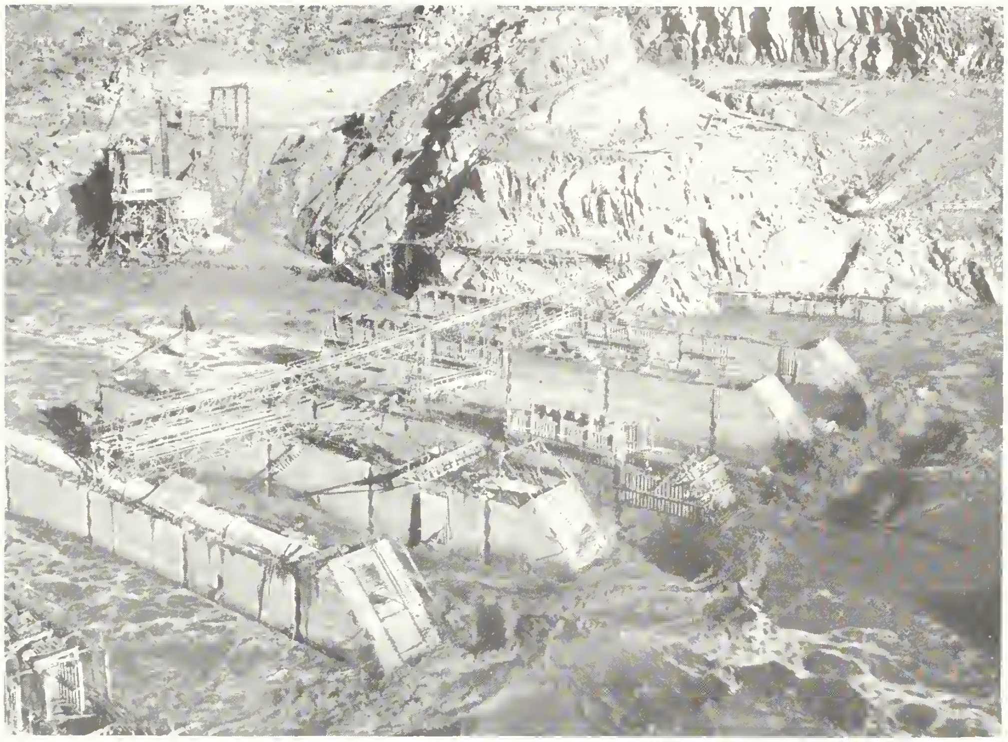
Secondary holes are mainly 25 feet deep, except a group of 50-foot holes on the left side of the canyon. Except in a few instances, grouting was deferred until all nearby primary holes had been grouted to full depth. And because of this prior grouting, most of the secondary holes were relatively tight.

In general the procedure in secondary grouting was similar to that used for the primary holes except that grouting was done in one stage to full depth. Pressures, however, were substantially reduced because most of the secondary work was done after arch construction had started. Grout feeding pressures ranged from 50 to 80 pounds per square inch with final maximums around 150 to 200 pounds.

Abutment drainage.—Provision for drainage under the gravity sections was made in the specification design for the dam. Drainage holes were drilled just behind the grout curtain at intervals of 10 feet. The holes are $2\frac{1}{8}$ inches in diameter and extend 25 feet into rock. Outlet for drainage is provided by a system of connected metal piping which was embedded in the concrete.

However, added provision for drainage was thought advisable because of the steepness and direction of the jointing in the abutment rock. These joints are spaced at intervals of 3 to 6 feet, are mainly close-set and filled with altered products, yet they may be sufficiently open to permit the entrapment of seepage under pressure. To relieve and perhaps eliminate the possibility of pressure on these steep joint planes, a number of 3-inch drain holes have been drilled into both abutments.

Modification of spillway.—The lower end of the spillway was modified because of the deeply disintegrated condition of the coarse-grained granite. The present arrangement, especially the direction of the terminal cut-off, takes advantage of better rock conditions at the right end and also at lesser depths all along. The aerated bucket at the lower end is designed to force the swiftly moving water to leap clear of the concrete lining and thus prevent, or at least greatly retard, the excavation of the weathered and softened rock adjacent to the cut-off.



Passing the largest flood of record, March 4, 1938, 100,000 second-feet

Engineering and Lay-out

The field and office engineering was intensely complicated throughout. The arches, especially the lay-out for the footings and the partial arches, required a large amount of study. Even a brief outline of the detail work, studies and drawings required for the dam and spillway would perhaps be out of place here. The following is confined, therefore, to only some of the principal high lights.

The plan of the dam is on a curve with radius of 1,379.7 feet. Buttress center lines are perpendicular to the axis of the dam and are spaced at intervals of 60 feet. They are not parallel but diverge from each other at an angle of 2°30′. The upstream face slabs and also the arch intrados is on a slope of 0.9 to 1. Arch spans are uniform throughout at 48 feet; similar uniform spacing between buttresses obtains also in any plane parallel to the upstream face but the spread or distance shortens downstream. Upstream face slabs, upstream ends of buttress walls and also the arches all have the same thickness, varying from 7 feet at spring elevation 1,540 to 2 feet at 1,795.5. Outer buttress faces taper vertically and horizontally downstream, the walls being of uniform thickness only in planes approximately normal to the upstream face. Inner faces of buttress walls are vertical with constant spacing of 8 feet. The arch intrados is a cylinder with central angle of 180°, the extrados is a cone. The downstream slope is 0.36 to 1.

The walls of the canyon at Bartlett are perhaps unusually steep for a multiple arch dam. Partial arches were necessary for 9 of the 10 arches, in one case reaching a maximum height of 77 feet. These conditions caused extreme complications in the problems of design, lay-out, and construction.

All concrete except that in gravity sections and footings is reinforced. In the arches both circumferential and longitudinal steel is provided at both faces, the partial arches requiring, of course, considerably more than the full arches. All arch reinforcement was spliced into the footings with dowels. Buttress reinforcement, diagonal and vertical, was placed only at the outer faces; the upstream face slabs are reinforced for water load.

An extraordinary amount of preliminary study was necessary before the actual lay-out drawings for construction could be prepared. Basic data, such as arch thicknesses in three directions; the values of the various angles, offsets, and stations of points on both surfaces of the arch at all elevations; also tables of angles and distances had to be computed and formulas developed for use in determining the many variables for laying out the work.

Closely spaced points around the arch barrels were required for construction. For this purpose, segments corresponding to one-thirty-second of a circle were selected and designated as one-eighth points in each quarter or from spring to crown. These were laid out on level, radial lines passing through the corresponding one-eighth points for the intrados and extrados. The centers of measurement shifted downstream with elevation and as a consequence the footing or cut-off excavation for the partial arches resembled fishhooks more than ellipses.

The final drawings for an arch footing could not be prepared until the excavation was nearly completed when 14 to 20 drawings had to be prepared quickly. How to prepare lay-out drawings for the closely spaced reinforcement steel dowels just inside of the trace of the arch on a steeply sloping and imaginary concrete footing so that they could be readily understood by a gang of carpenters was indeed a problem. The extrados string of dowels sloped with the face of the arch and the intrados string was vertical to fit the fillet on the down side. After several methods were tried the most workable provided for the lay-out of a complete template constructed in place at footing level for each arch. These were built while final clean-up of foundation rock was in process, grout holes being located and pipe being spudded in, and much other work was being done in a very small area.

Construction

Quantities.—Principal quantities are as follows:

Earth excavation____cubic yards__	195,000
Rock excavation___________do____	233,000
Grout holes__________linear feet__	34,000
Cement for grouting________sacks__	24,500
Concrete __________cubic yards__	181,500
Reinforcement steel______pounds__	6,700,000
Structural steel__________do____	2,760,000
Hoists, etc________________do____	540,000

The above is only a glimpse of the multitude of intriguing mathematical problems that were encountered. A continuation would be uninteresting to most persons who will read this story and it will perhaps suffice, therefore, to say merely that the problems of detail design and lay-out taxed the ingenuity, patience, and other attributes of engineers and workmen to the extreme limit.

Program.—The first part of the contractor's operations provided for stripping on the canyon walls, rough excavation for buttress footings, and also roughing out the spillway excavation. Next in order and overlapping the stripping was the unwatering of part of the river bed to permit the construction of several buttresses on the high part of the canyon floor on the left side. Beyond this the early plan provided for a sequence of operations which were calculated to finish the job some 6 months ahead of schedule. However, two large floods interfered with this program, and the contractor was required to modify his plans several times. Work was begun on August 26, 1936, and completed May 9, 1939.

Handling of river.—The first cofferdam was in the middle of the river with suitable connections at the ends, the idea being to crowd the stream to the right side to permit the hauling away of stripped material and the construction of buttresses on the left side. This worked very well, but deeper than expected excavation and heavy seepage through the river gravels delayed the work; moreover, the flood of February 1937 interfered with this plan. Cofferdams were next constructed across the river above and below the site, the small flow of the river being diverted into a pipe between the partially completed buttresses on the left side. Excavation operations were then begun in the entire river canyon. This plan of diversion simplified the handling of seepage but was hazardous because of the restricted capacity of the diversion pipe. A small rise occurred in the river on July 9 and again flooded the work, but in a few days the work was resumed on this plan and the key buttress and training wall completed to a safe height. This gave a flood capacity of about 15,000 second-feet around the left side and work was then begun in earnest in the main part of the river canyon, but several months behind schedule. By careful coordination and vigorous effort the work in the main part of the canyon was completed to above or just below river level prior to the big flood of 100,000 second-feet in early March 1938. This flood caused some further delay. Subsequently the small flow of the river was diverted from side to side without further incident.

Effect of delays.—The total delay of some 6 months was of itself not serious. However, there were several specification provisions which made it practically impossible for the contractor to make up this lost time. Alternate arches only could be built at any time; intermediate arches could be built only from October to May. Contraction joints in the buttresses could be filled only after 90 days. Still another requirement was that concrete could not be placed when the temperature of the materials exceeded 95°. These provisions, together with the delay that had already occurred, made it impossible to finish the job on the scheduled date of May 9, 1939. The contractor needed more winter time on arch construction—in other words, from October to May. All of this meant that the work could not be completed until early 1940.

Requirements modified.—At the urgent request of the contractor the Denver and local offices studied ways and means to satisfy requirements so that the work could be finished as scheduled. Temperature control of concrete, of course, was the answer. And temperature control in the hot summer climate of Arizona is not a simple problem, but a helpful feature is the relatively low humidity and the resulting wide difference between dry and wet bulb temperatures. Commonly when air temperatures are 110° or more, wet bulb temperatures stand at 68° to 74°. This condition has made possible the development and wide use of the desert cooler for the comfort of Arizonians; it employs the principle of cooling by evaporation. The problem was solved by a system of fog-spray nozzles for all recently placed concrete. Nozzles were placed about 30 inches away and in this distance the ordinary water temperatures of around 90° or more were reduced to about 72° and approximately this latter temperature was maintained as the

Bartlett Reservoir in service

thin sheet of water flowed over the concrete. Placing temperatures were held to a maximum of 88° by spraying stock piles, by using spray-cooled water for mixing and by wrapping the concrete delivery pipe with burlap and spraying.

With continuous fog-spraying, the setting heat of the concrete in arches and buttresses was dissipated and the temperature reduced to just above wet bulb in 12 to 18 days after placing, depending on the thickness of concrete. This arrangement made it possible to build adjacent arches, the only requirement being that they should be staggered two lifts or about 2 weeks to permit proper cooling. By a similar process the contraction joints in buttresses were filled in 2 weeks. This offset the delay from floods and related causes and made it possible for the contractor to finish the work on schedule.

Forms.—The type of form to be used presented an important problem to the contractor. The thinning of the arches with elevation and the thinning of the buttresses, both vertically and horizontally, presented not only problems in form design but also as regards cost because of the large reduction in concrete quantities at the higher levels. Some small amount of experimenting was done with wood forms. Structural steel forms, however, were used for nearly all buttresses above footing level and also for all full arches.

Arch forms provided for a lift of 15 feet measured along the upstream face of the dam. Construction joints were perpendicular to the upstream face. Intrados forms were made with a 1/4-inch steel skin-plate shaped to a radius of 24 feet; this was backed by I-beams and three trusses placed normal to the arch. In moving, this form was first lowered to a carriage which operated on rails attached to the adjacent buttresses. The extrados forms were also made with a 1/4-inch face plate; these were backed with I-beams rolled to an average radius. Narrow panels were removed at the springing line as the radius decreased. During concreting the forms were fastened at the ends by cone bolts; similar smaller bolts were provided around the arch. The intrados forms weighed about 36 tons and the extrados forms about 26 tons. The forms were raised by hand hoists at the ends and crown, the crown hoist being operated in connection with an A-frame which was temporarily erected atop arch concrete.

Buttresses varied in length from a maximum of 334 feet to a minimum of 4 feet at the top. These forms were built with a 3/16-inch steel skin plate backed by steel channels and angles for lifts of 10 feet. The outer walls tapered vertically and also horizontally; the inside walls were vertical with a constant spacing of 8 feet. These forms were complicated by the cross walls at intervals of 20 feet, the saw-tooth contraction joints at intervals of 41.5 feet, and also by the slopes at the up- and down-stream ends. Buttress forms were tied across with rods and cone bolts. These forms were raised with a 10-ton cableway, the outer forms in panels of 40 feet and the inner forms in sections of 20 feet. The cableway was fixed at both ends; side or lateral movement was provided by auxiliary parallel cableways.

The forms for partial arches, buttress footings and gravity sections were built of timber, faced with plywood. The intrados forms for partial arches were shored against foundation rock or timbers bolted to the buttresses. Extrados forms were commonly supported from the intrados form. Along the arch the forms were cone-bolted to anchors set in previous concrete. For the gravity sections the forms were made up in panels 5 by 10 feet. For the spillway side walls the metal buttress forms and also wood forms faced with plywood were used; anchoring was by steel dowels into rock.

Concrete plant.—The aggregate processing plant was located in the river bed about one-half mile below the dam. Pit-run material was loaded by dragline into 3-yard trucks which dumped into a hopper feeding a conveyor belt. Fine blending sand was added at the same point. Material was first conveyed to a grizzly, the reject returning to a crusher and again to the conveyor. Material passing the grizzly was conveyed to double shaker screens, being spray washed as it entered the screen. The sand passed through a drag-type washer. Screened and washed aggregate was conveyed to stock piles atop a tunnel composed of old steel forms. Dump trucks were loaded through gates in the roof and sides of the tunnel.

The batching and mixing plant was located on the right side of the river and about 100 yards below the dam. About 80 percent of the concrete was distributed by pumping through 8-inch pipe lines to various parts of the job. At the point of placement the pipe discharged into hoppers from which it was taken to the forms by hand buggies. For some of the larger pours in buttress and arch footings and for the spillway lining, the concrete was handled in 2-yard bottom-dump buckets by truck and placed by derrick or portable crane.

At the lower levels the mixer discharged directly into an agitator hopper at about elevation 1,640 for delivery by pump. This pump was of the dual type with a rated capacity of 60 cubic yards per hour. Concrete was delivered through a Y connection to a single line of pipe. For the higher levels the pump was shifted to a point adjacent to the dam at elevation 1,760, being supplied from the mixer by buckets and inclined cableway. Deliveries were made to points from 200 to 1,000 feet away from the pump with an average of about 600 feet and to levels as much as 80 feet below and 100 feet above the pump. Rate of delivery under good conditions was about 50 cubic yards per hour, which, of course, was reduced when pumping to high levels.

Spillway gate structure.—This structure is 136 feet high above spillway crest. It is equipped with three structural steel gates 50 by 50 feet, weighing about 200 tons each. On two other big gate jobs on the project, the gates were built in the up position; as a result of this previous experience, however, it was decided to build the Bartlett gates 10 feet up from the down position. Building the gates near the down position made the work easier and permitted a greater degree of accuracy. It also developed some new problems. Fairly elaborate provision was made for the accurate alignment of guides, end seals and track bases and holding them in place during concreting. This resulted in a high degree of accuracy and in smoothness of operation. Another feature was the use of steel girders to support the hoist-house beams and counterweights during concreting, thus eliminating high shoring.

The three gates were erected in about 60 shifts by the Allison Steel Manufacturing Co., of Phoenix, under subcontract. Concreting of the piers and side walls was begun as soon as end riveting was complete. Wood forms faced with plywood were used throughout; concrete was delivered by pumping. The large hoists for operating the spillway gates are located in the house atop the gate structure. Power is supplied by two 35-kilowatt generating units driven by gasoline engine. The large gate hoists are operated by 7.5-horsepower motors; the lifting speed is about 4 inches per minute. The generating units also supply power for the slide gates and for lighting.

Concrete Control

Cement.—Elimination of cracking in concrete was of extreme importance. Low-heat portland cement was therefore used for about 97 percent of total concrete. This cement, when combined with water, develops setting heat more slowly and also in much lesser volume than standard portland. Cracking was almost entirely eliminated. Low heat cement also develops strength less rapidly but is approximately equal to standard portland after a few months. A small amount of modified portland was used during the early part of the work.

Aggregate.—The sand and gravel involved many different kinds of rocks. The gravels consisted chiefly of basaltic lava and quartzite; the sand was mainly quartz and feldspar. Specific gravities averaged about 2.70. The deposit was high in sand which caused considerable waste. In general the sand was too coarse and required blending to the extent of 20 to 30 percent with a fine sand obtained from a deposit about 3 miles downstream.

Sieve analyses were made at the processing plant and also at the batching and mixing plant. Aggregate was relatively clean but was washed to secure adequate separation. Gravel was divided as follows: 3/16 to 3/4 inch, 3/4 to 1 1/2 inches, and 1 1/2 to 3 inches.

Concrete manufacture.—All materials, including the three sizes of gravel, sand, cement, and water, were weighed by individual weigh batchers. The weighing equipment was automatic with full reading dial scales of the double-pendulum type, an autographic recorder, a consistency meter of the wattmeter type, and a 2-cubic-yard mixer. Specifications required that the inaccuracies should not exceed 1.5 percent for water and cement and 2.5 percent for each separate aggregate. The results obtained were well within these limits.

Final sieve analyses, moisture content determinations, and slump tests were made in a small laboratory near the mixer. Sieve analyses were made at intervals of 2 hours. Slump tests were made for every 100 cubic yards and oftener when changes in consistency occurred. Average sieve analyses for several thousand sand samples are as follows:

Sieve sizes	*Cumulative percent*
4	1.9
8	13.2
14	31.4
28	56.9
48	82.2
100	95.2
Pan	100.0
Fineness modulus	2.81

Typical mixes, percentage of total concrete, and average slumps are as follows:

Gravel (inch maximum)	Mix proportions by weight				Percent of total	Slump
	Water	Cement	Sand	Gravel		
						Inches
3	0.58	1.0	2.55	4.90	92.8	3
1½	.58	1.0	2.40	4.00	6.5	4
¾	.58	1.0	2.45	3.23	.7	4½

Concrete handling.—Internal vibrators of both air and electric types with r.p.m. of 7,500 were used for concrete compaction. Arch construction joints were wet sandblasted immediately after the top forms were removed. Other construction joints were cleaned by jets of air and water applied at high velocities and then covered with about 1 inch of sand. In the foundation footings all joint faces were cleaned by sandblasting.

Curing.—All concrete was water cured. The common method of application was through perforated ½-inch pipe, supplemented with hand hose. During the summer of 1938 and to expedite certain parts of the work, curing water was applied through fog spray nozzles as previously described.

Considerable experimenting was done to determine the effectiveness of various water curing methods on the dissipation of setting heat. It was found that the thinnest practical sheet of water applied to the vertical walls of buttresses by perforated pipe acquired close to wet bulb temperature in a height of about 20 feet. With fog spray nozzles properly spaced and about 30 inches away, water was applied to the face of concrete at a temperature about 2 degrees above wet bulb temperature. It was found also that there is a wide variation in the results obtained with different types of nozzles.

Cracks in dam.—When modified portland cement was used at the beginning of the work, hair-line cracks occurred at about the third points on each 40-foot buttress section; this type of cracking, however, was eliminated entirely by the use of low-heat cement. Two small shrinkage cracks occurred in the gravity section and two similar cracks in the terminal arch on the right side, the latter being near the junction of the partial and complete arches.

Testing.—Control specimens 6 by 12 inches were made for each placing of concrete. The common test ages were 7 and 28 days. A number of specimens were broken at ages varying from 1 to 14 days, to provide information for form removal, etc., and others were set aside for longer term breaks. Aside from a part of the early age specimens that were field cured, all specimens were water-cured in the laboratory at 70° F. The strengths obtained for a number of the test ages are presented in the accompanying table, all concrete manufactured with low-heat cement.

Bartlett Dam in Service

Unseasonal and relatively small floods early in September gave the dam its first baptism and opportunity for service. This occurrence was especially timely and did much to offset an extremely short water condition. Maximum storage amounted to 52,000 acre-feet; the capacity is 200,000 acre-feet. The water level rose to elevation 1,728; ordinary river level is 1,608, and the top storage level is 1,798; in other words, the water was 120 feet deep against the upside of the dam with 70 feet to full reservoir level.

Inspection disclosed practically dry foundations adjacent to the downstream side of the dam. One of the 3-inch special holes drilled for abutment drainage on the left side discharged at the maximum rate of three gallons per minute; three drainage holes barely dripped water, the others were dry. There was no leakage through, or wet spots on, the downside of any of the 5 arches which were constructed from late 1938 to early 1939. Wet spots were observed at scattered points at the construction joints of other arches and also at intervals along the springing lines, but the leakage was sufficient only to keep the concrete wet for a few feet. All of these wet spots will perhaps seal and dry up in a few weeks.

Age	Number of specimens	Average compressive strength, pounds per square inch	Percentage of specimens within percent of average	
			10 percent	15 percent
7 days	625	1,450		
28 days	734	3,440	68	90
90 days	156	5,110	77	90
6 months	37	6,100	69	92
1 year	58	6,440	94	98
2 years	3	7,030		

Kittitas County Weed Program

By W. O. PASSMORE, *County Agent, Kittitas County*

S. C. SALMON, Agronomist in Charge of Weed Research for the Bureau of Plant Industry, Department of Agriculture; L. M. Pultz, Plant Physiologist in Charge of Weed Research at Cherokee, Iowa; and C. I. Seeley, in charge of the Weed Experiment Station at Genessee, Idaho, recently made an inspection tour of Kittitas County to investigate the program of weed control being carried out. They were highly enthusiastic in stating that the program is effecting real progress in a sensible and effective way. Their enthusiasm included not only the prevention of seeding in agricultural areas but the "exceptional results in watershed control work." Mr. Pultz was quoted as telling Kittitas residents: "If you don't get support to carry out the program as it is started, you are missing a golden opportunity to get rid of weeds."

A description or explanation of the program eliciting such favorable comment should begin with the statement that Kittitas County is weed-conscious and determined to do something about weed infestation. The farms are not more weedy than those of other areas, but because Kittitas farmers like their locations, realize they can no longer move off to other uninfested lands, and appreciate the seriousness of losses resulting from weeds, they organized and are fighting their principal weed enemies. Individual efforts had been made for years but had failed to check the spread of perennial root stock weeds.

The Kittitas weed-control program is based on the theory that landowners and operators are entitled to protection from infestation coming from beyond their own property but that they are primarily responsible for control and eradication efforts on lands which they own or operate. Owners and operators as used here mean not only individuals but corporations, cooperatives, and governmental agencies—any authority enjoying the use of jurisdiction over land. Benefits to the landholder vary with its type, location, and use. This fact has been recognized both in the Washington State weed laws and in the Kittitas program.

Washington's weed laws are enabling acts—each of the two provides a means of organizing communities, counties, or larger areas for weed-control work provided the people involved want such work. They do not attempt to force weed control upon that part of the State which does not feel that the benefits make a cooperative program desirable. The 1929 or Weed District law provides for organization of agricultural lands but excludes range logged-off and grazing lands. The Weed District regulations are made and enforced by three resident landowners and it is financed by a levy on property in the district for that purpose.

Program Started in 1931

It was under this law that the Kittitas program was started. More than 50 percent of the acreage had to be signed up by the owners on petitions for district organization. In spite of estimates that it would cost 7 to 10 cents an acre to operate the district and supervise only the prevention of seed production, two districts, 7,500 and 22,000 acres, respectively, were organized in 1931 and two more of 34,000 and 47,500 acres in 1932. In 1935, 20,000 acres were added to the first small district and in 1936 the "Upper County" was organized with 48,200 acres included. These districts included all of the Kittitas County which could come under the 1929 law, a total of 179,200 acres.

Weed District regulations have required only that the selected weeds, mainly rootstock perennials, be prevented from seeding. Weeds included in the rules are: Canada Thistle, Perennial Sow Thistle, Russian Knapweed, Hoary Cress, Siberian Mustard, Blue Flowering Lettuce, and Wild Snapdragon. Regulations are enforced by one to five inspectors in each district. Where the rules are not followed, inspectors have authority, after giving notice, to have the weeds destroyed, and the cost is charged against the land along with other regular taxes. Because of good cooperation the district costs have been only about one-third of the original estimate. The weed district levy has varied from 0 to 1 mill, averaging about one-half mill per year.

As leaders realized, control in the agricultural lands was not enough to check the spread of weeds there. The range cut-over and forest land was infested with many weeds which the districts were fighting and this infestation was increasing almost as fast as that on the farm land. Winds, irrigation, and floodwater and the movement of livestock from the farms to these areas and back carried seed from nonagricultural to agricultural lands. The 1937 weed laws, a part of the Kittitas program, were designed to meet this situation as well as overcome several other defects in the 1929 law. The method of organization was simplified and it was made to apply to any lands regardless of type or use. Rules and regulations are made and enforced by the Board of County Commissioners and work is financed by a general county levy. Provision is also made for cooperation of other agencies.

The cost of preventing seed production is specifically left to landowners but the cost of eradication methods are divided. On noncropland 75 percent is paid by the County Weed fund while on cropland the share of the landowner may be raised to 50 percent owing to the greater benefit accruing to him because of the work. The weed districts were maintained to give farmers final approval of operations affecting their cropland and because they could finance and continue their district program even though an unsympathetic Board of Commissioners should fail to finance the area work.

Watershed Control Work

Under the 1937 law, the Kittitas County Weed Extermination Area was set up with boundaries coextensive with those of the county. Weed-control work was started under this new law in the fall of 1937 and was restricted to county roads and noncropland in the watershed. Both prevailing wind and streamflow is from northwest to southeast in Kittitas County, consequently watershed work was started in the extreme northwest and moved southeasterly by drainage units. Each year the area previously covered is rechecked and the clean-up extended as far as possible. The Statement of Policy adopted by the Board of Commissioners is quoted below:

"It is our declared policy: 1. To strengthen and support the work of the weed districts in checking the spread of nearby infestations and making individual eradication work feasible; 2. To provide protection against further spread and infestation of noxious weeds not generally distributed throughout the area; 3. To start chemical treatment on noncropland of those noxious weeds which are causing serious loss or damage beginning in the northwest end of the county, working in the direction of prevailing winds and water, and using drainage basins as units of operation, and continuing in a general southeasterly direction as far annually as available funds will permit; 4. No program is contemplated on cropland until the infestation on noncropland and water courses is under control; 5. With the establishment of a regular weed-control budget under chapter 194 of the Session Laws of 1937, landowners will be assessed one-fourth of the cost of eradication and control operation performed on their noncroplands. Supervisory and location or survey work shall be a general charge prorated against all areas treated; 6. Cooperation of the Forest Service and of the State of Washington as well as private landowners is solicited in carrying out this program; 7. Areas treated will be posted and owners, lessees, or occupants notified."

Sodium chlorate was selected as the most practical material to use on noncropland. Approximately 25 tons have been used annually beginning in 1937. The fire hazard and stock poisoning are objectionable, but are largely overcome by treating in the fall after wet weather sets in. Used dry after cutting weeds and removing top growth, sodium chlorate has proven very satisfactory and efficient in the watershed work. Used at 3 to 5 pounds per square rod, it has given a kill of 90 percent or better in all but one or two locations on Canada thistle and wild morning glory. Other weeds will be dealt with as the program continues.

Along the county roads chlorates are usually sprayed on, beginning about the first of June. Some effectiveness is sacrificed to avoid the expense of cutting to prevent seeding. The State highway department has sprayed the noxious weeds along their rights-of-way with Pentox during the summer and is using some chlorate spray in the early fall. The cost of such work is rapidly decreasing after the first treatment and should not exceed that of preventing seeding by cutting within a 3 year period.

Results of the program would be difficult to measure accurately. Up until the current season the most optimistic could only say that the spread had been retarded. This year careful observers generally feel that the peak is passed, that some reduction has been accomplished, and that definite improvement will follow. Those familiar with irrigation farming realize that it makes weed control much more difficult than under nonirrigated conditions. What success has been secured in Kittitas County has resulted from excellent cooperation of all agencies and individuals—farmers; landowners; city, county, and State officials; irrigation districts and companies; railroads; and the United States Forest Service. The agricultural conservation program has also helped through payments for weed control on cooperating farms. It is felt that the program of preventing seed production, cleaning the watershed and progressive eradication on individual farms is fundamentally sound and will succeed. Efforts are being made to improve methods and technique as fast as information is available.

Peaches Shipped From Grand Valley

SHIPMENTS of peaches, for which acreage water is supplied almost entirely by the Grand Valley project, were made from Mesa County during September. Trucks moved 10,913,682 pounds, or a carload equivalent of 454 carloads, making a total of 1,902 carloads of peaches shipped.

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Activities at Grand Coulee Dam Columbia Basin Project, Washington July 1939

Acquisition of rights-of-way.
Aggregates, concrete, preparation.
Appraisal of lands and water rights.
Boats repaired and operated.
Building construction, concrete.
Cement purchase and blending.
Cemetery removal.
Clearing of reservoir site.
Concreting record of 2,500,000th cubic yard on July 24th—yard every 5.2 seconds.
Diamond drilling of sites.
Exploration by shafts.
Fish control and transportation.
Gates, outlet, installation.
Highway relocation.
Land classification.
Mapping of irrigable lands.
Penstock fabrication.
Railroad relocation.
Retracement surveys.
Topographic surveys.
Townsite operations.
Tunnel construction.
Water supply operations.
Water system, purchase.

Marshall Ford Contract

(Continued from page 307)

yards of concrete in a block 52 feet thick and 80 or more feet high along the upstream face of the low dam.

Other work involved includes installation of outlet pipes, placing of control gates, removal and reinstallation of trashrack structures, etc. The work covered by the change order is estimated to cost approximately $2,574,000.

The contractor is allowed 230 calendar days in which to complete the new work.

When this job is completed the work of raising the entire dam something more than 70 feet will be required in order to complete the high dam.

Marshall Ford Dam is one of a series of structures comprising the Colorado River of Texas flood-control and power project. Only Marshall Ford Dam, the principal flood-control structure, is under the jurisdiction of the Bureau of Reclamation. The other units are under the jurisdiction of the Lower Colorado River Authority, a Texas agency.

The high dam at Marshall Ford is considered essential to adequate control of the Colorado River of Texas, a particularly dangerous stream, subject to quick floods of great heights.

Minidoka Project Has New Courthouse

A NEW courthouse costing $118,000 has been completed at Burley, Idaho, and is ready for occupancy. This building is thoroughly modern and one of the most commodious structures of its kind in southern Idaho.

Boulder Dam at Work

DURING the week ending September 9 last a 35-year record rainfall of more than 4½ inches occurred in the Arizona and California deserts south of Boulder Dam, when the efficacy of Boulder, Parker, and Imperial Dams was put to the test. Although Parker and Imperial Dams were not built primarily for flood control, they proved their present effectiveness in the control of the dangerous Colorado, which otherwise would have become a raging flood, repeating the disasters experienced in many previous years.

A late summer rain, a most unusual occurrence along the lower Colorado River, on September 4, 5, and 6 reached cloudburst proportions over a wide area at 2 a. m. on Tuesday morning. The rain was largely confined to the 300-mile stretch along the Colorado between Boulder and Imperial Dams with Parker Dam in the middle of it, and to the Imperial Valley in California. When the storm struck, releases through the outlets at Boulder Dam were cut immediately to water for power generation.

Immediately the inflow at Lake Havasu, the reservoir above Parker Dam, 155 miles below Boulder Dam, began to increase and at 2 p. m., on September 6 it reached the remarkable peak of 146,000 cubic feet per second. It was a flash flood of this order which 34 years ago turned the Colorado River through breaks in its banks into the below-sea-level Imperial Valley, 150 miles farther downstream.

Water rose rapidly in Lake Havasu. The Parker Dam outlets were gradually opened wider and by 9 a. m., September 7, with the lake still rising the discharge from Parker Dam reached 50,000 second-feet. The lake began equalizing at this point, and discharges were not increased.

The peak of the flood below Parker Dam was reduced to a little more than one-third of the inflow into Lake Havasu by the operation.

Meantime, the comparatively small pond at the Imperial diversion dam was being rapidly emptied to take another slice of the flood peak before it reached Yuma, Ariz., and the headworks of the canal system of the Imperial Valley.

Reports were that the peak below Imperial Dam could be held to 35,000 second-feet, not a particularly dangerous height. This was accomplished under most difficult circumstances as all roads up the Colorado River from Yuma, where the river is controlled, were washed out, as were all other means of surface communication. Airplanes alone could get through to Parker Dam, and the weather was none too favorable for flying, but the engineers flew.

Lake Havasu at Parker Dam caught and held 151,000 acre-feet of floodwater, sufficient to cover 151,000 acres to a depth of a foot. The estimated total run-off at Parker Dam between the start of the rain and passage of the danger was 224,000 acre-feet.

By the control of the river, through coordinated operation of Boulder, Parker, and Imperial Dams in this emergency, serious damage was prevented in the Palo Verde area

Boulder Dam and Lake Mead

immediately below Parker Dam and in areas around Yuma, and a grave situation at the levees protecting the Imperial Valley along the west bank of the Colorado River was eliminated entirely.

The All-American Canal, which heads at Imperial Dam and which will, when finally completed carry water to the Imperial Valley displacing the present Mexican Canal, met another emergency.

Floods developing in washes in the rocky hills just west of Yuma washed out large sections of the Yuma Main Canal, which carries water to thousands of farms near Yuma. Many cattle were faced with a waterless fortnight, and several thousand acres of young lettuce, the farmers feared, would be killed by drought caused by disruption of the whole irrigation system.

Fortunately there were no breaks in the Yuma Canal below the structure through which eventually the All-American Canal will feed the Yuma Canal; water was diverted into the All-American Canal to supply the Yuma Canal through the new structure; and the situation on the Yuma project is being saved.

There was no considerable damage to the All-American Canal, a field investigation disclosed. All wash overchutes worked. In a few places small amounts of sand were washed into the canal, and in a few others the banks were eroded, but not seriously.

Communications are virtually reestablished now along the lower Colorado River, the mud is drying out, and the river is returning to normal. A telegraphic report from the field office at Yuma says laconically, "Repairs Yuma Canal well started. Require 10 days."

Carlsbad Building Activities

THE P. W. A. courthouse project was completed at the close of September except for landscaping improvements; two grammar-grade-school buildings were completed; the new high-school building was about 60-percent finished; and work on the sewer extensions was completed except for clean-up work.

PERSONNEL CHANGES

THE following recent personnel changes in the Bureau of Reclamation have been approved by the Secretary:

Appointments

Junior engineers, Denver, Colo.: Edward P. Martin; Waldron H. Yarger; David K. Cochrane (vice Louis Krasner); Byron N. Souder; William R. Wilson; Richard S. Saliman; Tauno Lappi; Thos. M. Austin; Joseph E. Shober (vice Olaf W. Nelson); Walter E. Rogers (vice Coleman A. Newland); Henry Blackstone (vice Roosevelt S. Christensen); Adrian Pauw.

Verney W. Russell, engineer, Columbia Basin project, by transfer from Department of Agriculture.

Clifton M. Fulton, junior engineer, Secondary Investigations, Weiser, Idaho.

Hugh A. McKellar, junior engineer, Provo River project, Provo, Utah.

Richard S. Reinhold, junior engineer, Central Valley project, Redding, Calif.

Harold W. Kirchen, junior engineer, Secondary Investigations, Denver, Colo. (from War Department).

James J. Murray, junior engineer, Pine River project, Colorado.

Transfers

Ross L. Heaton, from associate geologist, Colorado-Big Thompson project, Headquarters, Denver, Colo., to same, Headquarters, Estes Park, Colo.

William D. Wood, from associate engineer, Columbia Basin project, Coulee Dam, Wash., to engineer, Kennett division, Central Valley project, Redding, Calif.

Willis K. Zook, from junior engineer, Denver, Colo., to assistant engineer, Deschutes project, Bend, Oreg.

Otto Ehrenburg, from assistant engineer, Denver, Colo., to same at Friant division, Central Valley project, Friant, Calif.

Orville L. Kime, from assistant engineer, Vale, Oreg., to associate engineer, Secondary Investigations, Salmon, Idaho.

Clemeunt T. Douglass, Jr., from associate engineer, Kennett division, Central Valley project, Redding, Calif., to engineer, Friant division, Central Valley project, Friant, Calif.

William P. Price, Jr., from assistant engineer, Denver, Colo., to same, Friant division, Central Valley project, Friant, Calif.

George B. Snow, chief clerk, from Truckee storage project, Reno, Nev., to the Parker Dam power plant and transmission lines, Headquarters, Parker Dam, Calif.

Edwin O. Wilson, junior engineer, Salt Lake City, Utah, to United States Department of Agriculture.

Zacheus M. Marr, from assistant engineer, Denver, Colo., office to associate engineer, Denver Office Field Organization, Chicago, Ill.

Walter E. Sims, from junior engineer, Colorado-Big Thompson project, Denver, Colo., to assistant engineer, Fort Morgan, Colo.

Separations

Robert D. Morris, junior engineer, Boulder Canyon project, All-American Canal, Yuma, Ariz., resigned to accept appointment with War Department.

Richard R. Randolph, Jr., associate engineer, Denver, Colo., resigned to accept appointment with War Department.

Joseph A. MacDonough, junior engineer, Denver, Colo., resigned to accept appointment with War Department.

Alan W. Holliday, junior engineer, Heart Mountain division, Shoshone project, to accept appointment to the faculty of the University of Wyoming.

Einar T. Wulfsberg, junior engineer, Denver, Colo., to accept position with Food and Drug Administration.

Randolph L. Stanley, junior engineer, Central Valley project (Delta division), Antioch, Calif., resigned to accept private employment.

Ardis G. Ribbeck, junior engineer, Columbia Basin project, to accept position with the Bonneville project.

G. Raymond Rolin, assistant engineer, Denver, resigned to accept position in War Department.

Clifford C. Diemond, junior engineer, resigned to go to Bonneville Dam.

Edwin O. Wilson, junior engineer, Green River-Bear River Investigations, Utah, resigned without prejudice.

Leon R. Magee, assistant engineer, Buffalo Rapids, Glendive, Mont., to accept a civil service position in the Navy Department.

Moroni V. Hansen, junior engineer, Secondary Investigations, Utah, to accept appointment in Bureau of Mines.

John S. Gordanier, assistant engineer, Denver, Colo., to report for active duty in United States Navy.

James W. Taylor, junior engineer, Denver, Colo., to accept position with United States Engineers Office.

Paul A. Jones in Charge Second Division, Buffalo Rapids

PAUL A. JONES, construction engineer on the first division of the Buffalo Rapids project, Montana, has been placed in charge, in the capacity of construction engineer, of the second division of the project, work on which may require 2 or 3 years, depending upon the available relief labor.

Retirement

DANA TEMPLIN, superintendent of the Minidoka project, Idaho, will retire from active service on January 31, 1940. Mr. Templin has been connected with the Bureau of Reclamation for 31 years, the last 2 years of which he was in charge of the Minidoka project.

It is understood Mr. Templin will make his future home with his son in southern California. The good wishes of his Reclamation friends will go with him.

Reinstatements

Ralph W. Becker, junior engineer, Denver, Colo.

Robert E. Hill, assistant engineer, Vale project, Vale, Oreg.

Charles A. Bissell, engineer, Denver, Colo. (formerly Chief, Engineering Division, Washington Office).

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
868	Columbia Basin, Wash.	*1939* Aug. 22	Construction of garage and warehouse at Leavenworth station.	David A. Richardson	Caldwell, Idaho	$40,822.50		*1939* Sept. 15
873	Belle Fourche, S. Dak.	Sept. 6	Embankments at upstream toe of Belle Fourche Dam.	Northwestern Engineering Co.	Rapid City, S. Dak.	119,930.00		Sept. 26
1270-D	Yakima-Roza, Wash.	do	Construction of transformer and auxiliary-generator house.	[1]				
1273-D	Colorado River, Tex.	Sept. 11	Bypass, drain, and air-inlet piping for 102-inch gates for outlet works, Marshall Ford Dam.	Crane-O'Fallon Co.	Denver, Colo.	[2] 36,735.00	F. o. b. Rutledge, Tex.; discount 2 percent.	Oct. 2
1274-D	Boulder Canyon, Ariz.-Nev.	Sept. 12	Structural steel for 1 horizontal rim tower for city of Los Angeles transformer circuit No. 3 at Boulder switchyard.	Tulsa Boiler & Machinery Co.	Tulsa, Okla.	3,180.00	F. o. b. Boulder City; discount ½ percent.	Sept. 16
1275-D	Milk River, Mont.	Sept. 14	Construction of Kremlin bridge over Milk River.	Walter Mackin	Brockway, Mont.	8,087.00		Sept. 20
1276-D	do	Sept. 13	Structural steel for Kremlin bridge	Midwest Steel & Iron Works Co.	Denver, Colo.	5,797.00	F. o. b. Havre; discount ½ percent.	Sept. 21
1279-D	Kendrick, Wyo.	Sept. 18	Structural steel for steel structures for Gering substation.	Tulsa Boiler & Machinery Co.	Tulsa, Okla	6,660.00	F. o b. Gering, Nebr.; discount ½ percent.	Sept. 26
1281-D	Colorado-Big Thompson, Colo.	Sept. 20	Construction of garage at Estes Park headquarters camp.	Frank M. Kenney	Denver, Colo	15,887.00		Oct. 2
1282-D	do	Sept. 21	Construction of garage at Shadow Mountain camp.	Harold Easterday	do.	15,477.00		Oct. 3
33,325-A	Central Valley, Calif.	Sept. 20	110,000 couplings for 1-inch o. d. tubing.	Graybar Electric Co.	do.	15,500.00	F. o. b. Elizabethport, N. J.	Sept. 30
2,453-A	Carlsbad, N. Mex.	Sept. 15	10,000 barrels of standard portland cement in cloth sacks.	Southwestern Portland Cement Co.	El Paso, Tex.	32,220.00	F. o. b. Carlsbad; discount and sack allowance $0.50 per barrel.	Oct. 2
33,314-A	Central Valley, Calif.	Aug. 23	Copper-steel plates and bolts	Youngstown Sheet & Tube Co.	Youngstown, Ohio	[3] 36,689.31	F. o. b. Sacramento; discount ½ percent.	Sept. 22
33,282-A-1	do	Aug. 18	Rails, tie plates, rail braces, end points.	Southern Pacific Railway Co.	San Francisco, Calif	[4] 78,296.35	F. o b. Redding and Smithson	Oct. 2
A-46,422-B	Colorado-Big Thompson, Colo.	Sept. 6	Copper or aluminum conductor (871,200 linear feet) and accessories.	Aluminum Co. of America	Washington, D. C.	[5] 44,182.27	F. o. b. Massena, N. Y.; discount ½ percent.	Sept. 26
A-38,446-B	Columbia Basin, Wash	Aug. 29	750,000 feet of 1-inch o. d. black steel pipe and 2,000-180° bends.	Laclede Steel Co.	St. Louis, Mo.	[3] 21,730.40	F. o. b. Odair; discount 2 percent.	Sept. 21
1271-D	Colorado-Big Thompson, Colo.	Sept. 11	Street, driveway, and parking area, and construction of sewer, drainage and water systems for Shadow Mountain camp.	Ulrich S. Siegrist	Denver, Colo	17,763.35		Oct. 4
1277-D	Shoshone-Heart Mountain, Wyo.	Sept. 14	1 hoist for a 10-foot diameter cylinder gate for gate chamber of controlling works, Shoshone Canyon Conduit.	Commercial Iron Works	Portland, Oreg.	6,848.00	F.o.b. Portland; discount ½ percent.	Sept. 25
1283-D	Columbia Basin, Wash.	Sept. 20	4 welded plate-steel tanks	Seattle Boiler Works	Seattle, Wash.	2,530.00	F. o b. Seattle; discount 2 percent.	Do.
1287-D	Boulder Canyon, Ariz.-Nev.	Sept. 28	Steel partitions, steel doors, steel stairs, aluminum door frames and trim, miscellaneous architectural aluminum and steel works for Units A-6 and A-7.	A. J. Bayer & Co.	Los Angeles, Calif.	5,450.00	F. o. b. Los Angeles	Oct. 3
33,341-A	Central Valley, Calif.	Sept. 26	Steel reinforcement bars (2,260,000 pounds).	Colorado Fuel & Iron Corporation.	Denver, Colo.	58,632.00	F. o. b. Minnequa, Colo.	Oct. 6
1262-D	do	Aug. 8	Furnishing and delivering 27,000 tons of sand and 37,500 tons of gravel for the Contra Costa Canal.	Henry J. Kaiser Co.	Oakland, Calif	[5] 15,920.00 [6] 20,675.00	F. o. b. Radum, Calif. do.	Oct. 7 Do.
863	do	Sept. 14	Construction of Friant Dam.	Griffith Co. and Bent Co.	Los Angeles, Calif.	8,715,358.50		Oct. 9
870	Columbia Basin, Wash	Aug. 21	Earthwork, bench flume, canal lining and structures for Wenatchee Canal at Leavenworth station for migratory fish control.	David A. Richardson	Caldwell, Idaho	88,344.50		Do.
1284-D	Colorado-Big Thompson, Colo.	Sept. 21	Structural-steel roof trusses for garages at Estes Park and Shadow Mountain camps.	Wisconsin Bridge & Iron Co.	Milwaukee, Wis.	2,562.00	F. o. b. Milwaukee	Oct. 5
33,301-A-1	Central Valley, Calif.	Sept. 7	Steel reinforcement bars (2,674,900 pounds).	Columbia Steel Co.	San Francisco, Calif.	53,487.18	F. o. b. Pollock, Calif.; discount ½ percent b. p. v.; shipping point Pittsburg, Calif.	Oct. 9
867	Parker Dam Power, Ariz.-Calif.	Aug. 22	Hydraulic turbines (3-40,000 horsepower) and governors for units 1, 2, and 3, Parker power plant.	S. Morgan Smith Co. Woodward Governor Co.	York, Pa. Rockford, Ill.	[3] 749,000.00 [5] 56,040.00	F. o. b. York. F. o b. Rockford	Do. Do.
1285-D	Sun River, Mont.	Sept. 26	Earthwork and structures for open drains, Greenfields division.	Ray Schweitzer	Los Angeles, Calif.	24,354.00		Oct. 10
876	Central Valley, Calif.	Sept. 20	Gate frames for coaster gates for main unit penstocks at Shasta Dam.	American Bridge Co.	Denver, Colo.	85,874.00	F. o. b. Gary, Ind	Do.
1289-D	Provo River, Utah.	Sept. 25	65,000 barrels of finely ground standard portland cement.[7]	Portland Cement Co. of Utah.	Salt Lake City, Utah.	[8] 138,585.50	F. o. b. Salt Lake City; discount 10 cents per barrel; sack allowance 10 cents each.	Oct. 9
1290-D	Colorado-Big Thompson, Colo.	Oct. 2	Weather stripping buildings and residences at Government camp at Green Mountain Dam.	Ideal Metal Weather Strip Co.	Boulder, Colo.	502.70		Oct. 10
33,333-A	Central Valley, Calif.	Sept. 22	Steel reinforcement bars (8,100,000 pounds).	Columbia Steel Co.	San Francisco, Calif.	184,440.00	F. o. b. Redding, Calif.; shipping point, Pittsburg, Calif; discount ½ percent on $1.90 per hundred weight.	Oct. 12
1288-D	Yakima-Roza, Wash. Fruitgrowers Dam, Colo. All-American Canal, Calif.	Oct. 6	2 17- by 9-foot 8-inch radial gates and 2 7,500-pound capacity hoists. 1 6- by 9-foot and 1 8- by 8-foot radial gates and 2 2,300-pound capacity hoists 4 10- by 12-foot, 3 14-foot 3-inch by 9-foot 6-inch and 8 10- by 6-foot radial gates. 7 7,500-pound and 4 14,000-pound capacity hoists and float well equipment.	Smith Corporation d/b/a General Iron & Steel Works.	Portland, Oreg.	[9] 1,079.00	F. o. b. Portland	Oct. 13
				Southwest Welding & Manufacturing Co.	Alhambra, Calif.	[10] 635.00	F. o. b. Alhambra. Discount ½ percent.	Oct. 17
				Berkeley Steel Construction Co., Inc.	Berkeley, Calif.	[11] 6,410.00	F o. b. Berkeley. Discount ½ percent.	Oct. 13
				Hesse-Ersted Iron Works	Portland, Oreg.	[12] 1,642.40	F. o. b. Portland. Discount 1 percent.	Do.
				Silver-Roberts Iron Works, Inc.	Denver, Colo.	[13] 400.00	F. o. b. Denver	Oct. 16
				Smith Corporation d/b/a General Iron & Steel Works.	Portland, Oreg.	[14] 12,628.00	F. o. b. Portland	Oct. 13
				Schmitt Steel Co.	do	[15] 3,409.00	F. o. b. Portland; discount ½ percent.	Oct. 14

See footnotes at end of table.

NOTES FOR CONTRACTORS—Continued

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
865	Central Valley, Calif	1939 Aug. 15	Earthwork, canal lining and structures, Contra Costa Canal, stations 1066 to 1542+72 and 2349+83 to 2359+67; earthwork and structures, Nichols Wasteway.	Heafey - Moore Co. and Frederickson & Watson Construction Co.	Oakland, Calif	$276, 365. 00		1939 Oct.
874	Parker Dam Power, Calif.-Ariz.	Sept. 22	Excavation for powerhouse and appurtenant works at Parker Dam.	Clyde W. Wood	Los Angeles, Calif	276, 210. 00		Oct.
33, 342-A	Central Valley, Calif	Oct. 4	460,000 linear feet of thin-wall steel tubing (½-, 1-, and 1½-inch).	Clayton Mark & Co	Evanston, Ill	28, 703. 00	F. o. b. Coram, Calif.; discount 5 percent.	Oct.
1250-D	Columbia Basin, Wash	Sept. 19	Construction of icicle pipe line at the Leavenworth station.	Norris Bros	Burlington, Wash	59, 796. 00		Oct.
A 33, 344-A	Central Valley, Calif	Oct. 13	Annealed copper in rolls (220,600 pounds).	Goldberg Bros	Denver, Colo	35, 700. 00	F. o. b. Coram, Calif.; shipping point, Chicago, Ill.	Oct.
875	Shoshone-Heart Mountain, Wyo.	Sept. 11	Earthwork and structures, laterals 16 to 79, and sublaterals and checks.	Bushman Construction Co	St. Joseph, Mo	170, 670. 30		Oct.

[1] No bids received. [2] Items 1, 2, 3, and 4. [3] Schedule 1. [4] Schedules 1 to 14, inclusive, except items 13 and 27. [5] Schedule 2. [6] Schedule 4. [7] 30,000 bulk, 32,500 cloth sacks, 2,500 pape sacks. [8] Schedule 2, items 4, 5, and 6. [9] Item 1. [10] Item 2. [11] Item 3. [12] Item 4. [13] Item 5. [14] Item 6. [15] Item 7.

Federal Irrigation Congress Holds Annual Convention

AT THE Ninth Annual Convention of the Federal Irrigation Congress, held in Sidney, Mont. (Lower Yellowstone project), on August 28 and 29, R. D. Chambers, of Nebraska, was elected president to succeed F. W. Grebe, who has held that office since the congress was organized and who withdrew from running at this election. George G. Miller, chairman of the board of directors of the Truckee Carson Irrigation District, was made a member of the board of directors of the Federal Irrigation Congress.

Eight resolutions were approved by the convention, one of which calls attention to the fact that sugar-beet culture fits well into the Reclamation project scheme and calls upon Representatives and Senators from Western States to do their utmost to have the sugar-beet acreage quotas for 1940 liberalized and that quotas for farmers on Federal Reclamation projects be increased.

Other resolutions adopted included one commending John C. Page, Commissioner, and the Bureau of Reclamation for aid and support in the drafting and passage of the White Reclamation bill providing for a new plan of repayment to the Government of project construction charges. A similar resolution commended Congress for passage of the act.

One resolution recommended use of CCC labor to aid Reclamation farmers in their campaign for noxious weed eradication, and another pointed to the great amount of good accomplished on Reclamation projects by CCC labor, and asked for a continuation of it.

Congress was requested in another resolution to pass a law which will remove the limitations fixed by the existing Reclamation law limiting delivery of water to one ownership of 160 acres.

THE District Women's Club held a convention in Fairfield, Mont., headquarters of the Sun River project, in September.

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185315 U. S. GOVERNMENT PRINTING OFFICE: 1939

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

HAROLD L. ICKES, SECRETARY OF THE INTERIOR

John C. Page, Commissioner — **Harry W. Bashore, Assistant Commissioner**

J. Kennard Cheadle, Chief Counsel and Assistant to Commissioner; Howard R. Stinson, Assistant Chief Counsel; Miss Mae A. Schnurr, Chief, Division of Public Relations; George O. Sanford, General Supervisor of Operation and Maintenance; D. S. Stuver, Asst. Gen. Supr.; L. H. Mitchell, Irrigation Adviser; Wesley R. Nelson, Chief, Engineering Division; P. I. Taylor, Assistant Chief; A. R. Golzé, Supervising Engineer, C. C. C. Division; W. E. Warne, Director of Information; William F. Kubach, Chief Accountant; Charles N. McCulloch, Chief Clerk; Jesse W. Myer, Assistant Chief Clerk; James C. Beveridge, Chief, Mails and Files Section; Miss Mary E. Gallagher, Secretary to the Commissioner

Denver, Colo., United States Customhouse

R. F. Walter, Chief Eng.; S. O. Harper, Asst. Chief Eng.; J. L. Savage, Chief Designing Eng.; W. H. Nalder, Asst. Chief Designing Eng.; L. N. McClellan, Chief Electrical Eng.; Kenneth B. Keener, Senior Engineer, Dams; H. R. McBirney, Senior Engineer, Canals; E. B. Debler, Hydraulic Eng.; I. E. Houk, Senior Engineer, Technical Studies; Spencer L. Baird, District Counsel; L. R. Smith, Chief Clerk; Vern H. Thompson, Purchasing Agent; C. A. Lyman and Henry W. Johnson, Examiners of Accounts

Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge: Name	Official in charge: Title	Chief clerk	District counsel: Name	District counsel: Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon[1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr.	Edwin M. Bean	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr.	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif.	Boden, Oscar G.	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif.	R. B. Williams	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Porter J. Preston	Supervising engr.	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr.	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engr.	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr.	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah
Humboldt	Reno, Nev.	Chas. S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo.	Irvin J. Matthews	Constr. engr.[2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr.	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	S. R. Marean	Superintendent[2]	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz.	L. C. Koppen	Constr. engr.	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Bayfield, Colo.	Charles A. Burns	Constr. engr.	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah
Provo River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr.	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	L. C. Koppen	Constr. engr.	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent[2]	L. J. Windle[2]	W. J. Burke	Billings, Mont.
Heart Mountain Division	Cody, Wyo.	Walter F. Kemp	Constr. engr.	L. J. Windle[2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt.		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah
Upper Snake River Storage[3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.[2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr.	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official: Name	Operating official: Title	Secretary: Name	Secretary: Address
Baker (Thief Valley division)[1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root[4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise[1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise[1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa[3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn
Huntley[4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine
Hyrum[3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley[1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly[1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone[4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River, Chinook division[1]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity[1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding[1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands[3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division[4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division[4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering
Fort Laramie division[4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division[4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan[1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.)[3]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River[2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division[4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division[4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division[4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division[1]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield
Umatilla: East division[1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division[1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre[3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division[1]	Kittitas reclamation district	Ellensburg, Wash.	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Eastern Slope (Colo.)	Denver, Colo.	A. N. Thompson	Engineer.
Missouri River Tributaries and Pumping (N. D.-S. D.)	Denver, Colo.	W. G. Sloan	Engineer.
Canton and Fort Supply (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Arkansas Valley (Colo.-Kans.)	Denver, Colo.	A. N. Thompson	Engineer.
Black Hills (S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Balmorhea and Robert Lee (Tex.)	Austin, Tex.	E. A. Moritz	Construction engineer.

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THE RECLAMATION ERA

DECEMBER 1939

CHRISTMAS IN THE NORTHWEST

President Roosevelt Sends Greetings to President Warden of National Reclamation Association

IT IS a pleasure again to address a message to you on the occasion of the Eighth Annual Convention of the National Reclamation Association. I am proud of the advances made in the field of reclamation since I sent my first letter of felicitations to your association.

Work has been started, carried on, and completed on reclamation projects, great and small, throughout the arid West. This work is recognized as important and fruitful in our times and will continue to return benefits to the United States for many generations.

The conservation of water, by means of self-liquidating projects, for use in irrigation, for incidental power, and for the purpose of creating new homemaking opportunities in the West has for decades been an accepted and proved national policy. I am pleased that in recent years we have given this policy added meaning.

Recent legislation has extended benefits similar to those obtainable under the reclamation law to the Great Plains area on a businesslike basis. The Reclamation Project Act of 1939 has provided a formula for repayments, which, without loss to the United States, will make the settlers' task less difficult, and this law also has established an intelligent plan for the consideration by the Bureau of Reclamation of associated public benefits when new irrigation projects are being studied and designed. It is well, also, that under another authorization this year the Bureau of Reclamation and the Farm Security Administration are experimenting with a cooperative method which should make it easier for a family made homeless by continued drought successfully to make a place for itself on a new irrigated farm.

We can all look forward, I am sure, to another successful year for reclamation.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 29 • DECEMBER 1939 • NUMBER 12

National Reclamation Association Holds Annual Convention[1]

A UNITED WEST—17 States strong—marched out of the Eighth Annual Convention of the National Reclamation Association in Denver, November 14–16, confident in the belief that reclamation can rebuild the economy of the United States.

With the entrance of Oklahoma and Kansas into the association, the influence of the organization was extended for the first time all the way from the Missouri River to the Pacific Ocean, and with the expansion of the membership of the association came an expansion of the purpose of reclamation to take in the entire problem of self-sufficiency and security in this Nation.

The convention saw new and strong groups added to its rolls for the protection of western agricultural interests. A new tri-State alliance was created for Texas, Oklahoma, and New Mexico to provide water and flood control for the reclamation of the dust bowl area. Speaker after speaker stressed the parallel interests and the active cooperation of three arms of the Federal Government: the United States Bureau of Reclamation, the Corps of Engineers of the United States Army, and the Department of Agriculture, and reclamation gained new recognition as a major factor in the program for national defense.

President Warden Opens Convention

The opening address by O. S. Warden, President of the association, defined the spirit of the convention for every speaker who followed him to the rostrum during the 3-day conclave. An attendance record was set on the second day of the business session when more than 700 members of the association filled the convention hall. Their number reached 1,500 at the banquet with which the meeting came to a close.

The 23 resolutions passed by the convention were in line with the ideals set forth by President Warden, who described the solution to the question of relief and unemployment as possible through western reclamation, and defined the resettlement of wandering farm families on fertile and productive lands as a national problem to be answered by reclamation.

More lands for sugar beets and less restriction on sugar-beet production, he said, would settle permanently the preference for American farm products as a future solution to the growing foreign trade question.

Along with the terrific expenditures for arms and ammunition, he declared, should go expenditures for research and development of the sources of our national production to make us the strongest nation in the entire world. "To make a nation strong in peace and invincible in war—this is where reclamation and the West come into the national defense formula," he said.

He suggested new methods of extending the Great Plains program; and, in discussing these methods, offered the conclusion that if "general relief funds expended in the 17 Western States since July 1, 1935, amounting now to more than a billion dollars, had been applied to reclamation, no western farmer would now be obliged to search for good land."

These notes were part of the foundation on which the convention of the association built one of the most extensive programs it has ever undertaken. Every speaker at the convention took up one or more of the phases of this new interpretation in discussing his own particular part in the reclamation picture.

Reports of the State caucuses, held before the association convened, announced the election of directors and representatives from each State. The list of these officers for 1940 appears on next page.

Following the report of J. A. Ford, treasurer of the association, came the report of F. O. Hagie, secretary-manager. Mr. Hagie announced that action and results had been obtained on 13 of the 17 resolutions passed by the convention of the previous year. He enlarged on the work of guiding the repayment bill of 1939 through Congress, announced

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Convention Proceedings to be Continued in Next Issue

THE volume of the papers delivered at the convention and the limitation on the size of the magazine make it impossible to include all addresses in this issue. Because of their excellence and the importance that they be made available to the readers of *The Reclamation Era*, the balance will be printed in the January issue as follows:

The Domestic Sugar Problem, by Chas. M. Kearney, President, National Beet Growers' Association.

Land Use, Soil Conservation and Water Facilities, by E. H. Wiecking, Associate Coordinator, Office of Land Use Coordination, United States Department of Agriculture.

National Resources Planning Board, How It Should Be Constituted, by L. Ward Bannister.

The Great Plains Program in Congress, by Hon. Francis Case, Representative Second South Dakota District.

Drainage and Clearing, by William E. Warne, Director of Information, Bureau of Reclamation.

Sugar Beet Acreage on Reclamation Projects, by Hon. James F. O'Connor, Member of Congress from Montana.

What the State Ought To Do for Reclamation in Planning and Cooperation, by Clifford H. Stone, Director and Secretary, Colorado Water Conservation Board.

New Water Laws Needed in the West, by A. E. Chandler, Chairman, Subcommittee on State Water Law, Water Resources Committee of National Resources Planning Board.

The Repayment Law—Its Provisions and Aims, by J. M. Lampert, Chairman, Legislative Committee.

Improved Methods in Canal Maintenance, by W. H. Robinson, Manager of the Gem Irrigation District, Homedale, Idaho.

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[1] Program appears in November issue of Reclamation Era.

another step toward recognition of the West in the appointment of a western judge to fill the vacancy on the Supreme Court of the United States, and reported on the appreciable increase in appropriations for reclamation work during the past year.

At the evening session on November 14 discussions were heard on New Ideas in the Use of Water, by L. H. Mitchell of Washington, D. C.; Methods of Weed Control, by C. L. Corkins of Powell, Wyo.; and Improved Methods in Canal Maintenance, by W. H. Robinson of Homedale, Idaho.

Texas Proposes Triple Alliance

Texas delegates took the first extra-curricular step by proposing a tri-State alliance with Oklahoma and New Mexico for the purpose of building small dams and reservoirs to conserve water and control floods in the Dust Bowl area.

Carl Hinton, secretary of the Amarillo Chamber of Commerce and spokesman for the Texas delegation, said, "We want to convince the Reclamation Service at Washington, D. C., and the members of the association that Texas, Oklahoma, eastern New Mexico, and parts of southwestern Kansas can be taken out of the Dust Bowl if the Reclamation Service will follow as a general plan the program launched recently in the Texas Panhandle.

"Texas, with the assistance of the United States Department of Agriculture, has built six reservoirs on some of our main watersheds. These have conserved water for recreation purposes, that water eventually will be put to irrigation use, and we think what has been done in Texas, if done in the other States in our group, would result in savings to the Government in flood control.

"We are united in our aims. We intend to press for recognition, and we believe that our program is practical and should be carried out with Government assistance."

The Wednesday session was devoted to future reclamation work.

The entire speech of John C. Page, Commissioner of Reclamation, and part of the talk by Maj. Gen. Julian L. Schley, Chief Engineer of the United States Army Corps of Engineers, were broadcast over the Nationwide network of the Mutual Broadcasting System through Denver's station KFEL.

State	Board of directors	Legislative committee	Resolutions committee
Arizona	Hugo B. Farmer, Yuma	Jesse C. Wamslee, Phoenix	William J. Burns, Phoenix.
California	J. R. Farmer, Exeter	Roland Curran, Sacramento	H. L. Haehl, San Francisco.
Colorado	Clifford H. Stone, Denver	A. W. McHendrie, Denver	George M. Corlett, Grand Junction.
Idaho	N. U. Sharp, Filer	J. M. Lampert, Boise	E. H. Neal, Aberdeen
Kansas	W. E. Dannefer, Barr Oak	Charles H. Blosser, Concordia	Dr. E. Porter Ahrens, Scandia.
Montana	O. S. Warden, Great Falls	G. R. Walsh, Hamilton	H. R. Lentz, Great Falls.
Nebraska	C. E. Alter, Alma	B. F. Butler, Cambridge	D. F. Simmons, Beaver City.
Nevada	Alfred Merritt Smith, Carson City.	W. W. Carpenter, Lovelock	C. F. De Armond, Las Vegas
New Mexico	E. W. Bowen, Tucumcari	Sanley Phillipi, Albuquerque	Thomas M. McClure, Santa Fe.
North Dakota	K. W. Simons, Bismarck	C. F. Kelsch, Mandan	H. F. McColly, Bismarck.
Oklahoma	Frank Raab, Canton	W. C. Austin, Altus	Don McBride, Oklahoma City.
Oregon	Robert W. Sawyer, Bend	George Cochran, La Grande	Robert W. Sawyer, Bend.
South Dakota	W. D. Buchholz, Newell	R. F. Johnson, Rapid City	Raymond F. Lund, Rapid City.
Texas	Carl Hinton, Amarillo	Fritz Thompson, Borger	Carl Hinton, Amarillo.
Utah	Ora Bundy, Ogden	J. S. Reece, Payson	Gus P. Backman, Salt Lake City.
Washington	James A. Ford, Spokane	Fred J. Cunningham, Spokane	W. C. Muldron, Benton City.
Wyoming	Perry W. Jenkins, Cora	H. Melvin Rollins, Lyman	W. W. Hundson, Veteran.

National Reclamation Association officials reelected: (Left to right) Ora Bundy, Ogden, Utah, first vice president; J. A. Ford, Spokane, Wash., treasurer; O. S. Warden, Great Falls, Mont., president; Robert W. Sawyer, Bend, Oreg., second vice president; Floyd O. Hagie, Washington, D. C., secretary-manager.

Mr. Page outlined the aims of the Bureau and of the Nation as a whole with reference to the present world situation.

He contrasted the constructive public works programs of this Nation with those of other nations which have built vast fortifications and like projects for defense against military offensive.

Directly following Mr. Page, General Schley offered a strong plea for mutual cooperation between the Corps of Engineers of the United States Army and the United States Bureau of Reclamation.

In what was believed by delegates to be the beginning of closer relations between the two Federal agencies, General Schley announced that new methods and legislation in the matter of the use of water make full cooperation and mutual respect more and more necessary.

E. H. Wiecking of Washington, D. C., Associate Coordinator of Land Use in the Department of Agriculture, reiterated the offer of cooperation and mutual interest already made by heads of the other Federal agencies.

Describing the work of the Department of Agriculture and its association with reclamation in the West, Mr. Wiecking remarked that it may be a surprise to some whose memories go back a bit to learn "that the Department of Agriculture is playing on the same team with the Bureau of Reclamation, and with that Bureau as quarterback." "Times," he said, "have changed, and we're glad of it."

More cooperation—this time from Representative Dewey Short of Missouri, speaking as president of the National Rivers and Harbors Congress—was offered to the cause of reclamation in the West.

He argued that, whereas in the past divergent views were taken by each agency concerned with water conservation because their projects were built for only one particular purpose, all agencies now have conceded that the storage of water can be put to multiple use. As a result, each agency must act, confer and cooperate with the other in a coordinated program of (1) flood control, (2) water stabilization, and (3) power development.

At the luncheon, following the morning session Wednesday, S. R. DeBoer of Denver showed slides of community planning and reclamation projects in Holland. Representative Lawrence Lewis of Colorado presided at the luncheon.

Reclamation Legislation

Representative Compton I. White of Idaho opened the Wednesday afternoon session with comments on reclamation legislation in Congress. He called attention to a new field for the reclamation of potential agriculture land. This new field, which he described as apparently overlooked in the reclamation of the West, is the restoration of cut-over lands.

The repayment law of 1939, acclaimed by the National Reclamation Association as the most important piece of legislation supported by the group in the past year, was discussed in detail by J. M. Lampert of Boise, Idaho, chairman of the legislative committee of the association.

He described the work of the men who drafted the bill for enactment. The possibility of another moratorium on repayment of farmers for use of reclamation farms has been eliminated by the repayment act, according to Mr. Lampert.

His remarks were complemented by comments and discussions by Commissioner Page and J. K. Cheadle of Washington, D. C.; R. C. Chambers of Minatare, Nebr.; and G. W. Grebe of Kuna, Idaho—men who took an active part in drafting the act and making it a reality.

A. E. Chandler of San Francisco closed the Wednesday session with a progress report of the subcommittee on State water law in the water resources committee of the National Resources Planning Board.

Thursday's session brought out the domestic sugar problem, its relation to present foreign trade agreements, its connection with reclamation and its proposed solution.

Delegates to the convention heard talks by Charles M. Kearney of Morrill, Nebr., president of the National Beet Growers Association; Representative James F. O'Conner of Montana; Clifford H. Stone of Denver; and William E. Warne of Washington, D. C., Director of Information of the Bureau of Reclamation. Mr. Kearney and Congressman O'Connor spoke on the problems of the sugar beet industry, while Mr. Warne discussed further the matter of clearing cut-over lands, which was introduced by Congressman White, and drainage as a new project for reclamation work.

L. Ward Bannister of Denver, chairman of the Reclamation Committee of the Denver Chamber of Commerce, spoke to delegates at the Thursday luncheon on how a National Resources Planning Board should be constituted.

In the afternoon session, preceding the final business of the convention, Prof. Harlan H. Barrows of Chicago University spoke on Water Conservation Possibilities on the Northern Great Plains.

Representative Francis Case of South Dakota, member of the Appropriations Committee of the House of Representatives, spoke on the Great Plains Program in Congress.

All 23 of the resolutions, drawn up by the resolutions committee under the chairmanship of Judge Robert W. Sawyer, were adopted. These resolutions ranged from the promotion of greater Federal appropriations for reclamation of the West to a program of small dam projects.

Great Falls, Mont., was chosen by the convention as the convention city for 1940. Other cities bidding for the honor were Amarillo, Tex.; Phoenix, Ariz., Omaha, Nebr., Salt Lake City, Utah; and Boise, Idaho. The vote finally boiled down to a contest between Phoenix, Ariz., and Great Falls, and finally Great Falls was victorious by the small margin of 87 to 73.

All the officers of the National Reclamation Association were reelected for another term.

Senator Joseph C. O'Mahoney of Wyoming spoke over three local radio stations at the dinner. He described the past 6 years as the Golden Age of Reclamation. His talk dealt largely with the migration of rural population to the cities and the decline of agriculture.

Tribute was paid to Representative Edward T. Taylor, "Grand Old Man of Reclamation," and an engraved scroll was presented to him by the association.

Registrations at the convention exceeded those of any other year since the founding of the association. And with the addition of Kansas and Oklahoma to the association, more are expected next year.

Secretary Ickes Sends Greetings to N. R. A. Through President Warden

I RECALL with pleasure our meeting at Reno last year at the Seventh Annual Convention of the National Reclamation Association, and I want to extend to you, and through you to the entire membership, my best wishes for this year's meeting of the association at Denver.

I want to thank the association for a public service it rendered by generously giving its support to our efforts to work out and present an intelligent, workable bill to introduce a greater degree of flexibility into the reclamation repayment contracts.

We all should feel gratified, I believe, and you of the West especially, that the passing of another year finds the principles of conservation more widely applied and more firmly adhered to than ever before. Progress has been made toward centralizing administration of conservation activities in the Federal Government. Progress has been made, also, through the extension of the activities of many of the agencies which are responsible for conservation programs, and I am happy that this is true of the Bureau of Reclamation, which is the primary agency at work in the field of water conservation, particularly in the West.

For the first time this year, for example, sufficient funds have been made available by the Congress to the Bureau of Reclamation to enable the Bureau to conduct its preliminary investigations on a broad front with a view toward working out a comprehensive plan for future developments. You will, I know, appreciate the significance of this step forward, since it has been one of the planks in your platform for several years.

O. S. Warden, President, National Reclamation Association, Delivers Address at Eighth Annual Convention in Denver, Colo.

THIS annual message opens the routine work of the eighth annual convention of your association. For the fourth time I have the privilege of reviewing the progress of a year, of trying to reveal the problems of today and tomorrow. In my 4 years of service as your president there has been a full measure of satisfying opportunity. The reasons are evident. I have had two secretaries whose heart and soul were in the work, a board of directors ready to put their shoulders into the yoke and pull whenever there has been a need so to do, a continually increasing and loyal membership, a Government at Washington from the White House down through all of the cooperating agencies sympathetic in attitude and helpful in active support of reclamation as an established national policy. These perennial blessings merit expressions of appreciation by this convention.

The history of reclamation from the pioneering of the Spanish missionaries, even unto the engineering facility of Boulder Dam, has presented a constant problem of how to develop the greatest natural resource in any country, the land and the water—using the water here and there and over again—taking the moisture that the mountains sent down to the plains for storage or flow—and if we are ready, on to measuring gates and to fertile fields.

There were many mistakes and repeating tragedy in the early chapters of reclamation history. There has been much to learn since the Government began an organized effort in 1902. There are delegates in this convention who remember the Governor's meeting of 1932 when it was feared, after evident accomplishment, that the reclamation ship would smash upon the rock of eastern opposition, or upon the crags of nonsupport. When I became your president there were scanty funds to support reclamation work—there was no one in Washington or elsewhere providing support for the missionaries who were preaching the reclamation gospel. This association had neither cash nor credit. At congressional committee meetings in Washington there was neither a cordial welcome nor a pleasant goodbye when we began to declare that the existent legislative moratorium must come to an end or reclamation with a depleted revolving fund would die, and there was no need for refrigeration in the room. Those were the dark days. At the reclamation conference of 1932, with 91 delegates attending, John Haw, veteran supporter of reclamation, declared there was no light in the picture, that something had to be done or the revolving fund would shrink to a vanishing point, and authorized work would have to stop. A timid resolution was only brave enough to ask Congress for sympathetic consideration and a small advance of funds. It looked and felt like a winter at Valley Forge for reclamation.

A Testimonial of Appreciation

Presented to

HON. EDWARD T. TAYLOR

By the Seventeen States of the National Reclamation Association [1]

WORTHY son of western America in the pioneer days; sturdy builder among the strong men who founded the State of Colorado; educated in the law; diligent in all the duties of citizenship; interested through the earlier years in the law making of the new centennial State; father of the statute creating the supreme court of the State of Colorado; public servant in legislative halls at home and in the Capitol of the Nation for half a century of time; constant supporter of reclamation as a vitalizing national policy; author of the Taylor Grazing Act; on and on up to the great chairmanship of the Appropriations Committee of the House of Representatives in the Congress of the United States; never turning away from the best in government through a long and useful life; patient and tireless in all the work he has undertaken; unfaltering in courage to uphold every conviction; wise as a counselor supporting whatsoever is good, right, and just in public life.

This salutation from a multitude of friends who live in 17 States is presented in grateful appreciation—a personal tribute to Edward T. Taylor, true friend of the great West.

Mr. Dan Hughes, of the Fourth Congressional District of Colorado, will introduce the recipient of this memorial for Mr. Taylor.

There is always special delight when we honor faithful veterans of a great cause. In the 4 years of my service as president of the National Reclamation Association, there has been no assignment more pleasant than the preparation of this memorial to a distinguished citizen and statesman of the State of Colorado, Edward T. Taylor.

The presentation is a personal satisfaction, and it expresses in some measure the admiration and esteem of a group of fellow workers who unite in a heart-to-heart recognition.

[1] Delivered by President Warden.

Reclamation's Forward Look

By way of comparison, the present situation is one of distinct advantage. There is dependable revenue reaching out into the future—assured by legislative enactment. The moratorium menace is no more. The Washington office is making friends, and, I am sure, is continually assisting the Bureau of Reclamation. We have come out from the darkness of the moratorium night into the morning of a new day.

A review of the Reclamation appropriations made by the past Congress requires only a paragraph. Nearly $90,000,000 is the total of new money. With unused balances there is available for the construction period of this year considerably more than $100,000,000. The appropriated funds include more than $9,000,000 from the Reclamation Fund for the building of 17 projects, and $50,000,000 from the general fund for 7 projects. There was added $4,000,000 for Indian projects and $5,000,000 for the so-called Great Plains program. This last major item was supplemented by $7,500,000 of WPA relief funds to assist the expenditure. Forty-four CCC camps are helping Reclamation.

The toughest nut to crack in the past session of Congress was our appeal to increase the amount of funds for investigating new projects. The $200,000 of the previous year's appropriation was not enough to sufficiently engineer projects under way. Through pegging away at House and Senate committees this item was raised to $900,000. That was a Reclamation victory in itself. This much about finances—looking backward.

What about tomorrow? Speaking generally, I take it the Government will finish larger projects like the Central Valley of California and the Grand Coulee in Washington with funds from the General Treasury. There is no other consistent thing to do. If, however, we are to have a balanced Reclamation program thereafter, the revolving fund must be temporarily increased above the present assured flow of funds—until repayments come from Reclamation investment in the big projects—speaking concretely until the Hayden-O'Mahoney amendment assists the revolving fund. The money in sight for continuing planned expenditures upon smaller projects will adequately carry through the fiscal year of 1940–41. The outlook for the 5 years immediately following, beginning with the fiscal year 1941–42, is not so good unless an intermediate general assistance is supplied by the Congress. This is the time to consider such a sustaining plan.

There are a number of suggestions. The Great Plains program could be extended, assisted by WPA funds or by cooperation with Department of Agriculture appropriations. A revival of public works appropriations, with a bracket applying to reclamation, has considerable western approval. Lending proposals such as were before the Senate in the past Congress, without grants, may be revived. The Government may offer cooperative money to be matched by the States, like the Federal highway plan. In a consideration of these or other proposals, it is correct to say that the Reclamation States of the West prefer useful public works, with reclamation included, rather than continuing expenditures for unemployment relief.

The generous support of Reclamation by the Federal Government forbids overmuch comparison or criticism, but it is not an impertinence to repeat a conclusion that was presented to this convention a year ago. If the general relief funds expended in the 15 Western States since July 1, 1935, amounting now to more than a billion dollars, had been applied to Reclamation, no western farmer would now be obliged to search for good land. In the single year ending June 30, 1939, relief expenditures in these 15 Western States was more than $310,000,000, ranging all the way from $1,700,000 in Nevada to nearly $92,000,000 in California. That money would have built the Shasta Dam. The amount for my home State was more than $15,000,000 for this past fiscal year. There would be a jubilee celebration in Montana if that amount should come along for Reclamation.

Investment in Montana

In my remarks at the opening of our convention at Reno last year, reference was made to the building of 18 Reclamation projects by my home State, Montana, in cooperation with the Public Works Administration, the engineering and supervision supplied by State revenue plus Federal grants, plus bond issues enabled by water sales contracts completing the expenditure. Nearly complete figures are now in the record. The total investment will be $8,000,000. There is reclamation benefit to 328,000 acres of land. The facilities will store 360,000 acre-feet of water. The average repayable cost is $12.26 per acre. If the Congress makes further public works appropriations, Montana would like to have reclamation brackets included. It has been and is an interesting and profitable investment. Each one of these projects has already shown, or quite soon will prove itself economically sound. If I add a personal opinion, it would be that the States can help themselves in this way if they will. They can find and make ready feasible projects. State investigation, with cooperative expenditure, may bring feasibility into many reclamation projects. These suggestions contemplate the States offering some of their own money to the Government. Reclamation does not have to be like a one-way street.

In any event, we are not near to the end of the reclamation trail. Soil fertility, land productivity, the resettlement of wandering farm families still make up a national problem. Supplementary water is needed for many projects. We cannot rest with accomplishment. Reclamation, like other great enterprises, can only go forward if we continue to lead and to push. The tremendous mountains of the West will keep the snows of winter until the spring is warm, but following what has been done by diversion, we must plan and build storage to hold the water—all of the remaining available water—for the peak demand of the summer.

Reclamation History

In the past four of our conventions there has been plenty of history, the Federal story has become a reclamation catechism; 150 dams, ditches long enough to reach around the world, 50 incidental power plants, increased taxable value to balance the Government investment, an annual crop production equal to $1 for every person who lives in the United States, hurting no one because we buy more than we sell, making markets greater than those we enter trying to sell, building the West into a great self-supporting area. If I could stop to review 37 years of Government accomplishment, it would only recount what you know from A to Z.

Looking across association effort of the last year, it is my opinion that reclamation, as we advocate it, has more friends in the Congress, and in the whole country, than ever before. The first session of the Seventy-sixth Congress that finished its work in August of this year did more than any previous session for reclamation in money appropriations, and, of even greater importance, in the enactment of a flexible repayment and project-operation law. There has now been written into a comprehensive statute, provisions based upon the experience of 37 years plus studies by a competent research commission. The ability to pay out of the harvest of the year is the key note of this statute. The purpose of this reclamation act is to fairly protect the investment of the Government, but to let no collecting person injure a single water user who is honestly trying to meet his obligation.

There was a half-year grind writing this law—from January to June. There was interminable difficulty in the search for a normal formula that would fit a group of projects operating under varying contractual provisions. I was in Washington several times while this adaptation study was puzzling interested agencies. The chairman of your legislative committee came to the National Capitol representing the water user. The days were speeding along so fast there was danger that this repayment measure would not pass at all before the end of the session. It was a tight squeeze. It was one of those instances where an inch is as good as a mile. This statute is the most important reclamation enactment by the Congress since the passage of the original measure of 1902. The President signed the measure on August 4. It was the end of a long trail. This convention and its committees may wisely make an examination of this new statute, from preamble to final provision. I hope we have a law that merits approval.

Sugar-Beet Production

The production of sugar beets, and their conversion into sugar, has become a matter of importance to this association, primarily because sugar beets are a leading cash crop upon Reclamation projects in 10 or 11 States of the West. The present sugar-quota law expires in 1940. Production has already been hindered in the United States. A new law will be considered by the next Congress. To say that this is a ticklish subject does not justify evasion. Sugar is not one of our surplus crops, therefore the farmers of the United States have a moral as well as an economic right to preference. The home farmer in a dozen or more of the 48 States, the Hawaiian Islands, Puerto Rico, and the Virgin Islands—all under the American flag—seeks a progressively increasing acreage opportunity under quotas or otherwise, and protection from sugar imports enough to insure the home production. There are practical difficulties in the way. We may as well face them pleasantly if we can, but, nevertheless, firmly. Home labor has an interest and is entitled to consideration. American capital—large amounts—has become entangled in the Cuban sugar business, and you can depend upon it, a mortgage will follow its dollar a long way within this "good neighbor" doctrine that we hear so much about these days. Nevertheless, you will perhaps agree with me that the administration at Washington and the Congress of the United States ought to be a cordial neighbor of the sugar-beet farmer at home. The Federal Irrigation Congress in session at Sidney, Mont., a few weeks ago resolved that Representatives and Senators from Western States be urged to make every effort to secure the liberalization of quotas in the 1940 sugar act, to the extent that sugar-beet quotas may be increased so that farmers on Reclamation project farms may be practically unrestricted in the acreage that they may plant.

I hesitate to predict how the Congress will adjust these sugar production issues. There is need of study—a complete study—a consideration of what is fair to the individual grower who now enjoys a satisfying acreage, fair to the new regions that need the privilege of raising a surely profitable cash crop, fair to the sugar factories in the United States, fair to existing home refineries, fair to American labor now employed in the industry. Clearly, western Senators and Congressmen have a responsibility. Personally, I have enough faith in the Congress to believe that it will be unable to look the American farmer in the face, and say that he cannot raise as much as he may wish of a nonsurplus cash crop to pay the Government what he owes upon his Reclamation farm.

International Trade Treaties

Speaking a little further about trading with other countries, I am sure we are all pleased if the United States has friendly international neighbors. I am certain also we wish to be fair, even if interests differ somewhat, east or west, north or south. This is a far-reaching country. I was born and reared in New England. When we traded horses back there, the object was to get a little better horse each time. I am in favor of world trade—of reciprocal trade treaties—provided we get a bit the long end of the swap, and, I am not revealing a secret when I say that the farmers and stockmen of my country are not enthusiastic over some of these trade treaty trends. The present Canadian Trade Treaty does not have the approval of the western half of the United States. American business men if they build canneries in Argentine are likely to bring about the same situation that developed when financial interests put their money into Cuban sugar plantations and refineries. They may be helping a foreign country, but they are not particularly good neighbors of the American farmer.

The Middle West and the West have to earn their way largely through agriculture and stock raising. The National Reclamation Association has secured import figures from the Research Division of the Raw Materials National Council. It is a matter of serious concern when we learn that agricultural imports for the year 1938, based upon displacement in United States dollar values, reached the sum of $2,600,000,000, and that it would have required more than 40,000,000 American acres to produce these imports. A like record for 1935, 1936, and 1937 does not reassure the farmer. During the past year total exports have been going down. In the same period agricultural imports have been maintained or increased. It may take a long time, but we will learn after a while that these trade tariffs are a regional and economic, not a political, question.

Land Improvement

A new problem has come to the National Reclamation Association in the past year. This association is requested to take an interest in a dual enterprise—the drainage of swamp lands, and the clearing of stump acreage. This sort of land improvement has likewise been urged upon the officials of the Bureau of Reclamation. The impetus of these proposals arise within, or are a part of a Nation-wide appreciation of the importance of land use in the United States. Before we reach a conclusion there are a number of tests. In the rehabilitation of land, preclassification is just as important as it is before we develop the virgin prairie. There is a need to know something about potential productivity. Further, will the drained or the cleared stump land contribute to the general welfare of the region, as well as to the welfare of the whole Nation? Will there be a farmer demand for the improved land? Finally, will the general increment of value justify the cost? These are the tests if the Bureau of Reclamation and this association are to recommend these enterprises to the States and to the Government.

This convention further is close up to a compelling national situation. The Congress that convenes in January will appropriate large sums for the national defense. The whole country will ask—what about safety for the Nation? I am wondering then if this convention can suggest an answer to this challenging question.

Can we learn something if we look to what happened after the World War? Nearly every nation entered upon a diligent effort to diversify natural production—increasing each crop of the field, building new industrial life, searching its mines for mineral resources, bent upon meeting needs that had been emphasized by a war shortage, in other words, striving for self-sufficiency. Nationalistic was the word used. Call it what you will—the whole world went at it. In the realm of production there was a commerce declaration of independence. Now we are in another war. There will again be transitions in commerce—world-wide ambitions will again lead up to new situations. Permit here a question, please—what nations have always been unafraid and strong—shall I say invincible? A single paragraph is sufficient in reply. Those places and people where, under an encouraging government, free individuals have carried on studious research that has enabled diversified industrial production, where other free individuals farmed the land—working to bring every natural resource into the nation's storehouse—indeed there can be no greater national strength in time of peace, there can be no stronger national defense in time of war—cities with strength of industry, country life supplying its useful abundance, hunting out in sufficiency every mineral that can make its contribution—this is where Reclamation and the West come into the national defense formula with a balancing agriculture and with material from a thousand mountains.

In the Great War the United States paid from four to eight times the peace cost price for deficient strategic minerals. Government agencies now say we can discover supplies of antimony, chromium, manganese, mercury, nickel, tin, tungsten—I need not add more names. You can read the Government reports. The last Congress appropriated $100,000,000 for the accumulation of such materials. The American Congress and the American people with one voice are now for national defense. It will be so when the Congress convenes. When there is a proposal of money for the Army, we will with one accord say "Yes." If there is suggestion of funds for the Navy or the air forces, again we will say "Yes." Recruit the Army, build the Navy, fabricate for the air, but I would like to persuade you that there is more than this to national defense. A wide extending Nation like the United States, strong in every sinew and muscle of daily living—North and South, East and West—with every natural resource developed, with quick transportation to assemble and distribute, has no need to fear. We do not wave flags in the home, but we feed the soldier, sustain industry, and lay cornerstones of national confidence. The reclamation farm of the new West, the minerals and materials in the mountains, and the power to prepare them for utility—these things I urge can make a tremendous contribution to the national defense.

When the world is at peace again, we will still be making plans for reclamation. Wherever there is snow in a deep gorge or upon a high mountain in this western country, the people who live below may profit thereby. Wherever water flows over a spillway, there is still something to do. Wherever land in a watershed has been misused, there is a farm problem. Wherever care has not maintained construction, something can be done about it. Wherever the water flow does not meet the peak need of a season, a new plan may help. Wherever there is a long journey from the mountain spring to the sea, differing uses of the water often enable a multiple project. These problems still challenge this association—will continue to challenge the States and the National Government until all the water is at the gateway of service.

We said we could build a new West. Enough has been done to justify the faith. If we keep the faith, there will be another forest along the mountain slope, there will be new grass waiting for the flocks and the herds, there will be fertile fields along each stream, and the pasture land and green valleys will bring abundance at the harvest time.

The song of the pioneer can still be Home on the Range, but in the greater West we are making there will be new hopes and new realizations—a song that cannot die: "From the mountains to the prairies, to the oceans white with foam—God bless America—my home—sweet home."

Columbia Basin Irrigation Districts

ON December 6 land owners voted on the organization of two irrigation districts in the area to be served by Grand Coulee Dam. These districts, the east and west, counted votes totaling 617 for and 67 against the former and 735 for and 49 against the latter.

The bureau is working on a long term planning program in order to secure orderly development of the area for small single families owner-operated farms adequately serviced by transportation marketing and educational facilities.

Report of F. O. Hagie, Secretary-Manager National Reclamation Association

THIRTEEN months ago this body met in Reno, Nev., for 3 days. There you listened to a score of speakers on as many subjects—considered what they had to say—then in the light of your own intimate knowledge of the needs of your respective States and districts, you compressed all your ideas of what ought to be done for the reclamation and water conservation program into some 17 resolutions, passed them unanimously, laid them in the lap of your officers and directors as a program of work for the year, then adjourned and went home.

Now we are in Denver on a similar mission. This afternoon it is the purpose of your officers to review briefly the happenings, progress, and accomplishments in the field of the association, through the eyes of the president, the directors, the treasurer, and the secretary-manager, and perhaps to call to your attention matters which we believe warrant your consideration in the immediate future.

Concerning the progress and accomplishments which have been made on the association's program during the year, some of them have or will be elaborated on by others who are much better prepared to speak on many of the details than am I, so I will refer to them but briefly.

Repayment Bill

The repayment bill was one of the principal undertakings and one of the outstanding accomplishments of the year.

Action on Resolutions Passed Last Year

The 17 resolutions which you passed last year referred to numerous subjects bearing directly or indirectly upon reclamation and water conservation problems, but all affecting the development of the West in one way or another, touched the whole wide field of our western political economy and required action by the legislative, executive, and judicial branches of our Federal Government.

In addition to the enactment of the repayment bill, the Great Plains water conservation program was provided with $5,000,000 of hard money, negotiations were inaugurated with WPA officials for upwards of $7,500,000 of relief labor to supplement the program, and the Great Plains authorization act was passed, giving permanency to the program and making it eligible for budgetary consideration each year by the administration. At least three Great Plains projects have already been approved for construction.

The National Resources Planning Board was reorganized and continued for 1 year.

The CCC program, with 44 of its camps assigned to reclamation work, was continued by law for 4 more years.

A western judge was appointed to fill the vacancy on the Supreme Court.

Nine hundred thousand dollars was appropriated in place of the usual two or three hundred thousand for investigational work by the Bureau of Reclamation.

The beet sugar acreage allotment problem is all riled up at the moment, but we believe that it is much nearer a satisfactory solution than it was when we met before.

More than $51,000,000 was appropriated directly for construction work during the fiscal year.

Two new Federal reclamation projects were approved and started.

The appropriations for Indian irrigation projects were increased over those of a year ago.

Senate Document No. 36—a reference book on western reclamation—was assembled, printed, and distributed far and wide. The facts contained therein are already reappearing as the predominant thought in editorials, newspaper and magazine articles in all parts of the country, and in public statements wherever reclamation is discussed.

More money was appropriated for stream gaging and ground water studies than ever before.

Additional money was made available for extension work by the western agricultural colleges.

Progress has been made by the subcommittee of the National Resources Planning Board in its study of the needed water laws in the West.

In the consideration of the administration-sponsored lend-spend bill, which died by refusal of the House to consider the measure, the Senate had included $90,000,000 additional appropriations for western reclamation construction, thereby paving the way for further consideration in case such legislation may be considered in the future.

New Reclamation Allies

During the year four strong national and regional organizations have endorsed the Federal Reclamation policy in undeniably strong terms. These new allies of Western Reclamation are: The Mississippi Valley Association, representing 22 States; the Ohio Valley Conservation and Flood Control Congress, representing 4 States; the Chamber of Commerce of the United States, representing all 48 States and possessions; and the National Rivers and Harbors Congress, which likewise represents all States and possessions.

In each case the results achieved during the past 13 months are the product of much hard, coordinated teamwork and devotion to a cause on the part of the association members, Members of Congress, and Bureau of Reclamation officials.

So much for the results obtained on the jobs which you spelled out and set your minds to as wanting the association, the Bureau, and the Congress to accomplish during the year.

By and large, it was a successful year—probably one of the association's most successful years, and perhaps that is because the year was a 13-month year.

Past Year's Accomplishments

Miss Jones, my secretary, who has much more of a flare for details than have I, has provided me with the following summary of the part which your Washington office played as a sort of coordinating agency in the year's accomplishments. Her summary is as follows:

"During the year the Washington office prepared and mailed 18 general bulletins to the membership, newpaper, and congressional lists, totaling some 40,000 copies. Between 15 and 20 congressional memorandums on as many subjects were prepared and dispatched, as well as special letters on specific subjects to western Members of Congress. Some of the most effective pamphlets and folders include:

(1) The Displacement of American Agricultural Acreage by Foreign Grown Farm Products, compared with the Acreage and Productions of the Federal Reclamation Projects.

(2) National Irrigation Policy—Its Development and Significance (printed as Senate Document Number 36).

(3) Six graphical charts showing Reclamation crop statistics.

(4) Two precipitation maps of the United States showing why Reclamation is essential in the West.

(5) Reproduction of scores of editorial comments in support of Reclamation and water conservation taken from newspapers throughout the country.

Your Washington office held a series of weekly meetings in the Nation's capital for the purpose of bringing the friends of Reclamation together to exchange ideas and to coordinate their efforts. Between 70 and 80 project representatives and other friends of Reclamation visited the Washington office during the year, some of whom made our office more or less their Washington head-

(*Continued on page 330*)

A SECTOR FOR THE FUTURE

By JOHN C. PAGE, *Commissioner of Reclamation* [1]

WITH war clouds darkening other continents, this is an appropriate time for peaceful America soberly to consider her national objectives. Our aims, it has been clearly demonstrated, have been the improvement and defense of the United States, and a major program of action in line with these aims is the broad program for the conservation of our national resources.

Typical of the activities of the Federal Government under the leadership of President Franklin Delano Roosevelt, the conservation program constitutes a stirring attack on critical domestic problems, through the solution of which this and future generations will be benefited spiritually, socially, and materially.

The contrast between the wholesome national policies which have been absorbing our attention and energies and those of other peoples which have led to war is best illustrated by comparing the dams we have built to make our country more livable and productive with the lines of fortifications and the network of air-raid shelters which have made nightmares even for Mars of the public works programs in some sections of the world.

With respect to our national conservation program, the Honorable Harold L. Ickes, Secretary of the Interior, who has played a vital part in shaping it, said a few days ago at Friant Dam when we were starting work on that important structure of the Central Valley project:

"Conservation is no longer a slogan; it is a national policy. At long last, after years of exuberant squandering, our people are insisting that our public lands, our forests, our water, our soil, our metals and minerals, our wild life, and our natural recreational assets be used without waste. We want to enjoy our national riches, but we also want to preserve them for the use of generations to come."

Then he sounded this pertinent warning:

"We must not let our purposes be diverted by wars in Europe and Asia or halted by any mobilization for unjust profits at home. The gains already made must be preserved."

I want to emphasize these statements, for serious or irreparable damage will be done to such well-planned, long-term conservation programs as that of Reclamation by interruption or by ill-considered distortion in an hysterical moment.

[1] Address delivered November 15, 1939, before Eighth Annual Convention, National Reclamation Association at Denver, Colo.

Importance of Reclamation

Importance in the national defense is attached to the work we now are doing. Great storage dams now under construction in addition to irrigation will serve also to generate power. Several of them are located in regions which have undeveloped deposits of minerals and metals that would be strategically needed. The low-cost power would be essential, in many instances to their development and processing. Expansion and proper distribution of agricultural production might also be needed. Reclamation projects abuilding or planned could meet, in part, this need.

The Reclamation program is, as I view it, the keystone of our conservation activities in the arid and semiarid West. Without intelligent use and control of the water in this dry region, the point of other related programs would be dulled, and they would be rendered almost meaningless.

Let us review, therefore, the achievements of 1939 in the field of reclamation. The construction program, largest in our history, gained momentum and moved forward satisfactorily on all fronts. Generally this has been a good year on operating projects. Demand continues to outrun by many times the supply of new homemaking opportunities created on the new projects.

Probably most significant among the year's developments has been the enactment of the Reclamation Project Act of 1939. This act, representing the best thought of the Department of the Interior, of western irrigation leaders, and of the congressional committees on reclamation, was signed by President Roosevelt on August 4, 1939.

I consider it the most important legislation in this field since the basic reclamation law was enacted in 1902. It provides a workable means of adjusting repayment charges, year by year, to the ability of the water users to repay, and thus it increases the security of the investments of the United States in the projects. It provides for reclassification of lands on the projects from time to time. And in the planning and design of new projects it provides for consideration of benefits related to the primary irrigation function.

The repayment features of the act will be the subject of a special discussion on your program, so it will be sufficient for me to say now that we are sincerely hopeful that, under these provisions, we shall be able to make the modifications which the water users of each project may find necessary in order to avoid in the future requirements for moratoria on construction repayments. We have found no project situation as yet in which one or more of these provisions are not applicable, and I believe we shall find no such situation. The provisions of the so-called little relief act have been continued in force for 5 years, or, in other words, for a time ample to write new contracts. Under the little relief act, which made it possible for the Secretary of the Interior to postpone such of the construction charges for last year as conditions actually warranted, approximately 10 percent of the total construction charges due in 1938 was postponed. This is almost the same percentage of postponements as was found necessary for the previous year by the Repayment Commission.

There is little doubt that the flexible repayment formula in the Reclamation Project Act of 1939, or other provisions of the new law, would have cared for the situations which made these postponements necessary.

It has been necessary for the Bureau of Reclamation, operating as it does with the minimum of administrative personnel to request that the water users be patient with respect to their revised contracts. Immediately following the adjournment of the National Reclamation Association convention, the Bureau of Reclamation field personnel is convening here in Denver, and attention will be given during these meetings to the procedure which ought to be followed in the revision of contracts. Those desiring contracts revised under the 1939 act should consult first with the superintendent or the district counsel, in charge of the particular project which serves their lands.

Land Reclassification

Some requests are being received for land reclassifications under the new bill. It is anticipated that an orderly program of land reclassification will be undertaken by the Bureau in conformity with these requests as soon as weather conditions will permit next year.

I want to call the especial attention of the irrigation leaders of the West to section 9 of the new act. Under this section, for the first time, intelligent provision has been made by which the Bureau of Reclamation can, in planning a new project, take into consideration related benefits and make proper allocations of cost as among irrigation, flood control, miscellaneous uses, and power. For several years I have been urging that such recognition should be given to the multiple purposes served by our water-storage dams.

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Parallel Interests of the Bureau of Reclamation and the Army Engineers

By MAJOR GENERAL J. L. SCHLEY *Chief of Engineers, U. S. Army*[1]

THE Bureau of Reclamation and the Corps of Engineers, United States Army, are both well-established Federal agencies for the execution of public works operating under basic laws which, although amplified and amended from time to time, have been on the statute books for many years. Both agencies deal with the use and conservation of water resources; the Bureau of Reclamation in the primary interest of irrigation, the Corps of Engineers in the primary interest of navigation and flood control.

You are all well acquainted with the history of the Bureau of Reclamation and its outstanding service to the Nation, so I will not attempt to review its development and accomplishments. Rather, I shall attempt to review the circumstances and legislation which brought about the parallel interest of the Corps of Engineers and the Bureau of Reclamation in the needs of irrigation, to assure you that the Corps of Engineers realizes the importance of these needs, and that my organization now, as in the past, stands ready and willing to cooperate fully with the Bureau of Reclamation in seeing that these needs are met.

For some time after the Federal Government undertook reclamation of arid lands, the paths of the Corps of Engineers and the Reclamation Service did not come close together. In those days, Federal irrigation projects were mostly along streams not navigable, or not then considered susceptible of improvement for navigation, and in regions as yet not sufficiently developed for flood control to be a serious problem. Federal navigation and flood control projects were for the most part located in the earlier and more thickly settled regions of the country where abundant rainfall made irrigation unnecessary. Federal control of hydroelectric power development, as a matter of water conservation, was not then considered necessary.

As the development of the country progressed, improvement of our rivers for navigation went hand in hand with the westward spread of settlement on arid and semiarid lands which required only water to make them productive. More and more water was being used for power development. With the crowding of population and industry into the river bottoms, the additional problem of protection against floods arose. Under a policy of "first come, first served" the best dam sites were preempted, and both navigation and irrigation projects became more and more involved in the question of incidental production of hydroelectric power. It became apparent that further development of our water resources would be a complicated problem demanding study, planning, and regulation from the national standpoint. This situation received, in due course, the attention of Congress, and during the period 1912–17 there was considerable legislation pointing the way toward coordinated use of water in connection with stream improvement. Progress in this direction was delayed by entry of the United States in the World War.

Federal Power Commission Created

Soon after the World War, Congress again considered the question of water conservation and the result was the passage of the Federal Water Power Act and creation of the Federal Power Commission. This was followed by legislation calling upon the Secretary of War, through the Corps of Engineers and the Federal Power Commission, to prepare and submit a joint report giving an estimate of cost for making comprehensive investigations and surveys of practically all the important river systems of the country with a view to the formulation of general plans for the most effective stream improvement for the purposes of navigation, and for the prosecution of such improvement in combination with the most efficient development of potential water power, the control of floods and the needs of irrigation.

The joint report of the War Department and the Federal Power Commission called for by Congress was submitted in 1926 and published in House Document No. 308, Sixty-ninth Congress, First Session. The investigations and surveys outlined therein were authorized and directed by Congress in the River and Harbor Act of 1927 to be made by the Secretary of War through the Corps of Engineers. This action by Congress is especially noteworthy, since it placed national planning for water conservation on a firm working basis, and of particular interest to us here today because it is the reason for the official interest of the Corps of Engineers in the needs of irrigation.

The investigations and surveys by the War Department under the provisions of House Document No. 308, Sixty-ninth Congress, First Session, generally referred to as "308 Surveys," were prosecuted vigorously during the period 1928–34 and reports thereon duly submitted to Congress.

Throughout the studies full consideration was given to all the beneficial uses of water, including the needs of irrigation wherever they were found to exist. At all times the Corps of Engineers sought and received the cooperation and assistance of a great many public and private agencies concerned with water conservation, among which of course was the Bureau of Reclamation. This assistance was invaluable, and at this point I wish to pay tribute to the splendid spirit of helpfulness of the engineering profession, both in Government service and private practice, which contributed so generously to make the "308 reports" collectively a monumental success.

In compliance with the specific direction of law, each of the "308" reports sets forth a complete general plan for improvement of the streams in question in the combined interest of navigation, flood control, power development, irrigation, and other beneficial purposes, with discussion and estimates of the benefits that might reasonably be expected to accrue from improvements under these plans, and with recommendation for their adoption as a guide for future development of our water resources. These reports, most of which were printed as public documents, formed the basis for a large part of the expansion of our public-works program for relief of unemployment and constitute the framework for a great deal of the planning going on today. Realizing the importance of the "308 Surveys" in development of our water resources, Congress made provision for keeping them up to date through enactment of section 6 of the River and Harbor Act of 1935.

Flood Control

In 1936, after the country had been subjected to widespread and unusual floods of unexpected magnitude, a great public demand for flood control arose. In response thereto, Congress passed general legislation declaring flood control to be a matter of national concern and establishing the policy of Federal participation in construction of protective works when the benefits, to whomsoever they accrue, are commensurate with the cost. The War Department was charged with the duty of improving streams for flood control and the Department of Agriculture was charged with the duty of improving watersheds for retardation of run-off and preven-

[1] Address delivered at Eighth Annual Meeting of National Reclamation Association at Denver, Colo., November 15, 1939.

tion of soil erosion. The Flood Control Act of 1936 also authorized construction in the interest of flood control of many of the dams proposed in the "308 reports," and directed additional investigations and surveys to be made by the Corps of Engineers of many river systems throughout the country with a view to flood control. Similar flood control acts were passed by Congress in 1937, 1938, and 1939.

In the discharge of its duties under the various laws just referred to, the Corps of Engineers has in recent years had occasion to study and report upon and, in some instances, to build reservoirs affording incidental benefits to interests other than navigation and flood control. Likewise, the Bureau of Reclamation has had occasion to study, report upon, and, in some instances, to build reservoirs affording incidental benefits to interests other than irrigation. Indeed it may safely be said that there will henceforth be built very few large dams which will not have for their purpose the impounding of water for multiple use. I am happy to say that, in the investigations and reports on multiple-purpose projects, there has been, and is, complete cooperation between the Bureau of Reclamation and the Corps of Engineers, with duplication of effort practically eliminated.

Also there is generally close agreement between these agencies as to the possibilities and benefits of the proposed uses of water, as to engineering features, and as to costs. Divergence of view is possible having to do with local cooperation because of a difference in the basic laws governing the work of the two agencies concerned.

Both the Bureau of Reclamation and the Corps of Engineers are required by law to see to it that the United States is duly reimbursed by local interests for benefits accruing solely to them from Federal water conservation projects. Under the Reclamation laws, this local cooperation consists in repayment of construction costs chargeable to irrigation, without interest, and in installments spread over a long period of years. An annual charge is also by the Bureau of Reclamation to cover cost of operation and maintenance. Under the laws governing streams improvement for navigation and flood control, there is no provision for waiving payment of interest. Local interests are required to pay their just share of the cost of a project either by cash contributions in advance, furnishing necessary lands and rights-of-way, assuming the obligation of operation and maintenance, or a combination of these commitments. Whenever operation and maintenance is assumed by local interests, they do so under strict supervision of the Corps of Engineers in accordance with rules and regulations prescribed by the Secretary of War.

I feel sure that the divergent methods of requiring local cooperation used by the two agencies can be reconciled so that the cost to irrigation interests and the return to the United States will be practically the same under the two methods. Irrigation interests may rest assured of sympathetic cooperation of the Corps of Engineers with the Bureau of Reclamation in reporting on projects which may not be economically feasible unless incidental flood control, or navigation, benefits are taken into account. The Bureau of Reclamation can be of material assistance to the Corps of Engineers in reporting on flood-control projects affording incidental benefits to irrigation. As a matter of fact, the highly trained experts developed by the Reclamation Service and the Corps of Engineers, operating in their special fields and cooperating with each other, are the most competent officials to make into a unified whole the water-conservation projects undertaken by the United States.

As I have said before, our dealings with the Bureau of Reclamation have been cordial and cooperative. Until recently, the cases in which we have worked together have been comparatively few in number. Now that our paths are drawing closer together, I expect to see more and more of our friends, the Reclamation engineers, and I am confident that these contacts will result in greater mutual respect as well as in better and bigger public works for water conservation.

Secretary-Manager's Report

(Continued from page 327)

quarters; others frequently conferred on ways and means of advancing their particular project.

The office originated approximately 4,500 outgoing phone calls during the year. Approximately the same number of incoming phone calls may help to indicate to some extent the activity of the office.

Our records indicate that since our last meeting the association has added 625 individual memberships and 270 organization memberships.

Both President Warden and your secretary-manager appeared before such congressional committees and governmental departments as were necessary in the promotion of the association's program.

Now, what of the problems immediately before the association and the West to which this group should give attention?

While the continuance of the Federal Reclamation policy is contingent upon the repayment of construction costs by the water users, the association probably always will find it difficult to overlook for long the problems of the water users. In that regard the policy of the Federal Government concerning the allotment of increased acreage for the production of domestic sugar beets raises a serious problem, as well as the issue of whether the National Reclamation Association—or some other organization with a more single purpose—should take the lead in finding a solution. Opinions have been expressed on both sides of the issue as to whether the association should properly champion the cause of the domestic sugar beet producers and of course, the sugar question itself remains yet to be solved.

For several years there has been a growing desire on the part of leaders in the South and in the Pacific Northwest to amend the reclamation law to permit the Bureau of Reclamation to reclaim swamp lands by drainage, to reclaim cut-over land by clearing, and to rehabilitate drainage projects all on an interest-free repayment basis. During the past year at least two bills having such a purpose have been introduced in Congress. This association should give thought to what the western attitude on these proposals should be. The subject will be presented to you more fully on Thursday.

The place of Federal Reclamation in our national defense program is worthy of discussion here and among your groups at home, and by the press of the West as well. Construction progress during the next few years will probably depend largely upon the answer which this administration gives to that question.

During the past 47 years, reclamation and land and water conservation in the West have been sponsored in 9 different platforms of the Republican Party and in 7 platforms of the Democratic Party. Approaching as we are another national election next year, it seems appropriate that proper action be taken to have the two major political parties again declare their positions on this subject, which is of such vital interest to the entire West. That such declarations should be favorable, far-sighted, and fearless is the belief of many.

It is interesting to note that during the 8 years that this association has been in existence, more than $462,000,000 has been made available for reclamation construction, as compared with some $307,000,000 that had become available for construction during the preceding 30 years since the Reclamation Act was passed. I take some personal pride in the fact that of the $462,000,000 which has become available during the past 8 years, I have had some small part in helping with more than $415,000,000 of it. These are huge figures, but they represent self-liquidating capital investments made at a time when the labor employed and the materials required made an outstanding contribution to the recovery and welfare of the Nation. The works which this money will put into use will add to the permanent assets of the Nation.

Through the Bureau of Reclamation this Nation has invested over $770,000,000 in a series of engineering works of earth, concrete, and steel, many of them representing the height of achievement in the engineering world. If this investment in great engineering projects is to be repaid to the Government in full, and I believe it will be, it must be repaid largely through the practice of successful irrigation agriculture. It is apparent, therefore, that attention to this phase of the work should in the future share equally with the attention which is given to the more spectacular construction work of the projects.

It has been an inspiration to work with President Warden another year. He has been tireless in his devotion to greater progress in every phase of the association's program. No effort or sacrifice has been too great if necessary to accomplish the goal of the association or to advance the general cause of water and land conservation and use. High in the counsels of business and political groups of this Nation, President Warden probably has exerted more influence and made a greater contribution to the reclamation and water conservation program in America than any other man in civil life during the past few years.

We face the problems of a new year with the largest and strongest membership in the association's history; our organization has been definitely strengthened in at least five States; and western Senators, Congressmen, and Governors, almost to a man, are supporting this program as never before. At least two additional States are contemplating the advisability of joining hands with us in this common cause.

So, as we consider the problems which our convention speakers present during the next few days, may we remember that the West is now organized for effective action and results. We are prepared to represent the western half of continental United States as a solid unit while each in our respective areas seek out, plan, and construct the reclamation and water conservation and utilization projects upon which eventually another 12,000,000 men, women, and children will find their homes and opportunities. You are engaged in a great cause—a work of permanent benefit which is definitely linked with the destiny of the West.

Sector for the Future

(Continued from page 328)

Irrigators on the complex, multiple-purpose projects of the future, now that this has been done, will not be required to underwrite proportions of the construction costs of their project which logically should be charged against other beneficiaries.

Small-Dam Program

Section 9 holds great significance, especially for the large and complex projects. At the other end of the scale, a program for the construction of small dams was authorized in August 1937. This authorization provided that $500,000 could be appropriated to be expended on small-dam projects selected by the Secretary of the Interior, none of which was to cost more than $50,000.

The small-dam program was devised as a means of extending to the little streams in the isolated valleys the benefits of the Reclamation Act. To date there have been no funds made available for the construction of any projects under this small-dam program. I believe the time has arrived when we should give serious consideration to the undertaking of the demonstrational work in the field of small projects construction which was contemplated in the act adopted more than 2 years ago.

It has been most difficult to plan ahead our work because of the uncertain condition in which we find the Reclamation Fund. It is an old story to you that the sources of accretions to the fund have very largely dwindled away with the virtual cessation of the disposal or sale of public lands. The money obtained under the Hayden-O'Mahoney amendment, which placed in the Reclamation Fund a part of the royalties already collected from oil taken from naval reserves, has solved our financial problem temporarily. This temporary solution, however, has not cured the ill. By the close of the 1941 fiscal year the fund will again be depleted. The fact that sums received by the fund as repayments are expected to increase materially when such projects as Grand Coulee Dam and the Central Valley project begin to return revenues is comforting, but it does not solve the difficulties of the next few years.

In 1942 construction of projects now tied to the Reclamation Fund cannot be financed unless something is done. The financing of some of these projects might be shifted from the Reclamation Fund to the General Treasury, or an advance might be made by the General Treasury to the Reclamation Fund. These are suggestion; other and better solutions might be found. I hope, with all of you of the West, that a satisfactory solution will be found. I would like to see this problem receive the same careful and thorough attention that was given to the repayment and related problems during the past 2 years. If this study is given, I am confident that we can be assured of as logical and as satisfactory a solution.

That it is desirable that we go forward with the Reclamation program is beyond successful challenge. Let me, for a moment, review some of the results of the program as evidence supporting this statement.

I could tell you, for example, that in 37 years under the Federal Reclamation program we have constructed on a reimbursable basis 156 dams and 48 powerhouses; that the powerhouses produced more than 2 billion, 212 million kilowatt-hours of energy last year which sold for $5,610,847.14; that 903,897 people live on 52,552 farms and in 258 towns and cities we have created by irrigation, and that these people had on deposit in banks last year $226,645,573; that 3,040,695 acres were irrigated by Federal canals, and last year produced crops valued at $113,463,460, or $37.31 per acre. Without comparisons or interpretations, however, these bare facts would mean little.

Let us say, rather, that the great network of dams built by the Bureau of Reclamation in the big, arid, Western States provided water to irrigate the farms which supported nearly one-twelfth of the rural and urban population of the West, and furnished power for use on the farms and in the homes of about one-fourth of the West's people. Let us say, rather, that deposits in banks which never would or could have been opened without construction of these projects last year came pretty close to equaling the cost of construction of all of the operating Federal projects; noting also that the cost of construction of these projects is repayable to the United States and that more than $50,000,000 has been repaid. Let us say that the raw crops produced on the lands we irrigated represented a contribution to the national wealth last year alone of more than 113 million dollars, and that the per acre return to the farmer on our projects was considerably more than twice the national average.

To appreciate these facts fully one should realize the limitation placed by nature on the development of the West by the aridity of its climate. Only irrigated land, for the most part, in this arid third of our country can be closely settled. Only 2 out of each 70 acres of all the land in the West are irrigated. That means that the population of this region largely is concentrated in one thirty-fifth of the area, which leaves about 34 out of every 35 acres for the wide-open spaces.

Through additional irrigation where water can be had, additional communities can be created, and the social and economic structure of the West can be strengthened. Upon new irrigated lands will rest the foundation of the West's future growth. Here in this region are found our major undeveloped resources. The West is America's elbow room—her room to grow. Fundamental to the development of these resources, fundamental to our future growth, is irrigation. This should never be overlooked nor forgotten.

We must hew the line, because by irrigation and related conservation programs in this country we can peacefully work out our destiny. Our great works must be lines of life, as they are here today, and not the fortified lines of death they are elsewhere. Dams can be our forts, and canals our connecting network of trenches. Let the ramparts we watched symbolize the creation of civilization instead of serving as sentinels of doom.

You of the West have given your support to these programs of conservation and development, and I am confident we can count on continuation of your fine efforts. Let us continue to employ our intelligence for further advances on present paths—advances that can seize a sector for the future where we can expand and live without the sad saga of cannon and conquest we behold today beyond both oceans.

Reclamation Legislation in Congress

By HON. COMPTON I. WHITE, *Member of Congress from Idaho*[1]

AFTER years of exploitation and waste of our Nation's apparently limitless resources, the people of the country are coming more and more to the realization of the necessity for conserving our priceless natural resources.

Today we are witnessing a titanic struggle in Europe which is shaking the very foundation of civilization in the contest for the very resources which we are either neglecting or lavishly wasting. I am sure that most of those interested in the reclamation of our arid and semiarid lands keenly appreciate not only the national policy of reclamation but also the orderly utilization of our land and water resources and, I may say, all of our national resources.

Just as the use of land and water are inseparably linked in reclamation, so conservation and orderly utilization are interdependent if our country is to prosper and progress.

Our first and most important resource is our people. Providing a means for the rising generation to earn a living in liberty and security is the first duty of our Government. This task was easily and amply met in the era of territorial expansion just closed when new frontiers beckoned and rewarded the pioneer who settled new lands and established new communities. The pioneers brought water to arid lands of the West and by their enterprise and industry created conditions that brought advantages to these newly developed communities on irrigated land, superior in many cases to the natural conditions of the more favorably located agricultural lands in the Central and Eastern States.

Appreciating the beneficial effect of developing pioneer reclamation projects by private interests in building new communities and contributing to the Nation's prosperity, our Government in recognition of the opportunity to expand and offer new lands for settlement adopted the policy of National Reclamation and has set aside the funds obtained from the sale of land and minerals in the public-land States of the West in the Treasury to establish the reclamation fund which is used to finance the construction of Federal Reclamation projects, the money to be repaid to the Government by the water users without interest. This broad, constructive program administered by the Department of Interior has operated to conserve and utilize our land, water, and power resources providing a means of settling up large areas in our Western States with communities that vastly added to the Nation's wealth and expanded our domestic market for the products of all parts of the country, particularly the manufacturing sections of the Eastern States.

Today with a large part of the population unemployed and supported by relief appropriations, it is apparent that new lands must be opened for settlement and ways must be provided so that surplus population can establish homes and produce the necessities of life for their subsistence and support.

Importance of Reclamation Recognized

The Federal Government is appreciative of the importance of reclamation in the continued development of the country and is broadening and expanding its reclamation program and is now engaged in constructing the two largest projects ever undertaken—the Central Valley project in California and the Grand Coulee Dam and related Columbia Basin project in Washington which combines the conservation and utilization of three great resources, land, water, and power. Water that has been running away unused to the sea will now be permanently put to the twofold purpose of land utilization and power generation.

Reclamation has never been a partisan issue. It was inaugurated as a national policy in 1902 under the leadership of President Theodore Roosevelt, a Republican, and Congressman Francis G. Newlands, a Democrat from Nevada. The Federal Government has adhered to the Reclamation Act of 1902 although the statute has been amended and the sphere of reclamation enlarged. The original principles have been maintained and no one can successfully challenge the benefits to the country as a whole that have resulted from that policy. Partisan politics have not deterred the reclamation program but there has been difficulty in securing adequate appropriations for the reason that the 15 Western States where the projects are located have a small representation in Congress and have been faced with the problem of convincing the preponderant eastern members of the all-embracing national benefits of the program. It is significant of a new sentiment among political leaders that in the First Session of the Seventy-sixth Congress, which adjourned in August, a total of $88,326,148 was appropriated for irrigation and reclamation. Twenty-four new projects which will cost $59,323,030 were included in the appropriation. In preparation for guidance in consideration of future sessions of Congress an appropriation of $900,000 was made so that the Bureau of Reclamation could make adequate investigation of new possibilities for projects.

While enormous sums are appropriated for prosecution of the reclamation program, we must not lose sight of the fact that all of this money is merely a loan without interest and that it is all repaid by the settlers on the various projects. The record of repayment is one that can be pointed to with pride. Approximately 30 percent of the costs of reclamation projects completed and in operation had been repaid by June 1, 1938, and the record compares favorably with those of the other Federal activities relating to internal improvements or designed to protect the national interests. The West has given unqualified support to the national rivers and harbors and flood control programs in which the Federal Treasury has contributed more than 2 billion dollars without any obligation to repay which is in contradistinction to the plan that has always existed with reference to irrigation and reclamation.

Repayment Commission Created

From time to time it has become necessary for the irrigation farmers to seek adjustments in the matter of repayment to the Government which has been occasioned by economic processes not foreseen at the time the original contracts were entered into. After the passage of several moratorium bills affecting particular projects, it became evident that an over-all plan for the benefit of the irrigation farmers would be a salutary move on the part of the Government. A change in the existing laws relating to payment of the construction costs and on the irrigation projects could only be recommended after an intensive investigation of the need for such legislation was made. For this purpose I had the honor to present to the Congress in 1937 the bill to create the Repayment Commission. The bill became law and three outstanding western men were appointed by the Secretary of the Interior to make a report on reclamation and Indian irrigation projects on a feasible and comprehensive plan for adjustment of payments commensurate with the ability of the producers to pay and at the same time preserve the Government contracts inviolate.

Seventy hearings were held in the West and an exhaustive report transmitted by the Secretary of Interior to the Congress on May 18, 1938. As a result of the Repayment's Commission report and its subsequent study by the Members of Congress, there was introduced in the House of Representatives in the

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[1] Address delivered at eighth annual convention, National Reclamation Association, November 15, 1939.

Flood Control and Its Assistance to Reclamation

By HON. DEWEY SHORT, *Member of Congress from Missouri and President, National Rivers and Harbors Congress* [1]

I AM happy to be with you today and to return the courtesy of the distinguished president of your association, Dr. O. S. Warden, who has appeared several times in recent years on the programs of our annual conventions in Washington.

I bring you the greetings and cordial good wishes of the officers and directors of the National Rivers and Harbors Congress.

Work of the National Rivers and Harbors Congress

As all of you may not be familiar with the work of the Congress, permit me first to tell you something of our organization, its scope, and purposes. The National Rivers and Harbors Congress is a national organization dedicated to the improvement and development of the inland waterways and harbors of the United States, for purposes of navigation, commerce, recreation, etc., the prevention and control of floods, reclamation and irrigation, and the conservation and utilization of our land and water resources.

Originally organized in the year 1901, it was a pioneer in the struggle for the protection of our natural resources and has taken a leading and active part in this fight for nearly four decades.

The members of the Senate and House of Representatives are honorary members of the Rivers and Harbors Congress, and many of them take an active part in the work of the organization. The officers of the Corps of Army Engineers engaged in river and harbor work are likewise ex officio members of the congress. The congress acts in an advisory capacity to the National Congress and the Government agencies charged with matters relating to river and harbor development, flood control, irrigation, soil, and water conservation.

The membership of the congress is composed of States, cities, chambers of commerce, waterway and similar associations, firms, and individuals located in every State in the Union, its Territories and insular possessions. Among its members are many nationally known public officials, as well as outstanding leaders in the business and professional world.

The congress maintains permanent headquarters in Washington, D. C., where its annual conventions are held. From its offices, by group and sectional meetings, as well as its annual conventions and special sessions, through its news bureau, publications, and field agents, it keeps constantly before Congress, the Administration, and the public the desirability of needed waterway improvements and their fullest utilization for the public benefit.

The organization has for its purpose the promotion of continued improvement of the Nation's rivers, harbors, lakes, and waterways, and the investigation and approval of justifiable waterway projects throughout the country. It advocates the orderly development of our water resources for purposes of navigation, flood control and prevention, irrigation, reclamation, prevention of soil and shore erosion and stream pollution, increased recreational facilities, hydroelectric power, and related uses. It provides a forum for discussion of all problems relating to waterway development and utilization, and serves as a clearing house for uniting and coordinating the activities of local and sectional organizations.

The National Rivers and Harbors Congress, being the parent organization and representing as it does the entire country, affords a means for securing coordinated and united action by all the interests concerned with the various phases of water development.

Its work has received the highest commendations of every President of the United States from Theodore Roosevelt to Franklin D. Roosevelt, as well as of Cabinet Members, Governors, Senators, Representatives, and other high officials.

It is generally the policy of the organization to follow the recommendations of the United States Army Engineers and the Federal Bureau of Reclamation in advocating projects, and it is in no sense an organization which approves any project of the "pork barrel" type. Thus far there has been no adverse criticism of any of the recommendations made by the congress in its resolutions and reports, and virtually every bill passed by the Federal Congress for improvement of harbors and waterways has been composed almost in toto of projects previously investigated and recommended by the National Rivers and Harbors Congress.

Recommendations and resolutions adopted by the congress are presented by committees to the President of the United States, the Vice President, Speaker of the House of Representatives, the proper congressional committees, the Secretary of War, Secretary of the Interior, Commissioner of Reclamation, Chief of Army Engineers, and other appropriate officials and agencies. The projects endorsed by the congress upon the recommendation of its Projects Committee, headed by United States Senator John E. Miller of Arkansas, are vigorously and continuously advocated for inclusion in the Government's public works program and appropriations or allocations of funds sought therefor, while the congress endeavors to see that its policies are made the basis of legislative enactment.

Flood Control and Irrigation Interests Identical

In previous sessions of Congress, I had the privilege of serving as a member of the Committees on Rivers and Harbors and Flood Control of the House of Representatives and am now ranking minority member of the Committee on Irrigation and Reclamation under the chairmanship of my friend and colleague, Compton White, of Idaho. I have thus had occasion, during my service in Congress, to deal with the three principal features of water conservation. Taken together, I believe they represent one of the most important fields of development in our national life.

Flood control, and irrigation and reclamation interests in the arid and semiarid States of the West are identical. Our common objective is a coordinated program of (1) flood control, (2) water stabilization, and (3) power development. Experience has taught us that the wisest and most economical policy of conservation activity is one that recognizes the value of this combination. I realize that the public benefits derived from multiple-purpose projects differ with the location, and that irrigation and reclamation is the lifeblood of agriculture in this great West. While you may not be endangered by great floods that have taken their toll in other sections of the country—still the recurrence year after year of spring freshets is an alarming problem, resulting in a loss of topsoil and more than anything else a waste of the water, every drop of which is so precious and necessary to the farmer. Now by harnessing and controlling the flow of the stream not only are floods with their resulting damage prevented but this hostile force is converted into a profitable resource for power, reclamation, and irrigation. Flood control is in no sense limited merely to the building of levees and dams to guard against and protect life and property from destruction and devastation. It is not merely a problem of getting the water out to sea the safest and fastest way possible. The real problem—and the purpose of flood control as I see it—is prudent utilization of this natural resource in developing hydroelec-

[1] Address delivered before National Reclamation Association, November 15, 1939.

tric power in conjunction with and incidental to irrigation.

As you here in the West know, the flow of the rivers in the arid and semiarid regions fluctuates more widely than the natural flow of rivers in humid areas. The rainfall and snowfall being heavy in mountainous regions within certain seasons, it is practicable to predict the floods in the spring and the dwindling or drying up of the streams when the floods pass. This condition may well be alleviated by taking proper flood-control measures—i. e., storage of the water in reservoirs to prevent excessive flow and a flood—use of the water to generate electric power, and later releasing it for irrigation purposes. We have ample proof of the effectiveness of irrigation storage dams and their value in caring for dry weather flow, irrigation, and controlling floods.

I have only to cite you that great engineering feat completed by the Bureau of Reclamation, March 1, 1936—Boulder Dam. The highest dam in the world, Boulder impounds in Lake Mead the flood waters of the Colorado River, draining parts of six States, converting them from a hostile and destructive force into a beneficial resource for use in irrigation, in regulating and stabilizing the flow of that river, in silt control, improvement of navigation, and in generating hydro-electric energy. As more recent proof of the progress in multiple-purpose projects and the economical utilization of flood waters, I call your attention to the Conchas Dam project, just completed by the Army Corps of Engineers. Located across the South Canadian River in San Miguel County, New Mexico, this dam will materially reduce flood damage in the valley of the South Canadian River in the States of Texas and Oklahoma by impounding and retarding flood waters originating in New Mexico. In addition to flood control and the other benefits, approximately 45,000 acres of land will be irrigated by the project. Of course there are others that indicate the progress of a united effort and a coordinated program. Fort Peck, which when completed will be the largest earth dam in the world, has for its primary engineering purpose the improvement of river navigation from Sioux City, Iowa, to the mouth of the Missouri River. However, important incidental benefits will accrue from water conservation, power development, storage of flood waters, and reclamation. The Caddoa Dam, on which construction is now starting, was authorized by Congress because of the recognized fact that irrigation development is dependent on storage reservoirs on the main stem of the Arkansas River and its principal tributaries.

The problem of flood control is inextricably woven with irrigation and reclamation and the simple point is that if we control the flood we conserve the very resource necessary for irrigation. Another factor that lends emphasis to the importance of flood control and reclamation is this rather interesting but ominous phenomenon taken from reports issued by the Government: "the dust storm of May 11, 1934, swept 300,000,000 tons of fertile topsoil off the great wheat plans; 400,000,000 tons of soil material are washed annually into the Gulf of Mexico by the Mississippi River; that generally water and wind erosion together each year remove beyond use 3 billion tons of soil." One hundred million once fertile acres of farm land have been destroyed for profitable farming by these terrific, devastating and menacing dust storms. Of course these astronomical figures are hard to comprehend, but the serious part of it is that the damage is done—the loss is permanent and cannot be repaired. Now the farmers in these stricken areas had to move—they could not eke out a livelihood on the barren and desolate waste left. The Department of Agriculture has estimated that from 1934 to 1939, 75,000 farm families immigrated into 7 Western States—few have been able to settle permanently and the rest have had to depend upon seasonal agriculture—and relief. It would seem then that our mutual policy of flood control and irrigation and reclamation should be determinedly pursued so as to open up to these farmers the great expanse of arid land in the West that can only be farmed by irrigation.

Water Resources Planning

For many years the American people have been keenly interested in the irrigation and reclamation of the arid and semiarid lands in the western portion of our country. Consequently, time and time again, Congress has authorized reclamation projects and appropriated moneys for their execution. What have the results been? The answer to this question is an inspiring thought indeed. Thousands of acres of land in Arizona, California, Colorado, Idaho, New Mexico, Oklahoma, and Wyoming, once marked on the United States map as the "Great American Desert" and capable of producing only sage brush is now producing abundant crops of vegetables and grains of first quality.

The responsibility and credit for the successful farms that now dot the plains surrounding the reclamation projects operated in the 17 arid and semiarid States west of the 100th meridian and the excellent living conditions that have been developed where formerly not even the prairie dog could survive, belongs to the expert irrigation engineers that comprise the Bureau of Reclamation. These men in turn are only too glad that I should refer to the excellent cooperation they have received from your local agencies and share the credit with you. Without your interest and support much of the beneficial work that has been accomplished would probably never have been started.

This record of public improvements has been accomplished in the American way. The people have applied to Congress for investigation of proposed reclamation projects and after careful consideration of the reports that have resulted from such investigations the representatives of the people in Congress have designated the projects to be undertaken and the agency to execute the projects adopted.

The procedure in principle is similar to that for navigation and flood control improvements in that the Congress of the United States has the entire matter laid before it and decides what will be done. This is the method of democratic and republican forms of government. This is what we call liberty.

Nation-wide Benefits From Reclamation

The public benefits to the Nation that have come from the money spent by the Bureau of Reclamation since its organization in 1902 are numerous and widespread. In the interest of supplying adequate water to the arid and semiarid lands of the West the Bureau of Reclamation has constructed over 19,100 miles of canals, ditches and drains, including 183,000 canal structures and the excavation of 448,000,000 cubic yards of material. In connection with this work there has been constructed 138 storage and diversion dams, 297 tunnels, 1,900 miles of road, 159 miles of railroad, 4,367 miles of telephone line, and 3,912 miles of transmission line. I am sure that an organization that has been in existence for nearly half a century and accomplished this stupendous amount of work does not desire or need to be placed under the direction of a superboard. A superboard passing on numerous governmental projects of widely varying character, with only general supervision, even if acting only in an advisory capacity, cannot make the best selection of projects, and delays all projects.

As in the case of river and harbor and flood control work, public improvements for irrigation and reclamation are accomplished by a long-established and experienced agency of Government that is unbiased and free from political pressure. If it is desirable for the United States to enlarge its program of public construction, the Reclamation Service and the War Department have available plans for the initiation of more improvements and it is from these well-considered and well-rounded plans that Congress should select the projects to be undertaken and Congress should determine the order of national preference and desirability.

The control, conservation, and economic utilization of the Nation's water resources is a major problem before the country today. In their respective fields, the National Rivers and Harbors Congress and the National Reclamation Association have identical aims and objectives in these respects. Their interdependence has been recognized and with a continuance of cooperation and the cordial relationship existing, the way is paved for united action in behalf of a soundly conceived, coordinated program concerned with national development.

Resolutions Adopted by N. R. A. at 8th Annual Convention, Denver, Colo., November 14–16, 1939

Resolution No. 1

Whereas certain administrative, legal, and financial work of the Bureau of Reclamation must be performed at the seat of government in the District of Columbia; and

Whereas the Congress of the United States enacted the Reclamation Project Act of 1939, approved August 4, 1939, which provided among other things for the adjustment, on the basis of the ability of the water users to repay such charges, of over 100 existing contracts; and

Whereas the negotiation and consummation of such adjustment contracts have been delayed, and will continue to be delayed until there is sufficient personnel in the Bureau of Reclamation; and

Whereas delays in negotiation and consummation of the adjustment contracts withhold from the water users the benefits to which they are entitled, and constitute a threat to the welfare of the water users and to the security of large investments of the United States in reclamation projects; and

Whereas during recent years construction activities of the Bureau have increased tenfold and the number of operating projects has also increased, thereby increasing administrative, legal and financial work of the Bureau, which must be performed in the District of Columbia; and

Whereas many of the construction activities recently undertaken involve administrative problems of far greater complexity and difficulty than those encountered in the earlier periods of the reclamation program; and

Whereas during the years that these tremendous increases in responsibilities and duties have occurred, the expenditures for the office of Commissioner have increased only approximately 50 percent, and represent less than ½ of 1 percent of the total annual expenditures by the Bureau; and

Whereas because of the handicap of insufficient personnel, the Commissioner and his staff have been able to carry on only at the expense of unusual and unjust sacrifice of energy and time, and

Whereas important work has been delayed, and solutions to problems affecting progress in the field have been postponed, because of sheer physical inability of the administrative personnel to meet in an efficient and orderly manner all demands on them; and

Whereas restrictions contained in appropriation acts providing for the reclamation program, limit expenditures by the Bureau of Reclamation for personal services in the District of Columbia, and thereby make it impossible to meet the needs for administrative personnel:

Now, therefore, be it resolved, That the National Reclamation Association declares it to be the sense of the Eighth Annual Convention that the conditions above recited should be corrected immediately by the appropriation of adequate funds for administrative purposes within the District of Columbia and by the removal of the restrictions limiting the use of appropriated funds for personnel services in the District of Columbia so that there will be effected sufficient flexibility in the Office of the Commissioner to discharge promptly the additional administrative duties imposed by the act of August 4, 1939, and to handle promptly the increased responsibilities and duties that have resulted from the expansion of the reclamation program;

Be it further resolved, That copies of this resolution shall be sent by the secretary of this association to the President of the United States; the Secretary of the Interior; the Commissioner of Reclamation; the President of the Senate and the Speaker of the House of Representatives; and to each Member of the Congressional delegations of the Western States.

Resolution No. 2

Be it resolved, That the National Reclamation Association recommends to Congress the appropriation of a sufficient sum of money to make a comprehensive study of weed control, particularly as it affects the reclamation States.

Resolution No. 3

Whereas the success of reclamation projects depends upon the successful building and operation of farms and homes by project settlers and every project settler often needs scientific and specialized advice and guidance in laying out and building the distribution system upon his farm and in learning his soil and the best methods of irrigating and farming it and in solving serious problems which are beyond his scientific and financial ability, and

Whereas irrigation specialists qualified to advise and instruct farmers upon irrigation problems can be provided to act as advisers to project settlers in cooperation with experiment stations, county agents, and other agencies and,

Whereas the Bureau of Reclamation has had appropriations which could be used for providing such irrigation advisers, and no use has been made of such appropriations so that the amount thereof has been diminished from year to year,

Now, therefore, be it resolved, That the National Reclamation Association recommends to the Bureau of Reclamation that irrigation specialists be provided for reclamation projects whose duty will be to advise with the project settlers individually and collectively for the purpose of solving their irrigation problems and assisting them in perfecting their methods of irrigation, and that the expense of such irrigation specialists and advisers be borne by the Government.

Resolution No. 4

Whereas areas in the Western States have for many years been subject to disastrous floods which have caused great and increasing damage to life and property and have inundated and destroyed large areas of valuable agricultural lands and improvements in cities and towns dependent thereon, as well as highways, railroads, and other structures incident to the service of agriculture and industry, and

Whereas the Congress of the United States has declared it to be the national policy that the control of floods and the prevention of flood damage is a proper activity of the Federal Government in the interest of the general welfare when the benefits to whomsoever they may accrue are in excess of the estimated costs and if the lives and social security of the people are otherwise adversely affected, and

Whereas the Federal Government has from time to time caused investigations, surveys, and reports to be made to ascertain the facts relative to the justification for contributions and the construction of works in cooperation with States, political subdivisions, and localities, and

Whereas the safety and best interest of many irrigated areas as well as cities and towns in the West are served by the investigations, reports, and works so undertaken;

Now, therefore, be it resolved, That the officers of the National Reclamation Association be directed to use all honorable means to promote the study of flood-control problems and to cooperate with cities, towns, districts, and irrigated areas to the end that surveys and reports be promptly made and considered, and that the construction of flood-control works be expedited in conformity with Federal policy where the benefits to be secured exceed the cost thereof, and

Be it further resolved, That copies of this resolution be forwarded by the Secretary of this association to the President of the United States and to the Members of the Senate and of the House of Representatives of the United States with the request that they further such studies, the consideration thereof, and such authorizations and appropriation as may be found necessary to insure protection from floods in the Western States, when such action is economically justified in conformity with established national policy.

Resolution No. 5

Be it resolved, That the National Reclamation Association requests its officers to seek the aid of the Bureau of Agricultural Engineering; asking that a critical analysis and comparison of the irrigation district statutes of all member States be made and published as a department bulletin, and that said bulletin, when published, be distributed by the Association to the irrigation interests of the West, to encourage the development of a uniform and effective body of law in this important field.

Resolution No. 6

Whereas large areas of the West are dependent, to a great extent, on the maintenance and growth of the sugar beet industry, and

Whereas the sugar beet industry provides so much labor in field, factory, manufacture of supplies, and transportation that each acre of sugar beets is far reaching in its support of the economic structure of many large communities of American citizens; and

Whereas an orderly and sound expansion of beet plantings and processing as suitable land is developed is a reasonable and necessary condition precedent to the building up of this country and should be encouraged; and

Whereas the American sugar beet producers provide less than one-third of the requirements of our home market at the present time but could and should be supplying a major portion of its requirements to the economic advantage of the Nation; and

Whereas our Government should adhere to the principles of American markets for American producers first;

Now, therefore, be it resolved, by this association, that the Congress of the United States be urged, through proper legislation to provide for the progressive, orderly expansion of the production of beet sugar within the United States and to maintain the beet sugar industry on a reasonable income basis by quota regulations and adequate tariffs on foreign sugar, and

Be it further resolved, That a copy of this resolution be sent to the Secretaries of Agriculture, Interior, and State, and to the Senate and House of Representatives of the United States and to each of the Senators and Representatives of Western States in Congress.

Resolution No. 7

Whereas in the case of *Nebraska* v. *Wyoming and Colorado*, now pending in the Supreme Court of the United States, the Federal Government through its Department of Justice, is asserting claim to all of the unappropriated waters, even of nonnavigable streams of the Western States, and also that the return flow resulting from the irrigation of Federal Reclamation projects is subject to control and disposition by the Federal Government, and therefore, free from the control and supervision of the States in which such waters and projects are located, all of which is contrary to the fundamental principles of the water laws of these States, and

Whereas, judicial decisions of the Supreme Court of the United States affirm that the control of waters of the States is vested in the States themselves, and not in the United States except to the extent that in respect to the interstate commerce needs of a particular Federal project on a navigable stream the control is expressly or by implication vested in the Federal Government under the interstate commerce clause of the Constitution, and

Whereas in respect to Federal projects under the Reclamation Act, Section 8 thereof, contains a specific subjection of these projects to the laws of the State in which they are situated, and exacts compliance therewith and recognition of rights acquired thereunder, and

Whereas the Flood Control Act of June 28, 1938, and later acts, authorizing the construction of certain public works on rivers for flood control and other purposes; the Pope-Jones Act, otherwise known as the Water Facilities Act, authorizing the construction of water conservation and utilization projects in the Great Plains and arid and semiarid regions of the United States; the Wheeler-Case Act; the Taylor Grazing Act, and possibly other acts authorizing the construction by Federal agencies of works for the control and use of waters in the Western States, contain no statement that the activities of the Federal Government, under the provisions of these various Federal acts, shall be carried out in conformity with State laws covering the ownership, control, and use of the waters of these Western States.

Now, therefore, be it resolved, by the National Reclamation Association:

1. That, to clear away all misunderstandings, these several acts and all similar acts be forthwith amended to include provisions, requiring, in the prosecution of all works designed for water conservation and use, that the particular Federal agency or department involved shall in all respects, save in the single one mentioned as falling under the interstate commerce clause of the Constitution, comply with State laws relating to the ownership, control, administration, and use of the waters of these Western States as is now required by Section 8 of the National Reclamation Act in respect to projects constructed thereunder.

2. That this association renews its request to the various attorneys general of the Western States to the effect that at the proper time they appear in the interstate litigation above referred to, as "friends of the court," in support of the proposition that it is for the States and not for the Federal Government to control the waters of the States except to the extent that under the interstate commerce clause of the Constitution, a navigable stream may be involved, and even then only to the extent of the needs of the particular project on that stream, thus leaving the waters even of navigable streams, save to the extent mentioned, subject to the control of the States.

3. That it is suggested to the directors of this association that they consider the question of appearance of the association itself in such litigation at the appropriate time, should they deem it necessary.

Be it further resolved, That copies of this resolution be sent to the Senators and Representatives in Congress, Governors and attorneys general of the Western States with a request for their assistance in carrying out the purposes of this resolution; also that this association, its officers and members likewise lend their own assistance.

Resolution No. 8

Whereas the ability of the Western States properly to meet economic needs, to reduce unemployment, to relieve population pressure, and to establish stability and security is dependent upon the proper use and management of all of their natural resources.

Therefore, be it resolved, That the National Reclamation Association again insist that legislation be enacted which will require consideration by the people of each State and the formal approval by the Governor of said State before any further national parks, national monuments, reservoir areas or any other Federal reservations or special areas be established or extended within the 17 Western States.

Resolution No. 9

Whereas there are parts of the Great Plains which for the past few years have been termed the "Dust Bowl," and,

Whereas drought in this area has long since reached the proportions of a disaster that has gained national recognition, while in many parts thereof annual rainfall is still in excess of an amount termed adequate for successful farming, but much of the rainfall from flashy storms is lost as run off down stream beds, ordinarily dry, which water could be impounded in small reservoirs of 1,000- to 10,000-acre-foot capacity, and

Whereas sites for such small reclamation projects are numerous throughout the area, and their construction and development would mean the rehabilitation of thousands of homes in this area, and

Whereas such a program would further the retirement of submarginal lands from cultivation, until revegetation would reduce the Dust Bowl to a memory.

Now, therefore, be it, Recommended to the Congress of the United States that a program of small reclamation projects be provided for this area, with full consideration and study being given to the particular problems involved—on account of the wide difference in the water sources available, methods and facilities of storage, and in water use—from the predominant type of large Federal reclamation project.

Be it further resolved, That this association respectfully urges that the program and activities of the Great Plains committee be continued, enlarged, and that additional funds be appropriated to the end that the program may be expedited.

Resolution No. 10

Whereas serious drought conditions have prevailed in the West for many years and it is vital to the welfare of the arid and semiarid States that small reservoirs be constructed to prevent the waste of spring run-off and freshet water, and

Whereas an act of Congress, Public, No. 398, Seventy-sixth Congress, Chapter 717, First Session (S. 1802), authorizes the Secretary of the Interior "to undertake the construction of water conservation and utilization projects in the Great Plains and in other arid and semiarid areas of the United States" with the assistance and cooperation of Federal agencies, including the Works Progress and the Civilian Conservation Corps, and of States and municipalities, and

Whereas the State engineers and other administrative officers and boards in charge of the development, conservation, and use of water resources have already, in cooperation with various Federal agencies, made extensive investigations of the feasibility of small reservoir projects,

Now, therefore, be it resolved, by the National Reclamation Association in meeting assembled at Denver, Colo., November 14, 15, and 16, 1939, that the Secretary of the Interior and the Congress be urgently requested by the Governors of the arid and semiarid States to provide the necessary funds and prosecute the program of construction authorized by this act, including the construction of small reservoirs,

Be it further resolved, That a copy of this resolution be sent to the President of the United States, the Secretary of the Interior, the Governors of the arid and semiarid States, and to the Congressional delegations representing said States.

Resolution No. 11

Whereas under the act of Congress authorizing the Secretary of State to negotiate reciprocal trade treaties with the different nations, there is, contrary to the usual practice, no requirement that the treaties be submitted to the Senate for ratification, and

Whereas many competitive goods and commodities are being admitted to the United States under reciprocal treaties already negotiated, and doubtless would be admitted under other treaties yet to be negotiated, much to the prejudice in many instances of goods and commodities already being produced in this country, and

Whereas the Members of the Senate of the United States should have a chance to protect the producers of the United States by passing upon the wisdom of any and all reciprocal treaties negotiated,

Therefore, be it resolved, That any act or acts permitting the negotiation of reciprocal treaties should be so amended that hereafter all such treaties shall receive, before going into effect, the confirmation of the Senate, as contemplated by the Constitution.

And be it further resolved, by the National Reclamation Association that it is unalterably opposed to any type of reciprocal trade treaty which will penalize Western agriculture or industry,

Resolved further, That copies of this resolution be sent to the Senators and Representatives in Congress, of the States which are members of this association.

Resolution No. 12

Be it resolved, That it is apparent to the members of the National Reclamation Association that large areas in the United States are not adequately mapped from a topographic point of view and they urge the Federal Government to give its earnest attention to this problem. Proper and systematic land uses cannot be established without an accurate knowledge of the character of the terrain involved.

A report on this subject has been made to the United States Senate by the Secretary of the Interior and other cabinet officers, and it is urged that this report be given careful consideration.

Resolution No. 13

Be it resolved, by the National Reclamation Association that the officers, directors, and membership are urged to make a study during the coming year for the purpose of determining the attitude of the association in the matter of amendments to the reclamation laws to cover drainage of swamp lands and the clearing of stump lands.

Resolution No. 14

Whereas the National Reclamation Association recognizes the primary importance at this time of the National Defense Program, in view of critical world conditions; and

Whereas this association is convinced that the program of reclamation as now undertaken and projected under authority of the Federal Government is an essential and component part of a well-rounded National Defense Program, having particularly in mind, the tremendous importations of products and materials capable of being produced in western America; and

Whereas, the possibility of curtailment of importations of essential raw materials must be taken into consideration in both National Defense and Reclamation projects and to the same degree;

Now, therefore, it is resolved, by this association assembled in National Convention that the vigorous promotion and support of the National Reclamation Program is necessary for the support of a complete and coordinated program of National Defense.

Resolution No. 15

Whereas the reclamation of the arid West is a Federal problem, and

Whereas in addition to the projects which have been financed directly by the Federal Bureau of Reclamation there are many other irrigation projects which represent an acreage equal to or greater than Federal Reclamation projects which have been financed or refinanced by other Federal agencies, and are now paying interest on construction costs at the rate of 4 percent per annum and amortized in 30 years, and

Whereas reclamation projects and irrigation projects financed by other Federal agencies are generally contiguous and adjacent to reclamation projects and are producing similar crops at comparable production cost,

Now, therefore, be it resolved, by the National Reclamation Association in convention assembled, that this association endorse and recommend the enactment of Federal legislation providing for a more equitable rate for interest and amortization payments on such irrigation projects.

And whereas various P. W. A. loans were heretofore made to mutual cooperative nontaxable irrigation enterprises where no grants were made on account of the holding that the agencies to which such loans were made were not public corporations resulting in discrimination against water users under such projects,

Now, therefore, be it further resolved, That the Congress be urged to take such action as may equalize so far as possible the burdens of such water users with those of so-called public corporations.

Resolution No. 16

Whereas in order to avoid duplication, conflict, and to save Federal expense, there is great need of coordinating the plans of the various agencies and departments of Government for the conservation and development of the lands, waters, forests, and other natural resources of the country, and there has been a succession of coordinating boards or committees, variously known as National Planning Board, National Resources Board, National Resources Committee and National Resources Planning Board, and that the water committee of such coordinating boards or committees has been very helpful in the advancement of reclamation in the West and in the solution of interstate differences over interstate streams in that region, and

Whereas the existing National Resources Planning Board exists by Executive order, and there should be a permanent statutory coordinating agency, responsible, reporting, and furnishing information at all times to the Congress and the President alike, in order that the Senators and Representatives of the West may have, as a matter of legal right, instant information at all times from the coordinating agency, and

Whereas since the Departments of War, Interior, and Agriculture are especially concerned with the conservation and development of natural resources, and their membership on a coordinating agency along with that of the present and other lay members, is quite desirable for reasons of effective and harmonious coordination,

Therefore be it resolved, That this association favors the creation of a statutory coordinating agency or board composed of the Secretaries of War, Interior, and Agriculture or their chosen representatives, and a preponderant number of lay members appointed from widely separated regions to coordinate the plans for the conservation and development of natural resources, said agency or board to be equally responsible, accessible, and reporting to the Congress and the President alike.

Resolved further, That copies of this resolution be sent to the Senators and Representatives in Congress, of the States which are members of this association.

Resolution No. 17

Be it resolved, That the National Reclamation Association at its regular annual meeting held in Denver, Colo., November 14 to 16, 1939, recommends to the Bureau of Reclamation, the Soil Conservation Service, Coast and Geodetic Survey, the Bureau of Agricultural Economics, the Bureau of Agricultural Engineering, the United States Forest Service, and the United States Geological Survey, the absolute need of continuing investigations in cooperation between Federal and State agencies, and otherwise, to include stream gaging, ground-water studies, precipitation observations, snow surveys, topographical mapping, soil surveys, and geodetic surveys, in order that the essential basic information shall be available for the selection, promotion, design, construction, and successful operation of irrigation enterprises and other land uses.

Resolution No. 18

Whereas it is the policy of the United States Bureau of Reclamation to furnish adequate water supplies from reclamation projects to the irrigators at the lowest possible price, and the cost of reclamation in some instances is so great that repayment in 40 years from irrigation charges alone will impose a burden the farming industry cannot safely bear;

Now, therefore, be it resolved, That the National Reclamation Association favors the following policy in connection with Federal Reclamation projects: In cases where needed to reduce excessive cost of water to irrigators, such portion of the net revenue from the sale of the incidental electric power as in the judgment of the Secretary of the Interior shall be deemed proper as a fixed charge against power revenues shall be applied to the repayment of the reimbursable cost of the irrigation features of the project.

Resolution No. 19

Be it resolved, by the National Reclamation Association, that great and continuing benefit has come to the farmers on western irrigated lands from the work of the experiment stations on soil classification, duty of water, irrigation practices, crop investigations, and many related problems. It is vital to these water users that work along these lines be continued and expanded. The National Reclamation Association commends the work already done by the Agriculture Department in cooperation with the States, asks for more and better agricultural research into problems peculiar to irrigated farming, and strongly urges the Congress and the States to provide more adequate support for this valuable work.

Resolution No. 20

Whereas on irrigation projects, vast amounts of water are lost annually through canal leakage during the operation season, and

Whereas investments for irrigation purposes run into the hundreds of millions of dollars with seepage losses in many cases exceeding one-half of the quantity diverted;

Now, therefore, be it resolved, That this association petition the United States Bureau of Reclamation to cooperate with the Department of Agriculture in conducting experimental demonstrations of low cost canal lining in various canal systems throughout the irrigated districts of the United States, to the end that a tremendous saving may be made in water losses.

Resolution No. 21

Whereas necessity is recognized for developing and utilizing small water facilities in order to stabilize and insure a reasonable permanency and security in the agriculture and population of the arid and semiarid regions, and

Whereas there was passed by the National Congress in 1937 the Pope-Jones bill, known as the Water Facilities Act, authorizing the Secretary of Agriculture to plan, construct, or cause to be constructed, small facilities for water conservation projects for irrigation and other agricultural purposes, and

Whereas this water facility program is designed to serve a vital purpose in water conservation and better land use, and to promote human welfare, and

Whereas the best interests of the drought areas and the entire West demand that water conservation and proper land use be consummated as rapidly as is possible in order to improve the present unstable condition of agriculture, and

Whereas the present method of administering this act by the three divisions of the Department of Agriculture, it is believed, has not been conducive to an expeditious prosecution and carrying out of the provisions thereof, and

Whereas it is believed that a single agency of the Department of Agriculture can best accomplish this desired end

Now, therefore, be it resolved by the National Reclamation Association, in annual convention assembled at Denver, Colo., this 16th day of November, 1939, that it recommends that the carrying out of the provisions of this act be delegated to a single agency of the Department of Agriculture, and

Be it further resolved, That Congress be urged to continue its support of the Water Facilities Act and appropriate sufficient funds under this act so that the accomplishment of its purposes may be expedited, and

Be it further resolved, That the Secretary of this association be directed to send copies of this resolution to the Secretary of the United States Department of Agriculture and to the Congressional delegations of the 17 Western States included in this association.

Resolution No. 22

Be it resolved, That it is with great pleasure that this association acknowledges and recognizes the cooperation and support evidenced by the attendance at this meeting of Maj. Gen. Julian Schley, Chief of the Corps of Army Engineers, and his staff, including Col. W. T. Hannan, Division Engineer for the Southern California Division; Col. John C. H. Lee, Division Engineer for the Pacific Division, and Lt. Col. Edwin C. Kelton, for the Los Angeles, Calif., District of the Corps, Col. Reybold, Little Rock, Ark. And likewise, the association expresses its gratitude to the President of the National Rivers and Harbors Congress, Hon. Dewey Short, Congressman from Missouri. It is felt that the spirit of cooperation evidenced by the attendance and participation on the program by these outstanding leaders means much to the development of the west.

And be it further resolved, That the association also appreciates the attendance and participation in its program of Dr. Harlan H. Barrows, Chairman of the Water Committee of the National Resources Planning Board, and his past work and endeavor to coordinate the activities of Federal agencies; the appearance on the program of E. H. Wiecking, Associate Coordinator of Land Use, United States Department of Agriculture, as well as the cooperation given us by other prominent officials from Washington who participated in the deliberations of the convention.

Resolution No. 23

Be it resolved, That we the members of the National Reclamation Association assembled in Denver, Colo., at the Eighth Annual Meeting of the association, extend our thanks and appreciation to the State of Colorado and the city of Denver for a most enjoyable, instructive and profitable meeting and for the entertainment so generously provided by our hosts. We extend our thanks and appreciation to the Governor of the State and his committee, to the Colorado Water Conservation Board, the Chamber of Commerce of the city of Denver, the Denver Convention and Tourists Bureau, the Denver Water Board and the Colorado Association of Highway Contractors, the County Commissioners Association of Colorado and to the hotels, newspapers and broadcasting agencies of Denver and all others who have contributed so effectively and magnanimously in the preparation and financing of this meeting and have contributed so much to the success of the convention.

Reclamation Legislation

(*Continued from page 332*)

first session of the Seventy-sixth Congress by the chairman of the Committee on Irrigation and Reclamation a bill known as H. R. 6984, commonly referred to as the repayment bill, which became Public Law No. 260.

Briefly the objectives of the law are to modify existing contracts to permit an equitable and flexible plan for sliding-scale payments of construction charges in accordance with variation in crop returns, to provide for payments at times that will synchronize with marketing, to provide for classification and reclassification of lands on existing projects, to provide methods and responsibility for determining the feasibility of proposed new projects and for the allocation of costs, and to extend the authority of the Secretary of Interior to grant temporary relief to water users.

Discussion of ways and means to put this new law into operation is to be had at this convention, and it is to be hoped that its benefits will soon be extended where it is needed.

This sweeping change in the policy of the Federal Government will not only inure to the benefit of the million people already directly affected by the reclamation program but will as well offer encouragement to the quarter of a million immigrants who have flooded into the West from the drought areas of the country.

The West can and does take pride in the results of the Federal Reclamation program. It has fulfilled its mission and met the expectation of its original and subsequent proponents despite many difficulties and conditions that could not have been foreseen.

And now let me call your attention to a new field for the reclamation of potential agriculture land, a field it appears that not only the Federal Government but the business leaders in the local communities that would receive the direct benefits from opening up large and fertile areas for settlement have overlooked. Just as the forest land of the Great Territory that now comprises the States of Ohio and Indiana were settled by the pioneers to add some of the most important communities that now comprises the National Commonwealth, so the vast areas of our Western States present one of the most important and best fields for reclamation and settlement to be found anywhere in this country.

With improved machinery and land-clearing methods as now practiced by private enterprise, our Government, by expanding the activities of the Bureau of Reclamation to include the reclamation of cut-over land under a plan for repayment similar to the program being followed in irrigation and reclaiming of semiarid land, there can be opened large areas of new lands for settlement and for the establishment of productive farms and the upbuilding of prosperous communities. From my personal experience in reclaiming cut-over lands I know that if the Government through the Bureau of Reclamation will extend the same assistance to the so-called "stump rancher" that it does to the settler on sagebrush land and give just half the time—20 years—for the repayment of the cost of reclamation, new land supporting prosperous communities comparable to those to be found on the former forest lands of Ohio, Indiana, Wisconsin, and Minnesota, will spring up in cut-over sections of the Western States and thereby provide a practical means of bringing the unemployed back to the land. Many of the people now supported by Federal relief can build homes, become self-supporting, and take their place among the substantial citizens of our country just as did our forebears who reclaimed the forest lands west of the Allegheny Mountains to give our Nation the great States of Ohio, Indiana, Wisconsin, and Minnesota. Let our Government through the Bureau of Reclamation with its financial organization constituted to do this very thing take advantage of this big opportunity to reclaim these lands on which our unemployed can settle to build new communities throughout our Western States and add to the national prosperity.

In closing I want to commend the activities of the National Reclamation Association in keeping the objectives and possibilities of the national program before political and business leaders of the country, and I want at this time to urge vigilance upon its officers and members so that the reclamation program may be expanded to meet any emergency that might arise. I favor American markets for the American farmer and particularly do I favor the progressive, orderly expansion of the production of sugar in the continental United States and especially in reclamation States. I pledge you my interest and support in any further legislation that may seem advisable for alleviation of existing conditions or in the creation of expanded production.

American Farm Bureau Convention

THE American Farm Bureau Federation celebrated "20 years of organized agriculture" at its anniversary convention held in Chicago, December 4–7.

An educational and cooperative exhibit was installed in the exhibition hall of the Stevens Hotel for the purpose of visualizing the agricultural resources of the States composing the federation; present assets and advantages; and to indicate how problems have been met and are being met through farm cooperative effort, organization, and educational and administrative undertakings initiated by the States, frequently in cooperation with the Departments of the Federal and State Governments.

Fifty units representing civic, State, and national organizations, including the Bureau of Reclamation, entered exhibits. Others in this group were departments of Government, land-grant colleges, experiment stations, and State farm bureaus. In the field of cooperatives were both marketing and service organizations.

Thirty-two thousand square feet of exhibit space was reserved.

Grassy Lake Dam

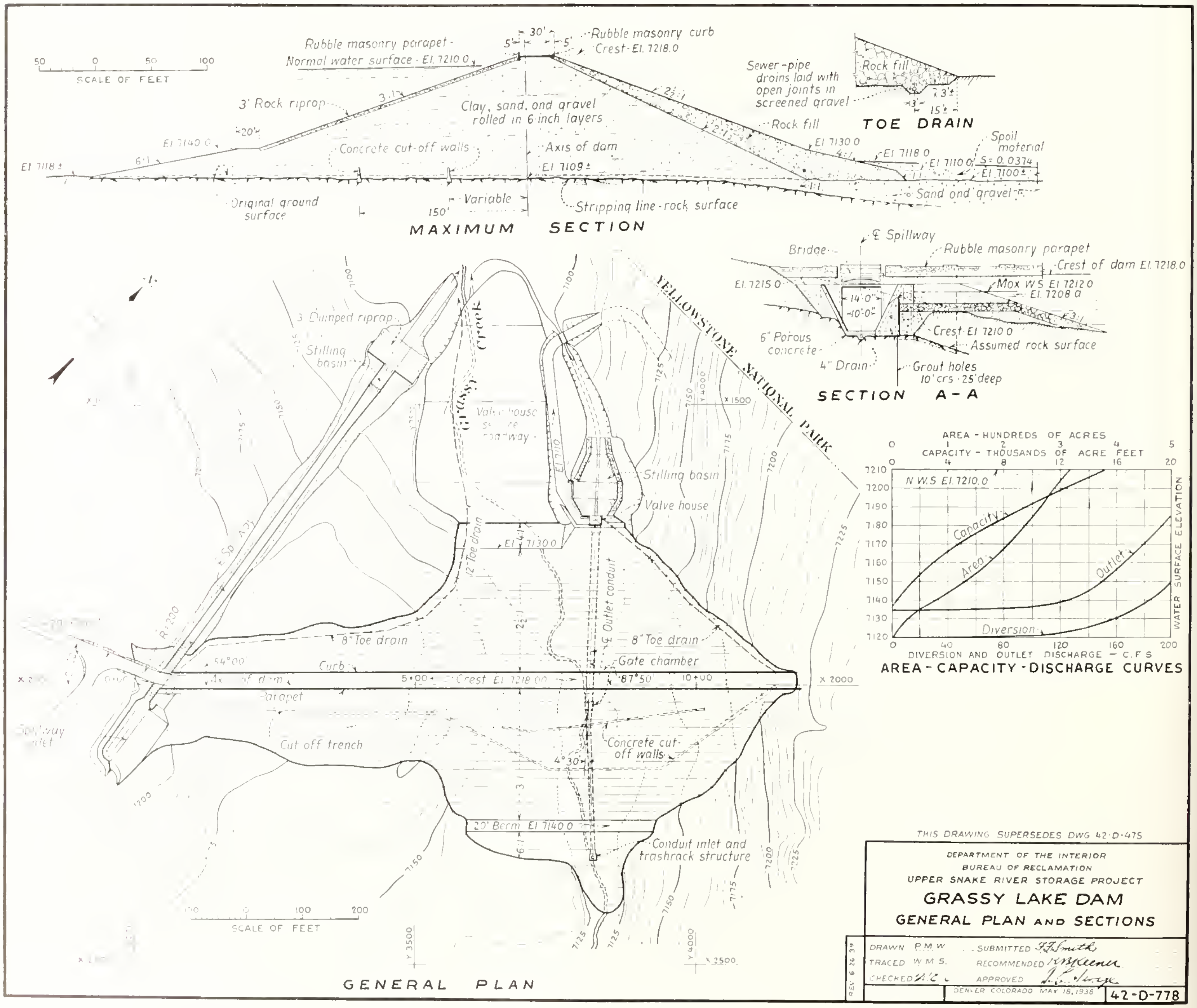
Upper Snake River Storage Project, Idaho-Wyoming

By I. DONALD JERMAN, *Acting Construction Engineer*

GRASSY LAKE DAM, completed October 14, 1939, is one of three major units of the Upper Snake River storage project, and the last to be completed. Other units consist of the Island Park Dam and Cross Cut diversion dam and canal. The construction work was undertaken to provide supplemental water to lands in the Fremont-Madison Irrigation District, located in the counties of Fremont and Madison, Idaho, which divert water from the Henry's Fork of Snake River and the Teton River. (See location map No. 42-D-825, Ashton No. 2-7.)

The Grassy Lake Dam is located in the rugged Teton Range in northwestern Wyoming, about 38 miles east of Ashton, Idaho, and is about a stone's throw from the southern boundary of Yellowstone National Park. The dam is constructed across Grassy Creek, a tributary of Falls River, and may be reached by way of the old wagon trail built years ago by the Bureau of Reclamation for the purpose of hauling materials and supplies during the construction of the Jackson Lake Dam near Moran, Wyoming. The nearest railroad point for Grassy Lake Dam is Marysville, Idaho, about 3 miles east of Ashton.

Investigation work at the site began in 1904, when studies were made to determine



the feasibility of utilizing storage sites on upper Falls River. In October 1932, a transit topographic survey was made of the dam and reservoir site. Work was discontinued early in 1933 because of lack of funds. A geological study of several dam sites in this vicinity was undertaken in 1932 and the report completed in 1933. Exploratory work began in 1934. On August 14, 1935, the dam site was declared feasible in a report submitted by the geologists. Further exploratory investigations were made from June to November 1935, and diamond drilling was begun in September 1935.

Final investigations were made during 1936, and plans and specifications drawn up, for the construction of an earth and rockfill dam. Bids were opened at Ashton, Idaho, on August 7, 1936, and the contract later awarded to S. J. Groves & Sons Co., 509 Wesley Temple Building, Minneapolis, Minn., whose low bid was $488,477.50. This company later sublet the entire job as follows: Earth and rock work to Lobnitz Brothers, Willmar, Minn.; and concrete work to Landreth Construction Co. of Scottsbluff, Nebr. The Government furnished the cement, steel, and outlet control equipment and all other material that went into the completed structure.

Earth embankment placement. Spillway in foreground

Water from the Grassy Lake Reservoir will be diverted for irrigation east of Ashton, Idaho, from the Falls River, a tributary of Henry's Fork of Snake River. The lands served by this reservoir are located at too high an elevation to be served by the water from the Island Park Reservoir, except by exchange of natural flow.

Construction Features and Requirements

Because the dam was located at an altitude exceeding 7,200 feet, and in the exceptionally rugged Teton Range of mountains, the winters there were long and severe, lasting from November until about the middle of June, with a maximum snow depth of about 12 feet. The average construction season was from July 10 to October 6, each summer.

Looking downstream from toe of Grassy Lake Dam. Grouting machine near trashrack structure

Funds for the construction of the project were authorized by the National Industrial Recovery Act of June 16, 1933, under which an appropriation of $4,000,000 was provided for the project. This amount was later reduced to $2,000,000; subsequently raised to $2,250,000 by a $250,000 allotment from the NIRA fund; still later increased by a $250,000 allotment from the Reclamation Fund; and finally increased again by an allotment of $350,000 from funds of the Public Works Administration, Act of 1938, making a total allotment of $2,850,000. This amount was recently reduced to $2,835,000 by transfer of NIRA funds to another project. Construction of the dam was authorized by an act of Congress on July 2, 1935.

A contract dated July 15, 1935, was entered into between the United States and the Fremont-Madison Irrigation District, which provides for the repayment of the construction charges in 40 annual payments, without interest, the first of which shall be due and payable on December 31 of the year in which the Secretary shall announce that stored water is ready for delivery from the said Island Park Reservoir, and one installment on December 31 of each year thereafter until the whole thereof has been paid.

Principal features involved in the construction of the Grassy Lake Dam were the earth and rock embankment across the channel of Grassy Creek; a concrete outlet conduit running through the base of the dam; a reinforced concrete valve house and outlet works; a concrete-lined, open channel spillway; two concrete cut-off walls, and a permanent roadway across the dam. It is anticipated that a rock masonry curb and parapet wall will be constructed across the top of the dam during the summer months of 1940.

The embankment is 120 feet high, and at crest elevation of 7,218 is 1,200 feet long. It is approximately 760 feet thick at the base. The upstream slope of the embankment is 3:1 above elevation 7,140, and is covered by a 3-foot layer of rock riprap. The downstream earth embankment slope is 2:1 above elevation 7,160 and is backed by a rock fill on a slope of 2½:1 above elevation 7,130. (See General Plan and Section Print No. 42-D-778.)

Reservoir

The dam will create a reservoir with a live storage capacity of about 15,000 acre-feet, and will cover 313 acres when the water is at spillway weir crest level of elevation 7,210. It was necessary to clear the reservoir site of heavy timber. This clearing was completed June 29, 1938, under contract with the Nevada Construction Co., Nevada, Mo., at a lump sum bid of $24,800.

The old reclamation road ran directly through the reservoir area, and it was necessary to build a new road around the north end of the reservoir. This work was completed by Lobnitz Bros. under a separate contract, and begins at the extreme right end of the dam, runs along the ridge above the reservoir, and joins the old road at the east end of the reservoir. The work was performed under specifications 941-D, contract for which was awarded to Lobnitz Bros. at their low bid of $7,680.

Cascade Diversion Dam and Canal

The waters of Cascade Creek are to be diverted into the Grassy Lake Reservoir through the Cascade Creek diversion canal. A detailed description of this feature may be found on page 104 of the June 1938 Reclamation Era.

Grassy Lake Dam

Principal quantities.

Principal quantities involved in the construction of Grassy Lake Dam, according to the October 1939 estimate, follow:

Stripping borrow pits	cubic yards	70,980
Stripping dam foundation for embankment	cubic yards	46,587
Excavation, common, for structures	cubic yards	19,807
Earth embankment	cubic yards	444,000
Excavation, rock, for structures	cubic yards	1,939
Rock fill, downstream slope	cubic yards	68,889
Riprap, upstream slope	cubic yards	20,259
Concrete in cut-off walls	cubic yards	618
Concrete in outlet conduit	cubic yards	797
Concrete in trash-rack structure, gate chamber, and needle valve house	cubic yards	658
Spillway concrete	cubic yards	1,390
Reinforcement bars	pounds	343,355
Drilling grout holes	linear feet	5,858
Cement for grout	sacks	6,455
Cement for structures	sacks	19,809

Government camp buildings

Outlet Conduit

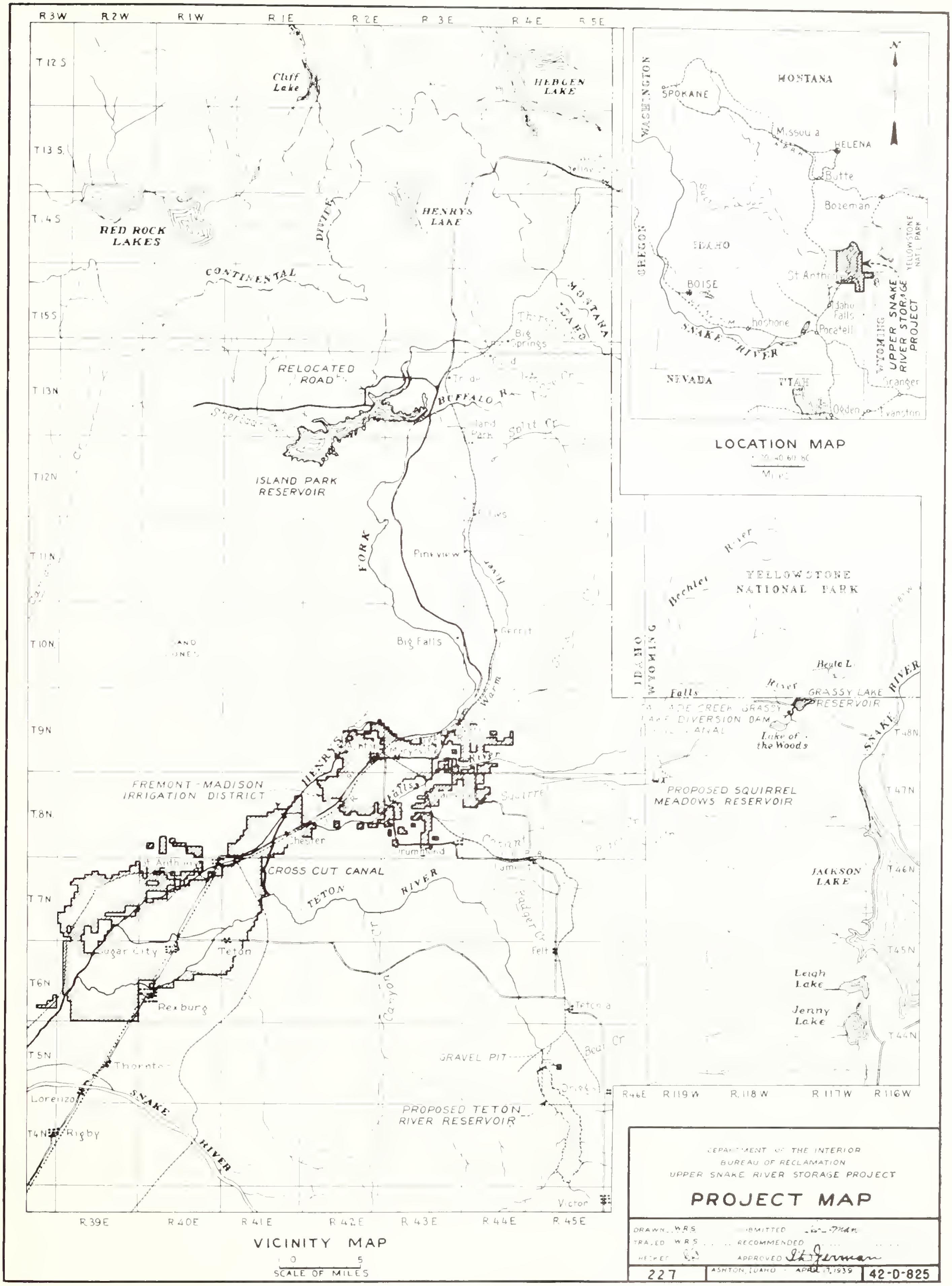
The contractor started work on the outlet conduit in July 1937. After final foundation stripping was completed, all trimming was accomplished with pavement breakers. Very little overbreak occurred. When the conduit foundation excavation reached station 10+80 it was discovered that bed rock dipped sharply down, and it was deemed advisable by the Denver office to shorten the conduit length, which left a rock foundation under the entire conduit. A concrete foundation of more than 120 cubic yards was placed under the valve house. Forms were used to place the invert of the 4-foot circular section. Holes were drilled in the foundation rock and threaded rods grouted into the holes. Cones and clamps attached to these rods held the forms in place. Rock pockets developed during the first placement of concrete on the inside face of the horseshoe cover section, near the invert. This was overcome by cutting windows about halfway up the outside forms, allowing better access for vibrating the concrete.

Stripping Foundation and Abutments

The foundation of the dam is composed of two rock formations, one being a porphyritic rhyolite, varying considerably in internal character, which forms the greater part of the area occupied by the dam. The other, apparently confined to the right abutment, is a glassy rhyolite, formed by a lava flow, grading to a felsitic texture. Stripping operations were started during November 1936. No work was done during the winter months, but the stripping was resumed June 22, 1937, and was approximately 90 percent completed by August 13, 1937. Suitable material from the stripping excavation was stock-piled and later used in the earth fill. Materials not suitable for earth embankment were wasted on the upstream and downstream edges of the dam embankment, and later leveled to blend into the natural topography of the area. A quantity of material was stripped during 1939 when a small spring area was found in the right abutment.

Stripping Borrow Pits

Timber was cleared from the earth borrow pit areas during each of the years 1937, 1938, and 1939, as the need for embankment material developed. Forty-five acres of land were cleared before the dam embankment was completed. This comparatively large acreage was required owing to the small shovel cut possible over the area where embankment materials were available.


VICINITY MAP
SCALE OF MILES
0 5
LOCATION MAP
Miles
RED ROCK LAKES
CONTINENTAL
DIVIDE
HENRYS LAKE
HEBGEN LAKE
Cliff Lake
MONTANA
IDAHO
RELOCATED ROAD
BUFFALO R.
ISLAND PARK RESERVOIR
Big Springs
Pineview
Big Falls
FORK
HENRYS
Warm River
FREMONT - MADISON IRRIGATION DISTRICT
Chester
Drummond
CROSS CUT CANAL
TETON RIVER
Sugar City
Teton
Rexburg
Felt
Badger Cr.
Canyon Cr.
GRAVEL PIT
Bear Cr.
Thornton
Lorenzo
SNAKE RIVER
Rigby
PROPOSED TETON RIVER RESERVOIR
Victor
YELLOWSTONE NATIONAL PARK
Bechler River
IDAHO
WYOMING
Falls River
CASCADE CREEK GRASSY LAKE DIVERSION DAM & CANAL
GRASSY LAKE RESERVOIR
Lake of the Woods
PROPOSED SQUIRREL MEADOWS RESERVOIR
JACKSON LAKE
Leigh Lake
Jenny Lake
SNAKE RIVER
MONTANA
SPOKANE
WASHINGTON
HELENA
Butte
Bozeman
OREGON
IDAHO
BOISE
Idaho Falls
Shoshone
Pocatello
SNAKE RIVER
NEVADA
UTAH
Ogden
Evanston
Granger
WYOMING
UPPER SNAKE RIVER STORAGE PROJECT
YELLOWSTONE NAT'L PARK
R 3 W
R 2 W
R 1 W
R 1 E
R 2 E
R 3 E
R 4 E
R 5 E
T 12 S
T 13 S
T 14 S
T 15 S
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R 39 E
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R 41 E
R 42 E
R 43 E
R 44 E
R 45 E
R 46 E
R 119 W
R 118 W
R 117 W
R 116 W
T 48 N
T 47 N
T 46 N
T 45 N
T 44 N
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER STORAGE PROJECT
PROJECT MAP
DRAWN W.R.S.
TRACED W.R.S.
SUBMITTED
RECOMMENDED
APPROVED
227
ASHTON, IDAHO - APRIL 17, 1939
42-D-825

Stripping excavation was accomplished with an RD-8 tractor with 12-cubic yard carry-all; and a 75-horsepower tractor with a bulldozer attachment.

The rock borrow pit, located about 600 feet upstream from the right abutment, was first excavated on the face of the rock with a 1¾ cubic yard Northwest shovel, casting the material sideways to form a bench for quarrying and loading operations. Later the overburden was pushed over the edge with a 75-horsepower tractor with bulldozer attachment and then picked up by the shovel, loaded into trucks, and end-dumped to widen the bench which later served as a haul road.

Spillway

The spillway is of the uncontrolled, side-channel type, with a capacity of 1,200 second-feet, and is located on the left abutment adjacent to the earth fill. A concrete bridge, located directly downstream from the weir section of the spillway, permits traffic to cross the structure onto the road across the top of the dam.

Common excavation was prevalent throughout, except under the spillway intake, the bottom 5 to 7 feet of which was rhyolite rock, which assures a rigid foundation for the intake structure. The remainder of the structure required ample drainage facilities for foundation protection. The bottom width of the excavation for the chute section of the spillway was 14⅓ feet; for the stilling basin, 23⅓ feet. The maximum hillside cut was approximately 35 feet, and the minimum cut 2 feet.

Rough excavation for the spillway structure was completed with power equipment the first season. Spring areas were encountered on the chute section, requiring considerable tamped backfill to be placed. Gravel drains were provided leading the water to the stilling basin.

One-and-one-eighth-inch-square anchor bars were placed in the rock on the floor and back wall of the overflow section. A 6-inch porous concrete floor with tile drains was provided under this floor.

A steel sheet piling curtain, 15 feet deep, was driven under the downstream cut-off wall.

Three concrete cut-off walls, at 100-foot centers, were placed monolithic with the floor and walls of the chute. They were 10 inches thick, placed 3 feet below the floor, and extended into the earth banks. The top was 12 inches above the chute wall, intercepting the run-off water and leading it into the chute.

Concrete Aggregate

Concrete aggregates were delivered to the dam site and stock-piled by the S. J. Groves & Sons Co. under a separate contract. The aggregate was obtained from a pit on Pilgrim Creek, near Moran, Wyo.—a distance of 31 miles from the dam.

Concrete Placement

A Koering 10 S, two-wheel type mixer, equipped with a loading hopper, water pump, automatic water control, and self-locking timing device, was used for mixing. Water for mixing was pumped from Grassy Creek for all structures except the spillway. A pump was installed at the diversion canal leading from Cascade Creek to the dam reservoir, and water pumped to an elevated tank. This water was used for concrete mixing and backfilling operations on the spillway structure.

The first placement of concrete was accomplished by two-wheel, concrete buggies, propelled by manpower, capable of holding a two-sack batch. Board runways and scaffolds were used to provide a transportation medium. This method was soon discontinued, and a dragline was used to transport the concrete from the mixer to the forms. The concrete was dumped directly from the mixer into a top-dump bucket, then carried to the forms by the dragline for direct placement. Segregation and piling up in the forms were held to a minimum with this placement method.

Concrete Control

Representative samples of the mixed aggregate and intermediate gravel, delivered during the fall of 1936, were obtained and forwarded to Denver for mix design data. Additional mix design information was obtained for temporary use from the Island Park field laboratory, pending results from Denver. Results of these investigations determined the following mix proportions of cement-sand-gravel: 1–2.35–3.65 and 1–2.42–3.75, requiring 1.42 and 1.39 barrels of cement per cubic yard of concrete, respectively, for the Island Park and Denver mix design data. Adjustments of over and under size were made for field conditions. Also, field adjustments were made to produce concrete of the desired slump for the various structures.

Field tests for sand production, moisture content, and determination of over and under sizes in the gravel were carried on by the field laboratory. Six by twelve-inch cylinders were fabricated for 7- and 28-day tests. Eighty-two cylinders, in all, were cast, or about one of each for every 80 yards of concrete placed. Average test cylinder breaking strengths in pounds per square inch were as follows: 7-day, 2,160; 28-day, 3,340.

Concrete Cut-off Walls

Excavation for the concrete cut-off wall footings was carried on with pavement breakers. The trench was excavated 3 feet deep by 3 feet wide. Very little overbreak occurred. The walls were approximately 1 feet high, with a top width of 12 inches an a side batter of one-fourth inch in 12 inche Openings were left in the walls along the be of the river, and on the right abutment t facilitate the movement of equipment. Clos ures were made as the earth fill progressed t an elevation near the top of the walls.

Earth Embankment

Placement of the earth fill required 3 con struction seasons. During 1937 about 29,08 cubic yards of fill were placed before col weather made it necessary to stop earth placement operations. This work was re sumed on August 15, 1938, at the upstrean toe of the dam.

A temporary earth dam was constructe across Grassy Creek, approximately 700 fee upstream from the upstream toe of the dan utilizing Grassy Lake as a temporary reser voir for the storage of Grassy Creek water This allowed sufficient earth embankment t be placed in order to divert the water throug conduit. Rapid progress was made durin the remainder of the 1938 season with a tota of 144,000 cubic yards of earth and 36,20 cubic yards of rock placed. Materials use during 1938 were excavated in earth borrow pits Nos. 1 and 2, with the impervious an semi-impervious materials coming from bor row pit No. 1, and the pervious material from borrow pit No. 2.

The material was excavated in the borrow pits with 1¾-yard northwest shovels, dumpe into 12-cubic-yard Euclid trac-trucks an dump trucks, and hauled an average distanc of 2,800 feet to the embankment area. Ther it was dumped in windrows and spread wit a 75-horsepower bulldozer to a loose laye thickness of 8 inches, after which it wa rolled 12 times with a sheepsfoot tampe having an effective unit pressure varyin from 265 to 270 pounds per square inch. Th thickness of a compacted layer did not excee 6 inches.

Earth placement was discontinued o October 6, 1938, and rock placement on Octo ber 22, 1938, due to winter weather.

The 1939 construction season opened o June 29, using two 8-hour shifts. Thre 6-hour 40-minute shifts were begun on July and continued to the end of the season. Place ment of earth and rock continued rapidly except for several shut-downs due to heav rains, until the earth and rock placement i the dam was completed on September 30 1939. General clean-up and shaping of th rock on the faces of the dam were complete by October 14, 1939, which is the date th job was accepted as being completed.

Parapet and Curb Walls

Settlement plugs were placed on the dam during the fall of 1939, and lines and grade established on each plug. When it is def nitely determined that the initial settlement has ceased, the parapet and curb walls will be constructed as shown on drawing No. 42-D-778.

Government Camp

A permanent Government camp was established at the dam in 1937, and consists of a 1½-story, 2-room caretaker's residence, three 2-room cottages, garage, office building, sewer system, and well. All buildings, except the office building, are constructed of peeled logs, to harmonize with the rustic surroundings. The garage was used as a field laboratory for earth and concrete tests during the construction of the dam. The Government camp was constructed by force account.

Installation of Hydrostatic Pressure Indicators

During the construction season of 1939, hydrostatic pressure indicator cells and connection tubes were installed in the earth embankment at various elevations. There were 52 cells, in two lines, at stations 6+70 and 8+00. Each cell is arranged to indicate the static head of water at the particular point at which it is located, thus making it possible to determine the line of saturation throughout the embankment.

Nine Months in Radio

THE Department of the Interior inaugurated as an experiment in a new field a Government radio studio.

Lower left: Reception room for radio studio
Upper right: Radio studio

In his report to Secretary Ickes, Michael W. Straus, Director of Information, gives a factual summary of the first 9 months of operation.

The radio section, which is under the Division of Information of the Department, has prepared and presented 53 coast-to-coast network broadcasts, varying in length from 15 minutes to a full hour.

All major established national networks—National Broadcasting Co. (Red and Blue), Columbia Broadcasting System, and Mutual Broadcasting Co.—as well as a number of regular hook-ups and many individual stations, have carried programs sponsored by name both by the Department of the Interior and its component bureau units. Air time contributed by networks has a commercial quoted value of $155,200.

Conservation problems, policies, and programs have been the predominant theme of all departmental programs. In these programs the work of all divisions and bureaus has been publicized by documentary, narrative, dramatic, and reportorial script technique. All radio scripts were reviewed and approved by the bureaus concerned before being put on the air. Programs presented in behalf of bureaus include national broadcasts as follows: General Land Office 4, Bureau of Reclamation 9, National Park Service 6, Bureau of Mines 7, Division of Grazing 3, Office of Indian Affairs 3, Petroleum Conservation Division 3, Biological Survey 2, Bureau of Fisheries 2, Geological Survey 2, Bituminous Coal Division 1, Territories and Islands 1, Public Works Administration 3, Travel Service 1, General Department of Interior 4.

The major continuing series of the Department's radio adventure is the What Price America show, which has, to date, been broadcast weekly for 36 weeks (over 102 long-wave stations on the Columbia Broadcasting System's domestic network plus two short wave stations to foreign countries) on Saturday afternoons.

What Price America shows, to October 16, 1939, have evoked individual written requests (postage paid by inquirers without distribution of forms or return mail franks) for over one hundred thousand (100,147) Department of Interior booklets on conservation programs and activities of the bureaus. These requests from every State of the Union, Canada, Mexico, South America, Oriental and European countries, have been met. (Volunteered written listener-comments, accompanying these requests, on file in the Radio Section, are favorable. They reflect a refreshing interest and, in many instances, positive enthusiasm for the conservation programs of the Department's line agencies.) Requests for printed conservation material resulting from broadcasts are increasing instead of decreasing, as might be expected with the exhaustion of novelty. The What Price America Show No. 26, broadcast September 11, pulled 3,214 requests.

Educational material on the Department's conservation work has been brought in dramatic form to an estimated 153,000,000 listeners, including many repeaters.

Radio was employed in a promotional test of three-way partnership between a national publication (Life), a domestic network (NBC Red, full hour), and Government (Department of Interior), in presenting the new issue of the United States map (General Land Office) in July. This map has been issued by the General Land Office approximately every 2 years since 1882. This year's handling, of which radio was the key, resulted in demand requiring two extra printings of 2,000 each by the Geological Survey.

In 3 months the Superintendent of Documents reported 2,195 copies of the 1939 issue sold at $2 each. Congressional supplies, etc., were exhausted. Over the entire 2-year sales period of the 1936 identical map, the Superintendent of Documents sold 577 maps. The same tendency resulted from dramatizing by radio the Department of Interior's Annual Report for 1938 in the My Dear Mr. President show, in which the Department of Interior bureau heads participated.

Because the studio equipment and professional radio staff are unique in Government, the Radio Section has been called on for counsel and assistance by many agencies outside the Department. Among the agencies assisted in this period are the Rural Electrification Administration, Department of Labor, Public Health Service, Civilian Conservation Corps, Social Security Board, Department of Commerce, Treasury Department, Wage and Hour Administration, Public Works Administration, Census Bureau, Library of Congress, Works Progress Administration, United States Housing Authority, Federal Works Agency, Farm Credit Administration, and the New York and San Francisco World Fair Commissions.

Radio networks have donated all air time and met all wire toll, production and music cost of departmental radio programs, without expense to the Government. They are willing to continue to do so if the Department's Radio Section continues to originate, prepare, and sponsor scripts.

No funds or financial aid have come from the Department of Interior for this radio work. It was started with PWA finance and personnel. Supervision and guidance was taken over by the Division of Information. Since the July 1 reorganization, the experiment continues on a temporary and terminable basis with PWA personnel, now in FWA doing the work.

THE CONQUEST OF THE COLORADO RIVER, a new lantern slide lecture which tells the story of Boulder, Parker, and Imperial, the three dams which control America's most dangerous river and put it to useful work, is now available for distribution. Requests for loan will be filled in the order they are received, and should be addressed to the Bureau of Reclamation, Department of the Interior, Washington, D. C. There is no charge, except that the borrower is responsible for the express fees.

White House Conference on Children in a Democracy

THE 1940 session of the White House Conference on Children in a Democracy will convene in Washington, D. C., January 18–20 at the request of President Roosevelt. At that time the report committee of the Conference will present its suggestions and recommendations for the development of a program of action with regard to providing and making available to the children of our Democracy those things which are essential to their happiness and well-being and to the security and future of the Nation.

The White House Conferences on Children developed as a result of suggestions coming to the President and to the Department of Labor from many sources in regard to a review of goals with reference to children and the extent to which they are being realized. Such review, with increasing breadth of approach and coverage, took place in 1909, 1919, and 1930.

The Conference has been charged by the President of the United States with the duty of reviewing the extent to which children are deprived of those things which are essential to their development and the ways by which, as individuals and through organized effort, public and private, we may open up opportunities for them which now are lacking.

This year it was decided that the trend of events in the world had made it necessary to extend the purpose of the Conference to include the relationship between a successful Democracy and the children who form an integral part of that Democracy.

In a far larger measure than any of the preceding meetings the coming conference is facing issues which are at the very roots of personal and social living and the foundations of our economic and political institutions. Existing knowledge and opinion rather than new research are being utilized in determining major goals for action. It is contemplated that the conference report will include consideration of (1) aspirations for children in America as determined by Democratic ideals; (2) opportunities and services available to children in different parts of the country and in the several economic strata and population groups; (3) difficulties in the way of attaining desirable opportunities and services; (4) specific recommendations for action.

Secretary of Labor Perkins Makes Statement

Secretary of Labor Frances Perkins, who is chairman of the conference, has stated that "The conference is not going to attempt to define or defend our American democracy though it may have to attempt to state some of its underlying purposes. Democracy is not only a form of government, it is not only a matter of people living in liberty with each other; there is involved in it the experience of men in liking each other, in getting on together, and in using the friendship so generated to develop a better life and a better relationship for all the people who come after us. We need to take these things for granted in America and go on to see what more we can do with them in behalf of the children of the next generation."

Conference Membership

The conference membership, including representatives appointed by the Governors of States and Territories, is made up of physicians, economists, sociologists, statisticians, educators, clergymen, social workers, housing experts, recreation workers, nutritionists, representatives of industry, labor, farm groups, and professional and civic organizations of men and women; as well as representatives of Federal, State, and local administrative agencies of the Government.

Additional Storage Provided in Clear Lake Reservoir, Klamath Project

By FRED C. LANGELL, *Superintendent, C.C.C. Camp, BR-41*

CLEAR LAKE Dam and Reservoir is located on Lost River in northern California approximately 4 miles south of the Oregon-California State line and 55 miles southeast of Klamath Falls, Oreg. This dam was constructed in 1909 by the Bureau of Reclamation as the first step toward the ultimate reclamation of the fertile lands of the Tule Lake division of the Klamath project. It is an earth and rock fill dam, 33 feet high with a crest length of 790 feet, and serves the dual purpose of providing storage of irrigation waters and flood control. The construction of the dam, as originally designed, formed a reservoir with a capacity of 454,000 acre-feet covering a surface area of 26,500 acres.

Studies and investigations over a period of years subsequent to the construction of the dam revealed the advisability of raising the crest of the spillway and dam to provide for additional storage of flood waters. In accordance with this decision, plans were prepared in the Office of the Chief Engineer for the installation of supports to 3-foot flashboards on the spillway and for raising the earth embankment. Plans for a timber truss bridge, replacing the original structure spanning the tailrace, were included in the proposed construction designed to develop an additional storage of 84,000 acre-feet.

As originally designed and constructed, the dam had a crest width of 20 feet. The upstream face was constructed on a 3:1 slope and protected by a 2-foot layer of rock riprap. The downstream face consisted of a rock fill placed on a 1½:1 slope. The new plan called for raising the earth and rock fill embankment 3 feet, with a slope of 2:1 on the upstream face and 1½:1 on the downstream side of the dam, retaining a crest width of 20 feet. This design automatically shifted the center line of the new crest 4½ feet toward the upstream face.

In November 1938 work was started by a Bureau of Reclamation crew on the installation of the flashboard supports on the spillway. These supports consisted of channel iron embedded in a continuous 6-inch concrete wall, 3 feet in front of the concrete spillway. Channel iron welded to the vertical members near the top and embedded in the concrete spillway served as braces for the structure. It was unnecessary to excavate to a very great depth because of the rocky formation present at the site, in order to secure a stable foundation.

As this type of construction seemed to lend itself admirably to CCC activities, it was deemed advisable to utilize the organization of Camp BR-41, Merrill, Oreg., in the fulfillment of the remainder of the program. With this thought in mind, the Bureau of Reclamation began the construction of the necessary buildings, appurtenant to the establishment of a CCC side camp, as the main camp was too far from the dam to permit daily transportation of enrollees. One Bureau carpenter and two helpers were employed from February 1939 to April 1939 in the construction of the side camp. Water for domestic purposes was available from a well which had been drilled a few years previously. Construction of a water tank and tower 30 feet high was one of the first jobs undertaken. Buildings erected were: a mess hall (20 by 50), a bathhouse equipped with a water heater and boiler in connection with 2 showers and 6 individual lavatories, and 9 tent frames 16 by 16 feet for pyramid tents. A complete plumbing system was installed for the entire camp, affording hot and cold water in the mess hall as well as the bathhouse. Lighting facilities were provided by a 32-volt electric plant taken from one of the Bureau of Reclamation draglines, which afforded an ample supply of current for all quarters, the mess hall, bathhouse, reading room, and office.

Camp Completed, Work Starts

On April 21, 1939, a detail of 36 enrollees from Camp BR-41, under the supervision of one foreman were moved into the camp. After the preliminary details of establishing camp were completed, work was started on the removal of the rock riprap on the upstream face of the dam. With the exception of a small portion, this work was completed by hand with the use of stone boats drawn by one 60-horsepower and one 22-horsepower crawler-type tractors.

In order to insure proper compaction of the earth fill embankment an 8-foot terrace was started at the point where the 2:1 slope intersected the 3:1 slope. This terrace was maintained throughout the entire operation until the original crest of the dam was reached. Earth at a borrow pit located ¾ of a mile south of the dam was loaded on dump trucks by a Bureau of Reclamation dragline. It was spread on the terrace in 6-inch lifts. A 2-inch force pump driven by a 3-horsepower gasoline motor, mounted on a raft, was used to supply the proper moisture content in the new embankment. Com-

Placing rock riprap on upstream face of Clear Lake Dam

paction was attained by the use of a 4-ton roller drawn by a 22-horsepower tractor. Protection against erosion of the new embankment was afforded by replacing the 2-foot layer of rock riprap on the upstream face. The new crest of the dam was surfaced with a 6-inch layer of cinders obtained from a pit on the southerly slope of Carr Butte. The cinders were loaded by the dragline and transported a distance of 7 miles to the dam.

A timber truss operating bridge was constructed across a tail race as a part of the program. Design of the bridge was in accordance with the standard specifications for highway bridges for an H-15 loading, with a center span of 64 feet and two end spans of 10 and 23 feet respectively for a total length of 97 feet. The structural timber and hardware used in the construction of the bridge was purchased by the Bureau of Reclamation. The timber was all creosote-pressure treated and framed when it arrived on the site of operations, and very little difficulty was encountered because of improper framing. A bridge carpenter was employed by the Bureau of Reclamation to assist in the construction of the bridge. In view of the fact that the finished deck was 30 feet above the bed of the tailrace, extreme precautions were necessary to insure the safety of the enrollees.

An estimate and authority for miscellaneous improvements on the caretaker's cottage and grounds was approved on June 6, 1939, and work was started on this project at once. A 12 by 12-foot addition to the cottage, and landscaping and construction of dry rubble masonry walls around a portion of the grounds were the main features of the work accomplished.

The final estimate of quantities for both projects was as follows:

Excavation for embankment class 1. cu. yds	6, 036
Excavation for riprap (includes removal) cu. yds	3, 185
Hand placed rock riprap (2 feet thick) cu. yds	2, 538
Pipe line for cottage, etc. lin. ft	200
Dry rubble masonry stone walls. rods	39
Landscaping acres	5
Enrollee man-days utilized on raising the dam	3, 774
Enrollee man-days utilized on bridge construction	458
Enrollee man-days utilized on miscellaneous improvements	675

Although the side camp was located 35 miles from the main camp, recreational facilities for the enrollees were provided during the entire time the camp was operating. Weekly recreational trips were made to the main camp and to Klamath Falls. Clear Lake Reservoir provided an ideal place for swimming and boating. Numerous fishing excursions were made to adjacent streams by those who found relaxation in this form of sport. A reading room adjoining the camp office afforded an abundant supply of interesting material at all times. Soft ball and horseshoes were other forms of available diversion.

The number of enrollees in the camp varied from 35 to 45 during the period of occupancy. The morale of the camp was excellent at all times, and the turn-over was sufficiently small to insure an adequate number of trained enrollees to properly conduct the work. Approximately 35 percent of the enrollees who made up the original detail remained during the entire time the work was in progress. This percentage would have been larger had it not been that some of the men were recalled to the main camp for transfer to other corps areas for discharge or reassignment late in September.

Much valuable and practical experience was gained by the enrollees. This was particularly true of those men who had the opportunity to be assigned to work on the bridge. Project training in close proximity to the actual work involved was carried on by the foremen and Bureau of Reclamation personnel.

Rapid Valley Project, South Dakota, Approved by President

THE Rapid Valley irrigation project, in South Dakota, has been approved for construction by the President. The project, located on the edge of the Black Hills in the western part of the State, comprises 12,000 acres and will cost $2,470,000, of which $980,000 is expected to be provided from the Interior Department 1940 appropriation and $1,490,000 by the Works Progress Administration.

The Bureau of Reclamation will construct, operate, and maintain a dam and reservoir for the project; the Department of Agriculture will arrange for settlement and operation of the project and repayment of charges for the land development, and the National Resources Committee will assist in planning.

The Rapid Valley project is the third of the so-called "relief" irrigation projects in the Great Plains area of the country to receive Presidential approval. The projects are expected to aid the rehabilitation and stabilization of the area, which has been badly hit by continued drought and depression.

Settlement opportunity will be offered to drought-stricken farmers by a subdivision of present land holdings into smaller farms, and the construction work on the project is expected to provide employment to men now on relief in the area.

The new construction will also help to stabilize the agricultural industry of the community by a supplemental supply of irrigation water which will provide protection from drought and permit more diversified farming. The lands of the project have been cultivated under irrigation for 30 years but the present supply of irrigation water drawn directly from Rapid Creek has always been inadequate. It was practicable in most cases to raise only native hay or other early maturing plants even though the soil and climate of the region was adapted to the cultivation of a large variety of crops.

The new dam and reservoir will also store water to meet the domestic supply requirements of Rapid City, an important commercial center of the Black Hills region.

Storage of water to meet the need of the agricultural lands and the city can be provided by the construction of an earth and rock fill dam 157 feet in maximum height and 1,100 feet in crest length, at the Pactola site on Rapid Creek, 15 miles upstream from Rapid City.

The reservoir formed by the dam would have a capacity of 40,000 acre-feet, 10,000 acre-feet of which would be reserved for municipal supply and the remainder allocated to the project lands. The reservoir would also provide considerable flood control if properly operated.

Construction of the project will not start immediately. It is not to be undertaken until arrangements are completed for the subdivision of present large farms, and considerable advance planning and coordination between the Bureau of Reclamation and the Department of Agriculture are necessary.

The project is expected to take 2 to 4 years to complete.

Engineer "Shoots" Deer with Level During Dam Survey

WHEN a Bureau of Reclamation engineer trained his Y-level on a bank of Provo River, Utah, being dammed to supply water for irrigating 45,000 acres in the Utah and Salt Lake Valleys, he found the cross hairs on a herd of deer at home in the snow.

A picture taken through the level showed more than a dozen does with a buck sentinel facing the surveyor's level almost at the center of the cross hairs.

In making the shot the surveyor first brought the level into focus and placed his camera's f. 4.5 lens close to its eyepiece. He protected the camera lens with a ring of tissue paper and covered the juncture with black camera cloth. Then he squeezed the shutter.

The deer were within gunshot of the future dam, which will be named Deer Creek after the region in which it is located. Construction Engineer E. O. Larson, of the Bureau of Reclamation, who made the picture, reported that more than 200 deer were wintering within a mile of the dam site.

Pit River Bridge Construction to Start

'ONSTRUCTION of concrete piers and butments for the Pit River Bridge, a feaure of the Central Valley project, Caliornia, and the highest double-deck bridge in he world, will begin in December under conract awarded to the Union Paving Co. of an Francisco, on its bid of $1,138,288, the owest of 10 proposals received and opened y the Bureau of Reclamation at its Sacraiento office on October 5, 1939.

This huge Pit River Bridge, to be almost 00 feet above the present level of the Pit iver, will carry the relocated main line of he Southern Pacific Railroad and four lanes f U. S. 99 highway traffic across an arm of he future Shasta Reservoir, 14 miles north of edding, Calif.

The 4 abutments and 10 piers covered in his contract will form the substructure of he bridge, which will be a combination canlever and truss structure two-thirds of a ile long. Bids for the fabrication and erecon of the steel superstructure are expected be advertised soon.

The Government will furnish cement, sand, nd gravel for the manufacture of 95,000 ubic yards of concrete, and also 11,000,000 ounds of steel reinforcement bars that will into the substructure. The contractor is furnish lumber for forms, construction quipment, and labor. The job also will inude 276,000 cubic yards of excavation and 0,000 cubic yards of backfill. The contract rovides the contractor must begin construcon within 30 days and is allowed 16½ onths to complete the work.

The tallest pier will be 358 feet high and 95 by 90 feet in size at the base. Another pier will be 356 feet high and 95 feet square at the base, and a third 271 feet high and 72 by 58 feet at the base. The concrete in these three largest piers will be artificially cooled by the circulation of river water through metal tubing embedded in the structures a practice developed by the Bureau of Reclamation and heretofore used only in the construction of giant dams.

The four abutments include two for the railroad, which is to occupy the lower deck, and two for the highway which will have curbed approaches leading to the upper deck. The main abutment at the southerly end of the bridge will be monolithic with the north portal of a half-mile railroad tunnel through Bass Hill. The tunnel, one of 12 on the 30-mile railroad relocation now under construction between Redding and Delta Station, was holed through a few weeks ago.

This Pit River bridge is the last of eight major bridges for which contracts have been awarded in connection with the big job of relocating 37 miles of the Southern Pacific's main line around the site of the future Shasta Reservoir.

Artificial Cooling of Concrete Central Valley Project

BIDS were received and opened by the Bureau of Reclamation at its Denver office on October 4, 1939, for furnishing more than a million feet of steel pipe or tubing for use in artificially cooling the concrete for Shasta Dam and other structures on the Central Valley project, California.

Award of contract was made to the National Electric Products Corporation of Pittsburgh, Pa., on its bid of $77,070, the lower of the two proposals received.

The contract calls for 1,400,000 feet of black steel pipe or tubing of 1-inch diameter and 15,000 feet of 90° and 180° bends. The contractor is required to ship all the material to Coram, Calif., within 45 days after notice of the award of contract has been received. The tubing will be supplied in minimum lengths of 20 feet and the bends in lengths of 9 feet 8 inches and 5 feet 4 inches.

The ingenious system of artificially cooling concrete by circulating cold river water through metal tubing embedded in structures was developed by the Bureau of Reclamation and has been used in the construction of such large dams as Boulder and Grand Coulee.

Shasta Dam, for which this pipe was ordered, will be second in height to Boulder, the highest dam in the world, and second in size to Grand Coulee, the most massive man-made concrete structure.

The pipe will also be used in cooling the concrete to be placed in the three largest piers of the Pit River Bridge, on the Southern Pacific's relocated line around the site of the future Shasta Reservoir. This will be the first time this system of artificial cooling will have been used in construction of other than large dams.

Parker Dam School

THE Parker Dam School has added a 4-year high-school course to its program. Ninety students are attending, of whom 10 are in high school. One room of the building has been assigned to the San Bernardino County Free Library to accommodate the community with free library books.

NOTES FOR CONTRACTORS

pecification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1939						*1939*
-46, 802-A	Colorado River, Tex	Oct. 20	Steel reinforcement bars (984,290 pounds).	Colorado Fuel & Iron Corporation.	Denver, Colo	$25, 870. 48	F. o. b. Rutledge. Discount ½ percent b. p. v.	Oct. 28
33, 343-A	Central Valley, Calif.	Oct. 4	1,400,000 linear feet of 1-inch o.d. black steel pipe or tubing; 6,500 bends (180°) and 8,500 bends (90°).	National Electric Products Corporation.	Pittsburgh, Pa	77, 070. 00	F. o. b. Coram. Discount, 5 percent. Shipping point Economy, Pa.	Nov. 3
877	do	Oct. 5	Abutments and piers, Pit River bridge, Southern Pacific R.R. and U. S. Highway No. 99 relocation.	Union Paving Co.	San Francisco, Calif	1, 138, 288. 00		Do.
1291-D	Boise-Payette, Idaho	Oct. 10	Earthwork for "D"-Line Canal laterals 24.6 to 38.5 and "A"-Line Canal laterals 20.4 to 32.3.	Ray Schweitzer	Los Angeles, Calif.	12, 263. 00		Do.
1295-D	Provo River, Utah	Nov. 2	Seven 72-inch o. d. welded plate-steel pipes for drainage crossings, Salt Lake Aqueduct.	Chicago Bridge & Iron Co.	Chicago, Ill.	3, 315. 00	F. o. b. Washington Heights, Ill.	Nov. 10
1296-D	Yakima-Roza, Wash.	Nov. 3	Two 6- by 6-foot slide gates and two 13,700-pound capacity motor-operated gate hoists.	Western Foundry Co	Portland, Oreg	[1] 707. 00 [2] 1, 318. 00	F. o. b. Portland do	Nov. 9 Do.
33, 354-A	Central Valley, Calif.	Oct. 26	Steel reinforcement bars (6,460,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	160, 422. 00	F. o. b. Coram. Discount ½ percent on $0.27 less per cwt. shipping point South San Francisco.	Nov. 15
1, 297-D	Parker Dam Power, Ariz.-Calif.	Nov. 7	6 cast-steel, draft tube pier hoses for Parker power plant.	Hardie-Tynes Manufacturing Co.	Birmingham, Ala.	7, 095. 00	F. o. b. Detroit, Mich	Do.
878	Boulder Canyon, Ariz.-Nev.	Nov. 16	Main and auxiliary control equipment, automatic oscillographs, battery distribution switchboard, auxiliary power control equipment and air circuit breakers.	General Electric Co. Roller-Smith Co.	Schenectady, N. Y. Bethlehem, Pa.	[3] 5, 277. 25 [4] 5, 152. 00		Nov. 24 Do.

[1] Item 1. [2] Item 2. [3] Schedule 2. [4] Shedule 4.

The 1939 Klamath Junior Livestock Show

By C. A. HENDERSON, *Klamath County Agricultural Agent*

NEW records were established all the way round in the 1939 junior livestock and baby beef show at Klamath Falls. Both 4–H and F. F. A. entries for the show showed an increase of approximately 20 percent, while the auction sale consisted of 79 lots, as compared with 73 in the 1938 sale. Total animals consigned in 1939 were 141, as compared with 111 in 1938, notwithstanding the limit set for each consignee of 1 beef, 3 sheep, or 3 hogs.

The sale was the highlight climaxing the 4 days of excitement and effort of youngsters of the Klamath Basin. The Klamath sale pavilion, seating 1,000 people, was not large enough for the crowd, an equal number having to remain just outside the entrance where loud speakers conveyed to them the progress of the sale. A total of 44 firms and individuals participated in the spirited bidding, making the sale an outstanding success.

Two tops were established, the grand champion 4–H steer owned by Walter Ritter bringing $1.50 per pound, purchased by Ted Medford, manager of the local Safeway Stores. In the sheep division, the grand champion fat lamb again went to Patty Hammond, bringing $1.25 per pound—another high in the history of this show—the purchaser being Emil's Grocery. The grand champio hog, owned and exhibited by Georgia Liske was purchased by Sears, Roebuck & Co. a 36 cents a pound. The total sale return th year was $12,835, as compared with $12,513 i 1938.

Bette Turner and her prize Suffolk fat lamb, purchased at 31 cents a pound by Elmer Balsinger

James Romtvedt and his first-prize FFA Hampshire fat lamb, greeting Tommy Thompson, purchaser of the lamb at 70 cents a pound

Another highlight of the 4-day event wa the barbecue given by the Rotary Club o Klamath Falls to all exhibitors and thei parents, purchasers at the sale, Rotary Clu members and families, totaling over 1,20 This was held in the grandstand and wa featured by a parade of livestock taking pa in the show. Twenty minutes were require for the stock to pass in review before th stand. Following the parade, awards wer made by Mitchell Tillotson, president of th Rotary Club, assisted by A. E. Street, F. F. A instructor, and Clifford Jenkins, 4–H Clu agent. Dr. Frederick M. Hunter, Chancello Oregon State System of Higher Education, i a 20-minute speech, stressed the object of th show. Dr. Hunter stated that the eviden full cooperation existing between rural an urban people, could not help but result i the excellent progress and fine communit spirit now so noticeable in the Klamat Basin. Dr. Hunter paid tribute to the ex hibitors and their parents, as well as th

Rotary Club and other organizations responsible for the outstanding success of the show. Joe Shirk, barbecue chef, cooked up 1,200 pounds of young steer beef for the event.

T. B. Watters, as chairman of the Rotary committee, did yeoman service during and 6 months preceding the show in insuring a successful event. L. A. West, the granddaddy of the show, was again in charge and kept the sale moving in clocklike order, the total of 79 lots being sold in approximately 2 hours.

Considerable disappointment was registered on the part of several prospective bidders when it was found there was not another capon to compete with the one that sold for $6.50 per pound in the 1938 show. One bid of $100 was placed as an opening bid on a quality capon for 1940.

Charles K. Wiese of Tulelake, again cried the sale and did an excellent job, being complete master of the occasion until the last hog was sold. A radio hook-up carried report of activities and news of the sale throughout the entire county direct from the ring, over radio station KFJI, this being in charge of Lee Jacobs of the Rotary Club. Walter Beane, Rotary Club sales chairman, officiated in the ring and did not miss a bid during the entire afternoon. Each year this show has shown remarkable progress since it was sponsored by the Klamath Falls Rotary Club in 1936. Plans are already laid for the 1940 show to be more outstanding than ever.

Judges for the livestock show were: D. E. Richards, superintendent of the Union Branch Experiment Station, Union, Oreg.; Harry Lindgren, Extension livestock husbandman, Oregon State College, and L. E. Francis, county club agent of Jackson County, Medford, Oreg.

Additional Reports, Technical Investigations of Boulder Dam Available

THERE are now available for distribution two additional reports of technical investigations of the Boulder Canyon project as follows:

BULL. 3. Model tests of Boulder Dam. illustrated, 402 pages, price, paper $1.50; cloth, $2.

BULL. 4. Stress studies for Boulder Dam. illustrated, 286 pages, price, paper $1.50; cloth, $2.

Six of the forty bulletins are now available. They are being prepared in the office of the Chief Engineer, Custom House, Denver, Colo., and may be purchased at that office or in the office of the Bureau at Washington, D. C.

Checks or money orders may be made payable to the Bureau of Reclamation and sent to either office.

Reclamation Employee Honored as Safe Driver

OSCAR BARKER, employed in the Washington office of the Bureau of Reclamation as a driver and messenger, is smiling broadly these days. He has received a merited, unsolicited award from the District of Columbia Department of Vehicles and Traffic, the 1940 Safety Award No. 1. The award was presented by the Washington Post and the WJSV radio station which are sponsoring a traffic safety program in the District, at a ceremony presided over by Eddie Cantor.

Mr. Barker was nominated for this citation by a motor policeman of the Traffic Division, who said he had followed him and that at several different intersections Mr. Barker had stopped his truck in traffic to permit pedestrians to cross in safety.

Mr. Barker admits he felt pretty dejected when the motor sergeant whistled him to the curb and asked to see his driver's permit. "Anything wrong with my driving, Officer," he asked, as he pulled out his permit. "You'll hear more from this later," was the reply.

The officer then recommended Mr. Barker to receive the first award of the safety campaign, and in 1940 his automobile license plate will carry a low number and his car will proudly wear an additional plate lettered "1940 Safety Award No. 1."

Oscar L. Barker

PHILO MILTON WHEELER

FEB. 11, 1876–NOV. 15, 1939

NEWS of the sudden death on November 15 of Philo Milton Wheeler, chief clerk of the Yakima project, has been received with sadness in the Bureau's Washington office. The end came at Yakima in the early morning following an acute heart attack.

Mr. Wheeler was born in DeWitt, Iowa, February 11, 1876. He was employed by the Geological Survey in various capacities from 1903 to 1905, when he entered the employ as engineer of the Great Northern Railway Co. and later became connected with a Spokane, Wash., contracting firm, returning to the Government service as surveyor on the Yakima project in 1908. In 1911 he was assigned to clerical duties on the project and has since advanced successively in various capacities as his ability was demonstrated. Upon the death on February 18, 1936, of R. K. Cunningham, chief clerk of the Yakima project, Mr. Wheeler took over the reins as his successor.

Mr. Wheeler's tenure in office was marked by efficiency, devotion to duty, loyalty to the service, a broad knowledge of reclamation procedure, organizational ability, and sterling character. His passing will be a distinct loss not only to the Yakima project, but to the Bureau at large.

Mr. Wheeler is survived by his wife, Mrs. Katherine R. Wheeler of Yakima; a son, Osborne, of Los Angeles; and two sisters, Mrs. Bess O. Steel of Hollywood, Calif., and Mrs. G. M. Badley of Carroll, Iowa.

Employment

IN employment alone, according to Bureau of Labor Statistics records on the labor required for Reclamation work, the Bureau of Reclamation's present contracted program of irrigation construction and development is creating more than 140,000,000 man-hours of work, both direct and indirect.

CONTENTS

THE RECLAMATION ERA • DECEMBER 1939

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Bureau of Reclamation,
Washington, D. C.

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SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

December 1939.

(Name)..........

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[1] Do not send stamps.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr.	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak.	Parley R. Neeley	Res. engr.	Robert L. Neuman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr.	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif.	R. B. Williams	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif.	Boden, Oscar G.	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Porter J. Preston	Supervising engr.	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr.	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engr.	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. C. Fisher	Constr. engr.	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev.	Chas. S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo.	Irvin J. Matthews	Constr. engr.[2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr.	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz.	E. C. Koppen	Constr. engr.	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo.	Charles A. Burns	Constr. engr.	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.	Samuel A. McWilliams	Resident engr.	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. C. Koppen	Constr. engr.	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr.	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt.		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.[2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Philo M. Wheeler	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr.	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [1]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook
	Zurich irrigation district	Harlem, Mont.	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Missouri River Pumping (N. Dak., S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Yellowstone Basin (Mont.)	Helena, Mont.	F. V. Munro	Engineer.
Big Horn Basin (Mont., Wyo.)	Denver, Colo.	W. G. Sloan	Engineer.
Mangum, North Canadian, Washita (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Arkansas Valley (Colo., Kans.)	Denver, Colo.	A. N. Thompson	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Robert Lee (Tex.)	Austin, Tex.	E. A. Moritz	Construction engineer.
Duchesne-Sevier (Utah)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Bill Williams, Hassayampa, Little Colorado (Ariz.)	Phoenix, Ariz.	Major O. Simons	Associate engineer

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