NINTH ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1909–1910

F. H. NEWELL, Director

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

LETTERS OF TRANSMITTAL

Department of the Interior,
Washington, *December 5, 1910.*

Sir: In compliance with the provisions of section 2 of the act approved June 17, 1902, entitled "An act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands," I have the honor to transmit the accompanying ninth annual report of the Reclamation Service.

Very respectfully,

R. A. Ballinger,
Secretary.

The Speaker of the House of Representatives.

Department of the Interior,
United States Reclamation Service,
Washington, D. C., September 20, 1910.

Sir: Transmitted herewith is the ninth annual report of the Reclamation Service. The report relates in particular to work completed and in progress during the fiscal year ended June 30, 1910, but contains, in addition, information in regard to previous operations in order that the methods, progress, and results of reclamation work may be more readily understood.

Very respectfully,

A. P. Davis,
Acting Director.

The Secretary of the Interior.

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RECLAMATION SERVICE

F. H. Newell, *Director*

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The reclamation act and acts of Congress affecting the operations thereunder have been printed in the fifth, sixth, seventh, and eighth annual reports. For convenience of reference the reclamation act is here reprinted together with laws affecting operations thereunder that have not heretofore been printed in the annual reports.

RECLAMATION ACT

An Act Appropriating the Receipts from the Sale and Disposal of Public Lands in Certain States and Territories to the Construction of Irrigation Works for the Reclamation of Arid Lands

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all moneys received from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming, beginning with the fiscal year ending June thirtieth, nineteen hundred and one, including the surplus of fees and commissions in excess of allowances to registers and receivers, and excepting the five per centum of the proceeds of the sales of public lands in the above States set aside by law for educational and other purposes, shall be, and the same are hereby, reserved, set aside, and appropriated as a special fund in the Treasury to be known as the "reclamation fund," to be used in the examination and survey for and the construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in the said States and Territories, and for the payment of all other expenditures provided for in this act: *Provided,* That in case the receipts from the sale and disposal of public lands other than those realized from the sale and disposal of lands referred to in this section are insufficient to meet the requirements for the support of agricultural colleges in the several States and Territories, under the act of August thirtieth, eighteen hundred and ninety, entitled "An act to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts, established under the provisions of an act of Congress approved July second, eighteen hundred and sixty-two," the deficiency, if any, in the sum necessary for the support of the said colleges shall be provided for from any moneys in the Treasury not otherwise appropriated.

SEC. 2. That the Secretary of the Interior is hereby authorized and directed to make examinations and surveys for, and to locate and construct, as herein provided, irrigation works for the storage, diversion, and development of waters, including artesian wells, and to report to Congress at the beginning of each regular session as to the results of such examinations and surveys, giving estimates of cost of all contemplated works, the quantity and location of the lands which can be irrigated therefrom, and all facts relative to the practicability of each irrigation project; also the cost of works in process of construction, as well as of those which have been completed.

SEC. 3. That the Secretary of the Interior shall, before giving the public notice provided for in section four of this act, withdraw from public entry the lands required for any irrigation works contemplated under the provisions of this act, and shall restore to public entry any of the lands so withdrawn when, in his judgment, such lands are not required for the purposes of this act; and the Secretary of the Interior is hereby authorized, at or immediately prior to the time of beginning the surveys for any contemplated irrigation works, to withdraw from entry, except under the homestead laws, any public lands believed to be susceptible of irrigation from said works: *Provided*, That all lands entered and entries made under the homestead laws within areas so withdrawn during such withdrawal shall be subject to all the provisions, limitations, charges, terms, and conditions of this act; that said surveys shall be prosecuted diligently to completion, and upon the completion thereof, and of the necessary maps, plans, and estimates of cost, the Secretary of the Interior shall determine whether or not said project is practicable and advisable, and if determined to be impracticable or unadvisable he shall thereupon restore said lands to entry; that public lands which it is proposed to irrigate by means of any contemplated works shall be subject to entry only under the provisions of the homestead laws in tracts of not less than forty nor more than one hundred and sixty acres, and shall be subject to the limitations, charges, terms, and conditions herein provided: *Provided*, That the commutation provisions of the homestead laws shall not apply to entries made under this act.

SEC. 4. That upon the determination by the Secretary of the Interior that any irrigation project is practicable, he may cause to be let contracts for the construction of the same, in such portions or sections as it may be practicable to construct and complete as parts of the whole project, providing the necessary funds for such portions or sections are available in the reclamation fund, and thereupon he shall give public notice of the lands irrigable under such project, and limit of area per entry, which limit shall represent the acreage which, in the opinion of the Secretary, may be reasonably required for the support of a family upon the lands in question; also of the charges which shall be made per acre upon the said entries, and upon the lands in private ownership which may be irrigated by the waters of the said irrigation project, and the number of annual installments, not exceeding ten, in which such charges shall be paid and the time when such payments shall commence. The said charges shall be determined with a view of returning to the reclamation fund the estimated cost of construction of the project, and shall be apportioned equitably: *Provided*, That in all construction work eight hours shall constitute a day's work, and no Mongolian labor shall be employed thereon.

Sec. 5. That the entryman upon lands to be irrigated by such works shall, in addition to compliance with the homestead laws, reclaim at least one-half of the total irrigable area of his entry for agricultural purposes, and before receiving patent for the lands covered by his entry shall pay to the Government the charges apportioned against such tract, as provided in section four. No right to the use of water for land in private ownership shall be sold for a tract exceeding one hundred and sixty acres to any one landowner, and no such sale shall be made to any landowner unless he be an actual bona fide resident on such land, or occupant thereof residing in the neighborhood of said land, and no such right shall permanently attach until all payments therefor are made. The annual installments shall be paid to the receiver of the local land office of the district in which the land is situated, and a failure to make any two payments when due shall render the entry subject to cancellation, with the forfeiture of all rights under this act, as well as of any moneys already paid thereon. All moneys received from the above sources shall be paid into the reclamation fund. Registers and receivers shall be allowed the usual commissions on all moneys paid for lands entered under this act.

Sec. 6. That the Secretary of the Interior is hereby authorized and directed to use the reclamation fund for the operation and maintenance of all reservoirs and irrigation works constructed under the provisions of this act: *Provided*, That when the payments required by this act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: *Provided*, That the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress.

Sec. 7. That where, in carrying out the provisions of this act, it becomes necessary to acquire any rights or property, the Secretary of the Interior is hereby authorized to acquire the same for the United States by purchase or by condemnation under judicial process and to pay from the reclamation fund the sums which may be needed for that purpose, and it shall be the duty of the Attorney-General of the United States, upon every application of the Secretary of the Interior under this act, to cause proceedings to be commenced for condemnation within thirty days from the receipt of the application at the Department of Justice.

Sec. 8. That nothing in this act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this act, shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or user of water in, to, or from any interstate stream or the waters thereof: *Provided,* That the right to the use of water acquired under the provisions of this act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right.

SEC. 9. (Repealed by act of June 25, 1910. [36 Stat., 835.])

SEC. 10. That the Secretary of the Interior is hereby authorized to perform any and all acts and to make such rules and regulations as may be necessary and proper for the purpose of carrying the provisions of this act into full force and effect.

Approved, June 17, 1902. (32 Stat., 388.)

REAPPRAISEMENT AND SALE OF LOTS IN TOWN SITES ON RECLAMATION PROJECTS

An Act Providing for the Reappraisement of Unsold Lots in Town Sites on Reclamation Projects, and for Other Purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior is hereby authorized, whenever he may deem it necessary, to reappraise all unsold lots within town sites on projects under the reclamation act heretofore or hereafter appraised under the provisions of the act approved April sixteenth, nineteen hundred and six, entitled "An act providing for the withdrawal from public entry of lands needed for town-site purposes in connection with irrigation projects under the reclamation act of June seventeenth, nineteen hundred and two, and for other purposes," and the act approved June twenty-seventh, nineteen hundred and six, entitled "An act providing for the subdivision of lands entered under the reclamation act, and for other purposes," and thereafter to proceed with the sale of such town lots in accordance with said acts.

SEC. 2. That in the sale of town lots under the provision of the said acts of April sixteenth and June twenty-seventh, nineteen hundred and six, the Secretary of the Interior may, in his discretion, require payment for such town lots in full at time of sale or in annual installments, not exceeding five, with interest at the rate of six per centum per annum on deferred payments.

Approved, June 11, 1910. (36 Stat., 465.)

WITHDRAWALS

An Act To Provide for Agricultural Entries on Coal Lands

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this act unreserved public lands of the United States exclusive of Alaska which have been withdrawn or classified as coal lands, or are valuable for coal, shall be subject to appropriate entry under the homestead laws by actual settlers only, the desert-land law, to selection under section four of the act approved August eighteenth, eighteen hundred and ninety-four, known as the Carey Act, and to withdrawal under the act approved June seventeenth, nineteen hundred and two, known as the reclamation act, whenever such entry, selection, or withdrawal shall be made with a view of obtaining or passing title, with a reservation to the United States of the coal in such lands and of the right to prospect for, mine, and remove the same. But no desert entry made under the provisions of this act shall contain more than one hundred and sixty acres, and all homestead entries made hereunder shall be subject to the conditions, as to residence and cultivation, of entries under the act approved February nineteenth, nineteen hundred and nine, entitled "An act to provide for an enlarged homestead:" *Provided*, That those who have initiated non-mineral entries, selections, or locations in good faith, prior to the passage of this act, on lands withdrawn or classified as coal lands may perfect the same under the provisions of the laws under which said entries were made, but shall receive the limited patent provided for in this act.

Sec. 2. That any person desiring to make entry under the homestead laws or the desert-land law, any State desiring to make selection under section four of the act of August eighteenth, eighteen hundred and ninety-four, known as the Carey Act, and the Secretary of the Interior in withdrawing under the reclamation act lands classified as coal lands, or valuable for coal, with a view of securing or passing title to the same in accordance with the provisions of said acts, shall state in the application for entry, selection, or notice of withdrawal that the same is made in accordance with and subject to the provisions and reservations of this act.

Sec. 3. That upon satisfactory proof of full compliance with the provisions of the laws under which entry is made and of this act the entryman shall be entitled to a patent to the land entered by him, which patent shall contain a reservation to the United States of all the coal in the lands so patented, together with the right to prospect for, mine, and remove the same. The coal deposits in such lands shall be subject to disposal by the United States in accordance with the provisions of the coal-land laws in force at the time of such disposal. Any person qualified to acquire coal deposits or the right to mine and remove the coal under the laws of the United States shall have the right at all times to enter upon the lands selected, entered, or patented, as provided by this act, for the purpose of prospecting for coal thereon upon the approval by the Secretary of the Interior of a bond or undertaking to be filed with him as security for the payment of all damages to the crops and improvements on such lands by reason of such prospecting. Any person who has acquired from the United States the coal deposits in any such land, or the right to mine or remove the same, may reenter and occupy so much of the surface thereof as may be required for all purposes reasonably incident to the mining and removal of the coal therefrom, and mine and remove the coal, upon payment of the damages caused thereby to the owner thereof, or upon giving a good and sufficient bond or undertaking in an action instituted in any competent court to ascertain and fix said damages: *Provided*, That the owner under such limited patent shall have the right to mine coal for use upon the land for domestic purposes at any time prior to the disposal by the United States of the coal deposits: *Provided further*, That nothing herein contained shall be held to deny or abridge the right to present and have prompt consideration of applications to locate, enter, or select, under the land laws of the United States, lands which have been classified as coal lands with a view of disproving such classification and securing a patent without reservation.

Approved, June 22, 1910. (36 Stat., 583.)

An Act To Enable the People of New Mexico to Form a Constitution and State Government and be Admitted into the Union on an Equal Footing with the Original States; and to Enable the People of Arizona to Form a Constitution and State Government and be Admitted into the Union on an Equal Footing with the Original States

NEW MEXICO

Sec. 10. Lands east of the line between ranges eighteen and nineteen east of the New Mexico principal meridian shall not be sold for less than five dollars per acre, and lands west of said line shall not be sold for less than three dollars per acre, and no lands which are or shall be susceptible of irrigation under any projects now or hereafter completed or adopted by the United States under legislation for the reclamation of lands, or under any other project for the reclamation of lands, shall be sold at less than twenty-five dollars per acre: *Provided*, That said State, at the request of the Secretary of the Interior, shall from time to time relinquish such of its lands to the United States as at any time are needed for irrigation works in connection with any such government project. And other lands in lieu thereof are hereby granted to said State, to be selected from lands of the character named and in the manner prescribed in section eleven of this act.

There is hereby reserved to the United States and exempted from the operation of any and all grants made or confirmed by this act to said proposed State all land actually or prospectively valuable for the development of water powers or power for hydro-electric use or transmission and which shall be ascertained and designated by the Secretary of the Interior within five years after the proclamation of the President declaring the admission of the State; and no lands so reserved and excepted shall be subject to any disposition whatsoever by said State, and any conveyance or transfer of such land by said State or any officer thereof shall be absolutely null and void within the period above named; and in lieu of the land so reserved to the United States and excepted from the operation of any of said grants there be, and is hereby, granted to the proposed State an equal quantity of land to be selected from land of the character named and in the manner prescribed in section eleven of this act.

ARIZONA

Sec. 28. No lands shall be sold for less than three dollars per acre, and no lands which are or shall be susceptible of irrigation under any projects now or hereafter completed or adopted by the United States under legislation for the reclamation of lands, or under any other project for the reclamation of lands, shall be sold at less than twenty-five dollars per acre: *Provided*, That said State, at the request of the Secretary of the Interior, shall from time to time relinquish such of its lands to the United States as at any time are needed for irrigation works in connection with any such government project. And other lands in lieu thereof are hereby granted to said State, to be selected from lands of the character named and in the manner prescribed in section twenty-four of this act.

There is hereby reserved to the United States and excepted from the operation of any and all grants made or confirmed by this act to said proposed State all lands actually or prospectively valuable for the development of water powers or power for hydro-electric use or transmission and which shall be ascertained and designated by the Secretary of the Interior within five years after the proclamation of the President declaring the admission of the State; and no lands so reserved and excepted shall be subject to any disposition whatsoever by said State, and any conveyance or transfer of such land by said State or any officer thereof shall be absolutely null and void within the period above named; and in lieu of the land so reserved to the United States and excepted from the operation of any of said grants there be, and is hereby, granted to the proposed State an equal quantity of land to be selected from land of the character named and in the manner prescribed in section twenty-four of this act.

Approved, June 20, 1910. (36 Stat., 557.)

An Act To Authorize the President of the United States to Make Withdrawals of Public Lands in Certain Cases

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President may, at any time in his discretion, temporarily withdraw from settlement, location, sale, or entry any of the public lands of the United States including the District of Alaska, and reserve the same for water-power sites, irrigation, classification of lands, or other public purposes to be specified in the orders of withdrawal, and such withdrawals or reservations shall remain in force until revoked by him or by an act of Congress.

Sec. 2. That all lands withdrawn under the provisions of this act shall at all times be open to exploration, discovery, occupation, and purchase, under the mining laws of the United States, so far as the same apply to minerals other than coal, oil, gas, and phosphates: *Provided*, That the rights of any person who, at the date of any order of withdrawal heretofore or hereafter made, is a bona fide occupant or claimant of oil or gas bearing lands, and who, at such date, is in diligent prosecution of work leading to discovery of oil or gas, shall not be affected or impaired by such order, so long as such occupant or claimant shall continue in diligent prosecution of said work: *And provided further*, That this act shall not be construed as a recognition, abridgment, or enlargement of any asserted rights or claims initiated upon any oil or gas bearing lands after any withdrawal of such lands made prior to the passage of this act: *And provided further*, That there shall be excepted from the force and effect of any withdrawal made under the provisions of this act all lands which are, on the date of such withdrawal, embraced in any lawful homestead or desert-land entry theretofore made, or upon which any valid settlement has been made and is at said date being maintained and perfected pursuant to law; but the terms of this proviso shall not continue to apply to any particular tract of land unless the entryman or settler shall continue to comply with the law under which the entry or settlement was made: *And provided further*, That hereafter no forest reserve shall be created, nor shall any additions be made to one heretofore created within the limits of the States of Oregon, Washington, Idaho, Montana, Colorado, or Wyoming, except by act of Congress.

SEC. 3. That the Secretary of the Interior shall report all such withdrawals to Congress at the beginning of its next regular session after the date of the withdrawals.

Approved, June 25, 1910. (36 Stat., 847.)

ASSIGNMENT OF HOMESTEAD ENTRIES ON RECLAMATION PROJECTS

An Act Providing that Entrymen for Homesteads within Reclamation Projects May Assign their Entries upon Satisfactory Proof of Residence, Improvement, and Cultivation for Five Years, the same as though said Entry had been Made under the Original Homestead Act

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the filing with the Commissioner of the General Land Office of satisfactory proof of residence, improvement, and cultivation for the five years required by law, persons who have or shall make homestead entries within reclamation projects under the provisions of the act of June seventeenth, nineteen hundred and two, may assign such entries, or any part thereof, to other persons, and such assignees, upon submitting proof of the reclamation of the lands and upon payment of the charges apportioned against the same as provided in the said act of June seventeenth, nineteen hundred and two, may receive from the United States a patent for the lands: *Provided*, That all assignments made under the provisions of this act shall be subject to the limitations, charges, terms, and conditions of the reclamation act.

Approved, June 23, 1910. (36 Stat., 592.)

An Act Granting Leaves of Absence to Homesteaders on Lands to be Irrigated under the Provisions of the Act of June Seventeenth, Nineteen Hundred and Two

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all qualified entrymen who have heretofore made bona fide entry upon lands proposed to be irrigated under the provisions of the act of June seventeenth, nineteen hundred and two, known as the national irrigation act, may, upon application and a showing that they have made substantial improvements, and that water is not available for the irrigation of their said lands, within the discretion of the Secretary of the Interior, obtain leave of absence from their entries, until water for irrigation is turned into the main irrigation canals from which the land is to be irrigated: *Provided*, That the period of actual absence under this act shall not be deducted from the full time of residence required by law.

Approved, June 25, 1910 (36 Stat., 864).

ADVANCES TO RECLAMATION FUND

An Act To Authorize Advances to the "Reclamation Fund," and for the Issue and Disposal of Certificates of Indebtedness in Reimbursement Therefor, and for Other Purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That to enable the Secretary of the Interior to complete government reclamation projects heretofore begun, the Secretary of the Treasury is authorized, upon request of the Secretary of the Interior, to transfer from time to time to the credit of the reclamation fund created by the act entitled "An act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands," approved June seventeenth, nineteen hundred and two, such sum or sums, not exceeding in the aggregate twenty million dollars, as the Secretary of the Interior may deem necessary to complete the said reclamation projects, and such extensions thereof as he may deem proper and necessary to the successful and profitable operation and maintenance thereof or to protect water rights pertaining thereto claimed by the United States, provided the same shall be approved by the President of the United States; and such sum or sums as may be required to comply with the foregoing authority are hereby appropriated out of any money in the Treasury not otherwise appropriated: *Provided,* That the sums hereby authorized to be transferred to the reclamation fund shall be so transferred only as such sums shall be actually needed to meet payments for work performed under existing law: *And provided further,* That all sums so transferred shall be reimbursed to the Treasury from the reclamation fund, as hereinafter provided: *And provided further,* That no part of this appropriation shall be expended upon any existing project until it shall have been examined and reported upon by a board of engineer officers of the army, designated by the President of the United States, and until it shall be approved by the President as feasible and practicable and worthy of such expenditure; nor shall any portion of this appropriation be expended upon any new project.

SEC. 2. That for the purpose of providing the Treasury with funds for such advances to the reclamation fund, the Secretary of the Treasury is authorized to issue certificates of indebtedness of the United States in such form as he may prescribe and in denominations of fifty dollars, or multiples of that sum; said certificates to be redeemable at the option of the United States at any time after three years from the date of their issue and to be payable five years after such date, and to bear interest payable semiannually, at not exceeding three per centum per annum; the principal and interest to be payable in gold coin of the United States. The certificates of indebtedness herein authorized may be disposed of by the Secretary of the Treasury at not less than par, under such rules and regulations as he may prescribe, giving all citizens of the United States an equal opportunity to subscribe therefor, but no commission shall be allowed and the aggregate issue of such certificates shall not exceed the amount of all advances made to said reclamation fund, and in no event shall the same exceed the sum of twenty million dollars. The certificates of indebtedness herein authorized shall be exempt from taxes or duties of the United States as well as from taxation in any form by or under state, municipal, or local authority; and a sum not exceeding one-tenth of one per centum of the amount of the certificates of indebtedness issued under this act is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to pay the expense of preparing, advertising, and issuing the same.

Sec. 3. That beginning five years after the date of the first advance to the reclamation fund under this act, fifty per centum of the annual receipts of the reclamation fund shall be paid into the general fund of the Treasury of the United States until payment so made shall equal the aggregate amount of advances made by the Treasury to said reclamation fund, together with interest paid on the certificates of indebtedness issued under this act and any expense incident to preparing, advertising, and issuing the same.

Sec. 4. That all money placed to the credit of the reclamation fund in pursuance of this act shall be devoted exclusively to the completion of work on reclamation projects heretofore begun as hereinbefore provided, and the same shall be included with all other expenses in future estimates of construction, operation, or maintenance, and hereafter no irrigation project contemplated by said act of June seventeenth, nineteen hundred and two, shall be begun unless and until the same shall have been recommended by the Secretary of the Interior and approved by the direct order of the President of the United States.

Sec. 5. That no entry shall be hereafter made and no entryman shall be permitted to go upon lands reserved for irrigation purposes until the Secretary of the Interior shall have established the unit of acreage and fixed the water charges and the date when the water can be applied and made public announcement of the same.

Sec. 6. That section nine of said act of Congress, approved June seventeenth, nineteen hundred and two, entitled "An act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands," is hereby repealed.

Approved, June 25, 1910 (36 Stat., 835).

DECISIONS OF THE SECRETARY OF THE INTERIOR

GENERAL STATEMENT

Below is given, under suitable headings, a digest of important decisions that have been rendered by the Secretary of the Interior and of some decisions rendered by the Comptroller of the Treasury during the past year relating to operations under the reclamation act.

WATER RIGHTS

An applicant for a water right must be the owner of the land and actually reside thereon or in the neighborhood. Having these qualifications, he may, after having disposed of the previously acquired water right, make another application, and as to that may be considered in the position of an original applicant. The landowner may be the purchaser of the right to the use of water for separate tracts at the same time, provided he can properly qualify and that the tracts involved do not exceed 160 acres in the aggregate. (Secretary, to William B. Bridgman, Sunnyside, Wash., November 20, 1909.)

The water-right application of a desert-land entryman under the act of June 27, 1906 (34 Stat., 520), may be forfeited upon his failure to make the payments as they become due. Final certificate and patent will not issue until all payments have been made. (First Assistant Secretary, September 13, 1909, 38 L. D., 194.)

Whenever, in case of foreclosure of a mortgage given to secure a loan on land in private ownership for which charges are payable for a water right under a reclamation project, the mortgagor buys in the land, no steps will be taken to cancel the water-right application on account of failure to maintain residence upon or in the neighborhood of the land until the expiration of one year from the date of the foreclosure sale, provided that all charges that may be due or that may accrue during such interval be paid, and also that within such period of one year a water-right application for such land be filed by a qualified person who, upon submitting satisfactory evidence of transfer of title, shall be entitled to a credit equal to all payments theretofore made on account of the water-right charges for said land. (Secretary, March 5, 1910, 38 L. D., 480.)

Where a tract of land under a reclamation project is owned by two or more persons jointly, unless each is a "resident" or an occupant on the land, as provided in section 5 of the reclamation act, no right to use water to irrigate the same can be acquired thereunder. (Secretary, in letter to Director of Reclamation Service, January 12, 1910.)

ENTRIES AND FILINGS

A settler on unsurveyed land subsequently embraced in a withdrawal under the reclamation act as subject to reclamation under an irrigation project may, upon survey of the land, make and complete entry for the full area allowed by law and appropriated by his settlement, notwithstanding such withdrawal previous to entry, free of the added conditions and limitations imposed by the reclamation act upon settlers subsequent to withdrawal. (First Assistant Secretary, May 23, 1910, 38 L. D., 603.)

CHARGES

The reclamation act does not make it a mandatory duty of the Secretary of the Interior to assess operation and maintenance charges against unentered land within a reclamation project, but he has authority to do so, and he has also sole authority to determine the time when such charges may be so assessed. (Secretary, April 4, 1910, North Platte project, Nebraska-Wyoming.)

Water can not be furnished from a reclamation project to the Idaho State Experiment Farm free of charge. (Acting Secretary, September 15, 1909.)

PAYMENTS

When the Secretary has fixed the number of installments to be paid and the time therefor, he is without authority to suspend payment of same in case the alkali has risen to the surface of the soil and interfered with the crop returns from the land. (Acting Secretary, September 24, 1909, case of Sam Hammond, Truckee-Carson project, Nevada.)

WITHDRAWALS

The reclamation act authorizes the withdrawal of public lands from entry to provide pasture for government animals used in carrying on operations under the act. (Secretary, March 21, 1910, Lower Yellowstone project, Montana.)

The discretion of the Secretary in making first-form withdrawals of lands can not be questioned, and no application to enter can be allowed on that ground. An application to enter lands withdrawn under the first form should not be received and suspended, but should be rejected. (First Assistant Secretary, December 14, 1909, 38 L. D., 349.)

A restoration of lands is not regarded as effective so that entry may be allowed until the order of restoration has reached the local land office. (First Assistant Secretary, August 17, 1909, 38 L. D., 146.)

The United States need assign no reason for declining to restore certain lands to entry when the applicant shows no equitable claim to the land, being merely desirous of entering same in case it can be restored to entry. (First Assistant Secretary, November 22, 1909, case of D. O. Robertson, Yakima (Sunnyside) project, Washington.

Contestant's preference right of entry is not applicable to first-form lands, and contest should be dismissed; but it is otherwise if contestant claims under placer location, as no right of entry is secured thereby. (38 L. D., 314.)

APPROXIMATION OF AREAS

Reclamation homestead entries and desert entries coming within the provisions of the reclamation act are subject to the rule that when the excess area therein above 160 acres is less than the deficiency would be if the subdivision were excluded it may be included in the entry; where it is greater it must be excluded. (Secretary, March 30, 1910, 38 L. D., 513.)

PURCHASE OF LAND

Where title passes to the United States pending taxing proceedings and prior to levy, the land passes beyond the taxing power of the State and no lien attaches, the United States taking the title free of incumbrance. (Secretary, April 25, 1910, case of John M. Simmons, Boise project, Idaho.)

Paragraph 9 of the regulations approved June 6, 1905 (33 L. D., 607), provides that in case of failure to agree upon the amount to be paid for improvements the amount shall be ascertained by appraisement. The paragraph is amended to read:

Ninth. Where the owners of the improvements mentioned in the preceding section shall fail to agree with the representative of the Government as to the amount to be paid therefor, the same shall be acquired by condemnation proceedings under judicial process as provided by section 7 of the reclamation act. (Acting Secretary, June 30, 1909, 38 L. D., 58.)

POWER

Power development for irrigation in connection with an irrigation project is appurtenant to the land irrigated. It may be the subject of a permanent contract and would not be limited under the act of April 16, 1906. (Secretary's letter to Hon. Wesley L. Jones, June 21, 1910, on letter of S. J. Harrison, Yakima (Sunnyside) project, Washington.)

RECLAMATION FUND

The reclamation fund may not be used as a reward for the apprehension of any employee of the Reclamation Service who may have been guilty of a breach of trust. (Secretary's memorandum, January 28, 1910.)

FURNISHING OFFICIAL INFORMATION TO INTERESTED PARTIES

Any water users' association or individual having an interest in the lands under a project may obtain information from the fiscal records by applying in writing to the supervising engineer, stating the interest applicant has in the project, the nature of the information desired, and the use proposed to be made thereof.

The supervising engineer, if satisfied that the giving of such information will not be detrimental to the public service, will indorse on such application his approval, whereupon the information sought will be promptly supplied and a record made thereof. If the application be denied, the supervising engineer will indorse the reasons for disallowance thereupon and promptly forward the same to the Secretary of the Interior. (Secretary, November 15, 1909, 38 L. D., 311.)

PAYMENT FOR RECORDING

Where the state statute so requires, payment may be made in advance for the recording of deeds. (Comptroller, September 13, 1909, Minidoka project, Idaho.)

PROOF OF RESIDENCE, CULTIVATION, IMPROVEMENT AND RECLAMATION

Homesteaders who have resided on and improved their lands for the time required by the homestead laws and have reclaimed at least one-half the irrigable area of their farm units, and have submitted satisfactory proof, will be excused from further residence on their lands. Final certificate and patent will issue after full payment of the water-right charges.

Homesteaders who have resided on, cultivated, and improved their lands for the time required by the homestead laws and have submitted satisfactory proof, but who are unable to furnish proof of reclamation because water has not been furnished or farm units not established, will be excused from further residence on their lands, but final certificate and patent will not issue until proof of reclamation of one-half the irrigable area and payment of all charges imposed by the public notice.

Upon proof of residence, cultivation, improvement, and reclamation required by the homestead and reclamation laws, the parties in interest may, if desired, exercise the option of immediately paying all installments of the charges for building, operation, and maintenance, whereupon final certificate and patent will be issued. (Secretary, September 17, 1909, 38 L. D., 229.)

LITIGATION

ARIZONA, SALT RIVER PROJECT

The suit of Hurley *v.* Abbott et al. is a proceeding brought in the district court of the third judicial district of the Territory of Arizona in and for the county of Maricopa for the purpose of determining individual water rights of land owners in the Salt River Valley who claim by virtue of appropriation the right to use for irrigation the natural flow of Salt River. On March 1, 1910, the court rendered a decision adjudicating all existing rights to the use of the unregulated flow of the Salt River, thus defining with considerable accuracy the unappropriated water which the Government would be entitled to store in the Roosevelt reservoir.

COLORADO, GRAND VALLEY PROJECT

November 2, 1908, a petition was filed in the district court of the State of Colorado for Mesa County, for the adjudication of the priorities of water rights in district No. 42, Mesa County, Colo. A referee was appointed by the court and statements of various ditch companies have been filed. The hearing has not yet been had.

COLORADO, UNCOMPAHGRE VALLEY PROJECT

The suit of the Denver Savings Bank by Guy Le Roy Stevick, receiver, is referred to on page 6 of the eighth annual report. This suit was brought to secure property mortgaged to the bank, by the Taylor-Moore Construction Company, defaulting contractor for construction of the Gunnison tunnel. A writ of replevin was issued October 5, 1905, but on October 10, 1905, an order was issued restraining the plaintiff from interfering with the property. On October 10, 1906, an application was filed to appeal the case to the United States circuit court of appeals. On October 16, 1906, a transcript of the record from the district court was filed and the hearing set for September 3, 1907. Two continuances of one year each were granted by stipulation, final hearing being fixed for September 6, 1909. A mandate dismissing the appeal to the United States circuit court of appeals was filed November 10, 1909.

A suit has been instituted in the district court of the State of Colorado for Delta County, Colo., for the adjudication of water rights in water district No. 40, affecting the Uncompahgre Valley project. A referee was appointed by order of the court on March 18, 1908, and a statement of the claims of the United States has been filed.

A petition has been filed in the district court of the State of Colorado for Montrose County, in the matter of adjudication of priorities of water rights in water district No. 62. The petition was filed on April 25, 1910, by the Cimarron and Uncompahgre Valley Canal and Reservoir Company. On April 25, 1910, the court ordered an adjudication of the water rights and appointed a referee.

IDAHO, BOISE PROJECT

On June 26, 1909, suit was commenced by the United States *v.* William V. Hitson to restrain the defendant from interfering with the maintenance and operation of a government canal across his land, the land being subject to right of way under the act of August 30, 1890. (26 Stat., 391.) The case was compromised, the defendant acceding to the demands of the United States.

IDAHO, MINIDOKA PROJECT

In 1908 the Minidoka and Southwestern Railroad Company filed right-of-way maps under the act of March 3, 1875 (18 Stat., 482), crossing various canals and laterals constructed under the provisions of the reclamation act. The company was notified that the right of way would be granted subject to a stipulation that it should construct and maintain all necessary structures and crossings and release the United States from liability for damage. The company failed to file the stipulation and the General Land Office rejected the application, but the company notwithstanding began construction. Proceedings were accordingly instituted in the circuit court of the United States for the central division of the district of Idaho by filing bill of complaint asking that the company be perpetually enjoined. The case was finally compromised, the company acceding to the demands of the United States.

In December, 1909, the same railroad company attempted to construct another line of road across the withdrawn lands and irrigation works of the Minidoka project without filing the required stipulation. A complaint was duly filed in the above court and a preliminary decision rendered which was not entirely satisfactory to the United States. Further proceedings have been taken with the view of perfecting an appeal.

A complaint has been filed by the Twin Falls Canal Company in the district court of the fourth judicial district of the State of Idaho for Twin Falls County, against Charles N. Foster; R. A. Ballinger, Secretary of the Interior; C. H. Paul, project engineer, et al., and petition for a decree determining the priorities of the parties to the use of the waters of Snake River. About 2,500 parties have been joined as defendants, of whom approximately one-half are applicants for water under the Minidoka project. Three demurrers have been filed by the United States on behalf of water-right applicants under the Minidoka project. On June 24, 1910, an order was issued making the project engineer a party defendant. A temporary order has been made, distributing the waters of the Snake River for the season of 1910 as to the Minidoka dam and canal system and the irrigation systems of the North Side Canal Company and of the plaintiff.

The Minidoka and Southwestern Railroad Company has instituted an action in the district court of the fourth judicial district of the State of Idaho for Lincoln County, against the engineers of the United States and contractors engaged in construction work on the Minidoka project, seeking an injunction and temporary restraining order prohibiting the defendants from trespassing on the plaintiff's alleged right of way and from constructing canals and other works, and asking $500 damages. On March 19, 1910, an answer was filed;

also a cross complaint asking $2,000 damages for delay of the work and for an injunction prohibiting the plaintiff from further obstructing the work. The case has not yet been finally decided.

KANSAS, GARDEN CITY PROJECT

In the suit of the United States *v.* United States Sugar and Land Company in the circuit court of the United States for the district of Kansas, referred to on page 6 of the eighth annual report, wherein it was sought to restrain the defendant from operating wells to the damage of the Garden City project, a stipulation has been entered into between the respective parties dismissing the proceeding without prejudice to either party.

MONTANA, HUNTLEY PROJECT

On August 31, 1909, an action was instituted in the United States circuit court for the district of Colorado against Piper Brothers Company, Whitney Newton, and George A. Newton for the recovery of extra expense incurred in completing a suspended contract for construction work on the Huntley project. The defendants demurred, alleging unconstitutionality of the reclamation act, but the demurrer was overruled on the ground that the defendants by contracting in pursuance of the reclamation act and participating in the benefits thereof had estopped themselves from denying its constitutionality.

NEBRASKA-WYOMING, NORTH PLATTE PROJECT

On May 10, 1909, suit was brought in the United States circuit court for Wyoming for the condemnation of lands of the Bothwell Company et al. required for the Pathfinder reservoir. An offer of $65,000 was made for the lands, which was declined and demand made for $169,800. The amount awarded was $108,250, judgment being entered December 28, 1909.

The suit of Heyward G. Leavitt *v.* Ethan Allen Hitchcock, Secretary of the Interior, is referred to on page 31 of the fifth annual report. On January 29, 1910, the court ordered that the case be dismissed at the cost of the plaintiff, the suit having abated because of the resignation of Secretary Hitchcock and not having been revived within the statutory period.

NEVADA, TRUCKEE-CARSON PROJECT

In the case of the United States *v.* Rickey Land and Cattle Company, in which it was sought to restrain the company from utilizing the Alkali Flat reservoir site, an injunction *pendente lite* was granted June 26, 1908. No further proceedings have been had.

NEW MEXICO, CARLSBAD PROJECT

No decision has been rendered in the case of Harkey & Brice et al. *v.* Judkins et al. the United States, intervener, referred to on page 7 of the eighth annual report.

NEW MEXICO, HONDO PROJECT

No decision has been rendered in the case of the United States *v.* Lillie C. Klasner, referred to on page 7 of the eighth annual report.

In October, 1907, proceedings were commenced in the district court of Lincoln County, N. Mex., sixth judicial district, by the El Paso and Rock Island Railway et al., against the United States et al., for the purpose of adjudicating the waters of the Hondo River, New Mexico. On December 6, 1907, the territorial engineer was ordered to make a hydrographic survey of the Rio Hondo stream system. The hearing has not yet been had.

NEW MEXICO-TEXAS, RIO GRANDE PROJECT

On November 5, 1909, complaint was filed in the district court of the seventh judicial district of the Territory of New Mexico *v.* Victorio Land and Cattle Company and Gregorio Gonzales for the acquisition of certain lands required for the Engle reservoir. The company demanded for the lands $600,000. An offer of $65,000 was made on behalf of the United States. The amount awarded to the Victorio Land and Cattle Company was $199,097.25 and to Gonzales $1,380, the order of the court being entered June 14, 1910.

OREGON, UMATILLA PROJECT

On June 3, 1910, E. P. Dodd and Fred A. Yates filed bills of complaint against H. D. Newell, project engineer, et al., in the circuit court of the State of Oregon for Umatilla County, and on the same date an order was issued restraining the defendants and their agents from cleaning out a section of canal purchased by the United States. A bill of complaint was immediately filed in the circuit court of the United States on behalf of the United States against Dodd, Yates, et al., and a temporary restraining order was obtained prohibiting them from interfering with the agents of the United States employed in the said work. A temporary injunction was filed July 2, 1910, and final decree with perpetual injunction August 25, 1910. On June 18, 1910, the suits in the state court were dismissed on motion of the plaintiffs' attorneys.

On November 16, 1909, a bill for injunction was filed by the United States against Joseph Ramos and the Wilson Irrigation Company to restrain the defendants from constructing or maintaining a dam across the Umatilla River above the government diversion. On January 4, 1910, a decree *pro confesso* was entered against the defendants, and on February 5, 1910, a final decree was entered perpetually enjoining the defendant from maintaining a dam, or in any way interfering with the rights of the Government.

OREGON-CALIFORNIA, KLAMATH PROJECT

On May 3, 1909, an action was commenced in the United States circuit court for the district of Oregon against Sophia A. Henley and J. B. Carroll to enforce payment of water-right charges in pursuance of agreement entered into between the said parties and the United States. Judgment was rendered for the amount of the claim, but

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by agreement between the parties the case was compromised by reduction of the amount of the judgment, the defendants giving a deed to the United States of certain lands required by the Government for rights of way in connection with the Klamath project.

On May 3, 1909, an action was commenced in the United States circuit court for the district of Oregon against Roscoe E. and Nanna M. Cantrall and Cordelia L. Ankeny to enforce payment of water-right charges in pursuance of contract entered into with the United States. The case was compromised by the defendants paying $750 and by the execution and delivery by Mrs. Ankeny of a deed conveying to the United States certain lands required for canal rights of way in connection with the Klamath project.

SOUTH DAKOTA, BELLE FOURCHE PROJECT

Suit has been commenced by the United States *v.* Widell-Finley Company, defaulting contractors on the main supply canal, Belle Fourche project, and also against the sureties on the bond to recover the sum of $59,009.06 against the contractors and $21,500 against the sureties. The suit is pending in the United States court, second division, at Mankato, Minn.

Progress of the suit of United States *v.* Moses, sheriff of Butte County, S. Dak., has been reported in preceding annual reports. The suit was commenced in October, 1907, to recover possession of certain personal property taken over by the Government upon default of the Widell-Finley Company, contractors on the Belle Fourche project. Taxes were levied against the property and complaint was filed by the United States in the United States court. The court ordered that the property be returned to the United States, the case to be later decided on an agreed statement of facts. In September, 1909, a decision was rendered to the effect that the property of the defaulting contractor in the possession of the United States is subject to taxation as belonging to the company or its creditors. It is expected that an appeal will be taken.

On May 9, 1908, a complaint was filed on behalf of the United States in the United States Circuit Court, District of South Dakota, Western Division, against William Casavant, being an action in replevin to recover certain property formerly belonging to Orman and Crook, defaulting contractors, for construction work on the Belle Fourche project. On July 6, 1908, part of the property was returned to the United States, and the case was subsequently dismissed.

WASHINGTON, YAKIMA PROJECT

The suit begun June 21, 1909, in the United States circuit court for the eastern district of Washington entitled United States *v.* H. K. Luce, the Standard Building Company, and Ira Petty, for the recovery of certain personal property valued at about $10,000 is referred to on page 8 of the eighth annual report. The case is still pending.

On August 9, 1909, S. D. Freed, a water user, was indicted for cutting a lateral of the United States and taking water therefrom for use on his land, in violation of the act of the State legislature approved March 19, 1909. It was shown at the trial that the defendant was not entitled to water from the said lateral; that without permission or authority he had cut the bank of the lateral with a flume, and conducted water therefrom to his land. The defendant pleaded that he had arranged to obtain on certain days water belonging to a landowner under said lateral, but could not show that such agreement existed. Defendant admitted that such arrangement was in violation of his contract. Defendant was found not guilty.

In November, 1909, a petition was filed in the United States Circuit Court for the Eastern District of Washington by Julius Anthon and wife, seeking to recover damages alleged to have resulted from the construction of the "Mabton syphon" across the land of the plaintiff. A demurrer has been filed on behalf of the United States, and the case is still pending.

WYOMING, SHOSHONE PROJECT

On page 8 of the eighth annual report reference is made to the suit of The United States *v.* Felix Alston, sheriff, who levied taxes on certain personal property which had come into the possession of the United States by default of Charles Spear in execution of his contract for the construction of the Corbett tunnel. On May 9, 1910, a decree was rendered in the United States circuit court for the eighth judicial circuit, district of Wyoming, restraining the defendant and his agents from selling or offering for sale any of the said property and making perpetual the injunction which was issued on May 10, 1909.

PURCHASES OF RIGHTS AND PROPERTY

Section 7 of the reclamation act provides that where, in carrying out the provisions of the act, it is necessary to acquire any rights or property the Secretary of the Interior may acquire them for the United States by purchase or by condemnation through judicial process.

The following is a complete list of all such completed purchases to June 30, 1910, except as heretofore reported in the annual reports:

Purchases of rights and property

ARIZONA, SALT RIVER PROJECT

Vendor	Description	Consideration	Date of deed
Armstrong, Geo. L. and wife	Part lot 5, Botts division, city of Phoenix	$57.00	Jan. 29, 1910
Babby, W. A	Part E. ½ NE. ¼ sec. 24, T. 1 N., R. 6 E., G. and S. R. B. and M.	1.00	May 5, 1910
Barnard, Mary E	Right of way across portion of N. ½ SE. ¼ sec. 8, T. 1 N., R. 4 E., G. and S. R. M.	1.00	
Blendinger, Eleanor E	Part W. ½ SE. ¼ sec. 27, T. 2 N., R. 3 E., G. and S. R. B. and M.	1,100.00	Mar. 8, 1910
Bond, E. C. and I. M	Right of way for power line across E. ½ SW. ¼ sec. 7, T. 1 N., R. 4 E., G. and S. R. B. and M.	150.00	Oct. 12, 1909
Boyd, Elmer F	W. ½ SE. ¼ sec. 20, T. 4 N., R. 13 E., G. and S. R. B. and M.	1,000.00	July 21, 1909
Campbell, John E	SE. ¼ SE. ¼ sec. 15, T. 4 N., R. 12 E., G. and S. R. B. and M.	600.00	July 27, 1909
Connor, Selden and wife	Part SE. ¼ NE. ¼ of NE. ¼ sec. 18, T. 3 N., R. 2 E., G. and S. R. B. and M.	275.00	June 20, 1910
Consolidated Canal Co	Consolidated Canal System	187,000.00	July 10, 1909
Cook, Geo. H. and wife	Right of way across portion sec. 24, T. 2 N., R. 1 E.	1.00	Nov. 14, 1908
Cummings, Jeremiah H	Part N. ½ NW. ¼ sec. 15, T. 1 N., R. 4 E., G. and S. R. B. and M.	100.00	Dec. 30, 1909

Purchases of rights and property—Continued

ARIZONA, SALT RIVER PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Cummings, W. T.	Right of way across N. ½ S. ½ sec. 8, T. 1 N., R. 4 E., excepting east 67 a.	$1.00	Nov. 14, 1908
Gage, Geo. H.	Right of way across N. ½ SE. ¼ sec. 15, T. 1 N., R. 4 E.	1.00	Nov. 7, 1908
Galpin, M. J. and wife	Part NW. ¼ sec. 23, T. 1 N., R. 5 E.	1.00	Feb. 3, 1910
Gilmore, Geo. and Nettie	Part SW. ¼ sec. 1, T. 1 N., R. 3 E., G. and S. R. B. and M.	243.00	Nov. 19, 1909
Hedgpeth, W. C. and L. S.	Part SW. ¼ NW. ¼ sec. 27, T. 2 N., R. 3 E., G. and S. R. B. and M.	450.00	Oct. 20, 1909
Henderson, John B. (clerk district court, fifth district).	E. ½ NW. ¼ and SW. ¼ NE. ¼, sec. 1, T. 4 N., R. 11 E., G. and S. R. B. and M.	2,000.00	Nov. 16, 1909
Hoghe & Luke	Part SE. ¼ sec. 1, T. 1 N., R. 3 E., G. and S. R. B. and M.	996.00	Sept. 30, 1909
Jones, Idonia M.	Part NW. ¼ sec. 26, T. 2 N., R. 2 E., G. and S. R. B. and M.	100.00	May 21, 1910
Killeen, Louis and A.	Part NW. ¼ NW. ¼ sec. 27, T. 2 N., R. 3 E., G. and S. R. B. and M.	410.00	Oct. 8, 1909
McRill, W. B.	Part E. ½ E. ½ of NE. ¼ sec. 2, T. 1 N., R. 3 E., G. and S. R. B. and M.	610.00	May 12, 1910
Miller, Marg. C. and W. H.	E. ½ of SW. ¼ and W. ½ SE. ¼ sec. 15, T. 4 N., R. 12 E., G. and S. R. B. and M.	800.00	Jan. 6, 1910
Miller, Maria	Right of way across NW. ¼ sec. 23, T. 1 N., R. 4 E., G. and S. R. B. and M.	1.00	July 8, 1908
Mosser, Fred. C.	Part SW. ¼ SE. ¼ of NW. ¼ sec. 35, T. 2 N., R. 3 E., G. and S. R. B. and M.	40.00	Jan. 26, 1910
Norton, J. C. and Clara T.	Part NW. ¼ sec. 14, T. 2 N., R. 1 E., G. and S. R. B. and M.	365.00	May 10, 1910
Osborn, Wm. and wife	Part NW. ¼ sec. 1, T. 1 N., R. 3 E., G. and S. R. B. and M.	2,200.00	May 31, 1910
Pierson, Josephine (guardian).	Part W. ½ E. ½ NE. ¼ sec. 2, T. 1 N., R. 3 E., G. and S. R. B. and M.	210.00	Nov. 6, 1909
Pierson, Harry W. and Josephine.	Part W. ½ E. ½ NE. ¼ sec. 2, T. 1 N., R. 3 E., G. and S. R. B. and M.	210.00	Nov. 6, 1909
Salt River Valley Water Users' Association.	S. ½ SW. ¼ sec. 5, NE. ¼ NE. ¼ sec. 7, NW. ¼ NW. ¼ sec. 8, T. 3 N., R. 14 E., G. and S. R. B. and M.	7,000.00	July 21, 1909
Schrader, Emma	Part NE. ¼ NE. ¼ sec. 28, T. 2 N., R. 3 E., G. and S. R. B. and M.	350.00	Apr. 20, 1909
Shott, J. M. and N. E.	Lots 8 and 10, block 52, city of Phoenix	2,000.00	Oct. 15, 1909
Steele, Porter	Right of way across N. ½ SE. ¼ sec. 7, T. 1 N., R. 4 E.	1.00	Nov. 30, 1908
Do	Sec. 7, T. 1 N., R. 4 E., G. and S. R. B. and M., tract No. 1.	1,000.00	May 23, 1910
Stewart, J. V. and wife	Right of way across NW. ¼ NE. ¼ sec. 23, T. 1 N., R. 4 E., G. and S. R. B. and M.	1.00	July 8, 1908
Stout, J. W.	Part E. ½ NE. ¼ sec. 20, T. 2 N., R. 3 E., G. and S. R. B. and M.	1.00	Mar. 9, 1910
Tempe Land and Improvement Co.	Right of way across S. ½ NW. ¼ sec. 15, T. 1 N., R. 4 E.	1.00	Oct. 16, 1908
Thomas, H. C. and M. R.	Part lots 2, 3, 4, Botts division, city of Phoenix, and part W. ½ SE. ¼ sec. 21, T. 2 N., R. 3 E., G. and S. R. B. and M.	257.00	Feb. 14, 1910
Wiberg, J.	Part SW. ¼ sec. 1, T. 3 N., R. 1 E., G. and S. R. B. and M.	180.00	May 25, 1910

ARIZONA-CALIFORNIA, YUMA PROJECT

Burgess, Wm., et al	All of lot 11 and south 10 feet of lot 12, in block 55, of the town site of Yuma, Ariz.	$50.00	[a]May 5, 1909
McGinty, John A.	SW. ¼ SE. ¼, SE. ¼ SW. ¼ sec. 8, also lot 1 and the NW. ¼ NE. ¼ sec. 17, T. 15 S., R. 24 E., S. B. M., Imperial County, Cal., 142.61 acres.	3,184.00	[a]July 29, 1909
Molina, Jose Maria et al	Lots 2 and 3, block 54, and part of block 50, town site of Yuma, Ariz., 1.52 acres.	200.00	[a]May 5, 1909

CALIFORNIA, ORLAND PROJECT

Beaver, W. J.	Part of sec. 17, T. 22 N., R. 3 W., M. D. M., for canal.	$1.00	Nov. 22, 1909
Brewer, Wm. A., et al	Part of sec. 23, T. 22 N., R. 3 W., M. D. M.	1.00	Oct. 30, 1909
Button, A. J., and wife	Parts of secs. 14 and 15, T. 22 N., R. 3 W., M. D. M., for canal, 4.9 acres.	122.50	Dec. 1, 1909
Bank of Orland, et al	Parts of secs. 27, 28, 33, and 34, T. 22 N., R. 3 W., M. D. M., 15 acres.	1.00	Apr. 7, 1910
Brown, Thomas	Part of sec. 5, T. 22 N., R. 3 W., M. D. M., containing 1.25 acres.	1.00	May 26, 1910

[a] Judgment.

Purchases of rights and property—Continued

CALIFORNIA, ORLAND PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Central Pacific Land and Lumber Co.	Parts of secs. 28, 29, 32, and 33, T. 22 N., R. 2 W., M. D. M.	$1.00	Nov. 3, 1909
Christian, A. D	Part of sec. 19, T. 22 N., R. 2 W., M. D. M., containing 0.9 acre.	1.00	Oct. 2, 1909
Christian, C., et al	Part of sec. 20, T. 22 N., R. 2 W., M. D. M., containing 0.9 acre.	1.00	Sept. 29, 1909
Clark, H. D	Part of sec. 26, T. 22 N., R. 3 W., M. D. M., containing 2.8 acres.	1.00	Oct. 29, 1909
Donohue, Charles L., and wife, et al.	Parts of secs. 10, 15, and 26, T. 22 N., R. 3 W., M. D. M., 12.7 acres.	1.00	Nov. 13, 1909
Flanagan Brothers	Parts of secs. 27 and 32, T. 23 N., R. 4 W., M. D. M.	250.00	May 24, 1910
Gaumnitz, A. J	Part of sec. 3, T. 22 N., R. 3 W., M. D. M., 0.8 acre.	1.00	Oct. 12, 1909
Hamilton, John Craig, Company.	Parts of secs. 29 and 30, T. 22 N., R. 3 W., M. D. M.	1.00	Jan. 25, 1910
Haring, C. M., and wife	Parts of sec. 28, T. 22 N., R. 3 W., M. D. M., containing 3 acres.	1.00	Oct. 28, 1909
Hicks, T. J., et al	Part of sec. 24, T. 22 N., R. 3 W., M. D. M., containing 2.4 acres.	1.00	Dec. 23, 1909
Iglick, S., et ux. et al	Part of sec. 4, T. 21 N., R. 3 W., M. D. M., containing 2.8 acres.	1.00	Nov. 10, 1909
Ioppini, C. G., and wife	Part of sec. 17, T. 22 N., R. 3 W., M. D. M., containing 1.2 acres.	1.00	Nov. 1, 1909
Koons, S. D	Part of sec. 26, T. 22 N., R. 3 W., M. D. M., containing 1.1 acres.	1.00	Jan. 13, 1910
Lemon Home Water Power and Light Co.	Lemon Home Canal system	15,250.00	Mar. 26, 1910
Lundeen, H. L	Part of sec. 27, T. 22 N., R. 3 W., M. D. M., containing 0.4 acre.	1.00	Oct. 21, 1909
Lundeen, J	Part of sec. 27, T. 22 N., R. 3 W., M. D. M., containing 2.1 acres.	1.00	Jan. 18, 1910
Mecum, George B	Part of sec. 20, T. 22 N., R. 3 W., M. D. M., containing 1.9 acres.	1.00	Dec. 22, 1909
Morrissey, W. H., and wife	Part of sec. 21, T. 22 N., R. 3 W., M. D. M., containing 5.2 acres.	1.00	Oct. 9, 1909
Murdock, G. W., and wife	Parts of secs. 17 and 20, T. 22 N., R. 3 W., M. D. M.	300.00	Sept. 10, 1909
Orland Land Company	Parts of secs. 19 and 20, T. 22 N., R. 3 W., M. D. M., containing 1.35 acres.	1.00	Oct. 1, 1909
Papst, Ida and Albert, et al	Parts of secs. 25 and 26, T. 22 N., R. 3 W., M. D. M., containing 5 acres.	1.00	Oct. 7, 1909
Rackcliffe, B. C., et al	Part of sec. 17, T. 22 N., R. 3 W., M. D. M., containing 0.45 acre.	1.00	Nov. 17, 1909
Reager, F. S., et al	Parts of secs. 19 and 20, T. 22 N., R. 2 W., M. D. M.	1.00	Oct. 1, 1909
Reager, Geo. A., et al	Parts of secs. 20, 21, 28, and 29, T. 22 N., R. 2 W., M. D. M.	1.00	Dec. 27, 1909
Schmidt, Eddie, and wife, et al.	Part of sec. 19, T. 22 N., R. 2 W., M. D. M., containing 1.8 acres.	1.00	Oct. 7, 1909
Scribner, C. C., and wife	Parts of sec. 28, T. 22 N., R. 3 W., M. D. M., containing 5.8 acres.	1.00	Oct. 11, 1909
Scribner, Maude A. and J. N.	Part of sec. 19, T. 22 N., R. 2 W., M. D. M., containing 0.85 acre.	1.00	June 17, 1910
Simpson, B. F., et al	Parts of sec. 27, T. 22 N., R. 3 W., M. D. M., containing 0.9 acre.	1.00	Oct. 13, 1909
Slewing, Robert R., et al	Part of sec. 20, T. 22 N., R. 2 W., M. D. M., containing 0.3 acre.	1.00	Oct. 11, 1909
Spencer, Eleanor	Parts of secs. 3 and 4, T. 22 N., R. 3 W., M. D. M., containing 18.3 acres.	1.00	Oct. 28, 1909
Sturm, Andrew	Part of secs. 13, 14, 23, and 24, T. 22 N., R. 3 W., M. D. M., containing 15.95 acres.	1.00	Oct. 2, 1909
Templeton, C. A., et al	Part of sec. 23, T. 22 N., R. 3 W., M. D. M., containing 3 acres.	1.00	Feb. 17, 1910
Wilson, N. S., and wife	Part of sec. 17, T. 22 N., R. 3 W., M. D. M., containing 1.56 acres.	1.00	Jan. 21, 1910
Warren, J. E., et al	Parts of sec. 20, T. 22 N., R. 2 W., M. D. M., containing 1.15 acres.	1.00	Nov. 10, 1909
Whitman, Emma J	Parts of sec. 26, T. 22 N., R. 3 W., M. D. M., containing 3.05 acres.	1.00	Oct. 22, 1909

IDAHO, BOISE PROJECT

Vendor	Description	Consideration	Date of deed
Brandt, Herman L., and wife.	Part of sec. 35, T. 3 N., R. 2 W., B. M., 1.11 acres.	$1.00	Mar. 25, 1910
Buis, Wm. A., and wife	Part of sec. 26, T. 3 N., R. 1 E., B. M., 2.11 acres.	211.00	June 7, 1910
Calkins, G. L., and wife	Part of sec. 36, T. 3 N., R. 2 W., B. M., 3.06 acres.	1.00	Apr. 10, 1910
Folsom, L. L., and wife	Part of sec. 10, T. 3 N., R. 1 W., B. M., 1.9 acres.	1.00	Nov. 5, 1909
Folsom, L. L., and wife	Part of sec. 26, T. 3 N., R. 2 E., B. M., 20 acres	750.00	May 25, 1910
Goodwin, Moses H	Part of sec. 24, T. 3 N., R. 2 E., B. M., and sec. 19, T. 3 N., R. 3 E., B. M., 2.5 acres.	1.00	Mar. 31, 1910
Goodwin, Moses H	Part of sec. 19, T. 3 N. R. 3 E., B. M	1.00	Apr. 6, 1910
Gray, John	Part of sec. 13, T. 3 N., R. 3 E., B. M. (easement)	1.00	

Purchases of rights and property—Continued

IDAHO, BOISE PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Green, R. E	Part of sec. 31, T. 3 N., R. 1 W., B. M., 0.69 acre	$1.00	Apr. 8, 1910
Green, R. E	Part of sec. 36, T. 3 N., R. 2 W., B. M., 1.10 acres	1.00	Apr. 8, 1910
Hickey, C. R., and wife	Part of sec. 26, T. 3 N., R. 2 W., B. M., 0.98 acre	1.00	Mar. 16, 1910
Hickey, John S., and wife	Part of sec. 26, T. 3 N., R. 2 W., B. M., 1.78 acres	1.00	Mar. 16, 1910
Hubbard, D. R., and wife	Lot 1, block 25, townsite of Kuna, Idaho	300.00	Apr. 22, 1910
Jellison, John S	Right of way for canal in W. ½ SE. ¼ sec. 13, NW. ¼ NE. ¼, sec. 24, T. 3 N., R. 2 E., B. M.	1.00	July 19, 1909
Langdon, George, and wife	Part of sec. 36, T. 3 N., R. 2 W., B. M., 2.27 acres	1.00	Mar. 25, 1910
Lemp, John	Part of sec. 17, T. 3 N., R. 3 E., B. M. (easement)	1.00	Apr. 9, 1910
Nelson, Solomon H., and wife	Part of sec. 10, T. 3 N., R. 1 W., B. M., 0.8 acre	100.00	Jan. 17, 1910
Niday, J. L	Part of sec. 36, T. 3 N., R. 2 W., B. M., 1.23 acres	1.00	Apr. 8, 1910
Payette Lumber & Mfg. Co	Right of way for dam and reservoir at outlet of Payette Lake in lots 4, 2, and 6, sec. 8, T. 18 N., R. 3 E., B. M.	1.00	Mar. 22, 1909
Pleasants, Wm. A., and wife	Part of sec. 25, T. 3 N., R. 3 W., B. M., 20 acres	2,500.00	Dec. 11, 1909
State of Idaho	Right of way for Deer Flat reservoir, being part of S. ½ NE. ¼ NW. ¼ sec. 36, T. 3 N., R. 3 W., B. M., 1.6 acres.	21.00	Feb. 24, 1909
Simmons, John M	Part of sec. 29, T. 3 N., R. 1 E., B. M., 3.5 acres	300.00	Jan. 18, 1910
White, Patrick	Part of sec. 25, T. 3 N., R. 2 W., B. M., 0.52 acre	1.00	Mar. 11, 1910
Wilson, Walter W., and wife	Part of sec. 13, T. 3 N., R. 1 W., B. M., 0.4 acre	75.00	May 5, 1910
Zimmer, Henry A	Part of sec. 25, T. 3 N., R. 2 W., B. M., 0.88 acre	1.00	Mar. 11, 1910

IDAHO, MINIDOKA PROJECT

Vendor	Description	Consideration	Date of deed
Axline, Geo. A., and wife	Part NW. ¼ NW. ¼ sec. 28, T. 10 S., R. 23 E., B. M., 1.2 acres.	$1.00	Apr. 30, 1910
Butler, John O., and wife	E. ½ NE. ¼, NE. ¼ SE. ¼, and lot 8, sec. 18, lot 1, sec. 19, lots 1 and 2, sec. 20, T. 1 N., R. 44 E., B. M., 239.29 acres.	5,700.00	July 13, 1909
Cleveland, O. L., and wife	Parts of lots 1, 2, and 3, sec. 20, T. 9. S., R. 29 E., B. M., 63.5 acres.	1,800.00	July 6, 1909
Glendale Investment Co	Portions of NW. ¼ SW. ¼ sec. 22, T. 10 S., R. 22 E., B. M.	1.00	Apr. 16, 1910
Miller, J. E., and wife	Part NE. ¼ NW. ¼, sec. 28, and SW. ¼ NW. ¼ and of SW. ¼ sec. 21, T. 10 S., R. 23 E., B. M. Portions of lots 3, and 4, sec. 6, T. 11 S., R. 23 E., B. M., 12.7 acres.	1.00	Apr. 6, 1910
Staten, John E., and wife	NW. ¼ sec. 17, T. 1 N., R. 44 E., B. M	4,800.00	July 30, 1909
Stout, A. J., and wife	Part SW. ¼ NW. ¼ sec. 21, T. 10 S., R. 23 E., B. M., 0.2 acre.	1.00	Apr. 29, 1910
Utah-Idaho Sugar Co	Portions of E. ½ NE. ¼ sec. 1, T. 11 S., R. 22 E., B. M., 4.5 acres.	1.00	Apr. 22, 1910

MONTANA, HUNTLEY PROJECT

Vendor	Description	Consideration	Date of deed
Kills at Night, et al., heirs of Old Snake.	Parts of lot 1 and SE. ¼ NE. ¼ sec. 33, T. 3 N., R. 28 E., M. P. M., 3.09 acres.	$45.90	Oct. 16, 1908
Pickett, Lucy	Part of NW. ¼ sec. 30, T. 3 N., R. 30 E., M. P. M., 3.99 acres.	59.85	Sept. 7, 1908
Pickett, Richard A	Parts of W. ½ NE. ¼ and NW. ¼ SE. ¼ sec. 30, T. 3 N., R. 30 E., M. P. M., 5.09 acres.	76.35	Sept. 7, 1908
Pickett, Robert A	Parts of E. ½ NE. ¼ and NE. ¼ SE. ¼ sec. 30, T. 3 N., R. 30 E., M. P. M., 5.10 acres.	76.50	Sept. 7, 1908
Puts on Antelope Cap	Parts of lot 4 and SW. ¼ NW. ¼ sec. 4, T. 2 N., R. 28 E.; lot 4, SW. ¼ SW. ¼, and W. ½ SW. ¼ sec. 33, T. 3 N., R. 28 E., M. P. M., 3.09 acres.	52.53	Oct. 16, 1908
Shively, Lucy Hawk, and husband.	Six pieces of land in sec. 5 T. 2 N., R. 29 E., M. P. M., 15.68 acres.	627.20	Dec. 21, 1909
Stands Over Bull	Parts of SE. ¼ sec. 6, T. 2 N., R. 28 E., M. P. M., 1.97 acres.	33.49	Oct. 16, 1908

MONTANA, MILK RIVER PROJECT

Vendor	Description	Consideration	Date of deed
Phillips, Benjamin D., and wife.	149 acres, more or less, in secs. 9, 10, 14, and 15, T. 30 N., R. 27 E., M. P. M.	$1,490.00	Nov. 6, 1909

MONTANA, SUN RIVER PROJECT

Vendor	Description	Consideration	Date of deed
State of Montana	11.26 acres in sec. 16, T. 20 N., R. 1 W; 15.66 acres in sec. 16, T. 20 N., R. 2 W.	$1.00	[a]

[a] No deed is necessary in this case, as the right of way inures to the United States under the grant contained in chapter 147, section 31, Revised Statutes of Montana. Plats and descriptions of the lands acquired from the State of Montana are filed in the office of the register of state lands.

Purchases of rights and property—Continued

MONTANA-NORTH DAKOTA, LOWER YELLOWSTONE PROJECT

Vendor	Description	Consideration	Date of deed
Adams, Walter K., and wife..	Part SE. 1/4 sec. 3, T. 21 N., R. 58 E.; part of sec. 29, T. 20 N., R. 58 E.; part SW. 1/4 sec. 11, T. 21 N., R. 58 E.; part secs. 33, T. 21 N., R. 58 E., and 31, T. 22 N., R. 59 E., M. P. M., 78.69 acres.	$786.90	June 7, 1909
Arndt, Annette M.	Part NE. 1/4 sec. 4, T. 22 N., R. 59 E., M. P. M., 4.2 acres.	42.00	Sept. 7, 1909
Anderson, Peter M., and wife.	Part sec. 29, T. 23 N., R. 59 E., M. P. M., 32.07 acres.	320.70	Nov. 24, 1909
Dawson County	Part of sec. 28, T. 21 N., R. 58 E., M. P. M., 4.4 acres.	1.00	June 11, 1909
Griffin, Anna, et al.	Part NE. 1/4 sec. 24, T. 22 N., R. 58 E., M. P. M., 3.3 acres.	33.00	Mar. 8, 1909
Kenoyer, Edgar A.	Part sec. 33, T. 23 N., R. 59 E., M. P. M., 19.34 acres.	193.40	Jan. 26, 1910
Northwestern Improvement Co.	Part sec. 21 T. 21 N., R. 58 E., M. P. M., 1.83 acres.	1.00	Jan. 26, 1910
Northwestern Improvement Co.	Part sec. 5, T. 19 N., R. 58 E., M. P. M., 48.1 acres.	1.00	Mar. 17, 1910
Northwestern Improvement Co.	Part of sec. 19, T. 19 N., R. 58 E., M. P. M., 5.7 acres.	1.00	Mar. 17, 1910
Northwestern Improvement Co.	Part of sec. 35, T. 22 N., R. 58 E., M. P. M., 1.42 acres.	1.00	(?)
O'Brien, John W.	Part of sec. 19, T. 22 N., R. 59 E., M. P. M., 12.2 acres.	244.00	July 2, 1909
Reid, John H.	Part of S. 1/2 SE. 1/4 sec. 5, T. 22 N., R. 59 E., M. P. M., 7.36 acres.	73.60	Feb. 10, 1909
State of Montana	Part of sec. 36, T. 25 N., R. 59 E., M. P. M., 7.71 acres.	1.00	([a])
Do	Part of sec. 36, T. 24 N., R. 59 E., M. P. M., 5.20 acres.	1.00	([a])
Do	Part of sec. 16, T. 20 N., R. 58 E., M. P. M., 13.11 acres.	1.00	([a])
Do	Part of sec. 16, T. 18 N., R. 57 E., M. P. M., 11.46 acres.	1.00	([a])
Do	Part of sec. 16, T. 23 N., R. 59 E., M. P. M., 21.32 acres.	1.00	([a])
Do	Part of sec. 36, T. 24 N., R. 59 E., M. P. M., 16.9 acres.	1.00	([a])

NEBRASKA-WYOMING, NORTH PLATTE PROJECT

Vendor	Description	Consideration	Date of deed
The Bothwell Co.	Lots 3 and 4, sec. 6, T. 29 N., R. 84 W.; N. 1/2 N. 1/2 and S. 1/2 NW. 1/4 and SW. 1/4 NE. 1/4 sec. 1; N. 1/2 sec. 2; N. 1/2 sec. 3; S. 1/2 N. 1/2 and N. 1/2 NW. 1/4 sec. 4; NE. 1/4 sec. 5; T. 29 N., R. 85 W.; lots 1, 2, 3, 4, and E. 1/2 SW. 1/4 sec. 31, T. 30 N., R. 84 W.; S. 1/2 S. 1/2 NE. 1/4, NW. 1/4, NE. 1/4, sec. 34; SW. 1/4 SE. 1/4 sec. 27; S. 1/2 sec. 35, T. 30 N., R. 85 W.; together with all water rights appurtenant to said lands; containing 2,573.66 acres, according to the government survey; a lease-hold interest from this date until April 8, 1912, with a right of renewal for an additional period of five years in and to the S. 1/2 sec. 36, in said township and range, containing 320 acres, together with all water rights appurtenant thereto.	$108,250	[b] Nov. 26, 1909
Pickrell, Wm	Parts of S. 1/2 SW. 1/4 and S. 1/2 SE. 1/4 sec. 20, T. 23 N., R. 53 W., 6th P. M.	1,000	Feb. 7, 1909
Savage, William, and Anna Savage.	S. 1/2 NW. 1/4, NE. 1/4 NW. 1/4, W. 1/2 NE. 1/4, NE. 1/4 NE. 1/4, sec. 13, and S. 1/2 SE. 1/4, NE. 1/4 SE. 1/4, sec. 12, T. 28 N., R. 85 W., 6th P. M., containing 360 acres.	7,200	Aug. 21, 1909

NEVADA, TRUCKEE-CARSON PROJECT

Vendor	Description	Consideration	Date of deed
Brown, E. M., and wife	Lots 13 and 14, block 204, "John Oats addition" to the town of Fallon, Nev.	$700.00	Sept. 7, 1909
Oats, John, and wife	A strip of land 150 feet wide and 3,157 feet long for right of way of "S" Line Canal across the S. 1/2 SW. 1/4 and W. 1/2 SE. 1/4 sec. 26, T. 19 N. R. 28 E., M. D. M., 10.85 acres.	200.00	Mar. 16, 1910
Williams, Anna	Right of way or easement for "S2" canal and "S2q" canal over lands in the N. 1/2 NW. 1/4 sec. 13, T. 19 N., R. 30 E., M. D. M.	1.00	Apr. 30, 1910

[a] No deeds are necessary in these cases. The right of way inures to the United States under the grant contained in chapter 147, section 31, Revised Statutes of Montana. Plats and descriptions of the lands acquired from the State of Montana are filed in the office of the register of state lands.
[b] Judgment.

Purchases of rights and property—Continued

NEW MEXICO, CARLSBAD PROJECT

Vendor	Description	Consideration	Date of deed
Pecos Irrigation Co.[a]	Irrigation system property and rights	$150,000	Dec. 18, 1905

NEW MEXICO-TEXAS, RIO GRANDE PROJECT

Chavez, Carpio, and wife	SE. ¼ sec. 1, T. 9 S., R. 3 W., N. M. P. M., 160 acres.	$1,600.00	Jan. 25, 1910
Gonzales, Gregorio	NW. ¼ NW. ¼ sec. 13, and E. ½ NE. ¼ sec. 14, T. 9 S., R. 3 W., N. M. P. M., 120 acres.	1,380.00	[b]May 14, 1910
Silva, Jose y Valdez	Lot 4, sec. 21; lot 1, sec. 28; N. ½ NE. ¼, and lots 1 and 2, sec. 29, T. 8 S., R. 2 W., N. M. P. M., 153.75 acres.	1,537.50	Jan. 19, 1910
Victorio Land and Cattle Co.	33,520 acres of land within Pedro Armendaris grants Nos. 33 and 34, in Sierra and Socorro counties, N. Mex.	199,097.25	[b]May 14, 1910

NORTH DAKOTA, BUFORD-TRENTON PROJECT

Thiffoe, Louis	Damages to improvements located on SE. ¼ sec. 12, T. 152 N., R. 104 W., 5th P. M.	$75.00	Dec. 20, 1907

NORTH DAKOTA, WILLISTON PROJECT

Bruegger, John	Part of lot 2, sec. 24, T. 154 N., R. 101 W., 5th P. M., 8.4 acres.	$420.00	Aug. 17, 1909
Broskowsky, John	A triangular-shaped parcel of land in the southeast corner of lot 4, block 22, amended plat, Bruegger addition to Williston, N. Dak.	50.00	Mar. 25, 1908

OREGON, UMATILLA PROJECT

Bowman, D. W., and wife, and Malcolm S. Corrigall and wife.	W. ½ NE. ¼ sec. 8, T. 3 N., R. 29 E., W. M.	$73.15	Sept. 23, 1909
Inland Irrigation Company, The.	Strip of land 25 feet wide on each side of center line of "A" line canal of distribution system in NW. ¼ sec 13, T. 4 N., R. 28 E., W. M.	1.00	Feb. 7, 1908
Marshall, Edwin P., and wife.	Portion of SW. ¼ NW. ¼ sec. 12, T. 4 N., R. 29 E., W. M.	1.00	May 23, 1910
Maxwell Land and Irrigation Company.	Irrigation system, lands, rights of way and water rights in Umatilla County, Oreg., as described in conveyance dated June 4, 1908.	15,000.00	June 4, 1908
Do	Lot 2 and north half lot 3 in Block 15—Hermiston—in NE. ¼ SE. ¼ sec. 10, T. 4 N., R. 28 E., W. M.	1.00	Dec. 3, 1906
Newport, Harry R., and William H. Skinner and wife.	N. ½ Block 3, town of Hermiston, Oreg., in NW. ¼ SW. ¼ sec. 11, T. 4 N., R. 28 E., W. M., for government offices.	1.00	Feb. 23, 1909

OREGON-CALIFORNIA, KLAMATH PROJECT

Adams, J. Frank, and wife	Part NE. ¼ NE. ¼ sec. 8, T. 41 S., R. 11 E., W. M.	$1.00	Oct. 9, 1908
Do	Part NE. ¼ NE. ¼ sec. 3, T. 41 S., R. 10 E., W. M.	1.00	Nov. 12, 1908
Do	Part NE. ¼ sec. 7, T. 41 S., R. 11 E., W. M.	1.00	Oct. 9, 1908
Do	Part SW. ¼ SE. ¼ sec. 4, T. 41 S., R. 11 E., W. M.	1.00	Nov. 12, 1908
Anderson, H. T., and wife	Part SW. ¼ NW. ¼; SE. ¼ NW. ¼; SW. ¼ SE. ¼ sec. 31, T. 40 S., R. 11 E., W. M.	1.00	Oct. 26, 1909
Anderson, R. C., and wife	Part W. ½ NE. ¼ sec. 6, T. 41 S., R. 11 E., W. M.	1.00	Apr. 29, 1909
Ankeny, Cordelia L	Part SW. ¼ sec. 12; NW. ¼ SE. ¼ SE. ¼ SW. ¼ sec. 13; N. ½ NE. ¼ and NE. ¼ NW. ¼ and E. ½ of sec. 14; NE. ¼ NE. ¼ sec. 23, NW. ¼, N. ½ SW. ½ sec. 24, T. 39 S., R. 9 E., W. M.	1.00	Apr. 23, 1910
Ball, W. D., and wife	Part NW. ¼ SE. ¼ and NE. ¼ SE. ¼ sec. 6, T. 41 S., R. 11 E., W. M.	1.00	May 17, 1909
Ball, Wm. D., and wife	Part SW. ¼ of sec. 6, T. 41 S., R. 11 E., W. M.	....	
Barrows, T. A., and wife	Part S. ½ SE. ¼ of NE. ¼ sec. 10, T. 41 S., R. 10 E., W. M.	1.00	Dec. 24, 1908
Bloomingcamp, Ed	Right of way across SE. ¼ sec. 30, T. 39 S., R. 10 E. W. M.	1.00	Jan. 21, 1909

[a] Erroneously reported in fifth annual report as purchased for the Hondo project, New Mexico.
[b] Judgment.

Purchases of rights and property—Continued

OREGON-CALIFORNIA, KLAMATH PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Bowman, D. W., et al	Part W. ½ NE. ¼ sec. 8, T. 3 N., R. 29 E., W. M.	$73.15	Sept. 23, 1909
Callahan, John	Part SE. ¼ SE. ¼ sec. 31, T. 40 S., R. 11 E., W. M.	1.00	May 1, 1909
Carlton, G. H., and J. G. Swan and wife.	Part E. ½ W. ½ sec. 36, T. 40 S., R. 11 E., W. M.	1.00	Nov. 11, 1908
Carlton, G. H., Anderson H. T., and wife, Tolle, H. F., and wife.	Part N. ½ sec. 36, T. 40 S., R. 10 E., W. M	1.00	Oct. 9, 1908
Carolan, Jas., and wife	Part NE. ¼ sec. 2, T. 40 S., R. 9 E., W. M	1.00	Jan. 26, 1910
Dixon, Samuel, and wife	Part lot 1, sec. 15, lots 5 and 6, sec. 14, T. 39 S., R. 10 E., W. M.	213.60	Feb. 8, 1910
Ellis, John, et al	Part S. ½ sec. 16, T. 39 S., R. 9 E., W. M	1.00	Feb. 5, 1910
Do	Part N. ½ NW. ¼ sec. 21, T. 39 S., R. 9 E., W. M.	1.00	Do.
Enterprise Land and Investment Company.	Part S. ½ NE. ¼ sec. 33, T. 39 S., R. 9 E., W. M., 25 acres.	500.00	June 18, 1909
Ezell, J. M., et al	Part S. ½ SE. ¼ sec. 11, T. 39 S., R. 9 E., W. M.	1.00	Dec. 18, 1909
Faught, W. E., and wife	Part NW. ¼ SW. ¼ sec. 21, T. 39 S., R. 9 E., W. M.	1.00	Jan. 17, 1909
Folsom, H. H., and wife	Part W. ½ SW. ¼ sec. 10; E. ½ SE. ¼ sec. 9, T. 40 S., R. 9 E., W. M.	1.00	Feb. 9, 1909
Greene, Wm	Part W. ½ SW. ¼ sec. 36, T. 39 S., R. 9 E., W. M.	1.00	Apr. 29, 1910
Hammond, E. M., and wife	Part S. ½ sec. 5, T. 41 S., R. 11 E., W. M	1.00	Oct. 9, 1908
Do	Part SE. ¼ SW. ¼; SW. ¼ SE. ¼ sec. 5, T. 41 S., R. 11 E., W. M.	1.00	May 29, 1909
Hammond, R. R., and wife	Part NW. ¼ NW. ¼ sec. 32; SW. ¼ SW. ¼ sec. 29, T. 39 S., R. 9 E., W. M.	1.00	Jan. 13, 1910
Hill, Wm. F., and wife	Part NE. ¼ of sec. 35, T. 40 S., R. 10 E., W. M.	1.00	Nov. 18, 1908
Hoyt, H. H., and wife	Part SW. ¼ SE. ¼ sec. 4, T. 41 S., R. 11 E., W. M.	1.00	Nov. 11, 1908
Humphrey, Will, and wife	Part NE. ¼ NE. ¼ sec. 15, T. 39 S., R. 9 E., W. M.	1.00	Dec. 17, 1909
Klamath Development Company.	Part N. ½ SE. ¼; N. ½ S. ½ SE. ¼; SE. ¼ SE. ¼ SE. ¼ of sec. 9; S. ½ of sec. 16; N. ½ NE. ¼ of sec. 21; SE. ¼ of sec. 17; NE. ¼ of sec. 20; N. ½ NW. ¼ sec. 21; S. ½ SW. ¼ sec. 15, T. 39 S., R. 9 E., W. M.	1.00	July 2, 1909
Langell, N., and wife	Part NE. ¼ sec. 16, T. 40 S., R. 9 E., W. M	1.00	Feb. 10, 1909
Leavitt, A. L. and wife	Part SW. ¼ NW. ¼ sec. 32, T. 38 S., R. 9 E., W. M.	3,000.00	Dec. 17, 1909
McCormick, Thos., and wife	Identification deed, part NE. ¼ SE. ¼; lots 8, 9, 10, 11, 12, and 13, sec. 36, T. 39 S., R. 7 E., W. M.	1.00	Aug. 5, 1909
Manning, J. W., and wife	Part NE. ¼ sec. 1, T. 40 S., R. 9 E., W. M., 1 acre.	50.00	Nov. 22, 1909
Martin, Thos., and wife	Part SW. ¼ sec. 14, T. 40 S., R. 9 E., W. M	1.00	May 5, 1910
Martin, Alex., jr., and wife	Part E. ½ SE. ¼ SE. ¼ sec. 9, T. 39 S., R. 9 E., W. M.	1.00	Feb. 11, 1910
Masten, J. W	Part S. ½ SE. ¼ sec. 11, T. 39 S., R. 9 E., W. M.	1.00	Jan. 24, 1910
Matney, John H., and wife	Part SW. ¼ sec. 13, T. 40 S., R. 9 E., W. M., 1.67 acres.	50.10	Aug. 20, 1909
Merrill, N. S	Part S. ½ SW. ¼ NW. ¼ sec. 2, T. 41 S., R. 10 E., W. M.	1.00	Oct. 7, 1908
Moore, Chas. S., and wife	Part S. ½ sec. 36, T. 40 S., R. 10 E., W. M	1.00	Jan. 28, 1909
Do	Part W. ½ sec. 36, T. 40 S., R. 11 E., W. M	1.00	Mar. 8, 1909
Moore, R. S., and wife	Part W. ½ NW. ¼; NW. ¼ SW. ¼ sec. 11, T. 40 S., R. 9 E., W. M.	1.00	Nov. 16, 1909
Moore, Chas. S., and wife	Part NE. ¼ sec. 19, T. 39 S., R. 10 E., W. M. 14.02., acres.	252.36	Nov. 24, 1909
Nixon, Samuel, and wife	Part lot 1, sec. 15, and lots 5 and 6, sec. 14, T. 39 S., R. 10 E., W. M.	213.60	Feb. 8, 1910
Offield, G. W., and wife	Part NE. ¼ sec. 3, T. 41 S., R. 10 E., W. M	1.00	Nov. 25, 1908
Offield, Lizzie F., and husband.	Part SE. ¼ SE. ¼ sec. 34; SW. ¼ SW. ¼ sec. 35, T. 40 S., R. 10 E., W. M.	1.00	Mar. 28, 1910
Offield, G. W., and wife	Part NW. ¼ NE. ¼ sec. 3, T. 41 S., R. 10 E., W. M., 3.56 acres.	142.40	Oct. 21, 1909
Do	Part NE. ¼ sec. 3, T. 41 S., R. 10 E., W. M	1.00	Apr. 28, 1909
Offield, T. J., and wife	Part SE. ¼ SE. ¼ sec. 35, T. 40 S., R. 10 E., W. M., 1 acre.	100.00	Nov. 4, 1908
Offenbacher, Henry	Part SW. ¼ SE. ¼ sec. 32, T. 39 S., R. 9 E., W. M.	1.00	Apr. 6, 1909
Purdy, Walter L., and wife	Part S. ½ SE. ¼ sec. 4, T. 41 S., R. 11 E., W. M.	1.00	Jan. 2, 1909
Pettit, H. C., and wife	Part NW. ¼ NW. ¼ sec. 35; NE. ¼ NE. ¼ sec. 34, T. 40 S., R. 10 E., W. M.	1.00	Apr. 27, 1910
Parrish, H. S., and wife	Part W. ½ W. ½ sec. 36, T. 40 S., R. 10 E., W. M.	1.00	Nov. 12, 1908
Do	Part W. ½ NW. ¼ sec. 36, T. 40 S., R. 10 E., W. M.	1.00	Mar. 31, 1909
Pope, Fred L., and wife	Part NE. ¼ sec. 9, T. 41 S., R. 11 E., W. M	1.00	Nov. 11, 1908
Roberts, J. T	Part N. ½ SW. ¼ sec. 25, T. 39 S., R. 9 E., W. M., 1.77 acres.	88.50	Nov. 9, 1909
Roberts, Homer, and wife	Part S. ½ SW. ¼ sec. 25, T. 39 S., R. 9 E., W. M., 2.24 acres.	112.00	Dec. 17, 1909
Rowlands, W. T	Part SW. ¼ SW. ¼ sec. 22, T. 39 S., R. 9 E., W. M.	1.00	Jan. 21, 1909
Shank, Jacob	Part NE. ¼ SW. ¼ and NW. ¼ SE. ¼ sec. 31, T. 40 S., R. 11 E., W. M.	1.00	Jan. 11, 1909
Swan, J. G., and wife	Part S. ½ sec. 36, T. 40 S., R. 10 E., W. M	1.00	Nov. 18, 1908
Shuck, Mrs. C	Part N. ½ NE. ¼ sec. 15, T. 41 S., R. 10 E., W. M.	1.00	Feb. 27, 1909
Summers, S. T., and wife	Part S. ½ SE. ¼ sec. 11, T. 39 S., R. 9 E., W. M., 0.6 acre.	30.00	Dec. 1, 1909
Do	Part W. ½ W. ½ of NE. ¼; SE. ¼ sec. 11, T. 39 S., R. 9 E., W. M.	1.00	Mar. 16, 1909
Terwilliger, E. S., and wife	Part SE. ¼ NW. ¼ and S. ½ NE. ¼ sec. 6, T. 41 S., R. 11 E., W. M.	1.00	Oct. 9, 1908

Purchases of rights and property—Continued

OREGON-CALIFORNIA, KLAMATH PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Whitlatch, W. W., and wife	Part SE. ¼ sec. 8, T. 41 S., R. 11 E., W. M	$1.00	Oct. 9, 1908
Do	Part SW. ¼ SE. ¼ sec. 6, T. 41 S., R. 11 E., W. M.	1.00	Oct. 9, 1908
Williard, H. E., and wife	Part W. ½ SE. ¼; W. ½ NE. ¼ sec. 17, T 39 S., R. 9 E., W. M.	1.00	Apr. 26, 1909
White, G. W., and wife	Part S. ½ NW. ¼; N. ½ SW. ¼ sec. 29, T. 39 S., R. 9 E., W. M.	1.00	Apr. 4, 1910
Willits, L. F., and wife	Part W. ½ W. ½ SE. ¼ sec. 31, T 39 S., R. 9 E., W. M.	1.00	Mar. 15, 1910
Wollam, A. L., and wife	Part W. ½ NW. ¼ sec. 31, T. 40 S., R. 11 E., W. M.	1.00	July 10, 1909
Willson, W. N., and Martin, C. J.	Waiver of damages on part of lot 2, sec. 31, T. 38 S., R. 9 E., W. M.	200.00	Oct. 23, 1909

SOUTH DAKOTA, BELLE FOURCHE PROJECT

Vendor	Description	Consideration	Date of deed
Lewis, Thomas J., and wife	Part of W. ½ sec. 15, T. 8 N., R. 5 E., B. H. M., 26.44 acres.	$528.80	May 28, 1910
Martin, Samuel H., and wife	Part E. ½ NE. ¼ sec. 3, T. 7 N., R. 5 E., B. H. M., 7.52 acres.	150.40	May 23, 1910
Russell, Michael R	E. ½ NE. ¼ sec. 19, and W. ½ NW. ¼ sec. 20, T. 9 N., R. 4 E., B. H. M., 160 acres.	2,800.00	Aug. 28, 1909
Sorensen, Soren	Part NW. ¼ sec. 17, T. 8 N., R. 5 E., B. H. M., 15.4 acres.	308.00	Sept. 11, 1909
Woolston, Jay I	Waiver of damage to lots 2, 3, and 4, block 13, City of Belle Fourche, S. Dak.	262.50	Sept. 15, 1909

UTAH, STRAWBERRY VALLEY PROJECT

Vendor	Description	Consideration	Date of deed
Andrus, Alma	Right of way and easement for electric transmission line across part of SE. ¼ sec. 28, T. 8 S., R. 3 E., S. L. B. and M.	$1.00	Oct. 19, 1909
Ballard, Francis M. and Lucinda A.	Part of NW. ¼ NE. ¼ sec. 22, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 6.6 acres.	50.00	Nov. 16, 1909
Cloward, Edward H. and Addie.	Part of SW. ¼ SE. ¼ and NE. ¼ SE. ¼ sec. 7, T. 9 S., R. 3 E., S. L. B. and M., for canal line.	350.00	Oct. 8, 1909
Gay, William	Part of SE. ¼ SW. ¼ sec. 14, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 0.81 acre.	48.00	Nov. 16, 1909
Hiatt, I. S., and wife	Part of S. ½ SE. ¼ NW. ¼ sec. 13, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 2.78 acres.	21.00	Oct. 26, 1909
Jex, Heber C., et al	Right of way and easement for electric transmission line across part of W. ½ NE. ¼ and E. ½ NW. ¼ sec. 33, T. 8 S., R. 3 E., S. L. B. and M.	1.00	Oct. 20, 1909
Jex, John B	Right of way and easement for electric transmission line across part of NW. ¼ NE. ¼ sec. 33, T. 8 S., R. 3 E., S. L. B. and M.	1.00	Oct. 20, 1909
Koyle, Albert H. and Charlotte L.	Part of W. ½ NW. ¼ sec. 8, and SE. ¼ NE. ¼ sec. 7, T. 9 S., R. 3 E., S. L. B. and M., for canal line, 23.33 acres.	200.00	Oct. 20, 1909
Lemmon, Hyrum, and wife	Right of way for high line canal across NE. ¼ NE. ¼ sec. 22, T. 9 S., R. 2 E., S. L. B. and M.	18.00	Oct. 26, 1909
Nuttall, R. J	Part of S. ½ NE. ¼ NW. ¼ sec. 13, T. 9 S., R. 2 E., S. L. B. and M., for canal line.	1.00	July 3, 1909
Schram, Ferdinand A., and wife.	Part of SE. ¼ SW. ¼ sec. 14, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 3.62 acres.	145.00	Oct. 12, 1909
Smith, Francis Levi	Part of NE. ¼ NE. ¼ sec. 13, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 6.45 acres.	250.00	Oct. 11, 1909
Taylor, Evan, and wife	Part of NW. ¼ SE. ¼ sec. 7, T. 9 S., R. 3 E., S. L. B. and M., for canal line, 5.21 acres.	225.00	Oct. 8, 1909
Wilson, Lillie E. and George E.	Part of NE. ¼ SW. ¼ sec. 14, T. 9 S., R. 2 E., S. L. B. and M., for canal line, 1.07 acres.	40.00	Oct. 16, 1909

WASHINGTON, OKANOGAN PROJECT

Vendor	Description	Consideration	Date of deed
Ostenburg, Charles, and Katie.	Water right appurtenant to NE. ¼ NW. ¼ sec. 17, T. 33 N., R. 26 E., W. M.	$2,200.00	Sept. 29, 1909

Purchases of rights and property—Continued.

WASHINGTON, YAKIMA PROJECT

Vendor	Description	Consideration	Date of deed
Ambler, Thomas H	A portion of NW. ¼ sec. 34, T. 21 N., R. 14 E., 43.46 acres.	$1,000.00	Dec. 12, 1908
Anthon, Julius, and wife	Strip 25 feet wide across SW. ¼ NE. ¼ sec. 36, T. 9 N., R. 23 E., W. M.	250.00	Jan. 19, 1910
Angel, Henry E., and wife	Part NE. ¼ SW. ¼ sec. 36, T. 12 N., R. 19 E., W. M., 1.4 acres.	700.00	Feb. 21, 1910
Alexander, John, and wife	Strip 135 feet wide across NW. ¼ sec. 6, T. 9 N., R. 23 E., W. M., 8.49 acres.	679.20	Apr. 14, 1909
Bardue, Elmer E. and Robert M. and Vade, his wife.	Part SW. ¼ SE. ¼ SW. ¼ sec. 3, T. 10 N., R. 21 E., W. M., 0.5 acre.	630.00	Oct. 13, 1909
Bowen, Waterman A., and wife.	Strip 15 feet wide across NW. ¼ SW. ¼, sec. 36, T. 12 N., R. 19 E., W. M., 0.5 acre.	600.00	June 6, 1910
Brown, John F	Lot 2, sec. 28, T. 21 N., R. 14 E., W. M	1.00	Sept. 25, 1906
Bruce, F. W., and wife	Strip 60 feet wide, across N. ½ NW. ¼ SW. ¼ sec. 20, T. 10 N., R. 23 E., W. M., 28 acres.	30.00	July 22, 1909
Byron Land Company	Part sec. 11, T. 8 N., R. 23 E., W. M., known as lot 41 of "The Byron Orchards," 2.70 acres.	350.00	Oct. 14, 1909
Cobb, Addison	Right of way 100 feet wide for canal through sec. 9, T. 14 N., R. 16 E., W. M., and right of ingress and egress through sec. 9.	1.00	Mar. 29, 1909
Do	Liquidation of damages to lands adjoining Tieton Main Canal in sec. 9, T. 14 N., R. 16 E., W. M.	350.00	Jan. 21, 1910
Cook, Samuel, and wife	Part N. ½ NE. ¼ NE. ¼ sec. 20, T. 10 N., R. 23 E., W. M., 0.87 acre.	56.55	June 29, 1909
Davis, George F., et ux	Part NW. ¼ sec. 2, T. 20 N., R. 14 E., 2.84 acres	30.00	Dec. 12, 1908
Dickey, S. A., and wife	Strip 15 feet wide across SE. ¼ sec. 28, T. 12 N., R. 19 E., W. M., 0.21 acre.	21.00	Nov. 12, 1909
Donnelly, Patrick, and wife	30-foot strip for roadway, 3.9 acres; 20-foot strip for right of way for transmission line, 1.2 acres; 150-foot strip for right of way Tieton Main Canal, 4.9 acres; all in sec. 7, T. 14 N., R. 16 E., W. M.	300.00	May 6, 1907
Frater, John T., and wife	Strip from 30 to 80 feet wide across NW. ¼ NE. ¼ sec. 36, T. 9 N., R. 23 E., W. M.	432.00	Oct. 7, 1909
Hansen, Chris. (ejectment)	E. ½ sec. 12, T. 21 N., R. 11 E., W. M	....	June 7, 1909
Hardman, John, and wife	Part SW. ¼ SE. ¼ NE. ¼ sec. 30, T. 9 N., R. 24 E., W. M., 2 acres.	200.00	Oct. 14, 1909
Harrison, W. H., and Fleming, A. G., and wife.	Strip 135 feet wide across E. ½ NW. ¼ NW. ¼ sec. 24, T. 9 N., R. 22 E., W. M.	1.00	June 30, 1909
Harrison, Charity A	Part S. ½ S. ½ sec. 34, T. 21 N., R. 14 E., W. M., 32.65 acres.	1,047.00	Dec. 12, 1908
Howson, Thos., and wife	Part W. ½ sec. 2, T. 20 N., R. 14 E., 141.78 acres	1,500.00	Dec. 12, 1908
Hood. G C., and wife	Strip 135 feet wide across E. ½ NE. ¼ SW. ¼ sec. 31, T. 10 N., R. 23 E., W. M., 3.11 acres.	388.75	Apr. 1, 1909
Hoag, D. A., and wife	Strip 135 feet wide across SW. ¼ NE. ¼ of sec. 31, T. 10 N., R. 23 E., W. M.	590.00	Do.
Koempel, John	Right of way for canal line across NW. ¼ NW. ¼ and S. ½ SW. ¼ sec. 10, T. 14 N., R. 16 E., W. M.	1.00	May 18, 1907
Lamson, J. H., and wife	Strip 45 feet wide across N. ½ NE. ¼ NE. ¼ sec. 22, T. 11 N., R. 20 E., W. M.	285.00	Sept. 25, 1909
Lantz, L. M., and wife	Strip 60 feet wide across N. ½ NE. ¼ SE. ¼ sec. 19, T. 10 N., R. 23 E., W. M., 1 acre.	125.00	Aug. 13, 1909
Little, A. L., and wife	Right of way for wagon road across SW. ¼ sec. 8, T. 14 N., R. 16 E., W. M.	50.00	Nov. 17, 1908
Little, A. L., and wife	Right of way for wasteway from Tieton Main Canal to Yakima River, in SW. ¼ sec. 8, T. 14 N., R. 16 E., W. M.	65.00	Feb. 28, 1910
McCaulay, Norman D	Right of way for telegraph line, across N. ½ S. ½ and S. ½ N. ½ sec. 36, T. 15 N., R. 16 E., W. M.	1.00	July 31, 1907
McKee, Redick H., and wife	Irregular parcel in sec. 25, T. 9 N., R. 23 E., W. M., for patrol-house site, 1.94 acres.	214.00	Nov. 1, 1909
Mead, Chas. S., and wife	Part SE. ¼ SW. ¼ and SW. ¼ SE. ¼ sec. 36, T. 12 N., R. 19 E. W. M., 11½ acres.	5,000.00	Feb. 28, 1910
Michels, Julian, and wife	Located mill site known as "Honolulu No. 1 mill site," in Kachess mining district, Washington.	500.00	Apr. 16, 1908
Moore, Elsie N	Part NW. ¼ NW. ¼ sec. 20, T. 10 N., R. 23 E., W. M., patrol house, site, 2.9 acres.	400.00	Apr. 4, 1910
Northern Pacific Ry. Co	Strip of land 135 feet wide across NW. ¼ NE. ¼ NW. ¼ sec. 13, T. 9 N., R. 22 E., W. M.	1.00	July 22, 1909
Packwood, Samuel F., and wife, and G. F. Davis and wife.	Part E. ½ sec. 4, T. 20 N., R. 14 E., 20.83 acres	105.00	Dec. 12, 1908
Rankin, G. S., and wife et al.	Private canal and right of way in sec. 11, T. 14 N., R. 16 E., W. M.; sec. 12, T. 14, R. 16; sec. 1, T. 14, R. 16; sec. 6-14-17; sec. 7, T. 14, R. 17.	1,300.00	June 5, 1909
Rankin, G. S., and wife et al	Relinquishment of all rights to property covered by above canal and right of way, together with right to maintain reservoir located upon parts of secs. 8 and 5, T. 14 N., R. 17 E., W. M.	1.00	June 5, 1909
Reed, Ora S., and wife	Part sec. 1, T. 8 N., R. 23 E., W. M. 11.29 acres	100.00	May 31, 1910

Purchases of rights and property—Continued

WASHINGTON, YAKIMA PROJECT—Continued

Vendor	Description	Consideration	Date of deed
Robson, John H., and wife	Strip of land 100 feet wide across E. ½ NW. ¼ NW. ¼ sec. 20, T. 10 N., R. 23 E., W. M.	$1.00	Apr. 14, 1909
Rohrer, William S., and wife	Strip 60 feet wide across S. ½ NE. ¼ SE. ¼ sec 19, T. 10 N., R. 23 E., W. M.	160.00	Aug. 31, 1909
Rote, John P. W., and wife	Strip 25 feet wide across parcel of land in SW. ¼ SE. ¼ sec. 27, T. 12 N., R. 19 E., W. M., 0.25 acre.	100.00	Mar. 9, 1910
Rowland, Christian, and wife	Strip 60 feet wide across SW. ¼ NW. ¼ sec. 20, T. 10 N., R., 23 E., W. M.	200.00	Aug. 14, 1909
Rush, Joseph A., and wife	Improvements on NW. ¼ NW. ¼ and SW. ¼ NW. ¼ sec. 29, T. 10 N., R. 23 E., W. M.	607.00	Dec. 28, 1908
Shafer, S. W., and wife	Strip 135 feet wide across E. ½ SW. ¼ SW. ¼ and W. ½ SE. ¼ SW. ¼ sec. 31, T. 10 N., R. 23 E., W. M., 3.41 acres.	426.25	Dec. 11, 1909
Shafer, S. W., and wife	Strip 135 feet wide across E. ½ NW. ¼ NE. ¼ and W. ½ NE. ¼ NE. ¼ sec. 31, T. 10 N., R. 23 E., W. M., 4.47 acres.	558.75	Dec. 11, 1909
Stampley, William A., and wife.	Strip 150 feet wide across N. ½ NE. ¼ sec. 30, T. 10 N., R. 23 E., W. M., 2.12 acres.	125.00	Apr. 13, 1909
Steward, O. J., and wife	Part W. ½ lot 4, George E. Shaws acre tracts (in Sunnyside, Wash.) block "D" .93 acre.	930.00	Mar. 31, 1910
Steward, O. J., and wife	Part lots 3 and 4, block "D" George E. Shaw's acre tracts in Sunnyside, Wash., 1.2 acres.	870.00	Jan. 25, 1910
Washington Irrigation Company.	Strip 135 feet wide across SW. ¼ SW. ¼ and W. ½ NW. ¼ sec. 13, T. 9 N., R. 22 E., W. M.	1.00	Jan. 14, 1910
Weddle, Joseph S., and wife	Right of way for wasteway from Tieton Main Canal to Yakima River in SE. ¼ sec 8, T. 14 N., R. 16 E., W. M.	300.00	Feb. 28, 1910
Wing, P. W., and wife	Part lot 4 sec. 26, T. 9 N., R. 22 E., W. M., 1.6 acres.	160.00	Aug. 20, 1909
Wilcox A. B., and wife	Strip 35 feet wide across parcel of land in NW ¼ SE. ¼ sec. 35, T. 12 N., R. 19 E., W. M., 0.7 acre.	280.00	Apr. 18, 1910

WYOMING, SHOSHONE PROJECT

Vendor	Description	Consideration	Date of deed
Alston, Felix, and wife	NE. ¼ SW. ¼, SE. ¼ NW. ¼, SW. ¼ NE. ¼ sec. 23, T. 52 N., R. 103 W., 6th P. M.	$1,318.76	May 25, 1909
Grinder, Edward H., and wife.	SE. ¼ SW. ¼ sec. 12; E. ½ NW. ¼, E. ½ SW. ¼, SW. ¼ SE. ¼ sec. 13; and SW. ¼ NE. ¼ sec. 24, all in T. 52 N., R. 103 W. 6th P. M.	17,000.00	Dec. 9, 1909
Jackson, Isaac E., and wife	SW. ¼ sec. 24, except 15 acres in SW. ¼ SW. ¼, being tract west of Carter Creek, all in T. 52 N., R. 103 W., 6th P. M., required for Shoshone Reservoir.	11,350.00	Apr. 23, 1910
Logan, George	SW. ¼ SW. ¼, E. ½ SW. ¼, SW. ¼ SE. ¼ sec. 7, T. 52 N., R. 103 W., 6th P. M., containing 160 acres, more or less.	7,600.00	Dec. 20, 1909
Martin, Benjamin F	W. ½ SE. ¼ sec. 8; N. ½ SW. ¼, S. ½ NW. ¼, NW. ¼ SE. ¼, and SW. ¼ NE. ¼ sec. 9, T. 52 N., R. 103 W., 6th P. M.	18,000.00	Dec. 24, 1909
Martin, Christopher E	NW. ¼ NE. ¼, N. ½ NW. ¼ sec. 9, T. 52 N., R. 103 W., and 25.19 acres in SW. ¼ SW. ¼ sec. 4, T. 52 N., R. 103 W., 6th P. M.	2,328.42	Nov. 27, 1909
Martin, Sarah B. and Andrew J.	S. ½ SW. ¼ sec. 8, T. 52 N., R. 103 W., 6th P. M.	4,000.00	Feb. 18, 1910
School District 23, Big Horn County, Wyo.	1 acre, more or less, in SE. ¼ SE. ¼ sec. 14, T. 52 N., R. 103 W., 6th P. M., Wyoming.	750.00	Apr. 4, 1910

TRANSPORTATION AND PURCHASES

The Trinity and Brazos Valley Railway Company and the Wichita Valley Railway Company have entered into general freight contracts during the fiscal year ending June 30, 1910, and the transportation companies named below have made special concessions in freight rates from important shipping points to particular points of delivery at one or more of the various reclamation projects, resulting in a substantial benefit to the service:

Colorado and Southern Railway Company.
Colorado Springs and Cripple Creek District Railway Company.
Denver and Rio Grande Railroad Company.
Fort Worth and Denver City Railway Company.
Great Northern Railway Company.
Morgan's Louisiana and Texas Railroad and Steamship Company.
Oregon Railroad and Navigation Company.
Adams Express Company.

On July 1, 1909, the unsettled bills for freight and express charges amounted to $54,064.47. There were received during the fiscal year for administrative examination bills amounting to $450,517.73; and bills amounting to $455,901.26 were examined, and bases for settlement thereof were arranged with the claimants, leaving outstanding June 30, 1910, unsettled bills amounting to $48,680.94. Claims made by the transportation companies on the freight bills settled during the fiscal year amounted to $455,901.26, and the amount found due thereon, after examination at the transportation office, was $437,032.61. The commercial charges on these bills would have been $758,808.76.

On June 30, 1910, the records of the transportation office showed the status of expense bills covering shipments consigned to contractors to be as follows:

Expense bills on hand July 1, 1909	$38.68
Expense bills received during the fiscal year	36,651.70
Expense bills on which claims were filed with the transportation companies during the fiscal year	15,534.17
Freight claims against transportation companies made on the above expense bills	7,083.64
Expense bills not subject to concessions on hand and received during the fiscal year	20,899.70
Expense bills on hand June 30, 1910	257.14

A total of 1,774 purchases of supplies for field use, amounting in cost to $504,023.60, were made through the Chicago office during the fiscal year.

CEMENT

PURCHASE AND MANUFACTURE

During the fiscal year ending June 30, 1910, about 130,000 barrels of cement were purchased by the Reclamation Service and about 116,000 barrels manufactured at the cement mill at Roosevelt, Ariz.

The following table contains data relating to the contracts for cement in operation or completed during the fiscal year ending June 30, 1910:

Contracts for cement

No.	Date	Contractor	Estimated number of barrels.	Estimated value	Estimated earnings June 30, 1910	Completion due
71	Oct. 25, 1905	Pacific Portland Cement Co.	40,000	$62,000.00	$56,063.70	
101	May 4, 1906	Illinois Steel Co.	14,000	22,400.00	[a] 22,818.80	
102	Apr. 23, 1906	do.	12,500	20,000.00	[a] 20,240.70	
113	July 27, 1906	do.	40,000	56,000.00	[a] 34,618.70	
155	Apr. 3, 1907	Universal Portland Cement Co.	55,000	82,500.00	[a] 84,090.60	Dec. 31, 1907
213	Nov. 20, 1907	Marquette Cement Manufacturing Co.	12,000	15,360.00	[a] 11,766.43	May 1, 1908
220	Mar. 3, 1908	do.	12,000	16,200.00	[a] 17,181.86	
224	Mar. 16, 1908	Universal Portland Cement Co.	10,000	9,500.00	11,112.90	Oct. 1, 1908
231	Apr. 2, 1908	Western Building Material Co.	7,500	8,250.00	9,906.20	Do.
258	Oct. 1, 1908	Iola Portland Cement Co.	40,000	25,600.00	28,160.00	June 1, 1909
271	Feb. 12, 1909	Pacific Portland Cement Co.	25,000	38,750.00	49,758.67	Dec. 31, 1909
273	Feb. 25, 1909	Iola Portland Cement Co.	63,000	50,400.00	45,959.90	Dec. 1, 1909
274	Feb. 27, 1909	Universal Portland Cement Co.	3,000	2,850.00	2,748.75	Do.
275	Feb. 19, 1909	Western Portland Cement Co.	12,000	26,160.00	25,216.06	
282	Mar. 2, 1909	Colorado Portland Cement Co.	26,600	27,404.00	29,867.60	Dec. 1, 1909
312	Feb. 7, 1910	Atlas Portland Cement Co.	14,000	11,200.00	5,280.00	Dec. 31, 1910
313	do.	Marquette Cement Manufacturing Co.	6,000	5,100.00	1,190.72	Do.
317	Feb. 8, 1910	Colorado Portland Cement Co.	15,000	17,250.00	8,116.80	Do.
318	Mar. 3, 1910	Atlas Portland Cement Co.	7,000	5,600.00		Do.
320	Feb. 25, 1910	Ash Grove Lime and Portland Cement Co.	17,000	16,150.00		Do.
327	May 17, 1910	Cowell Portland Cement Co.	1,000	1,550.00		May 17, 1911
329	May 21, 1910	Pacific Portland Cement Co.	6,000	9,300.00		Dec. 31, 1910
330	June 4, 1910	Union Portland Cement Co.	9,000	12,600.00		Do.

[a] Completed.

TESTING

The amount of cement for which tests were made during the fiscal year ending June 30, 1910, was 140,293 barrels, of which 127,743 barrels were accepted and 12,550 barrels were rejected.

The specifications under which cement is purchased by the Reclamation Service and the methods of testing employed in the laboratory conform in general to the standard specifications for cement and the methods of testing recommended by the American Society for Testing Materials.

Regular sets of long-time tests have been continued, and other miscellaneous work has consisted of sand tests for various projects, tests and analyses in connection with the matter of alkali investigation, and collection of samples from and inspection of new plants which have recently commenced operations in the territory from which the service draws its cement supplies. The accompanying tabulation gives the average results of all tests on accepted cement made at the main laboratory at Denver, Colo., and Chicago, Ill., and at the laboratory at Berkeley, Cal., from January 1, 1904, to June 30, 1910.

Tabulation of cement tests from January 1, 1904, to June 30, 1910

[Averages of accepted cement]

Brand	Quantity	Fineness		Setting time		Specific gravity	Composition of briquettes	Tensile strength																	
		Passing No. 100 sieve	Passing No. 200 sieve	Initial	Final			1 day		7 days		28 days		3 months		6 months		1 year		2 years		3 years		5 years	
								Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch	Number of briquettes	Pounds per square inch
	Barrels	*Per ct.*	*Per ct.*	*Hrs. m.*	*Hrs. m.*																				
Atlas	11,200	96.6	78.6	1 49	5 03	3.17	Neat	15	380	220	621	215	688	10	743	5	762	5	670	5	721	....	....	....	....
							3 to 1	....	....	220	247	215	373	10	472	5	426	5	435	5	384	....	....	....	....
Cowboy	15,645	96.1	77.1	3 11	6 15	3.16	Neat	25	316	570	758	570	878	25	887	25	890	25	816	25	780	15	811	....	....
							3 to 1	....	....	570	279	570	373	25	444	25	456	25	435	25	426	15	408	....	....
Golden Gate	168,570	95.5	76.5	3 17	5 43	3.12	Neat	20	281	6,596	643	5,230	784	125	775	25	739	10	741	....	....	....	....	....	....
							3 to 1	....	....	6,596	210	5,230	338	125	455	25	421	10	390	....	....	....	....	....	....
Ideal	111,082	95.1	77.6	3 13	6 55	3.12	Neat	75	398	2,284	684	2,284	742	80	754	75	756	65	736	50	749	40	724	15	662
							3 to 1	....	....	2,284	275	2,284	366	80	438	75	441	65	452	50	439	40	402	15	462
Iola	104,145	93.6	78.6	3 34	7 09	3.16	Neat	90	372	1,927	798	1,927	861	100	859	95	814	75	819	60	805	45	789	10	653
							3 to 1	....	....	1,927	309	1,927	426	100	449	95	450	75	429	60	423	45	384	10	413
Marquette	28,725	94.6	77.2	3 14	7 03	3.15	Neat	30	392	575	768	575	834	25	815	25	783	25	735	15	745	....	....	....	....
							3 to 1	....	....	575	297	575	402	25	432	25	442	25	439	15	466	....	....	....	....
Red Devil	820	96.4	76.8	4 41	9 30	3.15	Neat	20	397	107	736	107	839	25	790	15	840	10	797	5	717	....	....	....	....
							3 to 1	....	....	107	297	107	418	25	469	15	463	10	388	5	360	....	....	....	....
Red Diamond	19,711	96.1	74.8	3 57	8 22	3.15	Neat	35	329	1,195	649	1,195	717	45	738	45	761	40	790	40	793	40	724	10	680
							3 to 1	....	....	1,195	302	1,195	406	45	477	45	498	40	509	40	472	40	421	10	376
Standard (Napa)	8,996	97.8	87.6	4 00	6 41	2.97	Neat	10	295	280	598	300	703	20	672	10	616	....	....	....	....	....	....	....	....
							3 to 1	....	....	280	263	300	378	20	468	10	526	....	....	....	....	....	....	....	....
Sunflower	85,330	94.3	78.2	3 32	7 23	3.16	Neat	60	369	1,140	815	1,140	902	60	853	60	838	60	782	35	809	20	797	....	....
							3 to 1	....	....	1,140	283	1,140	427	60	448	60	445	60	405	35	414	20	356	....	....
Universal	184,100	96.9	81.0	3 24	7 26	3.14	Neat	70	343	3,635	659	3,635	803	70	860	70	817	65	804	60	791	45	781	....	....
							3 to 1	....	....	3,635	263	3,635	375	70	420	70	407	65	401	60	371	45	337	....	....
Yankton	28,484	96.3	80.4	3 53	8 28	3.21	Neat	85	261	945	644	945	775	60	791	60	785	45	776	30	761	20	768	5	608
							3 to 1	....	....	945	252	945	357	60	433	60	440	45	433	30	426	20	436	5	426
Total and averages	766,808	95.5	79.8	3 23	6 55	3.14	Neat	535	346	19,474	683	18,123	796	645	804	510	795	425	782	325	781	225	765	40	657
							3 to 1	....	....	19,474	256	18,123	375	645	447	510	445	425	432	325	422	225	388	40	423

SECONDARY PROJECTS

In addition to the primary irrigation projects which have been approved by the Secretary of the Interior for detailed investigation or for construction and which are discussed in this report under the head of "Discussion of projects," pages 57 to 320, a number of secondary projects have been investigated at various times since the organization of the Reclamation Service. The work on the secondary projects has in general been limited to the gathering of information as to water supply and the determination of the character and extent of irrigable lands. In table 11 on page 41 will be found a list of the secondary projects, together with statements of voucher transactions and net investments of the United States thereon to June 30, 1910.

INDIAN IRRIGATION

Under an agreement made in 1907 between the Office of Indian Affairs and the Reclamation Service, certain irrigation work on Indian reservations authorized by Congress and provided for in appropriations under the control of the Indian Office, is being performed by the Reclamation Service. Plans and estimates for proposed work are prepared by engineers of the Reclamation Service and transmitted to the Office of Indian Affairs for review. If the plans and estimates are concurred in by the Office of Indian Affairs and are afterwards approved and authorized by the Secretary of the Interior, the work is prosecuted by the Reclamation Service in accordance therewith, and the cost is returned to the reclamation fund from the authorized Indian appropriations upon statements rendered monthly. Important work of the Reclamation Service on Indian irrigation projects is described on pages 141 to 148, and the financial status of the work as a whole is shown by Table 20 on pages 46 and 47.

FINANCES

RECLAMATION FUND

The act of June 17, 1902 (32 Stat., 388), provides that all moneys received from July 1, 1900, from the sale and disposal of public lands in certain States and Territories, and including the surplus fees and commissions in excess of allowances to registers and receivers of the land office, and excepting the 5 per cent of the proceeds of the sales of public lands set aside by law for educational and other purposes, shall be reserved, set aside, and appropriated as a special fund to be known as the "reclamation fund."

Table 1 shows the accretions to the reclamation fund, by States, for the period covered by the fiscal years 1901 to 1909, inclusive, the present and probable further additions for the fiscal year 1910, and the estimated totals for the entire period covered by the fiscal years 1901 to 1910, inclusive. The amount estimated for the year 1910 is based upon the actual receipts from the sales of public lands as reported by receivers of the several land offices and the average percentage accruing to the reclamation fund, as shown by Table 2. The grand total, $65,714,179.06, represents the entire amount that will probably have become available for expenditure prior to December 31, 1911, exclusive of loans authorized by act of June 25, 1910.

(36 Stat., 835.) This table also shows the gross amount of the allotments to cover work to December 31, 1910, and the actual net investment of the United States to June 30, 1910, by States.

TABLE 1.—*Receipts from the sales of public lands, allotments, and net investment, by States*

State	Actual receipts to June 30, 1909	During fiscal year 1910		Estimated total to June 30, 1910	Allotments to Dec. 31, 1910	Net investment to June 30, 1910
		Actual	Estimated			
Arizona	$538,591.85		$165,057.05	$703,648.90	$12,663,752.25	$11,642,973.85
California	3,838,487.60		357,098.19	4,195,585.79	1,958,631.68	1,545,679.61
Colorado	4,410,577.05		747,776.68	5,158,353.73	4,684,352.95	4,244,102.37
Idaho	3,789,561.11		336,339.36			
Idaho, sales of town lots	69,660.00	$40,914.78		4,236,474.52	8,270,456.88	6,369,788.49
Kansas	615,716.51		138,833.24	754,549.75	419,000.00	378,316.07
Montana	4,618,092.29	586,489.60	591,225.65			
Montana, sales of town lots	14,756.91	3,048.08		5,813,612.53	4,737,393.45	4,319,763.34
Nebraska	1,073,023.57		143,924.37	1,216,947.94	3,597,377.01	3,229,510.56
Nevada	276,157.64		59,579.68	335,737.32	4,225,452.01	3,988,428.43
New Mexico	2,329,308.53		635,781.66	2,965,090.19	1,386,541.62	1,253,287.11
North Dakota	9,580,920.55	655,689.65	222,390.18	10,459,000.38	1,923,976.35	1,730,612.01
Oklahoma	5,266,323.43		228,230.36	5,494,553.79	72,215.12	69,088.29
Oregon	9,062,735.66		335,967.35	9,398,703.01	3,204,664.77	2,653,231.72
South Dakota	3,545,752.27	543,932.18	416,473.83	4,506,158.28	2,670,000.00	2,313,525.22
Texas					40,000.00	30,424.23
Utah	998,917.54		382,672.35	1,381,589.89	1,187,877.02	966,054.93
Washington	5,528,084.54		311,404.01	5,839,488.55	5,396,607.63	4,037,222.52
Wyoming	2,870,366.88		368,166.88			
Wyoming, sales of town lots	12,375.00	3,775.00		3,254,683.76	5,379,047.66	4,771,778.48
Secondary projects					67,653.80	
Town sites					23,000.00	
General accounts					300,000.00	237,515.65
Total	58,439,408.93	1,833,849.29	5,440,920.84	65,714,179.06	62,208,000.00	53,781,302.88

Because of the size of the work and consequent desirability of making plans far in advance it has been found necessary to make forecasts of the amount that will become available before the actual figures can be known. Table 2 shows by fiscal years the gross receipts from the sales of public lands, the amounts accruing to the reclamation fund, and the percentages of the totals represented by the amounts added to the reclamation fund.

TABLE 2.—*Total receipts from the sale of public land and resulting additions to the reclamation fund*

Fiscal year	Total receipts from reclamation States (not including town-site sales)	Additions to reclamation fund	
		Amount (not including town-site receipts)	Per cent of total receipts
1901	$3,618,546.38	$3,144,821.91	86.908
1902	5,115,619.61	4,585,520.53	89.637
1903	9,395,741.68	8,713,996.60	92.744
1904	7,605,978.29	6,826,253.59	89.748
1905	5,328,084.07	4,805,515.39	90.192
1906	5,732,554.35	5,166,336.50	90.122
1907	8,471,757.75	7,914,131.71	93.417
1908	10,235,294.28	9,430,573.98	92.137
1909	8,391,938.83	7,755,466.81	92.415
Total	63,895,515.24	58,342,617.02	91.309

ALLOTMENTS

From time to time as funds have become available and as the preliminary investigations of the several projects have shown their feasibility and practicability, the construction of such projects has been authorized and allotments therefor have been made with a view to providing the funds necessary to carry on the work. As the annual additions to the fund have usually become available about January 1 of each year, the annual allotments have been based upon the calendar year rather than upon the fiscal year. In making these allotments it has been found advisable to outline a general fiscal programme. The engineers of the service are asked to submit their plans of work and estimates of the funds necessary to carry them out. A conference is then called for consideration of these plans and estimates, and finally a programme is formulated and submitted to the Secretary of the Interior. Three such conferences have thus far been held, namely, at Fallon, Nev., July 24 to 31, 1907, Mitchell, Nebr., July 27 to 31, 1908, and at Portland, Oreg., and Seattle, Wash., July 30 to August 5, 1909.

Table 3 shows the approved allotments for projects, town-site operations, and general office administration.

TABLE 3.—*Allotments for primary and secondary projects, town-site development, and general expenses to December 31, 1910*

State	Per cent chargeable	Project	1902–1910 (see eighth annual report)	Additional, 1910	Total 1902–1910
Arizona		Salt River	$8,245,000.00	$925,000.00	$9,170,000.00
Arizona-California	83, 17	Colorado River	45,000.00		45,000.00
Do	83, 17	Yuma	3,710,000.00	410,000.00	4,120,000.00
California		Orland	608,000.00		608,000.00
Colorado		Grand Valley	225,000.00		225,000.00
Do		Uncompahgre	4,455,000.00		4,455,000.00
Idaho		Boise	3,463,000.00	804,000.00	4,267,000.00
Do		Minidoka	3,456,000.00	165,000.00	3,621,000.00
Do		Snake River storage	116,000.00	240,000.00	356,000.00
Kansas		Garden City	419,000.00		419,000.00
Montana		Huntley	955,000.00		955,000.00
Do		Milk River	593,000.00	50,000.00	643,000.00
Do		St. Mary	298,000.00		298,000.00
Do		Sun River	672,000.00	50,000.00	722,000.00
Montana-North Dakota	70, 30	Lower Yellowstone	2,910,000.00	35,000.00	2,945,000.00
Nebraska-Wyoming	70, 30	North Platte	5,085,000.00	50,000.00	5,135,000.00
Nevada		Truckee-Carson	4,198,000.00	15,000.00	4,213,000.00
New Mexico		Carlsbad	705,000.00	2,000.00	707,000.00
Do		Hondo	359,000.00		359,000.00
Do		Leasburg	210,000.00		210,000.00
New Mexico-Texas	60, 40	Rio Grande	100,000.00		100,000.00
North Dakota		Buford-Trenton	349,000.00		349,000.00
Do		Williston	634,000.00		634,000.00
Oklahoma		Cimarron	12,000.00		12,000.00
Oregon		Central Oregon	45,000.00		45,000.00
Do		Umatilla	1,225,000.00	100,000.00	1,325,000.00
Oregon-California	75, 25	Klamath	2,409,000.00	[a] 75,000.00	2,334,000.00
South Dakota		Belle Fourche	2,670,000.00		2,670,000.00
Utah		Strawberry Valley	1,030,000.00	105,000.00	1,135,000.00
Washington		Okanogan	583,000.00	20,000.00	603,000.00
Do		Yakima	4,576,000.00	135,000.00	4,711,000.00
Wyoming		Shoshone	3,828,000.00		3,828,000.00
		Secondary projects	724,000.00	[a] 58,000.00	666,000.00
		Town-site development	23,000.00		23,000.00
		General accounts	300,000.00		300,000.00
Total			59,235,000.00	2,973,000.00	62,208,000.00

[a] Allotment decreased.

CASH TRANSACTIONS AND BALANCES

In most governmental accounting the practice has been to limit the bookkeeping entries to completed cash transactions, and following that plan the general cash account was at first used in this service as the controlling statement for all other accounts and statements. Statements of this kind appeared in the fifth and sixth annual reports. But the cash transactions alone do not show the financial condition of the Reclamation Service. The accounts of the Reclamation Service are so kept as to show other assets and liabilities. The cash account, however, must, if correct, agree with the Treasury Department's statements of funds made available by appropriation and repayment of expenditures or withdrawals. Table 4 shows a condensed statement of cash appropriated, collected, disbursed, and on hand; Table 5, a reconciliation of the amounts of the appropriations, withdrawals, and balances with those shown by statements of the Treasury Department; and Table 6 shows balances in subtreasuries and United States depositories to the credit of special fiscal officers to June 30, 1910.

TABLE 4.—*Reclamation fund account (32 Stat., 388) to June 30, 1910*

Item		Debit	Credit
Balance end of fiscal year 1909, as per eighth annual report, page 23, Table 5			$50,671,567.12
Receipts during fiscal year 1910:			
Appropriation warrant—			
No. 3, July 1, 1909	$1,420,251.68		
No. 4, July 28, 1909	918,290.88		
No. 14, September 30, 1909	4,950.00		
No. 18, October 30, 1909	8,625.00		
No. 20, December 31, 1909	5,416,924.25		
No. 22, December 31, 1909	4,807.00		
No. 25, January 19, 1910	875.00		
No. 31, March 31, 1910	7,172.96		
No. 38, June 30, 1910	34,557.90		
Total	7,816,454.67		
Less surplus fund warrant No. 37, June 30, 1910, to correct appropriation warrants Nos. 25 and 31	875.00		
			7,815,579.67
Total			58,487,146.79
Disbursements, 175,785 vouchers, as per Table 7		$57,042,579.78	
Collections, 12,317 vouchers, as per Table 8			3,261,276.90
Balance with Treasurer of the United States, as per Table 5		4,000,106.26	
Balance with special fiscal agents, as per Table 6		705,737.65	
Total		61,748,423.69	61,748,423.69

TABLE 5.—*Balances of reclamation fund with the Treasurer of the United States to June 30, 1910*

Item		Appropriations	Withdrawals	Balances
Totals and balance end of fiscal year 1909 as per eighth annual report, page 23, Table 6[a]		$50,671,567.12	$46,568,342.46	$4,103,224.66
Fiscal year 1910		7,815,579.67	7,888,603.63	4,030,200.70
Totals and balance as per statements of the Treasury Department		58,487,146.79	54,456,946.09	4,030,200.70
For items in Reclamation Service accounts but not included in above—				
Add withdrawals on direct settlements by the auditor	$85,002.80			
Deduct repayments on deposits $54,653.20				
Deduct repayments on direct settlements 255.16	54,908.36			
Net withdrawals	30,094.44		30,094.44	30,094.44
Totals and balance as per Reclamation Service accounts		58,487,146.79	54,487,040.53	4,000,106.26

[a] The appropriations, withdrawals, and balances for the fiscal year 1909 shown in this table are taken from the Treasury Department's "Statement of balances, appropriations, and disbursements of the Government for fiscal year 1909," page 69.

TABLE 6.—*Balances with special fiscal agents on June 30, 1910*

Name	Located at—	Amount
Arthur, Wm. S	Williston, N. Dak	$22,376.51
Barnhard, C. B	Phoenix, Ariz	35,273.47
Brown, Geo. W	Fort Shaw, Mont	33,088.71
Buck, N. K	Sunnyside, Wash	13,669.07
Burrows, O. P	Mitchell, Nebr	24,273.14
Caden, Harry	Klamath Falls, Oreg	2,311.42
Caldwell, H. T	Powell, Wyo	47,902.60
Cavis, F. L	Boise, Idaho	40,000.00
Clawson, Ray R	do	5,673.05
Cundiff, F. S	Yuma, Ariz	11,227.92
Donnally, Chas. W	St. Ignatius, Mont	1,796.95
Duganne, Chas. G	Washington, D. C	37,011.07
Eddington, H. E	Provo, Utah	20,885.24
Frisbee, C. E	Family, Mont	12,614.03
Furstenfeld, E. R	Montrose, Colo	33,362.69
Gawler, Jos. C	North Yakima, Wash	11,499.27
Glenn, Claud	Oswego, Mont	15,639.39
Gullickson, A. H	North Yakima, Wash	24,888.04
Hedden, S. E	Rupert, Idaho	4,044.83
Hogue, C. C	Klamath Falls, Oreg	31,146.80
Israel, F. J	Glendive, Mont	22,316.68
Jensen, N. K	Rupert, Idaho	14,369.18
Jones, T. E	Belle Fourche, S. Dak	18,755.06
Kellogg, C. W	Hermiston, Oreg	15,215.50
Meglasson, W. H	St. Ignatius, Mont	32,615.79
Olsen, Swan T	El Paso, Tex	14,173.69
Philebaum, E. M	Sunnyside, Wash	2,500.00
Post, John R	Fallon, Nev	36,300.71
Segall, John L	Phoenix, Ariz	25,000.00
Shellenberger, A. H	Washington, D. C	5,670.76
Spencer, Jas. W	Orland, Cal	26,340.83
Ummel, J. R	Pathfinder, Wyo	13,414.16
Waite, Jas. P	Ashton, Idaho	37,510.82
Yates, H. A	Okanogan, Wash	12,654.47
General Land Office		215.80
Total		705,737.65

DISBURSEMENTS, COLLECTIONS, AND TRANSFERS

In three tables below are shown the expenditures, collections, and transfers between projects to June 30, 1910. Table 7 shows total disbursements for all operations, amounting to $57,042,579.78; Table 8 shows total collections, amounting to $3,261,276.90; and Table 9 shows the value of equipment, material, supplies, and services transferred between projects to be $2,887,556.91.

In addition to the figures presented in these three tables, it should be mentioned that a great many collections are made that do not appear, for they are deducted from disbursement vouchers. The most important of these are the charges for meals furnished, for supplies sold through mercantile stores, for cottage rentals, and for electric power furnished contractors.

TABLE 7.—*Disbursement vouchers paid to June 30, 1910*

By fiscal years		By fiscal quarters			By calendar years	
Year	Amount	Quarter ended—	Number of vouchers	Amount	Year	Amount
1903	$269,094.47	Sept. 30, 1902	123	$18,251.51	a1902	$98,981.37
		Dec. 31, 1902	587	80,729.86		
		Mar. 31, 1903	632	82,601.13	1903	690,174.62
		June 30, 1903	740	87,511.97		
1904	1,513,431.22	Sept. 30, 1903	1,788	217,021.46		
		Dec. 31, 1903	2,364	303,040.06		
		Mar. 31, 1904	2,029	321,625.62	1904	2,684,307.74
		June 30, 1904	2,726	671,744.08		
1905	3,767,921.78	Sept. 30, 1904	3,284	812,101.88		
		Dec. 31, 1904	3,878	878,836.16		
		Mar. 31, 1905	3,241	871,721.49	1905	5,109,538.27
		June 30, 1905	3,968	1,205,262.25		
1906	7,107,715.90	Sept. 30, 1905	5,581	1,604,912.35		
		Dec. 31, 1905	5,513	1,427,642.18		
		Mar. 31, 1906	4,900	1,727,511.14	1906	9,585,708.74
		June 30, 1906	5,969	2,347,650.23		
1907	12,533,916.06	Sept. 30, 1906	7,103	2,721,978.31		
		Dec. 31, 1906	7,815	2,788,569.06		
		Mar. 31, 1907	8,380	3,682,704.32	1907	13,817,634.58
		June 30, 1907	9,217	3,340,664.37		
1908	11,775,419.52	Sept. 30, 1907	9,127	3,471,601.07		
		Dec. 31, 1907	7,753	3,322,664.82		
		Mar. 31, 1908	6,798	2,482,944.74	1908	10,228,512.55
		June 30, 1908	7,170	2,498,208.89		
1909	10,269,005.76	Sept. 30, 1908	7,742	2,434,448.46		
		Dec. 31, 1908	9,016	2,812,910.46		
		Mar. 31, 1909	7,548	2,225,064.85	1909	9,879,364.63
		June 30, 1909	8,216	2,796,581.99		
1910	9,806,075.07	Sept. 30, 1909	8,458	2,301,434.10		
		Dec. 31, 1909	7,902	2,556,283.69		
		Mar. 30, 1910	7,380	2,398,786.27	a1910	4,948,357.28
		June 30, 1910	8,137	2,549,571.01		
Total	57,042,579.78		175,075	57,042,579.78		57,042,579.78

a Six months.

TABLE 8.—*Collection vouchers collected to June 30, 1910*

By fiscal years		By fiscal quarters			By calendar years	
Year	Amount	Quarter ended—	Number of vouchers	Amount	Year	Amount
1903 [a]	$242.37	Mar. 31, 1903	5	$202.21		
		June 30, 1903	13	40.16	1903	$328.66
		Sept. 30, 1903	2	74.31		
1904	710.84	Dec. 31, 1903	3	11.98		
		Mar. 31, 1904	10	416.78		
		June 30, 1904	107	207.77	1904	1,371.08
		Sept. 30, 1904	13	661.32		
1905	1,338.85	Dec. 31, 1904	27	85.21		
		Mar. 31, 1905	74	370.40		
		June 30, 1905	112	221.92	1905	13,032.24
		Sept. 30, 1905	57	6,066.77		
1906	22,924.63	Dec. 31, 1905	109	6,373.15		
		Mar. 31, 1906	138	8,178.25		
		June 30, 1906	60	2,306.46	1906	42,910.08
		Sept. 30, 1906	101	12,864.55		
1907	157,984.45	Dec. 31, 1906	124	19,560.82		
		Mar. 31, 1907	144	47,211.81		
		June 30, 1907	165	78,347.27	1907	427,890.97
		Sept. 30, 1907	310	202,160.11		
1908	530,966.20	Dec. 31, 1907	714	100,171.78		
		Mar. 31, 1908	698	53,262.13		
		June 30, 1908	927	175,372.18	1908	454,174.43
		Sept. 30, 1908	805	61,950.38		
1909	764,418.43	Dec. 31, 1908	936	163,589.74		
		Mar. 31, 1909	906	203,501.85		
		June 30, 1909	1,378	335,376.46	1909	1,168,191.49
		Sept. 30, 1909	1,112	253,857.06		
1910	1,782,691.13	Dec. 31, 1909	873	375,456.12		
		Mar. 31, 1910	964	449,801.22	[a]1910	1,153,377.95
		June 30, 1910	1,430	703,576.73		
Total	3,261,276.90	....	12,317	3,261,276.90	....	3,261,276.90

TABLE 9.—*Transfer vouchers approved to June 30, 1910*

By fiscal years		By fiscal quarters			By calendar years	
Year	Amount	Quarter ended—	Number of vouchers	Amount	Year	Amount
1905 [b]	$2,275.45	June 30, 1905	12	$2,275.45		
		Sept. 30, 1905	5	331.30	[c]1905	$7,704.63
1906	445,806.96	Dec. 31, 1905	20	5;097.88		
		Mar. 31, 1906	48	11,988.55		
		June 30, 1906	227	428,389.23	1906	704,003.51
		Sept. 30, 1906	87	182,534.09		
1907	508,693.42	Dec. 31, 1906	126	81,091.64		
		Mar. 31, 1907	116	78,016.26		
		June 30, 1907	120	167,051.43	1907	1,088,808.73
		Sept. 30, 1907	100	84,989.10		
1908	1,030,342.18	Dec. 31, 1907	93	758,751.94		
		Mar. 31, 1908	53	58,232.88		
		June 30, 1908	182	128,368.26	1908	489,434.02
		Sept. 30, 1908	239	112,774.86		
1909	534,618.33	Dec. 31, 1908	232	190,058.02		
		Mar. 31, 1909	193	132,980.39		
		June 30, 1909	224	98,805.06	1909	417,215.06
		Sept. 30, 1909	254	96,387.55		
1910	365,820.57	Dec. 31, 1909	246	89,042.06		
		Mar. 31, 1910	226	92,819.85	[a]1910	180,390.96
		June 30, 1910	259	87,571.11		
Total	2,887,556.91	....	3,062	2,887,556.91	....	2,887,556.91

[a] Six months. [b] Three months. [c] Nine months.

INVESTMENT IN PROJECTS

While the cash transactions alone do not fully show the financial status of the service and the several projects undertaken by it, they do show the actual amount invested in each undertaking, and represent nearlv 95 per cent of the total expense incurred. For convenience the various work under way is grouped under five general heads, as follows: Primary projects, those for which definite allotments of funds are in effect and on which in most cases construction is underway or can soon be taken up or which have been completed; secondary projects, those for which no definite allotments of funds are in effect and on which in most cases preliminary studies and surveys have been made to determine their feasibility and practicability; town-site operations under the acts of April 16 and June 27, 1906 (34 Stat., 116, 519), the expense of which is not reimbursable; Indian irrigation, projects on Indian reservations undertaken for the Office of Indian Affairs and for which repayment is made monthly by that office to the extent of the actual expense incurred; and general accounts, for those expenditures that can not be directly charged to any project when first incurred, but that are subsequently transferred to projects on the basis of the benefits received. Tables 10, 11, and 12 show the total voucher transactions and net investment on each undertaking of these classes, and Table 13 gives a recapitulation of all such transactions.

TABLE 10.—*Voucher transactions and net investments of the United States on primary projects to June 30, 1910*

State	Project	Debits		Credits			Net investment
		Disbursement vouchers	Transfers received	Collection vouchers		Tranfers issued	
				Miscellaneous	Water-right charges		
Arizona	Salt River	$8,872,292.00	$232,893.89	$550,494.67	$100,000.00	$23,732.06	$8,430,959.16
Arizona-California	Colorado River	41,570.19	5,552.86	760.32		2,160.76	44,201.97
Do	Yuma	3,867,589.00	105,116.55	144,156.54	42,269.51	4,924.31	3,781,355.19
California	Orland	361,834.39	25,174.65	5,857.24		2,548.69	378,603.11
Colorado	Grand Valley	69,479.00	6,401.48	35.69		2,734.35	73,110.38
Do	Uncompahgre	4,229,588.66	86,427.10	143,384.34		5,992.38	4,166,639.04
Idaho	Boise	3,352,382.88	94,612.23	43,791.29		29,911.52	3,373,292.30
Do	Minidoka	3,018,916.20	120,950.87	21,384.37	151,116.53	66,469.61	2,900,896.56
Do	Snake River Storage	40,846.23	41,631.69	6,598.10		6,737.07	69,142.75
Kansas	Garden City	375,453.30	11,022.18	3,584.88	247.00	4,327.53	378,316.07
Montana	Huntley	980,291.72	32,072.53	24,191.05	75,357.10	58,395.74	854,420.36
Do	Milk River	497,523.04	31,325.53	3,897.93		5,563.41	519,387.23
Do	St. Mary	279,166.56	12,146.88	7,271.87		18,167.54	265,874.03
Do	Sun River	626,638.30	24,769.62	8,286.41	34,612.25	8,550.67	599,958.59
Montana-North Dakota	Lower Yellowstone	2,876,992.46	72,399.71	30,480.53	15,449.25	14,562.56	2,888,899.83
Nebraska-Wyoming	North Platte	4,167,495.43	572,834.32	45,073.15	77,288.36	8,491.74	4,609,476.50
Nevada	Truckee-Carson	3,977,154.98	160,371.36	27,043.23	107,067.50	27,439.19	3,975,976.42
New Mexico	Carlsbad	706,905.21	15,952.38	14,079.13	80,288.95	10,823.95	617,665.56
Do	Hondo	364,052.88	10,908.15	28,395.09		541.18	346,024.76
Do	Leasburg	221,551.89	9,667.00	32,376.11		5,423.96	193,418.82
New Mexico-Texas	Rio Grande	69,597.74	26,312.10	19,246.19		603.07	76,060.58
North Dakota	Buford-Trenton	311,132.46	64,753.88	1,559.29	1,360.06	94,672.59	278,294.40
Do	Williston	502,325.67	77,468.91	5,009.76	3,421.41	43,192.10	528,171.31
Oklahoma	Cimarron	8,577.96	321.76			26.55	8,873.17
Oregon	Central Oregon	40,036.02	1,668.91	1,228.58		342.91	40,133.44
Do	Umatilla	1,259,802.38	28,890.80	33,369.40	67,476.04	31,864.52	1,155,983.22
Oregon-California	Klamath	1,907,463.74	46,721.21	37,834.18	75,114.98	10,635.40	1,830,600.39
South Dakota	Belle Fourche	2,337,372.11	54,358.43	16,617.15	46,909.88	14,678.29	2,313,525.22
Utah	Strawberry Valley	943,073.83	26,549.79	50,034.85		6,410.86	913,177.91
Washington	Okanogan	557,740.31	17,885.19	5,287.48	26,374.57	5,682.04	538,281.41
Do	Yakima	3,461,833.45	493,900.19	248,298.41	163,549.99	127,551.76	3,416,333.48
Wyoming	Shoshone	3,472,081.92	93,925.32	66,404.41	84,556.06	36,658.90	3,378,387.87
Total		53,798,761.91	2,604,987.41	1,626,031.64	1,152,459.44	679,817.21	52,945,441.03

TABLE 11.—*Voucher transactions and net investments of the United States on secondary projects to June 30, 1910*

State	Project	Debits: Disbursement vouchers	Debits: Transfers received	Credits: Collection vouchers	Credits: Transfers issued	Net investment
Arizona	Little Colorado	$9,515.33	$40.00	$1.00		$9,554.33
Do	San Carlos	24,589.74	243.74	12.90		24,820.58
Do	San Pedro	.2,423.72	3.97	.35		2,427.34
California	Owens Valley	25,957.91	121.00	14,016.99		12,061.92
Do	Sacramento Valley	52,450.42	2,973.62	91.79	$11,843.69	43,488.56
Do	San Joaquin	3,448.92	82.48	.20		3,531.20
Colorado	White River	4,348.04	5.06	.15		4,352.95
Idaho	Dubois	21,418.38	834.98	1.81	5,068.29	17,183.26
Do	Port Neuf	2,165.77	2.24			2,168.01
Montana	Clark Fork	5,417.71	433.67	.25	269.90	5,581.23
Do	Crow Reservation	21,029.47	5.01	1.90	2,111.62	18,920.96
Do	Lake Basin	7,044.39	79.87		19.75	7,104.51
Do	Madison River	10,795.45	2.57	1.85	67.08	10,729.09
Do	Marias	13,878.31	93.30	1.55	632.20	13,337.86
Nebraska	South Platte	1,913.96	963.05			2,877.01
Nevada	Walker River	12,450.48	1.53			12,452.01
New Mexico	La Plata	29,598.20	168.55	1,702.42		28,064.33
Do	Las Vegas	5,012.16	2.23	.30		5,014.09
Do	Urton Lake	19,329.15	273.71	1,225.51	914.15	17,463.20
North Dakota	Bismarck	16,709.04	26.69	14.70	3,098.34	13,622.69
Do	Little Missouri	11,623.95	1,670.14	1.00	1,439.82	11,853.27
Do	Nesson	7,473.02	29,786.35	4.14	19,801.89	17,453.34
Do	Washburn	9,950.70	1,948.34	42.38	1,350.68	10,505.98
North Dakota-South Dakota.	Bowman	3,639.36	1,493.30	.50	1,091.09	4,041.07
Oklahoma	Red River	59,413.75	1,902.64	161.77	939.50	60,215.12
Oregon	Malheur	82,592.87	4,293.93	279.80	2,442.23	84,164.77
Utah	Bear Lake	18,859.06	30.72	62.06		18,827.72
Do	Utah Lake	34,044.67	9.25	4.62		34,049.30
Washington	Palouse	76,558.48	359.52	126.38	400.00	76,391.62
Do	Priest Rapids	6,218.98	247.58	250.55		6,216.01
Wyoming	De Smet	9,053.32	2.51	39.55	98.90	8,917.38
Total		608,924.71	48,101.55	18,046.42	51,589.13	587,390.71

TABLE 12.—*Voucher transactions and net investments of the United States on town-site development, Indian irrigation, and miscellaneous to June 30, 1910*

Item	Debits: Disbursement vouchers	Debits: Transfers received	Credits: Collection vouchers, miscellaneous	Credits: Transfers issued	Net investment
Town-site development:					
Idaho, Minidoka project	$2,455.08	$4,650.53			$7,105.61
Montana—					
Huntley project	106.05	1,085.72	$4.00		1,187.77
Sun River project	111.23	920.60			1,031.83
Wyoming—					
Shoshone project	232.61	1,401.77	4.10		1,630.28
Total	2,904.97	8,058.62	8.10		10,955.49
Indian irrigation:					
Montana—					
Blackfeet project	254,332.66	25,123.03	191,117.05	$5,353.99	82,984.65
Flathead project	283,233.29	24,696.75	212,655.35	370.85	94,903.84
Fort Peck project	57,430.63	9,670.29	46,002.08	283.12	20,815.72
Total	594,996.58	59,490.07	449,774.48	6,007.96	198,704.21
Miscellaneous:					
General accounts	1,156,121.98	109,350.50	13,130.90	1,213,530.14	38,811.44
Closed accounts	880,869.63	57,568.76	1,825.92	936,612.47	
Total	2,036,991.61	166,919.26	14,956.82	2,150,142.61	38,811.44

TABLE 13.—*Recapitulation and verification of voucher transactions and all net investments of the United States paid from the reclamation fund to June 30, 1910*

Item	Debits		Credits			Net investment
			Collection vouchers			
	Disbursement vouchers	Transfers received	Miscellaneous	Water-right charges	Transfers issued	
Primary projects	$53,798,761.91	$2,604,987.41	$1,626,031.64	$1,152,459.44	$679,817.21	$52,945,441.03
Secondary projects	608,924.71	48,101.55	18,046.42		51,589.13	587,390.71
Town-site development	2,904.97	8,058.62	8.10			10,955.49
Indian irrigation	594,996.58	59,490.07	449,774.48		6,007.96	198,704.21
Miscellaneous	2,036,991.61	166,919.26	14,956.82		2,150,142.61	38,811.44
Total	57,042,579.78	2,887,556.91	2,108,817.46	1,152,459.44	2,887,556.91	53,781,302.88

ANALYSIS OF COLLECTIONS

All moneys collected under the operations of the Reclamation Service are authorized either by section 4 of the reclamation act (32 Stat., 388), by sections 2 and 4 of the act of April 16, 1906 (34 Stat., 116), or by the act of March 3, 1905 (33 Stat., 1032). Collections under the first law mentioned are repayments of cost. Collections under sections 2 and 4 of the act of April 16, 1906, and the act of March 3, 1905, are reductions of the cost of the projects.

Under the authority of these acts there has been collected a total of $3,261,276.90. Of this, $22,709.73 is repayment of overpayments and is a reduction of disbursements. The balance, $3,238,567.17, represents actual cash receipts, of which $1,152,459.44 are repayments of cost and $2,086,107.73 are reductions of cost. Those collections which operate as repayments of cost are received from the water users in settlement of building and operation and maintenance charges under public notices issued by the Secretary of the Interior. The collections which result in reductions of the cost of projects arise from a number of sources, all of which are incidental to the work under the reclamation act. Table 14 shows the sources of cash collections, by calendar years, and Table 15 shows the amounts collected for water rights, by projects, to June 30, 1910.

TABLE 14.—*Sources of cash collections to June 30, 1910, by calendar years*

Calendar year	Miscellaneous sales	Miscellaneous services	Temporary water rentals	Transportation refunds	Forfeitures by bidders and contractors	Water-right building charges	Water-right operation and maintenance charges	Over disbursements	Total
1903								$328.66	$328.66
1904								1,371.08	1,371.08
1905	$2,483.55			$693.88	$9,000.00			854.81	13,032.24
1906	22,441.97	$300.00		16,492.42				3,675.69	42,910.08
1907	79,650.57	13,637.27	$128,534.23	62,943.00		$126,542.44	$4,124.94	12,458.52	427,890.97
1908	96,776.40	59,232.51	188,134.29	9,668.98	1,000.00	77,984.64	20,350.33	1,027.28	454,174.43
1909	81,545.19	441,612.18	261,158.93	62,411.63	24,000.00	231,900.98	64,290.63	1,271.95	1,168,191.49
1910[a]	58,156.38	237,112.53	202,646.65	26,475.17		466,394.19	160,871.29	1,721.74	1,153,377.95
Total	341,054.06	751,894.49	780,474.10	178,685.08	34,000.00	902,822.25	249,637.19	22,709.73	3,261,276.90

[a] Six months.

TABLE 15.—*Collection of water-right charges, by projects, to June 30, 1910*

State	Project	Building charges	Operation and maintenance charges	Total
Arizona	Salt River	[a] $100,000.00		$100,000.00
Do	Yuma	35,766.51	$6,503.00	42,269.51
Idaho	Minidoka	115,776.74	35,339.79	151,116.53
Kansas	Garden City	142.50	104.50	247.00
Montana	Huntley	58,319.34	17,037.76	75,357.10
Do	Sun River	29,623.08	4,989.17	34,612.25
Do	Lower Yellowstone	6,770.25	8,679.00	15,449.25
Nebraska-Wyoming	North Platte	72,745.02	4,543.34	77,288.36
Nevada	Truckee-Carson	73,308.51	33,758.99	107,067.50
New Mexico	Carlsbad	48,549.10	31,739.85	80,288.95
North Dakota	Buford-Trenton	680.20	679.86	1,360.06
Do	Williston	342.72	3,078.69	3,421.41
Oregon	Umatilla	53,891.44	13,584.60	67,476.04
Do	Klamath	46,532.45	28,582.53	75,114.98
South Dakota	Belle Fourche	29,733.48	17,176.40	46,909.88
Washington	Okanogan	14,020.57	12,354.00	26,374.57
Do	Yakima (Sunnyside unit)	148,336.42	15,213.57	163,549.99
Wyoming	Shoshone	68,283.92	16,272.14	84,556.06
Total		902,822.25	249,637.19	1,152,459.44

[a] Collection through auditor's office for lands of Pima Indians.

BALANCE SHEETS OF ASSETS AND LIABILITIES

The Reclamation Service includes in its accounts not only the cash transactions and accrued current assets and liabilities, but also the capital assets, realization upon which must under the law be deferred and the capital liability represented by a reimbursable special fund that must ultimately be returned to the Treasury of the United States. An independent account is kept for each project, covering all current assets and liabilities, including cost of work as an asset to be realized upon in the future, and net investment of the United States as a liability to the Reclamation Service. A balance sheet is prepared for each project and the director's office monthly. For the entire service these balance sheets are combined into a consolidated balance sheet, into which are brought the assets for cash in the Treasury and with fiscal officers and the capital liability for the appropriation, reclamation fund. Table 16 is a statement of assets and liabilities at the close of accounts on June 30, 1910, made up from the consolidated balance sheet, and Tables 18, 19, and 20 are statements of assets and liabilities for the director's office, the secondary projects, and the Indian irrigation projects, respectively, on June 30, 1910. The statements of assets and liabilities for the primary projects are given in the body of this report under the project headings.

TABLE 16.—*Consolidated statement of assets and liabilities for operations under reclamation fund to June 30, 1910*

ASSETS

Cash (as per Table 4):			
With Treasurer United States		$4,000,106.26	
In depositories to credit of special fiscal agents		705,737.65	
			$4,705,843.91
Accounts receivable:			
Uncollected freight refunds		7,477.02	
Uncollected water rentals		20,829.55	
Uncollected miscellaneous rentals		71,083.22	
Uncollected miscellaneous		140,232.41	
Collections by General Land Office		20,662.50	
Uncollected water-right building charges		864,873.26	
Uncollected water-right operation and maintenance charges		73,456.96	
			1,198,614.92
Inventories:			
Mercantile stores		32,306.44	
Government animals	$228,321.95		
Less depreciation	55,646.16		
		172,675.79	
Equipment in use	901,498.10		
Less depreciation	72,597.01		
		828,901.09	
Storehouses		519,161.87	
Cement		123,530.17	
Iron and steel		27,691.07	
Lumber		65,806.36	
Explosives		13,908.56	
Forage		36,025.59	
Fuel		16,827.47	
Cash in project offices		6,033.77	
Local products		31,573.34	
Unadjusted transfers		[a] 1,134.63	
Freight and handling undistributed		83,483.56	
			1,956,790.45
Cost of work:			
Building cost		54,367,536.16	
Less adjustments	83,496.31		
Less accrued revenues	1,410,764.03		
		1,494,260.34	
			52,873,275.82
Operation and maintenance cost		1,728,637.07	
Less accrued revenues		295,226.79	
			1,433,410.28
Total assets			62,167,935.38

LIABILITIES

Capital:		
Reclamation fund (reimbursable), as per Table 5	58,487,146.79	
Less expenditures on town sites (nonreimbursable), as per Table 12	10,955.49	
		58,476,191.30
Accounts payable:		
Unpaid labor	255,951.59	
Unpaid purchases	316,770.46	
Unpaid contract estimates	249,516.94	
Unpaid contract holdbacks	238,415.67	
Unpaid freight and express	158,691.03	
Unpaid passenger fares	7,155.35	
Unpaid land agreements	106,371.32	
Unredeemed coupon books	2,239.16	
Unredeemed meal tickets	1,728.76	
Unpaid miscellaneous	10,235.66	
		1,347,075.94
Repayments accrued:		
Building charges	1,953,793.42	
Operation and maintenance charges	390,874.72	
		2,344,668.14
Total liabilities		62,167,935.38

[a] Credit amount.

TABLE 16a.—*Project costs to June 30, 1910*

State	Project	Building	Operation and maintenance
Arizona	Salt River	$8,964,868.30	
Arizona-California	Colorado River	44,201.97	
Do	Yuma	3,717,472.71	$14,510.80
California	Orland	397,334.80	
Colorado	Grand Valley	65,684.97	
Do	Uncompahgre	4,263,656.37	
Idaho	Boise	3,404,327.18	
Do	Minidoka	3,172,421.02	168,731.27
Do	Snake River Storage	66,820.00	
Kansas	Garden City	337,568.21	48,569.64
Montana	Huntley	843,894.56	88,490.40
Do	Milk River	502,867.31	
Do	St. Mary	231,109.47	
Do	Sun River	561,605.49	47,812.89
Montana-North Dakota	Lower Yellowstone	2,760,824.27	135,571.82
Nebraska-Wyoming	North Platte	4,299,509.81	351,306.28
Nevada	Truckee-Carson	3,778,831.97	283,748.16
New Mexico	Carlsbad	604,738.62	97,645.02
Do	Hondo	349,386.27	
Do	Leasburg	217,296.60	
New Mexico-Texas	Rio Grande (reclamation fund)	76,060.58	
North Dakota	Buford-Trenton	262,912.59	16,324.34
Do	Williston	441,147.34	81,774.65
Oklahoma	Cimarron	8,753.99	
Oregon	Central Oregon	39,344.71	
Do	Umatilla	1,127,046.30	61,624.91
Oregon-California	Klamath	1,850,987.45	64,327.05
South Dakota	Belle Fourche	2,394,512.91	24,751.49
Utah	Strawberry Valley	907,682.51	
Washington	Okanogan	555,637.49	12,659.72
Do	Yakima	3,474,331.79	194,457.43
Wyoming	Shoshone	3,502,195.09	36,331.20
	Secondary projects	582,188.14	
Montana	Indian projects	560,315.37	
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		54,367,536.16	1,728,637.07

TABLE 17.—*Estimated cost of contemplated works on the several projects, exclusive of operation and maintenance*

State	Project	Contemplated works
Arizona	Salt River	$600,000
Arizona-California	Yuma	3,000,000
Colorado	Uncompahgre	5,000,000
Idaho	Boise	[a] 8,000,000
Do	Minidoka	6,400,000
Montana	St. Mary-Milk River	6,200,000
Do	Huntley	200,000
Do	Sun River	9,000,000
Montana-North Dakota	Lower Yellowstone	500,000
Nebraska-Wyoming	North Platte	[b] 1,200,000
Nevada	Truckee-Carson	3,500,000
New Mexico-Texas	Rio Grande	9,000,000
North Dakota	Williston-Buford	300,000
Oregon	Umatilla	[c] 400,000
Oregon-California	Klamath	[d] 3,000,000
South Dakota	Belle Fourche	600,000
Utah	Strawberry Valley	3,100,000
Washington	Yakima	[e] 13,000,000
Wyoming	Shoshone	4,000,000
Total		77,000,000

[a] Does not include North Side nor Payette.
[b] Does not include Fort Laramie Canal nor Goshen Park.
[c] Does not include West Umatilla.
[d] Does not include marsh lands.
[e] Does not include Benton unit.

Estimate does not include Grand Valley project in Colorado.

TABLE 18.—*Assets and liabilities on June 30, 1910, director's office*

ASSETS

Accounts receivable:			
Uncollected miscellaneous			$749.33
Inventories:			
Equipment in use	$21,131.94		
Less depreciation	890.02		
		$20,241.92	
Storehouse		16,610.35	
Local products		3,470.31	
Unadjusted transfers		256.41	
Freight and handling undistributed		2,681.49	
			43,260.48
Cost of work:			
Accrued revenues			[a] 783.64
Total assets			43,226.17

LIABILITIES

Investment of the United States:			
Disbursement vouchers	1,156,121.98		
Transfer vouchers received	109,350.50		
		1,265,472.48	
Collection vouchers	13,130.90		
Transfer vouchers issued	1,213,530.14		
		1,226,661.04	
			38,811.44
Accounts payable:			
Unpaid labor		951.67	
Unpaid purchases		2,475.47	
Unpaid freight and express		71.00	
Unpaid passenger fares		916.59	
			4,414.73
Total liabilities			43,226.17

TABLE 19.—*Assets and liabilities on June 30, 1910, secondary projects*

ASSETS

Inventories:			
Government animals		$633.61	
Equipment in use		958.93	
Storehouse		3,725.77	
			$5,318.31
Cost of work:			
Building cost [b]			582,188.14
Total assets			587,506.45

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$608,924.71		
Transfer vouchers received	48,101.55		
		657,026.26	
Collection vouchers	18,046.42		
Transfer vouchers issued	51,589.13		
		69,635.55	
			587,390.71
Accounts payable:			
Unpaid freight and express		113.39	
Unpaid passenger fares		1.35	
Unpaid miscellaneous		1.00	
			115.74
Total liabilities			587,506.45

TABLE 20.—*Assets and liabilities on June 30, 1910, Indian irrigation projects*

ASSETS

Accounts receivable:			
Uncollected freight refunds		$330.77	
Uncollected miscellaneous		61,554.44	
			$61,885.21
Inventories:			
Mercantile store		11,866.44	
Government animals	$47,219.08		
Less depreciation	5,000.73		
		42,218.35	
Equipment in use	43,295.17		
Less depreciation	1,052.00		
		42,243.17	

[a] Credit amount.

[b] The building cost may be determined by adding the total net investment as shown by Table 11 and the total accounts payable as shown above and deducting from their sum the inventory amount shown above.

Inventories—Continued				
Storehouse		$18,361.65		
Cement		2,393.09		
Iron and steel		723.35		
Lumber		3,192.47		
Explosives		1,547.83		
Forage		6,000.62		
Fuel		58.08		
Cash in office safe		1,200.14		
Unadjusted transfers		2,247.27		
Freight and handling undistributed		364.20		
			$132,416.66	
Cost of work:				
Building cost		560,315.37		
Less adjustments	$7,274.27			
Less accrued revenues	506,229.35			
		513,503.62		
			$46,811.75	
Total assets				241,113.62

LIABILITIES

Investment of the United States:				
Disbursement vouchers	594,996.58			
Transfer vouchers received	59,490.07			
		654,486.65		
Collection vouchers	449,774.48			
Transfer vouchers issued	6,007.96			
		455,782.44		
			198,704.21	
Accounts payable:				
Unpaid labor		21,634.48		
Unpaid purchases		13,474.79		
Unpaid contract holdbacks		1,790.00		
Unpaid freight and express		4,635.39		
Unpaid land agreements		180.71		
Unredeemed coupon books		694.04		
			42,409.41	
Total liabilities				214,113.62

Summary of cost of Indian projects

Montana:	
Blackfeet	$241,763.93
Flathead	255,297.21
Fort Peck	63,254.23
Total building cost as per debit in cost of work in statement of assets and liabilities	560,315.37

EXPLANATION OF ASSETS AND LIABILITIES

The significance of the data shown in the statements of assets and liabilities for projects will be better understood after consideration of the following explanation of the items entering into the foregoing general statement of assets and liabilities.

The several items appear in the statement of assets and liabilities in the order in which they can or must be liquidated.

The accounts receivable are shown under seven heads, as follows: Uncollected freight refunds, consisting of claims against railroads for contract concessions upon freight moved for contractors on irrigation work; uncollected water rentals, consisting of claims against irrigators for water furnished under rental contract; uncollected miscellaneous rentals, consisting of claims against the lessees of lands or buildings under the control of the service; uncollected miscellaneous, consisting of claims against contractors or other persons for services or materials furnished that will be deducted from current earnings by them; collections by General Land Office, consisting of collections of water-right building and operation and maintenance charges by special fiscal agents and transmitted to local land offices but not yet covered into the Treasury by the receivers of land offices; uncollected water-right building charges and uncollected water-right operation and maintenance charges, consisting of claims against water-right applicants for the portions of annual installments of water-right charges that have accrued under their applications but that have not become delinquent.

The inventories are self-explanatory, but an explanation of the methods of handling these accounts will make them more easily understood. With the regular use of government animals and equipment there is a deterioration in value that should be written off from these asset accounts and included with that of cost of work. Actual depreciation is determined from time to time by surveys and appraisals or by sale, but pending such determination estimated wear and tear is credited to the respective accounts for depreciation and debited to cost of work, to be more accurately adjusted when appraisals or sales are made. Unadjusted transfers are for materials or services furnished by one project to another for which the vouchers have not been checked so as to warrant their entry to the proper accounts under inventories or cost of work.

Cost of work represents the outlay upon the net asset in the irrigation projects, for which reimbursement will later be required from the water-right applicants. The bulk of the outlay is shown in the two accounts, building cost and operation and maintenance cost. Table 16a shows the cost of each project for building and operation and maintenance. The amount appearing in these two accounts is analyzed for each project in a subsidiary statement that shows the cost of the principal physical features. A table showing an analysis of these costs by features is given in this report under each project. In computing the current costs for such features there are certain expenses that can not be accurately determined when incurred, but that are estimated as closely as possible, subject to readjustment at a later time. The expenses that must be thus estimated do not represent a large proportion of the cost of any feature of the work, but are numerous and varied in kind. Most of them arise from what are known as incidental operations, such as power plants, manufacturing shops, storehouses, mess houses, mercantile stores, etc. The net gain or loss on such operations is a decrease or increase of the actual cost of the project and of the features to which they have contributed. It is usually impracticable to revise and readjust the charges made for the benefits that these incidental operations have contributed to the various features, and therefore the gains or losses are applied only to the cost of the project as a whole. The projects derive various revenues from dealings with the general public, such as rentals of lands and buildings, payment for services performed at its manufacturing shops, rentals of irrigating water, etc. These revenues do not reduce the original cost of the features whose operations produce the revenues, but they do reduce the cost of the entire project. The net cost of a project is, therefore, obtained from the building cost, operation and maintenance cost, adjustments, and revenues.

The capital account represents the indebtedness of the service to the United States. The reclamation fund is ultimately reimbursable and therefore a liability. The amount of the liability would be the total amount appropriated to it, except that the acts of April 16 and June 27, 1906 (34 Stat., 116, 519), make the disbursements therefrom for the development of certain town sites a final expenditure that is not repayable to the service and accordingly not reimbursable to the United States. The total amount of such expenditures for town-site operations to June 30, 1910, is $10,955.49. The law, furthermore, makes no provision for the return to the reclamation fund of amounts expended on the investigation of projects that prove ultimately to be not feasible.

The accounts payable are shown under ten heads, as follows: Unpaid labor, consisting of claims in favor of employees for services performed, the greater part of which is always paid on or before the tenth of the following month; unpaid purchases, consisting of claims in favor of merchants for current bills, most of which are paid during the following month; unpaid contract estimates and unpaid contract holdbacks, both consisting of claims in favor of contractors upon construction work, the former representing the amount now due and that will be paid as soon as settled by the auditor, and the latter representing the amount withheld until the completion of the work under the provisions of the contract; unpaid freight and express and unpaid passenger fares, consisting of claims in favor of transportation companies, both representing the estimated indebtedness for transportation furnished by carriers, the respective charges being secured for freight from delivering agents' expense bills, for express from delivering agents' oral statements of the charges, and for passenger fares from ticket sellers' oral statements of the fares; unpaid land agreements, consisting of claims in favor of the grantors of real property upon negotiated contracts for the acquisition of their titles and not payable until complete investigation of such titles and final determination of the exact amounts payable to the grantors; unredeemed coupon books and meal tickets, consisting of employees' claims that are not payable in cash except upon discharge, but for which they are entitled to receive appropriate issues at the mercantile stores and mess houses; and unpaid miscellaneous, consisting of claims payable in cash that do not properly come within the limits of the foregoing classes of liabilities.

The repayment accounts are set forth separately and treated as liabilities, as it is desirable to show the total amount of repayments accrued. They might, perhaps, very properly be considered as a reduction of the asset account "cost of work," since that account, as an asset, is reduced by repayments.

ENGLE DAM

The act of March 4, 1907 (34 Stat., 1357), provided an appropriation of $1,000,000 toward the construction of a dam in the bed of the Rio Grande for storing and delivering water, as provided by a convention between the United States and Mexico. Tables 21, 22, and 23 show the transactions under this appropriation and its condition on June 30, 1910, and are similar to the tables relating to the reclamation fund.

TABLE 21.—*Special appropriation for Rio Grande (Engle) dam (34 Stat., 1357) to June 30, 1910*

	Debit	Credit
Appropriation warrant, No. 19, March 4, 1907		$1,000,000.00
Disbursements (1,154 vouchers)	$390,662.91	
Collections (19 vouchers)		78.92
Balance with Swan T. Olsen, special fiscal agent	27,774.39	
Balance with Treasurer of the United States	581,641.62	
Total	1,000,078.92	1,000,078.92

TABLE 22.—*Balances of appropriation for Rio Grande (Engle) dam with Treasurer of the United States, June 30, 1907, to June 30, 1910* [a]

Fiscal year	Appropriation	Withdrawals	Balances
1907	$1,000,000.00		$1,000,000.00
1908		$33,113.21	966,886.79
1909		137,074.22	829,812.57
1910		247,217.23	582,595.34
Totals and balance per Treasury accounts, June 30, 1910	1,000,000.00	417,404.66	582,595.34
To reconcile with accounts of the Reclamation Service: For items not in above but in Rio Grande (Engle) dam appropriation accounts, per direct settlement by the auditor, add to withdrawals		953.72	953.72
Total and balance per Reclamation Service accounts	1,000,000.00	418,358.38	581,641.62

TABLE 23.—*Disbursement and collection vouchers (appropriation for Rio Grande (Engle) dam) paid and collected to June 30, 1910*

Quarter ended—	Disbursement vouchers		Collection vouchers	
	Number	Amount	Number	Amount
March 31, 1908	78	$7,888.14		
June 30, 1908	144	16,717.46	16	$68.70
September 30, 1908	163	22,484.55	1	5.00
December 31, 1908	137	33,749.30		
March 31, 1909	199	26,836.99	1	1.52
June 30, 1909	184	38,325.24		
September 30, 1909	46	8,056.42		
December 31, 1909	110	22,692.24		
March 31, 1910	40	8,587.13	1	3.70
June 30, 1910	53	205,325.44		
Total	1,154	390,662.91	19	78.92

[a] The appropriations and balances shown in this table for the fiscal years 1907, 1908, 1909, and 1910 are taken from the books and financial statements of the Treasury Department.

RECLAMATION DEPOSIT ACCOUNT

The Treasury Department, in a letter to the Secretary of the Interior dated December 18, 1909, authorized the opening of an account known as the "reclamation deposit account," in which are deposited to the official credit of the special fiscal agent of the Reclamation Service located at Washington, D. C., the amounts of all certified checks received with proposals to insure the execution of contracts and bonds in the event of the proposals being accepted. After award of contract and execution of bond by a successful bidder, the amounts deposited by all bidders under the same advertisement are returned by check of the special fiscal agent. The account was opened May 31, 1910, and on June 30, 1910, $522 had been deposited and nothing withdrawn.

UNIT PRICES UNDER FORMAL SPECIFICATIONS

In the table below are given the principal unit prices bid for work and materials and contract unit prices therefor in connection with formal specifications, proposals for which have been received by the Reclamation Service during the fiscal year ending June 30, 1910. In almost all cases contracts have been awarded to the lowest bidder, but as the contracts have been awarded on definite divisions of the work as a whole, it has frequently happened that the contract price for a particular item is higher than the lowest bid on that item.

Unit bids and contract prices

State and project	Date	Specification No.	Feature or description	Unit	Quantity	Bids per unit: Lowest	Bids per unit: Next	Contract price
BACKFILLING								
Washington: Yakima (Sunnyside)	Aug. 16, 1909	159	Sulphur Creek wasteway, structures	Cubic yard	3,000	$0.15	$0.30	$0.30
BROKEN STONE								
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike	Cubic yard	8,000	$4.50	$5.00	(a)
CLEARING AND GRUBBING								
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike	Acre	8	$20.00	$30.00	(a)
CONCRETE								
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike, core wall	Cubic yard	1,800	$8.00	$13.00	(a)
Do	do	160	Pathfinder dike, spillway dams and shaft cover	do	250	8.50	14.00	(a)
Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway, channel lining	do	2,000	9.00	9.47	$9.47
Do	do	158	Sulphur Creek wasteway, check basin	do	106	12.00	12.50	14.00
Do	Aug. 16, 1909	159	Sulphur Creek wasteway, structures	do	1,600	10.00	10.50	11.95
DRAIN								
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike, 8-inch vitrified pipe	Linear foot	1,350	$0.85	$0.75	(a)
Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway, 4-inch tile	do	6,800	.11⅓	.15	$0.11⅓

a Rejected.

Unit bids and contract prices—Continued

EXCAVATION

State and project	Date	Specification No.	Feature or description	Unit	Quantity	Bids per unit: Lowest	Bids per unit: Next	Contract price
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike, embankment	Cubic yard	155,000	$0.79	$0.95	(a)
Do	do	160	Pathfinder dike, cut-off trenches	do	7,000	.80	.90	(a)
Do	do	160	Pathfinder dike, for spillway dams	do	300	3.00	4.00	(a)
Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway, for lined channel	do	12,400	.25	.32	$0.25
Do	do	158	Sulphur Creek wasteway, check basin, without sheeting or bracing.	do	400	.60	1.00	.60
Do	do	158	Sulphur Creek wasteway, check basin, with sheeting and bracing.	do	375	.85	1.20	1.20
Do	Aug. 16, 1909	159	Sulphur Creek wasteway, for unlined channel	do	200,000	.12	.12½	.12
Do	do	159	Sulphur Creek wasteway, structures, without sheeting or bracing.	do	3,000	.37	.50	.37
Do	do	159	Sulphur Creek wasteway, structures, with sheeting or bracing.	do	4,700	.60	.75	.60

HAULING STEEL

State and project	Date	Specification No.	Feature or description	Unit	Quantity	Lowest	Next	Contract price
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike	Hundredweight.	1,400	$1.00	$1.00	(a)

HAULING CEMENT

State and project	Date	Specification No.	Feature or description	Unit	Quantity	Lowest	Next	Contract price
Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike	Barrel	2,500	$3.25	$3.75	(a)

LUMBER

State and project	Date	Specification No.	Feature or description	Unit	Quantity	Lowest	Next	Contract price
Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway	M feet b. m.	5,000	$40.00	$50.00	$50.00

PAVING

Nebraska-Wyoming: North Platte	Oct. 28, 1909	160	Pathfinder dike	Cubic yard	8,000	$6.00	$8.00	(a)
Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway, laid in mortar	do	67	7.00	7.50	$7.50
Do	do	158	Sulphur Creek wasteway, laid dry	do	63	5.25	7.00	7.10
Do	Aug. 16, 1909	159	Sulphur Creek wasteway, laid in mortar	do	105	6.00	7.90	8.00
Do	do	159	Sulphur Creek wasteway, laid dry	do	1,680	7.00	7.50	7.00

SHEET PILING

Washington: Yakima (Sunnyside)	July 30, 1909	158	Sulphur Creek wasteway, check basin	M feet b. m.	5,000	$40.00	$50.00	$50.00
Do	Aug. 16, 1909	159	Sulphur Creek wasteway, structures	do	94,000	40.00	45.00	48.00

a Rejected.

RECLAMATION ORGANIZATION

GENERAL OFFICES

Hon. Richard A. Ballinger, Secretary of the Interior.

Brig. Gen. William L. Marshall, U. S. Army, retired, consulting engineer to the Secretary of the Interior.

Frederick Haynes Newell, Director of the Reclamation Service, Washington, D. C.

Arthur Powell Davis, chief engineer, Washington, D. C.

E. C. Finney, chief law officer, Washington, D. C.

Morris Bien, supervising engineer, in charge land and legal division, Washington, D. C.

O. H. Ensign, chief electrical engineer, 626 Citizens National Bank Building, Los Angeles, Cal.

D. W. Murphy, engineer, in charge of Washington office engineering, Washington, D. C.

D. C. Henny, consulting engineer, 501 Beck Building, Portland, Oreg.

A. J. Wiley, consulting engineer, Boise, Idaho.

W. H. Sanders, consulting engineer, 915 Grand View avenue, Los Angeles, Cal.

J. H. Quinton, consulting engineer, 4 Quinton court, 827 Green avenue, Los Angeles, Cal.

W. H. Code, chief engineer, Indian irrigation, consultation on Indian matters, 522 Bumiller Building, Los Angeles, Cal.

W. W. Follett, consulting engineer, International (Water) Boundary Commission, consultation on Rio Grande, El Paso, Tex.

E. T. Perkins, engineer, in charge of purchasing and transportation, 777 Federal Building, Chicago, Ill.

C. J. Blanchard, statistician, Washington, D. C.

J. Y. Jewett, cement expert, 408 Commonwealth Building, Denver, Colo.

E. G. Paul, chief clerk, Washington, D. C.

V. G. Croissant, accountant, Washington, D. C.

C. G. Duganne, fiscal agent, Washington, D. C.

SOUTHERN DIVISION

ARIZONA, NEW MEXICO, TEXAS, UTAH, CALIFORNIA

L. C. Hill, supervising engineer, Phoenix, Ariz.; J. D. Stannard, engineer; C. S. Witbeck, examiner; S. B. Taggart, chief clerk; C. B. Barnhard and J. L. Segall, fiscal agents.

Salt River project.—C. W. Smith, engineer, Roosevelt, Ariz.; W. A. Farish, engineer; H. S. Reed, assistant engineer, operation and maintenance of canals, Phoenix, Ariz.

Yuma project.—F. L. Sellew, project engineer, Yuma, Ariz.; L. M. Lawson, acting project engineer; J. D. Fauntleroy, engineer; A. N. Kelley, chief clerk; F. S. Cundiff, fiscal agent.

New Mexico projects.—W. M. Reed, district engineer, El Paso, Tex.; P. W. Dent, assistant examiner; W. H. Frankland, chief clerk; S. T. Olsen, fiscal agent.

Carlsbad project.—L. E. Foster, assistant engineer, in charge of operation and maintenance, Carlsbad, N. Mex.

Hondo project.—C. A. May, junior clerk, in charge of operation and maintenance, Roswell, N. Mex.

Leasburg project.—Earl Patterson, junior engineer, in charge of operation and maintenance, Selden, N. Mex.

Rio Grande project.—H. J. Gault, engineer, El Paso, Tex.; J. A. French, engineer, Las Cruces, N. Mex.

Strawberry Valley project.—J. L. Lytel, project engineer, Provo, Utah; A. J. Hughes, chief clerk; H. E. Edington, fiscal agent.

PACIFIC DIVISION

CALIFORNIA, OREGON, NEVADA

E. G. Hopson, supervising engineer, 501 Beck Building, Portland, Oreg.; O. P. Morton, examiner.

Orland project.—W. W. Schlecht, project engineer, Orland, Cal.; A. N. Burch, irrigation manager; E. W. Burr, assistant examiner; C. H. Lillingston, chief clerk; J. W. Spencer, fiscal agent.

Truckee-Carson project.—D. W. Cole, project engineer, Fallon, Nev.; L. W. Hall, engineer; H. W. Marean, superintendent of irrigation; J. R. Post, chief clerk and fiscal agent.

Umatilla project.—H. D. Newell, project engineer, Hermiston, Oreg.; R. W. Hawley, superintendent of irrigation; E. S. Taylor, assistant examiner; C. W. Kellogg, chief clerk and fiscal agent.

Klamath project.—W. W. Patch, project engineer, Klamath Falls, Oreg.; W. S. Wiley, examiner; C. C. Hogue, chief clerk and fiscal agent; W. H. Heileman, engineer, operation and maintenance.

NORTHERN DIVISION

MONTANA, NORTH DAKOTA, WYOMING

H. N. Savage, supervising engineer, Helena, Mont.; W. J. Egleston, examiner.

Blackfeet project.—R. M. Snell, acting project engineer, Family, Mont.; C. E. Frisbee, chief clerk; H. W. Bruen, fiscal agent.

Flathead project.—E. F. Tabor, project engineer, St. Ignatius, Mont.; Joseph Wright, engineer; C. W. Donnally, chief clerk; W. H. Meglasson, fiscal agent.

Fort Peck project.—C. J. Moody, acting project engineer, Oswego, Mont.; Claude Glenn, chief clerk and fiscal agent.

Huntley project.—C. D. Howe, assistant engineer, in charge of operation and maintenance, Huntley, Mont.; E. B. Leclaire, fiscal agent.

Milk River project.—C. P. Williams, project engineer, Malta, Mont.; E. G. Lee, chief clerk; Frank Nivens, fiscal agent.

Sun River project.—Judson Bond, superintendent of construction, acting project engineer, Fort Shaw, Mont.; J. E. Moran, chief clerk; G. W. Brown, fiscal agent.

Buford-Trenton and Williston projects.—G. O. Sanford, project engineer, Williston, N. Dak.; W. S. Arthur, chief clerk and fiscal agent.

Lower Yellowstone project.—R. S. Stockton, engineer, in charge of operation and maintenance, Glendive, Mont.; F. J. Israel, fiscal agent.

Shoshone project.—W. A. Sickler, superintendent of irrigation, Powell, Wyo.; C. A. Peavy, chief clerk; H. T. Caldwell, fiscal agent.

Shoshone dam.—G. E. Stratton, engineer, Cody, Wyo.

CENTRAL DIVISION

COLORADO, KANSAS, OKLAHOMA, SOUTH DAKOTA, NEBRASKA, WYOMING

R. F. Walter, acting supervising engineer, 519 Commonwealth Building, Denver, Colo.; A. R. Honnold, examiner; J. A. Dolphin, chief clerk and fiscal agent.

Grand Valley project.—S. O. Harper, junior engineer, Grand Junction, Colo.

Uncompahgre Valley project.—C. T. Pease, project engineer, Montrose, Colo.; A. F. Ross, engineer; J. M. Luney, chief clerk; E. R. Furstenfeld, fiscal agent.

North Platte project.—Andrew Weiss, project engineer, Mitchell, Nebr.; E. D. Newman, chief clerk; O. P. Burrows, fiscal agent.

Pathfinder dam.—B. H. Davis and L. V. Branch, engineers, Pathfinder, Wyo.; J. R. Ummel, fiscal agent.

Belle Fourche project.—R. F. Walter, project engineer, Belle Fourche, S. Dak.; E. R. Mills, chief clerk; T. E. Jones, fiscal agent; O. T. Reedy, engineer, Orman, S. Dak.; F. C. Magruder, assistant engineer, operation and maintenance.

IDAHO DIVISION

IDAHO, OREGON, WYOMING

F. E. Weymouth, supervising engineer, Boise, Idaho; B. E. Stoutemyer, examiner.

Boise project.—F. W. Hanna, project engineer, Boise, Idaho; G. H. Bliss, engineer, operation and maintenance; J. F. Richardson, surveyman, in charge of Boise River storage unit; F. L. Cavis, chief clerk; R. R. Clawson, fiscal agent.

Minidoka project.—C. H. Paul, project engineer, Rupert, Idaho; C. A. Lyman, chief clerk; S. E. Hedden, fiscal agent.

Snake River storage.—F. T. Crowe, instrumentman, in charge, Ashton, Idaho; J. P. Waite, chief clerk and fiscal agent.

WASHINGTON DIVISION

WASHINGTON

C. H. Swigart, supervising engineer, 305 Miller Building, North Yakima, Wash.; R. B. Williamson and H. B. Gilbert, examiners.

Okanogan project.—Ferdinand Bonstedt, project engineer, Okanogan, Wash.; H. A. Yates, chief clerk and fiscal agent.

Yakima project.—J. S. Conway, assistant supervising engineer, North Yakima, Wash.; A. H. Gullickson, chief clerk; J. C. Gawler, fiscal agent.

Storage unit: E. H. Baldwin, project engineer, Naches, Wash.

Sunnyside unit: Ernest McCulloh, project engineer, Sunnyside, Wash.; R. K. Tiffany, superintendent of irrigation; N. K. Buck, chief clerk and fiscal agent; E. M. Philebaum, fiscal agent.

Tieton unit: J. S. Conway, project engineer, North Yakima, Wash.; C. E. Crownover, engineer.

DISCUSSION OF PROJECTS

ARIZONA, SALT RIVER PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Maricopa and Gila.
Townships: 7 N. to 2 S., Rs. 2 W. to 14 E., Gila and Salt River meridian.
Railroads: Gila Valley, Globe and Northern; Santa Fe, Prescott and Phoenix; Arizona Eastern.
Railroad stations: Phoenix, Tempe, Mesa, and Globe, Ariz.
Average elevation of irrigable area: 1,200 feet above sea level.
Average annual rainfall on irrigable area: 7 inches.
Range of temperature on irrigable area: 20° F. to 120° F.

WATER SUPPLY

Source of water supply: Salt and Verde rivers and wells.
Area of drainage basins: Salt River, 6,260 square miles; Verde River, 6,000 square miles.
Annual run-off in acre-feet: Salt River at Roosevelt (5,760 square miles), 1888 to 1907—maximum, 3,260,000; minimum, 154,000; mean, 804,000. Verde River at McDowell (6,000 square miles), 1888 to 1908—maximum, 1,850,000; minimum, 117,000; mean, 586,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Roosevelt—area, 16,320 acres; capacity, 1,284,000 acre-feet; length of spillway, 400 feet; elevation of spillway, 220 feet above stream bed.
Storage dam: Roosevelt—type, rubble masonry arch gravity; maximum height, 280 feet; length of crest, 1,080 feet; volume, 332,300 cubic yards.
Diversion dams: Granite reef—type, rubble concrete weir; maximum height, 38 feet; length of masonry, 1,100 feet. Power canal—type, rubble concrete weir; maximum height, 12¾ feet; length of masonry, 400 feet.
Length of canals now in use: 96 miles with capacities greater than 300 second-feet; 54 miles with capacities from 300 to 50 second-feet; 321 miles with capacities less than 50 second-feet.
Aggregate length of tunnels: 9,780 feet.
Water power: 4,500 horsepower developed from power canal; estimated total on completion, 4,500 horsepower from power canal, 6,000 horsepower from Roosevelt reservoir, 10,000 horsepower from Salt River below Roosevelt and drops in canals.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project about 220,000 acres; gravity system, 170,000 acres; pumping system, 50,000 acres.
Present status of irrigable lands (whole project): 16,000 acres entered subject to the reclamation act, 14,080 acres of state lands, 190,000 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 150,000 acres.
Area irrigated, season of 1910: 131,000 acres.
Length of irrigating season: 365 days.
Character of soil of irrigable area: Sandy loam, with clay in places.
Principal products: Semitropical fruits, cereals, alfalfa.
Principal markets: Phoenix and other Arizona towns, Pacific coast cities, and eastern markets.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1902.
Construction authorized by Secretary March 14, 1903.
Cement mill completed and machinery installed March, 1905.
Sand-crushing plant completed January, 1906.
Temporary power plant installation completed March, 1906; three power units with aggregate capacity of 4,500 horsepower installed in permanent power plant in 1909.
Power canal completed October, 1906.
Grand, water-power, Salt River Valley, Maricopa, and joint-head canals purchased June 15, 1906.
Arizona canal purchased June 20, 1906.
First irrigation by the Reclamation Service, season of 1907.
Granite Reef dam completed August, 1908.
Appropriators canal acquired January 19, 1909.
South canal completed June, 1909.
Consolidated canal purchased July 10, 1909.
Eastern canal completed December, 1909.
Roosevelt dam 97 per cent completed June 30, 1910.
Whole project 87 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Salt River project provides for the storage of water in a reservoir controlled by Roosevelt dam on Salt River, at Roosevelt, Ariz., about 78 miles northeast of Phoenix; the diversion of water from Salt River by the granite reef dam, about 4 miles below the mouth of Verde River, into the old Arizona canal on the north side of the river and into the south canal on the south side of the river; the enlargement of the Arizona canal and the consolidation of the canal systems in Salt River Valley in the vicinity of Phoenix and Mesa into two systems receiving water from the Arizona and south canals. A power plant at the storage dam generates power from stored water in the reservoir and from water delivered from a power canal heading at a diversion dam in Salt River about 19 miles above the storage dam. Other power plants will be established on Salt River below Roosevelt and at drops in canals. A part of the power developed will be used for pumping water for extending the irrigated area and a part will be sold for industrial purposes.

ORIGIN OF PROJECT AND INVESTIGATIONS

Scattered throughout the Salt River Valley are remains of numerous canals and irrigation works, giving evidence that the country was inhabited in earlier times by people versed in the practice of irrigation. The lines of at least eleven of the old main canals, aggregating about 135 miles in length and which must have watered more than 100,000 acres of land, have been traced.

Modern irrigation in the Salt River Valley dates from the beginning of construction, in 1867, of what was known as the Swilling ditch and its distributing system. A part of this system was later known as the Maricopa canal, another part as the Salt River Valley canal, and the first mile and a half of the original main canal as the joint-head canal. From 1870 to 1894 various other canals were built, the principal canals on the north side of the river being the Grand canal, the Arizona canal, and the Cross-cut canal connecting these two. The principal canals constructed on the south side of the river were the

Tempe canal, the San Francisco or Wormser canal, the Utah canal, the Mesa canal, the Consolidated canal, and the Highland canal.

The diversion for the Arizona canal was made by means of a timber-crib rock-filled dam covered with heavy planking. The other dams on the river were temporary affairs of brush and rock, that were usually swept away more or less completely by the periodic floods that occur in the river with great regularity. After the floods these dams could not be repaired until the river had reached a comparatively low stage, with little water available for irrigation, and as a result the valley was generally in a state of water famine.

In about 1884 or 1885 it became evident that the development of agriculture in the valley had reached the point where the low-water flow of the river was insufficient for satisfactorily watering the lands then in cultivation, and it was realized that storage reservoirs were desirable, so that the flood waters might be utilized. During the period from 1890 to 1899 the shortage of water was very pronounced and some of the cultivated land reverted to desert.

As extensive canal systems had been constructed and the irrigation of large areas was in progress, investigations in recent years have been concerned mainly with the feasibility and cost of storing water to supplement the flow of the river in its low stages. In the summer of 1889 the surveyor of Maricopa County made a reconnoissance survey of a reservoir site at the junction of Tonto Creek and Salt River, 78 miles northeast of Phoenix, Ariz. Examinations and surveys of a number of other reservoir sites, including the McDowell reservoir site on the Verde River near its mouth and the Horseshoe reservoir site farther up on the same river, were made by various private parties and corporations and by the United States Geological Survey. In 1900 the citizens of Phoenix organized a water-storage committee for "promoting investigations and developing some project for the storage of water," and requested the Department of the Interior to undertake the investigation of the feasibility of storing water for the use and benefit of the existing canal systems in the Salt River Valley. In 1901 Mr. A. P. Davis, acting for the Geological Survey and cooperating with the citizens' water-storage committee of Phoenix and with a water-storage commission created by an act of the territorial legislature, made further investigations of the McDowell and Tonto Creek reservoir sites. Borings, detailed surveys at the sites of the proposed dams, and topographic surveys of the reservoir basins were made for the purpose of determining the character of the foundations and the most suitable types of dam to be constructed. After the organization of the Reclamation Service, the investigations begun by the Geological Survey were continued, and in the fall of 1902 and the early part of 1903 general plans for the storage and utilization of the waters of Salt River were prepared. These plans, as outlined by the Director of the Geological Survey, in a letter to the Secretary of the Interior dated March 7, 1903, included the construction of a dam on Salt River near the mouth of Tonto Creek for storing water for irrigating private lands in the Salt River Valley and for watering a considerable extent of public land, if the water supply should be sufficient, and the pumping of water from wells by means of electricity generated by a hydro-electric power plant at the reservoir. It was recommended that the development of the general project as outlined be approved, that negotiations be initiated with the owners of irrigable lands relating to the terms upon which the lands might secure the benefits of the project, and that work be continued in greater detail for the ascertainment of the facts necessary for the preparation of specifications and for the letting of contracts for the construction of the irrigation works. On March 14, 1903, the Secretary of the Interior approved the general plan of the project as recommended, and authorized the preparation of plans and specifications for construction to be later submitted to him for approval. In March, 1903, articles of incorporation of the Salt River Valley Water Users' Association were approved by the Secretary of the Interior, and in February, 1904, a contract with the water users' association was executed.

CONSTRUCTION

PRELIMINARY AND AUXILIARY WORK

On account of the location of Roosevelt dam in a practically uninhabited region and at a great distance from railroads and large towns or cities, it was necessary to undertake considerable preliminary work before the construction of the dam could be commenced and to carry on auxiliary operations during its construction. The dam, located on Salt River below the mouth of Tonto Creek, is 78 miles from Phoenix, the nearest large city, and 60 miles from Mesa, the nearest railroad station on the west, and from which supplies and material were hauled by wagon.

A camp was established at the site of the dam, and as the work progressed the town of Roosevelt grew up near the work in the basin of the proposed reservoir, and in 1906 had a population of about 2,000 people. Office and shop buildings, power plants, and warehouses were built, residences for engineers and a hospital for the benefit of the laborers were constructed, and water, lighting, and sewer systems for the town were established.

To facilitate the hauling of supplies to the work, many miles of wagon road were constructed by the Reclamation Service. In 1903 and 1904 roads were built from Roosevelt to the clay pits, to the sawmill, and for a part of the distance to Globe and to Mesa. The most important road and the one involving the heaviest work was that from Roosevelt to Mesa. The towns of Phoenix and Mesa aided materially in providing funds for carrying on the work. The road traverses very rough country, and many deep cuts in solid rock were required in its construction. By the fall of 1904 about 80 miles of road had been constructed, and later additions have been made, bringing the total length built to 147 miles.

On December 26, 1903, a contract was executed for the construction of about 55 miles of telephone line from Arizona dam to Roosevelt, and from there to the diversion dam of the power canal. The line was completed in 1904 and the system was afterwards extended to Phoenix and other parts of the project by force account, a total of 140 miles of line now being in use.

In January, 1904, a sawmill was set up in the Sierra Ancha, 30 miles from Roosevelt, and in October, 1905, nearly 3,000,000 feet, board measure, of lumber had been manufactured for use on the project. Brick and lime kilns were established late in 1903, and during the winter of 1903–04 over 100,000 bricks and 2,000 barrels of lime were burned for use in the cement mill and other structures.

Investigations and chemical analyses established the fact that a fine quality of Portland cement could be manufactured from clay and limestone found in ample quantities near the site of the dam. Consideration of the cost of freight and hauling necessary to secure cement from commercial manufacturers led to the conclusion that direct manufacture of the cement would save the Government much more than the total cost of constructing a modern cement mill. Excavation for the foundations of a two-kiln cement mill with a capacity of 350 barrels per day was begun by force account in November, 1903, and contracts were executed in the early part of 1904 for the erection of a building and the purchase of the necessary machinery. The building was completed and all the machinery installed in March, 1905, and on April 21, 1905, the manufacture of cement was begun. At first the electricity for operating the mill was supplied by a steam plant, but in the spring of 1906 a water-power plant was completed for this purpose and used thereafter. On April 28, 1910, the operation of the kilns was discontinued, and on June 30, 1910, 337,212 barrels of cement had been ground and a few thousand barrels of clinker still remained to be ground.

The natural sand found in the vicinity of the Roosevelt dam being in the river where it would be inaccessible during floods, crushing machinery with a capacity of crushing 60 cubic yards of stone in eight hours to a fineness suitable for sand was purchased under a contract executed on June 28, 1905, and was installed early in 1906. A quarry was opened, and the manufacture of sand commenced in September, 1906.

POWER CANAL

The power canal is constructed for the purpose of furnishing a constant head of water for power purposes at the Roosevelt dam. The canal has a capacity of 225 second-feet and heads at a diversion dam in Salt River 19 miles above Roosevelt. It is constructed above the high-water line of the reservoir to a point near the Roosevelt dam, whence the water is conducted by an inclined penstock tunnel in the walls of the canyon to a power house below the dam.

The diversion dam for the power canal comprises a concrete ogee weir 400 feet long and 12 feet high and a low earth embankment about 300 feet long. At the south end of the weir are four sluice gates, and in an upstream extension of the south abutment of the dam are three openings supplied with regulator gates, each 5 feet high by 7 feet wide, admitting water to the intake tunnel of the power canal. There are a number of concrete-lined tunnels on the canal, aggregating 9,700 feet in length. The tunnels are 8 feet wide and 7 feet 6 inches high at the center. Two wide and deep canyons at Cottonwood and Pinto creeks are crossed by inverted siphons under a maximum head of 85 feet. Each crossing consists of two lines of reinforced concrete pipe with an internal diameter of 5 feet 3 inches. Parts of the open canal are lined with concrete and there are also numerous cross-drainage culverts and other structures on the canal line, built mainly of concrete. The inclined penstock tunnel at the end of the power canal connecting it with the power house is 610 feet long and has an internal diameter of 7 feet. The upper part of the tunnel is lined with concrete and the lower part with steel plates backed with concrete.

The final location survey of the power canal was completed in September, 1903, and proposals for the construction of the canal, under specifications No. 9, were opened December 8, 1903. In March, 1904, two contracts were executed, one for the tunnels and one for open canal excavations and the construction of the pressure pipes was authorized to be done by force account. The tunnels were completed in August, 1905, the open canal in November, 1905, and the pressure pipes in July, 1906. The inclined penstock tunnel at the end of the power canal was excavated by force account in 1905 and the work of lining it with steel and concrete was begun in September, 1905, and completed in February, 1906. The power canal was put in operation in the spring of 1906 and was utilized thereafter to deliver water at Roosevelt for power purposes. In the summer of 1906, a temporary brush and rock diversion dam was utilized at the head of the power canal. The permanent dam was built by force account and completed on October 29, 1906.

OUTLET TUNNELS AND GATES

Preliminary to construction work on the Roosevelt dam a tunnel was driven on the south side through the rock walls of the canyon to serve as an outlet for the reservoir and to aid in removing the deposit of silt from the bottom. During the building of the dam, the flow of the river was diverted through the tunnel. The tunnel is 450 feet long and in section is 13 feet wide and 8 feet high on the sides with a rise of 2 feet at the center. In it are installed 6 Stoney gates, arranged in groups of three, side by side. The upper group of gates is designed for emergency use and the lower group for ordinary operation. The opening for each gate is 10 feet high and 4 feet 9 inches wide. The gates and the gate frames are made of cast iron, steel, and Tobin bronze. The total weight of steel and iron castings and bronze for all of the gates and frames is over 800,000 pounds, the heaviest parts weighing over 9 tons each. When the reservoir is full the water pressure on each gate is 800,000 pounds and the discharge capacity of the tunnel is 10,000 second-feet.

Proposals for construction of the tunnel, under specifications No. 7, were opened December 22, 1903, and a contract was executed March 23, 1904. The tunnel was completed during 1904. Proposals for furnishing the gates for the sluicing tunnel, under specifications No. 18, were opened on October 1, and a contract was executed November 14, 1904. The delivery of the gates was completed in 1906, but on account of the tunnel being utilized to divert the river during the construction of the base of the dam, the gates were not installed until 1908, when the work was begun on January 31, and finished on July 2. On May 8, 1909, the gates were closed, and upon investigation it was found that the bottom of the tunnel and parts of the sides had become badly eroded. The floor was therefore lined with concrete and the part of the tunnel near the gates was lined with steel plates.

On account of the high velocity of water through the lower outlet tunnel, which has a maximum head of over 200 feet, an additional outlet was constructed in 1909 at the north end of the dam with its center 115 feet above the river bed. This outlet consists of three lines of 5-foot cast-iron pipe through the dam discharging into a tunnel 260 feet long excavated in rock. The tunnel is 9 feet in diameter at its minimum section and it is lined with concrete throughout. The discharge to the pipes is controlled by means of 58-inch balanced valves.

About 65 feet above the bed of the stream a steel pipe 10 feet in diameter was laid through the dam and connected with an inclined steel penstock leading to the power house below the dam. The flow into this penstock is controlled by a 10-foot balanced valve. Two outlets from the penstock within the power house, each controlled by a 43-inch balanced valve, provide means for regulating the flow from the reservoir in addition to the discharge utilized for power purposes.

ROOSEVELT DAM

The Roosevelt dam, located in the Salt River Canyon just below the mouth of Tonto Creek, is a masonry structure of the arch type, the center line of the top having a radius of 410 feet. Its maximum height is 280 feet, its length on top 1,080 feet, and its width on top 16 feet. The dam is constructed of broken range cyclopean rubble masonry except that the face stones are laid in courses with horizontal and vertical joints. The top of the dam is surmounted on each side by a parapet 4 feet high and 2 feet wide supported by a corbel through its full width so as to leave a roadway with a clear width of 16 feet between the parapets. At each end of the dam is a spillway 200 feet long excavated from the solid walls of the canyon and spanned by arches of reenforced concrete supporting a roadway connecting with the roadway along the top of the dam.

General plans for construction of the dam were reviewed and approved on July 28, 1904, by a board of engineers consisting of Messrs. A. P. Davis, G. Y. Wisner, W. H. Sanders, and J. H. Quinton, and detail plans were designed and specifications prepared under the direction of the board. On February 8, 1905, proposals for construction, under specifications No. 25, were opened, and on April 21, 1905, a contract for the work was executed. On December 15, 1905, a board of engineers consisting of Messrs. A. P. Davis, W. H. Sanders, G. Y. Wisner, and L. C. Hill, recommended increasing the height of the dam 10 feet, raising the crest, exclusive of parapet, from 230 to 240 feet above stream bed. The recommendations were approved and the plans adopted.

In May, 1905, the contractor began to assemble equipment and to establish construction camps. In November, 1905, a cofferdam for diverting the river through the sluicing tunnel was constructed and excavation for the foundation of the dam begun. On September 20, 1906, the first masonry was laid in the dam, the work of excavating for the foundation having been delayed by repeated floods in the river. In the latter part of 1906, and during the seasons of 1907 and 1908, floods and high water in the river interfered to a considerable extent with the progress of the work.

The excavation for the foundation of the dam was made to a depth of about 35 feet; and sand and gravel was removed from the foundation pit by two 11-inch hydraulic elevators supplied with giants to wash the material to them. In laying masonry and transporting the materials therefor, derricks and air compressors were used in the quarries, two cableways across the canyon, each 1,200 feet long and attached to the cliffs near each abutment of the dam, were utilized, and an aerial tramway 1,700 feet in length was installed for transporting cement from the mill to the site of the work. On June 30, 1910, the main part of the dam was practically completed except for the parapet walls, excavation of the spillways was in progress, and a part of the concrete had been placed in the piers, abutments and arches for the roadway over the spillways.

POWER PLANTS AND TRANSMISSION LINES

It was planned to utilize, in the operation of the cement mill and shops and in the construction of the dam, electric power generated by water turbines supplied by the penstock at the end of the power canal. The machinery for generating current equivalent to 1,300 horsepower was installed in the fall of 1905 in a temporary power plant, located in a cave in the canyon at the end of the inclined penstock, and the operation of this plant was begun early in 1906 and continued until August, 1909, when power machinery in the permanent power plant was ready for use. The building for the permanent power plant is located on the south side of the river immediately below the dam, and is constructed of stone and concrete masonry. The building was erected by force account, excavation for the foundations being commenced in October, 1906, and the building completed in the spring of 1908. The penstock at the end of the power canal was extended into the power plant building and supplies water to an exciter unit and to three power units, each consisting of a vertical turbine direct connected with a three-phase, alternating-current generator. One of these power units was installed and put in operation in June, and the others in August, 1909, after which the use of the power unit in the temporary power plant was discontinued. In 1910 the extension to the power house of the 10-foot penstock through the dam was begun, and at the end of the fiscal year was still in progress. This penstock will be arranged to supply water to three power units, two developing 1,800 horsepower each and one 2,500 horsepower.

A short distance from the power house is a transformer house, in which are installed the transformers for stepping up the current, generated at 2,200 volts, to 45,000 volts for the transmission line. Other equipment necessary for control and distribution of the current generated in the power house is also installed in the transformer house.

Two power substations have been constructed—No. 1, eight miles south of Mesa, and No. 2, near Sacaton, on the Gila River Indian Reservation. In these stations are installed the equipment necessary for controlling the distribution of the current and the transformers for stepping down the current to 10,000 volts for distributing to pumping stations. Power substation No. 1 was finished in July, and the installation of its equipment was completed in November, 1909. Power substation No. 2 was completed in October, 1909.

A main power transmission line extends from the power house at Roosevelt to Phoenix and is about 75 miles long. It consists of two circuits of three wires each, and carries current at 45,000 volts. A branch line 19 miles long and carrying one three-wire circuit extends from about a mile and a half northeast of Mesa to power substation No. 2, and from this line about 8½ miles from the switching station a branch 1 mile in length extends to power substation No. 1. Surveys for the transmission lines were made in the spring of 1907 and anchors for the towers were set in the summer of that year. Contracts for furnishing the towers and poles were executed in the spring of 1908 and the main line was practically completed in May, 1909. In September, 1909, the delivery under contract of current for industrial purposes at Phoenix was commenced. In June, 1910, the use of the electric current for pumping water on the Gila River Indian Reservation was begun, two pumps having been installed and put in operation.

GRANITE REEF DAM

The granite reef dam, located on Salt River about 4 miles below the mouth of Verde River, is a rubble concrete weir 1,000 feet long, with a maximum height of 38 feet, a base 36 feet wide, and curtain walls at heel and toe extending to bed rock near the ends of the dam and to a foundation of compact sand, gravel, and bowlders in the center of the channel, where a concrete apron 18 inches thick extends 75 feet downstream from the toe of the dam. At each end of the weir are sluiceways cut through solid rock, in which are installed sluice gates 9 feet high and 15 feet wide, four gates being in the sluiceway at the north end and two in that at the south end. Beyond the sluiceways at each end are the intake basins for the main canals of the project. The canal intakes are concrete structures, supplied with regulator gates 7 feet high by 5 feet wide. The intake at the north end has a capacity of 2,000 second-feet, and admits water through 18 gate openings to the Arizona canal and thence to the entire north side system. The intake at the south end has a capacity of 1,600 second-feet, and admits water through 9 gate openings to the south canal and thence to the south side system. The sluice gates and regulator gates are operated by power furnished by gasoline engines.

Borings at the site of the dam were made in June, 1906, and on July 26 of that year authority was granted by the Secretary of the Interior for the construction of the dam by force account. The work was begun in October, 1906, and completed in August, 1908. Electricity was used for power wherever possible, and the principal equipment consisted of a cableway 1,600 feet long, extending the entire length of the dam and inlet works, a trolley road 1 mile in length to the quarry, electric motors, dump cars, and stone-crushing and concrete-mixing plants.

CANALS

Construction work for canals has been confined to enlarging the Arizona and grand canals on the north side, construction of the south and eastern canals on the south side, and the construction of a flood-water canal and distributing system for the Gila River Indian

Reservation. The enlargement of the Arizona canal to a capacity of 2,000 second feet by means of a dredge was begun in the fall of 1907, and in 1909 a Lidgerwood excavator was added to the equipment in use on the work. On June 30, 1910, the work of enlarging this canal was about 40 per cent completed. The enlargement of the grand canal and the building of structures to enable this canal to be used in supplying the distributing systems of some of the other canals on the north side was begun in November, 1907, and on June 30, 1910, the new work of the system was about 70 per cent completed.

The south canal, with a capacity of 1,600 second-feet, is 2 miles long, extending from the intake at granite reef dam to the head of the consolidated canal, to which it supplies water and through which the other old canal systems on the south side are supplied. The construction of the south canal was begun in 1908 and completed in June, 1909.

The eastern canal, with a capacity of 250 second-feet, diverts from the south canal about 1½ miles below its head and supplies water for irrigating lands above the consolidated canal. The excavation of the eastern canal was begun early in the season of 1909 and completed in December, 1909, a part of the work being done under the tcooperative plan by the water users' association and paid for by certificates receivable by the Reclamation Service for building and operation and maintenance charges. Concrete structures for the eastern canal were built by force account in the fall of 1909, and the farmers whose lands will be watered by the canal are constructing the lateral system.

The construction of the flood-water canal and distributing system for the Gila River Indian Reservation was begun in January, 1910, and on June 30, 1910, the system was about 80 per cent completed.

WELL DRILLING

Wells have been drilled for the utilization of underground water for irrigation in a district from 6 to 8 miles south of Mesa and in the Gila River Indian Reservation. There are no flowing wells in the valley, water being found from 20 to 50 feet below the surface of the ground; the pumps for raising the water will be operated by electric power generated at the Roosevelt power house. The drilling of wells on the Indian reservation was begun in April, 1908, and completed in March, 1909, 9 wells being driven to an average depth of 233 feet. The wells are cased with double-steel stovepipe casings, 16 inches in diameter. For a part of the wells concrete caissons 9 feet in diameter have been sunk around the well casings to a depth of about 50 feet. If the use of the caissons proves effective in increasing the available water supply from the wells all of the wells will be supplied with caissons. In the district south of Mesa the drilling of wells was begun in December, 1908, and on June 30, 1910, 18 wells, with an average depth of 248 feet, had been driven, grouped in batteries of three wells. These wells are cased with double-steel stovepipe casing 16 inches in diameter, and each battery will be provided with a concrete caisson near the wells and in which the pump for the battery will be installed.

OPERATION AND MAINTENANCE

In June, 1906, the United States purchased most of the canal systems in the Salt River Valley on the north side of the river, and in May, 1907, the operation of all these canals by the Reclamation Service was begun. The canals and the structures, mostly of wood, were in a poor state of repair and are being constantly improved. For the first year of operation by the Reclamation Service a temporary dam was built and maintained at the head of the Arizona canal, but in June, 1908, the new intake at the granite reef dam was completed and the old headworks were abandoned. The consolidated canal on the south side of the river was acquired by purchase in July, 1909, and its operation was begun by the Reclamation Service in the fall of 1909. In the spring of 1910 the operation of the Mesa canal system and of the Eureka canal, a part of the Utah canal system, both on the south side of the river, was begun by the Reclamation Service under agreements to purchase the canals at appraised valuations and pay for them by allowing to the stockholders credits on building charges to be hereafter assessed by the Secretary of the Interior.

Irrigation on the Salt River project is practiced throughout every month of the year, the year being divided for operation purposes into a summer season from June 1 to September 30 and a winter season from October 1 to May 31 of the following year. The two seasons of irrigation serve to make it somewhat difficult to estimate the area irrigated in any one year, but in the season of 1908 approximately 112,000 acres of land were irrigated, and in 1909 about 126,000 acres. In 1910 about 131,000 acres are being irrigated. During the early part of the season of 1910 the natural flow of the Salt and Verde rivers has been less than at any time during the past six years. The water stored in the Roosevelt reservoir, has, however, been utilized to supplement the natural flow of the river so that there has been an adequate supply at all times. On June 30, 1910, there were still 116,000 acre-feet of water in the reservoir. Service pumps were installed in two wells on the Gila River Indian Reservation, and the pumping of water for irrigation was begun in May, 1910. About 200 acres of wheat grown on the reservation are being irrigated.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year important construction work has been in progress on the Roosevelt dam, the Arizona and eastern canals, and on the Gila River Indian Reservation flood-water canal; well drilling has been continued, the cement, sand and power plants at Roosevelt were operated, and the installation of machinery and extensions of the power system were continued.

At the Roosevelt dam 75,705 cubic yards of masonry were placed in the main dam, 4,737 cubic yards in wing walls, 339 cubic yards in pilasters and coping. The elevation of the dam was brought to 238½ feet above stream bed, and about 18 feet of the downstream parapet wall was built. The second outlet tunnel from the reservoir was built under a supplemental contract by the contractor for the dam, the work being commenced in July and completed in November, 1909. The installation of the balanced valves for control of the inlets to the tunnel was completed in January, 1910. Two power units were installed in the permanent power house, and the use of the temporary power station was abandoned. The installation of the 10-foot balanced valve for the 10-foot penstock through the dam and of two 43-inch balanced valves for outlets from the same penstock was begun and preparations were commenced for the installation of power units to be supplied by the penstock. Two power substations on the transmission line were built and secondary transmission lines for current at 10,000 volts were completed. At the granite reef dam repairs to the concrete apron were made and concrete cottages for gate tenders, one on each side of the river, were completed. In the enlargement of the Arizona canal 380,936 cubic yards of material were excavated with the dredge and 219,589 cubic yards with the excavator. The eastern canal was completed in December, 1909, including all necessary concrete structures. Eight additional wells were completed in the district south of Mesa, and the sinking of caissons for pump pits was begun. The construction of concrete caissons about the wells in Gila River Indian Reservation was continued and concrete pump houses were completed at three of the wells.

The construction of the flood-water canal on the Gila River Indian Reservation was begun, 6 miles of canal being excavated, and most of the concrete structures were built. Work was suspended in April, 1910, and will be resumed after the flood season in the Gila River.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Salt River project

No.	Date	Contractor	Description	Estimated value	Estimated earnings, June 30, 1910	Completion due
32	Feb. 4, 1905	Wolf Sachs	Hauling freight	$75,000.00	[a]$94,632.04	
35	Apr. 8, 1905	J. M. O'Rourke & Co.	Roosevelt dam	1,197,600.00	1,546,559.00	
79	Dec. 20, 1905	General Electric Co.	Electrical apparatus	32,521.00	[a]25,630.00	Feb. 20, 1908
85	Jan. 15, 1906	S. Morgan Smith Co.	Water wheels	19,165.00	19,255.00	Sept. 10, 1908
291	July 6, 1909	W. B. Pollock Co.	Penstock	5,068.60	[a]5,068.60	Oct. 11, 1909
299	Oct. 20, 1909	C. F. Elmes Engineering Works.	Balanced valves	14,184.66	[a]14,184.66	Nov. 10, 1909
300	Nov. 5, 1909	Byron Jackson Iron Works.	Centrifugal pumps	6,500.00	9,699.95	May 26, 1910
304	July 15, 1909	J. M. O'Rourke & Co.	Tunnel No. 2	13,173.00	[a]13,173.00	Dec. 1, 1909
305	Dec. 1, 1909	General Electric Co.	Induction motors	4,428.00	[a]4,428.00	Apr. 7, 1910
307	Dec. 10, 1909	Allis-Chalmers Co.	Transformers	6,120.00	[a]6,120.00	Apr. 8, 1910
308	Dec. 13, 1909	Wagner Electric Co.	Transformers	1,800.00	[a]1,775.00	Jan. 23, 1910
309	Nov. 23, 1909	Westinghouse Electric and Manufacturing Co.	Switchboard apparatus.	2,322.00	[a]2,322.00	Feb. 2, 1910
311	Jan. 17, 1910	Fulton Engine Works.	Tunnel linings	1,175.00	[a]1,175.00	Mar. 31, 1910

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Salt River project

ASSETS

Accounts receivable:			
Uncollected miscellaneous rentals		$5,796.42	
Uncollected miscellaneous		51,965.68	
			$57,762.10
Inventories:			
Government animals	$11,002.40		
Less depreciation	148.52		
		10,853.88	
Equipment in use	29,852.22		
Less depreciation	3,308.71		
		26,543.51	
Storehouse		139,022.52	
Cement		16,316.40	
Forage		2,953.44	
Cash in office safe		1,316.23	
Unadjusted transfers		4,435.31	
Freight and handling undistributed		50,444.71	
			251,886.00
Cost of work:			
Building cost		8,964,868.30	
Less adjustments	18,090.13		
Less accrued revenues	383,362.81		
		401,452.94	
			8,563,415.36
Total assets			8,873,063.46

LIABILITIES

Investment of the United States:			
Disbursement vouchers	8,872,292.00		
Transfer vouchers received	232,893.89		
		$9,105,185.89	
Collection vouchers	650,494.67		
Transfer vouchers issued	23,732.06		
		674,226.73	
			$8,430,959.16
Accounts payable:			
Unpaid labor		25,465.08	
Unpaid purchases		21,969.97	
Unpaid contract estimates		38,602.05	
Unpaid contract holdbacks		130,073.21	
Unpaid freight and express		37,792.90	
Unpaid passenger fares		171.40	
Unpaid land agreements		87,000.00	
Unpaid miscellaneous		1,029.69	
			342,104.30
Repayments accrued: Building			100,000.00
Total liabilities			8,873,063.46

Feature costs to June 30, 1910, Salt River project

Storage works:		
Roosevelt dam and spillway	$3,009,991.33	
Sluicing tunnel	124,884.76	
Hydraulic gates	245,188.94	
Reservoir, moving camp and clearing site	7,146.07	
Outlet tunnel	54,168.02	
Approach to east end dam	13,223.41	
Repairs to toe of dam	13,399.77	
Lands submerged by reservoir	152,414.04	
		$3,620,416.34
Power system:		
Diversion dam	117,753.91	
Power canal construction	1,230,237.53	
Settling basin	18,140.43	
Penstock tunnel	66,485.07	
Auxiliary penstock	8,222.01	
Cost of machinery and installing hydro-electric power plant	102,043.67	
Hydro-electric power plant building No. 1	159,679.42	
Power house No. 2	1,083.55	
Dam, penstock	65,571.66	
Transformer house	114,554.28	

Power system—Continued.		
Transmission line	$340,888.34	
Switching station	34,739.37	
Substation No. 1	26,778.14	
Secondary transmission line, Mesa district	15,538.04	
Power generated at power plant No. 1	28,582.55	
Hydro-electric power plant No. 3, preliminary expense	105.69	
		$2,330,403.66
Granite Reef dam:		
Borings	6,589.25	
Diversion dam	581,305.04	
Arizona canal heading	30,854.76	
Park	7,747.69	
		626,496.74
North side canal system:		
Arizona canal	640,590.47	
Grand canal	268,777.34	
Maricopa canal	80,774.90	
Salt canal	71,820.32	
Power canal	15,729.99	
Appropriators canal, miscellaneous expense	383.22	
		1,078,076.24
South side canal system:		
South canal	152,671.07	
Eastern canal	129,134.93	
Consolidated canal	218,159.34	
Tempe canal, examination	544.97	
Mesa canal, examination	412.61	
Utah canal, examination	273.87	
		501,196.79
Irrigable lands, farm-unit subdivision		3,779.04
Well drilling, Mesa district		37,004.01
Plant accounts, miscellaneous plant and buildings	489,460.66	
Less depreciation (credit)	418,137.02	
		71,323.64
Real estate (rights and property), land purchased (not submerged)		14,098.15
Telephone system, construction		63,275.03
Roads and highways (construction and maintenance):		
Phoenix	352,703.11	
High line	94,655.20	
Tonto	70,668.61	
Miscellaneous	17,100.86	
		535,127.78
Work done for Indian Service (reimbursable)		5,107.76
Examination of project as a whole:		
Agua Fria cement-investigation	833.50	
Underground water supply	15,658.86	
Surveys	42,230.38	
Investigations, Phoenix Valley	4,456.64	
Hydrography	12,613.81	
		75,793.19
Inventory of unused supplies		2,769.93
Total building cost as per debit in cost of work in statement of assets and liabilities		8,964,868.30

ARIZONA-CALIFORNIA, COLORADO RIVER PROJECTS

IRRIGATION PLAN

The Colorado River projects consist of a number of possible irrigable developments on the lower Colorado River in Arizona and California, the principal of which are the Blythe-Parker and Needles projects. The irrigation plan of these projects provides in general for the diversion of water from Colorado River for irrigation of lands near the river; the diversion for the Blythe-Parker project being made at Headgate rock, near Parker, Ariz., about 120 miles above Yuma; and the diversion for the Needles project being made a few miles north of Mohave City, Ariz., and about 200 miles above Yuma. The normal low-water supply of Colorado River is insufficient for present satisfactory irrigation of these projects, and their success therefore will depend on the storage of water in the drainage areas of the Grand and Green River systems, forming the Colorado River.

INVESTIGATIONS

In 1903 topographic surveys were made of the lands along the Colorado River from the Mexican border to about 100 miles north of Needles. Beginning in 1904 and continuing intermittently to the present time, preliminary examinations and surveys of reservoir sites on the Grand and Green River systems have been made as follows: The Kremmling, Windy Gap, and Lehman, on the Grand River; the Grand Lake, at the head of the North Fork of Grand River; the Flaming Gorge, Island Park, and Browns Park, on Green River; and two sites on Yampa River, a tributary of Green River. Preparations for making diamond-drill borings at the proposed dam site for Browns Park reservoir were begun in the summer of 1907 and drilling was commenced on October 28, 1907. The work was carried on through the seasons of 1908 and 1909 and discontinued in November of the latter year. The first work consisted of making wash borings to a depth of 80 feet up and down stream for a distance of about three miles in order to determine the best possible place to make a series of borings. No rock was reached in the middle of the river at this depth. By a line of borings at right angles to the river at the upper dam site bed rock was found at a depth of about 139 feet. By a similar line of borings about three miles further downstream bed rock was found at a depth of about 109 feet except at one hole near the west side of the river where a depth of 160 feet, the limit of depth for the apparatus at hand, was reached without encountering bed rock. In this hole a boulder several feet in thickness was encountered at about the same depth as bed rock in the other holes on the line.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Colorado River projects

ASSETS

Cost of work: Building cost			$44,201.97

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$41,570.19		
Transfer vouchers received	5,552.86		
		$47,123.05	
Collection vouchers	760.32		
Transfer vouchers issued	2,160.76		
		2,921.08	
			44,201.97

Feature costs to June 30, 1910, Colorado River projects

Preliminary examination and surveys $44,201.97

ARIZONA-CALIFORNIA, YUMA PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Yuma, Ariz.; Imperial, Cal.
Townships: 3 to 13 S., Rs. 21 to 25 W., Gila and Salt River meridian; 9 to 17 S., Rs. 16 to 23 E., San Bernardino meridian.
Railroad: Southern Pacific.
Railroad station: Yuma.
Elevation of irrigable area: 100 to 300 feet above sea level.
Average annual rainfall on irrigable area: 2½ inches.
Range of temperature on irrigable area: 22° F. to 118° F.

WATER SUPPLY

Source of water supply: Colorado River.
Area of drainage basin: 160,000 square miles above Laguna dam.
Annual run-off in acre-feet of Colorado River at Yuma (225,000 square miles) 1902 to 1908: Maximum, 25,400,000; minimum, 7,960,000; mean, 15,400,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Diversion dam: Laguna—type, Indian weir; maximum height, 40 feet in main channel, 19 feet outside of main channel; length of masonry, 4,780 feet; area flooded, 6,400 acres.
Length of canals: 32 miles with capacities greater than 300 second-feet; 25 miles with capacities from 300 to 50 second-feet; 100 miles with capacities less than 50 second-feet.
Aggregate length of tunnels: 800 feet.
Aggregate length of dikes: 388,080 feet.
Water power: Estimated total, 1,000 horsepower at drops in main canal.

AGRICULTURAL CONDITIONS

Irrigable area: 90,160 acres.
Present status of irrigable lands: 29,463 acres entered subject to the reclamation act, 15,497 acres withdrawn from entry, 45,200 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 16,500 acres.
Area irrigated, season of 1910: 10,000 acres.
Length of irrigating seasons: 365 days.
Character of soil of irrigable area: Rich alluvium.
Principal products: Semitropical fruits, alfalfa, grain.
Principal markets: Los Angeles and San Francisco, Cal.; Arizona towns; eastern markets for early produce.

LANDS OPENED FOR IRRIGATION

Date of public notice: January 12, 1910.

Location of lands opened: Townships 15 and 16 S., R. 25 E., San Bernardino meridian.

Present status of irrigable lands opened: 6,503 acres entered subject to the reclamation act and the act of April 21, 1904.

Limit of area of farm units: Public, 80 acres; private, 160 acres.

Duty of water: 5½ acre-feet per acre per annum at the farm.

Building charge per acre of irrigable land: $55.

Annual operation and maintenance charge: $1 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1902.

Construction authorized by Secretary May 10, 1904.

Canal system of Colorado Valley Pumping and Irrigating Company purchased March 15, 1907.

First irrigation by Reclamation Service season of 1907.

Canal system of Yuma Valley Union Land and Water Company (Farmers' gravity canal) purchased February 3, 1908.

Rollins ditch (including Ives heading pumps and ditches) purchased July 23, 1908.

Laguna dam completed March, 1909.

Whole project 80.8 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Yuma project provides for the diversion of water from Colorado River at Laguna dam, 10 miles northeast of Yuma, Ariz., into two canal systems, one heading on the California side of the river conveying water to irrigable lands on that side of Colorado River, including those in the Yuma Indian Reservation, crossing Colorado River at Yuma by an inverted siphon, and serving the irrigable lands in the Colorado River valley below Yuma; and the other, heading on the Arizona side of Colorado River, watering lands in the Colorado and Gila River valleys lying east of Colorado River and north of Gila River. The plan also provides for a pumping plant at the terminus of the gravity canal on the Arizona side of the river for raising water through a small lift to irrigate 6,000 acres of land. Lands adjacent to the Gila and Colorado rivers are protected from overflow of these streams by means of dikes.

ORIGIN OF PROJECT AND INVESTIGATIONS

Settlement on the lands in the Yuma project was begun about five years before the passage of the reclamation act, lands in the valley below Yuma being taken up and irrigation systems developed. The settlers were confronted with many difficulties, among which were contests for land titles against claimants of a Spanish grant, overflow of lands from Colorado River, and irrigation from poorly planned and constructed canal systems. The settlers were practically unanimous in appealing to the Reclamation Service to take over the old canals and provide a more satisfactory irrigation system. In November, 1903, the Yuma County Water Users' Association was organized and practically all of the private lands within the limits of the Yuma project were subscribed and placed under contract to take water in accordance with the provisions of the reclamation act.

Investigations for the development of irrigation projects along the Colorado River were begun by the Reclamation Service in October, 1902. A reconnaissance was made of the Colorado River Valley from about 100 miles above Needles, Ariz., to the Mexican boundary, some 300 miles below. Levels were extended from the Pacific Ocean to Yuma, Ariz., a distance of 275 miles, and many miles of level lines were run on both sides of the river. Gaging stations were established and borings were made at suggested sites for high dams.

The most promising project for immediate development was found to be that at Yuma, and during the winter season of 1903–4 extensive preliminary surveys were made, topographic maps were prepared, the routes of canals were outlined, and borings at possible dam sites were continued. It was first planned to construct a diversion dam 70 feet in height about 22 miles above Yuma for the irrigation of several hundred thousand acres of land in Arizona and California. However, examinations disclosed the fact that the depth to bed rock was so great that the construction of such a dam was not feasible, and plans were then made for the development of the Yuma project practically as it is now being constructed. On April 8, 1904, a board of engineers, consisting of Messrs. A. P. Davis, G. Y. Wisner, J. H. Quinton, W. H. Sanders, B. M. Hall, and H. N. Savage, approved the plans for the project, and on May 10, 1904, the Secretary of the Interior authorized the construction of the project and set aside from the reclamation fund $3,000,000 for the work.

CONSTRUCTION

LAGUNA DAM

Laguna dam is located on Colorado River about 10 miles above Yuma where granitic mountains encroach on the river valley, leaving an opening about a mile wide. Rock foundations for a dam could not be secured, and the Indian type of diversion dam was selected as being most suitable for the conditions. The dam contains three parallel concrete walls about 4,800 feet in length, extending from bluff to bluff. These walls are 5 feet in thickness. The upstream and middle walls are 10 feet in height and are 57½ feet apart. The downstream wall is 7 feet in height and 93½ feet from the middle wall. The upstream or crest wall rests upon a continuous line of 8-inch sheet piles driven 12 to 32 feet. Sheet piling was driven in places under the middle wall to prevent excessive seepage and under the downstream wall to supply a satisfactory foundation. The spaces between the three walls is filled with broken stone and capped, except over a small portion, with a concrete pavement 18 inches in thickness. That portion of the surface not paved with concrete is covered with a pavement of rough stones from 2 to 3¼ feet in thickness. It was originally planned to pave the entire dam with stones, but a concrete surface was substituted because suitable paving stones were not obtainable. An apron 7 feet in thickness, composed of derrick-sized rock, extends about 40 feet below the downstream wall. In and near the old river channel the apron was extended to 50 feet below the downstream wall and protected with rock beyond the toe. On the upstream side of the dam the crest wall is protected by a rock filling 10 to 30 feet in top width and with a slope of about 3 to 1. The minimum width of the dam is 215 feet and its maximum bottom width about 250 feet; its maximum height in the old river section is 40 feet, the height for the greater part of its length being 10 feet. The length of the dam between the sluiceways is 4,780 feet.

The slope from upstream to downstream walls is 1 to 12. The crest wall extends 10 feet above and the top of the downstream wall is 3 feet below low water.

A sluiceway is located at either end of the dam. The sluiceways are built through rock, are lined and paved with concrete, and have a floor elevation 13 feet below the crest of the dam. The California sluiceway has a width of 116 feet and is controlled at its lower end by three sluice gates of the Stoney iron-roller type. The gates are each 18 feet high by 34 feet 9½ inches wide, and are supported between piers which are constructed to a height of 41 feet above the floor of the sluiceway. On the Arizona side the sluiceway is 40 feet wide and is controlled by a single gate. The gates are operated electrically. The original plans provided for the main sluiceway and headworks on the Arizona side of the river, but the plans were changed in accordance with the revised location of the distribution system. Water is taken into the canals on the two sides of the river through regulator gates at the sides of the sluiceways. The canal intakes are located at a higher elevation than the bottom of the sluiceways, so that the waters least burdened with sediment are taken into the canal system.

On March 15, 1905, proposals for the construction of Laguna dam (specifications No. 27) were opened, but extensive floods caused a delay in receipt of proposals and all were rejected. The work was readvertised under specifications No. 33, and proposals were opened on June 5, and contract awarded on July 6, 1905. The work of construction was commenced by the contractors on July 19, 1905. In August, 1906, the contractors petitioned for relief from the contract, claiming that they were meeting with excessive losses. A board of engineers considered the claim of the contractors and subsequently a supplemental contract was approved whereby certain changes were made in the specifications. The result of the changes made was the advancement of the contract price from $797,650 to $1,129,135 and the extension of the time of completion from July 19, 1907, to January 19, 1908. The increased prices, however, appeared not to have been sufficient for the work and the new schedules had been in force only four months when the contractors again appealed for release from the contract. The release was granted on January 23, 1907, about 34 per cent of the work provided for in the contract having been done by the contractors. The work was taken up by the Reclamation Service by force account and was completed on March 20, 1909.

The actual quantities for the dam were greater than the estimated quantities by the following amounts:

Rock excavation, 139,640 cubic yards, or about 46 per cent. Earth excavation, 64,930 cubic yards, or about 23 per cent. Placing rock in dam, 70,018 cubic yards, or about 23 per cent. Sheet piling, 29,779 linear feet, or about 56 per cent. Concrete, 48,916 cubic yards, or about 180 per cent. Rock paving was decreased from 80,000 square yards to practically nothing, it having been found necessary to substitute concrete therefor.

The increase in rock excavation was caused by the fact that much material in the sluiceways had to be wasted in order to prepare a channel for bypassing the water during the closing of the river channel, and that rock necessary to complete the dam had to be borrowed from beyond the sluiceway lines. The earth excavation was originally estimated to the neat lines, but much additional earth had to be taken out by the dredges before the bottom could be reached and maintained. The change from proposed rock paving to concrete paving for the surface of the dam and the necessity for paving the sluiceways accounts for the decrease in rock paving and increase in concrete. Scour in the river section just prior to the closure of the dam so deepened the channel that a considerable increase in the quantity of rock fill was made necessary. The original estimates provided for sheet piling under the upstream wall only, but it was found necessary to drive piling under portions of the other walls also.

Laguna dam was constructed simultaneously from both sides of the river. Quarries were opened at the abutments and derricks loaded the output on cars hauled by dinky locomotives to various parts of the work. Cofferdams were extended into the stream above and below the dam by dumping spoil from the quarries. Inside the cofferdams large pumps were used to remove the water. The first excavation was done with scrapers and teams and the remainder of the excavation accomplished by means of suction dredges and pumps. The piling was then driven, the concrete walls built, and the open space filled with rock from the quarries.

This method of construction was continued from the two ends of the dam until a gap of about 800 feet was left in the river channel. The excavation of the sluiceways was then completed in order that the flow of the river might be passed through these channels while the closure of the dam was effected. Trestles carrying railroad tracks were built above and below the line of the dam entirely across the gap and were connected with the quarries on both sides of the river. Cofferdams were then constructed across the gap by dumping quarry spoil and large rock from the trestles. The water above the upper cofferdam was raised 11 feet and the river turned into the sluiceways after 82,794 cubic yards of rock had been dumped from the trestles.

The sand and broken stone for concrete used in the construction of the dam was made from rock obtained at the quarries and delivered to crushers situated at the ends of the dam. The product of the crushers was delivered by ordinary bucket elevators to bins and from the bins to concrete mixers. The mixers discharged into cars, which were hauled to various parts of the work by dinky engines.

Proposals for furnishing and installing sluice gates, regulator gates, and operating machinery for the main sluiceway and headworks (specifications No. 72) were opened on February 28, 1906, and the contract awarded to the contractors for Laguna dam. Under the agreement of January 23, 1907, the United States assumed all work on this contract except the furnishing of the gates and other machinery. Orders for the remaining gates were given at a later date, and all sluice gates and regulating works were installed in the winter of 1908–1909.

DIKES

In order to prevent much of the irrigable land on the Yuma project from being flooded at times of high water, it was found necessary to construct about 75 miles of dikes along Colorado and Gila rivers. The general plan of the dikes provides for embankments 4 to 15 feet high and 8 to 10 feet wide on top, with a water slope of 3 to 1 and a landward slope of 2½ to 1. The top of the dikes is about 4 feet above high water. Proposals for the construction of about 10 miles of the

Yuma dike, along Colorado River below Yuma (specifications No. 41), were opened on August 17, 1905, and a contract for this work was executed in October, 1905. The work of construction for about 12 miles of dike was completed and accepted in March, 1906. This dike was extended about 1½ miles under informal contracts, the clearing and grubbing of this extension being done by force account. Further extensions of this dike were made by force account, and in May, 1908, it had been completed to the Mexican boundary, a distance of about 25 miles.

The Gila Valley dike extends along Gila River and along Colorado River between Gila River and Laguna dam. Construction of this dike was begun by force account early in 1906, and was completed for a distance of 7.8 miles in the spring of 1907.

The reservation dike, which extends downstream from Laguna dam along the California bank of Colorado River was constructed by force account. This dike was begun in March, 1907, and was completed to about two miles below the railroad bridge at Yuma early in 1909. After the construction of the reservation dike between the railroad crossing at Yuma and Laguna dam, a branch railroad was laid on it by the Southern Pacific Railroad Company to facilitate transportation to the site of operations at Laguna dam.

CANAL SYSTEMS

The irrigable lands in the Yuma project lie in Arizona between Laguna dam and the Gila River and between the Gila River and the Mexican boundary; and in California, in the Yuma Indian Reservation southwest of Laguna dam. The original plans provided for a main canal heading at the Arizona end of the Laguna dam, watering lands north of Gila River, crossing Gila River by pipes laid under the river bed, passing through the town of Yuma in a concrete conduit, and watering lands between Yuma and the Mexican boundary. A secondary main canal, heading in California at Laguna dam, provided for the irrigation of lands in the Yuma Indian Reservation.

On account of the difficulty of securing a satisfactory crossing at Gila River and right of way through the town of Yuma, the general plan of the irrigation system was changed to the following: A secondary main canal, heading at the Arizona end of Laguna dam, provides for the irrigation of lands in Arizona north of Gila River by gravity and by pumping against heads of 5 to 25 feet. It is possible that a crossing may be constructed at Gila River and provision thus be made for the irrigation of the bottom lands on the south side of the river. A primary main canal with a maximum capacity of 1,700 second-feet, heading at the California end of Laguna dam, follows the general course of the river southward, crossing Colorado River by an inverted siphon a short distance below the railroad bridge at Yuma, and divides into the eastern and western canals which follow the borders and provide for the irrigation of the bottom lands in Arizona from Yuma to the Mexican boundary. A pumping plant with a 70-foot lift, supplied from the eastern canal, provides for the watering of bench lands south of Yuma, and a main drainage canal through the middle of the bottom lands south of Yuma provides for the removal of surplus waters. A mile and a half below the heading of the main canal in California a 250-second-foot canal branches through the

Yuma Indian Reservation and, together with other smaller diversions from the main canal, provides for the watering of lands in the reservation. A wasteway, with sluice gates, $1\frac{1}{2}$ miles below the heading of the main canal provides for the removal of silt deposits, and about 3 miles north of the siphon a 12-foot drop makes possible the development of about 1,000 net horsepower. The plans for the Colorado River siphon provide for concrete shafts sunk as open caissons on either side of the river and connected by a concrete-lined tunnel through sandstone rock over 50 feet below the river bed. The tunnel will be about 1,000 feet long and will have a circular section with internal diameter of 14 feet. The siphon is designed for a capacity of 1,400 second-feet, and the flow through it will be controlled by a cylinder gate at the California end. A screen will prevent the passage of large objects into the siphon and a wasteway will provide for the passage of canal waters to the river when the gate of the siphon is closed.

All work on the canal systems so far undertaken was done by force account. Excavation of the main canal in Arizona was begun 1 mile below Laguna dam in November, 1908, but was suspended in March, 1909, after about 2 miles had been completed. The construction of the canals on the Yuma Indian Reservation was begun on June 18, 1908, and the first unit of the distribution system was completed on November 12, 1909. The main canal in California was begun in April, 1909, and was completed as far as the heading of the Indian canal on March 2, 1910, the material excavated being used to blanket the reservation dike. The construction of the Colorado River siphon was begun on November 10, 1909, on the Arizona side, and on January 1, 1910, on the California side; and on June 30, 1910, the shaft on the Arizona side of the river was completed and that on the California side well advanced.

SETTLEMENT AND IRRIGATION

Irrigation of the bottom lands between Yuma and the Mexican boundary was begun about 1897, and when the Reclamation Service began operations on the Yuma project there were four canal systems in operation. The plant of the Colorado Valley Pumping and Irrigating Company was taken over by the United States in August, 1907, and has been operated since that date for the irrigation of about 3,800 acres of land. The pumping plant, which has a capacity of about 40 second-feet, and the canal system have been repaired and improved. The system of the Yuma Valley Union Land and Water Company was purchased in 1907. A new heading with a capacity of 100 second-feet was built for this system in the spring of 1908. A scoop wheel with a capacity of 80 second-feet, operated by producer-gas engines, was installed at the heading in 1908 to provide for irrigation at times of low water. Purchase of the Ives heading pumps and ditches and of the Rollins ditch was made in 1908. From 3,800 to 10,000 acres of land have been irrigated from the canal systems purchased by the Government beginning with August, 1907.

On January 12, 1910, a public notice opening for irrigation 6,500 acres of land in the Yuma Indian Reservation was issued, and on March 1 this land was opened to entry. Water was first turned into the reservation canals on March 14, 1910, and irrigation of allotted Indian lands and of the lands opened is in progress.

PROGRESS DURING FISCAL YEAR 1910

At Laguna dam the work during the fiscal year has consisted of the finishing of minor features, repairing and storing the machinery and equipment, and erecting the power house for the operation of the sluice gates on the California side of the river.

Preliminary work on the Colorado River siphon was commenced in November, 1909. Shafts are being sunk at both ends of the siphon by the open-caisson method. The shaft on the Arizona side has been completed, the depth being 140 feet, and the shaft on the California side has been sunk to a depth of 90 feet, 40 feet remaining to be excavated.

The main canal on the California side has been completed for a distance of 1½ miles below Laguna dam, and the rock spoil from the canal excavation was used for blanketing the reservation levee. About 55 miles of canals and laterals, together with the necessary head gates, check gates, culverts, bridges, and turnouts, have been completed for the irrigation of lands on the Yuma Indian Reservation. During the year about 40,000 cubic yards of material were placed in building extensions of levees on the Indian reservation. About 86½ per cent of the entire levee construction for the project is now completed.

Water has been furnished for the irrigation of about 10,000 acres of land below Yuma, the steam pumping plant and the scoop wheel having been operated a large portion of the time. During 1910 a small amount of water has been delivered to the settlers on the Indian reservation, and it is expected that by the fall of 1910 the entire area opened for entry on the reservation will have been settled and will be receiving water service. The principal crops raised have been alfalfa and barley, the average yield for alfalfa being 10 tons and for barley 35 bushels per acre.

PUBLIC NOTICE DATED JANUARY 12, 1910

Pursuant to the provisions of section 4 of the reclamation act of June 17, 1902 (32 Stat., 388), notice is hereby given as follows:

1. Water will be furnished from the Yuma project, California, under the provisions of the reclamation act, in the irrigation season of 1910, for the irrigable lands shown on farm unit plats of Tps. 15 and 16 S., R. 23 E., S. B. M., approved December 13, 1909, by the Secretary of the Interior, and on file in the local land office at Los Angeles, Cal., and the lands will be opened to entry and settlement in accordance herewith.

2. Warning is hereby given that no person will be permitted to gain or exercise any rights whatever under any settlement or occupation begun prior to March 1, 1910, on any land covered by this notice, and all such settlement or occupation is hereby forbidden.

3. Homestead entries accompanied by applications for water rights and the first installment of the charges may be made at the local land office in Los Angeles, Cal., on and after March 1, 1910, beginning at 9 o'clock a. m., under the provisions of said act and the act of April 21, 1904 (33 Stat., 224), for the farm units shown on said plats. Water-right applications may also be made for lands in private ownership, and the time when payments will be due therefor is hereinafter stated.

4. The limit of area per entry, representing the acreage which in the opinion of the Secretary of the Interior may be reasonably required for the support of a family on the lands entered subject to the provisions of the reclamation act, is fixed at the amounts shown on the plats for the several farm units.

5. The limit of area for which water-right application may be made for lands in private ownership shall be 160 acres of irrigable land for each landowner.

6. The charges which shall be made per acre of irrigable land in the said entries are in three parts, as follows:

(*a*) The value of the lands before reclamation, $10 per acre for the total area in each entry, as required by section 25 of said act of April 21, 1904, payable in not more than 10 annual installments, the first of which shall be $1 per acre, and the remaining installments at the rate of $1 per acre per annum until fully paid.

(*b*) The building of the irrigation system, $55 per acre of irrigable land, payable in not more than 10 annual installments, the first of which shall be $5.50 per acre and the remaining installments at the rate of $5.50 or some multiple thereof per acre. Full payment may be made at any time of any balance of the building charge remaining due after certification by the Commissioner of the General Land Office that full and satisfactory compliance has been shown with all the requirements of the law as to residence, cultivation, and reclamation.

(*c*) For operation and maintenance for the irrigation season of 1910, and annually thereafter until further notice, $1 per acre of irrigable land, whether water is used thereon or not. As soon as the data are available, the operation and maintenance charge will be fixed in proportion to the amount of water used with a minimum charge per acre of irrigable land, whether water is used thereon or not.

7. The charges which shall be made per acre of irrigable land in private ownership are those above stated for homestead entries, except that the portion of the charge for the value of the lands before reclamation is inapplicable.

8. All entries made for any of the lands shown on said plats shall be accompanied by applications for water rights in due form, and by the first installment of the charges for the Indian lands and for building, operation, and maintenance, not less than $7.50 per acre of irrigable land plus $1 per acre for the nonirrigable land, if any, included within the entry. The second installment for the Indian lands and for building, operation, and maintenance shall become due on December 1, 1910, and subsequent installments shall become due on December 1 of each year thereafter until fully paid.

9. All water-right applications made for private lands shown on said plats shall be accompanied by the first installment of the charge for building, operation, and maintenance, $6.50 per acre of irrigable land included in the application. The second installment shall become due on December 1, 1910, and subsequent installments shall become due on December 1 of each year thereafter until fully paid.

10. The first installment of the water-right charges for all irrigable areas shown on these plats, whether or not water-right application is made therefor or water is used thereon, shall be due and payable as herein provided.

11. The regulation is hereby established that no water will be furnished in any year until the portions for operation and maintenance of all installments then due shall have been paid. Accordingly, no water will be furnished for the irrigation season of 1911 for any lands unless the portion for operation and maintenance of the installment due on or before December 1, 1910, has been paid, and in like manner for subsequent years.

12. The regulation is hereby established that every water-right application shall contain a provision whereby the applicant shall agree to relieve the United States from all liability for loss or damage which he may sustain on account of the exclusion of his lands or improvements, or any part thereof, from any farm unit established or to be established under said project and the failure to supply water for the irrigation of the land so excluded on account of the destruction by flood, erosion, or other encroachment or action of said river, of the levee erected along the banks of the Colorado River for the protection of the irrigation works of the project and to prevent the overflow by the waters of said river of lands irrigable from said project, or in case a change in the location of the levee is considered necessary by the proper officials of the United States to prevent its destruction from the causes aforesaid, thereby rendering impracticable the irrigation of the land so excluded. Lands so excluded from irrigation shall be relieved from payment of any installments on account of the building charge not due at the time of such exclusion, and no charge for operation and maintenance shall, after such exclusion, be levied for such lands.

13. Failure to pay any two installments of the charges when due, whether on entries made subject to the reclamation act or on water-right applications for other lands, shall render such entries and the corresponding applications, if any, or the water-right applications for other lands subject to cancellation, with the forfeiture of all right under the reclamation act of June 17, 1902, as well as of any moneys paid.

14. All charges must be paid at the local land office at Los Angeles, Cal. The charges, except the first payment, may, for the convenience of applicants, be paid to the special fiscal agent of the United States Reclamation Service assigned to the Yuma project, for transmission to the register and receiver of the local land office on or before the date specified for payment at the local land office, but in case this privilege is availed of the necessary charges for transportation of the cash, as determined by the special fiscal agent, must accompany the payment of the charges.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal current contracts, Yuma project

No.	Date	Contractor	Description	Estimated value	Estimated earnings, June 30, 1910	Completion due
221	Mar. 14, 1908	Fairbanks, Morse & Co.	Gas engines	$5,050.00	[a] $5,025.50	May 15, 1908
222	Mar. 24, 1908	Western American Gas Co.	Gas plant	3,000.00	[a] 3,000.00	July 13, 1908
226	Mar. 11, 1908	General Electric Co.	Generators	2,415.00	1,783.00	July 3, 1908

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Yuma project

ASSETS

Accounts receivable:			
Uncollected water rentals		$4,140.00	
Uncollected miscellaneous		275.98	
			$4,415.98
Inventories:			
Mercantile store		1,839.47	
Government animals		16,556.00	
Equipment in use	$190,941.33		
Less depreciation	42,688.11		
		148,253.22	
Storehouse		73,029.73	
Cement		12,693.34	
Iron and steel		4,830.72	
Lumber		1,520.31	
Forage		522.27	
Fuel		3,718.77	
Cash in office safe		288.95	
Unadjusted transfers		625.74	
Freight and handling undistributed		3,273.22	
			267,151.74
Cost of work:			
Building cost		3,717,472.71	
Less adjustments	44,080.96		
Less accrued revenues	87,732.63		
		131,813.59	
			3,585,659.12
Operation and maintenance cost			14,510.80
Total assets			3,871,737.64

LIABILITIES

Investment of the United States:			
Disbursement vouchers	3,867,589.00		
Transfer vouchers received	105,116.55		
		3,972,705.55	
Collection vouchers	186,426.05		
Transfer vouchers issued	4,924.31		
		191,350.36	
			3,781,355.19
Accounts payable:			
Unpaid labor		7,625.95	
Unpaid purchases		21,440.76	
Unpaid freight and express		17,996.58	
Unpaid passenger fares		124.10	
Unredeemed coupon books		382.25	
Unredeemed meal tickets		406.85	
Unpaid miscellaneous		136.45	
			48,112.94
Repayments accrued:			
Building		35,766.51	
Operation and maintenance		6,503.00	
			42,269.51
Total liabilities			3,871,737.64

Feature costs to June 30, 1910, Yuma project

Laguna dam:		
Excavation, class 1	$638, 807. 49	
Excavation, class 2	134, 143. 42	
Rock in dam	208, 059. 81	
Concrete core walls	177, 905. 03	
Rock paving	9, 175. 53	
Concrete paving	246, 619. 60	
Sheet piling for upper walls	39, 095. 12	
Sheeting for lower wall	3, 434. 90	
Clearing above dam	177. 76	
Cofferdam	90, 816. 66	
River front protection	31, 021. 19	
Rock training dike	5, 355. 85	
Flood expense	57, 087. 89	
Diking and ditching at toe of dam	17, 555. 89	
Preliminary expense	5, 537. 77	
Clearing face of dam and razing cofferdam	7, 374. 29	
Repairs and maintenance	662. 20	
		$1, 672, 830. 40
Sluice and regulator works:		
Sluiceway excavation	519. 44	
Sluiceway piers and abutments	52, 878. 58	
Sluice and regulator gates, machinery and installation	77, 068. 62	
Sluiceway walls and lining	82, 216. 73	
Sluiceway paving	22, 623. 05	
Concrete bridge over sluiceway	10, 124. 76	
Canal heading walls and lining	25, 865. 30	
Sluiceway excavation	26, 387. 52	
Power house	11, 839. 04	
Sluiceway protection and repairs	35, 772. 88	
Sluice gates (protection and repairs)	157. 02	
		345, 452. 94
Canals:		
Reservation canal construction, excavation, structures and bridges	272, 618. 72	
Arizona main canal	23, 145. 98	
Yuma main canal	137, 877. 28	
Colorado River siphon	101, 391. 66	
		535, 033. 64
Levees:		
Gila Valley	63, 053. 47	
Yuma Valley	229, 834. 97	
Reservation	263, 324. 69	
		556, 213. 13
Pumping plants with canal system:		
Steam pumping plant and canal	$63, 260. 60	
Gravity plant and canal	89, 614. 14	
Pumping plant No. 3, preliminary expense	400. 69	
		$153, 275. 43
Examination of project as a whole:		
Preliminary surveys previous to selection of project	174, 735. 85	
Subdivision of reservation, engineering	10, 013. 27	
Colorado River investigations	5, 961. 91	
Gila Valley topography	4, 861. 65	
		195, 572. 68
Real estate (rights and property): Lands purchased		77, 062. 43
Administration of project as a whole:		
General expense prior to 1907	90, 684. 70	
General expense since 1907	88, 070. 43	
Expense of convention	266. 30	
		179, 021. 43
Inventory of unused supplies		3, 010. 63
Total building cost		3, 717, 472. 71
Operation and maintenance:		
Diversion works	145. 78	
Sluice and regulator works	8, 009. 38	
Reservation	6, 355. 64	
		14, 510. 80
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		3, 731, 983. 51

CALIFORNIA, ORLAND PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Glenn and Tehama.
Townships: 21 to 23 N., Rs. 2 to 4 W., Mount Diablo meridian.
Railroad: Southern Pacific.
Railroad stations: Orland, Greenwood, and Malton, Cal.
Average elevation of irrigable area: 225 feet above sea level.
Average annual rainfall on irrigable area: 17 inches.
Range of temperature on irrigable area: 26° F. to 120° F.

WATER SUPPLY

Source of water supply: Stony Creek.

Area of drainage basin: Above diversion dam, 790 square miles; above East Park dam, 102 square miles.

Annual run-off in acre-feet of Stony Creek near Fruto (760 square miles), 1901 to 1908: Maximum, 775,000; minimum, 311,000; mean, 543,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: East Park—area, 1,800 acres; capacity, 46,000 acre-feet; length of spillway, 415 feet; elevation of spillway, 85 feet above stream bed.

Storage dam: East Park—type, concrete gravity section, arch plan; maximum height, 139 feet; length of crest, 250 feet; volume, 12,000 cubic yards.

Diversion dam: Type, sheet piling capped with concrete; length, 900 feet.

Length of canals: No canals with capacities greater than 300 second-feet; 25 miles with capacities from 300 to 50 second-feet; 80 miles with capacities less than 50 second-feet.

Water power: None developed; estimated total, 600 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area, 14,000 acres.

Present status of irrigable lands: No lands entered subject to the reclamation act or open to entry; 160 acres withdrawn from entry; 13,840 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 2,000 acres.
Area irrigated, season of 1910: 700 acres.
Length of irrigating season: 150 days.
Character of soil of irrigable area: Sandy and gravelly loam, silt loam.
Principal products: Alfalfa, citrus and other fruits, and vegetables.
Principal markets: San Francisco, Cal.; Portland, Oreg.; eastern markets.

CHRONOLOGICAL SUMMARY

Reconnoissance made in 1906.
Board report November 12, 1906.
Construction authorized by Secretary December 18, 1906.
Miller Buttes concrete headworks for South canal completed November, 1908.
Canal system of Stony Creek Irrigation Company purchased May 21, 1909.
Lemon Home canal purchased March 26, 1910.
East Park dam completed June, 1910.
Whole project 73 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Orland project provides for the storage of water in a reservoir controlled by East Park dam on Little Stony Creek at a point about 40 miles above Orland, Cal., and the diversion of water from Stony Creek for the irrigation of lands in the vicinity of Orland by a dam at Miller Buttes into two canal systems, one on either side of the creek, and in each of which a purchased canal system is incorporated. The present limits of the Orland project may be considered as a unit of the Sacramento Valley project. It may be expanded by constructing additional reservoirs on Stony Creek and its tributaries. The chief additional reservoir sites available are Millsite, on Stony Creek, near Fruto; Briscoe, on Briscoe Creek, near Elk Creek; Stonyford, on Stony Creek, at Stonyford; and Stony Gorge, on Stony Creek near Elk Creek.

INVESTIGATIONS AND ORIGIN OF PROJECT

The California Water and Forest Association having requested the United States Geological Survey to make a study of Glenn County to ascertain if suitable reservoir sites could be found on Stony Creek, investigations were begun in 1902 by Burt Cole. A general study of irrigation possibilities was made, storage sites on Stony Creek and its tributaries were examined, and dam sites were investigated. Maps of reservoir and dam sites, and plans, specifications, and estimates of cost for dams on Briscoe Creek, at Millsite on Stony Creek, and at East Park on Little Stony Creek were made. A detailed account of these investigations is given in Water-Supply Paper No. 86 of the United States Geological Survey.

The development of projects in the San Joaquin and Sacramento valleys by the Reclamation Service was requested in a letter from Hon. George C. Perkins dated August 28, 1902. Resolutions of the Sacramento Valley Development Association urging the construction of a unit of the Sacramento project were passed on October 21, 1905, and letters from the president of this association, dated December 2, and from the secretary, dated December 14, to the same effect were received.

In 1905 a committee of citizens secured the signatures of the owners of 40,000 acres of land near Orland, Cal., to a statement indicating their willingness to comply with the terms of the reclamation act if the Government would build for them an irrigation system. In February, 1906, the Orland Water Users' Association was formed, and on April 21, 1906, this organization presented a petition to the Secretary of the Interior through the Sacramento Valley Development Association in which it was asked that an irrigation project on Stony Creek in the vicinity of Orland be developed under the terms of the reclamation act. In compliance with this request survey parties were organized in July, 1906, and the irrigation possibilities of Stony Creek were further investigated. The results of these investigations were considered by a board of engineers consisting of Messrs. D. C. Henny, E. G. Hopson, and S. G. Bennett, and the construction of the Orland project was recommended by this board on November 12, 1906. On December 15 the Orland Water Users' Association adopted resolutions urging the approval of the project, and on December 18, 1906, the Secretary of the Interior authorized construction, subject to the following conditions:

(1) That 12,000 acres of land be pledged by the owners in a form to be approved by the department, so that the lands will be held bound to repay the cost of construction under the terms of the reclamation act.

(2) That satisfactory arrangements be made and agreements completed for the adjustment of water rights or for options to purchase certain properties and rights, notably those of the Stony Creek Irrigation Company and the Lemon Home Water and Light Company.

(3) That satisfactory arrangements be made for the purchase of lands needed for reservoir purposes.

(4) That the owners of lands agree to subdivide their holdings in excess of 160 acres into farm units of not to exceed 40 acres.

The Orland Water Users' Association was reorganized in such form as to secure compliance with the conditions imposed by the secretary, and contracts were made for the purchase of two existing irrigation systems.

CONSTRUCTION

EAST PARK DAM, SPILLWAY, AND DIKES

East Park reservoir is formed by East Park dam across Little Stony Creek, Gordon dike across a depression about 2,100 feet south of the dam, and Coleman dike across a depression about 3,000 feet south of the dam. A spillway a short distance north of Gordon dike provides for the discharge of surplus waters into a channel that leads back to the creek and two outlet conduits through the dam provide for the release of water from the reservoir. Elevations for the reservoir are referred to a datum 100 feet below the level of low water at the dam and the assumed level of high water in the reservoir is at elevation 188.7, the crest of the spillway being at elevation 185.

East Park dam is a concrete structure of the gravity type, built on an arch plan. The dam is founded and abuts on conglomerate rock. The lowest point in the foundation is at elevation 51 and the main crest at elevation 187. A parapet wall on the upstream side and a concrete railing on the downstream side extend to elevation 190. The upstream face of the dam has a batter of 1 horizontal to 25 vertical from the foundation to elevation 155 and is vertical from elevation 155 to the parapet wall, which has a stepped overhang of 12 inches. The downstream face has a batter of 2 horizontal to 3 vertical from the foundation to elevation 166.04, is curved on a 24-foot radius to elevation 179.40, and finally rises vertically to the 6-inch overhang of the railing. The arch of the dam is on a radius of 275 feet to the center line of the crest and the crest length is 226 feet. The crest width is 10 feet, excluding 18 inches overhang for parapet wall and railing, and the maximum bottom width is about 90 feet. Expansion joints are provided above elevation 155 for every 20 feet of crest length. The main outlet is a 5-foot circular opening through the dam at elevation 119.5 and is controlled by a double set of steel gates operated from the crest of the dam through a gate tower. A secondary outlet, at elevation 100, is a 2-foot iron pipe through the dam controlled by a standard steel gate operated from the crest of the dam.

The spillway is a concrete structure founded on conglomerate rock. It consists of nine circular bays of 13.5-foot inside radius, convex upstream, connecting 8-foot concrete piers. The maximum height of the spillway structure is about 12 feet and its total length 460 feet. The spillway crest of bays and piers is at elevation 185, the abutments rising to elevation 192. Water cushions are maintained below the bays by concrete bulkheads 2 feet in height and a concrete apron 8 inches thick extends about 30 feet downstream.

The two earthen dikes have crests 20 feet wide at elevation 194. The slopes are faced with rock pitching 12 inches thick, the water slopes being 3 to 1 and the landward slopes 2 to 1. Gordon dike has a maximum height of about 10 feet and a length of 227 feet. Coleman dike has a maximum height of about 14 feet and a length of 139 feet. The earth fill was placed in 6-inch layers, thoroughly wet and rolled. Fine material was selected for the upstream slope, the surface of the ground was plowed before placing earth fill, and trenches were excavated to rock at the foot of the slopes.

Proposals for the construction of East Park dam, spillway, and dikes (specifications No. 155) were opened on August 27, 1908, and a contract for the work was executed on October 5, 1908. The contractor began to prepare for construction in November, 1908, but was soon obliged to suspend work for the winter. Operations were resumed in May, 1909, the placing of concrete was begun September 1, 1909, and the work was finished in June, 1910. High water retarded masonry work at the dam several times and meager force and equipment during the early stages of construction delayed the completion of the contract. The specifications provided for the embedding of sandstone rocks to the amount of 20 to 35 per cent of the concrete in all concrete over 2 feet in thickness, but stone of suitable quality could not be obtained near the work and this stipulation was annulled by mutual agreement.

A telephone line from Orland to the dam site was constructed in the spring of 1908.

CANAL SYSTEMS

The canal systems head near Miller Buttes, 9 miles from Orland and about 60 miles below the storage dam, and will water about 14,000 acres of land on both sides of Stony Creek in the vicinity of Orland. The construction of canal head works at Miller Buttes and the excavation of a portion of the south-side canal to connect with the old canal of the Stony Creek Irrigation Company were begun in July and completed in November, 1908. A short section of the proposed diversion dam, consisting of sheet piling capped with concrete, was also built on each side of the creek, leaving about 600 feet of this dam for future construction. The canal system of the Stony Creek Irrigation Company was purchased in May, 1909. The enlargement by force account of the main canal of that system as a part of the south-side canal, the excavation under small contracts of the distribution system, and the building by force account of structures for the distribution system were begun in November, 1909, and have been continued since that date. Plans, specifications, and advertisement for proposals for the construction of a high-line canal and distribution system on the south side were prepared in June, 1910. The canal system of the Lemon Home Water and Light Company was purchased in 1910 and will be utilized in the irrigation of the north-side lands, the main canal being enlarged and the distribution system extended.

HEADQUARTERS FARM

A 10-acre tract near Orland was purchased in June, 1908, for use as a headquarters site. Buildings were erected, a 12-inch well bored, a transmission line built, and a centrifugal pump with electrical equipment installed in the summer of 1908. In 1909 this land was utilized for manufacturing concrete pipe and for housing and feeding stock. The area not thus used was irrigated by pumping and cultivation was begun. The land of the tract was apparently almost valueless for agriculture, but with irrigation has been successfully farmed, excellent crops being produced during the season of 1909.

IRRIGATION AND SETTLEMENT

The normal flow of Stony Creek is very small after June, and in the absence of storage little irrigation can be done. The reservoir at East Park will not be utilized for the furnishing of stored water until the season of 1911. The first irrigation from the canals of the Reclamation Service was effected in the spring of 1910, water being turned into the canals for priming on April 7. About 700 acres were irrigated under rental contracts during May and June, 1910, but the water supply was becoming scarce by the end of the latter month.

The lands of the project are in private ownership. They have mostly been held in large tracts for the raising of grain and the soil has become impoverished. Irrigation and intensive cultivation will restore the fertility of the soil, and since a government canal system has become assured the large holdings of land have been subdivided into tracts of 40 acres or less and are being taken up by settlers in preparation for irrigation operations when water becomes available. The average size of farms is about 20 acres, the subdivision being brought about by natural economic causes.

PROGRESS DURING FISCAL YEAR 1910

The construction of East Park dam, spillway, and dikes has been in progress throughout the greater part of the year, the spillway being completed in April and the dam and dikes in June, 1910.

The south-side canal, which was purchased from the Stony Creek Irrigation Company, has been enlarged from Hambright Creek to the irrigable area. Twenty concrete drops have been built on this canal above Hambright Creek. Surveys for a high-line power canal have been completed and negotiations for the right of way for this canal are in progress. It is estimated that sufficient power will be developed from the high-line canal to irrigate 3,000 acres of land by pumping ground water from depths of 30 to 40 feet. The excavation for the south-side distribution system is 70 per cent completed and will be finished under small contracts during the calendar year. The structures are being built by force account, 432 concrete structures having been built since February, 1910.

Flood water from Stony Creek is being furnished for irrigation. Applications for water from 118 water users for the irrigation of 700 acres have been received. Of this area 600 acres were planted to alfalfa, 50 acres to citrus fruits, and 10 acres to deciduous fruit.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Orland project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
257	Oct. 5, 1908	Stanley Contracting Co.	East Park dam	$79,881.65	$85,949.99	July 1, 1910
301	Oct. 29, 1909	Hale, Downen & Smith.	Excavation, distributing system.	2,979.50	[a] 2,936.96	May 1, 1910
302	Nov. 1, 1909	S. D. Koons & W. P. Gay.	Excavation, distributing system.	3,389.50	[a] 3,344.91	May 1, 1910
303	Oct. 29, 1909	A. B. Munson	Excavation, distributing system.	26,500.00	18,361.03	Oct. 7, 1910

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Orland project

ASSETS

Inventories:			
Government animals		$555.00	
Equipment in use	$7,351.47		
Less depreciation	243.12		
		7,108.35	
Storehouse		1,061.35	
Cement		2,903.83	
Iron and steel		1,099.41	
Lumber		927.42	
Explosives		51.06	
Forage		112.44	
Local products		674.74	
Unadjusted transfers		956.78	
Freight and handling undistributed		1,019.81	
			$16,470.19
Cost of work:			
Building cost	397,334.80		
Plus adjustments	6.51		
		397,341.31	
Less accrued revenues		7,216.48	
			390,124.83
Total assets			406,595.02

LIABILITIES

Investment of the United States:			
Disbursement vouchers	361,834.39		
Transfer vouchers received	25,174.65		
		387,009.04	
Collection vouchers	5,857.24		
Transfer vouchers issued	2,548.69		
		8,405.93	
			378,603.11
Accounts payable:			
Unpaid labor		1,652.80	
Unpaid purchases		1,516.89	
Unpaid contract estimates		7,742.45	
Unpaid contract holdbacks		9,624.83	
Unpaid freight and express		1,935.23	
Unpaid passenger fares		134.71	
Unpaid land agreements		5,385.00	
			27,991.91
Total liabilities			406,595.02

Feature costs to June 30, 1910, Orland project

Storage works:		
East Park dam	$231,013.48	
Stonyford reservoir examination	128.28	
Millsite reservoir examination	328.21	
		$231,469.97
Diversion system: Dam and head works, south canal		16,671.01
Canal system:		
North main	22,162.29	
South main	48,392.81	
Malton branch examination	448.25	
Central branch examination	39.38	
Stony Creek branch examination	55.47	
Middle branch examination	2.50	
Orland branch examination	128.32	
		71,229.02
Lateral system:		
North main canal	9,073.54	
South main canal	20,956.00	
Malton branch canal examination	10.56	
		30,040.10
Structures:		
Bridges and culverts	2,481.84	
Drops—south main canal	3,041.57	
Spillways	285.34	
Special structures	555.61	
Checks and drops	7,650.38	
Turnouts for farms	1,617.41	
Railroad crossing	3,979.41	
Deck bridges over 10-foot span	905.58	
Deck bridges from 5 to 9-foot span	1,411.72	
Turnouts for laterals	369.59	
		22,298.45
Buildings and grounds:		
Office	2,504.87	
Barn	481.64	
Wagon shed	92.25	
Storehouse	701.90	
Cottage—engineers	2,244.04	
Tank house	719.36	
Headquarters grounds	3,070.73	
		9,814.79
Administration of project as a whole: General expense		10,856.68
Irrigable lands: Farm-unit subdivision		89.36
Headquarters farm:		
Cultivation	2,122.29	
Power line, construction	271.72	
		2,394.01
Inventory of unused supplies		1,115.23
Total building cost		395,978.62
Operation and maintenance (during construction):		
Maintenance	921.62	
Operation	355.66	
Betterments	78.90	
		1,356.18
Total building and operation and maintenance cost during construction, as per debit in cost of work in statement of assets and liabilities		397,334.80

COLORADO, GRAND VALLEY PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Mesa.

Townships: 1 N., Rs. 1 E. and 1 to 3 W.; 2 N., Rs. 2 and 3 W.; 1 S., Rs. 1 E. and 1 W., Ute meridian. 9 S., Rs. 101 to 104 W.; 10 S., Rs. 98, 101, and 103 W.; 11 S., Rs. 98 and 99 W., sixth principal meridian.

Railroads: Denver and Rio Grande; Colorado Midland.

Railroad stations: Palisade, Clifton, Grand Junction, Fruita, Loma, and Mack, Colo.

Average elevation of irrigable area: 4,700 feet above sea level.

Average annual rainfall on irrigable area: 8 inches.

Range of temperature on irrigable area: −15° F. to 100° F.

WATER SUPPLY

Source of water supply: Grand River.

Area of drainage basin: 8,550 square miles above Palisade.

Annual run-off in acre-feet of Grand River at Palisade, 1897 to 1899 and 1902 to 1908: Maximum, 5,200,000; minimum, 2,300,000; mean, 3,700,000.

AGRICULTURAL CONDITIONS

Irrigable area: 53,000 acres.

Present status of irrigable lands: 18,500 acres entered subject to the reclamation act, 13,000 acres withdrawn from entry, 21,500 acres in private ownership.

Length of irrigating season: 210 days.

Character of soil of irrigable area: Sandy loam, sandy mesas, and adobe.

Principal products: Fruit, sugar beets, alfalfa.

Principal markets: Large cities east of Rocky Mountains for fruit; other products, local.

IRRIGATION PLAN

The irrigation plan of the Grand Valley project provides for diversion of water from Grand River by a dam about 8 miles northeast of Palisade, Colo., into a canal system on the north side of the river for irrigating lands lying north and west of Grand Junction, Fruita, and Mack, Colo.

ORIGIN OF PROJECT AND INVESTIGATIONS

In the valley of Grand River in western Colorado for a few miles above and below the mouth of Gunnison River, irrigation has been practiced since about 1883, and more than 50,000 acres of land are being watered by various canal companies, irrigation districts, and private canal lines. The supply of water in Grand River is sufficient for irrigating much greater areas and plans have long been under consideration by private parties for the construction of a suitable canal for supplying the higher lands along the valley. Surveys were made as early as 1897 by Mr. C. D. Page, of Greeley, Colo., for determining the location of such a canal line and other investigations and surveys were made by various parties.

In June, 1902, investigations of irrigation possibilities in Grand Valley were ordered by the chief engineer of the Reclamation Service. During the season of 1902 and the winter of 1902–3 topographic surveys of portions of the canyon of Grand River and of adjacent areas in which possible canal routes might be found were made. On June 10, 1903, a board of engineers consisting of Messrs. A. P. Davis, G. Y. Wisner, and W. H. Sanders, after investigation of the project and examination of the maps and reports of surveys, recommended the survey of a canal line designed to water about 51,000 acres of land, 7,000 acres of which were at that time irrigated by a private pumping system, and the balance of which were unirrigated. Further surveys were postponed, however, on account of the contemplated construction of canals by private capital and the formation under the laws of the State of Colorado of an irrigation district embracing some of the lands that might be irrigated by the proposed government canals. After efforts had been made to arrange for construction by sale of bonds of the irrigation district, a meeting largely attended by the water consumers of the district was held on October 3, 1904, at which resolutions were adopted requesting the Government to construct the project for the benefit of the irrigation district already incorporated, proposing the formation of a water users' association, and requesting conferences with officers of the Reclamation Service regarding possible construction plans. Other letters and petitions from citizens in the valley urging the Government to undertake the construction of an irrigation project were also received.

In February, 1908, investigations were resumed and topographic surveys of the irrigable lands were begun. In the seasons of 1908 and 1909 these surveys were completed and a final location was made of a main canal line 32 miles in length diverting from Grand River about 6 miles northeast of Palisade, Colo.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year surveys have been made for an alternate location of the main canal, and about 8 miles of the new location have been staked out. Final paper location of the other 18 miles has been made, and plans have been prepared for a large number of the principal structures that would be required. Estimates of cost of each of the proposed canal lines have been prepared, and careful revisions of the estimates for the entire project have been made. Negotiations have been carried on with the Palisade and Mesa County irrigation districts with reference to the inclusion of these irrigation districts in the project of the Reclamation Service.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Grand Valley project

ASSETS

Inventories:			
Government animals		$277.00	
Equipment in use		1,314.19	
Storehouse		2,655.20	
Lumber		3,285.90	
Forage		238.84	
Unadjusted transfers		[a]542.32	
			$7,228.81
Cost of work:			
Building cost	$65,684.97		
Plus adjustments	714.70		
		66,399.67	
			66,399.67
Total assets			73,628.48

[a] Credit amount.

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$69,479.00		
Transfer vouchers received	6,401.42		
		$75,880.42	
Collection vouchers	35.69		
Transfer vouchers issued	2,734.35		
		2,770.04	
			$73,110.38
Accounts payable:			
Unpaid labor		356.00	
Unpaid purchases		151.10	
Unpaid freight and express		6.50	
Unpaid passenger fares		4.50	
			518.10
Total liabilities			73,628.48

Feature costs to June 30, 1910, Grand Valley project

Examination of project as a whole: Preliminary examination and surveys	$31,938.51
Administration of project as a whole: General expense	33,113.11
Irrigable lands: Farm-unit subdivision	633.35
Total building cost, as per debit in cost of work in statement of assets and liabilities	65,684.97

COLORADO, UNCOMPAHGRE VALLEY PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Montrose and Delta.

Townships: 15 S., Rs. 94 to 96 W., sixth principal meridian; 48 to 51 N., Rs. 7 to 12 W., New Mexico meridian.

Railroad: Denver and Rio Grande.

Railroad stations: Montrose, Olathe, and Delta, Colo.

Average elevation of irrigable area: 6,000 feet above sea level.

Average annual rainfall on irrigable area: 9 inches.

Range of temperature on irrigable area: −20° F. to 98° F.

WATER SUPPLY

Sources of water supply: Gunnison and Uncompahgre rivers.

Area of drainage basins: Gunnison River, 3,850 square miles. Uncompahgre River, 500 square miles.

Annual run-off in acre-feet: Gunnison River at River Portal (3,850 square miles) 1903 to 1908—maximum, 1,900,000; minimum, 840,000; mean, 1,400,000. Uncompahgre River at Fort Crawford (500 square miles) 1895 to 1899, 1903 to 1905, and 1908—maximum, 250,000; minimum, 180,000; mean, 210,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Taylor Park—area, 2,260 acres; capacity, 106,000 acre-feet; length of spillway, 125 feet; elevation of spillway, 150 feet above stream bed.

Storage dam: Taylor Park—type, arched masonry; maximum height, 200 feet; length of crest, 700 feet; volume, 212,000 cubic yards.

Diversion dams: Five; type and design not determined.

Length of canals: 30 miles, with capacities greater than 300 second-feet; 100 miles with capacities from 300 to 50 second-feet; 200 miles with capacities less than 50 second-feet.

Aggregate length of tunnels: 35,000 feet.

Water power: None developed; estimated total, 10,000 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: 140,000 acres.

Present status of irrigable lands: 15,000 acres entered subject to the reclamation act, 19,000 acres withdrawn from entry, 106,000 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 20,600 acres.
Area irrigated, season of 1910: 20,600 acres.
Length of irrigating season: 214 days.
Character of soil of irrigable area: Red sandy gravel, adobe, and clay loam.
Principal products: Alfalfa, grain, fruits, sugar beets, vegetables.
Principal markets: Denver, Colo.; Chicago, Ill.; local mining camps.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in December, 1902.
Construction authorized by Secretary, March 14, 1903.
South canal completed May, 1908.
Montrose and Delta canal purchased May 4, 1908.
Loutsenhizer Canal purchased September 25, 1908.
First irrigation by Reclamation Service, season of 1908.
Gunnison tunnel completed for present use June, 1910.
Whole project 59.5 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Uncompahgre project provides for the diversion of water from the canyon of Gunnison River by means of a tunnel 6 miles long and a canal 12 miles long to supplement the flow of Uncompahgre River in the irrigation of lands in Uncompahgre Valley. To distribute the waters of Uncompahgre and Gunnison rivers, thus combined, the plan provides for the purchase and utilization of some of the private ditches taking water from Uncompahgre River, and for supplementing them by high-line canals, one on either side of the valley, taking water from Uncompahgre River and by laterals diverting from the south canal.

ORIGIN OF PROJECT

Settlement of the Uncompahgre Valley began in 1882 and progressed rapidly. By 1884 ditches for irrigating a large acreage had been projected and partially constructed. Optimistic views on the sufficiency of the available water supply prevailed and many ill-advised developments were made. By 1904, of about 100,000 acres which had been patented, loan companies held 20,000 acres obtained by foreclosure proceedings, and but 30,000 acres were cultivated, the water supply being inadequate for even this small area. Plans for securing water by a tunnel from the Gunnison River to the Uncompahgre Valley were discussed at an early date, and their practicability was demonstrated in 1895 by a survey financed by public subscriptions. State aid for the work, under the name of state canal No. 3, was solicited, and an appropriation of $25,000 was made by the legislature April 11, 1901. (Colo. Session Laws, 1901, p. 369.) In October, 1901, the state authorities began the expenditure of this appropriation in driving a tunnel on a location selected by their engineers. A year later, when the appropriation had been exhausted, the State and citizens of the valley requested the Reclamation Service to complete the project. The support which the citizens of the valley assured to the service was practically unanimous, and the owners of the existing ditches, either officially or as individual stockholders, with few exceptions, went on record committing themselves to some equitable method of transferring their ditches to a water users' association.

INVESTIGATIONS

The Gunnison River diversion, as it was at first called, was one of the first five projects authorized under the reclamation act. In June, 1901, Mr. A. L. Fellows, of the United States Geological Survey, began a systematic survey of Vernal Mesa, which separates the Gunnison River from the Uncompahgre Valley, in order to select the shortest and most feasible route for a tunnel and prepare estimates for its construction. When the Reclamation Service was organized in 1902, Mr. Fellows was detailed to continue for the service the investigations begun for the Geological Survey. His report, submitted in May, 1904, demonstrated the desirability of abandoning the tunnel commenced by the State of Colorado and recommended that the boat landing location for the tunnel be adopted on account of less difficulty in access to the canyon portal, simplicity of engineering problems, shorter length, increase in irrigable land, and relief from the necessity of building several miles of very costly canal.

By the act of March 16, 1903 (sec. 6928, p. 1614, Rev. Stat. Colo., 1908), the state legislature authorized the conveyance to the United States of all property and rights acquired for state canal No. 3. In pursuance of this statute, conveyance of all such property and rights was made on behalf of the State by the state board of control on August 14, 1906.

General plans for the development of the project as outlined in a letter of March 7, 1903, from the Director of the Geological Survey to the Secretary of the Interior, provided for the construction of a tunnel to divert water from the Gunnison River for the irrigation of lands in the Uncompahgre Valley. It was recommended that the general project as outlined be approved, that the examination of irrigable lands, etc., be continued, and that work be continued in greater detail for the ascertainment of facts necessary for the preparation of specifications and letting of contracts for the construction of irrigation works. On March 14, 1903, the Secretary of the Interior approved the general project as recommended and authorized the preparation of plans and specifications for construction to be submitted to him for approval. On June 7, 1904, the Secretary of the Interior set aside $2,500,000 from the reclamation fund for the construction of the Uncompahgre Valley project and authorized the taking of such action as might be necessary to carry out the project in all its details.

CONSTRUCTION

TUNNEL ROAD AND TELEPHONE LINE

Work on the final location of the tunnel and of a wagon road to River Portal was begun promptly after the authorization of the project. The construction of the wagon road, a necessary preliminary to work at River Portal, was commenced in July and completed in October, 1904, by force account. The road was located with an average rise in grade of 5.16 per cent for the 6.5 miles from Cedar Creek to Vernal Mesa and an average fall of 11.5 per cent, with a maximum of 23 per cent, for the 3.36 miles from Vernal Mesa to River Portal. The construction of the road involved the excavation of 30,000 cubic yards of material, the clearing of 38 acres of roadway, and the building of 19 wooden box culverts and 300 linear feet of cribwork along cliffs.

A telephone line was constructed by contract in November and December, 1904. The line, which is 24.32 miles long, extends from Montrose to the west portal of the tunnel, thence to Cedar Creek station and River Portal. A branch from this line extends along the south canal to Uncompahgre River.

GUNNISON TUNNEL

The western end of Gunnison tunnel is located on the Marshall Pass line of the Denver and Rio Grande Railroad and the eastern end is located in the canyon of Gunnison River and is reached by a wagon road. The tunnel takes water from Gunnison River, the bottom of the intake being about 7 feet below the low-water line, and delivers it in Uncompahgre Valley.

The tunnel is 30,645 feet in length and has a uniform grade of 2.02 in 1,000, the upper end being 6,433 and the lower end 6,371 feet above sea level; the bottom is flat and 10 feet in width, the straight sides are 10 feet high and batter outward toward the top 6 inches in 10 feet, and the roof is arched with a span of 11 feet and a rise of 2½ feet within the cement lining. The entire area of the cross section inside the masonry is 122 square feet, the water-carrying cross section is estimated at 100 square feet, and the flow of water that can be delivered through the tunnel is estimated at 1,300 second-feet.

Proposals for the construction of the Gunnison tunnel under specifications No. 19 were opened October 5, 1904, and a contract for the work was executed on November 21, 1904. The contract provided for the excavation and lining of 30,582 feet of tunnel and of a cut at the west portal 1,950 feet long, with a maximum depth of excavation of 49 feet.

Excavation was begun on January 11, 1905. At the east portal an incline 137 feet long on a 25 per cent grade, beginning at an elevation slightly above high-water level, was excavated to reach the tunnel grade. An undercut drift 11 feet by 8½ feet was driven and this was later enlarged to full section by shooting down the roof. Work proceeded slowly, due to delay of the contractors in installing a plant of sufficient power. On May 25, 1905, at the east portal, 436 feet of undercut drift on the grade of the tunnel had been driven, 135 feet of this had been enlarged to full size, and a power plant with capacity sufficient to operate two air drills and an air hoist at the incline and to supply air power to a pump in the heading had been installed and operated for a little over thirty days.

At the west portal the contractor began operations by excavating a 20 per cent incline to the face of the portal. This was completed on February 28, 1905. Excavation in the tunnel was made by driving an 8 by 8-foot bottom heading and later removing sufficient material from the sides and roof to make the full section. The moist adobe and gravel encountered required heavy timbering, and frequent falls delayed the work. On May 25, 1905, 574 feet of full-sized tunnel and 108 feet of 8 by 8-foot drift had been excavated. A 65-ton Bucyrus steam shovel was first operated at the portal cut on April 11, 1905. The shovel was idle for repairs sixteen days of the following thirty-six, and on May 25 only 37,000 cubic yards of material had been removed.

On May 11, 1905, the sinking of a shaft was begun on the tunnel line about 1 mile distant from the west portal, this location being the nearest to the middle of the tunnel tangent which could economically be utilized as a site for a shaft. This shaft was excavated and timbered to give a single compartment 5 feet by 10 feet in the clear, and on May 24, of the 262 feet of total depth, 75 feet had been excavated.

About the middle of May, 1905, 15 per cent of the contract time had elapsed and less than 4.5 per cent of the work had been accomplished. Neither the organization developed nor the mechanical plant installed were adequate for the work and the contractors were in financial difficulties. The contract was therefore suspended and on May 27, 1905, the Reclamation Service undertook the continuation of the tunnel.

Working facilities were bettered as fast as circumstances would permit. Equipment and tools urgently needed were purchased and the organization was improved and increased. Proposals under specifications No. 51 for the completion of the work were invited, to be opened on September 26, 1905, and pending the opening of proposals very little change was made in the methods of tunnel excavation. The three proposals opened on September 26 were rejected and the decision made to complete the tunnel by forces working under the direct supervision of the engineers of the Reclamation Service.

Gunnison tunnel was driven at four headings, as follows: Heading No. 1 driven westward from the east portal for a distance of 10,879 feet; heading No. 2 driven eastward from the main shaft for a distance of 14,824 feet; heading No. 3 driven westward from the main shaft for a distance of 1,696 feet; and heading No. 4 driven eastward from the west portal for a distance of 3,246 feet. The main shaft is located 4,942 feet from the west portal, and headings 3 and 4 were driven to the meeting point on July 4, 1906, about fourteen months after the work was taken over by the service. During this interval heading No. 2 had been driven eastward from the main shaft nearly 1 mile. Headings 1 and 2 were connected on July 6, 1909.

Beginning at the west portal, the character of material encountered was as follows: First, 2,000 feet of heavy water-bearing alluvial deposit consisting of clay, gravel, or sand beds. Second, 1,200 feet with the lower part of the tunnel section in hard shale and the upper part in gravel. This portion of the tunnel included the transition from the heavy soils into and under the shales of the hill. A considerable volume of water followed the plane of contact and percolated through the overlying gravel. The top required the most careful timbering to prevent caving, while the bottom required blasting for its removal. Third, 10,000 feet of black shale, carrying fossil deposits and small pockets of combustible gas, with practically no water in the seams. Fourth, 2,000 feet through a fault zone, badly shattered and tilted at widely divergent angles in a very irregular manner. High temperature, hot and cold water, coal, marble, hard and soft sandstone, limestone, and carbonic-acid gas in overwhelming quantities were encountered in this section and tunnel excavation was both difficult and dangerous. Fifth, 15,445 feet, the remainder of the tunnel, in metamorphic granite. This section of the tunnel presented much variety in the hardness of the rock, about 3,000 feet requiring timbering. Many water-bearing seams were encountered.

The equipment for tunneling operations included, at the east portal, a power plant of 320-horsepower boiler capacity in four units; air compressors having a total capacity of 2,300 cubic feet of free air per minute compressed to 100 pounds per square inch, in three units; electric generators with a total capacity of 225 kilowatts in three units, producing a 250-volt direct current; two 6,000-cubic-foot cycloidal ventilating blowers with 20-inch outlets operating against a pressure of 2 pounds per square inch; and a jet condenser. At the west portal there were installed a power plant of 320-horsepower boiler capacity in four units; air compressors with a total capacity of 1,560 cubic feet of free air per minute compressed to 100 pounds per square inch, in three units; electric generators of 275-kilowatt capacity in three units, furnishing direct current at 250 volts; cycloidal ventilating blowers as at the east portal, the blowers being located in the tunnel and operated by electric motors.

Tramming was carried on with electric locomotives of 6 tons weight, guaranteed drawbar pull of 2,400 pounds, and speed of 6 to 8 miles per hour, operated on a 24-inch gauge track. In the western part of the tunnel side-dump cars of 35 cubic feet capacity were used. In the eastern part of the tunnel 54-cubic-foot nondumping cars mounted on four wheels rigidly attached to the car body were used, the cars being dumped with the aid of a derrick. In the beginning of the work the hoist and swinging device on the dump derrick at the east portal was operated by compressed-air motors. These motors were unsatisfactory and were eventually replaced by electric motors, which operated successfully.

One ventilating blower was located in the power house at the east portal, and was direct connected to a 25-horsepower steam engine. This blower was used as an exhaust fan, and was operated for two or more hours after each blast to draw foul air from the heading. As the heading advanced the suction draft was carried as close to the heading as possible by 16-inch slip-joint riveted iron pipe. After the heading had advanced about 6,000 feet, a second blower, operated by an electric motor, was installed in the pipe line to act as a booster. Little trouble on account of ventilation was experienced in No. 1 heading, as the excavation was entirely in granite rock, of moderate temperature, free from noxious gases. At first ventilation for heading No. 2 was also secured by exhausting foul air and powder smoke. As the heading advanced, however, the temperature rose to such a degree that some relief became necessary, and in addition small pockets of explosive gases and a strong flow of carbonic-acid gas were tapped. To overcome these difficulties an inclined shaft nearly 700 feet in depth was driven at a point 8,800 feet east of the west portal. This shaft was connected to the heading by two lines of 16-inch pipe, the pipe lines being used intermittently as suction lines and as pressure lines. Immediately after blasting the blowers were operated for about an hour as suction fans, drawing foul air from the heading. As soon as the powder smoke was well cleared out, the blowers were reversed and blew a draft of cool air into the heading.

Drilling was carried on with drills considered best adapted to the character of ground encountered at any given time. In the hard granites the Sullivan 3-inch piston drill was used. In less refractory ground the Sullivan 2½-inch drill gave good service. For certain classes of work the Leyner drills, especially the newer models, gave satisfactory results. In the shales, which have about the hardness of semibituminous coal, the Jeffrey coal auger, air driven, was used with highly satisfactory results. In the clays, some of which were sufficiently compact to shoot to advantage, a soft auger gave best results. Pop holes, holes for trolley hangers, for pipe hangers, for feed-wire brackets, and similar uses, were drilled with stoping drills, of which several types were used.

After the installation of electrical apparatus all lighting was done by electricity. For operations removed 300 feet or more from the heading, lights were attached to the main lighting circuit and installed with more or less permanence as conditions required. Heading lights which had to be removed prior to blasting and returned immediately thereafter were attached to a sufficient length of flexible lamp cord, which was hung along the roof or side walls from the point of permanent support to the heading.

In the east heading, for about a year after work began, an undercut drift approximately 8 feet high and the full width of the tunnel was driven, with the idea that the remainder of the section overhead could be taken down without serious interruption to heading routine. As soon as the heading advanced far enough to be safely removed from the blasting in the rear, work was begun on the removal of the overhead section. It soon became evident that while the overhanging section could be removed very cheaply, the saving did not compensate for the continued interruption to ventilating, water, and power circuits. The plan was promptly abandoned, and thereafter, so long as the tunnel was excavated to full size, the work was done by the heading and bench method. In August, 1907, owing to lack of available funds, it became necessary to reduce expenditures. It was decided to continue excavations in both headings and to confine the work to an undercut drift 8 feet high and the full width of the tunnel. There remained at that time a distance of approximately 10,000 feet between the headings. After the headings were connected the section was enlarged to full size, this work being completed in February, 1910.

All water that came into the east end of the tunnel had to be removed by pumps. Almost at the portal small streams of water were encountered, and as the heading advanced into the mountain water-bearing seams with increasing pressures and volumes of water were tapped at frequent intervals. Late in 1907 a flow was tapped that increased the necessary pump discharge to 2⅓ second-feet. In April, 1908, a vein was tapped that stopped all progress in the heading for six months, and required the installation of an additional 10-inch pumping main and additional pumps before the tunnel could be drained sufficiently to permit the resumption of excavation.

In the west end the first 4,000 feet of tunnel produced less than one-half second-foot of water. The succeeding 8,000 feet produced no water; then in December, 1906, there was encountered a seam which carried warm water and carbonic-acid gas in large quantities. The flow was first tapped through a drill hole and the discharge was of such violence that operations at this heading were suspended for six months. The tunnel was then driven for 2,000 feet through a geological fault zone in which at frequent intervals rushes of water would break in from the sides or face, carrying in hundreds of yards of sand which buried tracks and tools for 500 or 600 feet from the breast. In one instance a rush of water under foot loosened the drill columns in the heading by scouring out the sandy bench underneath. After nearly a year of painfully slow and excessively costly work, this ground was passed and the tunnel entered the granites that constitute the main body of the mountain. The various streams encountered in this heading produced a flow of water amounting to 8 second-feet without great diminution from December, 1906, to March, 1909. About the latter date there commenced a gradual reduction in outflow.

Some very creditable progress records were made in driving the tunnel. In the twelve months ending July 1, 1906, there were driven 7,500 feet of tunnel in shale with one gang composed of three shifts. The greatest progress in any month was 824 feet of heading advance. In 1905 there were driven 384 feet of undercut drift in one month in granite rock. One year later, in the same material, there were driven 392 feet of full-size tunnel in one month. Some months later there were driven 449 feet of heading advance in one month, which at the time was the American record in tunnel driving. In March, 1909, there were driven over 400 feet of heading. In a general way, 300 feet per month in granitic formation free from unusual difficulties, 240 feet per month in heavy ground, and 600 to 750 feet per month in shale offering no unusual obstacles, was regarded as satisfactory progress. From the time of opening the portals to the final connection of headings, the average progress for all headings was 255 feet per heading per month. The enlargement from the undercut drift to full tunnel section was accomplished with two gangs at the average rate of 1,665 feet per month. The maximum month's progress was 1,315 feet from the east portal heading and 1,416 feet from the west portal heading.

Soon after excavation was begun it became evident that in parts of the tunnel the walls were disintegrating rapidly under the influence of the air and that the heat and moisture of the tunnel were destroying the timbers. Plans were therefore made to begin immediately the lining of the tunnel with concrete. On the crest of a steep hill overlooking the main shaft a bed of suitable sand and gravel was found and utilized. The mixed product was screened and the separated sand and gravel deposited in storage bins, whence it was hauled downhill 4,500 feet and dumped into chutes leading down the main shaft. At the foot of the shaft it was drawn by gravity into measuring bins, thence into a rotary mixer. The concrete was dumped from the mixer into special cars and transported to the point where it was placed in the forms. For placing the concrete a traveler provided with a hoist was used. The traveler permitted the passage of muck cars underneath and furnished a platform upon which the concrete cars were dumped after being hoisted to the proper height. The concrete was remixed on this platform and shoveled into place. All timbered and a part of the untimbered portions of the tunnel were lined with concrete prior to June 30, 1910. There remain 13,825 feet of unlined rock section of tunnel which it appears will not require lining in the near future. Present plans for construction on the tunnel were completed in June, 1910, and the first water for irrigation purposes was delivered through the tunnel on July 6, 1910.

The following table shows the yearly progress in the construction of Gunnison tunnel:

Gunnison tunnel progress, by years

	1905	1906	1907	1908	1909	1910	Total
Full section:							
Earth and gravel	1,956	1,066					3,022
Shale	3,154	5,146					8,300
Gravel and shale		660					660
Sandstone		304	1,264				1,568
Granite and schist	477	3,181	1,527	200			5,385
Total	5,587	10,357	2,791	200			18,935
Undercut drift, 11 by 8 feet:							
Granite and schist	1,691		2,257	4,077	3,478		11,503
Sandstone			207				207
Total	1,691		2,464	4,077	3,478		11,710
Enlargement:							
Granite and schist	1,691				8,105	1,707	11,503
Sandstone					207		207
Total	1,691				8,312	1,707	11,710

SOUTH CANAL

The south canal has a capacity of 1,300 second-feet, is 11½ miles in length, and extends from the west portal of Gunnison tunnel to the Uncompahgre River, about 9 miles southeast of Montrose, Colo. Its main purpose is the conveyance of water from Gunnison River to Uncompahgre River for distribution through other canals diverting from that river. A small amount of water, however, is distributed directly from several diversion head gates along the south canal.

The west portal cut of Gunnison tunnel is 2,050 feet in length and lined with concrete. From the portal cut to Uncompahgre River the south canal consists of 35,777 feet of earth canal, 19,544 feet of concrete-lined canal, 5 tunnels 2,663 feet in aggregate length, and a wooden flume 352 feet in length. There are twelve vertical drops aggregating 117.5 feet in height and three inclined chutes aggregating 91 feet in height on the concrete-lined portion of the canal. Beginning at the end of the portal cut, the dimensions, distances, and facing materials of the south canal are as follows: A concrete-lined chute ending in a vertical drop of 10 feet and given a total fall of 30 feet in 520 feet; concrete-lined canal with bottom width of 25 feet, depth of 4.5 feet, side slopes of 1 to 1, including two vertical drops each of 11.55 feet fall; earth canal with bottom width of 30 feet, depth of 10 feet, side slopes of 2 to 1 extending 1½ miles; a concrete-lined section with bottom width of 6.3 feet, depth of 8.45 feet, and side slopes of 1 to 1 extending through a 40-foot cut and ending in two 8.17-foot drops; an earth section with bottom width of 30 feet, depth of 10 feet, and side slopes of 2 to 1 extending nearly half a mile to mile 2; an inclined concrete chute with a fall of 46 feet in 350 feet; a concrete-lined canal with bottom width of 8 feet, depth of 8½ feet, and side slopes of ½ to 1 extending 1.5 miles through deep cuts and along steep hillsides and including 3 concrete-lined tunnels 10 feet square and aggregating 1,877 feet in length; a concrete-lined section with a bottom width of 25 feet and containing seven vertical drops with a total fall of 68 feet in 2,430 feet; a concrete-lined section with bottom width of 13 feet, depth of 6.4 feet, and side slopes of ½ to 1 extending half a mile; an earth section with bottom width of 30 feet, depth of 10 feet, and side slopes of 2 to 1 extending, with the exception of a concrete-lined 35-foot cut, to a short distance beyond mile 8; a concrete-lined canal 13 feet in bottom width passing through a 40-foot cut; a short section of earth canal; tunnel No. 4, 396 feet in length; a concrete-lined canal 8 feet in bottom width extending 500 feet; a 352-foot wooden flume across an arroyo; tunnel No. 5, 390 feet in length; a short length of concrete-lined canal 8 feet in bottom width; an inclined chute with a fall of 25 feet in 260 feet; a concrete-lined canal 13 feet in bottom width extending a third of a mile; an earth canal with a bottom width of 40 feet, depth of 8.3 feet, and side slopes of 2 to 1 extending 2½ miles and ending in a timber-crib outlet structure discharging into the channel of Uncompahgre River.

The approximate location of the south canal was determined from a study of the topographic maps of the project during the winter of 1903-4. A field party began the preliminary location in April and completed the final location early in July, 1904. On July 13, 1904, a board of engineers, consisting of W. H. Sanders, G. Y. Wisner, and J. H. Quinton, recommended the approval of the location and of the plans that had been prepared.

Proposals for the earthwork of approximately 4 miles of canal comprising divisions 1 to 9 were opened under Specifications No. 16 on September 15, 1904, and three contracts for the work were executed October 18. The work under these contracts was completed, respectively, in April, June, and September, 1905. On August 28, 1905, proposals under specifications No. 47 were opened for the work on divisions 10 to 21, inclusive, of the south canal. A contract for the entire twelve divisions was executed on September 30, 1905. The contractors began work in October, 1905, and completed the contract in October, 1907. Proposals for the construction of division 22 were opened June 1, 1907, and a contract for the work was executed on June 3. This contract was completed in May, 1908. Miscellaneous construction work on the canal was done under contract and some minor parts of the work were executed by force account.

During the years 1908 and 1909 a ditch rider, assisted occasionally by a gang of laborers, used water from the Gunnison tunnel to season the banks of the canal and to puddle leaks, and placed earth lining through shale cuts and fills. A break on division 18 necessitated the relocation and reconstruction of a part of that division, including the construction of a temporary 352-foot flume with capacity of 400 second-feet, for use pending the construction and seasoning of a dike which has not yet been completed.

MONTROSE AND DELTA CANAL

The Montrose and Delta canal diverts water from Uncompahgre River 2 miles below the south canal outlet, crosses the bottom lands, follows the bluff on the west, crosses Spring Creek Mesa, and discharges into Coal Creek. The natural channel of Coal Creek is used for about 5 miles. A timber dam then diverts the water into an extension of the canal which follows the foot of the small mesas. The total length of main line is 31½ miles, and the system includes six laterals aggregating 46½ miles in length.

The construction of the Montrose and Delta canal was begun in 1883 and completed to Coal Creek in 1884. The extension was constructed in 1885 and 1886. The system was acquired by the United States through purchase from the Montrose and Delta Canal Company in May, 1908. The principal structures, which are all of timber, are the intake, the flumes over Horsefly, Dolores, Happy Canyon, Spring, and Dry Creeks, and the head gates for supplying the laterals.

During the winters since the canal was purchased the first 15 miles of the main line were enlarged to double its former capacity, the whole system was cleared of brush, some lateral reconstruction was done, and some new timber structures were built. During the summer of 1910 the lateral system under the extension canal is being extended and completed to cover a considerable area of land hitherto unirrigated.

LOUTSENHIZER CANAL

The Loutsenhizer canal is the third largest canal diverting water from the Uncompahgre River. The system includes 26.3 miles of main line and 12.3 miles of laterals. The lands irrigated lie east of the river and principally between Montrose and Olathe. The large structures on this canal are the diversion weir at the headworks and the flume over Cedar Creek, both of which are built of timber. The Loutsenhizer canal was built in 1883 by O. D. Loutsenhizer and subsequently purchased and enlarged and extended by the Loutsenhizer Canal Company. The canal was purchased by the United States in September, 1908, and will be enlarged and used as part of the distribution system of the completed project.

IRRIGATION

Irrigation by the Reclamation Service has been confined to the delivery of water from the Montrose and Delta and Loutsenhizer canals. In 1908, 11,000 acres were irrigated from the Montrose and Delta canal; in 1909, 15,600 acres were irrigated from the Montrose and Delta and the Loutsenhizer canals; and in 1910 approximately 20,600 acres are being irrigated from these canals.

PROGRESS DURING FISCAL YEAR 1910

Force account work on Gunnison tunnel has been continued throughout the year. The headings of the undercut drift met on July 6, 1909. The water and ventilating pipes were then removed and the work of enlargement to full section was begun. The enlargement, trimming, and cleaning of the tunnel was completed in March, 1910. By June 30, 1910, the concrete lining for all timbered sections and all rock sections where rapid disintegration would be likely to occur had been completed. The portal cut at the west end of the tunnel was lined with concrete and the steel head gates at River Portal were installed during July and August, 1909. A concrete-lined channel and earth and rock dikes have been constructed to protect the tunnel and portal cut from injury by cloud-bursts in Cedar Creek Valley.

During July and August, 1909, the work on the new location of division 18 of the south canal was completed, concrete lining being placed in parts of the canal and in the tunnel on the canal line, and a wooden flume 352 feet long being constructed. The concrete chute connecting the portal cut of Gunnison tunnel with the south canal was completed in September, 1909.

The enlargement of the Montrose and Delta canal from Uncompahgre River to Coal Creek by force account was authorized by the Secretary of the Interior on October 13, 1909, and was begun on November 1, 1909, and completed on April 1, 1910. The first half mile of King lateral was relocated; and the work on the new line, including timber diversion works, a galvanized-iron flume 208 feet long, and three timber drops, has been completed. The location surveys for 21 miles of main laterals from the Montrose and Delta canal have been made and the excavation of 11½ miles of these laterals has been completed by force account.

Many landowners are subdividing their holdings, and many sales of small tracts to new settlers have been made. Water service on the Montrose and Delta and Loutsenhizer canals was maintained throughout the irrigation seasons, the routine cleaning of canals and repairing of structures having been carried on as required. It is estimated that during the season of 1910 about 16,000 acres have been irrigated from the Montrose and Delta canal and about 4,600 acres from the Loutsenhizer canal.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Uncompahgre Valley project

ASSETS

Accounts receivable: Uncollected miscellaneous			$113.50
Inventories:			
Mercantile store		$4,224.18	
Government animals		505.25	
Storehouse		28,096.37	
Cement		8,938.05	
Lumber		1,432.44	
Explosives		401.93	
Forage		1,876.28	
Fuel		271.25	
Cash in office safe		1,005.40	
Unadjusted transfers		1,366.87	
			48,118.02
Cost of work:			
Building cost		4,263,656.37	
Less adjustments	$12,724.91		
Less accrued revenues	89,617.68		
		102,342.59	
			4,161,313.78
Total assets			4,209,545.30

LIABILITIES

Investment of the United States:			
Disbursement vouchers	4,229,588.66		
Transfer vouchers received	86,427.10		
		4,316,015.76	
Collection vouchers	143,384.34		
Transfer vouchers issued	5,992.38		
		149,376.72	
			4,166,639.04
Accounts payable:			
Unpaid labor		22,765.13	
Unpaid purchases		9,563.57	
Unpaid contract holdbacks		1,000.00	
Unpaid freight and express		8,899.06	
Unpaid passenger fares		156.70	
Unredeemed coupon books		521.80	
			42,906.26
Total liabilities			4,209,545.30

Feature costs to June 30, 1910, Uncompahgre Valley project

Storage: Preliminary examination Taylor Park dam		$485.37
Cimarron lateral: Topography		1,209.38
Gunnison tunnel:		
Headworks—head gates, excavation, and concrete	$20,726.20	
River portal heading	993,033.92	
West portal heading	1,646,547.84	
Portal cut excavation	118,218.73	
Tunnel road	37,345.26	
Engineering	61,481.55	
		2,877,353.50
Canal system:		
South canal	763,791.52	
West canal	14,544.42	
East canal	8,817.57	
Purchase of existing canal systems (outstanding water rights and real estate)	138,335.17	
Lateral system—Loutsenhizer canal	2,268.88	
Spillway—South canal	1,309.88	
Channel lining Cedar Creek	2,843.72	
		931,911.16
Preliminary operation of canals:		
General expense	8,203.27	
Earthwork	145,571.71	
Structures	9,792.94	
Distribution	9,443.46	
Protection	824.63	
		173,836.01
Buildings: Montrose office		11,353.03
Telephone system construction		6,256.27
Topographic surveys		64,609.88
Irrigable lands: Farm-unit subdivision and soil examination		3,180.23
Examination of project as a whole: Expert engineering, hydrography, geology, lateral investigation, reconnaissance, etc		26,842.46
Administration of project as a whole:		
General expense	$130,707.99	
Montrose office expense	35,650.92	
		166,358.91
Power development: Surveys		260.17
Total building cost as per debit in cost of work in statement of assets and liabilities		4,263,656.37

IDAHO, BOISE PROJECT[a]

LOCATION AND CLIMATIC CONDITIONS

Counties: Ada and Canyon.
Townships: 1 S. to 4 N., Rs. 1 to 5 W. and 1 to 3 E., Boise meridian.
Railroads: Oregon Short Line; Boise, Nampa and Owyhee; Idaho Northern.
Railroad stations: Boise, Nampa, Caldwell, and Meridian, Idaho.
Average elevation of irrigable area: 2,500 feet above sea level.
Average annual rainfall on irrigable area: 12.7 inches.
Range of temperature on irrigable area: −28° F. to 107° F.

WATER SUPPLY

Source of water supply: Boise River.
Area of drainage basin: 2,610 square miles.
Annual run-off in acre-feet of Boise River near Highland (2,610 square miles): Maximum, 3,100,000; minimum, 1,200,000; mean, 2,190,000.

ENGINEERING DATA

Reservoir: Deer Flat—area, 9,250 acres; capacity, 186,000 acre-feet; no spillway.
Storage dams: Upper Deer Flat—type, earth fill; maximum height, 70 feet; length of crest, 4,000 feet; volume, 932,200 cubic yards. Lower Deer Flat—type, earth fill; maximum height, 40 feet; length of crest, 7,200 feet; volume 936,600 cubic yards. Others not designed.
Diversion dam: Boise—type, rubble concrete weir; maximum height, 45 feet; length of crest, including logway, 246 feet.
Length of canals: 83 miles with capacities greater than 300 second-feet; 100 miles with capacities from 300 to 50 second-feet; 360 miles with capacities less than 50 second-feet.
Water power: Estimated total, 4,000 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: 243,000 acres.
Present status of irrigable lands: 85,820 acres entered subject to the reclamation act, 30,059 acres of state lands, 127,130 acres in private ownership.
Area for which the Service is prepared to supply water, season of 1910: 65,000 acres.
Area irrigated, season of 1910: 30,000 acres.
Length of irrigating season: 214 days.
Character of soil of irrigable area: Light sandy loam.
Principal products: Alfalfa, sugar beets, apples, prunes, and small fruits.
Principal markets: Payette, Nampa, Boise, Meridian, and Caldwell, Idaho; Portland, Oreg.; eastern cities.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1902.
Construction authorized by Secretary March 27, 1905.
First irrigation by Reclamation Service, season of 1906.
Main canals of New York Canal Company and Idaho-Iowa Lateral and Reservoir Company acquired March 3, 1906.
Boise dam completed September, 1908.
Lower Deer Flat embankment completed January, 1908.
Upper Deer Flat embankment completed September, 1908.
Project, exclusive of Boise River storage, 70 per cent completed June 30, 1910. Storage possibilities not fully determined.

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[a] Described in former reports as the south-side Boise unit of the Payette-Boise project.

IRRIGATION PLAN

The irrigation plan of the Boise project provides for the storage of water in reservoirs on the headwaters of Boise River and in Deer Flat reservoir, near Caldwell and Nampa, Idaho; the diversion of water from Boise River by the Boise dam about 8 miles southeast of Boise, Idaho; the distribution of water on the south side of the river through a main canal leading from the diversion dam to the Deer Flat reservoir, laterals heading in the main canal, distributing canals taking water from the reservoir, and canal systems taking water from Boise River below the Boise dam; and the distribution of water on the north side of the river to a small area of land east of Boise, through a canal system heading at the Boise dam.

ORIGIN OF PROJECT

The settlement and irrigation of Boise River Valley above the confluence of Boise River with Snake River have been in progress for many years. The first efforts at irrigation were confined to the bottom lands along the river below Boise. The river through this section is broad and shallow, with low banks and a fall of about 8 feet to the mile, making it easy to divert water to the bottom lands at nearly any point in its course. At a distance of one-half to 2 miles from the river on the south side are found bench lands arising somewhat abruptly to a height of 40 to 75 feet above the bottom lands with gradual upward rise farther toward the south. These bench lands form a ridge between the Boise and Snake rivers and reach heights of 200 to 500 feet above the latter stream toward which they slope quite abruptly. The construction of canals for irrigating these bench lands was first begun in 1888, and after that time a number of canal systems irrigating quite extensive areas of land were built. After the passage of the reclamation act great interest was taken by the settlers of the Boise Valley in the extension of irrigation in this valley by the Reclamation Service. In 1903 and the early part of 1904 various meetings of citizens, irrigation associations, and other local bodies were held to urge upon the Secretary of the Interior the importance of establishing a reclamation project in the valley. Petitions urging the same matter were prepared and forwarded with the signatures of over 1,200 citizens, owning about 95,000 acres of land.

INVESTIGATIONS

A study of conditions in relation to irrigation in the Payette and Boise valleys was begun in May, 1902, by the United States Geological Survey in cooperation with the State of Idaho, the work being under the immediate supervision of the state engineer. The work was continued later by the Reclamation Service and general reconnaissances and preliminary surveys with special reference to the investigation of storage facilities on the headwaters of Boise River were completed early in 1903. In 1904 further surveys were made to determine the character of the works necessary for the proposed project and for making estimates of the cost of construction. These surveys were completed in November, 1904, and together with estimates of costs and preliminary plans were considered by a board of engineers consisting of Messrs. H. N. Savage, A. J. Wiley, H. A. Storrs, and D. W.

Ross, of the Reclamation Service, assisted by F. R. Gooding, governor, and James Stevenson, jr., state engineer of Idaho. This board, under date of February 15, 1905, recommended the immediate commencement of construction of works for bringing under irrigation additional bench lands on the south side of Boise River together with completion of arrangements by which the landowners along the existing canals should gain complete control of the canals and operate them eventually in conjunction with the Reclamation Service. On March 27, 1905, the Secretary of the Interior authorized the commencement of construction on the lines recommended by the board of engineers and allotted $1,300,000 from the reclamation fund for carrying on the work.

INCORPORATION INTO THE PROJECT OF EXISTING CANAL SYSTEMS

Among the considerations deemed of greatest importance in developing the project was that of the relation of the existing canal systems to the project to be developed by the Reclamation Service. The eventual inclusion in the project of all of the canals irrigating lands on the south side of the river was deemed essential to a satisfactory control of the situation and early efforts were directed toward the formation of a water users' association to bring about the coordination of all of the existing canals and irrigation districts. After extended consideration by the landowners concerned and by the representatives of the Reclamation Service, the Payette-Boise Water Users' Association was formed and incorporated in May, 1904. A large number of the owners of irrigated as well as desert lands subscribed for stock in the association and the association contracted with the United States to return the cost of building the necessary irrigation works.

On March 3, 1906, the Reclamation Service entered into contracts with the New York Canal Company and the Idaho-Iowa Lateral and Reservoir Company by which the service secured the right to occupy, control, and enlarge the main canals of these companies extending from Boise River to Indian Creek. By these contracts the service in turn agrees to supply to the stockholders of the New York Canal Company and to the owners of water rights represented by contracts with said company, through existing laterals or new laterals constructed by the service, not to exceed 277.86 second-feet of water, which is the vested water right claimed by the company and its stockholders, and which shall be regarded as of the priority determined by the courts; and agrees to deliver to the stockholders of the Idaho-Iowa Lateral and Reservoir Company, for irrigation and domestic uses, exclusively from the unregulated flow of the Boise River an amount of water not exceeding 10,000 acre-feet in each year with certain allowances for seepage and evaporation, said water to be diverted into reservoirs constructed or to be constructed by the said company.

The formal control by the Reclamation Service and incorporation into the project of other existing canal systems on the south side of the river will be postponed until the construction work shall have been well advanced, but the method and terms of such incorporation are fully determined by contracts entered into during 1906 between the Payette-Boise Water Users' Association and the Pioneer Irrigation District, the Riverside Irrigation District, and the Nampa-Meridian Irrigation District, providing that the owners of irrigated lands in these several districts shall have the right to subscribe for stock in the water users' association and eventually to perfect water rights under the reclamation act by payment of the charges to be assessed by the Secretary of the Interior, a credit of $14 per acre being allowed for the irrigation works constructed or owned and maintained by the said irrigation districts. Previous to this time the Nampa-Meridian Irrigation District had been formed for the purpose of bringing into the mutual ownership of the landowners the Ridenbaugh and Settlers canals theretofore owned by other parties and operated on a rental basis. All of the other canals on the south side of Boise River were already in the mutual ownership of the irrigators or embraced within irrigation districts organized under the laws of the State of Idaho.

STORAGE

In addition to the early surveys relating to storage possibilities on the headwaters of Boise River, further investigations were begun in 1909 and are now being carried on. There have been selected for immediate investigation seven reservoir sites on Boise River and its tributaries, designated and located as follows: Hellgate, on Boise River; Rossi, on north fork of Boise River; Twin Springs and Alexander, on middle fork of Boise River; Joy, Casey, and Bascom, on south fork of Boise River; and Grimes, on Grimes Creek. Borings have been made and bed rock reached at the Hellgate dam site and preparations are under way for prosecuting similar work at the other sites as rapidly as possible.

CONSTRUCTION

DEER FLAT RESERVOIR

An important feature of the project is the Deer Flat reservoir, situated about 4 miles west of Nampa, Idaho. To form this reservoir two dams were required, known as the upper Deer Flat embankment and the lower Deer Flat embankment. The upper embankment has a maximum height of 70 feet and a length of crest of 4,000 feet and contains 932,200 cubic yards of material. The lower embankment has a maximum height of 40 feet, a length of crest of 7,200 feet, and contains 936,600 cubic yards of material.

Through the upper embankment reenforced concrete outlets are provided for two canals, one at each end of the embankment, and through the lower embankment an outlet is provided for one canal. The east outlet through the upper embankment and the outlet through the lower embankment each have three openings 6 feet square, closed at the upper end by 5 by 6-foot rectangular cast-iron gates. The gates are operated from gate towers that extend above the water in the reservoir and are connected to the crests of the embankments with steel-stringer footbridges resting on steel and concrete supports. The west outlet through the upper embankment consists of a 4½ by 6-foot rectangular culvert in which is installed a 30-inch cast-iron pipe controlled at its lower end by a 30-inch cast-iron valve. During the summer and fall of 1905, plans and specifications were prepared for the construction of the upper and lower Deer Flat embankments, the dam and diverting works on Boise River and the main canal from the diversion dam to the Deer Flat reservoir. In October, 1905, these plans and specifications were reviewed by a board of engineers consisting of Messrs. A. J. Wiley, D. C. Henny, D. W. Ross, and F. C. Horn and recommended to the department for approval and advertisement. Proposals for the construction of these works, under specifications No. 68, were opened February 1, 1906. All bids received for the construction of the upper Deer Flat embankment were deemed excessive and were rejected, and construction by force account was authorized. The work was completed in September, 1908. A contract was awarded on June 16, 1906, for the construction of the lower Deer Flat embankment, and this work was completed in January, 1908.

BOISE DIVERSION DAM

The diversion of water from Boise River into the main canal supplying water to distributing laterals and Deer Flat reservoir is accomplished by means of a dam on Boise River about 8 miles southeast of Boise, Idaho. The dam is built of rubble concrete masonry founded on compact gravel and is 35 feet in height above the river bed and 400 feet in length. It is back-filled with earth and gravel along the upstream face and has a rock-and-gravel-filled timber apron at its toe. At the west end of the structure there are two diverting tunnels 8½ by 15 feet in cross section, a logway with a crest 4 feet lower than that of the spillway, a fish ladder, and the headworks of the main canal. The diverting tunnels are controlled by two 6 by 10-foot cast-iron gates, and in the headworks of the canal are installed eight 5 by 9-foot gates. At the east end of the dam is located a small canal conduit having a single intake gate. Proposals for the construction of the dam and diversion works, under specifications No. 68, were opened February 1, 1906, a contract was executed February 21, 1906, and the work completed in October, 1908. The first work done under the contract was the construction of the diverting tunnels, in order that the flow of the river might be turned through the tunnels as soon as possible, so as to facilitate the excavation for the foundations for the remaining part of the dam. A portion of the foundation excavation at the east end of the dam was accomplished by means of a cofferdam previous to the completion of the diverting tunnels.

Concrete for the tunnels and for most of the fish ladder and a part of the headworks was mixed on the west side of the river, using gravel from the necessary excavations. The plant for the work consisted of a Blake crusher and a large Colorado mixer driven by electric motors, slip scrapers for handling the gravel, and ore cars and skips for delivering the concrete to the work. All of the concrete for the east abutment and cut-off wall, for the body of the dam, for the spillway crest, and for part of the headworks and west cut-off wall was mixed on the east side of the river, gravel being used from a pit on a side hill about a quarter of a mile upstream from the mixer. Blake crushers, driven part of the time by electric motors and part of the time by steam, and a 20-foot Smith mixer driven by an electric motor were used. The concrete was transported from the mixer to the work in ore cars run on a bridge and was at first dumped through chutes into skips which were handled with derricks; later the ore cars were handled directly with the derricks. The main body of the dam, amounting to nearly 16,000 cubic yards, consisted of rubble concrete, except that face courses composed of embedded rocks at least 30 inches in depth laid in Portland cement mortar were required. The rock for the masonry was secured from a vertical cliff on the east side of the river, the face of which was from 80 to 100 feet above the dam. Derricks were used at the quarry for loading the rock on cars running on an inclined track to the site of the dam, where other derricks lowered the rocks into place. The most satisfactory method of construction was found to be for a day force of masons and helpers to lay the face course of solid rock, keeping both faces higher than the interior part of the masonry, and for a night force of laborers to place the uncoursed masonry in the interior part of the dam, using rock directly from the cars and also from piles laid aside by the masons during the day. In placing the interior masonry, concrete was spread to a depth of 6 to 12 inches, large rocks were carefully bedded in the concrete as close together as possible, the spaces being filled with smaller stones, and the whole was then filled with fresh concrete, the rocks being given a final shaking to insure filling all crevices. A timber-crib apron 216 feet long, 48 feet wide, and at its lower side extending 13 feet below the bed of the stream, was constructed below the dam. It is made of 12 by 12-inch timbers placed about 8 feet from center to center, the timbers being drift-bolted together and also fastened together with rods and yokes. The top or deck course is laid solid and the upstream portion is reenforced with 4 by 12-inch planks spiked to the 12 by 12 timbers; 3 by 12-inch sheet piling driven along the downstream face of the crib is spiked thereto. Before putting on the deck course the cribs were filled with coarse gravel sluiced into place. For a distance of 40 feet on the downstream side of the apron riprap 3 feet in thickness and consisting of stones up to one-half cubic yard each in volume was placed by hand. A contract for the gates, guides, and lifting devices to be used in the diversion tunnels and canal headworks was executed April 5, 1906, and delivery of the material was completed in April, 1907. The gates were installed by the contractor for constructing the dam and diverting works.

MAIN CANAL

The main canal of the project heads at the Boise diversion dam and follows the course of the canal acquired in 1906 from the New York Canal Company and the Idaho-Iowa Lateral and Reservoir Company, a distance of 26 miles to Indian Creek. The waters are here diverted into the creek and conveyed through its channel for a distance of about 9 miles and there diverted into a new canal 8 miles in length, discharging into Deer Flat reservoir. The construction of this canal, covered by specifications No. 68, consisted of enlarging portions of the existing canal from the headworks to Indian Creek and the construction of a canal from Indian Creek to

Deer Flat reservoir. The capacity of the canal before enlargement was about 200 second-feet and the capacity to which it was to be enlarged was 1,500 second-feet. The new bottom width is generally 40 feet and depth of water 8 feet. The proposals received on February 1, 1906, for the first part of the work, from the diversion dam to Indian Creek, were deemed unsatisfactory, but a contract was awarded at that time for the portion of the canal from Indian Creek to Deer Flat reservoir. The contract was executed in February, 1906, and the work completed in March, 1908. The work of enlarging the canal from Boise River to Indian Creek as a part of the main canal, after the rejection of bids under specifications No. 68, was readvertised under specifications No. 79. Proposals were opened April 16, 1906, and two contracts for different parts of the work were executed on April 19 and May 12, respectively. The contract for the part of the work beginning at the diversion dam was completed in April, 1908. The contractor for the other portion of the work carried it on so unsatisfactorily that it was necessary to suspend the contract on October 27, 1908, after which time the work was done by force account and completed in January, 1909. During the years 1909 and 1910 parts of the canal were lined with concrete and concrete checks were constructed.

A further enlargement of the main canal above Indian Creek to give it a bottom width of 70 feet instead of 40 feet and a capacity of 2,700 second-feet was begun in the season of 1909, and plans and specifications for the completion of this work have been prepared. In connection with the enlargement some parts of the canal will be lined with concrete and in other parts concrete drops are constructed to diminish the grade of the water surface and the velocity of the water.

DISTRIBUTING CANALS AND LATERALS

The distributing canals and laterals constructed by the Reclamation Service include main distributing canals heading at the Deer Flat reservoir outlets and the necessary lateral systems to convey the water to the irrigable lands, the enlargement and extension of existing laterals from the main canal, the construction of new laterals from the main canal, and the construction of a few new laterals from the Ridenbaugh canal. Construction work was begun in 1908, the excavation being carried on mainly by contract and the structures being erected by force account. During the season of 1908 and 1909 a large part of the excavation of the laterals was done with the cooperation of the Payette-Boise Water Users' Association, the association entering into contracts with the settlers to do the work, the Reclamation Service making the surveys and supervising the construction of the canals, and payments for the work being made with certificates receivable by the Reclamation Service in payment of water-right charges. More than 2,000,000 cubic yards of material were excavated under these contracts, and certificates to an amount greater than $277,000 were issued therefor. The work during the season of 1910 has been entirely under cash contracts, and on June 30, 1910, the construction of the distribution system was about 75 per cent completed.

IRRIGATION AND SETTLEMENT

Beginning with the season of 1907, when the management and operation of the New York canal was assumed, the Reclamation Service has each year delivered water through this canal to the stockholders of the New York Canal Company in accordance with the contract with that company. During the season of 1907 about 10,000 acres, during the season of 1908 about 15,000 acres, and during the seasons of 1909 and 1910 about 18,000 acres of such lands were irrigated. During the season of 1909 the Reclamation Service, in addition to supplying water to the stockholders of the New York Canal Company, furnished water on a rental basis to about 4,000 acres of new land on the project, and during the season of 1910 the lands receiving water on a rental basis were increased to about 12,000 acres. The operation of the private canals has been carried on by the irrigation districts controlling them, and from 60,000 to 70,000 acres of land have been irrigated each year from them.

Practically all of the public land of the project has been entered and nearly all of the entries have been conformed to farm units as shown on the farm-unit plats. Opportunities for additional settlers to obtain lands lie, therefore, in the subdivision and disposal of private holdings and assignment of homestead entries, the residence requirements for which have been completed. Partially as a result of irrigation development of the project and partially as a result of general development of the country, the towns located on the project are making rapid advancement and growth.

PROGRESS DURING THE FISCAL YEAR 1910

Investigations of storage possibilities on the headwaters of Boise River were resumed during the fiscal year and will be continued.

At the Boise dam repairs consisting of filling with large rocks the supporting cribs of the apron, replacing the timber floor of the apron, riprapping the banks and bed of the river below the dam with large-sized rocks, and grouting the riprapped area below the logway were made. These repairs required the placing of 4,760 cubic yards of rock and 178,432 feet b. m. of lumber.

Nine thousand two hundred seventy-one linear feet of the main canal were lined with concrete 4 inches thick, placed in sections 16 feet long, with suitable longitudinal joints, 8,347 cubic yards of concrete being used. Seven thousand two hundred linear feet of the canal were widened from a 40-foot base width to a 70-foot base width, 86,667 cubic yards of material being excavated in the work. The portion of the channel of Indian Creek through which the waters of the main canal are conveyed was improved by straightening and riprapping, 18,120 cubic yards of material being excavated and 6,611 square yards of riprap being placed. Eleven checks were placed in the canal during the fiscal year, three in the section below Indian Creek and eight in the upper section, 8,000 cubic yards of material being excavated and 1,690 cubic yards of concrete, 192,470 pounds of steel reenforcement, 24,120 feet b. m. of lumber, and 1,597 square yards of riprap being placed. In the widening and lining of the main canal above Indian Creek there remain about 400,000 cubic yards of material to be excavated and 23,000 cubic yards of concrete lining to be placed.

Owing to the appearance of seepage water below the upper Deer Flat embankment, improvements, consisting of a suitably drained gravel blanket about 200 feet wide and 1,000 feet long over the area below the embankment, the driving of a line of sheet piling along the lower edge of this blanket and the installation of a drain beneath the blanket next to the line of piling, for conducting the accumulated seepage water into an open drain, were made. About 78,000 cubic yards of gravel, 8,000 linear feet of tile, 1,500 linear feet of closed box drain, and 88,000 feet b. m. of sheet piling were required for the work. It is proposed to place additional protection from wave action on the water slopes of both the upper and lower Deer Flat embankments, and studies are being made for the purpose of determining the most economical and efficient kind of protection to be used.

Surveys for the lateral system have been practically completed. Excavation of laterals has been in progress throughout the year and has been done almost wholly by contract. During the year, 91 contracts were let, involving the excavation of approximately 300,000 cubic yards of material. Numerous drops, weirs, checks, flumes, culverts, and bridges have been built during the year by force account. In the building of these structures approximately 2,500,000 feet b. m. of lumber have been used.

In March, 1910, work was begun on the construction of a telephone system for use in the operation of the canals, and at the close of the fiscal year the main trunk lines of the system were completed. Contracts have been entered into with two private telephone companies permitting the Reclamation Service to string wires on the pole lines of these companies. About 110 miles of metallic circuit have been installed on new pole lines and 31 miles on the pole lines of the private companies. The whole telephone system of the service is about half completed, but it already connects the Boise office with the offices of the various water masters.

Owing to the unusually warm weather during March and April, the maximum run-off of Boise River occurred considerably earlier than usual, and the low-water period consequently began comparatively early in the season. Water was turned into the main canal for the purpose of storing in Deer Flat reservoir on January 26. On March 2 the water in the reservoir reached the height of the outlets and on June 30 there were 19,700 acre-feet of water in the reservoir available for use. Considerable seepage has taken place from the reservoir during the year, but a marked improvement is shown in this respect over the seepage losses occurring in 1909. The reservoirs of the Idaho-Iowa Lateral and Reservoir Company were filled during the season in accordance with the contract between that company and the United States. The delivery of water for irrigation was begun on April 15, and on June 30 water had been delivered to about 18,000 acres of land covered by New York canal rights and to about 12,000 acres under rental contracts.

Owing to the lateness of planting and in some cases improper preparation of the ground, lateness of construction of field ditches, and damage by squirrels and rabbits, the yields of crops on the new lands in cultivation are rather light. On the whole, however, they are regarded as satisfactory in consideration of the newness of the lands, and general good feeling prevails among the water users on the project.

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PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal current contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Boise project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
103	May 19, 1906	Page & Brinton	Main canal, excavation.	$135,900.00	$244,111.13	Oct. 28, 1908
104	Feb. 21, 1906	Utah Fireproofing Co.	Boise River dam and headworks.	158,950.00	[a]171,358.02	Jan. 1, 1908

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Boise project

ASSETS

Inventories:				
Mercantile store			$32.35	
Government animals			7,052.50	
Equipment in use			63,816.34	
Storehouse			3,083.50	
Cement			14,013.93	
Iron and steel			2,938.74	
Lumber			7,786.02	
Forage			1,856.32	
Fuel			228.86	
Cash in office safe			32.45	
Local products			3,443.49	
Unadjusted transfers			1,909.83	
				$106,194.33
Cost of work:				
Building cost			3,404,327.18	
Less adjustments	$1,762.36			
Less accrued revenues	66,631.64			
		68,394.00		
				3,335,933.18
Total assets				3,442,127.51

LIABILITIES

Investment of the United States:			
Disbursement vouchers	3,352,382.88		
Transfer vouchers received	94,612.23		
		3,446,995.11	
Collection vouchers	43,791.29		
Transfer vouchers issued	29,911.52		
		73,702.81	
			3,373,292.30
Accounts payable:			
Unpaid labor		15,743.17	
Unpaid purchases		14,220.55	
Unpaid contract estimates		22,558.98	
Unpaid freight and express		9,774.90	
Unpaid passenger fares		89.35	
Unpaid land agreements		3,973.00	
Unredeemed meal tickets		797.35	
Unpaid miscellaneous		1,677.91	
			68,835.21
Total liabilities			3,442,127.51

Feature costs to June 30, 1910, Boise project

Administration of project as a whole, general expenses		$166,229.65
Examination of project as a whole:		
Surveys	$36,049.24	
Water supply	10,147.93	
		46,197.17

Diversion dam in Boise River:		
Location and surveys	$944.70	
Original construction	269,219.24	
Repairing	48,696.01	
		$318,859.95
Main canal:		
Location and surveys	6,515.52	
Right of way	2,991.29	
Canal construction, earthwork	774,991.06	
Structures	177,878.55	
Lining	113,279.00	
		1,075,655.42
Distributing system from main canal:		
Location and surveys	29,931.09	
Right of way	2,461.48	
Canal construction, earthwork	304,048.36	
Structures	157,927.80	
Drainage system, examination	88.83	
		494,457.56
Storage, Deer Flat reservoir:		
Location and surveys	3,305.97	
Right of way	215,459.17	
Upper embankment	302,777.31	
Lower embankment	288,590.09	
Small embankment	11,637.50	
		821,770.04
Distributing system from reservoir:		
Location and surveys	16,516.49	
Canal construction, earthwork	204,061.67	
Structures	103,095.61	
Drainage system	10,372.39	
		334,046.16
Storage on Boise River: Preliminary investigations and surveys		10,408.19
Penitentiary canal:		
Right of way	1,661.47	
Canal construction by cooperative contract	14,245.87	
Structures—Miscellaneous force account work	3,219.67	
		19,127.01
Irrigable lands:		
Farm units, subdivision	9,123.66	
Crop reports, investigation, etc	967.26	
Experiment farms, cultivation of	2,254.25	
		12,345.17
Telephone system:		
Location and surveys	306.97	
Construction	12,480.36	
		12,787.33
Payette division: Location and surveys		231.22
Storage, Payette Lake: Right of way		1,679.08
Operation and maintenance:		
Main canal system	79,367.05	
Reservoir system	8,214.29	
Penitentiary canal	2,951.89	
		90,533.23
Total building and operation and maintenance cost during construction as per debit in cost of work in statement of assets and liabilities		3,404,327.18

IDAHO, MINIDOKA PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Lincoln and Cassia.
Townships: 8 to 11 S., Rs. 22 to 25 E., Boise meridian.
Railroads: Minidoka and Southwestern; Oregon Short Line.
Railroad stations: Acequia, Rupert, Heyburn, and Burley, Idaho.
Average elevation of irrigable area: 4,200 feet above sea level.
Average annual rainfall on irrigable area: 14 inches.
Range of temperature on irrigable area: −2° F. to 98° F.

WATER SUPPLY

Source of water supply: Snake River supplemented by storage. (See Snake River storage.)

Area of drainage basin: 22,600 square miles above diversion dam.

Annual run-off in acre-feet of Snake River at Neeley (16,000 square miles) 1895 to 1908: Maximum, 8,900,000; minimum, 3,830,000; mean, 6,470,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Lake Walcott—area, 11,350 acres; capacity above fixed crest of spillway, 53,500 acre-feet; length of spillway, 2,385 feet; elevation of fixed crest of spillway, 42 feet above stream bed.

Storage and diversion dam: Minidoka—type, rock fill with concrete regulating works; maximum height, 86 feet; length of masonry, 201 feet; length of rock fill, 736 feet; volume, 216,000 cubic yards.

Length of canals: 33 miles with capacities greater than 300 second-feet; 117 miles with capacities from 300 to 50 second-feet; 363 miles with capacities less than 50 second-feet.

Water power: 6,000 horsepower developed; estimated total under present plans, 10,000 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, about 124,700 acres; gravity unit, 76,700 acres; south side pumping unit, 48,000 acres.

Present status of irrigable lands (whole project): 99,500 acres entered subject to the reclamation act, 2,500 acres open to entry, 20,200 acres of state lands, 2,500 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 101,000 acres.
Area irrigated, season of 1910: 62,000 acres.
Length of irrigating season: 214 days.
Character of soil of irrigable area: Clay, sandy loam, and loose sandy soil.
Principal products: Alfalfa, grass, wheat, oats, sugar beets, potatoes, small fruits.
Principal markets: Pocatello, Idaho; Salt Lake, Utah; Butte and Helena, Mont.

LANDS OPENED FOR IRRIGATION (GRAVITY UNIT)

Dates of public notices and orders relating thereto: Public notices, March 9, 1907; November 23, 1908; February 11, 1909; March 30, 1909; February 7, 1910; March 22, 1910; June 10, 1910. Orders: July 19, 1907; December 10, 1907; July 9, 1908.

Location of lands opened: Townships 8 to 10 S., Rs., 22 to 25 E., Boise meridian.

Present status of irrigable lands opened: 71,997 acres entered subject to the reclamation act, 2,500 acres open to entry, 6,236 acres of state lands, 255 acres in private ownership.

Limit of area of farm units: Public, 80 acres; private, 160 acres.
Duty of water: 3 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $22 and $30.
Annual maintenance and operation charge: $0.75 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun March, 1903.
Construction authorized by Secretary April 23, 1904.
Minidoka dam completed September, 1906.
North canal and distributing system completed July, 1907.
First irrigation by Reclamation Service, season of 1907.
Power house completed for present use December 1, 1909.
Machinery for 5,760 horsepower installed prior to June 30, 1910.
South-side pumping system, 67 per cent completed June 30, 1910.
Whole project, 79 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Minidoka project provides for the diversion of the waters of Snake River by a combined storage, diversion, and power dam about 6 miles south of Minidoka, Idaho, into two canal systems, one on either side of the river, watering lands in the vicinity of Acequia, Rupert, Burley, and Heyburn, Idaho. Power developed at the dam will be utilized for industrial purposes and for pumping from the canals to irrigate high lands. Storage for the project will be provided mainly by a reservoir or reservoirs to be constructed in the upper drainage basin of Snake River. (See Snake River storage.)

ORIGIN OF PROJECT

The United States Geological Survey began investigations relative to the possibilities of irrigation development in the Snake River basin in the summer of 1889, and in the spring and summer of the following year a party in charge of F. J. Mills made canal surveys for lands embraced in the Minidoka project. A canal line 35 miles in length, heading a mile and a half above the Minidoka ferry, was surveyed on the south side of the river, and the conclusion was reached that about half a million acres of land could be irrigated from this canal. A canal on the north side of the river, heading at the same place, was run for a distance of 15 miles, but was assumed to be impracticable on account of excessive cost of construction. In 1895 surveys of canal lines 35 miles in length on either side of the river, on a grade plane beginning 42 feet above the elevation of low water, were made by the Idaho state engineer. Private parties have also been interested in the project at various times since about 1888, but no careful surveys were made by them.

After the passage of the reclamation act the lands of the project, which were practically all government lands, were withdrawn from entry by order of the Secretary of the Interior dated November 17, 1902, investigations for development by the Reclamation Service being considered advisable.

INVESTIGATIONS

In March, 1903, surveys by the Reclamation Service were begun. Level lines were run, canals were located, topographic surveys made, and power possibilities and foundations at the Minidoka dam site were investigated. Estimates of cost and plans and specifications under three plans of development were prepared. The investigations were continued in 1904, and in March of that year a board of engineers consisting of Messrs. A. P. Davis, G. Y. Wisner, and H. N. Savage examined the project and the plans for its development and submitted a report approving the project and recommending that $2,600,000 be set aside from the reclamation fund for its construction. The recommendations of the board were approved and the construction of the project authorized by the Secretary of the Interior on April 23, 1904.

CONSTRUCTION

MINIDOKA DAM AND SPILLWAY AND RELATED WORK

Proposals for the construction of Minidoka dam, spillway, gates, and a part of the north-side canal (specifications No. 12) were opened on July 2, 1904, and a contract for the work was executed on September 17, 1904. The construction work was begun in October, 1904, and completed in September, 1906, but the testing of gates and structures was not completed until February, 1907.

The Minidoka dam is an earth, gravel, and rock-fill structure with a concrete core, a water face on a slope of 3 to 1, and a downstream face on a slope of 1½ to 1. The rock fill is 736 feet long, 25 feet wide on top, about 300 feet in average bottom width, and rises to a maximum of 86 feet above the river bed, which is of solid lava rock. At the south end of the dam is a concrete gravity section spillway 2,385 feet long and 2 to 15 feet high. The spillway follows the high points of a bed of lava rock in irregular alignment. In the autumn of 1909 reenforced concrete piers 8 feet high, about 5½ feet wide at the base, 4 feet wide at the top, and 18 inches thick were built by force account every 7 feet along the spillway, and the crest of the spillway was raised 2½ feet for a distance of 77 feet at the shore end. A walk was built on the piers for the entire length of the spillway and flashboards that can be placed in grooves in the piers provide for raising the level of the water about 5 feet above the fixed spillway crest, and thus make available additional local storage of about 53,500 acre-feet. At the south end of the spillway are located the headworks of the south-side canal. These works are of reenforced concrete and contain twelve 5 by 6-foot gate openings, controlled by cast-iron sluice gates. An 800-foot earth embankment extends from the headworks to the higher ground on the south side of the river. At the north end of the dam are the controlling works and power-house site. These works are of concrete, founded on rock, and are built across a diversion channel 80 feet wide that was excavated at the end of the dam. They contain five sluice gates, each 8 feet wide by 12 feet high, set at the low-water level of the river, and also ten circular penstock openings for use in connection with the power plant that was later erected. A wall at the elevation of the crest of the dam extends northward from the controlling works a distance of 70 feet to the headworks of the north-side canal. These headworks are of reenforced concrete and contain nine 5-foot by 7-foot openings, controlled by sluice gates. The crest of the dam is 4,250; the main portion of the crest of the core wall, 4,206; the fixed crest of the spillway, 4,240, and the movable crest, 4,245; the bottom of the controlling-works channel, 4,192; the centers of the penstock openings, 4,231; the bottom of the north-canal intake, 4,230; and the bottom of the south-canal intake, 4,234 feet above sea level.

Weather conditions were generally favorable to the work. Labor conditions were favorable at the beginning of the work, efficient labor at reasonable wages being obtainable. Before the completion of the contract, however, scarcity of common labor became a serious handicap. Two 25-per-cent increases in the wage scale were made and efficiency was found to decrease about in proportion to the increase in wages.

The excavation of rock in the diversion channel and canal section was all heavy work. The rock was taken out in lifts of 16 to 20 feet and was transported chiefly by means of cableways. The drills were run by compressed air. A stratum of sand added considerably to the cost and introduced unexpected complications in the work and in the design of the controlling works. Practically all the excavation for the foundation of the dam was wet and required constant pumping, but very little solid rock was removed. The channel section of the river was narrow, but the depth to bed rock was about 25 feet, and sheet piling had to be driven ahead of the excavation for the full depth. Two sets of piling were used. A break in the cofferdam when the excavation was practically completed caused considerable delay and additional expense to the contractor.

Practically all the material excavated from the diversion channel and canal was used in the dam. The rock was loaded into steel skips of 3 cubic yards capacity, and hauled on trucks to two cableways extending across the river channel, but about one-eighth of the total material could be reached directly from the cableways without the use of trucks. Each cableway had a 1,150-foot span and was supported on towers 81 feet high mounted on movable trucks. The safe working load for each cableway was 7 tons. The arrangement was such that the load could be dumped at any point desired by the engineman. The rock in the dam was dropped from a height of from 10 to 60 feet, making a very compact fill. The earth and gravel for the fill was loaded on 3-yard steel dump cars with an orange-peel excavator at borrow pits 1,200 to 1,800 feet from the dam. The cars were drawn to the dam on a tramway and dumped from a double trestle built across the river. The elevation of the trestle was about 20 feet below the top of the dam, and when it could no longer be used a track was laid on top of the rock fill. Water was allowed to rise nearly to the top of the rock fill and the earth and gravel were dumped into the water until the spaces in the rock were filled and a practically water-tight structure was secured.

The concrete core wall has a heavy section, but is without reenforcement. A concrete mixer was set up at the south side of the dam, gravel was delivered to it by a derrick, and the concrete was transported to its place of deposit in cars suspended from the cableway. Later the mixer was moved closer to the work, gravel was delivered to it by wheelbarrows, and the concrete was taken from the mixer and placed with a derrick. Some of the concrete was mixed and placed by hand.

The concrete spillway has a gravity section without reenforcement. The gravel was hauled in wagons and dumped at convenient places along the line of the spillway. A mixer was moved along from place to place, and all concrete was placed with wheelbarrows. Some concrete in the spillway was mixed by hand. The new spillway piers were keyed into the top of the old spillway by cutting notches in the old work, and the vertical reenforcement was anchored into the old work to a depth of about 2½ feet, the lower ends of the reenforcing bars being upset. Collapsible wooden forms were used for the piers. The gravel was hauled and screened under contract, but all other work was done by force account. The concrete was mixed in a ⅓-yard Chicago mixer connected to a gas engine, all mounted on trucks. The aggregate was wheeled up an incline to the mixer and from the mixer the concrete was wheeled along scaffolding to the piers. The mixer was moved to suit the conditions of the work. Before the work was started the water level of the lake above the dam was lowered about 2 feet below the spillway crest, and during construction the river was diverted through the sluice gates at the power-house site.

The concrete in the wall across the diversion channel has a very heavy section and is reenforced with I beams and rails above the gate openings and above and below the penstock openings. The gravel for the concrete was hauled with teams to storage bins and the concrete was prepared with a Smith mixer. A small flat car with two dump buckets conveyed the concrete from the mixer to two derricks, with which the buckets were picked up and dumped. The controlling works were built during the winter and water used for mixing concrete was heated. The sluice gates for the diversion channel, weighing 13 tons each, were hauled to the site from Minidoka. The frames were erected before the concrete was placed in the controlling works, and the stems and lifting devices were installed after the placing of concrete was completed.

Beyond the headgates at the south end of the spillway an embankment of loose rock with earth backfilling was constructed. Rock was at first quarried near the site and hauled in stone boats and wagons. Later, however, the contractor found it more economical to pick up loose rock from the surface of the ground. The earth for backfilling was borrowed from a pit parallel to the embankment, and was handled with Fresno scrapers.

GRAVITY CANAL SYSTEMS

The north side canal heads at the diversion dam with a normal capacity of about 1,400 second-feet. About 8 miles below the dam it divides into four main branches from which are taken smaller branches. About 72,000 acres of land are watered by the system, which includes about 20 miles of main canals and about 260 miles of laterals.

The south side canal has a capacity at present of 650 second-feet, but will be enlarged to a capacity of about 800 second-feet. The main canal is 13 miles long, and waters an area of about 8,000 acres. About 20 miles of laterals distribute the water over this land. The main canal also carries water to supply the pumps which are located at its lower end and raise water for the irrigation of about 50,000 acres of land under the pumping system. The main south side canal was built by contract and has since been enlarged by force account. The smaller laterals were constructed by force account and by the settlers.

The construction of the north side system was begun in the fall of 1904, about 2,000 feet of the main canal being included in the contract for the diversion dam. Most of the heavy work was done by contract, but the smaller laterals were built by force account or by the settlers. The principal difficulties encountered were due to the sandy soil combined with the high winds, which completely or partially filled some of the ditches several times before they were in operation. The topography of the country, also, which in many places follows no general slope, but is simply a series of hills and hollows, made the location of the canals very difficult.

Proposals in accordance with specifications No. 35 for the construction of the north side canal branches and laterals and the south side canal and laterals, for bridges and structures on both canal systems, and for gates and lifting devices for the canal headworks were opened on June 15, 1905. The work was executed under four contracts let in June and July, 1905, and was completed in July, 1907.

POWER PLANT

The power house is located on the downstream side of the concrete controlling works across the diversion channel. The building is of reenforced concrete and consists of a turbine floor, a generator floor, and galleries. The turbine floor, 26 feet 6 inches above the bottom of the tailrace, is supported by a series of arches between foundation walls, spaced 18 feet from center to center. Between these foundation walls are spaces through which the draft tubes discharge.

The generator floor is supported by walls directly above the arches supporting the turbine floor. Through each of these supporting walls a 12-foot arch is located for communication between the several machines. Through the generator floor, located 17 feet 6 inches above the turbine floor, are circular openings 10 feet in diameter, over which the generators are placed. A gallery located 16 feet above the generator floor extends the whole length of the building and across one end and is constructed of structural steel, with a concrete floor. On this gallery floor, across the end, are located the switchboard and field rheostats. On the gallery, along the side, are the transformers and 33,000-volt busses. Under the transformers is located an air duct, through which the air is discharged from the blowers for the cooling of the transformers, and under the switchboard, on the generator floor, are located the 33,000-volt oil switches for the outgoing lines. Twelve feet six inches above the switchboard gallery a lightning arrester gallery is provided for the transmission lines.

The building is 150 feet long, 50 feet wide, 85 feet high on the downstream side, and 18 feet high on the upstream side above the concrete wall across the diversion channel. The roof is supported by structural steel Fink trusses. The purlins are 10-inch channels, on which 4-inch by 6-inch timbers are bolted. On these are nailed matched roofing boards covered by one layer of Regal roofing felt covered with corrugated iron.

The hydraulic machinery consists of vertical turbines of radial and axial downward-flow type, located on the turbine floor and connected to the headwater by means of short penstocks. The penstocks are 10 feet in diameter at the top, tapering to 8 feet 9 inches in diameter, and from there gradually changing to a rectangular section 5½ feet by 9½ feet. The case is of the cylindrical type. The guaranteed average efficiency of these turbines between one-half and full gate is 77 per cent. The average gross head on the turbines during the season is 46 feet, 13 feet of this being draft head. The machines when fully loaded are rated at 2,000 horsepower, and at normal load and highest efficiency use 425 second-feet of water under normal head. The exciter turbines, also of the vertical type, are located on the turbine floor in one of the 18-foot bays and take their water from one of the 10-foot penstock openings, which is provided with a suitable casting containing the penstock gates and seats. The exciter turbines are rated at 180 horsepower at full load, use 44 second-feet of water under normal head, and have an average efficiency between one-half and full gate of 79 per cent.

The electric generating apparatus is located on the generator floor. The main units are 1,200-kilowatt, 2,300-volt, 3-phase vertical alternators of the revolving-field type and are operated at 200 revolutions per minute. On top of each generator are thrust bearings for supporting the rotating element of the turbine as well as the generator. The exciters are 6-pole, 120-kilowatt, 125-volt, compound-wound, vertical, direct-current machines, operating at 425 revolutions per minute. The thrust bearings for supporting the rotating elements of these machines are on top of the turbines. An air-cooled, 3-phase, 60-cycle transformer, stepping the voltage up to 33,000 volts, is provided for each alternator. The blowers for cooling the transformers have a capacity of 20,000 cubic feet of air per minute. They are driven by 17-horsepower direct-current motors, operated at 515 revolutions per minute.

The governors are of the flyball, oil-pressure type. A duplicate apparatus for furnishing oil pressure is installed and consists of a 40-horsepower direct-current motor, driving a rotary oil pump. The oil is furnished by this motor and pump at a pressure of 250 pounds per square inch and is delivered to the regulating valve operated by the flyballs.

A 20-ton hand-operated crane runs the entire length of the building above the transformer gallery. It has a span of 34 feet 2 inches, and the rails are 31 feet above the generator floor. The upstream end of the crane is supported by structural steel columns resting on the transformer gallery. The other end is supported by a concrete girder, which forms part of the downstream side of the building.

The upper end of each penstock is provided with a cast-iron gate and seat having a double bronze stem and equipped with a small auxiliary or filler gate. The filler gate is opened first, equalizing the pressure, then only the dead weight of the gate itself has to be raised, and any friction load due to unbalanced pressure is eliminated. The gates are raised by 6-horsepower, direct-current, series-wound motors and are operated from the generator floor. Each gate is equipped with a limit switch or stop, which cuts out the motor when the gate is completely up or down. In front of the penstock gates are vertical trash racks, consisting of $\frac{3}{8}$-inch by 3-inch bars spaced 1 inch apart.

Proposals for furnishing the hydraulic machinery (specifications No. 153) were opened on June 23, and contract was executed August 5, 1908. Proposals for the electrical apparatus (specifications No. 154) were opened June 24, and this apparatus was furnished under four contracts executed in July, August, and December, 1908. These specifications and contracts included machinery for the three pumping stations as well as for the power house.

The construction of the power house and the installation of the machinery was accomplished by force account, the work being commenced in October, 1908. The first machinery, consisting of a main unit and one exciter, arrived in January, 1909. This machinery was hauled to the dam and installed, and operation was commenced on the 1st of May of that year. By January, 1909, the building was completed to the top of the generator floor, and on top of this was placed a wooden structure to protect the machinery from the weather. In June, 1909, the building construction was continued, the entire structure being completed in October. During the winter of 1909 and 1910 a second exciter and two additional alternators were installed. Space is provided in the power house for a total of five main power units of 1,800 horsepower each, normal rating.

PUMPING STATIONS

About 15 miles below the diversion dam, on the south side of the river, are located the three pumping stations. Station 1 draws its water from the main south-side gravity canal and is designed to pump 500 second-feet of water. One-fourth of this amount will be required by the land under the first-lift canal, while the remainder is elevated at station 2, 1¾ miles distant, to the second-lift canal. A portion of the water in this canal is lifted for the third time at station 3, about one-half mile from station 2, into the third-lift canal. The lift at each station is approximately 31 feet.

Station 1 will, when completed, be equipped with four pumping units, each unit consisting of a vertical, double suction, 125-second-foot, centrifugal pump, direct connected to a 600-horsepower synchronous motor. Each pump is located in a separate pit, and under normal conditions is submerged to a depth of 3 feet. The discharge of the pump is regulated by means of a special cylinder gate, which fits outside the impeller of the pump and which can be moved up or down parallel with the shaft, thus increasing or diminishing the opening between the impeller and the casing. Reenforced concrete pressure pipes 5½ feet in diameter lead from the discharge nozzles of the pumps to the upper canal. The upper end of each discharge pipe is provided with a swinging flap gate or check valve, which prevents the water in the upper canal from running back through the pipe. The motors are located on the main floor of the station building, immediately above the pumps, and the weight of the rotating element of the entire unit is suspended from a roller thrust bearing located on top of the motor. Power is supplied from the main transmission line at 30,000 volts and is stepped down by means of air-blast transformers to 2,200 volts for supplying the motors. The switchboards and transformers are placed on a raised portion of the floor at one end of the building. The structure is built entirely of reenforced concrete. The end of the building containing the electrical apparatus is approximately 30 by 50 feet in plan while the end containing the pumps is 18 by 91 feet. The partitions between the pump pits are 12-inch reenforced concrete walls and the motor floor is supported by heavily reenforced beams. Pilasters 20 inches deep supporting the crane beam divide the side walls of the pump end into panels and add greatly to the architectural effect. The roof is of reenforced concrete 3 inches thick and supported by concrete purlins and beams of neat and substantial design. The electrical end is similar to the pump end except that the crane beam is carried on columns separate from the wall. Station 2 is almost identical with station 1, except that this station will contain but three 125-second-foot pumps and provision is made for the additional transformers necessary for supplying station 3 with electric current at 2,200 volts. Station 3 is similar in general plan to the other two plants, except that it contains no transformers. It is equipped with one 125-second-foot pump and one pump of 75-second-foot capacity. Station 1 rests on earth foundation, but stations 2 and 3 are on solid lava rock.

Construction work was begun November 9, 1908, when ground was broken at station 1. A large amount of rock was encountered in excavating at station 2, and this made progress much slower than at the other stations. Derricks were installed for handling rock, two shifts put on, and the work prosecuted with all possible speed. A rock crusher at station 2 supplied crushed lava rock for all of the structures. Concrete was mixed in the proportions of one part of cement to two parts of sand and four parts of broken lava rock. Freezing of fresh concrete was prevented by building rough sheds over the forms and heating with sagebrush fires for several days after the concrete was placed. A single unit with the necessary switchboards and auxiliary apparatus was installed at each station, and this machinery was housed in temporary wooden buildings for the irrigation season of 1909.

During the summer and fall of 1909 the structures were completed, additional units installed, and the switchboards and other apparatus placed in their permanent positions. The structures were built and all apparatus was installed by force account. The apparatus was furnished under contract in connection with the machinery for the power house.

PUMPING DISTRIBUTION SYSTEM

The canal lengths and lifts of the pumping distribution system are as follows: From the end of the south-side gravity canal to the first pumping station the feeder is 1,650 feet in length, the lift at the station being 29.4 feet. From station 1 the first main canal winds along a bench in a westerly direction parallel to the river for a distance of 18 miles, irrigating about 11,000 acres. From the first-lift canal to the second pumping station the feeder, beginning at station 1, is approximately 1¾ miles in length, and the second lift raises the water 31.6 feet. The main canal for the second lift runs southwest and westerly for a distance of 26½ miles, and irrigates 15,900 acres. From the second to the third station the feeder is one-half mile in length, and the third lift raises the water 31.1 feet. The third-lift canal follows in general the same directions as the second-lift canal, is 25 miles long, and irrigates 23,400 acres, thus completing a total area of 50,300 acres irrigable by pumping.

In order to preserve the priority of filing on the waters of Snake River it became necessary to construct the main works for the south-side tract prior to June 23, 1908. As the land had been open to settlement under the reclamation act for several years, all of the farm units had been filed on, settlers were actually residing upon the land, and a water users' association had been incorporated in the spring of 1908. To expedite construction a contract was entered into between the water users' association and the Secretary of the Interior, whereby the former agreed to build the necessary canals and to issue as payment to the contractors and others performing work or furnishing materials certificates setting forth the value thereof, and receivable by the United States in reduction of water-right charges due, or to become due, upon lands within the project. Contracts were let in March, 1908, by the association for the construction of the first-lift canal. These were awarded entirely to local settlers, either singly or in groups, and for small stretches of work. Upon completion of this canal, the second lift was started, and then the third. A few heavy stretches were built by force account, but these were inconsiderable. In all, about 870,000 cubic yards of material were excavated, and the work was practically completed by the required date. No actual cash was paid for this work, but certificates to the amount of $150,400 were issued by the association.

Contracts for the first portion of the distribution system were let soon after this on the same basis as that on which the main canals had been built, and by this means and through force-account work water was made available in 1908 on a small area lying under the first lift.

In the spring of 1909, by order of the Secretary of the Interior, all outstanding contracts for work payable in certificates were completed, but no new contracts were let except upon a cash basis. The total value of certificate work done was $202,500. Informal contracts were then let to settlers for cash for the excavation of portions of the distribution system. The work was continued throughout the season and practically all of the laterals leading to government farm units were completed. The structures were built by force account, all structures, with the exception of small timber checks and the farm-unit boxes, being constructed of plain and reenforced concrete, in a substantial and careful manner.

SETTLEMENT AND IRRIGATION

About 80 per cent of the lands of the Minidoka project were in government ownership at the inception of the project, and most of the remainder were school lands of the State of Idaho. The lands were rapidly settled when it became known that the Reclamation Service had undertaken the construction of the project and most of the irrigable area had been entered under the homestead act before the farm units had been determined and considerably in advance of the delivery of water. A public notice dated March 9, 1907, opened for irrigation about 82,159 acres of land irrigable from the north-side canal system, 79,987.31 acres of which were in public ownership, divided into 1,202 farm units. However, 985 of these farm units, including 67,145.06 acres, had been previously entered under the homestead act. About 15,000 acres of the lands opened were irrigated during the season of 1907, 24,500 acres during the season of 1908, and 40,000 acres during the season of 1909. During the season of 1910 about 48,000 acres are being irrigated. The usual troubles incident to the early stages of irrigation, such as seepage from canals, erosion of canal banks by waves, and the uprooting of crops in sandy soil by high winds, were encountered. General success, however, attended the efforts of the operation and maintenance force and of the settlers, and satisfactory crops have been produced. Drainage systems for all parts of the project have been found necessary.

Operation of the power plant was commenced about the first of May, 1909, pumping station 1 was first operated on May 7, and the other pumping stations were placed in operation soon after. However, a temporary pumping equipment had been utilized in the season of 1908, beginning June 22, for the irrigation of a small area of land. About 3,600 acres of land in the pumping system were irrigated in 1909 under rental contracts, at the rate of $1 per acre-foot of water used. Water is being supplied to about 14,000 acres of land during the season of 1910, at the rate of $1.50 per acre-foot, and it is expected that the entire area of the pumping system will be regularly opened for irrigation in the autumn of 1910.

PROGRESS DURING THE FISCAL YEAR 1910

The surveys and construction work accomplished during the fiscal year 1910 are as follows: At the power plant the erection of the superstructure of the power house was completed, the second exciter unit and the second and third power units were installed, and a cottage for the superintendent was erected; the temporary buildings for the three pumping stations were replaced by concrete structures, pressure pipes for additional pumping units were built, additional pumping units were installed, a permanent camp and a small cottage were built at the second-lift station, and the erection of a cottage at the first-lift station was begun; surveys for storage at Lake Walcott were made and a movable crest for the spillway, providing for the storage of about 53,500 acre-feet of water, was constructed; the south side pumping distribution system for all government land and for all state land sold prior to 1910, comprising about 42,000 acres of land, was completed, the excavation being done under informal contracts and the structures being built by force account; enlargement of the south side gravity canal to provide the necessary capacity for irrigation in 1910 was accomplished under small contracts and by force account; plans for the waste-water system on the north side were made, the construction of waste-water canals under informal contracts and by force account was begun, and two 6-inch drainage outlets into lava rock were drilled; revision of the farm-unit plats for the gravity system, and preparation of farm-unit plats for the south side pumping system were completed; and contracts for the distribution of surplus electric power for industrial purposes in Rupert, Heyburn, and Burley were let.

Water service was carried on throughout the irrigation season without material difficulty. During the winter the canals and structures were improved and repaired as was found necessary. The season of 1909 was not favorable to agriculture owing to wind and weather conditions. During 1910 conditions have been favorable and excellent crops seem to be assured.

During April, 1910, a sale of town lots in Rupert was held and practically all of the lots were sold. The state land board of Idaho offered for sale several thousand acres southeast of Burley and about 3,000 acres of this land were sold. Many homestead settlers have made proofs as to residence requirements, and some homesteads have been sold. A new cut-off branch of the Oregon Short Line Railroad from Rupert to Bliss and a branch from Burley to Oakley have been graded.

PUBLIC NOTICE DATED FEBRUARY 7, 1910

1. On March 9, 1907, public notice was issued, announcing that water would be furnished in 1907 from the Minidoka project, Idaho, under the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), for the irrigable lands shown upon farm-unit plats of Ts. 9 and 10 S., Rs. 22 and 23 E., Ts. 8, 9, and 10 S., R. 24 E., and Ts. 8 and 9 S., R. 25 E.

2. Many of the farm units shown upon said plats contain irrigable areas which lie above the level of the gravity canals and which it is practicable to irrigate onlv by means of pumping. Water-right applications have, however, in all such cases been required for the total irrigable area of the farm unit.

3. On July 19, 1907, an order was issued announcing that for any farm unit containing an area in excess of 3 acres above the grade of gravity distribution the first installment of the charges for building, operation, and maintenance for such high areas will become due December 1, 1910. On November 26, 1907, a list showing the lands under the gravity system was approved by the Secretary of the Interior, and subsequently filed in the local land office.

4. Water will not be available in 1910 for the high areas for many of such farm units, and in order to provide for a more equitable apportionment of the charges, it is hereby announced that township plats will be filed as soon as practicable in the local land office at Hailey, Idaho, amendatory of and supplemental to the plats and list now on file in the local land office, showing separately for each farm unit the acreage which it is practicable to irrigate by gravity, and the high land acreage irrigable by pumping, or otherwise.

5. After the revised plats have been filed all entrymen whose holdings include irrigable lands which can not be reached by the gravity system will be allowed to amend their water-right applications to conform to the irrigable areas to be shown on the amended plats, and to subscribe to the following conditions, viz:

(*a*) For lands irrigable by gravity the times, terms, and conditions of payment of water-right charges shall be as heretofore announced, and all payments heretofore made shall be credited upon the charges for the gravity-land areas; provided, that whenever lands are added to the areas under the grade of gravity distribution, the first installment of the charges for building, operation, and maintenance therefor, shall become due on the first day of the following December.

(*b*) For the high-land areas payment of the charges shall not begin until means shall have been provided for the reclamation thereof by pumping or otherwise, whereupon public notice will be given announcing the charges which shall be made per acre upon such high areas, the number of installments in which such charges shall be paid, and the time when such payments shall commence. The charges to be announced for such lands shall include an equitable apportionment of the costs on account of the construction, maintenance, and operation of any pumping system or other expenditures incurred by the United States for the reclamation of such high lands.

PUBLIC NOTICE DATED MARCH 22, 1910

In pursuance of the terms of the public notice issued March 9, 1907, under the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), for the Minidoka project, Idaho, it is hereby announced that the portion of the installment on account of operation and maintenance to become due December 1, 1910, shall be 75 cents per acre of irrigable land, and the said rate shall remain in effect for subsequent years until further notice, the charges becoming due on December 1 of each year.

In accordance with the order issued December 10, 1907, payment of the portion of the installment for operation and maintenance due December 1, 1910, must be made on or before April 1, 1911, and in like manner for subsequent years, and no water will be furnished to any lands until payment of said portion of the installment is made.

PUBLIC NOTICE DATED JUNE 10, 1910

1. In pursuance of the provisions of section 4 of the reclamation act of June 17, 1902 (32 Stat., 388), public notice for the Minidoka project, Idaho, is issued as follows:

2. Certain sublaterals are not being maintained in proper condition by the district organization, with the result that some of the lands entitled to water can not be properly irrigated.

3. In order to maintain the efficiency of the sublaterals so that all lands entitled to water may receive an adequate supply, notice is hereby given that in any case where

such ditches are not maintained in a proper condition or state of repair by the water users, the necessary work will be done and materials and supplies purchased by the United States to put the said ditches in proper condition.

4. The cost of all such work, materials, and supplies will be charged equitably against the land benefited thereby, as part of the installment of the charges under the reclamation act. The charges therefor shall become due on December 1 of the year in which the work is done, and no water shall be furnished in any subsequent year for any tract until all such charges against the same shall have been paid.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ended June 30, 1910:

Principal contracts, Minidoka project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
55	July 8, 1905	Monarch & Porter	Canals and structures.	$194,826.75	$185,047.11	Aug. 21, 1906
247	Aug. 5, 1908	Allis-Chalmers Co	Electrical apparatus.	39,710.00	27,730.00	Jan. 4, 1909
248	do	do	Turbines and pumps.	193,617.00	73,164.50	Feb. 3, 1909
249 264	July 29, 1908 Dec. 9, 1908	General Electric Co	Electrical apparatus.	9,970.80	[a] 9,970.80	Jan. 29, 1909
250 259	Aug. 12, 1908 Oct. 30, 1908	Westinghouse Electric and Manufacturing Co.	do	113,892.35	81,092.89	Jan. 29, 1909
265	Dec. 22, 1908	Niles-Bement-Pond Co.	Cranes	3,643.50	[a] 3,643.50	Feb. 19, 1909
267	Dec. 18, 1908	Westinghouse Electric and Manufacturing Co.	Controlling apparatus.	300.00	450.00	Jan. 24, 1909
272	Jan. 22, 1909	Des Moines Bridge and Iron Works.	Structural steel	2,687.80	[a] 2,701.03	Apr. 26, 1909
279	Feb. 26, 1909	Fulton Engine Works.	Gates	10,994.00	7,759.00	Mar. 25, 1909
285	July 18, 1908	S. Morgan Smith Co	Pumping apparatus.	11,530.00	10,495.00	
290	June 23, 1909	Fulton Engine Works.	Gate-controlling apparatus.	8,046.00	4,955.00	Jan. 15, 1910
310	Dec. 14, 1909	General Electric Co	Transformers	1,057.00	[a] 1,027.00	Feb. 24, 1910
324	Apr. 28, 1910	Standard Underground Cable Co.	Copper wire	3,174.87	3,174.87	Apr. 28, 1910

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Minidoka project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$134,040.94	
Uncollected water-right operation and maintenance charges		7,873.82	
			$141,914.76
Inventories:			
Equipment in use	$49,152.39		
Less depreciation	10,865.02		
		38,287.37	
Storehouse		35,814.33	
Cement		927.39	
Iron and steel		1,897.09	
Lumber		11,856.58	
Explosives		1,775.89	
Forage		589.57	
Fuel		2,083.94	
Local products		1,860.99	
Unadjusted transfers		1,440.91	
			96,534.06
Cost of work:			
Building cost		3,172,421.02	
Less adjustments	1,432.33		
Less accrued revenues	18,326.60		
		19,758.93	
			3,152,662.09
Operation and maintenance cost		168,731.27	
			168,731.27
Total assets			3,559,842.18

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$3,018,916.20		
Transfer vouchers received	120,950.87		
		$3,139,867.07	
Collection vouchers	172,500.90		
Transfer vouchers issued	66,469.61		
		238,970.51	
			$2,900,896.56
Accounts payable:			
Unpaid labor		25,811.75	
Unpaid purchases		103,652.65	
Unpaid contract estimates		16,350.73	
Unpaid freight and express		24,722.51	
Unredeemed meal tickets		338.24	
Unpaid miscellaneous		583.71	
			171,459.59
Repayments accrued:			
Building		400,550.96	
Operation and maintenance		86,935.07	
			487,486.03
Total liabilities			3,559,842.18

Feature costs to June 30, 1910, Minidoka project

Gravity system:		
Diversion dam and spillway		$539,352.11
Main canals, north and south side—		
Earthwork	$540,993.51	
Canal structures	81,614.43	
		622,607.94
Distributing system:		
Earthwork	286,211.95	
Structures and bridges	175,283.01	
		461,494.96
Pumping system:		
Power plant at dam—		
Buildings	78,471.57	
Cost of machinery and installation	184,325.99	
Enlargement of diversion channel	57,641.10	
Operation and maintenance of plant when not charged to operation and maintenance of project	7,803.87	
		328,242.53
Pumping stations—		
Temporary plant, south side	9,563.98	
Station No. 1 and machinery and pressure pipe and camp No. 1	115,632.91	
Station No. 2 and machinery and pressure pipe and camp No. 2	119,993.86	
Station No. 3 and machinery and pressure pipe and camp No. 3	80,538.89	
Station No. 2, south side pumping; operation and maintenance of, when not charged to operation and maintenance of project	14,135.36	
		339,865.00
Wasteways and feeders—		
Earthwork	406,433.55	
Structures	112,657.87	
Operation of canal system when not charged to operation and maintenance of project	31,187.41	
		550,278.83
Transmission system:		
Building	25,369.71	
Maintenance	949.17	
		26,318.88
Telephone system:		
Building	25,997.13	
Maintenance	1,228.32	
		27,225.45

Real estate (rights and property): Lands purchased		$33,515.56
Buildings: Construction		40,630.73
Irrigable lands: Farm units, subdivision		3,834.29
Roads and highways:		
Construction	$3,718.85	
Maintenance	2,082.19	
		5,801.04
Wells: Drilling		3,127.06
Examination of project as a whole: Survey and design		77,288.10
Administration of project as a whole:		
General expense	95,491.23	
Engineering	17,347.31	
		112,838.54
Total building cost		3,172,421.02
Operation and maintenance:		
Telephone system	3,856.77	
Experiment farm	9,138.59	
Dam and headworks	942.29	
Canals and laterals	64,961.35	
Jackson Lake dam	4,196.92	
Administration charges	46,602.09	
Engineering, gravity system	3,575.70	
Waste-water system	35,457.56	
		168,731.27
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		3,341,152.29

IDAHO, SNAKE RIVER STORAGE

GENERAL PLAN

The plan for Snake River storage provides for the storage of flood waters in reservoirs on the headwaters of Snake River and its tributaries where feasible sites for storage dams may be found in order to regulate the flow of Snake River to conform as far as possible to the needs of irrigation and power. Suggestions have been made by the Twin Falls North Side Land and Water Company and the American Falls Canal and Power Company to join with the United States in the construction of permanent storage works for the benefit of lands irrigated by those companies and for irrigation projects of the Reclamation Service.

INVESTIGATIONS

In 1902 surveys were made by the Reclamation Service with reference to storage possibilities of Shoshone, Jackson, Two Ocean, Emma Matilda, and Jenny lakes. The results of the surveys are published in the first and second annual reports of the Reclamation Service. In June, 1906, further investigations at Jackson Lake in preparation for building a temporary storage dam were made and a survey of the site of a proposed dam for the Swan Valley reservoir on the South Fork of Snake River about 120 miles below the outlet of Jackson Lake was made. In 1908 surveys of the flow line of Swan Valley reservoir and profiles of several locations for the site of the dam were made. In 1909 and 1910 borings and surveys in contemplation of constructing a large permanent storage dam at the outlet of Jackson Lake were made, more extensive surveys of the lake shore were undertaken, and a reconnoissance was made to determine the advisability of constructing a road shorter than the existing one to the site of the dam.

CONSTRUCTION

The construction of a temporary storage dam at the outlet of Jackson Lake was begun in June, 1906, and completed by force account in October, 1907. This dam raises the surface of the lake 15 feet and provides storage for about 300,000 acre-feet of water. The dam consists of a timber crib, in three sections, 185 feet in total length, filled with rock and gravel. In the middle section there are nine 6-foot gate openings with their sills 1.4 feet below low-water elevation. The discharge of the gates with a head of 5 feet above low water is about 2,000 second-feet. The crib part of the dam is flanked at each end by timber and rock-fill abutments; and from the north abutment an earth embankment from 0 to 13 feet high, its crest being 19 feet above low-water level, extends a distance of 1,500 feet. During the summer of 1909 some work was done in strengthening and reenforcing the structure.

CONTROL AND REGULATION OF WATER SUPPLY

During the seasons of 1908 and 1909 the flow of Snake River was to some extent regulated by storing water in Jackson Lake and releasing it during the period of low flow in the river.

The storage capacity of the lake by means of the temporary dam in use being greater than required for present use on the Minidoka project, contracts were entered into with the Twin Falls North Side Land and Water Company and the American Falls Canal and Power Company in December, 1907, and January, 1908, providing for the delivery to these companies of a part of the water stored each year and for the payment by them of part of the expense of storage and operation. These contracts are annual rental contracts and provide for termination upon due notice by either party. In accordance with these provisions in the contracts, and because it is deemed desirable to retain for the exclusive use of the Minidoka project the present available capacity of the reservoir, notice was served upon each company in March, 1910, that the United States would terminate the contracts with the irrigation season of 1910.

The amount of water stored and delivered for use on the Minidoka project and to supply the Twin Falls North Side Land and Water Company and the American Falls Canal and Power Company was about 155,000 acre-feet in 1908 and 300,000 acre-feet in 1909. On June 30, 1910, no water had been stored or released for the present season.

PROGRESS DURING THE FISCAL YEAR 1910

During the fall of 1909 surveys of Jackson Lake reservoir site and wash borings at three different dam sites, Moran, Conrad, and Pacific, were made. At the Moran site 19 holes were drilled from 30 to 49 feet in depth, the material encountered being sand, gravel, cobblestones, and clay. At the Conrad site, 12 holes were drilled from 27 to 63 feet in depth, the material encountered being sand, gravel, cobblestones, clay, and coal. At the Pacific site, 21 holes were drilled from 20 to 137 feet in depth, the material encountered being sand, gravel, sandstone, coal, cobblestones, and bowlders. None of the sites appear suitable for a high masonry dam. The approximate areas and available capacities of reservoirs formed by dams at the Moran and Conrad sites, assuming the outlet at elevation 6,730 feet above sea level (the present low-water elevation being 6,732), are shown in the following table:

Elevations, areas, and capacities, Jackson Lake reservoir

Elevation of water surface (feet)	Moran dam site			Conrad dam site		
	Area in acres	Capacity between elevations in acre-feet	Total available capacity in acre-feet	Area in acres	Capacity between elevations in acre-feet	Total available capacity in acre-feet
6,730	17,043			17,151		
6,740	19,649	183,460	183,460	20,072	186,120	186,120
6,750	22,258	209,530	392,990	22,926	214,990	401,110
6,760	23,971	231,150	624,140	24,869	238,980	640,090
6,770	25,731	243,560	867,700	26,855	258,620	898,710
6,780	28,209	269,700	1,137,400	29,610	282,320	1,181,030
6,790	31,452	298,300	1,435,700	33,139	313,750	1,494,780

The area of the drainage basin above the sites of the storage dams is 980 square miles and the annual run-off near the site of the dam for the years 1904 to 1909 was as follows:

	Acre-feet		Acre-feet
1904	1,520,000	1908	1,350,000
1905	920,000	1909	1,530,000
1906	1,100,000		
1907	1,640,000	Average	1,343,000

During the present season it is planned to construct a new reinforced concrete dam upon a timber crib at the Moran site, raising the water surface to an elevation sufficient to impound 380,000 acre-feet of water. In connection with the construction of this dam, and for the purpose of facilitating access to the site, 35 miles of road will be constructed from Ashton, Idaho, to a point on the South Fork of Snake River, about 4 miles south of the south boundary of Yellowstone Park, from which a satisfactory road 30 miles in length to the dam site now exists. The construction of this road was begun in June, 1910, and on June 30 about 18 miles had been completed.

At Jackson Lake reservoir the storing of water was begun July 1, 1909; and during August and September, 1909, the stored water was released as required. At the close of the irrigating season it was found that the crib portion of the dam had been considerably damaged, and during September, October, and November repairs were made and 3,300 cubic yards of rock placed at the toe of the dam.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Snake River storage

ASSETS

Inventories:		
Storehouse	$4,798.54	
Unadjusted transfers	157.95	
		$4,956.49
Cost of work: Building cost		66,820.00
Total assets		71,776.49

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$40,846.23		
Transfer vouchers received	41,631.69		
		$82,477.92	
Collection vouchers	6,598.10		
Transfer vouchers issued	6,737.07		
		13,335.17	
			$69,142.75
Accounts payable: Unpaid miscellaneous			2,633.74
Total liabilities			71,776.49

Feature costs to June 30, 1910, Snake River storage

Swan Valley reservoir:		
Reconnaissance	$632.93	
Right of way	10,741.81	
		$11,374.74
Jackson Lake dam (temporary):		
Buildings and quarters	361.91	
Crib dam and embankment	25,770.73	
General expense—engineering	715.79	
Operation and maintenance	246.98	
Right of way	3,056.69	
Road building	297.91	
		30,450.01
Jackson Lake dam (permanent):		
Surveys and reconnaissance	7,377.61	
Testing	6,492.19	
General expense, engineering and administration	5,188.42	
Ashton-Moran wagon road	5,937.03	
		24,995.25
Total building cost as per debit in cost of work in statement of assets and liabilities		66,820.00

KANSAS, GARDEN CITY PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Finney and Kearny.
Townships: 23 and 24 S., Rs. 32 to 34 W., sixth principal meridian.
Railroad: Atchison, Topeka and Santa Fe.
Railroad stations: Garden City and Deerfield, Kans.
Average elevation of irrigable area: 2,925 feet above sea level.
Average annual rainfall on irrigable area: 20 inches.
Range of temperature on irrigable area: −20° F. to 105° F.

WATER SUPPLY

Source of water supply: Shallow wells near Arkansas River.

ENGINEERING DATA FOR COMPLETE PROJECT

Length of canals: 2.1 miles with capacities from 300 to 50 second-feet and 1.7 miles with capacities less than 50 second-feet constructed and operated by the Reclamation Service; 20 miles of main canal and 12 miles of laterals constructed and operated by the water users.

Steam power: 600 horsepower developed in steam-turbine power plant.

AGRICULTURAL CONDITIONS

Irrigable area: 10,677 acres, all in private ownership.

Irrigation season of 1910: No water supplied by the Reclamation Service on account of failure of water users to pay charges due.

Character of soil of irrigable area: Fertile black sandy loam.
Principal products: Alfalfa, sugar beets, melons, sweet potatoes, small fruits.
Principal markets: Garden City, Kans.; Kansas City, Mo.; Chicago, Ill.

LANDS OPENED FOR IRRIGATION

Dates of public notices: March 6, 1908, and November 30, 1908.

Location of lands opened: Tps. 23 and 24 S.; Rs. 32, 33, and 34 W., sixth principal meridian.

Irrigable lands opened: 10,677 acres, all in private ownership.
Limit of area of farm units: 160 acres.
Duty of water: 2 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $37.50.
Annual operation and maintenance charge: $2.75 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnoissance made and preliminary surveys begun in 1904.
Construction authorized by Secretary October 5, 1905.
Power plant completed July, 1907.
Conduit and siphon completed July, 1907.
First irrigation by Reclamation Service, season of 1908.
Wells completed April, 1908.
Pumps: 10 installed in 1907, 13 installed in 1908.
Whole project 98 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Garden City project provides for the utilization by pumping of the underground flow of the Arkansas River Valley to supplement the normal flow of Arkansas River distributed through the farmers' ditch to irrigate lands northwest of Garden City, Kans.

A power house is located on the main line of the Atchison, Topeka and Santa Fe Railroad at Deerfield, Kans. Electrical energy is transmitted to 23 pumping stations, which are located along a concrete-lined canal 20,000 feet in length. The pumps are connected at three of these stations to twelve 15-inch wells each and at 20 stations to nine wells each.

ORIGIN OF PROJECT

In order to comply with section 9 of the reclamation act, which provides for the expenditure of the reclamation fund in those States from which it was derived by the sale of public lands, an effort was made to find feasible irrigation projects in the State of Kansas. In eastern Kansas humid conditions prevail and irrigation is not practiced to any great extent. In western Kansas irrigation has been found to be a valuable adjunct to agricultural operations, but is not considered a necessity; the rainfall is about 20 inches per annum and, except in dry years, provides sufficient water to bring crops to maturity.

A petition dated December 26, 1902, from residents of Hamilton County, requested that investigations be made for the development of irrigation projects. A reconnaissance of western Kansas in 1903 indicated the only feasible irrigation development to be the utilization of the ground waters in the Arkansas River Valley. From investigations of these ground waters, it was concluded that the Reclamation Service could take up, to best advantage, a project near Garden City supplementing, by means of water pumped from wells, the partial water supply of an existing irrigation system taking water from the Arkansas River.

INVESTIGATIONS

In the vicinity of Garden City, Kans., there is an area of about 8,600 acres, watered by a canal known as the farmers' ditch, that diverts water from Arkansas River near Deerfield. This canal has a maximum capacity of about 200 second-feet and is used during the irrigation season whenever there is water in the river. But the river is often dry during the months when irrigation is most needed and the canal can not therefore furnish a reliable supply of water. Investigations of the underflow in this section of the Arkansas River Valley were made in 1904 and 1905 under the direction of Charles S. Slichter. The results of these underflow investigations, which are published in detail in Water Supply Paper 153 of the United States Geological Survey, indicate that there would pass a section 2,400 feet in length across the direction of the underflow by 100 feet in depth, 54,000 acre-feet of water a year. It was estimated that a line of wells taking water from such a section would supply 100 second-feet of water for a period of one hundred and fifty days, or a total of

30,000 acre-feet each year, which amount would be sufficient to satisfactorily supplement the surface flow diverted into the farmers' ditch. Preliminary plans and estimates for a pumping system were prepared and submitted to a board of engineers, consisting of Messrs. A. P. Davis, H. A. Storrs, and C. S. Slichter, on March 24, 1905. This board recommended that the investigations be continued and that alternative estimates be prepared for future consideration. The additional plans were considered by a board of engineers consisting of Messrs. Morris Bien, W. H. Sanders, O. H. Ensign, H. A. Storrs, and C. S. Slichter on September 5, 1905. This board recommended that the project be constructed as soon as a water users' association had been formed and practically the entire area of land in the proposed project had been subscribed. The board recommended further that plans and specifications for construction be prepared in order that construction could be undertaken without delay after the land had been subscribed to the water users' association. On June 7, 1905, an appropriation of 200 second-feet of the underflow of Arkansas River at Deerfield was made on behalf of the United States, and on October 5, 1905, the construction of the project was authorized by the Secretary of the Interior. After the authorization of the project the Finney County Water Users' Association was incorporated under the laws of Kansas and contracts with the association were approved for lands amounting to 9,625 acres.

CONSTRUCTION

POWER PLANT

The power plant is located adjacent to the Atchison, Topeka and Santa Fe Railroad near Deerfield, Kans., and consists of a pressed-brick building in which are located two 350-horsepower De Laval steam turbines, direct-connected to two 60-cycle, 3-phase, alternating-current dynamos of the revolving field, stationary armature type, having a combined capacity of 225 kilowatts and generating current at 6,600 volts. Each alternator is direct-connected with a direct current exciter, supplying excitation at 125 volts. The power is supplied from two 203-horsepower Sterling boilers, set singly. The boilers generate steam at 160 pounds pressure and are equipped with superheaters raising the temperature of the steam to 450° F. and with feed pumps and a Cochrane feed-water heater and purifier. The steam turbines operate with their highest economy at 160 pounds steam pressure and are each equipped with a service condenser of 5,200 pounds hourly capacity, with cooling water at 65° F. and a vacuum pump maintaining a vacuum of 29 inches. The cooling water is furnished by an 8-inch electrically driven centrifugal pump.

The building and the foundations for the machinery were constructed by force account and the machinery was furnished under contract. The plans and specifications for the machinery (specifications No. 85) provided for the use of either coal or oil as fuel and for steam turbines, reciprocating steam engines or gas engines for the production of power. Proposals were opened on May 28, 1906. The successful bidder submitted a proposal providing for steam turbines, with coal as fuel, as indicated in the foregoing description of the plant. During the winter of 1908 and 1909 however patent furnaces and burners for the use of oil as fuel were installed under the boilers and a 55,000-gallon concrete oil-storage tank was constructed. The change of fuel from coal to oil has resulted in a marked saving in cost of operation. A contract for the power-plant machinery was awarded on June 21, 1906, and the plant was completed in July, 1907.

CONDUIT AND STRUCTURES

The plans for the development of underground water provided for 23 groups of wells, 10 north and 13 south of Arkansas River, from which water would be discharged into a concrete-lined conduit leading to the farmers' ditch. For each group of wells there is a concrete pump house 10 feet wide, 12 feet long, and 9¾ feet high to the eaves. The pump houses are located, approximately, 1,000 feet apart. Three of the groups contain 12 wells each and the others 9 wells each, making a total of 216 wells. The wells are 15 inches in diameter and from 35 to 60 feet in depth. Each well is lined with galvanized-iron casing, perforated below the water plane with rectangular slots $\frac{3}{16}$ by $1\frac{1}{4}$ inches. Each group of wells was estimated to have a capacity of about 5 second-feet with a water-plane draw down of 18 feet. The conduit is about 20,000 feet in length, 6,927 feet being in a closed box form and the remainder being an open trapezoidal canal. The conduit passes under an irrigation ditch through a concrete siphon and under Arkansas River through a large wooden siphon 900 feet long. The conduit passes the various pumping stations in succession and gradually increases in carrying capacity throughout its length. In June, 1906, specifications No. 101 for the conduit and structures were prepared and advertisement issued for proposals to be opened July 6, 1906. No proposals were received and the work was readvertised under specifications No. 113, the proposals being opened on September 28, 1906. All bids were unsatisfactory and were rejected, and construction by force account was authorized on October 9, 1906. An informal contract for the construction of the shallow wells was entered into on November 7, 1906, and the wells were completed in readiness for the irrigation season of 1908. The concrete-lined conduit constructed by force account was completed in June, 1907, and the siphon under the river was finished one month later.

PUMPING MACHINERY

Each pumping unit is supplied with a vertical centrifugal pump direct-connected to a 25-horsepower 3-phase induction motor. The pumps are of top suction, inclosed balanced impeller, vertical-shaft type, and have a capacity of 5 second-feet each at 580 revolutions per minute. The impellers are balaced by means of water pressure. Each pump is provided with a small rotary priming pump, belt driven from the common shaft of the main pump and its motor. The motors have a capacity of 25 horsepower, are supplied with current at 220 volts, and are equipped with starting compensators. The electric current is transmitted to the pump houses at the generator voltage of 6,600, and is there changed to the motor voltage of 220 by oil-cooled transformers located in the pump houses. The transmission line is 25,000 feet in length and was constructed by force account.

Proposals for the pumping machinery (specifications No. 95) were opened on July 7, 1906. The specifications provided for furnishing ten or more pumping units, and on September 1, 1906, contract for furnishing ten 9-inch centrifugal pumps connected to 25-horsepower electric motors was executed. Proposals for thirteen additional centrifugal pumps with 25-horsepower electric motors were opened on January 2, 1907; and on January 27 a contract was executed for furnishing thirteen 10-inch pumps under these specifications. The ten 9-inch pumps were installed and ready for operation by September, 1907, and the thirteen 10-inch pumps were installed during June and July, 1908.

OPERATION AND MAINTENANCE

A public notice dated March 6, 1908, opened for irrigation 10,656 acres of irrigable land. The delivery of water for irrigation was begun on April 1, 1908, from the ten pumping units then installed, and the other pumping units were utilized as they were installed in the months of June and July. There was little rainfall and practically no water in the river during the irrigation season of 1908 and the plant was operated almost continuously. The water plane was drawn down very low and the discharge from the pumps was, in consequence, materially decreased. The removal of sand from the wells was found to be necessary at frequent intervals. During the season of 1908, 4,885 acres of land were irrigated in part with pumped water. On November 30, 1908, a public notice increasing the charge for the building of the irrigation system to $37.50 was issued. The plant was placed in operation for the season of 1909 on April 5, and water was furnished throughout that season, except when there was considerable rainfall or water was available in the river. By June 30, 1909, 75 certificates providing water rights for 6,976 acres of irrigable land had been issued. During the season of 1909, 7,555 acre-feet of water were pumped for use on 6,546 acres of land during an operation period of ninety-six days and seven hours. The output of the wells has not been as great as was anticipated, and various causes have combined to make the cost of operation and maintenance high. However, during the irrigation seasons of 1908 and 1909 the operation of the project was fairly successful. The necessarily high cost of pumping water generally renders unprofitable the irrigation of crops grown in large tracts and farmed in accordance with customary methods. On the Garden City project the average size of farms is over 90 acres, and the economy of irrigating holdings of this size is necessarily small. This circumstance and the fact that the rainfall is usually sufficient to secure the maturing of fair crops has apparently lessened the desire of the landowners for an irrigation system, and payment of the Reclamation Service charges as they became due has not been made. Inasmuch as the public notices which have been issued provide that no water shall be furnished in any irrigation season until the operation and maintenance charges of the previous season have been paid, the plant at Garden City has been closed and put in charge of a care taker. Future operations will depend upon the action of the settlers.

PROGRESS DURING FISCAL YEAR 1910

No construction work has been done during the fiscal year.

During the irrigation season of 1909, 7,555 acre-feet of water were pumped for the irrigation of 6,456 acres of land, but the pumping plant has not been operated in 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Garden City project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$25,038.75	
Uncollected water-right operation and maintenance charges		18,361.75	
			$43,400.50
Inventories:			
Equipment in use		5,080.21	
Storehouse		2,267.21	
Fuel		985.02	
Unadjusted transfers		249.04	
Freight and handling undistributed		.12	
			8,581.60
Cost of work:			
Building cost		337,568.21	
Less adjustments	$1,446.40		
Less accrued revenues	7,933.63		
		9,380.03	
			328,188.18
Operation and maintenance cost			48,569.64
Total assets			428,739.92

LIABILITIES

Investment of the United States:			
Disbursement vouchers	375,453.30		
Transfer vouchers received	11,022.18		
		386,475.48	
Collection vouchers	3,831.88		
Transfer vouchers issued	4,327.53		
		8,159.41	
			378,316.07
Accounts payable:			
Unpaid labor		198.33	
Unpaid purchases		1,865.13	
Unpaid contract holdbacks		3,695.54	
Unpaid freight and express		816.68	
Unpaid passenger fares		200.67	
			6,776.35
Repayments accrued:			
Building		25,181.25	
Operation and maintenance		18,466.25	
			43,647.50
Total liabilities			428,739.92

Feature costs to June 30, 1910, Garden City project

Power station:		
Power house and generating machinery	$82,454.12	
Power-house accessories	26,687.18	
		$109,141.30
Transmission line and electrical installation (transmission line, pump houses, electric lighting, etc.)		15,470.75
Pumping stations:		
Pump houses and pumping units	$55,608.23	
Supply wells	53,680.51	
		109,288.74
Canal system:		
Earthwork	58,938.22	
Structures	29,535.13	
		88,473.35
Real estate (rights and property): Lands purchased		1,349.23
Buildings:		
Oil house	374.85	
Workshop	730.74	
Buildings at headquarters	4,866.87	
		5,972.46

Irrigable lands: Farm-unit subdivision		$253.66
Preliminary examination: Proposed extension of project		7.89
Administration of project as a whole:		
General expense	$7,343.60	
United States sugar land litigation	267.23	
		7,610.83
Total building cost		337,568.21
Operation and maintenance:		
Operation	719.67	
Telephone line	4.19	
Transmission line	9.63	
Power plant	31,233.25	
Power-plant accessories	1,539.69	
Miscellaneous operating charges	11,723.58	
Canal system	3,095.92	
Care of plant during nonuse	243.71	
		48,569.64
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		386,137.85

MONTANA, BLACKFEET (INDIAN) PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Teton.

Townships: 31 to 34 N., Rs. 5 to 10 W.; 29 N., R. 8 W.; 30 N., Rs. 6 to 9 W.; and 35 N., Rs. 6 and 7 W., Montana meridian.

Railroad: Great Northern.

Railroad stations: Browning, Blackfoot, Bombay, Seville, Opal, and Cut Bank, Mont.

Average elevation of irrigable area: 3,850 feet above sea level.

Average annual rainfall on irrigable area: 16 inches.

Range of temperature on irrigable area: — 40° F. to 100° F.

WATER SUPPLY

Source of water supply: Cut Bank, Two Medicine, Badger, Birch, Whitetail, and Blacktail creeks.

Area of drainage basins: 1,700 square miles.

Annual run-off in acre-feet: Cut Bank Creek at Cut Bank (977 square miles), 1905 to 1908—maximum, 269,000; minimum, 167,000; mean, 212,000. Two Medicine Creek at Family (368 square miles), 1907 and 1908—mean, 335,000. Badger Creek at Family (224 square miles), 1907 and 1908—mean, 240,000. Birch Creek at Dupuyer (155 square miles), 1907 and 1908—mean, 130,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Two Medicine Lake—area, 723 acres; capacity, 9,886 acre-feet; length of spillway, 50 feet; elevation of spillway, 25 feet above stream bed. Spring Lake—area, 1,400 acres; capacity, 29,000 acre-feet; length of spillway, 50 feet; elevation of spillway, 45 feet above stream bed. Four Horns—area, 1,867 acres; capacity, 60,640 acre-feet; length of spillway, 50 feet; elevation of spillway, 57 feet above stream bed.

Storage dams: Two Medicine Lake—type, rock-filled log crib; maximum height, 50 feet; length of crest, 435 feet. Spring Lake—type, earth fill; maximum height, 50 feet; length of crest, 1,500 feet; volume, 75,000 cubic yards. Four Horns—type, earth fill; maximum height, 62 feet; length of crest, 2,225 feet; volume, 149,000 cubic yards.

Diversion dams: For Badger, Birch, and Cut Bank creeks; not designed. Two Medicine—type, brush and rock; maximum height, 4 feet; length of weir, 165 feet; length of earth fill, 1,000 feet.

Length of canals: 40 miles with capacities greater than 300 second-feet; 144 miles with capacities from 300 to 50 second-feet; 25 miles with capacities less than 50 second-feet.

Aggregate length of dikes, 800 feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 133,000 acres; Two Medicine unit, 50,000 acres.

Character of soil of irrigable area: Rich sandy loam.

Principal products: Hay, grain, and vegetables.

Principal markets: Local and eastern.

IRRIGATION PLAN

The irrigation plan of the Blackfeet project provides for five irrigation systems on the Blackfeet Indian Reservation, as follows: The Carlow canal system, heading on the right bank of Cut Bank Creek, and supplying water to about 20,000 acres of land near Carlow station on the Great Northern Railway; the Cut Bank canal system, heading on the left bank of Cut Bank Creek, and supplying water to 20,000 acres of land, 11,000 acres of which are outside of the reservation and directly north of the town of Cut Bank; the Two Medicine canal system, diverting from the left bank of Two Medicine Creek, and supplying water to 50,000 acres of land; the Badger-Fisher canal system, diverting from the right bank of Badger Creek, and supplying water to 38,000 acres of land between Birch and Badger creeks; and the Birch Creek canal system, diverting from Birch Creek, and supplying water to about 5,000 acres of land between Birch and Blacktail creeks. The irrigable lands of the project are located in general in the southeastern portion of the Blackfeet Indian Reservation between Cut Bank and Birch creeks.

INVESTIGATIONS AND CONSTRUCTION

Topographic surveys of irrigable lands and canal location surveys were begun by the Reclamation Service in the summer of 1907. Construction work on the Two Medicine unit was begun in July, 1908, and on June 30, 1910, was 33 per cent completed.

PROGRESS DURING THE FISCAL YEAR 1910

Surveys and construction work have been confined during the fiscal year to the Two Medicine unit. The location and cross sectioning of 56 miles of main canal and the location of about 60 miles of laterals, about one-half of which have been cross sectioned, were completed, and topographic surveys and maps covering an area of 140 square miles were made. The excavation of the main canal was continued throughout the fiscal year, with the exception of a period from March 5 to April 20, 1910, and about 10 miles of the canal were completed. Some work was done on roads, including the building of several small bridges in order to facilitate hauling in connection with the work of the project. All construction work has been done by force account, principally with Indian labor and teams.

FINANCIAL STATUS

Feature costs to June 30, 1910, Blackfeet project

Storage works:		
Two Medicine Lake reservoir examination		$884.19
Diversion works:		
Dam surveys	$97.95	
Canal headworks surveys	173.86	
		271.81
Canal system:		
Main canal, division 1	204,194.38	
Main canal, division 2	2,978.13	
South canal	3,076.02	
		210,248.53
Lateral system:		
Main canal surveys	5,093.33	
South canal survey	2,170.22	
		7,263.55
Spring Lake reservoir:		
Storage dam survey	1,282.70	
Outlet works survey	6.34	
Dike at west end of reservoir, survey	46.10	
		1,335.14

Telephone line:		
Construction	$3,095.71	
Maintenance	46.72	
		$3,142.43
Roads and bridges:		
Construction		482.36
Buildings:		
Construction		11,590.30
Examination of project as a whole:		
Water supply	1,297.02	
Surveys	2,811.03	
Hydrography	1,953.30	
		6,061.35
Inventory of unused supplies		484.27
Total building cost as per summary in Table 20, page 47		241,763.93

MONTANA, FLATHEAD (INDIAN) PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Flathead, Sanders, and Missoula.
Townships: 15 to 25 N., Rs. 17 to 25 W., Montana meridian.
Railroad: Northern Pacific.
Railroad stations: Evaro, Arlee, Ravalli, Dixon, and Perma, Mont.
Average elevation of irrigable area: 2,800 feet above sea level.
Average annual rainfall on irrigable area: 15 inches.
Range of temperature on irrigable area: —30° F. to 96° F.

WATER SUPPLY

Source of water supply: Flathead, Jocko, and Little Bitter Root rivers; Mud, Crow, Post, Mission, Dry, Finley, Agency, Big Knife, and Valley creeks.
Area of drainage basin: 8,000 square miles.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Seventeen; aggregate area, 12,000 acres; aggregate capacity, 140,000 acre-feet.
Storage dams: About 12; most of which will be of the earth-fill or earth-and-rock-fill type.
Diversion dams: Rock-filled log crib.
Length of canals: 14 miles with capacities greater than 300 second-feet; 80 miles with capacities between 300 and 50 second-feet; 800 miles with capacities less than 50 second-feet.

AGRICULTURAL CONDITIONS

Irrigable area: 152,000 acres.
Area for which water can be supplied, season of 1910: 10,000 acres.
Area irrigated, season of 1910: 1,500 acres.
Length of irrigating season: 150 days.
Character of soil of irrigable area: Ranges from heavy clay to light sandy loam.
Principal products: Grain, hay, alfalfa, apples, vegetables, small fruits, cattle.
Principal markets: Spokane, Seattle, and Tacoma, Wash.; Butte and Anaconda, Mont.; mining and lumber towns and camps.

IRRIGATION PLAN

The irrigation plan of the Flathead project provides for the irrigation of about 150,000 acres of land in various parts of the Flathead Indian Reservation, water being taken by simple diversion works from several rivers and creeks rising in the Mission Mountains and the stream flow being conserved by storage in about twelve reservoirs and supplemented by pumping from Flathead River by water power. Irrigable tracts in Jocko and Mission valleys and near Polson have been selected for first development.

INVESTIGATIONS

In a letter dated April 26, 1907, the Office of Indian Affairs requested that the Reclamation Service undertake investigations of water supply and lands to be irrigated on the Flathead Indian Reservation. In July, 1907, field surveys of irrigable lands and investigations of possible reservoir sites were begun. The gauging of some of the streams from which the project might secure water was also undertaken. A report of the investigations of the season and recommendations for the beginning of work on certain parts of the project were made in November, 1907. Congress by act approved April 30, 1908, appropriated $50,000 for surveys and the beginning of construction work. Under this appropriation a general survey of the reservation was begun and plans made for the beginning of construction work on certain parts of the project.

Construction work was begun on Jocko division in the spring of 1909, and this division is now 48 per cent completed. Some work was also done during that year and the first half of 1910 on Mission, Pablo, Polson, and Post divisions.

SETTLEMENT AND IRRIGATION

The reservation was formally opened to settlement on May 2, 1910, and a few filings have been made. Canals on the Jocko and Mission divisions were completed sufficiently to supply water to some of the lands during the season of 1910. During April and May there was little call for irrigation water, but in the month of June about 1,000 acres of hay and grain in Jocko division and 500 acres in Mission division were irrigated. Many of the crops were, however, suffering from want of water and have been injured by the delay in beginning irrigation.

PROGRESS DURING FISCAL YEAR 1910

Topographic surveys have been extended to cover a total of about 187,000 acres, including reservoir sites, probable canal locations, and most of the irrigable lands east of the Flathead River. Location surveys have been made for canals diverting water from Crow, Big Knife, and Post creeks and for distributing it over about 15,000 acres of land.

On Jocko division during 1909 canals were completed to irrigate about 5,000 acres of land, and during the early part of 1910 canals were finished to supply water to nearly 3,000 acres more. On the Mission division canals were completed in 1909 to irrigate about 5,000 acres of land and the excavation of other canals has been continued during the season of 1910. On Pablo division a steam-shovel outfit has been assembled near Polson and put in operation in the excavation of the 300-second-foot canal to supply Pablo reservoir. This canal will take water from Crow Creek at a distance of about 12 miles and will later be extended 12 miles farther to secure water from Post Creek. On Polson division the sinking of the shaft near the intake end of Newell tunnel, begun in June, 1909, was continued until its completion in December, 1909, when the work of driving the tunnel itself was begun. On June 30, 1910, 480 linear feet of tunnel had been driven through hard limestone, the character of the rock and the use of hand drills rendering the progress slow. A power-house site has been graded at the west portal of the tunnel. Excavation of canals has also been in progress on this division. On Post division the construction of a canal to water about 10,000 acres of land was begun in April, 1910, and on June 30, 1910, was well advanced.

PRINCIPAL CURRENT CONTRACT

The following statement contains data relating to the principal contract in operation during the fiscal year ending June 30, 1910: No. 321; date, April 13, 1910; contractor, Atlantic Equipment Company; for steam shovel; estimated value, $6,900; estimated earnings, June 30, 1910, $7,160; completion due, May 20, 1910.

FINANCIAL STATUS

Feature costs to June 30, 1910, Flathead project

Headquarters:		
Buildings and grounds	$5,965.41	
Telephone system	4,006.64	
		$9,972.05
Jocko division:		
Surveys and design	14,327.99	
Canal system	48,491.40	
Lateral system	11,415.03	
Buildings and grounds	3,301.15	
Roads and bridges	206.70	
Hydrography	1,128.85	
		78,871.12
Mission division:		
Survey and design	8,902.33	
Canal system	17,101.84	
Lateral system	3,262.47	
Buildings and grounds	1,347.49	
Roads and bridges	809.88	
Hydrography	804.04	
		32,228.05
Polson division:		
Survey and design	3,994.89	
Canal system	5,588.33	
Buildings and grounds	7,880.33	
Roads and bridges	3,225.50	
Hydrography	646.46	
Storage works, survey	358.96	
Newell tunnel	27,347.85	
Power plant	7,081.25	
Pumping station	755.12	
		56,878.69
Little Bitterroot division:		
Survey and design		2,627.11
Camas division:		
Survey and design		469.61
Post division:		
Survey and design	22,608.74	
Canal system	9,181.66	
Lateral system	1,413.90	
Hydrography	387.32	
Storage works (reservoir) preliminary work	535.61	
Bridges and roads, preliminary expense	13.72	
		34,140.95
Crow division:		
Survey and design		7,819.11
Pablo division:		
Survey and design	25,559.97	
Canal system	2,801.37	

Pablo division—Continued.		
Feeder canal	$1,337.19	
Flathead camp construction	131.00	
		$29,829.53
Inventory of unused supplies		2,460.99
Total building cost as per summary in Table 20, page 47		255,297.21

MONTANA, FORT PECK (INDIAN) PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Valley.
Townships: 26 to 33 N., Rs. 40 to 55 E., Montana meridian.
Railroad: Great Northern.
Railroad stations: Milk River, Kintyre, Frazer, Oswego, Lohmiller, Wolf Point, Macon, Chelsea, Poplar, Sprole, Brockton, Chalais, and Blair, Mont.
Average elevation of irrigable area: 2,000 feet above sea level.
Average annual rainfall on irrigable area: 13 inches.
Range of temperature on irrigable area: 40° F. to 100° F.

WATER SUPPLY

Source of water supply: Missouri and Poplar rivers, Big Porcupine, Little Porcupine, Wolf, Smoke, and Big Muddy creeks.
Area of drainage basins: Missouri River, 85,000 square miles; Poplar River, 3,000 square miles.

ENGINEERING DATA FOR LITTLE PORCUPINE UNIT

Reservoir: Capacity, 2,000 acre-feet.
Diversion dam: Little Porcupine Creek—type, concrete weir on rock-filled timber-crib base; maximum height, 4 feet; length, 150 feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 132,000 acres; Little Porcupine unit, 2,000 acres.
Character of soil of irrigable area: Heavy clay and loam.
Principal products: Hay, grain, vegetables.
Principal markets: Local.

IRRIGATION PLAN

The irrigation plan of Fort Peck project provides, in so far as the water supply is sufficient, for the irrigation of lands in various parts of the Fort Peck Indian Reservation and adjacent thereto, as follows: 8,000 acres in the vicinity of Milk River station, with water supply from Big Porcupine Creek conserved by storage; 2,000 acres in the vicinity of Frazer, with water supply from Little Porcupine Creek conserved by storage; 20,000 acres in the vicinity of Poplar, and extending along Poplar River a distance of about 35 miles, with water supply from Poplar River, conserved by storage at the forks of Poplar River and West Branch; 15,000 acres lying along the west side of Big Muddy Creek with water supply from Big Muddy Creek conserved by storage at the mouth of Wolf Creek; 50,000 acres of clear bench land and approximately 25,000 acres of brush and timber land extending along Missouri River with water supply from Missouri River by a gravity canal heading near the site of old Fort Peck; and two tracts of 6,000 acres each adjacent to and above the gravity canal that can be irrigated by pumping from the Fort Peck canal with lifts of 12 and 20 feet, respectively. Steam power for the pumping can be developed from coal obtainable on the reservation, large deposits of coal occurring near Brockton on the main line of the Great Northern Railway, and other deposits being known to exist at a number of points on the south side of Missouri River.

INVESTIGATIONS AND CONSTRUCTION

In July, 1908, investigations and surveys of the Fort Peck project were begun by the Reclamation Service and reconnaissance and topographic surveys and investigations of storage sites and power opportunities have been made. In September, 1909, construction work on Little Porcupine unit was begun and on June 30, 1910, was 90 per cent completed.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year topographic surveys of about 97 square miles of irrigable lands along Missouri River and about 6 square miles along Poplar River, a preliminary location of over 68 miles of canal lines and surveys of the Little Porcupine unit were made. Construction work was begun in September, 1909, upon the Little Porcupine unit. The work involves the construction of a small rock-filled timber-crib dam with concrete superstructure on Little Porcupine Creek, a flood canal of 200 second-foot capacity and 6,000 feet long, and a reservoir of 2,000 acre-foot capacity near the town of Frazer with concrete outlet works. The work has been carried on continuously, except for about three months during severe winter weather and is about 90 per cent completed.

FINANCIAL STATUS

Feature costs of June 30, 1910, Fort Peck project

Surveying and designing:		
Galpin division	$2,947.39	
Milk River division	3,076.28	
Frazer division	4,429.63	
Oswego division	3,721.37	
Wolf Point division	2,871.33	
Chelsea division	2,519.04	
Poplar division	4,524.15	
		$24,089.19
Camp construction:		
Oswego division		3,519.74
Camp maintenance:		
Galpin division	32.17	
Milk River division	32.17	
Frazer division	80.13	
Oswego division	904.45	
		1,048.92
Water supply:		
Oswego division		628.98
Gaging streams:		
Galpin division	56.70	
Milk River division	93.58	
Frazer division	93.61	
Oswego division	422.01	
		665.90
Tunnels:		
No. 1, Frazer division (preliminary expense)	938.97	
No. 2, Frazer division (preliminary expense)	952.40	
		1,891.37

Little Porcupine reservoir:		
Survey and design	$2,207.14	
Diversion dam and headgates (preliminary expense)	17.25	
Feed canal	4,741.74	
Crossing under Great Northern Railroad	44.32	
Small embankment	2,700.40	
Large embankment	6,077.32	
Outlet structures (preliminary expense)	167.02	
		$15,955.19
Distributing system, Little Porcupine unit		15,099.00
Inventory of unused supplies		185.40
Operation of storehouse		170.54
Total building cost as per summary in Table 20, page 47		63,254.23

MONTANA, HUNTLEY PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Yellowstone.

Townships: 2 and 3 N., Rs. 27 to 31 E., Montana meridian.

Railroads: Northern Pacific; Chicago, Burlington and Quincy.

Railroad stations: Huntley, Osborn, Worden, Newton, Pompey's Pillar, Bull Mountain, Ballantine, and Anita, Mont.

Average elevation of irrigable area: 3,000 feet above sea level.

Average annual rainfall on irrigable area: 12 inches.

Range of temperature on irrigable area: —35° F. to 100° F.

WATER SUPPLY

Source of water supply: Yellowstone River.

Area of drainage basin: 12,000 square miles.

Annual run-off in acre-feet of Yellowstone River at Huntley (12,000 square miles), 1904 to 1908: maximum, 7,040,000; minimum, 4,590,000; mean, 5,690,000.

ENGINEERING DATA FOR MAIN UNIT

Reservoirs, dikes, and dams: None.

Length of canals: 8.5 miles with capacities greater than 300 second-feet; 19 miles with capacities from 300 to 50 second-feet; 241 miles with capacities less than 50 second-feet.

Aggregate length of tunnels: 2,654 feet.

Water power: Estimated total 600 horsepower; 286 net horsepower developed.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 32,521 acres; main unit, 28,921 acres.

Present status of irrigable lands (whole project): 17,488 acres entered subject to the reclamation act, 8,241 acres open to entry, 3,600 acres withdrawn from entry, 3,192 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 28,809 acres.

Area irrigated, season of 1910: 12,000 acres.

Length of irrigating season: 160 days.

Character of soil of irrigable area: Ranges from heavy clay to light sandy loam.

Principal products: Alfalfa, oats, barley, potatoes, sugar beets, apples.

Principal markets: Billings, Mont.; St. Paul, and Minneapolis, Minn.; Denver, Colo.; Kansas City, Mo.

LANDS OPENED FOR IRRIGATION

Dates of public notices: May 21, 1907; March 3, 1909.

Location of lands opened: Tps. 2 and 3 N., Rs. 27 to 31 E., Montana meridian.

Present status of irrigable lands opened: 17,488 acres entered subject to the reclamation act, 8,241 acres open to entry, 3,192 acres in private ownership.

Limit of area of farm units: 160 acres.

Duty of water: 2½ acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $30.
Annual operation and maintenance charge: $0.60 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1904.
Construction authorized by Secretary April 18, 1905.
First irrigation by Reclamation Service, season of 1908.
Main unit completed in 1908.
Whole project 96 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Huntley project provides for the diversion of water from the south side of Yellowstone River, about 2 miles above Huntley, Mont., into a main canal, a major part of the water being distributed by gravity through a system of laterals and a small portion being pumped into a high-line canal and thence distributed through laterals for irrigation. The power for pumping is developed at a 34-foot drop in the main canal 14 miles below the head gates, and 56 second-feet of water are elevated 45 feet by two centrifugal pumps.

ORIGIN OF PROJECT AND INVESTIGATIONS

The Crow Indian Reservation was established by presidential order dated January 31, 1874. An act of Congress, approved April 27, 1904, provided for the cession to the United States, subject to certain conditions, of a strip of land in the northern part of the reservation south of Yellowstone River and extending along Bighorn River to the Fort Custer Military Reservation. This act also provided that the Reclamation Service should make surveys and investigations for the reclamation of the irrigable area within the ceded portion of the reservation. A reconnaissance of the ceded lands was carried on by the Reclamation Service during the early part of May, 1904, and general surveys of all apparently feasible reclamation projects were begun on May 27, 1904. Surveys of what is now the Huntley project were begun in August, 1904, and in the fall of 1904 this project was designated for first development. During the winter and spring of 1905, detailed plans for the development of Huntley project were prepared and reviewed by a board of engineers that recommended approval of the project as feasible and the allotment of funds for its construction. On April 18, 1905, the Secretary of the Interior authorized the construction of the project and set aside $900,000 from the reclamation fund to provide for the necessary expenditures.

CONSTRUCTION

MAIN CANAL

The Huntley main canal, with a capacity of 400 second-feet at the intake heads on the south side of Yellowstone River about 2 miles above Huntley, Montana, and extends northeast a distance of about 30 miles, diverging not more than 4 miles from the river channel. Division 1 extends from Yellowstone River along the bluffs south of the river to station 126, a distance of about 2.2 miles. The headworks consist of a reenforced concrete structure provided with two steel gates each 5 feet by 7 feet and arranged to divert water from the river without a diversion dam. The floor elevation of the headworks is 2,996.2, and the elevation of the low-water surface of the river is 3,003.5 feet above sea level. From the headworks the water is carried through tunnel 1, which is 724 feet long, thence through a rock cut to tunnel 2, which is 1,545 feet long, and thence through open cut to tunnel 3, which is 385 feet long. The three tunnels have a total length of 2,654 feet, are 9.2 feet wide, 9 feet high at the center of the arch, and are lined throughout with concrete. At the entrance to tunnel 3 there is a heavily reenforced concrete wasteway through which at low stages of the river water can be discharged under the tracks of the Northern Pacific Railway into Yellowstone River and through which, during flood stages of the river, water may be taken into the main canal. Regulating gates at the entrance to tunnel 3 provide for the proper regulation of the flow of the canal below. Between tunnels 2 and 3 the canal passes across a low depression or slough. The upper bank of the main canal was not built along this section, and the water is allowed to spread in a natural settling basin.

Proposals under specifications No. 39 for the construction of divisions 1 to 3 of the main canal were opened on June 28, 1905. Three contract awards were made, but the successful bidders refused to undertake the construction. The work was again advertised, under specifications No. 67, the original plans having been changed to include an additional length of tunnels. Proposals were opened and a contract for the work was awarded on January 15, 1906. Excavation was begun in March, 1906, but was carried on slowly. The tunnels were completed on May 26, 1907, and the final work on the contract was completed on January 15, 1908.

Division 2 of the main canal follows the general direction of the Chicago, Burlington and Quincy Railroad eastward to within 3 miles of Ballantine. The first three-fourths of a mile on this division is in thorough cut from 8 to 17 feet deep, and the remainder is located approximately on the economic contour. The location of the canal crosses the original channel of Pryor Creek eight times, and to avoid danger from the waters of this stream a new channel for the creek was cut to carry the water over the main canal in a direct line 1,500 feet in length to Yellowstone River. Proposals under specifications No. 39 were opened June 28, 1905. The successful bidders refused to execute contracts and a second award for the construction of division 2 was made on November 6, 1905. During the winter of 1905–6 the contractor erected an Armstrong steam excavator, with which work was begun on the upper end of the division in April, 1906. Excavation with scrapers and teams was begun at about the same time, and the work was completed on May 1, 1907. Work on the new Pryor Creek channel, which was included in the contract, was begun about April 1, 1906, and continued to June 22, 1906. A needle dam was then built, and the creek was turned into the new channel on June 15, 1906.

Division 3 of the main canal extends from about 3 miles west of Ballantine eastward along the general course of the Chicago, Burlington and Quincy Railroad to 1 mile northeast of Ballantine, where are located a 34-foot drop and a power plant which develops power for pumping about 56 second-feet of water from the main canal into a high-line canal. From the pumping plant the main canal continues in a northeasterly direction for about 10 miles to Lost Boy Creek, near the town of Pompey's Pillar. The high-line canal, which is also included in division 3, is about 7 miles long and extends easterly from the pumping plant and waters about 3,000 acres of land on the Ballantine bench. Proposals under specifications No. 39 were opened June 28, 1905, and the successful bidders refusing to execute contracts, a second award was made for the construction of division 3. The contractors, however, failed to begin work within a reasonable time, and the contract was suspended and the work readvertised under specifications No. 94. Proposals were opened on June 20, 1906, and a contract was awarded soon after that date. Work was begun by the contractor on August 1, 1906, and was continued in a satisfactory manner to completion in December, 1907. The work was done chiefly with fresno and slip scrapers, the overhaul being handled with wheel scrapers.

The pumping station, gates and guides for the headworks and wasteways on division 1, all concrete structures on divisions 2 and 3 of the main canal, together with two steel highway bridges and 120,000 pounds of steel for concrete reenforcement, were included in proposals under specifications No. 40, opened on June 28, 1905. A contract was executed soon after the opening of proposals, and the work was commenced in October, 1905. Changes in design of the power plant made it advisable to draw new plans for this structure and to request new proposals for its construction. The remainder of the work under the structures contract was carried on satisfactorily and was completed June 1, 1907. The work executed under the contract included the placing of 2,284 cubic yards of concrete in the structures included the specifications and 1,019 cubic yards in additional structures which were paid for as extra work.

DISTRIBUTION SYSTEM

The distribution system of the Huntley project consists of about 268 miles of laterals and sublaterals. Proposals under specifications No. 64 for the excavation and structures on this system were opened on December 15, 1905, and a contract was executed on January 2, 1906. Work was begun by the contractors early in January, 1906. The bids were made just previous to a great increase in the cost of construction work, and the contractors lost heavily in consequence. On November 16, 1906, satisfactory progress not having been made, the contract was suspended, and the work was continued by force account, being completed October 31, 1907.

The reenforcing and structural steel and the gates, guides, and lifting devices for the distribution system were furnished under a separate contract, the required material being delivered during the summer of 1906.

PUMPING PLANT

The pumping plant is located about 1 mile east of Ballantine, where there is a fall of about 34 feet in the main canal. The power house is 32 feet 8 inches by 16 feet 8 inches in plan and 21 feet 6 inches in height and is built of reenforced concrete. The fore bay is of reenforced concrete, and two 62-inch reenforced concrete pipes extend from the fore bay to the power house. The interior is one room containing two pumping units. The two pumping units are connected to a 48-inch reenforced concrete pipe, 1,388.5 feet long, which extends from the power house to the high-line canal. Each pumping unit consists of a vertical turbine actuating a 20-inch centrifugal pump, turbine and pump being mounted on the same shaft, and inclosed in a steel cylindrical casing. The weight of the moving parts is carried on a water bearing under pressure from the discharge pipe. The pumping units are practically automatic in their operation, only occasional inspection and regulation of the supply of water being necessary. The total head of water of the turbines is about $33\frac{1}{2}$ feet, of which $26\frac{1}{2}$ feet is pressure head. The total pumping lift is about $48\frac{1}{2}$ feet, including 3 feet loss of head from friction in the delivery pipe. Each unit has a capacity of 28 second-feet.

The pumping plant was originally included in the structures contract for the main canal, but was later withdrawn from this contract. A readvertisement of the work was issued and proposals under specifications No. 102 for the construction of the pumping plant were opened on August 7, 1906. The specifications included two schedules, the first embracing the excavation and construction of the reenforced concrete building and pressure pipes and steel for concrete reenforcement, and the second schedule including the furnishing and construction of pumping units, pipes, valves, and head gates. No formal proposal was received for schedule 1, and the work under this schedule was executed by force account. The work was begun on October 23, 1906, and was completed on November 15, 1907. A contract was executed for schedule 2 and the machinery was delivered July 8, 1907. A test of the machinery was made on September 7, 1908, a second test was made on July 27, 1909, and a third test was made on October 8, 1909. These tests were not satisfactory; but the contractors made changes in the machinery during the winter of 1909–10, and a satisfactory test was made July 13, 1910.

TELEPHONE SYSTEM

The telephone system of the Huntley project consists of 22.7 miles of two-wire, metallic-circuit line. Proposals for the construction of the telephone system were opened on December 15, 1905. The contract for the work was awarded soon after this date and the installation of the system was completed on May 20, 1906.

SETTLEMENT AND IRRIGATION

Settlement on the Huntley project practically dates from the beginning of operations by the Reclamation Service. Towns were planned every 5 miles along the Chicago, Burlington and Quincy and the Northern Pacific railways. The town sites of Huntley, Worden, Osborn, Ballantine, Newton, Anita, Pompeys Pillar, and Bull Mountain were laid out during the spring of 1907. Huntley and Osborn are on both railroads, Ballantine and Anita are on the Chicago, Burlington and Quincy Railroad and the other town sites are on the Northern Pacific Railroad. A part of the lots in each town site were appraised and were placed on sale in September, 1907. Additional lots were appraised in the fall of 1909 and placed on sale April 7, 1910.

The lands on the Huntley project were opened to entry under the provisions of the reclamation act and the act of April 27, 1904, on July 22, 1907, by public notice dated May 21, 1907. Registration of prospective entrymen was required on or before June 25, 1907, and 5,491 registrations were made. The precedence of entry was determined by lot on June 26, and beginning July 22, 50 applicants were allowed to file entries each day. On August 23 the lands were thrown open to unrestricted entry under the provisions of the reclamation act. There were 28,921.44 acres of land in 585 farm units opened to entry by the public notice of May 21, 1907. On June 30, 1910, 393 farm units, containing 17,488 acres of irrigable land, had been entered. The farms are being improved rapidly.

During the summer of 1907 the canals were primed and prepared for the delivery of water for irrigation in 1908. In the spring of 1908 the laterals were cleaned, checks were installed, and water was delivered during the season to about 4,100 acres of land. In 1909 irrigation water was furnished between June 1 and October 1 to about 8,500 acres of land, or about one-half the irrigable area that had been entered. In 1910 about 12,000 acres of land are being supplied with water.

PROGRESS DURING FISCAL YEAR 1910

The work on the Huntley project during the fiscal year has been that of operation and maintenance. Water has been delivered during the irrigation season and repairs and betterment to the canals have been made as required.

During the fiscal year 84 new settlers have taken up lands. An increased area has been planted to sugar beets and alfalfa this year and several hundred acres have been planted to peas, the crop being intended for use as seed for eastern seed houses. A decreased area has been planted to potatoes and small grains.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Huntley project

ASSETS

Accounts receivable:		
Uncollected water-right building charges	$28,853.20	
Uncollected water-right operation and maintenance charges	653.14	
		$29,506.34
Inventories:		
Government animals	2,653.50	
Equipment in use	9,242.55	
Storehouse	1,170.86	
Cement	150.08	
Unadjusted transfers	3,941.42	
Freight and handling undistributed	152.32	
		17,310.73
Cost of work:		
Building cost	843,894.56	
Less accrued revenues	7,542.80	
		836,351.76
Operation and maintenance cost	88,490.40	
Less accrued revenues	1,150.59	
		87,339.81
Total assets		970,508.64

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$980,291.72		
Transfer vouchers received	32,072.53		
		1,012,364.25	
Collection vouchers	99,548.15		
Transfer vouchers issued	58,395.74		
		157,943.89	
			854,420.36

Accounts payable:		
Unpaid labor	$4,123.68	
Unpaid purchases	722.73	
Unpaid contract estimates	5,738.69	
Unpaid freight and express	379.94	
Unpaid passenger fares	259.80	
		$11,224.84
Repayments accrued:		
Building	87,172.54	
Operation and maintenance	17,690.90	
		104,863.44
Total liabilities		970,508.64

Feature costs to June 30, 1910, Huntley project

Main canal and high-line canal:		
Earthwork	$370,108.35	
Structures	87,079.64	
Railroad bridges and culverts	16,535.52	
		$473,723.51
Distributing system:		
Earthwork and structures	246,722.45	
Pumping plant	71,510.12	
Pryor Creek improvement	19,165.64	
		337,398.21
Real estate (rights and property): Lands purchased		1,007.46
Buildings and grounds: Construction		16,737.43
Telephone system: Construction		9,041.01
Supplemental construction		5,986.94
Total building cost		843,894.56
Operation and maintenance:		
Main canal	18,370.20	
Lateral system	58,187.46	
Structures	3,285.29	
Pumping plant	4,751.88	
Buildings and grounds	993.10	
Telephone system	129.34	
Demonstration farm	2,032.40	
Inventory of unused supplies	740.73	
		88,490.40
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		932,384.96

MONTANA, MILK RIVER PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Valley and Chouteau.

Townships: 27 to 33 N., Rs. 17 to 40 E., Montana meridian.

Railroad: Great Northern.

Railroad stations: Havre, Chinook, Harlem, Dodson, Malta, Saco, Hinsdale, and Glasgow, Mont.

Average elevation of irrigable area: 2,200 feet above sea level.

Average annual rainfall on irrigable area: 13 inches.

Range of temperature on irrigable area: −45° to 100° F.

WATER SUPPLY

Source of water supply: Milk and St. Mary rivers.

Area of drainage basin: Milk River above Hinsdale, 196,000 square miles.

Annual run-off in acre-feet of Milk River: At Havre (7,000 square miles), 1902 to 1908—maximum, 424,000; minimum, 17,400; mean 225,000. At Malta (14,000 square miles), 1902 to 1908, March to November—maximum, 794,000; minimum, 29,400; mean, 330,000. (For run-off of St. Mary River see St. Mary project.)

ENGINEERING DATA

Reservoirs: Chain Lakes—area, 13,422 acres; capacity, 437,560 acre-feet; length of spillway, 1,000 feet; elevation of spillway, 85 feet above stream bed. Nelson Lake—area, 6,842 acres; capacity, 190,000 acre-feet; available capacity above elevation 2,200, 142,000 acre-feet.

Storage dams: Chain Lakes—type, earth fill; maximum height, 100 feet; length of crest, 2,130 feet; volume, 1,727,000 cubic yards. Nelson Lake—type, earth fill; maximum height, 33 feet; length of crest, 15,135 feet; volume, 911,540 cubic yards.

Diversion dams: Chinook—type and length not determined; height, 14 feet. Dodson—type, rock-filled timber-crib with automatic needle crest; maximum height, 26 feet; length, 320 feet. Vandalia—type not determined; height, 27 feet; length, 300 feet.

Length of canals, Dodson division: 42 miles with capacities greater than 300 second-feet; 60 miles with capacities from 300 to 50 second-feet.

Aggregate length of tunnels: 465 feet.

Aggregate length of dikes constructed: 22,700 feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 255,000 acres; first unit under Dodson south canal, 10,000 acres.

Present status of irrigable lands (whole project): 78,000 acres entered subject to the reclamation act, 16,000 acres withdrawn from entry, 13,000 acres of state lands, 148,000 acres in private ownership (including 31,000 acres of Indian lands).

Length of irrigating season: 200 days.

Character of soil of irrigable area: Sandy loam and gumbo.

Principal products: Hay, grain, and vegetables.

Principal markets: Local.

CHRONOLOGICAL SUMMARY

Reconnoissance and preliminary surveys begun in 1902.

Construction authorized by Secretary March 14, 1903.

Dodson diversion dam completed in January, 1910.

First unit under Dodson south canal 80 per cent completed June 30, 1910.

Whole project 12 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Milk River project provides for the utilization of the water of St. Mary River as outlined under the description of St. Mary project; the storage of water in a reservoir at Chain Lakes on Milk River about 12 miles northeast of Burnham, Mont., and in Nelson Lake reservoir south of Milk River, near Malta; the discharge of stored water into Milk River as required; the diversion of water from Milk River by a dam near Chinook into two canals, one on each side of the river, for the irrigation of lands near Chinook and Harlem, comprising the Chinook division; the diversion of water from Milk River by a dam near Dodson into two canals, one on each side of the river, for the irrigation of lands near Dodson, Malta, Saco, and Hinsdale, comprising the Dodson division; and the diversion of water from Milk River by a dam near Vandalia into a canal on the south side of the river, watering lands in the vicinity of Glasgow.

ORIGIN OF PROJECT AND INVESTIGATIONS

Investigations of irrigation possibilities in the Milk River Valley were begun in 1900 by the United States Geological Survey. It was found that a large part of the flow of the river was being diverted for the irrigation of lands in Canada and that the low water flow in most years was insufficient for properly supplying the irrigation systems then in operation. In the United States there were several private systems diverting water from Milk River for irrigating about 20,000 acres of land and a system constructed by the Indian Service for the Fort Belknap Indians and designed to irrigate 15,000 acres. To satisfactorily supply the existing systems and to provide for additional irrigation the storage of flood waters would therefore be essential. The investigations begun by the United States Geological Survey were continued by the Reclamation Service after its organization in 1902, and in the spring of 1903, general plans, based on the results of the investigations then completed, were made. These plans, as outlined in a letter of March 7, 1903, from the Director of the Geological Survey to the Secretary of the Interior, included the storing of water in St. Mary Lakes on St. Mary River and its diversion to the Milk River to supplement the low water flow of that stream; and the diversion of water from Milk River for irrigation of lands in the lower Milk River Valley near Havre, Malta, and Glasgow, Mont. It was recommended that development of the general project as outlined be approved, that the examination of irrigable lands, reservoirs, etc., be continued, and that work be prosecuted in greater detail for the ascertainment of facts necessary for the preparation of specifications and the letting of contracts for the construction of irrigation works. On March 14, 1903, the Secretary of the Interior approved the general project as recommended and authorized the continuation of the work of investigation and preparation for construction. During 1903 and 1904, surveys were continued, including reconnaissance surveys from Chinook to Glasgow, preliminary location of various canal lines, investigation of a storage dam site at Chain Lakes and of diversion dam sites near Chinook and Dodson, including borings at the Dodson site. In September, 1904, a board of engineers, consisting of Messrs. A. P. Davis, G. Y. Wisner, and H. N. Savage, recommended that construction be commenced as soon as satisfactory negotiations could be arranged with the Canadian government with regard to the water supply and when a reasonable acreage of the private lands to be benefited had been subscribed to the water users' association to guarantee the return to the reclamation fund of the cost of construction of the project. The Lower Milk River Water Users' Association was formed in 1908 and entered into a contract with the Reclamation Service on February 10, 1909, guaranteeing the payment to the United States of the cost of the irrigation works as assessed by the Secretary of the Interior against the lands of the shareholders of the association.

The contemplated arrangement with the Canadian government for control of the water supply was effected through a treaty with Great Britain, proclaimed May 13, 1910, as described in the report of the St. Mary project.

CONSTRUCTION

DODSON DIVERSION DAM

The Dodson diversion dam is located about 50 miles below the proposed Chinook diversion and about 3 miles west of Dodson, Mont. The dam is a rock-filled timber-crib weir, and is to have a movable crest. The maximum height of the fixed crest is 20 feet and of the movable crest 26 feet above the river bed. The movable crest is to be a modified form of Poiree needle dam. The downstream face of the dam is formed by heavy timbers bolted to the timber cribs and is protected by railroad iron spiked to the deck. In connection with the construction of the dam it was necessary that about 4 miles of the tracks of the Great Northern Railway be raised 4 feet or less and the railroad embankment protected by riprap. The raising and protecting of these tracks has been practically completed by the railroad company under an agreement by which the United States is to pay one-half of the cost.

On August 6, 1908, authority was given for the construction of the Dodson dam by force account. Excavation for the foundation was begun in September, 1908, and the dam completed in March, 1909, to the height of the fixed crest for 152 feet of its length and 6 feet below this height for the remaining 168 feet. In the fall and winter of 1909, the dam was completed to the height of the fixed crest for its entire length. Work on the 13 concrete piers for the movable crest was commenced in December, 1909, and completed in January, 1910.

DODSON SOUTH CANAL

The Dodson south canal, as designed, will be 42 miles long, extending from the Dodson diversion dam to Nelson Lake reservoir, formerly known as Mud Lake reservoir. At present but 9 miles of this canal including structures is constructed. It has a capacity of 900 second-feet. The headworks are located on the south bank of Milk River about a half mile above the Dodson diversion dam and consist of a concrete structure containing 15 gates, each 4 feet wide by 5 feet high. About 7 miles below the headworks is a small reservoir forming a part of the canal and known as Point of Rocks reservoir. The outlet from the reservoir is a concrete structure having four regulator gates and eight openings controlled by flash boards. Two laterals, the foothill and river laterals, now constructed, head in the main canal and supply water to about 10,000 acres of irrigable lands between Point of Rocks and Malta.

Part of the main canal was excavated in 1908 and 1909 under the cooperative plan by contract with the water users' association, which in turn contracted with local settlers to do the work and to receive payment in certificates receivable by the United States in payment of water-right charges. The remainder of the excavation for the first 9 miles of the main canal and for the foothill and river lateral systems was done by small contracts and force account in 1909 and 1910. The structures for the main canal and laterals supplying water to about 7,800 acres of irrigable land were built by force account, the work having been commenced in 1908 and practically completed in June, 1910.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year the Dodson diversion dam was completed to the elevation of the fixed crest for its entire length, and concrete piers were constructed for supporting the movable crest to be constructed in the future. A temporary flashboard crest was placed on the dam between the concrete piers for the present in order to provide for diverting 200 second-feet of water to Dodson south canal. The Great Northern Railroad Company has raised its track above the level of the backwater from the Dodson dam. The Dodson south canal was completed for 9 miles of its length and the river and foothill laterals were constructed, together with the necessary structures, including three steel highway bridges. The construction of the upper Peoples Creek dike by contract and force account and of the lower Peoples Creek dike by force account was in progress during parts of the fiscal year and was completed in June, 1910.

Prior to June 30, 1910, there was no water available for the canal, as the entire flow of the river had been diverted above the Dodson dam. This condition will be obviated in the future by the construction of storage works.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Milk River project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
288	May 27, 1909	New Jersey Foundry and Machine Co.	Head gates	$1,035.00	[a] $1,035.00	Aug. 30, 1909
289	June 3, 1909	Coffin Valve Co.	Gate stands	3,000.00	[a] 3,000.00	Aug. 8, 1909
319	Mar. 14, 1910	Des Moines Bridge and Iron Works.	Highway bridges	1,082.00	1,082.00	May 6, 1910

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Milk River project

ASSETS

Inventories:			
Mercantile store		$1,296.54	
Government animals		4,797.32	
Equipment in use	$7,399.72		
Less depreciation	450.83		
		6,948.89	
Storehouse		22,035.85	
Cash in office safe		15.00	
Unadjusted transfers		[a] 1,695.65	
Freight and handling undistributed		642.03	
			$34,039.98
Cost of work:			
Building cost	502,867.31		
Plus adjustments	290.40		
		503,157.71	
Less accrued revenues		198.00	
			502,959.71
Total assets			536,999.69

LIABILITIES

Investment of the United States:			
Disbursement vouchers	497,523.04		
Transfer vouchers received	31,325.53		
		528,848.57	
Collection vouchers	3,897.93		
Transfer vouchers vouchers issued	5,563.41		
		9,461.34	
			519,387.23

[a] Credit amount.

Accounts payable:		
Unpaid labor	$5,824.10	
Unpaid purchases	4,310.45	
Unpaid contract estimates	953.60	
Unpaid contract holdbacks	1,933.74	
Unpaid freight and express	2,597.72	
Unpaid passenger fares	204.70	
Unpaid miscellaneous	1,788.15	
		17,612.46
Total liabilities		536,999.69

Feature costs to June 30, 1910, lower Milk River project

Diversion works:		
Dodson dam	$109,429.81	
South headworks	13,277.07	
Dodson headworks dike	374.07	
		$123,080.95
Canal system:		
Dodson south canal	158,720.78	
Dodson south canal, distributing	83,990.35	
Vandalia canal	1,302.18	
Dodson north canal	2,707.45	
		246,720.76
Real estate (rights and property): Land purchased		8,831.78
Buildings: Construction		6,518.02
Examination of project as a whole:		
Hydrography	13,963.16	
Survey	36,363.34	
		50,326.50
Administration of project as a whole: General expense		66,257.72
Inventory of unused supplies		1,131.58
Total building cost, as per debit in cost of work in statement of assets and liabilities		502,867.31

MONTANA, ST. MARY PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Teton.
Townships: 34 to 37 N., Rs. 1 to 13 W., Montana meridian.
Railroads: Great Northern; Alberta Railway and Irrigation Company.
Railroad stations: Browning, Mont.; Cardston, Alberta, Canada.

WATER SUPPLY

Source of water supply: St. Mary River.
Area of drainage basin: 452 square miles.
Annual run-off in acre-feet of St. Mary River, 1902 to 1908: At Babb (177 square miles)—maximum, 528,000; minimum, 306,000; mean, 439,000. At international line (452 square miles)—maximum, 1,220,000; minimum, 511,000; mean, 782,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: St. Mary Lakes—area, 7,880 acres; capacity, 218,000 acre-feet; length of spillway, 500 feet; elevation of spillway, 31 feet above stream bed.
Storage and diversion dam: St. Mary Lakes—type, earth fill; maximum height, 44 feet; length of crest, 2,800 feet; volume, 198,000 cubic yards.
Length of canals: 26 miles with capacity of 850 second-feet.
Aggregate length of tunnels: 1,170 feet.

CHRONOLOGICAL SUMMARY

Reconnaissance begun in 1900.
Preliminary surveys by the Reclamation Service begun in 1902.
Construction authorized by Secretary March 25, 1905.

Treaty with Great Britain relating to distribution between Canada and the United States of the waters of St. Mary and Milk rivers signed January 11, 1909, and proclaimed May 13, 1910.

St. Mary canal, excavation 10 per cent completed June 30, 1910.

GENERAL PLAN

The plan of the St. Mary project provides for the storage of water in St. Mary lakes by means of a dam at the outlet of lower St. Mary Lake and its diversion though a canal 26 miles long, heading at the reservoir and discharging into the North Fork of Milk River. The water thus diverted will enter Canada, through which country it will flow for 100 miles or more and then return to the United States. A plan for utilizing this water in the lower Milk River Valley is described under Milk River project.

ORIGIN OF PROJECT AND INVESTIGATIONS

The St. Mary project as now planned is a project for the storage and diversion of the waters of St. Mary River for use in the lower Milk River valley. Investigations for the utilization of the waters of St. Mary River were first made by the United States Geological Survey in 1900. Gaging stations have been maintained since 1901. The principal surveys in connection with the project were practically completed in 1902, but the development of the project has been delayed because of the uncertainties in the international features involved. By reason of the proposed diversion of water from St. Mary River through the channel of the North Fork of Milk River in Canada, it was necessary to secure an agreement between the United States and Canada that would insure the return to the United States of an equitable amount of the water of St. Mary and Milk rivers. Commissioners representing the two countries were appointed in 1908, and after several conferences and examinations in the field a satisfactory agreement was reached, and on May 13, 1910, there was promulgated a water-boundary treaty that provides for the use in Canada and the United States of the waters of the two streams.

The Secretary of the Interior on March 25, 1905, gave his preliminary approval to the St. Mary project and set aside from the reclamation fund the sum of $1,000,000 for its construction.

CONSTRUCTION

The construction work on St. Mary project has been confined to the excavation of a canal from St. Mary River to the North Fork of Milk River, a distance of about 26 miles. On July 31, 1906, proposals under specifications No. 97 were opened for the construction of the first 14 miles of the canal. One proposal was received and the bid being considered excessive was rejected. The construction of the canal by force account was then authorized. Orders were placed during 1906 for machinery, scrapers, dump wagons, steam rock drills, one steam shovel, one Channon-Armstrong excavator, one traction engine and cars for hauling purposes, and other miscellaneous supplies. In the spring of 1907 the machinery was assembled and excavation of the canal was begun. The steam shovel and excavator were operated during the greater part of 1907. During 1908, 1909, and 1910 the steam shovel has been in operation a part of the time. It was planned to excavate the last 10 miles of the canal with teams and scrapers operated by Indian labor, this portion of the canal being located on the Blackfeet Indian Reservation. During 1907, 79,126 cubic yards of material were excavated in this manner, but the work was not very satisfactory and has not been resumed.

The main canal has a capacity of 850 second-feet. The earth sections have a bottom width of 27 feet, side slopes of 1½ to 1, and a water depth of 8 feet. In rock the canal has a bottom width of 14 feet, side slopes of ½ to 1, and a water depth of 8 feet. About 14,000 linear feet of the canal will be lined with concrete and will have a bottom width of 7 feet, side slopes of 1¼ to 1, and a water depth of 6½ feet. The canal grade is 0.0002 in the earth sections and will reach a maximum of 0.00125 where concrete lining is used.

PROGRESS DURING THE FISCAL YEAR 1910

The steam shovel was operated for the excavation of the main canal from August 10 to October 31, 1909, when operations were suspended for the winter. Excavation was resumed in April, 1910, and has been continued to the end of the fiscal year. On May 13, 1910, a water boundary treaty providing for the equitable division of the waters of the St. Mary and Milk rivers in Canada and the United States was proclaimed. The consummation of this treaty does away with the principal difficulty in connection with the St. Mary project.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, St. Mary project

ASSETS

Accounts receivable: Uncollected miscellaneous rentals			$90.00
Inventories:			
Equipment in use		$23,967.12	
Storehouse		7,675.63	
Lumber		3,915.31	
Unadjusted transfers		16.51	
Freight and handling undistributed		75.79	
			35,650.36
Cost of work:			
Building cost	$231,109.47		
Plus adjustments	2,319.83		
		233,429.30	
Less accrued revenues		724.32	
			232,704.98
Total assets			268,445.34

LIABILITIES

Investment of the United States:			
Disbursement vouchers	279,166.56		
Transfer vouchers received	12,146.88		
		291,313.44	
Collection vouchers	7,271.87		
Transfer vouchers issued	18,167.54		
		25,439.41	
			265,874.03
Accounts payable:			
Unpaid labor		1,468.16	
Unpaid purchases		386.19	
Unpaid freight and express		284.03	
Unredeemed meal tickets		.50	
Unpaid miscellaneous		432.43	
			2,571.31
Total liabilities			268,445.34

Feature costs to June 30, 1910, St. Mary project

Canal system: Main canal		$99,703.80
Buildings: Construction		19,536.42
Real estate (rights and property): Lands purchased		14,253.75
Roads and highways:		
Browning-St. Mary	$11,776.46	
Sawmill-canal	604.37	
Cardston	3,977.28	
		16,358.11
Telephone lines: Construction		1,747.79
Coal mine: Development		2,593.90
Waterworks: Construction		1,248.04
Examination of project as a whole:		
Hydrography	3,052.45	
Surveys	34,347.09	
Topography, Blackfeet Indian Reservation	1,702.57	
		39,102.11
Administration of project as a whole: General expense		36,523.45
Inventory of unused supplies		42.10
Total building cost as per debit in cost of work in statement of assets and liabilities		231,109.47

MONTANA, SUN RIVER PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Teton, Lewis and Clark, Choteau, Cascade.
Townships: 20 to 25 N., Rs. 3 E. to 8 W., Montana meridian.
Railroad: Great Northern.
Railroad Stations: Vaughn, Power, Dutton, and Collins, Mont.
Average elevation of irrigable area: 3,700 feet above sea level.
Average annual rainfall on irrigable area: 12 inches.
Range of temperature on irrigable area: —40° F. to 100° F.

WATER SUPPLY

Source of water supply: Sun River and tributaries, Deep Creek and Bowl Creek.

Area of drainage basins: Sun River, 850 square miles; Deep Creek, 290 square miles; Bowl Creek, 9 square miles.

Annual run-off in acre-feet, 1905 to 1908: North Fork of Sun River near Augusta—maximum, 120,000; minimum, 42,700; mean, 74,600. Willow Creek near Augusta—maximum, 26,100; minimum, 8,000; mean, 18,100. Sun River at Sun River—maximum, 971,000; minimum, 380,000; mean, 760,000.

ENGINEERING DATA

Reservoirs: Willow Creek—area, 2,285 acres; capacity, 84,000 acre-feet; length of spillway, 2,600 feet; elevation of spillway, 100 feet above stream bed. Warm Springs—area, 1,976 acres; capacity, 156,800 acre-feet; length of spillway, 5,000 feet; elevation of spillway above stream bed, 180 feet. Pishkun—area, 1,542 acres; capacity, 45,700 acre-feet. Lake Benton—area, 9,130 acres; capacity, 140,200 acre-feet.

Storage dams: Willow Creek—type, earth fill; maximum height, 110 feet; length of crest, 1,045 feet; volume, 437,000 cubic yards. Warm Springs—type, rock and hydraulic fill; maximum height, 190 feet; length of crest, 762 feet; volume, 1,030,000 cubic yards. Benton Lake—type, earth fill; maximum height, 35 feet; length of crest, 120 feet; volume, 12,000 cubic yards.

Diversion dams: Canyon—type, reenforced concrete weir; maximum height, 72 feet; length of crest, 150 feet; volume, 6,800 cubic yards. Deep Creek—type, reenforced concrete weir; maximum height, 12 feet; length of crest, 100 feet; volume, 500 cubic yards.

Length of canals, Fort Shaw unit: 0.3 mile with capacity greater than 300 second-feet; 18 miles with capacities from 300 to 50 second-feet; 99 miles with capacities less than 50 second-feet.

Aggregate length of tunnels: 12,600 feet.

Aggregate length of dikes: 2,700 feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project about 300,000 acres; Fort Shaw unit, 16,000 acres.

Present status of irrigable lands (whole project): 92,000 acres entered subject to the reclamation act, 2,740 acres open to entry, about 130,000 acres withdrawn from entry, 24,000 acres of state lands, 48,000 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 16,377 acres.

Area irrigated, season of 1910: 9,535 acres.

Length of irrigating season: 130 days.

Character of soil of irrigable area: Sandy loam, clay, adobe, and alluvium.

Principal products: Hay, grain, and vegetables.

Principal markets: Great Falls, Helena, and Butte, Mont.

LANDS OPEN FOR IRRIGATION

Date of public notice: March 26, 1908.

Location of lands opened: Tps. 20 and 21 N., Rs. 1 to 3 W., Montana meridian.

Present status of irrigable lands opened: 9,535 acres entered subject to the reclamation act; 2,743 acres open to entry; 377 acres of state lands; 1,984 acres in private ownership.

Limit of area of farm units: 160 acres.

Duty of water: 2 acre-feet per acre per annum at the farm.

Building charge per acre of irrigable land: $30.

Annual operation and maintenance charge: $0.50 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnoissance made and preliminary surveys begun in 1905.
Construction authorized by Secretary February 26, 1906.
Fort Shaw main canal completed July, 1908.
First irrigation by Reclamation Service, season of 1909.
Fort Shaw unit completed December, 1909.
Willow Creek dam 10 per cent completed June 30, 1910.
Whole project 7 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Sun River project provides for the storage of water in the Warm Springs reservoir on the North Fork of the North Fork of Sun River, in the Willow Creek reservoir on Willow Creek, in Pishkun reservoir north of Sun River and in Benton Lake reservoir, 8 miles north of Great Falls, Mont; the diversion of water from South Fork of North Fork of Sun River through a supply canal into Warm Springs reservoir; the diversion of water from the North Fork of Sun River through supply canals into Willow Creek and Pishkun reservoirs; the diversion of flood waters of Deep Creek into the Benton Lake reservoir; the diversion of water from Bowl Creek, a tributary of Flathead River, on the west side of the continental divide through a canal one and one-half miles in length into the North Fork of the North Fork of Sun River; the diversion of water from Sun River, supplemented by stored water released from Warm Springs and Willow Creek reservoirs, into a canal system watering lands mainly in the abandoned Fort Shaw military reservation; the diversion of water from Pishkun reservoir into a high-line canal supplying water for lands in the Sun River valley; the diversion of water from Deep Creek, supplemented by stored water released from Pishkun reservoir, and for the lower lands of the system by stored water released from Benton Lake reservoir, into a canal system supplying water to lands in the Sun and Teton River valleys.

ORIGIN OF PROJECT AND INVESTIGATIONS

An examination of Sun River valley with special reference to irrigation possibilities was made by H. M. Wilson, of the United States Geological Survey, in 1890–91. Detailed surveys of ten reservoir sites were made and a general plan for irrigation was developed. The first investigation by the Reclamation Service was made in the fall of 1903, at which time stream gaging was begun. Further investigations were made in 1904, and in 1905 location surveys were made on the north side of Sun River for the north supply canal. Surveys of storage reservoirs were also made, and the Warm Springs, Pishkun, and Willow Creek sites were selected for development. The supply canal to the Willow Creek reservoir was located for a distance of 8 miles. The construction of the project was authorized by the Secretary of the Interior on February 26, 1906, and on March 19, 1906, an allotment of $500,000 for construction purposes was approved. Surveys on the north side were discontinued in April, 1906, and resumed in the summer of 1910. On June 9, 1906, an act of Congress was approved opening for settlement the Fort Shaw military reservation, which contains about 16,000 acres of irrigable land on the south side of Sun River. During the following summer topographic surveys of the irrigable area and plans for a canal system to irrigate these lands were developed and during the winter of 1906–7 plans and estimates for the canals and structures of the Fort Shaw unit were prepared.

CONSTRUCTION

WILLOW CREEK DAM

Proposals for the construction of Willow Creek dam and outlet works under specifications No. 130 were requested for opening on March 15, 1907. No proposals were received and the construction of this feature by force account was authorized on April 29, 1907. The plans for Willow Creek dam provide for an earth-fill structure, with a crest length of 1,045 feet and a maximum height of about 110 feet. The downstream face has a slope of 2 to 1 and the upstream face has a slope of 3 to 1 and is riprapped with a 2-foot thickness of loose gravel and bowlders. The crest of the dam is 20 feet wide and is riprapped with loose gravel and bowlders. The elevation of the crest of the dam is 4,140, the maximum elevation of the water surface in the reservoir is 4,130, and the intake to the outlet conduit is at elevation 4,085 feet above sea level. The controlling works consist of a tunnel, gate chamber, gate shaft, and gate house. The tunnel extends around the dam through the west bank of the canyon, is lined with concrete, has a length of 630 feet, and an inside diameter of 4 feet 6 inches. About 160 feet from the entrance to the tunnel there is a concrete gate chamber, above which is built a concrete gate shaft surmounted with a corrugated iron and timber gate house. The tunnel portals are of reenforced concrete.

During 1907 the tunnel was driven, excavation for the gate shaft was made, and the concrete lining of the tunnel was placed. This work was completed in October, 1907. The contract for the circular sluice gate, wall pipe, shaft for gate, shaft guides, and gate stand for the outlet tunnel was awarded in April, 1907. Work at the dam was suspended until September, 1909, when preliminary work for the construction of the embankment was begun. In March, 1910, the controlling gate for the outlet tunnel was installed and the gate shaft and gate house completed. The construction of the embankment was begun at about the end of the fiscal year 1910. It is proposed to construct the dam to a height of only 70 feet at the present time, providing storage capacity of 16,700 acre-feet. It is anticipated that the dam can be completed to this extent during 1911.

FORT SHAW CANAL SYSTEM

Proposals under specifications No. 131 for the construction of the Fort Shaw canal system were opened on April 3, 1907. The specifications provide for five divisions of the work, each containing separate schedules for excavation and for structures. Division 1 includes about 6 miles of main canal from the headworks to the east end of Simms Creek siphon; division 2 includes about 6 miles of canal from the east end of Simms Creek siphon to the end of the main canal; division 3 includes about 21 miles of laterals and sublaterals; division 4 includes about 39 miles of laterals, sublaterals, and waste-water ditches; and division 5 includes about 24 miles of laterals and sublaterals. Separate contracts were entered into for the excavation on each division. No proposals for the building of structures were received, and on April 29, 1907, authority was granted for executing this work by force account. The important structures of the canal system are reenforced concrete headworks, a reenforced concrete pressure pipe across Simms Creek, and two concrete drops. The headworks structure is designed to divert water from the south bank of Sun River. The floor of the intake is 3,666 feet above sea level or about 2 feet below the low-water level of Sun River. Water enters this structure over a low weir 70 feet in length set in the river bank. The intake channel narrows to a width of 26 feet in a distance of 25 feet from the weir to the intake gate chamber. The flow of water to the canal is controlled by four gates, each 4 feet square. Simms Creek siphon is a circular reenforced concrete pressure pipe 5 feet 1½ inches in inside diameter and about 1,600 feet in length. One of the concrete drops is 175 feet long, 4 feet wide, and has a fall of 50 feet. The other concrete drop is 785 feet long and 8 feet wide, and has a fall of 60 feet. Practically all the work of excavation and construction on the canal system was completed by June 30, 1908.

SETTLEMENT AND IRRIGATION

A public notice dated March 26, 1908, opened for irrigation 14,796.08 acres of land in the Fort Shaw unit. Of this area 12,417.36 acres were public land. Water was diverted from the river from July 1 to October 24, 1908, for the purpose of priming the canals and laterals, but water for irrigation was not delivered until May 8, 1909. During the season of 1909, 7,674 acres were irrigated, and about 9,535 acres are being irrigated in the season of 1910.

The town sites of Fort Shaw and Simms were surveyed and lots were appraised and put on sale in 1908. Many lots have been sold and towns are growing rapidly at both of these sites.

Eleven other town-site reservations have been made on the project.

On June 30, 1910, 162 filings and water-right applications on public lands and 4 water-right applications for private lands had been received. The water-right applications are for 9,686 acres of irrigable land.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year surveys of reservoir sites, examination and borings at proposed dam sites, location surveys for the main canal on the north side, topographic surveys, soil examinations, and farm-unit subdivisions of lands on the north side were made. The construction work accomplished during the fiscal year comprised, in the Fort Shaw unit, the practical completion of excavation of laterals, the construction of a number of minor structures, and the construction of a waste-water ditch 6,900 feet in length and 6 feet in bottom width connecting the end of the main canal with the river; at Willow Creek dam, the completion of the outlet tunnel and gate shaft, the installation of outlet gates, the commencement of work on a diffusion chamber and outlet structure at the lower end of the tunnel, and the excavation of cut-off trenches for the dam, including a fourth trench not provided for in the original design. In the operation and maintenance of Fort Shaw unit, water was delivered for the irrigation of over 9,000 acres of land. Laterals were cleaned of weeds and grass and in places protected with riprap, and in a few places of excessive grades rock checks were constructed. In the season of 1909 good crops were harvested from the land in cultivation, although many of the farmers had failed to appreciate the advantage of plenty of distributing ditches and thorough leveling of the land. Many fruit trees are being planted and the general progress of the farmers on the project is evident. Owing to the warm and dry spring the irrigation season of 1910 was begun on April 11. There has been ample water for all users, and no trouble has been experienced in delivering water when needed to those entitled to it.

PRINCIPAL CURRENT CONTRACT

The following statement contains data relating to the principal contract in operation during the fiscal year ending June 30, 1910: No. 321; date, April 13, 1910; contractor, Atlantic Equipment Company, for steam shovel; estimated value, $6,900; estimated earnings, June 30, 1910, $7,160; completion due May 20, 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Sun River project

ASSETS

Acccounts receivable: Uncollected water-right building charges			$323.93
Inventories:			
Mercantile store		$218.40	
Government animals	$10,726.09		
Less depreciation	260.00		
		10,466.09	
Equipment in use	18,412.40		
Less depreciation	304.00		
		18,108.40	
Storehouse		3,462.81	
Cement		3,930.02	
Iron and steel		410.10	
Lumber		8,590.26	
Explosives		608.46	
Forage		1,837.87	
Fuel		329.44	
Unadjusted transfers		302.07	
Freight and handling undistributed		108.57	
			48,372.49

Cost of work:			
Building cost		$561,605.49	
Less adjustments	$1,409.26		
Less accrued revenues	4,017.59		
		5,426.85	
			$556,178.64
Operation and maintenance cost		47,812.89	
Less accrued revenues		363.12	
			47,449.77
Total assets			652,324.83

LIABILITIES

Investment of the United States:			
Disbursement vouchers	626,638.30		
Transfer vouchers received	24,769.62		
		651,407.92	
Collection vouchers	42,898.66		
Transfer vouchers issued	8,550.67		
		51,449.33	
			599,958.59
Acccounts payable:			
Unpaid labor		5,535.85	
Unpaid purchases		11,761.33	
Unpaid freight and express		132.88	
			17,430.06
Repayments accrued:			
Building		30,016.02	
Operation and maintenance		4,920.16	
			34,936.18
Total liabilities			652,324.83

Feature costs to June 30, 1910, Sun River project

Storage works:		
Willow Creek dam	$29,936.38	
Willow Creek outlet tunnel	16,669.38	
Driving and timbering shaft	6,912.64	
		$53,518.40
Diversion works: Canal headworks		17,618.17
Canal system:		
Main canal, division 1	83,106.28	
Main canal, division 2	53,401.17	
Willow Creek supply canal	11,482.17	
Lateral system	177,997.37	
Simms Creek siphon (part of main canal, division 1)	36,759.20	
		362,746.19
Telephone system: Construction		6,445.93
Real estate (rights and property): Lands purchased		14,269.94
Irrigable lands: Farm-unit subdivision		1,463.07
Buildings: Construction		19,422.17
North side survey: Surveys, topography, subdivision, etc		74,579.35
Plant account: Operating accounts		4,330.94
Examination of project as a whole: Stream gaging		6,440.28
Inventory of unused supplies		771.05
Total building cost		561,605.49
Operation and maintenance:		
Main canal	10,065.27	
Lateral A	17,894.45	
Lateral C	5,031.66	
Lateral D	969.10	
Laterals C5, K, and H	3,984.75	
Miscellaneous structures	1,787.75	
Telephone system	989.49	
Publicity and settlement	4,663.39	
Demonstration farm	807.88	
Instructions and demonstration at Fort Shaw	1,141.88	
Ditch riders cottage	286.90	
Inventory account	190.37	
		47,812.89
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		609,418.38

MONTANA-NORTH DAKOTA, LOWER YELLOWSTONE PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Dawson, Mont.; McKenzie, N. Dak.

Townships: 18 to 26 N., Rs. 56 to 60 E., Montana meridian; 150 to 152 N., R. 104 W., fifth principal meridian.

Railroads: Northern Pacific; Great Northern.

Railroad stations: Glendive and Mondak, Mont.

Average elevation of irrigable area: 1,900 feet above sea level.

Average annual rainfall on irrigable area: 16 inches.

Range of temperature on irrigable area: $-30°$ F. to $100°$ F.

WATER SUPPLY

Source of water supply: Yellowstone River.

Area of drainage basin: 66,000 square miles.

Annual run-off in acre-feet of Yellowstone River at Glendive (66,000 square miles) 1903 to 1908: Maximum 13,000,000; minimum, 8,500,000; mean, 11,000,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Diversion dam: Type, rock-filled timber weir; maximum height, 12 feet; length of crest, 700 feet.

Length of canals: 49 miles with capacities greater than 300 second-feet; 19 miles with capacities from 300 to 50 second feet; 191 miles with capacities less than 50 second-feet.

Aggregate length of dikes: 35,600 feet.

Water power: Estimated total, 290 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 63,780 acres; first unit, 43,310 acres.

Present status of irrigable lands (whole project): 12,532 acres entered subject to the reclamation act, 1,597 acres open to entry, 4,784 acres withdrawn from entry, 1,955 acres of state lands, 42,912 acres in private ownership (including railroad lands).

Area for which the service is prepared to supply water, season of 1910: 40,133 acres.

Area irrigated, season of 1910: 7,000 acres.

Length of irrigating season: 150 days.

Character of soil of irrigable area: Deep sandy loam.

Duty of water: 2½ acre-feet per acre per annum at the farm.

Principal products: Grain, hay, and vegetables.

Principal markets: Minneapolis and St. Paul, Minn.; local.

LANDS OPENED FOR IRRIGATION

Dates of public notices: December 21, 1908; April 24, 1909.

Location of lands opened: Tps. 18 and 19 N., R. 57 E.; Tps. 19 and 20 N., R. 58 E.; Tps. 21 to 25 N., R. 59 E.; T. 24 N., R. 60 E., Montana meridian. T. 150 N., R. 104 W.; T. 151 N., R. 104 W., fifth principal meridian.

Present status of irrigable lands opened: 5,586 acres entered subject to the reclamation act, 1,597 acres open to entry, 1,232 acres of state lands, 31,718 acres in private ownership (including railroad lands).

Limit of area of farm units: Public, 80 acres; private, 160 acres.

Building charge per acre of irrigable land: $42.50.

Annual operation and maintenance charge: $1 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnoissance made and preliminary surveys begun in 1903.
Construction authorized by Secretary May 10, 1904.
Yellowstone dam completed January, 1910.
Main canal: 62 miles completed March, 1909.
First irrigation by Reclamation Service, season of 1909.
Whole project 95 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Lower Yellowstone project provides for the diversion of water from Yellowstone River at a point about 18 miles below Glendive, Mont., into a canal system on the north side of the river extending to Missouri River at the mouth of Yellowstone River for the irrigation of lands lying between the main canal and Yellowstone River. The fall of the water discharged from the main canal into one of the laterals will be utilized in operating direct-connected turbines and centrifugal pumps for raising water to irrigate a small area of bench lands located above the gravity canals.

ORIGIN OF PROJECT AND INVESTIGATIONS

The Lower Yellowstone project was first examined in July, 1903, by F. E. Weymouth and J. N. Kerr. A considerable area of land lying along the Yellowstone River between the Yellowstone and Missouri rivers was found to be irrigable from canals leading from the northwest bank of Yellowstone River. In August, 1903, surveys for a canal heading at Terry, Mont., 40 miles above Glendive, were begun. It was found that a canal heading at Terry would furnish water for but little land above Glendive, and a survey was therefore begun for a canal heading 2 miles above Glendive. This line was surveyed to the Missouri River, a distance of a little over 80 miles, but preliminary estimates indicated that the cost of construction would be excessive. Meanwhile a petition signed by 82 residents of the lower Yellowstone Valley, owning about 12,000 acres of land, was received by the Secretary of the Interior in July, 1903, and other petitions signed by 146 residents of the valley were transmitted to the Geological Survey through Hon. W. A. Clark in January, 1904. These petitions requested that the construction of a project in the lower Yellowstone Valley be undertaken by the Government.

A survey for a canal heading about 19 miles below Glendive was undertaken after the other two locations had proved unsatisfactory. In April, 1904, a board of engineers consisting of Messrs. A. P. Davis, J. H. Quinton, B. M. Hall, and C. H. Fitch examined the location of the canal heading below Glendive and directed that complete surveys of the area irrigable from this canal be made. After these surveys had been made and preliminary estimates of the cost of constructing the project had been prepared a board of engineers consisting of Messrs. A. P. Davis, J. H. Quinton, and B. M. Hall recommended that the project be approved as feasible if satisfactory agreements could be made with the owners of lands within the limits of the project. The construction of the project was authorized by the Secretary of the Interior on May 10, 1904, and $1,200,000 of the reclamation fund was set aside therefor. A water users' association was incorporated in the summer of 1904 and practically all of the private lands of the project were subscribed to this association.

Satisfactory agreements for the subdivision and sale of lands were made with the Northern Pacific Railway and other holders of large tracts.

CONSTRUCTION

MAIN CANAL AND LATERALS

The main canal of the Lower Yellowstone project heads on the north bank of Yellowstone River about 19 miles below Glendive, with a capacity of 830 second-feet. The canal extends northeastward to the Missouri River, a distance of about 67 miles, diverging not more than 5 miles from Yellowstone River. A grade of about 6 inches to the mile is maintained for nearly 46 miles and is then gradually increased as the capacity of the canal is lessened. Beginning at the head gates the canal is located in thorough cut for about 4 miles, the excess material being used on the side adjacent to the river for protection from overflow due to ice gorges. Less excavation is required from the fourth to the ninth mile, where there is about three-quarters of a mile of sidehill work. Burns Creek, one of the largest tributaries of Yellowstone River within the project, is crossed in the tenth mile, following which is a short stretch of thorough cut, succeeded by a location at the foot of steep bluffs to the thirteenth mile. From this point to the twenty-fifth mile the canal follows the hillside, gradually increasing its elevation above the near-by bottom lands. Comparatively little land can be watered from the first 26 miles of the canal, although occasional areas are irrigable. One of the largest of these areas is reached from the twentieth mile by a lateral on which will be located a power and pumping plant with capacity sufficient to pump water for the irrigation of about 2,500 acres of bench land above the main canal. From the twenty-sixth mile there is about 8 miles of location in fairly flat country. In the thirty-sixth mile Fox Creek is reached after 2 miles of heavy sidehill construction. Beyond this creek the canal is located almost entirely on level bench lands and is bordered by large irrigable areas. About 70 per cent of the total irrigable acreage lies beyond Fox Creek, and from this creek onward the canal decreases rapidly in size until at the sixty-seventh mile it becomes a lateral, watering a part of the Missouri River bottom lands. In addition to the main canal, 205 miles of laterals are required for the distribution system. On account of the narrowness of the irrigable area these laterals are of moderate size and are in most cases located along section lines.

The head-gate structure is built of concrete. The main wall, parallel to the direction of the river, and the upstream wing wall have gravity sections sufficiently heavy to resist maximum floods. The downstream wing wall is designed as a retaining wall for earth, and is heavily reenforced with steel bars. The main wall is about 160 feet long and contains 11 sluice gates, each 5 feet in diameter. Each of these gates is set in a separate recess, and the entire front of the wall is protected by 12-inch timber guards spaced 2 feet on centers.

The structures on the main canal are built of reenforced concrete. Creek crossings have been accomplished by means of conduits on grade or pressure pipes under the creeks, by means of culverts under the canal, and by means of flumes over the canal. Conduits were used for the three largest creeks. The conduits are box-shaped structures designed for a velocity about double that used in the canal and joined to the earth section by wing walls. Culverts were built for small drainage channels where the stream flow could be estimated with considerable accuracy. Flat, box-shaped structures were used, the outer slopes of the canal banks being protected by flaring wing walls. Vitrified pipe culverts were used for the smaller water crossings. A total of over 60 culverts were built along the canal, 10 of which were of considerable size. Pressure pipes were used for crossing seven creeks along the lower half of the canal line. These pipes are of reenforced concrete, are circular in section, and have concrete inlet and outlet chambers adjoining the earth section of the canal. The largest of these crossings is at Fox Creek, where 2 pipes, each 7 feet in diameter and 225 feet in length, are used to carry the canal water. Each pipe is provided with a drain valve connecting with vitrified pipe leading to the creek channel. Twelve rectangular concrete flumes were built where the main canal is located in thorough cut. In addition to the structures for cross drainage, checks, sluiceways, and turn-outs were built on the main canal where necessary. A number of bridges for road crossings were also constructed, steel bridges with concrete abutments being used on the main canal and timber bridges on the laterals.

During the winter of 1904–5 plans for the first four divisions, about 34 miles of the main canal, were prepared. These plans were examined and approved in March, 1905, by a board of engineers consisting of Messrs. J. H. Quinton, A. J. Wiley, and H. N. Savage. Proposals for this portion of the canal, including earthwork and structures, submitted under specifications No. 31, were opened on June 1, 1905.

A contract for the earthwork on division 1 was entered into on July 22, 1905. This contract was suspended in March, 1906, when it was 29.2 per cent completed, on account of the insolvency of the contractors. Proposals for the remainder of the work under this contract were opened on May 3, 1906, and a contract therefor was executed on June 4, 1906. The work required the excavation of about 800,000 cubic yards of material in 7½ miles of canal. A steam shovel was used for the excavation of the first 1,000 feet, and three excavating machines of the dredge type were used for the remainder of the first 4 miles of canal, and teams and scrapers for the last 3½ miles. The work was completed on March 7, 1909.

A contract for the earthwork on divisions 2, 3, and 4 of the canal was executed on July 21, 1905. On account of advances in the prices of material and labor, the contractors refused to begin work, and the contract was therefore suspended. A readvertisement was made under specifications No. 81, and proposals opened April 12, 1906. A contract for division 2 was executed on May 12, 1906, and the work was completed on May 15, 1908. One steam shovel was employed on this division, but the greater part of the excavation was accomplished with teams and scrapers. A contract for division 4 was executed April 30, 1906. Work was begun by the contractor on May 3, 1906, and completed on September 30, 1908. The excavation was accomplished with teams and scrapers and with excavating machines. No proposals for division 3 were received on April 12, but informal proposals were requested and were opened on July 5, 1906. A contract was executed on July 26, 1906, and the work completed on August 21, 1908. The greater part of the excavation on this division was accomplished with three excavating machines, though teams and scrapers were utilized to some extent.

A contract for the structures on divisions 1, 2, and 3 was executed on July 24, 1905, work was begun in August, 1905, and the contract was assumed by the original contractors' sureties on October 26, 1906. A supplementary contract was entered into on January 10, 1910, eliminating the Linden Creek flume and Nelson Slough sluiceway from the contract. Work under the supplementary contract was completed on November 4, 1908. The Linden Creek flume and sluiceway were readvertised under informal specifications and proposals were opened on March 28, 1908. All proposals received were rejected, but a satisfactory informal proposal was received a few days later and a contract was awarded on May 15, 1908.

On November 15, 1905, proposals under specifications No. 60 for the earthwork on divisions 5 to 9 of the main canal and on the lateral system were opened. The work on divisions 5, 6, 7, and 9 of the main canal and on laterals A to M, except F, was contracted for in December, 1905, but the contracting company went into the hands of a receiver before work was commenced. A new contract was entered into on behalf of the sureties on April 20, 1906, division 9 of the main canal being eliminated from the contract by agreement, and the work was completed on September 30, 1908. Lateral N was contracted for on December 16, 1905. Work was started soon after the execution of the contract, and was completed on September 25, 1907. Division 8 of the main canal and laterals F, O, and P were contracted for soon after the opening of proposals, but the contracting company passed into the hands of a receiver in February, 1906, making necessary the suspension of the contract. A new contract on behalf of the sureties was entered into on May 1, 1906, and the work was completed on July 31, 1908.

Proposals for the structures on divisions 5 to 9 of the main canal and on laterals A to P, inclusive (specifications No. 78), were requested for opening on April 12, 1906. No proposals were received, and the contractor for the structures on division 4 of the main canal was asked to submit an informal proposal for the work. A contract was executed on August 7, 1906, and the building of the structures was completed on December 28, 1908, the structures on divisions 8 and 9 having been previously eliminated from the contract by agreement. Proposals under specifications No. 121 for the construction of laterals and waste-water ditches from the main canal headworks to Newlon were opened on December 15, 1906. No satisfactory proposals were received and the work was eventually executed under two informal contracts, being completed in August, 1908. Proposals for the building of the structures for this work under specifications No. 123 were opened on December 15, 1906. The proposals received were not satisfactory, and the work was executed under informal contracts, being completed December 15, 1908. A dam at Nelson Slough to protect the bank of the main canal was built under informal contract, the work being completed on December 24, 1907. Collins, Hell, and Squaw Coulee flumes, wooden structures at various points between the main canal headworks and Newlon, seven pipe culverts, and two pipe turnouts were built by force account. Reinforced concrete culverts were substituted for wooden structures in waste-water ditches 6W and 7W, and after their completion the headworks of the pumping plant were built.

LOWER YELLOWSTONE DAM

Lower Yellowstone dam is a rock-filled timber crib structure on a pile foundation. It is 700 feet in length, is at right angles to the direction of the current, and will raise the low-water level of the river about 4 feet. The dam is specially designed to resist the destructive effects of ice by having an approach on a slope of 3 to 1 and the downstream face ogee-shaped and protected by a heavy rock apron. The face timbers are protected by steel strips 4 inches wide and 1 inch thick, spaced 2 feet on centers. The north abutment of the dam is the head-gate structure, the bank on this side of the river being 50 to 60 feet in height above low water. On the south side the ground is much lower, and at this end of the dam a concrete abutment backed by a dike faced with riprap and extending inland to high ground was built. The low-water level in the river at the intake of the main canal is 1,976.8, the bottom of the canal is 1,970.5, the water surface in the canal at full capacity is 1,980.5, and the elevation of the crest of the dam is 1,981 feet above sea level.

Proposals for the construction of the dam under specifications No. 57 were opened on December 5, 1905. The bids were considered excessive and the proposals were rejected. The work was readvertised under specifications No. 83 and proposals were opened on May 10, 1906. The lowest bidderwas unable to give satisfactory bond and the work was offered to the next lowest bidder. This firm refused to execute a contract,and the work was finally awarded to the third lowest bidder. The contract, which includes the dam proper, the concrete abutments at the south end of the dam, and the dike from this abutment to a small hillock on Joes Island, was executed on September 21, 1906, and construction was begun late in the fall of 1906. Following a controversy in regard to changes in the materials of construction, the contractor discontinued operations and the contract was suspended on September 15, 1908. At this time the south abutment had been completed, a stone-paved dike from the south abutment to the hillock on Joes Island had been completed, stone riprap on the river bank below the south abutment had been placed, stone for the construction of the dam had been quarried and hauled to the dam site, the required number of piles had been delivered at the work, 473 round piles had been driven, and the unsatisfactory driving of 154 sheet piles had been accomplished. On September 15, 1908, the construction of the dam was undertaken by force account. Because of the great scour which had taken place in the river bed at the dam site during the high water of 1908, it was necessary to pull all the round piles that had been driven by the contractor. On account of the lateness of the season and the insufficiency of the plant owned by the contractor, it was decided not to attempt to build the dam during the ensuing low-water period, but to pull the piles, build a 62-foot section of the dam adjoining the south end, and remove the plant and material to a safe location. This work, with the exception of the removal of the plant, was accomplished by January 1, 1909. The plant was moved to the north side of the river during January and the quarrying and hauling of rock was in progress throughout the winter. A new camp was established, the contractor's plant was repaired, and additional equipment and material were purchased and assembled. By August 1 all preparations for the completion of the dam had been made and on August 13 the river had reached a sufficiently low stage to permit the beginning of operations. The construction was carried on night and day until completed on January 29, 1910.

SETTLEMENT AND IRRIGATION

Settlement of the lands within the Lower Yellowstone project was begun early in the nineteenth century, but progressed very slowly until the building of the Great Northern Railway in the summer of 1886. The only irrigation work carried on previous to the government development of the project consisted of flood irrigation of meadow land and the watering of a few small tracts from local streams.

A more extensive irrigation plan was undertaken by Mr. A. F. Nohle. This consisted of a series of reservoirs and dams on Four Mile Creek. This project embraced a considerable acreage, but little or no practical irrigation was attempted. The main dam broke in March, 1907, and was never repaired.

Many homestead entries were made at about the time of the withdrawal of lands for the irrigation project on August 23, 1903, and there are but few farm units open to entry, but much land held in large tracts is for sale. The settlement of the project is progressing satisfactorily. A branch line of the Northern Pacific Railway from Mandan to Glendive is under construction.

A public notice dated December 21, 1908, opened for irrigation 43,712 acres of land, and on April 24, 1909, a public notice was issued in which it was stated that it would be impracticable to furnish water for all of these lands during the irrigation season of 1909. Water was first admitted to the main canal on April 30, 1909, and the work of operation and maintenance has been carried on successfully since that time. During the season of 1909, about 5,000 acres of land were irrigated and during the season of 1910, 7,000 acres are being irrigated.

PROGRESS DURING FISCAL YEAR 1910

Active work in the building of Yellowstone dam was in progress by force account from August, 1909, to January, 1910, the structure being completed in the latter month. During the fiscal year work under several minor contracts for the construction of small laterals, waste-water ditches, etc., was carried on and some similar work was done by force account. Operation and maintenance work, including the delivery of water, the repair and betterment of the canals, and the installation of checks, culverts, turn-outs, etc., was carried on throughout the year.

On June 30, 1910, 146 water-right applications for the irrigation of 12,897 acres of land had been received. About 7,000 acres of land are being irrigated, about 6,000 acres of this area being in wheat and oats, and the remainder being planted to alfalfa, flax, barley, rye, garden vegetables, etc. Indications are that excellent crops will be harvested in 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Lower Yellowstone project

ASSETS

Accounts receivable:			
Uncollected freight refunds		$1,456.86	
Uncollected miscellaneous		20,039.52	
Uncollected water-right building charges		44,199.87	
Uncollected water-right operation and maintenance charges		3,313.97	
			$69,010.22
Inventories:			
Government animals		4,282.50	
Equipment in use		9,590.82	
Storehouse		2,333.13	
Cement		1,645.26	
Iron and steel		6,435.06	
Lumber		793.69	
Fuel		685.28	
Local products		162.28	
Unadjusted transfers		521.97	
Freight and handling undistributed		1,544.80	
			27,994.79
Cost of work:			
Building cost	$2,760,824.27		
Plus adjustments	5,597.64		
		2,766,421.91	
Less accrued revenues		25,974.21	
			2,740,447.70
Operation and maintenance cost			135,571.82
Total assets			2,973,024.53

LIABILITIES

Investment of the United States:			
Disbursement vouchers	2,876,992.46		
Transfer vouchers received	72,399.71		
		2,949,392.17	
Collection vouchers	45,929.78		
Transfer vouchers issued	14,562.56		
		60,492.34	
			2,888,899.83
Accounts payable:			
Unpaid labor		3,425.59	
Unpaid purchases		933.62	
Unpaid contract holdbacks		13,832.11	
Unpaid passenger fares		.60	
Unpaid land agreements		1,614.41	
Unpaid miscellaneous		1,355.28	
			21,161.61
Repayments accrued:			
Building		50,970.12	
Operation and maintenance		11,992.97	
			62,963.09
Total liabilities			2,973,024.53

Feature costs to June 30, 1910, Lower Yellowstone project

Diversion works: Lower Yellowstone dam		$318,071.35
Canal system:		
Earthwork	$1,412,515.02	
Structures	577,774.09	
		1,990,289.11
Distributing system:		
Earthwork	213,421.51	
Structures	20,886.86	
		234,308.37
Highway bridges:		
Bridge No. 3	8,643.69	
Bridges, force account	2,959.06	
Bridges, schedule 1	22,561.79	
Bridges, schedules 2 and 3	22,357.82	
Wooden structures, headworks to Newlon	14,002.42	
Approaches	4,275.98	
		74,800.76
Real estate (rights and property): Lands purchased		28,536.46
Buildings:		
Construction	17,895.32	
Maintenance	266.71	
		18,162.03

Telephone system:		
Construction	$19,184.50	
Maintenance	4,532.82	
		$23,717.32
Irrigable lands:		
Land survey	12,450.01	
Soil survey	1,890.55	
Farm units	1,016.24	
		15,356.80
Examination of project as a whole:		
Reconnaissance	20,442.76	
Surveys	30,009.98	
		50,452.74
Administration of project as a whole: General expense		7,129.33
Total building cost		2,760,824.27
Operation and maintenance:		
Main canal, earthwork	34,210.27	
Main canal, structures	14,402.47	
Lateral system	38,780.39	
Demonstration farms	6,261.92	
Telephone system	5,738.35	
Buildings and grounds	24,836.28	
Administration charges	11,342.14	
		135,571.82
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		2,896,396.09

NEBRASKA-WYOMING, NORTH PLATTE PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Sioux, Scotts Bluff, Banner, and Cheyenne, Nebr.; Natrona, Carbon, Converse, and Laramie, Wyo.

Townships: 19 to 27 N., Rs. 48 to 67 W.; 26 to 30 N., Rs. 83 to 85 W., sixth principal meridian.

Railroads: Chicago, Burlington and Quincy; Union Pacific; Chicago and Northwestern; Colorado and Southern.

Railroad stations: Bridgeport, Bayard, Minatare, Scottsbluff, Mitchell, Morrill, and Henry, Nebr.; Torrington, Vaughn, Single, Barnes, Fort Laramie, Whalen, Guernsey, and Caspar, Wyo.

Average elevation of irrigable area: 4,100 feet above sea level.

Average annual rainfall on irrigable area: 15 inches.

Range of temperature on irrigable area: —25° F. to 100° F.

WATER SUPPLY

Source of water supply: North Platte River.

Area of drainage basin: 12,000 square miles.

Annual run-off in acre-feet of North Platte River: At Pathfinder (12,000 square miles), 1905 to 1908—maximum, 1,800,000; minimum, 930,000; mean, 1,370,000. At Guernsey (16,200 square miles), 1900 to 1908—maximum, 2,480,000; minimum, 1,250,000; mean, 1,690,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Pathfinder—area, 21,774 acres; capacity, 1,025,000 acre-feet; length of spillway, 660 feet; elevation of spillway, 182 feet above stream bed.

Storage dam: Pathfinder—type, broken range cyclopean rubble masonry arch; maximum height, 218 feet; length of crest, 432 feet; volume, 60,712 cubic yards.

Diversion dams: Whalen—type, concrete weir; maximum height, 29 feet; length of masonry, 300 feet; length of earth-fill, 2,000 feet. Guernsey—not designed.

Length of canals now constructed: 98 miles with capacities greater than 300 second-feet; 35 miles with capacities less than 300 and greater than 50 second-feet; 455 miles with capacities less than 50 second-feet.

Aggregate length of tunnels: 943 feet.

Aggregate length of dikes: 3,200 feet.

AGRICULTURAL CONDITIONS, INTERSTATE CANAL UNIT

Irrigable area: 129,000 acres (Nebraska, 107,000 acres; Wyoming, 22,000 acres).

Present status of irrigable land: 79,172 acres entered subject to the reclamation act, 851 acres open to entry, 3,335 acres withdrawn from entry, 11,048 acres of state lands, 34,864 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 88,700 acres (Nebraska, 69,000 acres; Wyoming, 19,700 acres.)

Area irrigated, season of 1910: 51,000 acres (Nebraska, 44,000 acres; Wyoming, 7,000 acres.)

Length of irrigating season: 180 days.

Character of soil of irrigable area: Sandy loam.

Principal products: Alfalfa, cereals, corn, sugar beets, potatoes.

Principal markets: Omaha, Nebr.; Kansas City and St. Joseph, Mo.; Denver, Colo.; central Wyoming.

LANDS OPENED FOR IRRIGATION

Dates of public notices and orders relating thereto: July 29, 1907; May 29, 1908; June 16, 1908; November 12, 1908; March 3, 1909; March 27, 1909; and June 2, 1909; March 12, 1910; April 4, 1910; June 6, 1910.

Location of lands opened: Townships 22 to 26 N., Rs. 53 to 60 W., sixth principal meridian.

Present status of irrigable lands opened: 51,972 acres entered subject to the reclamation act, 851 acres open to entry, 8,652 acres of state lands (including 2,179 acres of Carey Act lands), 26,539 acres in private ownership (including 12,326 acres of Carey Act lands).

Limit of area of farm units: Public, 80 acres; private, 160 acres.

Duty of water: $2\frac{1}{2}$ acre-feet per acre per annum at the farm.

Charges per acre of irrigable land: Building $35, operation and maintenance $2 per annum; building $45, no charge for operation and maintenance for two years.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1902.

Construction authorized by Secretary March 14, 1903.

Contract with the North Platte Canal and Colonization Company for right of way for first part of interstate canal, December 22, 1904.

First irrigation by Reclamation Service, season of 1908.

Interstate canal, 95 miles completed May, 1908.

Whalen diversion dam completed February, 1909.

Pathfinder dam completed June, 1909.

Pathfinder dike, 30 per cent completed June 30, 1910.

Whole project 74 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the North Platte project provides for the storage of the flood waters of North Platte River in a reservoir controlled by the Pathfinder dam, about 3 miles below the junction of the North Platte and Sweetwater rivers and 50 miles southwest of Casper, Wyo., and in smaller reservoirs along the canal lines; the diversion of water from North Platte River by a dam near Whalen, Wyo., into the interstate canal, supplying water for lands on the north side of the river, and into the Fort Laramie canal, watering lands on the south side of the river; and the diversion of water from North Platte River by a dam a short distance above Guernsey, Wyo., into a canal system supplying water for lands in Goshen Park, south of the river.

ORIGIN OF PROJECT AND INVESTIGATIONS

The census of 1890 reports that a little more than 10,000 acres of land were irrigated in 1889 in Nebraska, mainly from North Platte River, and the census of 1900 reports nearly 150,000 acres similarly irrigated in 1899. The areas irrigated in Wyoming from the North Platte River are small, but some lands are being irrigated along its tributaries. During the latter part of the irrigation season the lands in irrigation were often inadequately supplied by the natural flow of the river and it was apparent that storage of flood waters would be necessary in order to extend the areas irrigated. In the summer of 1902, shortly after the organization of the Reclamation Service, investigations were begun of a reservoir site on Sweetwater River a short distance above the confluence of the Sweetwater and North Platte rivers, and of the irrigable lands along North Platte River in the States of Wyoming and Nebraska. The investigation of the Sweetwater reservoir site was resumed in 1903, and the surveys were extended downstream to a point on North Platte River about 3 miles below the mouth of Sweetwater River. The plans for a dam on this location proved so satisfactory that detail surveys and borings at the dam site were at once begun. A triangulation system was established and surveys made of the proposed reservoir and dam site.

The investigation of irrigable lands was continued in the seasons of 1903 and 1904, and preliminary surveys of various canal lines, diverting from North Platte River near Alcova, Caspar, Guernsey, and Whalen, and from Sweetwater River at Devils Gate, were made. The surveys showed that but small areas could be irrigated from the upper diversions. From Guernsey a line of levels had been run some years before by Mr. Clarance T. Johnston, showing the possibility of carrying water to a large body of land known as Goshen Hole or Goshen Park, in southeastern Wyoming and western Nebraska, and the surveys of the Reclamation Service in this region covered practically the same ground and indicated a large area of good land susceptible of irrigation.

In the investigation of canal lines north of the river near Whalen to irrigate lands in eastern Wyoming and western Nebraska, the most feasible route was found to be occupied by the Whalen canal, then partly constructed by the North Platte Canal and Colonization Company. A lower line would leave out a large part of the irrigable land and a higher line would require construction through rough country, involving expensive rock excavation. It was found that a canal on the chosen location could be extended far into Nebraska and be made to cover a very large area of good irrigable land.

In the spring of 1903, general plans for storage of water and irrigation from North Platte River, based on the surveys and investigations then made, were prepared. The plans as outlined in a letter by the Director of the Geological Survey to the Secretary of the Interior, dated March 7, 1903, included the storing of water in a reservoir on Sweetwater River and irrigation of lands along the North Platte River. It was recommended that development of the general project as outlined be approved, that the examination of irrigable lands, reservoirs, etc., be continued, and that work be carried on in greater detail for the ascertainment of facts necessary for the preparation of specifications and the letting of contracts for the construction of irrigation works. On March 14, 1903, the Secretary of the Interior approved the general project as recommended and authorized the preparation of plans and specifications for construction to be submitted to him for approval. In 1904 recommendations were made for the construction of a reservoir on the North Platte River below the mouth of Sweetwater River in place of the reservoir first proposed on the Sweetwater River. The reservoir selected received the name of "Pathfinder" on account of a tradition that General John C. Fremont, popularly known as the "Pathfinder," passed through the canyon at the reservoir site on one of his exploring expeditions. Contingent on favorable reports on details of construction and of lands proposed to be reclaimed, authority for the construction of a dam at the Pathfinder site was granted by the Secretary of the Interior on May 3, 1904.

CONSTRUCTION

PATHFINDER SLUICING TUNNEL

In order to provide for diverting the flow of the river during the construction of the Pathfinder dam, the first work undertaken was the construction of a sluicing tunnel on the north side of the canyon around the site of the dam. The tunnel is driven through solid granite and has a length of 480 feet. Its entrance is 90 feet from the upper face of the dam and its outlet 230 feet from the toe of the dam. The tunnel is 13 feet wide, 10 feet high in the center, and 9 feet high at the sides, and the floor and the lower 2 feet of the sides are lined with concrete. The floor of the tunnel is at elevation 5,670 at its upper end and has a slope of 1 in 100. Two gate shafts 170 feet deep connect the tunnel with the ground surface. One shaft is located at the point where a line between the abutments of the dam intercepts the tunnel line and will contain the gates for ordinary use. The other shaft is located about 60 feet upstream and contains the gates intended for emergency use.

Plans for the sluicing tunnel were prepared in the fall of 1904, and were reviewed and approved by a board of engineers consisting of Messrs. A. P. Davis, A. J. Wiley, W. H. Sanders, and J. H. Quinton. Proposals for the construction of the tunnel, under specifications No. 23, were opened January 9, 1905, and a contract was executed January 21, 1905. The work was begun in February and completed in August, 1905.

The tunnel was driven from both portals and taken out full size. Hand drills were first used but afterwards four electric air drills mounted on columns and operated by a power plant consisting of a 50-horsepower engine and boiler and a 30-kilowatt generator were used, two in each heading. Sand and broken stone for concrete used in lining the tunnel were obtained by screening the material excavated from the tunnel. This material was hard, close-grained granite. In the winter of 1908–9 there was built by force account at the upper portal of the tunnel a grillage of concrete beams and columns supporting $1\frac{1}{4}$ by 6 inch steel bars; and in January, 1910, the construction by force account of a drainage tunnel from the upper gate shaft to the canyon wall below the dam was begun. This tunnel is 155 feet in length and has a section 5 feet square.

PATHFINDER DAM

The Pathfinder dam is located in a deep narrow canyon on the North Platte River 3 miles below the mouth of the Sweetwater River and 50 miles from Casper, Wyo., the nearest railroad station. It is an arched masonry structure, the radius of the center line of the top being 150 feet. It has a maximum height of 218 feet, a maximum length of 432 feet, and a width at the top of 10 feet. The top of the dam is surmounted by a stone parapet wall 4 feet high and 2 feet thick on the upper face and a pipe railing on the lower face. The elevation of the top of the parapet is 5,864 feet above sea level. The upstream face has a batter of one horizontal to four vertical and the downstream face a batter of one and one-half horizontal to ten vertical. At the north end of the dam, with crest at elevation 5,850, or 10 feet below the top of the dam, exclusive of parapet, is a spillway about 600 feet long over a solid rock ledge excavated to a uniform elevation. A curved concrete guide wall extends from the north end of the dam a distance of 108 feet along the side of the spillway to protect the toe of the dam, and a bridge extends from the north end of the dam to the gatehouse above the service gate shaft and another from this gatehouse to that above the emergency gate shaft. The stones on the faces of the dam are squared and faced and are laid in regular courses with horizontal and vertical joints. The interior of the structure consists of irregular-shaped stones up to 10 tons in weight embedded in cement mortar with concrete filling between stones. The upper 27 feet of the dam to a depth of 5 feet from either face is reenforced with horizontal steel bars. Two lines of 36-inch cast-iron pipe pass through the dam at elevation 5,675, or 5 feet higher than the intake floor of the tunnel, and with floor elevation 5,691 there is an opening through the dam the section of which is a square with side of 4 feet surmounted by a semicircle with radius of 2 feet. Changes made in the plans after the specifications were issued include the substitution of a tangent extension of the dam for the spillway on the south side, the elimination of bastions and guide walls along the canyon, and the substitution of a curved guide wall along the spillway on the north side, and the enlargement of the spillway on the north side by excavating 200 feet into the side of the canyon.

In March, 1905, a board of engineers consisting of Messrs. A. P. Davis, G. Y. Wisner, J. H. Quinton, A. J. Wiley, H. N. Savage, C. E. Wells, and D. C. Henny approved plans and specifications for the dam. Proposals, under specifications No. 36, were opened in Denver June 15, 1905, and a contract was awarded, but the bidder failed to qualify. The work was readvertised, under specifications No. 50, and proposals were opened August 16, 1905. A contract for construction was executed on September 1, 1905, and work was begun on September 25, 1905, and finished on June 14, 1909.

The plant of the contractor consisted principally of 10 guy derricks with 60-foot masts and 55-foot booms, 2 cableways of 375-foot span, 1 rock crusher, 3 concrete mixers, and 1 35-kilowatt electric generator with the necessary machinery to operate them with steam power supplied by 4 boilers having a combined capacity of 170 boiler horsepower.

A cofferdam was constructed just below the intake of the sluicing tunnel and excavation for the foundation of the dam was continued during the winter of 1905–6 until the latter part of March, 1906, when floods interrupted the work and deposited a large amount of sand in the foundation pit. Operations were resumed in August, 1906, and on the 15th of that month the placing of masonry was begun. Operations were suspended for the winter in November, 1906, at which time the dam had been constructed to an elevation 2 feet above low water or 23 feet above the lowest part of the foundation. Work was resumed in March, 1907, and continued until November, when the dam had been constructed to elevation 5,722, or 55 feet above low water. In November, 1908, when the work was suspended for that season, the dam had been constructed to elevation 5,830, or 108 feet above low water. Work was resumed again on March 3, 1909, and the last parapet stone was placed on June 5, 1909.

The stone used in the dam was hard coarse-grained granite secured from three different quarries, each less then ¼ mile from the site of the dam. The face stones were 2 to 3 feet thick and were laid in courses with joints 1 to 2 inches thick. The backing stones, averaging 4 tons in weight, were irregular in size, and were laid in beds of cement mortar and the vertical joints, about 6 inches wide, were filled with concrete.

HIGH PRESSURE GATES

At the bottom of the gate shafts enlargements of the sluicing tunnel form the gate chambers. In the upper gate chamber are installed four gates at present furnishing the only means of controlling the discharge of the tunnel, but intended eventually for emergency gates when the service gates shall be installed in the other gate chamber. The gate chamber is separated into four passageways by means of three concrete piers that in conjunction with the side walls of the chamber serve as supports for the framework of the gates. Surrounding the piers and attached to the side walls of the chamber are massive gray-iron castings forming the gate frames. The gates are made of gray cast iron with the contact portion of the faces covered with bronze strips to facilitate sliding on corresponding bronze surfaces attached to the gate frames. Each gate is 7½ feet long by 4½ feet wide and controls a waterway 7 feet high by 3 feet 8 inches wide, and its total weight, including the lifting rod and piston, is estimated to be about 10,000 pounds. Directly above each gate is a recess into which it rises on being opened. Over the gate shaft is a gate house or power house which contains the operating machinery for the four gates. The operating mechanism consists of an oil cylinder for each gate, a piston rod which is attached to the gate, a large oil-supply tank, a pipe system connecting the oil-supply tank and cylinders, a power plant consisting of a 15-horsepower gasoline engine direct connected to a direct-current 10-kilowatt dynamo, wound for 220 volts, and a pumping unit consisting of a 7½-horsepower electric motor, wound for 220 volts, and a triplex pump having a capacity of 19 gallons per minute with 50 strokes under a pressure of 600 pounds per square inch. By proper manipulation of throttle valves in the piping, the oil pressure produced by the pump can be applied to either the top or the bottom of the piston and thus close or open the gate. Designs for the gates, operating mechanism, gate chamber, and power house were prepared in 1906 and reviewed on July 16 and 17, 1906, by a board of engineers, consisting of Messrs. O. H. Ensign, A. J. Wiley, H. N. Savage, W. H. Sanders, and L. C. Hill. After certain changes proposed by the reviewing board had been made, the designs, plans, and specifications were prepared, and were approved by the department on October 26, 1906. Proposals for supplying and installing the gates and operating mechanism, under specifications No. 122, were opened on December 20, 1906, and a contract was executed February 14, 1907. The contractor was required to erect the gate frames and install the gates and operating mechanism, but the excavating required the placing of the necessary concrete, and the construction of the gate house were done by the United States. The manufacture of the gates was begun by the contractor soon after the execution of the contract, and the delivery at the project of the gates, gate frames, and operating mechanism was made in January and February, 1908. The installation of the gates was begun in February and completed in April, 1908. The power house over the gate shaft was constructed by force account in the winter of 1908–9, and the operating machinery for the gates was installed during April and May, 1909.

PATHFINDER DIKE

The Pathfinder dike is located at a gap in the rim of the reservoir one-quarter of a mile south of the Pathfinder dam. The elevation of the lowest point of the gap is 5,832, or 18 feet below the elevation of the spillway of the dam. The dike is an earth embankment 1,650 feet long and 20 feet wide on top, with a slope of 3 to 1 on the water face and 2 to 1 on the lower face, and a maximum height of 38 feet. Twenty-five feet upstream from the center line is a concrete core wall which reaches within 12 feet of the top of the dike or 8 feet above the crest of the spillway. The core wall is built of reenforced concrete, and has a maximum height of 31 feet. It is 24 inches thick near the foundation and 12 inches at the top, and has a footing 18 inches thick and 5 feet wide resting in a trench 5 feet deep. The upstream part of the embankment consists of earthy material paved with granite blocks 18 inches thick on a foundation of crushed rock 18 inches thick, and the downstream part is built of gravelly material.

Proposals for the construction of the dike under specifications No. 129 were opened February 27, 1907, but all bids were rejected because they were considered excessive. The work was readvertised and proposals requested for June 5, 1907, but no proposals were received. A small embankment on the site of the dike was built by force account in July, 1909, and proposals for the completion of the dike under specifications No. 160 were opened on October 28, 1909. The bids received were considered excessive and were rejected, and on December 22, 1909, the Secretary of the Interior authorized the construction of the dike by force account. On June 30, 1910, the dike was about 30 per cent completed.

SOUTH-SIDE OUTLET TUNNEL

The south-side outlet tunnel will pass around the south end of the dam and will be about 350 feet long, 14 feet wide, and 15 feet high. The elevation of the tunnel floor at its upper end will be 5,730. The discharge of the tunnel will be controlled by six 58-inch balanced valves.

On January 24, 1910, a board of engineers reviewed and approved plans for the tunnel, and its construction by force account was begun February 7, 1910. Only the upper part of the tunnel, 7½ feet high and 14 feet wide, is under construction. On June 30, 1910, the upper section was completed with the exception of a bulkhead of solid rock, 21 feet thick, which will be excavated when the water is drawn from the reservoir.

WHALEN DIVERSION DAM

The Whalen diversion dam is located on North Platte River near Whalen, Wyo., more than 150 miles below the Pathfinder reservoir, and diverts water into the Interstate and Fort Laramie canals. The dam is a concrete weir, 300 feet long, with a maximum height of 29 feet, resting on a conglomerate foundation. At each end of the dam are two sluice gates each 5 feet 9 inches wide and 6 feet high. Beyond the sluice gates and at right angles to the dam are located at the north end the headworks for the Interstate canal, and at the south end the headworks of the Fort Laramie canal. For the Interstate canal there are 9 regulator gates, and for the Fort Laramie canal, 7, each 5 feet 9 inches wide and 6 feet high. The crest of the weir is $6\frac{1}{2}$ feet above the sills of the canal intake gates and $10\frac{1}{2}$ feet above the canal grade. Beyond the headworks of the Fort Laramie canal is an earth dike extending 2,000 feet to high ground, with a maximum height of 25 feet and slopes of $2\frac{1}{2}$ to 1.

Plans for the construction of the diversion dam and headworks were reviewed and approved by a board of engineers consisting of Messrs. A. P. Davis, W. H. Sanders, C. E. Wells, and John E. Field, and proposals for the work, under specifications No. 117, were opened November 1, 1906. As there was but one bidder, no award was made, and the work was readvertised under specifications No. 124. Proposals were opened on January 9, 1907, and a contract was executed and the work begun during February, 1907. The progress of the work was unsatisfactory, and after the dam and the headworks of the interstate canal had been nearly completed, the contract was suspended on August 18, 1908, and the work was completed by force account in February, 1909.

On account of the failure to complete the dam before the beginning of the irrigation season of 1908 it was necessary for the United States to build a temporary dam to divert water to the Interstate canal during that season. The temporary dam was built of logs, gravel, and rock, with a bush apron and a concrete crest, and diverted water into the Whalen Falls canal and thence into the Interstate canal.

INTERSTATE CANAL

The Interstate canal heads at the Whalen diversion dam on North Platte River and for the first part of its course follows the line of the Whalen Falls canal.

Division 1 of the canal is 45 miles long and extends from the headworks nearly to the Wyoming-Nebraska state line. The canal is designed for a capacity of 1,400 second-feet at the headworks and 1,200 second-feet at the end of the first division. The bottom width at the headworks is 34 feet and its depth is 13 feet throughout with a water depth of 10 feet. This division of the canal is located for the most part through a rough country which has required the construction of several large flumes, siphons, and culverts. One of the largest structures is Spring Canyon flume, which carries the canal across a deep draw about 14 miles from the head gates. The flume is 280 feet long, including approaches, 34 feet wide, and 13 feet deep, and is supported by three arches, the center one having a span of 50 feet and the end arches spans of 30 feet each. The side walls, constructed of reenforced concrete, are connected at the top by a lateral system of structural steel.

Division 2 of the canal extends from the forty-fifth to the ninety-fifth mile at reservoir site No. 1. It is designed for a capacity ranging from 1,200 second-feet at the upper end to 743 second-feet at the lower end; its bottom width is 28 feet at the upper end and 22 feet at the lower end. The principal structures on this division consist of 9 large concrete culverts, sluiceways, and siphons, 13 lateral turnouts, and 10 steel-truss highway bridges of 54-foot span.

Division 3 of the canal will head at the lower end of reservoir No. 1 and will extend for about 70 miles in a general southeasterly direction. Final plans for this division have not been prepared and no construction work has been done on it.

Plans for excavation of the first division of the Interstate canal were reviewed and approved by a board of engineers consisting of Messrs. A. P. Davis, J. H. Quinton, and H. N. Savage, and proposals for construction under specifications No. 29 were opened May 16, 1905. The work involved the excavation of about 3,000,000 cubic yards of material, and five contracts were executed for different parts of the work. The work was begun in July, 1905, and completed in June, 1906.

Proposals for building structures on the first division of the interstate canal under specifications No. 63 were opened November 8, 1905; contract was executed November 23, 1905; and the work was begun January 3, 1906, and completed in July, 1907. The work involved the excavation of nearly 50,000 cubic yards of earth and the placing of about 12,000 cubic yards of concrete.

Proposals for excavation of the second division of the Interstate canal under specifications No. 62 were opened on November 8, 1905. Three contracts were executed, involving in all the excavation of about 3,000,000 cubic yards of material. The work was begun in March, 1906, and completed in July, 1907.

Proposals for building structures for the second division of the canal under specifications No. 146 were opened June 26, 1907. Contracts were executed and the work was begun July 25, 1907, and completed May 18, 1908.

DISTRIBUTING SYSTEM

The distributing system as at present under construction by the United States consists of three districts. The first district embraces about 135 miles of canals serving lands west of Dry Spotted Tail Creek under the first 30 miles of the second division of the Interstate canal. The second district embraces about 114 miles of canals serving lands east of Dry Spotted Tail Creek on the last 20 miles of the second division of the Interstate canal. The third district embraces lateral systems serving lands in the vicinity of and beyond Winter Creek to the east of the present terminus of the Interstate canal. The water supply for the laterals now under construction in this division is taken from a reservoir at the end of the second division of the Interstate canal. The laterals of districts 1 and 2 are completed and a part of the lateral system of district 3 is under construction.

Proposals for excavating the laterals of the first district in accordance with specifications No. 91 were opened June 15, 1906. Twelve contracts were executed for different parts of the work. The work was begun in the summer of 1906 and completed in the spring of 1907. Plans for the structures in this district were included in specifications No. 146, but they were built by force account and were completed in the spring of 1908.

Proposals for excavating the laterals of the second district, in accordance with specifications No. 140, were opened May 21, 1907, and four contracts were executed. The work was begun in June and completed in December, 1907, and involved the excavation of about 700,000 cubic yards of material. The lateral structures for the district were built by force account and consist of about 300 concrete drops, flumes, wasteways, and other structures, and numerous wooden structures. Work on the structures, was begun in June, 1908, and completed in the spring of 1909.

Excavation of a part of the laterals of the third district was begun by informal contracts and carried on during the winter of 1909–10. Construction of the structures by force account has been authorized and the work is in progress.

IRRIGATION

In accordance with the contract with the North Platte Canal and Colonization Company, water was delivered through the Interstate canal during the season of 1906 to the lands controlled by that company under the provisions of the Carey act. Only 150 second-feet of water was needed.

In 1907 a larger acreage was under cultivation in this district and 200 second-feet of water was used.

In 1908, 16,000 acres of land in the first lateral district in Nebraska were irrigated, besides 6,500 acres in Wyoming cultivated the previous season, necessitating the use of 500 second-feet of water, which required the construction of a temporary crib dam on North Platte River to secure the necessary flow. Checks $3\frac{1}{2}$ to 5 miles apart were built to regulate the water in the Interstate canal and several waste gates were provided.

In 1909 a total of 44,262 acres were irrigated, 19,665 acres being in the first lateral district, 16,970 acres in the second lateral district, and 7,627 acres being supplied in accordance with the contract with the North Platte Canal and Colonization Company.

About 51,000 acres of land are being irrigated this season. The maximum flow of water in the Interstate canal was 1,300 second-feet. The stored water in the Pathfinder reservoir on June 30, 1910, amounted to about 310,000 acre-feet, and the maximum amount in the reservoir at any time during the fiscal year was nearly 700,000 acre-feet.

PROGRESS DURING THE FISCAL YEAR 1910

The Pathfinder dam was completed in June, 1909, with the exception of the pipe railing on the downstream side which was erected in July. A boat house was constructed by the United States for a motor boat in use on the reservoir.

The emergency section of the Pathfinder dike, 8 feet high, begun on June 22, 1909, was finished July 9, 1909. Proposals received for the construction of the Pathfinder dike not being considered satisfactory, in November the Secretary of the Interior authorized the work to be done by force account. A plant consisting of a steam shovel, traction engine, grader, scrapers, cars and wagons was purchased and the work of excavation was begun March 15, 1910. On June 30, 1910, 53,600 cubic yards of material had been placed in the embankment and the dike was 30 per cent completed.

A drainage tunnel for the emergency gate shaft at the Pathfinder dam was begun January 23, 1910, and on June 30, 1910, 133 feet had been driven, leaving 22 feet to be excavated to complete the work.

Excavation of the upper half of the section of the south-side outlet tunnel for the Pathfinder reservoir was begun February 7, 1910, and on June 4 the work was stopped, leaving a bulkhead of 21 feet of solid rock to be removed after the water is drawn down in the reservoir.

A portion of the third lateral system was excavated by contract and the building of the wooden structures was done by force account. A breakwater was built near Whalen to protect the Interstate canal headworks.

Surveys were made of canal lines and reservoir sites in the third lateral district, of the right of way of the first division of the Interstate canal, of the Sheep Creek bottom, and of irrigable areas and canal lines and reservoir sites in the Goshen Park unit.

A large amount of work was done on betterments of the existing canals, the work consisting of riprapping canal banks with brush and gravel and raising and strengthening the banks as required.

The operation of canals and the delivery of water for irrigation have been carried on without unusual incident.

PUBLIC NOTICE DATED MARCH 12, 1910

In pursuance of the provisions of section 4 of the reclamation act, approved June 17, 1902 (32 Stat., 388), notice is hereby given to all entrymen and private landowners within the first lateral district, North Platte project, Nebraska and Wyoming, whose entries and water-right applications continue under the provisions of the public notice of July 29, 1907, that the portion of the installment for operation and maintenance which must be paid on or before April 1, 1910, and on or before April 1 of each subsequent year, shall be $2 per acre of irrigable land, until further notice.

PUBLIC NOTICE DATED APRIL 4, 1910

In pursuance of the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), notice is hereby given as follows:

All entries made and all water-right applications filed on and after May 2, 1910, for lands in the first lateral district, North Platte project, Nebraska-Wyoming, whether for public or for private lands, shall be accompanied by a payment equal to the sum of all installments which shall, at the time of such entry or of the filing of water-right application, have become due and remain unpaid under the provisions of public notices and orders in force for lands in said district, or which would have become due thereunder had the entry or water-right application been filed on March 4, 1909.

All entries made and all water-right applications filed on and after May 2, 1910, for lands in the second lateral district of said project, whether for public or private lands, shall be accompanied by a payment equal to the sum of all installments which shall, at the time of such entry or of the filing of water-right application, have become due under the provisions of public notices and orders in force for lands within said district, or which would have become due thereunder had the entry or water-right application been filed on March 29, 1909.

PUBLIC NOTICE DATED JUNE 6, 1910

1. In pursuance of section 4 of reclamation act of June 17, 1902 (32 Stat., 388), public notices have heretofore been issued opening to irrigation lands in the North Platte project, Nebraska-Wyoming.

2. Water will be ready for delivery in the irrigation season of 1910 for the additional lands shown on farm unit plats of Ts. 23 and 24 N., R. 56 W., Nebraska; Ts. 23, 24, and 25 N., R. 57 W., Nebraska; Ts. 23, 24, and 25 N., R. 58 W., Nebraska; Ts. 24 and 25 N., R. 60 W., Wyoming.

3. Revised plats of the said townships were approved by the Secretary of the Interior on May 7, 1910, and copies thereof are on file, for the lands in the State of Nebraska, in the local land office at Alliance, Nebr., and for lands in the State of Wyoming, in the local land office at Cheyenne, Wyo.

4. Homestead entries accompanied by applications for water rights may be made under the provisions of said act for the farm units shown on said plats. Water-right applications may also be made for lands heretofore entered and for lands in private ownership, and the time when payments will be due therefor is hereinafter stated. The development of the lateral system has also made possible the irrigation of additional areas in a number of the farm units and private land areas heretofore opened to irrigation; water-right applications may likewise be made for such additional areas, and the time when payments will be due therefor is hereinafter stated.

5. The limit of area per entry, representing the acreage which in the opinion of the Secretary of the Interior may be reasonably required for the support of a family on the lands entered subject to the provisions of the reclamation act, is fixed at the amounts shown on the plats for the several farm units.

6. The limit of area for which water-right application may be made for lands in private ownership shall be 160 acres of irrigable land for each landowner.

7. The charges which shall be made per acre of irrigable land in the said entries and for lands heretofore entered or in private ownership which are opened to irrigation in 1910 are as follows:

For building, operation, and maintenance, $45 per acre of irrigable land, plus such additional amounts for operation and maintenance, beginning with the third annual installment, as shall be hereafter announced, payable in not more than ten annual installments. Full payment may be made at any time of any balance of the building charge remaining due after certification by the Commissioner of the General Land Office that full and satisfactory compliance has been shown with all the requirements of the law as to residence, cultivation, and reclamation.

8. For all lands shown on the said plats as opened to irrigation in 1910, the first installment of the charges for building, operation, and maintenance, $2 per acre of irrigable land, shall be due December 1, 1910; the second installment, $3 per acre, shall be due December 1, 1911; one of the subsequent installments, $5 per acre, plus such sum as may be hereafter announced as the portion of the installment for operation and maintenance, shall be due on December 1 of each succeeding year until fully paid.

9. Water-right applications filed after December 1, 1910, for the private lands hereby opened to irrigation must be accompanied by payment of all installments of the charges for building, operation, and maintenance which have at that time accumulated under the provisions of this notice.

10. All entries made after December 1, 1910, for the lands hereby opened to irrigation, whether for lands not heretofore entered or for lands covered by prior entries which have been canceled by relinquishment or otherwise, must be accompanied by applications for water rights in due form, and by an amount equal to the sum of all unpaid (or paid and unassigned) installments for building, operation, and maintenance which have at that time accumulated under the provisions of this notice.

11. The readjustment of the lateral system has caused a reduction in the irrigable area of certain tracts, and the reduced area is shown on the plat. In such cases any payments heretofore made will be adjusted to the reduced area.

12. Failure to pay any two installments of the charges when due, whether on entries made subject to the reclamation act or on water-right applications for other lands, shall render such entries and the corresponding water-right applications, or the water-right applications for other lands, subject to cancellation with the forfeiture of all rights under the reclamation act, as well as of any moneys already paid.

13. The first and all subsequent installments of the charges for building, operation, and maintenance for all irrigable areas shown on said plats shall accrue and be due and payable whether or not water-right application is made for said lands, or whether or not homestead entries under the provisions of said reclamation act are made thereon. Furthermore, all water-right applications and homestead entries made for the irrigable areas shown on said plats subsequent to the times and dates when one or more installments of the charges for building, operation, and maintenance shall have accrued thereon as aforesaid, shall be subject to the payment of and be accompanied by all such prior installments as have thus accrued and remain due and unpaid, or paid but not assigned.

14. All charges must be paid at the local land office at Alliance, Nebr., or, in the case of lands in Wyoming, at the land office at Cheyenne, Wyo.

15. The charges herein provided for may, for the convenience of applicants, be paid to the special fiscal agent of the United States Reclamation Service assigned to the North Platte project, for transmission to the registers and receivers of the local land offices on or before the date specified for payment at the local land offices, but in case this privilege is availed of, the necessary charge for transportation of the cash, as determined by the special fiscal agent, must accompany the payment of the water-right charges.

PRINCIPAL CURRENT CONTRACT

The following statement contains data relating to the principal contract in operation during the fiscal year ending June 30, 1910: No. 316; date, February 14, 1910; contractor, St. Paul Foundry Company, for tunnel lining; estimated value, $4,293; estimated earnings, June 30, 1910, $4,454.10; completion due, May 13, 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, North Platte project

ASSETS			
Accounts receivable:			
Uncollected freight refunds		$3,137.34	
Uncollected miscellaneous rentals		65,196.80	
Uncollected miscellaneous		1,894.01	
Uncollected water-right building charges		104,175.42	
			$174,403.57
Inventories:			
Mercantile store		1,026.75	
Government animals		35,872.54	
Equipment in use	$71,869.37		
Less depreciation	17,309.08		
		54,560.29	
Storehouse		27,748.28	
Cement		4,624.62	
Iron and steel		3,229.10	
Lumber		2,789.13	
Explosives		1,425.93	
Forage		7,667.24	
Fuel		5,742.24	
Cash in office safe		1,520.48	
Unadjusted transfers		4,150.92	
Freight and handling undistributed		5,288.45	
			155,645.97
Cost of work:			
Building cost		4,299,509.81	
Less adjustments	4,846.08		
Less accrued revenues	24,861.43		
		29,707.51	
			4,269,802.30
Operation and maintenance cost		351,306.28	
Less accrued revenues		82,302.50	
			269,003.78
Total assets			4,868,855.62
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	4,167,495.43		
Transfer vouchers received	572,834.32		
		4,740,329.75	
Collection vouchers	122,361.51		
Transfer vouchers issued	8,491.74		
		130,853.25	
			4,609,476.50
Accounts payable:			
Unpaid labor		21,899.41	
Unpaid purchases		22,222.51	
Unpaid contract estimates		866.08	
Unpaid contract holdbacks		4,490.57	
Unpaid freight and express		14,805.02	
Unpaid passenger fares		1,311.27	
			65,594.86
Repayments accrued:			
Building		180,518.62	
Operation and maintenance		13,265.64	
			193,784.26
Total liabilities			4,868,855.62

Feature costs to June 30, 1910, North Platte project

Storage works:		
Real estate (lands submerged)	$205,816.22	
Pathfinder dam	887,514.98	
Buildings: Gatekeeper's house, emergency gatehouse, and storehouse	19,291.53	
Pathfinder dike	90,659.68	
Pathfinder tunnel	46,795.41	
High-pressure gates	115,320.05	
Pile bridge	4,507.57	
South side tunnel	31,318.82	
Emergency gate shaft-drainage tunnel	7,613.95	
		$1,408,838.21
Diversion works:		
Whalen dam, contract	204,221.29	
Whalen dam, force account	29,037.68	
Guernsey dam	5,720.59	
		238,979.56

Canal system:		
Main canal, earthwork	$1,330,305.30	
Main canal, structures	567,845.35	
Main canal, district 3 survey	11,777.23	
Alcover Casper canal survey	1,222.09	
Goshen Hole survey	22,563.78	
		$1,933,713.75
Lateral system:		
Earthwork	345,763.07	
Structures	282,944.42	
Bridges	29,245.68	
Land lines and subdivision	28,882.42	
		686,835.59
Real estate (rights and property): Lands purchased (not submerged)		31,142.70
Total building cost		4,299,509.81
Operation and maintenance:		
Pathfinder dam	7,035.69	
Main canal, division No. 1	153,512.43	
Rawhide lateral district	185,948.62	
Farm demonstration No. 1, first district	1,570.46	
Farm demonstration No. 2, second district	3,239.08	
		351,306.28
Total building and maintenance and operation cost as per debit in cost of work in statement of assets and liabilities		4,650,816.09

NEVADA, TRUCKEE-CARSON PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Churchill, Storey, and Lyon.

Townships: 17 and 18 N., Rs. 17 to 30 E.; 19 N., Rs. 26 to 31 E.; 20 N., Rs. 22 to 31 E., Mount Diablo meridian.

Railroad: Southern Pacific.

Railroad stations: Fernley, Hazen, and Fallon.

Average elevation of irrigable area: 4,000 feet above sea level.

Average annual rainfall on irrigable area: 4 inches.

Range of temperature on irrigable area: 0° F. to 105° F.

WATER SUPPLY

Source of water supply: Truckee and Carson rivers.

Area of drainage basin: 3,450 square miles.

Annual run-off in acre-feet: Truckee River at Tahoe (519 square miles), 1901 to 1908—maximum, 703,000; minimum, 112,000; mean, 310,000. Truckee River at Vista (1,520 square miles), 1890 to 1892 and 1899 to 1907—maximum, 2,220,000; minimum, 394,000; mean, 927,000. Carson River at Empire (988 square miles), 1890, 1895, and 1900 to 1908—maximum, 789,000; minimum, 178,000; mean, 434,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Lake Tahoe.[a]—Area, 125,000 acres; capacity, 750,000 acre-feet; length of spillway, 85 feet; elevation of spillway, 6 feet above stream bed. Alkali Flat.—Area, 8,500 acres; capacity, 228,000 acre-feet. Lower Carson.—Area, 11,000 acres; capacity, 290,000 acre-feet.

Storage dams: Lake Tahoe.—Type, concrete sluiceway regulator; maximum height, 14 feet; length of crest, 109 feet; volume, 425 cubic yards. Lower Carson not designed.

Diversion dams: Truckee River.—Type, concrete sluiceways; maximum height, 22 feet 4 inches; length of masonry, 171 feet; length of earth fill, 1,160 feet. Carson River.—Type, concrete sluiceways; maximum height, 20 feet 9 inches; length of masonry, 240 feet. Others not designed.

Length of canals (first unit): 104 miles with capacities greater than 300 second-feet; 79 miles with capacities from 300 to 50 second-feet; 502 miles with capacities less than 50 second-feet.

Aggregate length of tunnels: 2,830 feet.

Aggregate length of dikes: 50,000 feet.

Water power: Estimated total, 8,000 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 206,000 acres; first unit, 96,573 acres.

Present status of irrigable lands (whole project): 21,979 acres entered subject to the reclamation act, 21,859 acres open to entry, 96,613 acres withdrawn from entry, 102 acres of state lands, 65,447 acres in private ownership (including 10,031 acres of railroad lands).

Area for which the Service is prepared to supply water, season of 1910: 85,000 acres.

Area irrigated, season of 1910: 35,000 acres.

Length of irrigation season: 214 days.

Character of soil of irrigable area: Sand, sandy loam, adobe, and clay.

Principal products: Alfalfa, grain, potatoes, and onions.

Principal markets: Nevada mining camps, California cities.

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[a] Control of Lake Tahoe not fully acquired.

LANDS OPENED FOR IRRIGATION

Dates of public notices and orders relating thereto: May 6, 1907; November 1, 1907; January 30, 1908; April 4, 1908; June 5, 1908; December 26, 1908; March 1, 1909; September 28, 1909; April 26, 1910.

Location of lands opened: Tps. 18, 19, and 20 N., Rs. 24 to 30 E., Mount Diablo meridian.

Present status of irrigable lands: 21,979 acres entered subject to the reclamation act, 102 acres of state lands, 46,117 acres in private ownership (including 10,031 acres of railroad lands).

Limit of area of farm units: Public, 80 acres; private, 160 acres.

Duty of water: 3 acre-feet per acre per annum at the farm.

Building charge per acre of irrigable land: $22 and $30.

Annual operation and maintenance charge: $0.60 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1902.
Construction authorized by Secretary March 14, 1903.
Main Lower Truckee canal completed June, 1905.
Carson River headworks and main distributing canals completed September, 1905.
First irrigation by Reclamation Service, season of 1906.
First unit 90 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Truckee-Carson project provides for the storage of water in a number of small reservoirs on the headwaters of Truckee River, in Lake Tahoe, in the Alkali Flat reservoir, near Churchill, Nev., and in lower Carson reservoir, on Carson River near Hazen, Nev.; the diversion of water from Truckee River by a dam about 20 miles below Reno, Nev., into the main lower Truckee canal, supplying water to lands in the Truckee and Carson River valleys and to the lower Carson reservoir; the diversion of water from Carson River by a dam near Dayton, Nev., into two canals, one watering lands south of the river and the other watering lands north of the river and supplying Alkali Flat reservoir; the return to Carson River through an outlet tunnel and canal of water from Alkali Flat reservoir; the diversion of water from Carson River by a dam about 3 miles below the outlet of Alkali Flat reservoir into two canal systems watering lands in Churchill Valley on both sides of the river; and the diversion of water from Carson River by a dam about 5 miles below the lower Carson storage dam into two canal systems, one on either side of the river, watering lands in the lower Carson River Valley.

ORIGIN OF PROJECT AND INVESTIGATIONS

Irrigation has been practiced in a small way along the streams of Nevada for a good many years. In 1889 and 1890, under the direction of Maj. J. W. Powell, Director of the United States Geological Survey, systematic investigations were begun of the flow of Truckee River and tributary streams, and reconnaissance and surveys of lakes considered feasible for storage reservoirs were made. Further surveys of the lakes were made in 1900, and additional data collected in reference to stream flow. On January 11, 1902, the Director of the Geological Survey, in response to a resolution by the United States Senate, submitted to the Secretary of the Interior a report upon the utilization of Lake Tahoe as a reservoir of water for irrigation purposes, in which report it was held that by providing for control of 6 feet in depth on the lake, or an actual storage capacity of 750,000 acre-feet, an annual storage supply of 200,000 acre-feet could be depended upon for irrigation.

Immediately after the organization of the Reclamation Service in June, 1902, Mr. L. H. Taylor, in charge of the investigations in Nevada, was instructed to prepare plans for utilizing the waters of Truckee and Carson rivers in an irrigation project. Based upon the investigations that had already been made, and on further surveys begun immediately, general plans were prepared in the fall of 1902 and the early part of 1903. These plans, as outlined in a letter by the Director of the Geological Survey to the Secretary of the Interior, dated March 7, 1903, included the storing of water in Lake Tahoe, the construction of a canal from Truckee River, near Wadsworth, to the Carson River, a storage reservoir on Carson River, the necessary systems of distribution canals, and eventually other storage reservoirs in the Truckee and Carson river basins. It was recommended that development of the general project as outlined be approved, that the examination of irrigable lands, reservoirs, etc., be continued, that steps be taken to procure title to the lands needed for reservoirs, and that work be continued in greater detail for the ascertainment of facts necessary for the preparation of specifications and the letting of contracts for the construction of irrigation works. On March 14, 1903, the Secretary of the Interior approved the general project as recommended and authorized the preparation of plans and specifications for construction to be submitted to him for approval.

CONSTRUCTION

MAIN LOWER TRUCKEE CANAL

The first work undertaken on the Truckee-Carson project was the construction of a canal, known as the main lower Truckee canal, to divert water from Truckee River and convey it in part to the Carson River and in part for the irrigation of adjacent lands. This canal is 31 miles in length and has a capacity of 1,500 second-feet at the intake, and of 1,200 second-feet at its end where it discharges into the Carson River. For about 10 miles, the canal passes along the steep sides of the canyon of Truckee River, where concrete lining was required in many places and where three tunnels were needed, aggregating about 2,700 feet in length. For the remaining distance, the canal is in earth section and in general offered little difficulty in construction.

The diversion dam on Truckee River comprises a set of 16 concrete sluiceways and an earth-fill dam 1,160 feet in length. The concrete structure rests on a foundation of compact gravel and bowlders. It has a floor 30 feet wide and 8.8 feet thick and the length of the structure including the abutments is 171 feet. The foundation was reenforced with old steel rails and the upper part of the structure was reenforced with steel girders. Each sluiceway is 5 feet wide, and is closed by double cast-iron gates to a height of 10 feet, and, when desired, by 5 flashboards reaching 40 inches higher. The intake to the canal is placed at right angles to and at the south end of the diversion dam. It contains 9 gate openings, closed by double cast-iron gates similar to those used in the diversion sluiceways, and by flashboards increasing the height by 16 inches. The intake structure is reenforced with a steel girder above the gates and steel columns in the piers. Immediately below the intake of the canal is a concrete spillway, 100 feet in length, discharging through a concrete and rock-lined channel into the river below the diversion dam.

In a distance of 2 miles, beginning about $6\frac{1}{2}$ miles from the head of the canal are three tunnels having lengths of 901, 308.7, and 1,515 feet, respectively. All of the tunnels are lined with concrete. In the canyon there are, besides the headworks, three important concrete structures, two wasteways, 4.6 and 7.6 miles, respectively, from the head of the canal, and the headworks of the Pyramid branch canal 6 miles from the Truckee River diversion dam. Each of the wasteways has 5 openings placed in the side of a concrete-lined basin 45 feet long with its bottom 6 feet below the bed of the canal. The basin in the first wasteway is 36 feet wide, and in the second 16 feet wide. The wasteway openings are each 5 feet square in the clear and are closed by Taintor gates operating on horizontal shafts at the level of the top of the gate openings. The radius from the center of the shaft to the outside surface of the gate is 7 feet $5\frac{7}{8}$ inches. The gates are counterweighted with buckets filled with water; and all of the gates can be opened in one operation by means of a crank turning a shaft to which the gates are attached by wire cables and suitable drums.

The discharge from the first wasteway is into an open channel lined with concrete for a distance of about 80 feet, but the second wasteway discharges into a shaft about 47 feet deep, and thence through a tunnel 115 feet in length under the Southern Pacific Railway to an open channel lined with concrete for a short distance. In both cases the waste water returns to Truckee River. In connection with the headworks of the Pyramid branch canal there is installed in the main canal a check-gate structure with six openings, each 5 feet wide by 13 feet high. Above the check gates and on the north side of the canal are located the headworks of the Pyramid branch canal, with two openings 5 feet wide by 10 feet high. Both the check gates and the canal head gates are double cast-iron gates, similar to those used in the diversion dam and the Truckee canal headworks. When desired, flashboards can be used over the check gates to close the full height of 13 feet. The abutments for the Pyramid branch headworks were stepped down to the foundations and left in this condition with the intention of extending the walls to include a fore bay for a siphon across the canyon when the branch line shall be built. The gates were banked with earth on both sides for the present.

About 10 miles from the headworks of the canal the end of the Truckee Canyon is reached, and the remainder of the canal line lies on a gentle slope from the foothills along the edge of a wide valley. The canal terminates about 7 miles south and west of Hazen, and at this point the water is discharged into the Carson River through a temporary wooden flume or chute built on a steep side of a hill. No other structures were built on this division of the canal.

Plans and specifications for the construction of the main Truckee canal and headworks were approved by the department in May, 1903 (specifications No. 1), and proposals were opened July 15. The work was divided into three divisions, the first embracing the diversion dam, the headworks of the canal, a portion of the canal excavation in the canyon, and the Pyramid branch headworks; the second division including the remaining canal excavation in the canyon, with the tunnels and wasteways; and the third division consisting of canal excavation only for about 20 miles through the valley. Contracts were executed for divisions 1 and 2 on September 3, 1903, and for division 3 on August 28, 1903. The work on division 1 was completed in June, 1905; that on division 2 in April, 1905; and that on division 3 in September, 1904. The temporary chute at the end of the canal for discharging its waters into Carson River was built by force account in the year 1905. In the spring of 1910 the construction of a permanent concrete structure for this purpose was begun by force account.

CARSON RIVER DIVERSION WORKS AND MAIN DISTRIBUTING CANALS

On Carson River, about 4 miles below the end of the Truckee Canal, are located the headworks of the main distributing canals of the project. Diversion is accomplished by means of concrete regulator sluiceways across the river and concrete canal headworks with rising weir gates. The dam or regulating works contains 23 gate openings, each 5 feet wide. The openings are closed by double cast-iron gates 10 feet in combined height and similar to those used in the Truckee dam, together with flashboards for an additional height of 32 inches when desired. The concrete floor of the dam is about 32 feet wide in the direction of the stream and rests on a timber floor, supported by round piles and having two rows of sheet piling, one at the upper and the other at the lower edge. At the south end of the dam is the intake of a canal having an initial capacity of 1,500 second-feet, and at the north end is located the intake of a canal having an initial capacity of 500 second-feet. The intake for the south side canal is controlled by three steel rising weirs, each 15 feet long and 5 feet high, and the intake for the north side canal has one such rising weir. The south side canal constitutes the main canal system and extends for a distance of about 22 miles, and together with the necessary laterals and distributing ditches will irrigate a large amount of land on the south side of the river. The canal in its course crosses both the South Branch and New River, which are channels carrying parts of the natural flow of Carson River. About 7 miles from the head of the canal is located a drop in the canal line of 6.74 feet, in connection with which there is a wasteway designed for returning any desired portion of the canal flow to South Branch. The north side distributing canal serves lands north of Carson River and northwest of Old River branch. Both of the distributing canals have concrete structures for diverting water into laterals at various places.

Early in 1904 plans and specifications were prepared for the construction of the distributing canals and structures, including the headworks on Carson River (specifications No. 13). These plans and specifications were approved by the department April 15, 1904, and proposals for the work were opened July 15, 1904. Four contracts were executed as follows: For bridges, on August 19, 1904; for the excavation work, on September 9, 1904; for the head gates and other structures, except the Carson River headworks, on September 17, 1904; and for the Carson River headworks, on September 29, 1904. The work was begun promptly on all of the contracts and was carried on during the fall of 1904 and the early season of 1905. The bridges were completed in March, the excavation in June, the Carson River headworks in July, and the other structures in September, 1905.

LATERAL DISTRIBUTION SYSTEM

The lateral system for the distribution of waters from the main distributing canals to the lands to be irrigated is divided into seven divisions or districts, supplying from 20,000 to 50,000 acres of land each. In the larger laterals the principal structures are made of concrete in a substantial manner, but many of the farm turn-outs and other structures on small laterals are constructed of wood. On November 17, 1904, the department approved plans and specifications for the construction of about 150 miles of lateral irrigation canals, together with necessary structures (specifications No. 20). Proposals were received December 15, 1904, and three contracts were executed for different parts of the work on, respectively, January 21, 24, and 30, 1905. The contracts were completed during the season of 1905 and 1906. In connection with the structures for these laterals there was included the construction of a large concrete drop on the main south side distributing canal about 6 miles below the head of the canal. The drop in water surface is 25.6 feet, and the capacity of the canal at this point is 1,400 second-feet. In connection with the structure there were built substantial concrete foundations for a proposed power house for utilizing the fall of water in developing electric power, but no superstructure has yet been erected or planned.

Other plans and specifications for extension of laterals and the building of structures were approved by the department on March 9, 1906 (specifications No. 80), and July 27, 1906 (specifications No. 112). No proposals were received under the advertisement for either of these sets of specifications and the work was authorized to be done by force account and was completed in the seasons of 1906 and 1907. Slight additional extensions of the distributing laterals and the building of a few additional structures were carried on during the seasons of 1908 and 1909, when the distribution system for the irrigation of the first unit of the project, containing about 90,000 acres of irrigable lands, was practically completed.

LAKE TAHOE RESERVOIR

On April 29, 1905, the department approved plans and specifications for the construction of outlet controlling works for Lake Tahoe (specifications No. 37). Proposals were opened on June 15, 1905, and a contract was executed for the work on July 5. Shortly after the contractor began work he was stopped by an injunction secured by landowners in the vicinity of the outlet. Settlement was finally made with the contractor and the work abandoned for the time. In 1909, however, under a proposed contract with one of the power companies utilizing water from Lake Tahoe the construction of regulating works was begun by the company and partially completed. It is hoped that the project will be able in the near future to control the outlet of the lake and gain the full advantage of its storage capacity.

IRRIGATION

In 1906 the service began the delivery of water through the distributing system for irrigation purposes. For that season delivery of water was confined to lands in private ownership that had previously been irrigated and for which the service was bound by contract to supply water. About 15,000 acres were irrigated during the season. In succeeding seasons the delivery of water for irrigation was gradually extended to larger areas, including both private lands previously irrigated and public lands entered under the homestead laws. The areas irrigated have been 27,450 acres in 1908, 33,000 acres in 1909, and 35,000 acres in 1910.

PROGRESS DURING FISCAL YEAR 1910

The extension of the lateral system in district 5 to water a portion of the land allotted to the Piute Indians was surveyed in the fall of 1909, and proposals for excavation were received and contracts awarded in November, 1909. There were 21 miles of laterals and drains, and the excavation of 94,000 cubic yards of material was required. The necessary structures were built by force account, and the work was completed in April, 1910. An office building for project headquarters at Fallon was constructed by contract, and was completed in May, 1910. A topographic survey of the site of Lower Carson storage dam was made, and the subsurface foundation material was investigated by diamond drill and wash drill borings, test pits, and tunnels. The construction of a concrete chute to discharge water from the main lower Truckee canal into the Carson River has been commenced. During the year a complete review and revision of project estimates and general plans for development were made, new estimates of cost of the parts of the project not yet constructed being prepared. The character of ownership and irrigability of the lands in various parts of the project were given special attention, and reports of areas have been adjusted to conform to the conditions thus determined. The operation and maintenance of the completed portions of the project have been continued during the fiscal year without unusual incident. An adequate supply of water has been available to meet all demands for irrigation and no serious interruptions in delivery have occurred. In July, August, and September, 1909, and in June, 1910, stored water from Lake Tahoe was used, through the courtesy of the power company in control of the outlet, to supplement the natural flow of Truckee and Carson rivers. This was done pending the conclusion of arrangements by means of which the United States would secure the control of storage rights on Lake Tahoe. On June 30, 1910, there were in effect on the project 261 homestead entries, containing 16,748 acres of irrigable land; 373 water-right applications for lands in private ownership, containing 30,317 acres of irrigable land; and contracts recognizing vested water rights for 12,861 acres of land. The production of crops during the season of 1909 was generally good throughout the valley. The principal crops, acreages, and yields were: Alfalfa, 8,124 acres, 21,265 tons; grass hay, 2,083 acres, 2,777 tons; small grains, 4,873 acres, 2,972 tons; potatoes, 385 acres, 1,793 tons; 13,685 acres were used as pasture and 134 acres have been planted to orchards in which over 8,000 trees are growing.

PUBLIC NOTICE DATED SEPTEMBER 28, 1909

In pursuance to the provisions of section 4 of the reclamation act approved June 17, 1902 (32 Stat., 388), notice is hereby given that water will be furnished from the Truckee-Carson project, Nevada, for lands included in the extension of the irrigable area under the project shown on farm unit plats for the following-described townships approved by the Secretary of the Interior June 29, 1909, and on file in the local land office at Carson City, Nev.: T. 17 N., R. 28 E., M. D. M.; T. 17 N., R. 29 E., M. D. M.; T. 19 N., R. 29 E., M. D. M.; T. 19 N., R. 30 E., M. D. M.; T. 19 N., R. 31 E., M. D. M.; T. 20 N., R. 24 E., M. D. M.

Applications for water rights, the charges, time, and manner of payment will be governed by the terms of existing public notices and orders thereof issued in connection with said project.

PUBLIC NOTICE DATED APRIL 26, 1910

In pursuance of the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), notice is hereby given as follows:

For all irrigable lands shown on the approved farm unit plats of lands under the Truckee-Carson project, Nevada, the portion of the installment for operation and maintenance to become due December 1, 1910, and annually on the same date of each year thereafter until further notice, shall be 60 cents per acre of irrigable land.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Truckee-Carson project

ASSETS			
Accounts receivable:			
Uncollected freight refunds		$173.24	
Uncollected miscellaneous		850.59	
Uncollected water-right building charges		54,875.31	
Uncollected water-right operation and maintenance charges		3,699.17	
			$59,598.31
Inventories:			
Mercantile store		1.76	
Government animals		1,495.35	
Equipment in use		18,470.67	
Storehouse		21,887.71	
Unadjusted transfers		810.81	
Freight and handling undistributed		8,575.84	
			51,242.14
Cost of work:			
Building cost	$3,778,831.97		
Plus adjustments	457.03		
		3,779,289.00	
Less accrued revenues		4,382.26	
			3,774,906.74
Operation and maintenance cost		283,748.16	
Less accrued revenues		2,100.91	
			281,647.25
Total assets			4,167,394.44
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	3,977,154.98		
Transfer vouchers received	160,371.36		
		4,137,526.34	
Collection vouchers	134,110.73		
Transfer vouchers issued	27,439.19		
		161,549.92	
			3,975,976.42
Accounts payable:			
Unpaid labor		1,584.46	
Unpaid purchases		2,039.68	
Unpaid contract estimates		6,850.15	
Unpaid freight and express		3,569.60	
Unpaid passenger fares		126.04	
Unredeemed meal tickets		11.25	
			14,181.18
Repayments accrued:			
Building		133,620.32	
Operation and maintenance		43,616.52	
			177,236.84
Total liabilities			4,167,394.44

Feature costs to June 30, 1910, Truckee-Carson project

Buildings:		
Headquarters and permanent buildings	$42,743.64	
Ditch tender's houses	6,338.75	
		$49,082.39
Distributing system:		
Main canals	407,751.13	
Lateral and drainage system	1,225,965.04	
Carson River channel (straightening old river)	125,051.84	
Lower Carson diversion dam	82,222.92	
Power-house drop, V-line	61,843.29	
Lower Carson reservoir investigations	200.00	
New Truckee chute	3,943.83	
Lower Carson storage dam investigations	81.26	
		1,907,059.31
Examination of project as a whole:		
Examination, general	39,096.78	
Examination, reservoir sites and storage	52,917.22	
Hydrography	7,187.92	
Topographic surveys	55,002.36	
		154,204.28
Experimental farms: Buildings		6,299.43
Lake Tahoe reservoir and regulating works:		
Preliminary examination	2,920.96	
Construction of regulating works	1,335.93	
		4,256.89
Main Truckee canal:		
Earthwork and structures, including Derby bridge	1,534,696.60	
Improvements	115.90	
		1,534,812.50
Pyramid Lake canal:		
Preliminary location	2,258.86	
Examination	597.39	
		2,856.25
Real estate (rights and property): Lands purchased		54,665.29
Irrigable lands:		
Farm-unit subdivision	1,917.11	
Location survey, miscellaneous	1,441.98	
Section lines (Carson Sink valley)	10,342.51	
		13,701.60
Telephone system: Construction		40,726.38
Carson Sink drain: Preliminary expense		3,690.82
Administration of project as a whole: General expense		5,488.71
Inventory of unused supplies		1,988.12
Total building cost		3,778,831.97
Operation and maintenance:		
Operation (all features)	83,740.99	
Flood expense (extraordinary)	73,550.02	
Maintenance, including repairs, betterments, inspection, etc., on all features	126,457.15	
		283,748.16
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		4,062,580.13

NEW MEXICO, CARLSBAD PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Eddy.

Townships: 21 S., Rs. 26 and 27 E.; 22 S., Rs. 26, 27, and 28 E.; 23 S., Rs. 27 and 28 E.; 24 S., R. 28 E., New Mexico meridian.

Railroad: Eastern Railway of New Mexico (Santa Fe System).

Railroad stations: Carlsbad, Otis, Loving, and Malaga, N. Mex.

Average elevation of irrigable area: 3,100 feet above sea level.

Average annual rainfall on irrigable area: 15 inches.

Range of temperature on irrigable area: 0° F. to 110° F.

WATER SUPPLY

Source of water supply: Pecos River.

Area of drainage basin: 22,000 square miles.

Annual run-off in acre-feet of Pecos River at Carlsbad (22,000 square miles), 1899 to 1906: Maximum, 912,000; minimum, 148,000; mean, 326,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Avalon—area, 1,600 acres; capacity, 6,000 acre-feet; length of spillways, 1,000 feet; elevation of spillways, 21 feet above stream bed. McMillan—area, 6,300 acres; capacity, 29,000 acre-feet; No. 1 spillway, 250 feet in length and 23.3 feet above stream bed; No. 2 spillway, 600 feet in length and 25 feet above stream bed.

Storage dams: Avalon—type, earth and rock fill with concrete core wall; maximum height, 50 feet; length of crest, 1,380 feet; volume, 168,300 cubic yards. McMillan—type, earth and rock fill; maximum height, 52 feet; length of crest, 1,686 feet.

Length of canals: 5 miles with capacities greater than 300 second-feet; 25 miles with capacities from 300 to 50 second-feet; 120 miles with capacities less than 50 second-feet.

Aggregate length of dikes: 4,000 feet at Lake McMillan.

AGRICULTURAL CONDITIONS

Irrigable area: 20,255 acres, all in private ownership.

Area irrigated, season of 1910: 12,500 acres.

Length of irrigating season: 270 days.

Character of soil of irrigable area: Fertile alluvium.

Principal products: Alfalfa, apples, corn, cotton, grapes, melons, peaches, and vegetables.

Principal markets: Carlsbad, N. Mex.; Denver, Colo.; Chicago, Ill.; Kansas City, Mo.; and Fort Worth, Tex.

LANDS OPENED FOR IRRIGATION

Dates of public notices: December 17, 1907; November 30, 1908; June 2, 1909; November 17, 1909.

Location of lands opened: Tps. 21, 22, 23, 24 S., Rs. 26, 27, 28 E., New Mexico meridian.

Irrigable lands opened: 20,255 acres, all in private ownership.

Limit of area of farm units: 160 acres.

Duty of water: 3 acre-feet per acre per annum at the farm.

Building charge per acre of irrigable land: $31.

Annual operation and maintenance charge: $1.35 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1904.
Canal system of Pecos Irrigation Company purchased December 18, 1905.
Construction authorized by Secretary February 24, 1906.
First irrigation by Reclamation Service, season of 1906.
Black River canal: Reconstruction completed May, 1906.
Avalon dam: Reconstruction completed November, 1907.
McMillan reservoir: Reconstructed 1907–8.
Main canals and distribution system rebuilt 1906 to 1909.
Project completed July, 1909.

IRRIGATION PLAN

The irrigation plan of the Carlsbad project provides for the storage of water in Lake McMillan, on Pecos River, near McMillan, N. Mex., and in a storage and distributing reservoir on the same river near Carlsbad, N. Mex., controlled by Avalon dam; and the diversion of water from Avalon reservoir into a canal system, watering lands on both sides of Pecos River in the vicinity of Carlsbad.

ORIGIN OF PROJECT

The Carlsbad project had its inception in a private enterprise begun in 1888, when a small diversion dam was built on Pecos River, near the present site of the Avalon dam, to divert water for the irrigation of lands near La Huerta, about 6 miles from Carlsbad. This irrigation system was enlarged and storage facilities in lakes McMillan and Avalon were provided, so that in 1904 about 13,000 acres of land were irrigated. In October, 1904, however, an unusual flood carried away the dam at Avalon and greatly damaged the distribution system then in use. The Pecos Irrigation Company, which controlled the system at that time, was unable to repair the damage in a satisfactory manner and place the delivery of water on a permanent basis. The construction of temporary works was begun, but they were carried away by floods, and the Government was requested to acquire the rights of this company and establish a permanent irrigation system that would be satisfactory to the settlers. The following requests and petitions for the undertaking of this work were received: Resolutions of Carlsbad Commercial Club, dated October 5, 1905; resolutions of the Irrigation Commission of the Territory of New Mexico, dated October 9, 1905; resolution of Roswell Commercial Club, dated October 17, 1905, and letter of G. A. Richardson, president of said club, dated October 18, 1905; petition of a committee of the citizens of Carlsbad and members of the Pecos Water Users' Association, dated November 10, 1905.

INVESTIGATIONS

Prior to the consideration of the Carlsbad project by the Reclamation Service, investigation of the silt accumulation in Lake McMillan, a storage reservoir of the Pecos Irrigation Company, had been made in June, 1904, upon the recommendation of A. P. Davis, supervising engineer, and J. H. Quinton and W. H. Sanders, consulting engineers. This investigation, which was conducted under the direction of W. M. Reed, district engineer, showed that in ten years 12,200 acre-feet of silt had been deposited. A study of the leakage from Lake McMillan through strata of gypsum was also made by Mr. Reed during 1904.

After the Reclamation Service had been requested to undertake the reconstruction of the Carlsbad project, investigations relative to feasibility and cost were begun in January, 1905.

The main storage reservoir of the Pecos Irrigation Company was Lake McMillan, formed by a dam 1,686 feet long and 52 feet high across the channel of Pecos River and an embankment 5,200 feet in length with a maximum height of 10.8 feet across low ground to the west of the main dam. This reservoir had originally a total storage capacity of 80,000 acre-feet and an area of 8,331 acres, but silt deposits, leaks through gypsum strata, and erosion of spillway embankments had made impracticable its utilization for the storage of more than 15,900 acre-feet of water. The reservoir was provided on the east side of the river with an outlet canal discharging into the river about 300 feet below the head gates. The six head gates were made of wood and were operated by hand. The spillway used at ordinary flood stages was cut through rock about 1 mile west of the dam, the water discharging into an arroyo, which discharged into the river about 2 miles below the reservoir. A second spillway discharging into the same arroyo was provided still farther west. The water has cut back to the bank of this second spillway so that large floods would be likely to destroy the embankment and empty the reservoir.

The successful utilization of Lake McMillan as a reservoir depended on the possibility of enlarging the storage capacity by stopping large leaks along the eastern shore, the rebuilding of the destroyed portions of the fill along the southern shore, the repairing and in part rebuilding of the spillway, and the construction of new head gates.

The main canal which had its heading at Lake Avalon on the east side of Pecos River, was a 1-bank canal, 45 feet in bottom width at the reservoir but 1,000 or more feet wide in places. The canal divided about 3 miles below the head gates, one branch, known as the east canal, watering lands in the vicinity of La Huerta and Hagerman Heights and extending about 28 miles below the intake. The other branch or southern canal, with a bottom width of 25 feet, crossed the river by a concrete aqueduct consisting of four arched spans of 100 feet each and served land on the west side of Pecos River above Black River. From the aqueduct to Dark Canyon, a distance of about 3 miles, there was considerable loss from seepage through porous soil. For about 13 miles below Dark Canyon the soil contains more clay, but the seepage loss was nevertheless considerable and lands below the canal have been rendered unfit for cultivation by the seepage waters. Near Gyp Bend the canal was excavated for several miles through gypsum, which allowed the loss at times of 75 per cent of the water flowing in the canal. Three miles below Gyp Bend the canal reached Black River, which was formerly crossed by a timber flume. Later the canal was discharged into the river and a concrete dam 70 feet long and 2 to 4 feet high was constructed to divert the water from the river to a new canal about 3 miles long, this rendering available about 9 second-feet of water from the flow of Black River.

The lands of the Pecos Irrigation Company were sold at $35 to $40 per acre, and a deed was given attaching a permanent water right to the land in consideration of the payment of a rental charge of $1.25 per acre for delivery to the consumer at the main canal of 1 acre-foot of water or so much thereof as might be necessary for the cultivation of the crop. Private landowners were permitted to purchase water rights for the sum of $10 per acre on the same rental conditions as if the land had been purchased from the company.

From 1899 to 1903 the water required for irrigation was 6.6 to 10.1 acre-feet per acre at the head gates, only 38 per cent of which reached the lands.

BOARD REPORT AND AUTHORIZATION

A consulting board, consisting of Messrs. W. H. Sanders, G. Y. Wisner, Morris Bien, B. M. Hall, and W. M. Reed, met at Carlsbad on August 28, 1905, and after consideration of the conditions on the project recommended that $600,000 of the reclamation fund be allotted for the purchase and repair of the system of the Pecos Irrigation Company, $150,000 being specified as the purchase price. It was further recommended that all construction, except the rebuilding of Avalon dam, should be done by government force account. The recommendations of the board were approved by the Secretary of the Interior on November 28, 1905. The Pecos Irrigation Company agreed to accept $150,000 for its rights and property, and after title was examined and perfected, construction of the project was authorized by the Secretary of the Interior February 24, 1906.

CONSTRUCTION

BLACK RIVER CANAL

The reconstruction of Black River canal was begun in March, 1906, and was completed two months later, water being delivered for irrigation on May 22, 1906. About 6 miles of canal were reconstructed, and a concrete lining was placed in the canal for 4,000 feet below the heading. While the old canal delivered but a small percentage of the water diverted to it from the river, the new canal is practically watertight.

AVALON DAM

The present Avalon dam was built on the site of the old dam at the head of the main-canal system 6 miles above Carlsbad, a portion of the old dam being utilized in the new structure. In March, 1906, specifications No. 74 for the construction of this dam were prepared and advertisement issued inviting proposals. No proposals, however, were received and on April 18 authority was granted for the construction of this feature by force account. Preparatory work was begun at the dam May 1 and actual construction was commenced June 1, 1906, and completed in November, 1907. Changes in design, made after the issue of specifications and before the beginning of construction work, include the substitution in the upper 24 feet of the core wall of a vertical reenforced concrete wall for an inclined sheet-steel diaphragm, the changing of the slope of the upper part of the water face from $3\frac{1}{2}$:1 to 2:1, and the increase of top width from 20 to 40 feet. The designs, as approved for construction, are published in the fifth annual report. A further change in design was made after construction was begun, a concrete core wall to bedrock being substituted for steel-sheet piling on the west bank of the river, where bowlders prevented the satisfactory placing of the piling. The Avalon dam is an earth and rock fill structure 50 feet in height above river bed and 1,025 feet long. For its entire length it has a core wall founded on bedrock and extending to the top of the dam. From bedrock to the elevation of maximum water surface in the canal, which is 24 feet below the crest of the dam, the core wall consists partly of rubble concrete and partly of heavy steel interlocking channel-bar sheet piling. The piling was driven in that part of the old dam where deep trenching would have been required to construct a concrete core wall on bed-rock. From the top of the rubble concrete and sheet piles to the crest of the dam the core wall consists of reenforced concrete, tapering from 12 to 8 inches in thickness. The outer face of the downstream side of the dam consists of a layer of broken rock 10 feet in thickness with a slope of 1½:1, and the space between the core wall and the broken rock is filled with earth and rock. The upstream face of the dam has a slope of 3½:1 from the foundation to mid-height and a slope of 2:1 from mid-height to the top. The width across the top is 43 feet. In trenching for the core wall on the west side of the river, a bed of gravel averaging 8 feet in thickness was disclosed between nearly horizontal strata of solid rock. Seepage through this gravel was cut off by a 6-inch concrete wall built between the rock strata for a distance of 129 feet.

The construction of the dam was carried on simultaneously from the two ends, and the river section of the core wall was used as an overflow weir, being built up in steps confining the flow of the river to the middle of the channel. After March 25, 1907, the flow of the river was diverted into the outlet canal, the core wall having been completed to a height greater than the bottom of the canal. Spillway No. 1, located between the dam and the headgates of the main canal, was lengthened to 250 feet, and quick-acting emergency gates of special design were installed, which, when closed, raise the elevation of the spillway crest from 11 to 21 feet above stream bed.

DISTRIBUTION SYSTEM

The main canals purchased from the Pecos Irrigation Company had but one bank, were as much as a thousand feet in width at some places, and had irregular slopes. The Reclamation Service reconstructed the canals during 1906 and 1907, bringing them to uniform width and grade. A large amount of repair work was done on the laterals. For the Avalon headworks, a reenforced concrete shell with earth and rock loading was built, and the following reenforced concrete structures were constructed: East canal headworks; main-canal spillway, main-canal check gate above Pecos River flume; Dark Canyon check gate; Dark Canyon spillway. Five plain concrete spillways (paved and grouted) were built to relieve the canal of flood waters. A great many wooden lateral headgates and division boxes were replaced with concrete structures. A new foundation was built for a pier of the Pecos River flume which had been partly undermined in 1904. The other piers were given an increased bearing surface, and other repairs to the structure were made. A reenforced concrete siphon having an inside diameter of 6 feet and a length of 400 feet was built under Dark Canyon. Water was first admitted to it on April 2, 1907.

LAKE MCMILLAN

During 1908–9 the outlet works at Lake McMillan were reconstructed, and a dike 4,000 feet long was built around leaky portions of the reservoir, making possible the filling of Lake McMillan to 23.5 feet above the floor of the outlet, and increasing the reservoir capacity to about 30,000 acre-feet. Necessary repairs were made to the dam and embankment forming the reservoir.

OPERATION AND MAINTENANCE.

About 13,000 acres of land had been irrigated with water delivered through the system of the Pecos Irrigation Company. During 1905, 1906, and 1907 practically no water could be utilized on the project for irrigation purposes except from the reconstructed Black River canal, from which delivery of water was begun in May, 1906. The cultivation of considerable areas of land on the project was abandoned during those years. On December 17, 1907, a public notice was issued which opened for irrigation 20,073 acres of land, the entire area of the irrigable lands selected for the project. A public notice dated June 2, 1909, increased the charge for operation and maintenance from $0.75 to $1.35 per annum per acre of irrigable land, and a public notice dated November 17, 1909, provided for a revision of irrigable areas and the amending of entries. The first irrigation season for the whole reconstructed system was that of 1908 and by June 30 of that year water-right applications had been received for 7,557 acres of land, a little more than this amount being in actual cultivation. During the following autumn and winter many new settlers arrived on the project and by June 30, 1909, water-right applications for about 14,000 acres of irrigable land had been received and about 12,000 acres of land were in cultivation. By June 30, 1910, water-right applications for 15,778 acres of land had been received and 12,400 acres of land were being irrigated. Crops have generally done very well and the agricultural development of the project has been very satisfactory. The operation of the distribution system has been conducted in an economical and satisfactory manner. Water users have been required to file written applications three days in advance of the desired delivery. The work of operation is becoming simpler as the farms are better cared for and the farmers make progress in the art of irrigation. The principal maintenance work has been the regular winter cleaning of canals and laterals, minor repairs and changes of the spillway at Avalon reservoir and removing moss from the main canal by dragging the canal with a heavy anchor chain once in about twelve days during the late spring and summer months.

PROGRESS DURING FISCAL YEAR 1910.

The capacity of the Black River cut-off ditch has been increased from 27 second-feet to 40 second-feet. A number of concrete lateral diversion structures have been built to replace wooden structures and to provide for the irrigation of new tracts. Water service has been maintained for about 12,400 acres of land, the canals having been cleaned and repaired as required.

The crops on the land being irrigated are alfalfa, fruit, Indian corn, cotton, cantaloupes, and sorghum. It is expected that a considerable area of new land will be planted to alfalfa, grain, and fruit this fall. About 200 acres were planted to cantaloupes this spring, and the product is now being shipped out in carload lots and excellent prices are being received. The alfalfa crop is in excellent condition, and it is expected that the crop of alfalfa seed from 2,500 acres will be worth over $75,000.

PUBLIC NOTICE DATED NOVEMBER 17, 1909

On December 17, 1907, public notice was issued announcing that water would be furnished in 1908 under the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), for the irrigable land shown upon plats of: T. 22 S., R. 26 E.; Ts. 21, 22, and 23 S., R. 27 E.; Ts. 23 and 24 S., R. 28 E.; T. 23 S., R. 29 E.

The application of water to said lands has shown that the soil of a number of the tracts is of such poor quality that it is unfit for successful farming, necessitating the selection of other tracts better suited to cultivation.

Revised plats of these townships, showing lands finally selected for irrigation under the project, as well as all amendments heretofore made, and including also a few added areas for which water will be available for the irrigation season of 1910, were approved by the Secretary of the Interior on November 1, 1909, and copies thereof are on file in the local land office at Roswell, N. Mex.

These plats amend and supplement those heretofore approved, and all amendments thereof, but they do not affect any rights acquired under the plats approved December 14, 1907, and continued by the plats approved November 1, 1909, and the public notices issued in connection therewith.

Water-right applications heretofore filed for areas now eliminated from the plats must be amended to cover lands shown on the plats approved November 1, 1909, and the times when payments of water-right charges become due thereon will remain as heretofore announced for other lands under this project.

For lands substituted for areas hereby eliminated, and for which water-right applications have not heretofore been filed, the manner of applying for water rights, the amount of the charges to be assessed, and the time when payments become due will be as set forth in the public notices and orders heretofore issued in connection with this project.

For the following lands, which have been added to the project, the charges, time, and manner of payment will be governed by the terms of public notices and orders heretofore issued in connection with the Carlsbad project, except that the first installment of the charges for building, operation, and maintenance shall become due December 1, 1909: T. 22 S., R. 26 E., SW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 1.; T. 22 S., R. 27 E., SE. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 10; T. 23 S., R. 28 E., SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 27; T. 24 S., R. 28 E., E. $\frac{1}{2}$ NW. $\frac{1}{4}$ SE. $\frac{1}{4}$, sec. 9.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Carlsbad project

ASSETS			
Accounts receivable:			
Uncollected water-right building charges		$48,918.00	
Uncollected water-right operation and maintenance charges		1,414.20	
			$50,332.20
Inventories:			
Government animals	$805.00		
Less depreciation	211.74		
		593.26	
Equipment in use		5,201.85	
Storehouse		1,563.18	
Cement		76.20	
Lumber		856.80	
Forage		592.80	
			8,884.09
Cost of work:			
Building cost	604,738.62		
Plus adjustments	83.53		
		604,822.15	
Less accrued revenues		9,648.34	
			595,173.81
Operation and maintenance cost		97,645.02	
Less accrued revenues		2,329.90	
			95,315.12
Total assets			749.705.22
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	706,905.21		
Transfer vouchers received	15,952.38		
		722,857.59	
Collection vouchers	94,368.08		
Transfer vouchers issued	10,823.95		
		105,192.03	
			617,665.56
Accounts payable:			
Unpaid labor		1,088.91	
Unpaid purchases		69.69	
Unpaid freight and express		243.31	
Unpaid passenger fares		16.60	
			1,418.51

Repayments accrued:		
Building	$97,467.10	
Operation and maintenance	33,154.05	
		$130,621.15
Total liabilities		749,705.22

Feature costs to June 30, 1910, Carlsbad project

Storage works:		
Avalon storage and diversion dam	$215,024.31	
McMillan storage dam	4,751.58	
		$219,775.89
Canal distributing system:		
Main, east-side and Black River canals	179,241.30	
Lateral system—earthwork and structures	11,996.00	
		191,237.30
Real estate: Lands and right of way		151,904.96
Preliminary examination:		
Engineering	16,162.86	
Examination	8,887.99	
Surveys	9,445.79	
Drilling	3,801.76	
Designs	1,202.33	
Hydrography	1,928.27	
Classification and subdivision	391.47	
		41,820.47
Total building cost		604,738.62
Operation and maintenance:		
Operation as a whole	27,029.77	
Maintenance Avalon dam	3,256.48	
Maintenance McMillan reservoir	29,089.68	
Maintenance canal system	8,248.37	
Maintenance laterals and ditches	22,465.77	
Maintenance evaporation stations	717.98	
Maintenance buildings	1,710.16	
Maintenance Black River cut-off	3,463.47	
Operation and maintenance, experimental farm	1,220.60	
New spill gates	442.74	
		97.645.02
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		702,383.64

NEW MEXICO, HONDO PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Chaves.
Townships: 11 and 12 S., Rs. 22, 23, and 24 E., New Mexico meridian.
Railroad: Eastern Railway of New Mexico (Santa Fe system).
Railroad station: Roswell, N. Mex.
Average elevation of irrigable area: 3,750 feet above sea level.
Average annual rainfall on irrigable area: 16 inches.
Range of temperature on irrigable area: 0° F. to 100° F.

WATER SUPPLY

Source of water supply: Hondo River.
Area of drainage basin: 1,037 square miles.
Annual run-off in acre-feet of Hondo River at the diversion dam (1,037 square miles), 1903 to 1907: Maximum, 90,500; minimum, 10,100; mean, 46,300.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Hondo—area, 1,910 acres; capacity, 40,000 acre-feet.
Storage dams: 6 earth embankments; maximum height, 25 feet; aggregate length, 16,200 feet.
Diversion dam: Type, earth fill; maximum height, 20 feet; length, 100 feet.
Length of canals: 3 miles with capacities greater than 300 second-feet; 2 miles with capacities from 300 to 50 second-feet; over 40 miles with capacities less than 50 second-feet.

AGRICULTURAL CONDITIONS

Irrigable area: 10,000 acres.

Present status of irrigable lands: 240 acres entered subject to the reclamation act; 9,760 acres in private ownership.

Practically no irrigation, season of 1910, because of lack of water.

Length of irrigating season: 240 days.

Character of soil of irrigable area: Rich alluvium.

Principal products: Alfalfa and fruits.

Principal markets: Roswell, N. Mex.; Kansas City, Mo.; Chicago, Ill.; and Texas cities.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.

Construction authorized by Secretary September 6, 1904.

Hondo reservoir site purchased December 3, 1904.

Hondo reservoir and inlet canal completed August, 1906.

Distributing canals completed April, 1907.

Project completed May, 1907.

IRRIGATION PLAN

The irrigation plan of the Hondo project provides for the diversion of water from Hondo River about 10 miles southwest of Roswell, N. Mex., through a short inlet canal, into a natural storage reservoir, the capacity of which is increased by embankments; the return of stored water to the river and the diversion of water from the river by three dams 2, 4, and 6 miles, respectively, below the reservoir, into canal systems watering lands in the vicinity of Roswell, N. Mex.

ORIGIN OF PROJECT

Hondo River has its source in the White Mountains in Lincoln County, N. Mex., and flows in an easterly direction to Pecos River, about 5 miles east of Roswell, N. Mex. Previous to 1869 the Hondo had a perennial flow and irrigation was carried on to a considerable extent on lands adjacent to the present town of Roswell. With increased settlement, however, the use of water became so great that the river was dry near Roswell except during the floods of spring and summer and during the nonirrigating season. The irregular flow was the cause of abandonment of many farms along the lower course of the river, and investigations relative to the possibility of conserving the flood waters in reservoirs were instituted.

Leslie M. Long, an engineer, discovered two possible reservoir sites about 12 and 15 miles, respectively, southwest of Roswell, and through his efforts there was formed in December, 1888, The First New Mexico Reservoir and Irrigation Company. Mr. Long surveyed the reservoirs and filed maps of them in the land office at Roswell on March 14, 1890. Some tests for foundations were made and a small amount of preliminary work was done. Presumably on account of lack of funds, this company failed to construct the reservoirs, and early in 1892 all of its rights were sold to the Pecos Irrigation and Improvement Company. Construction of a reservoir at the present site of the Hondo reservoir was begun by that company during the latter part of 1892. In August, 1893, construction was suspended on account of heavy floods, and thereafter, because of financial difficulties, the Pecos Irrigation and Improvement Company did only sufficient construction work to maintain its rights.

In 1898 the rights to the Hondo reservoir site were sold to Mr. J. J. Hagerman. Mr. Hagerman was never able to complete the reservoir, and attempts at construction by other interested parties brought no practical results. After the passage of the reclamation act all available data regarding the Hondo reservoir and the related irrigation system were presented to the Reclamation Service, and a request was made for the completion of the system by the Government.

INVESTIGATIONS

The site of the proposed project was visited by F. H. Newell, then chief engineer of the Reclamation Service, in September, 1902, and arrangements were made for preliminary surveys and estimates. Beginning with January, 1903, complete location surveys of the inlet and outlet canals and the proposed distribution system and topographic surveys of the reservoir site were made. Lands that might be needed in the development of the project were withdrawn from entry on January 31, 1903. Gaging stations were established on the Hondo near the reservoir site in March, 1903, and at Roswell in April, 1903. Reports on the project were made on October 1, 1903, by J. H. Quinton, consulting engineer, and on October 6, 1903, by George Y. Wisner, consulting engineer. A joint report by Messrs. Quinton and Wisner, consulting engineers, and A. P. Davis, then supervising engineer, was made on October 22, 1903. These reports being favorable, the construction of the project was recommended by the chief engineer and approved by Charles D. Walcott, Director of the Geological Survey, on November 3, 1903; and on November 10 the Secretary of the Interior granted authority to take such further action as might be necessary. After further examination of the project a board of engineers, composed of Messrs. A. P. Davis, H. N. Savage, and W. H. Sanders, rendered a supplementary report on December 21, 1903. Abstracts of title on project lands were prepared and plats were made showing the ownership of the lands and the areas under cultivation.

In December, 1903, a party in charge of E. W. Myers began a topographic survey of the reservoir site and irrigable lands covering about 60 square miles and subdivided and classified all lands that might possibly come within the limits of the project. This work was finished in April, 1904. During March and April, 1904, diamond-drill borings were made at the sites of the principal structures and at various points in the reservoir site, and an examination of the geological conditions was made by C. A. Fisher in the spring of 1904. Further examinations of the project were made by Messrs. A. P. Davis, G. Y. Wisner, W. H. Sanders, J. H. Quinton, and B. M. Hall. Plans and specifications for the necessary work of construction were made during October and November, 1903, and on June 6, 1904, after careful consideration of all available information, a board of engineers, consisting of Messrs. G. Y. Wisner, W. H. Sanders, and H. N. Savage, recommended the construction of the project as planned.

Before construction could be undertaken, it was necessary to secure title to the proposed reservoir site and the execution of contracts between the water users' association and landowners to assure the return of money expended in construction. A water users' association had been formed in the latter part of 1903, and on September 19, 1904, this association had apportioned the 10,000 acres of irrigable land and filed a map defining the irrigation district.

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In June, 1904, negotiations were entered into with Mr. J. J. Hagerman, and $20,000 was agreed upon as the price for the 800 acres of land and the water rights which were held by Mr. Hagerman. On December 3, 1904, this property was conveyed to the United States.

CONSTRUCTION

TELEPHONE SYSTEM AND WATCHMAN'S HOUSE

The first work of construction was done in December, 1904. This work consisted of the building of a telephone line 14.7 miles in length between the reservoir site and Roswell and the erection of a house at the reservoir site, and was carried on by force account.

STORAGE WORKS

Proposals were opened on September 6, 1904, and contracts were entered into on December 5, 1904, for the construction of Hondo reservoir and its related structures and canals (specifications No. 15). The work covered by these specifications includes the construction of a diversion dam on Hondo River, an inlet canal about 2 miles in length from the diversion dam to the reservoir site, embankments to convert a natural depression into a satisfactory storage reservoir, an outlet canal from the reservoir to Hondo River below the diversion dam, and the necessary controlling works. The following is a brief general description of these features:

The diversion dam is an earth embankment 100 feet long and 20 feet high, with a crest width of 20 feet, a water-surface slope of 3½ to 1, protected by riprap, and a downstream slope of 2 to 1. This dam diverts the entire flow of the river to the inlet canal, which was specially designed to avoid the discharge of large amounts of silt into the reservoir. The inlet canal crosses the mouths of three flat arroyos that act as settling basins and has a flat slope to provide for a low velocity. The canal has a bank on one side only. This bank extends 8 feet above canal grade and has an 8-foot crown and side slopes of 1½ to 1. At two places along the inlet canal automatic spillways cut through rock provide for the passage of excess flood waters over the canal bank and into the river below the diversion dam. Check gates are provided at the reservoir end of the inlet canal and the water is discharged into the reservoir over a 200-foot weir in the side of the canal. This construction induces the deposition of silt in the settling basins and at the end of the inlet canal, where scour gates provide for its removal. The reservoir proper is a natural depression surrounded by hills. The construction of six embankments across low portions of the perimeter greatly increase the storage capacity. The embankments have a crown width of 20 feet and outer slopes of 2 to 1. Embankment 5 has a water slope of 3½ to 1 and the other embankments have water slopes of 3 to 1. The water slopes of embankments 1, 2, 4, and 5 are protected by riprap of limestone blocks sledged into place. Embankment No. 1 is 2,016 feet long, and has a maximum height of 20.2 feet; embankment No. 2 is 2,191 feet long and has a maximum height of 13.2 feet; embankment No. 2½ is 730 feet long and has a maximum height of 6.8 feet; embankment No. 3 is 1,359 feet long and has a maximum height of 7.6 feet; embankment No. 4 is 5,468 feet long and has a maximum height of 24.6 feet; and embankment No. 5 is 4,440 feet long and has a maximum height of 24.6 feet. The crest of embankment No. 2½ is 2 feet lower than the other embankments and can be used for discharge of flood waters in case of necessity. The outlet canal is 5,300 feet long and connects the low levels of the reservoir with the old river channel, which is used as the distributing canal. This canal has a bottom width of 10 feet, side slopes of 2 to 1, and a berm of 8 feet. Near the end of the outlet canal and at the inner edge of embankment No. 5 is a reenforced concrete outlet tower provided with gates which regulate the discharge from the reservoir through two 36-inch pipes under the embankment.

The contractor for rock work began operations in January, 1905, and continued the work to successful completion in July, 1905. The contractor for the remainder of the work began operations in January, 1905, but was unable to continue the work successfully. The contract was suspended on June 7, 1905, and the construction was then carried on by force account until other arrangements could be made.

In July, 1905, W. H. Sanders, consulting engineer, recommended the reletting of the contract for embankments 3 and 4 and the completion of the remainder of the work at the reservoir by force account. In compliance with this recommendation, proposals were requested for the construction of embankments 3 and 4 (specifications No. 54) and a contract for this work was entered into on November 13, 1905. The contract was completed satisfactorily in June, 1906. The force account work on the reservoir was completed in August, 1906. The contracts for the construction of the reservoir and accessory canals and structures were let on a basis of bids totaling about $123,300. Increases over the estimated quantities of earth and rock excavation, overhaul, riprap, concrete, and other items of work caused an increased cost of a little over 50 per cent on the basis of the bids. The accepted bids were, however, less than the character of the work justified. Poor management and inefficient equipment in the execution of the contract and increasing construction costs combined to make the actual cost much higher than the estimated contract price. The construction was therefore done at a loss to the contractors and the cost to the United States was considerably more than was at first anticipated.

DISTRIBUTION SYSTEM

The plan of the distribution system provides for the discharge of water from the outlet canal of the reservoir into Hondo River, which is used as the main canal for the distribution system. Two miles southeast of the reservoir a dam diverts water for division A of the distribution system which lies to the south of the river and consists of 0.7 of a mile of main canal, 6.57 miles of laterals, and 1.27 of sublaterals. About 3½ miles south of the reservoir is the diversion dam of division B of the distribution system. This division consists of 0.53 mile of main canal, 2.88 miles of laterals, and 1.05 miles of sublaterals on the south side of the river; and 3.71 miles of main canal, 5.26 miles of laterals, and 6.08 miles of sublaterals on the north side of the river. About 6 miles east of the reservoir is the diversion dam of division C of the distribution system. This division consists of 4.6 miles of main canals, 5.89 miles of laterals, and 9.02

miles of sublaterals on the south side of the river. The entire distribution system includes about 9½ miles of main canals, involving about 42,000 cubic yards of excavation, 20.6 miles of laterals, and 17.4 miles of sublaterals. The diversion dams consist of concrete floors, 1 foot in thickness, and superstructures of collapsible piers and flashboards. The headworks, drops, turn-outs, and checks are made of concrete.

Proposals for the excavation of the canals and laterals in the distribution system (specifications No. 69) were opened on February 1, 1906, and a contract for the execution of this work was entered into on March 2, 1906. The work under this contract was begun on March 5 and was finished in June, 1906.

All structures of the distribution system were erected by force account and were completed by April, 1907. The total cost of the distribution system was about $39,000, of which amount $11,397.94 was paid for the earthwork, which was done by contract.

OPERATION AND MAINTENANCE

The canals of the Hondo project were ready for operation in the spring of 1907, but since that date an unprecedented period of drought has existed and the flood waters of Hondo River have been so small in quantity that but little use has been found for the reservoir. Inasmuch as the normal flow of the stream above the project lands is fully appropriated, the settlers on the project have had a very scant supply of water. On this account the lands on the project have not been formally opened for irrigation, and the operation and maintenance work has so far been confined to the distribution under rental contracts of the small supply of water that has been available and the making of minor repairs and betterments to the canals and structures.

PROGRESS DURING THE FISCAL YEAR 1910

For three years the run-off from the Hondo watershed has been less than half of normal, and even less water was available this year than last. The canals have been cleaned and the water available has been distributed for partial irrigation of about 1,000 acres of land.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Hondo project

ASSETS

Inventories: Government animals			$60.00
Cost of work:			
Building cost		$349,386.27	
Less accrued revenues		3,106.63	
			346,279.64
Total assets			346,339.64

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$364,052.88		
Transfer vouchers received	10,908.15		
		374,961.03	
Collection vouchers	28,395.09		
Transfer vouchers issued	541.18		
		28,936.27	
			346,024.76

Accounts payable:		
Unpaid labor	$258.64	
Unpaid purchases	34.00	
Unpaid freight and express	16.84	
Unpaid passenger fares	5.40	
		$314.88
Total liabilities		346,339.64

Feature costs to June 30, 1910, Hondo project

Storage works:		
Reservoir and embankment	$96,246.60	
Outlet canal, excavation and embankment	57,772.59	
Protection embankment and outlet canal	825.48	
		$154,844.68
Diversion system:		
Inlet canal, headworks and earthwork	58,362.38	
Diversion dam, rock excavation	35,536.31	
		93,898.68
Distributing system: Laterals		39,004.24
Real estate (rights and property): Lands purchased		21,599.46
Irrigable lands: Farm-unit subdivision		19,837.41
Buildings:		
Construction	1,738.99	
Maintenance	331.61	
		2,070.60
Telephone line:		
Construction	4,170.42	
Maintenance	65.95	
		4,236.37
Total building cost		335,491.44
Operation and maintenance during construction:		
Operation	10,973.40	
Maintenance inlet canal	106.90	
Maintenance outlet canal	14.25	
Maintenance reservoir	589.57	
Maintenance distributing system	2,210.71	
		13,894.83
Total building and operation and maintenance cost during construction, as per debit in cost of work in statement of assets and liabilities		349,386.27

NEW MEXICO, LEASBURG PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Dona Ana.
Townships: 22 to 24 S., Rs. 1 and 2 E., Mew Mexico meridian.
Railroad: Atchison, Topeka and Santa Fe.
Railroad stations: Selden, Leasburg, Mesquite, Vado, Berino, La Luna, Las Cruces, Dona Ana, and Mesilla Park, N. Mex.
Average elevation of irrigable area: 3,800 feet above sea level.
Average annual rainfall on irrigable area: 9½ inches.
Range of temperature on irrigable area: 0° F. to 110° F.

WATER SUPPLY

Source of water supply: Rio Grande. (See Rio Grande project.)

ENGINEERING DATA FOR COMPLETE PROJECT

Diversion dam: Type, rubble concrete weir; maximum height, 9 feet; length of masonry, 600 feet; length of earth fill, 1,600 feet.
Length of Leasburg canal: 6 miles with capacity of 520 second-feet.

AGRICULTURAL CONDITIONS

Irrigable area: 25,000 acres, all in private ownership.
Area irrigated, season of 1910: 25,000 acres.
Length of irrigating season: 270 days.
Character of soil of irrigable area: Fertile alluvium.
Principal products: Alfalfa, corn, wheat, melons, fruits, vegetables.
Principal markets: Towns in Texas and New Mexico; eastern cities.

CHRONOLOGICAL SUMMARY

Reconnaissance made and preliminary surveys begun in 1903.
Construction of project authorized December 2, 1905.
Project completed July, 1908.

IRRIGATION PLAN

The irrigation plan of the Leasburg project provides for the diversion of water from the Rio Grande, by a dam at Penasco Rock, about 17 miles north of Las Cruces, N. Mex., into the Leasburg canal, 6 miles long, on the east side of the river, supplying canal systems for watering lands in Messilla Valley.

ORIGIN OF PROJECT AND INVESTIGATIONS.

Soon after the passage of the reclamation act, investigations relative to the utilization of the Rio Grande for irrigation were undertaken by the Reclamation Service. One of the chief areas irrigable from the Rio Grande was found to be the Messilla Valley, portions of which have been watered for many years by canals with temporary headings on the east side of the river a few miles below Selden, N. Mex. Pending settlement of conflicting rights involved in the development of the Rio Grande project as a whole, petitions were received in 1904 from residents of Messilla Valley requesting the construction of a diversion dam that would give to the existing canals in the valley a permanent heading. After a careful examination by engineers of the service, the construction of a dam and about 6 miles of canal near Selden was recommended as being a commendable development that would ultimately become an integral part of the Rio Grande project and that would meantime be of great advantage to agriculture in the Messilla Valley. On December 2, 1905, the construction of this unit, now known as the Leasburg project, was authorized by the Secretary of the Interior and $200,000 set aside from the reclamation fund to defray the necessary expenditures.

CONSTRUCTION

The construction features of the Leasburg project consist of a reenforced rubble concrete weir resting on piles and on two cut-off walls of sheet piling; a rubble concrete abutment at the west end of the weir resting on round piles and sheet piling; an earth embankment about 1,500 feet long extending from the west abutment of the dam to high ground; a sluiceway with three openings cut through Penasco Rock, which forms the east abutment of the dam; a canal intake with five openings just east of the sluiceway; a concrete wall connecting the sluiceway and canal intake; a 520-second-foot canal about 6 miles in length extending from the intake to an old river channel leading to existing irrigation ditches, and structures on the canal, including a sand sluiceway, two cross drainage structures and two drops; and a change of river channel about 1 mile long. The diversion weir is about 600 feet long and 9 feet in maximum height. Its crest is 3,921 feet above sea level, or about 5 feet above the mean level of the river bed. The toe of the dam extends a distance of 30 feet from the upstream face in an apron of reenforced rubble concrete 2 feet in thickness, and the end of the apron is protected by loose rock fill which extends a distance of 15 feet farther downstream. The earth embankment has an upstream slope of 3 to 1 and a downstream slope of 2 to 1 and is 15 feet wide on top. The sluiceway and intake openings are controlled by wooden gates 5 feet wide and 8 feet high. The elevation of the floors of the sluiceway and canal intake is 3,913.5 feet above sea level. The first 6,000 feet of canal has a bottom width of 34 feet and side slopes of 1 to 1 in earth and 1 to 4 in rock, and the remainder of the canal has a bottom width of 30 feet and 1 to 1 side slopes in excavation and 1½ to 1 slopes in embankment. The grade of the canal is 0.0004 throughout the greater part of its length. The original plans provided for timber drops and cross-drainage structures, but the drops were constructed of concrete. The change of river channel included the excavation of an open cut about 1 mile long and the construction of a spur dike, built of piles, wire, and brush weighted with bowlders, for deflecting the river into the cut.

The above-described features were advertised for construction under specifications No. 110. Proposals were opened on October 16, 1906, and a contract for the work was executed soon after that date. Earth excavation on the canal progressed satisfactorily between November 29, 1906, and May 1, 1907, when the excavation was 88 per cent completed. The earth embankment at the west end of the diversion dam was practically completed by March 19, 1907. Excavation and pile driving for the change of river channel was completed by April 16, 1907. Work on the concrete weir, the abutments, the sluiceway, canal headworks, and other structures on the canal was delayed by slow delivery of materials, and floods of the river caused extensive delays in the completion of the contract. Gravel and bowlder deposits about 10 feet below the foundation of the weir made the driving of timber and sheet piling very difficult. The work on the contract was finally completed on February 14, 1908.

SETTLEMENT AND IRRIGATION

Irrigation in Messilla Valley was practiced by the Pueblo Indians prior to settlement by European races. Spanish colonies were established in the latter part of the sixteenth century and the valley was largely settled by Spaniards and Mexicans, who practiced irrigation from early times. The lands of the Leasburg project are all in private ownership, and prior to the undertaking of construction by the Reclamation Service about 17,000 acres of land had been irrigated from the Dona Ana, Las Cruces, and other canals. Their diversion works were of the crudest character, being made of loose rock and brush inclosed by stakes driven in the river bed. These were usually destroyed by high water and could not be replaced until the freshet subsided; the water supply was therefore precarious. The operation of the Leasburg canal, constructed by the Reclamation Service, was begun in the spring of 1908. The permanency of the works built by the Service assures a supply of water whenever there is a flow in the river, and in consequence farming by irrigation has been greatly encouraged. On account of the difficulty of establishing farm-unit boundaries, it has not been feasible to open the project for irrigation and its operation has been carried on under temporary water-rental contracts. During the season of 1908, 17,000 acres, during 1909, 22,000 acres, and during 1910, 25,000 acres of land have been supplied with water.

PROGRESS DURING THE FISCAL YEAR 1910

During the fiscal year the field work in connection with farm-unit surveys has been completed. During the progress of this work many boundary conflicts were eliminated, but there remain some that probably will require adjudication in the courts. Cribs and wings of brush, wire, and rock have been built in the river to direct the current away from the canal and some lining has been placed in cross-drainage flumes over the canal.

Water service has been maintained on a rental basis, the water being diverted through the government canal and delivered into the heads of three community ditches, a charge being made for water so delivered. The river sometimes goes dry and it is impossible to assure the delivery of a definite amount of water. During the past fiscal year there was a shortage of water for a short period in July and August, 1909. Agricultural development has been greatly stimulated by the construction of the permanent diversion dam, and crops better in quantity and quality are being raised.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Leasburg project

ASSETS

Accounts receivable: Uncollected water rentals			$8,543.05
Inventories:			
Government animals		$275.00	
Equipment in use		1,462.20	
Storehouse		324.42	
Cement		67.00	
			2,128.62
Cost of work:			
Building cost		217,296.60	
Less accrued revenues		33,782.50	
			183,514.10
Total assets			194,185.77

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$221,551.89		
Transfer vouchers received	9,667.00		
		231,218.89	
Collection vouchers	32,376.11		
Transfer vouchers issued	5,423.96		
		37,800.07	
			193,418.82
Accounts payable:			
Unpaid labor		495.50	
Unpaid purchases		193.00	
Unpaid passenger fares		58.15	
Unpaid miscellaneous		20.30	
			766.95
Total liabilities			194,185.77

Feature costs to June 30, 1910, Leasburg project

Preliminary examination: Surveys		$5,776.78
Diversion dam:		
Sluiceway and headworks	$8,065.95	
Concrete weir and abutments	73,696.50	
Embankment at west end	4,495.91	
		86,258.36
Main canal:		
Excavation, stations 0–60	31,030.46	
Excavation and structures, stations 60–309	43,847.98	
Sand sluiceway	6,749.38	
Change of river channel	11,980.59	
		93,608.41
Buildings:		
Concrete house	3,031.66	
Miscellaneous	1,530.19	
Tents	226.39	
		4,788.24
Telephone system: Construction		870.41
Real estate (rights and property): Lands purchased		1,556.67
Irrigable lands: Farm-unit subdivision		13,652.90
Roads and bridges:		
Construction of bridges	398.08	
Construction of roads	224.63	
		622.71
Operation and maintenance (during construction):		
Operation	7,866.18	
Maintenance, main canal and sluiceway	1,137.31	
Maintenance, change of river channel	395.02	
Maintenance, canal structures	278.54	
Maintenance, dam and structures	70.25	
Maintenance, watchman's house	414.82	
		10,162.12
Total building and operation and maintenance cost during construction, as per debit in cost of work in statement of assets and liabilities		217,296.60

NEW MEXICO-TEXAS, RIO GRANDE PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Sierra, Socorro, Dona Ana, N. Mex.; El Paso, Tex.

Railroads: Atchison, Topeka and Santa Fe; El Paso and Southwestern; Southern Pacific; Texas and Pacific.

Railroad stations: Engle, Rincon, and Las Cruces, N. Mex.; El Paso and Ysleta, Tex.

Average elevation of irrigable area: 3,700 feet above sea level.

Average annual rainfall on irrigable area: 9½ inches.

Range of temperature on irrigable area: 0° F. to 100° F.

WATER SUPPLY

Source of water supply: Rio Grande.

Area of drainage basin: 37,000 square miles.

Annual run-off in acre-feet of Rio Grande: At San Marcial (30,000 square miles), 1895 to 1908—maximum, 2,420,000; minimum, 201,000; mean, 1,120,000. At El Paso (38,600 square miles), 1889 to 1893 and 1897 to 1908—maximum, 2,010,000; minimum, 50,700; mean, 861,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Engle—Area, 41,280 acres; capacity, 2,760,000 acre-feet; length of spillway, not determined; elevation of spillway, 200 feet above stream bed.

Storage dam: Engle—Type, rubble concrete gravity; maximum height, 265 feet; length of crest, 1,480 feet; volume, 410,000 cubic yards.

Diversion dams: Three, not designed.

AGRICULTURAL CONDITIONS

Irrigable area: 160,000 acres in the United States (including 25,000 acres in the Leasburg project) and 25,000 acres in Mexico, making a total of 185,000 acres.

Present status of irrigable lands (in the United States): 1,423 acres entered under the reclamation act; 11,616 acres withdrawn from entry; 146,961 acres in private ownership.

Length of irrigating season: 270 days.

Character of soil of irrigable area: Sandy loam and fertile alluvium.

Principal products: Alfalfa, corn, wheat, melons, fruits, vegetables.

Principal markets: Towns in Texas, New Mexico, and Louisiana; eastern cities.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in March, 1903.

Treaty with Mexico providing for distribution of waters of the Rio Grande proclaimed January 16, 1907.

Construction of Engle dam authorized by Congress and $1,000,000 appropriated March 4, 1907. (34 Stat., 1357.)

Reclamation act extended to Texas June 12, 1906. (34 Stat., 259.)

Construction of Engle dam authorized by Secretary May 23, 1910.

IRRIGATION PLAN

The irrigation plan of the Rio Grande project provides for the storage of flood waters of the Rio Grande in a reservoir controlled by Engle dam, about 12 miles west of Engle, N. Mex.; diversions of water from the Rio Grande, about 6 miles below the storage dam, for the irrigation of lands in Las Palomas Valley, about 24 miles below the storage dam, for watering lands in Rincon Valley, and about 120 miles below the storage dam for supplying water to lands in El Paso Valley; the furnishing of stored water to the Leasburg project to provide for the irrigation of 25,000 acres of land in Mesilla Valley; and the furnishing of 60,000 acre-feet of water per annum for use on 25,000 acres of land in El Paso Valley on the Mexican side of the Rio Grande. The irrigation works required for the Las Palomas and Rincon valleys will be new, and those required for El Paso Valley will supplement and improve existing canal systems.

ORIGIN OF PROJECT AND INVESTIGATIONS

The Rio Grande was one of the first streams investigated by the United States Geological Survey under the Powell irrigation survey, a gauging station having been established at Embudo, N. Mex., in December, 1888. Since that time records of flow and other data have been collected at various times and places. The low-water flow of the river has long since been appropriated for irrigation purposes in Colorado, New Mexico, Texas, and Mexico, and further development must necessarily depend upon the storage of flood waters. In addition to complications arising from conflicting claims of water rights, the problem of water storage on the Rio Grande is largely affected by the large quantity of sediment carried by the waters of the river, especially in its lower course. Investigations have shown the proportion of sediment to be very large, and plans for storing the waters must be considered with reference to the probable rapid silting of the reservoirs. A number of reservoir sites have been surveyed and investigated by various parties since about 1889, many of them by the hydrographic branch of the Geological Survey in the prosecution of the Powell irrigation survey. By special acts of Congress large areas of land were donated to the Territory of New Mexico for the purpose of irrigation and improving the Rio Grande. In order to carry out the purposes of the donation, a land board and a commission of irrigation were provided for by the legislature of New Mexico in 1897 and 1899. Little was accomplished, however, by these boards beyond the selection of certain tracts of land and the consideration of general plans of storage and irrigation.

In March, 1903, the Reclamation Service began investigations on the Rio Grande. In the seasons of 1903 and 1904 a detailed survey of a dam site on the Rio Grande a short distance below Elephant Butte, borings at this site to determine the depth and character of bed rock, topographic surveys of irrigable lands in Mesilla Valley, borings for a diversion dam near Fort Selden, N. Mex., and other studies of the Rio Grande with reference to water supply and storage and irrigation possibilities, were made. In succeeding seasons general investigations have been continued.

By a treaty with the Republic of Mexico, signed May 21, 1906, and proclaimed January 16, 1907, the United States undertakes to deliver to Mexico, after the completion of a proposed storage dam on the Rio Grande, 60,000 acre-feet of water annually in the bed of the river near the city of Juarez, Mexico. To carry out the provisions of the treaty, Congress, by an act approved March 4, 1907 (34 Stat., 1357), made a direct appropriation of $1,000,000, to be available as needed and to be expended under the direction of the Secretary of the Interior in connection with the irrigation project on the Rio Grande, and at the same time provided that the balance of the cost of the irrigation project should be paid from the reclamation fund.

In 1909 a topographic survey of the Engle reservoir site was completed, some development work at the site of the dam proposed for this reservoir was done for the purpose of determining a suitable location and the kind of material that would be encountered, and a branch railway from the Santa Fe System near Engle, N. Mex., to the site of the dam was surveyed and located and a small part of the road constructed. Preparations are under way for letting a contract for the construction of the balance of the roadway.

In 1905 two water users' associations, the Elephant Butte Water Users' Association, of New Mexico, with headquarters at Las Cruces, and the El Paso Valley Water Users' Association, of Texas, with headquarters at El Paso, were formed and have obtained subscriptions from the owners for a large part of the lands that can be irrigated under the project.

PROGRESS DURING THE FISCAL YEAR 1910

Surveys of lands within the Engle reservior site and other lands required for the use of the project have been made during the fiscal year and condemnation suits brought to acquire title to about 33,000 acres. Judgment has been entered in these cases, and possession of the land will be secured as soon as the amounts awarded are deposited with the court. A survey party was employed for a short time on canal surveys near Las Cruces, N. Mex., and later transferred to general investigations of water supply, ditches, farm lands, reservoirs, and reservoir sites on the Rio Grande watershed in Colorado and New Mexico above the Engle reservoir site.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Rio Grande project

[Reclamation fund]

ASSETS			
Cost of work: Building cost			$76,060.58
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	$69,597.74		
Transfer vouchers received	26,312.10		
		$95,909.84	
Collection vouchers	19,246.19		
Transfer vouchers issued	603.07		
		19,849.26	
			76,060.58
Total liabilities			76,060.58

[Appropriation for Rio Grande (Engle) dam]

ASSETS			
Cash (as per Table 21, p. 49):			
With Treasurer United States	$581,641.62		
In depository to credit of special fiscal agents	27,774.39		
		$609,416.01	
Less liabilities:			
Unpaid labor	1,230.31		
Unpaid purchases	415.75		
Unpaid freight and express	2,530.86		
Unpaid passenger fares	133.70		
Unredeemed coupon books	10.40		
		4,321.02	
			$605,094.99

Inventories:			
Government animals		$1,090.00	
Equipment in use		16,747.51	
Storehouse		13,886.55	
Cement		176.43	
Lumber		4,059.15	
Forage		2,030.16	
Unadjusted transfers		2,684.33	
Freight and handling undistributed		3,730.21	
			$44,404.34
Cost of work:			
Building cost		354,500.80	
Less adjustments	3,764.13		
Less accrued revenues	236.00		
		4,000.13	
			350,500.67
Total assets			1,000,000.00

LIABILITIES

Capital (as per Table 21, p. 49): Special appropriation for Rio Grande (Engle) dam (nonreimbursable)	1,000,000.00
Total liabilities	1,000,000.00

Feature costs to June 30, 1910: Rio Grande project

Examination of project as a whole: Preliminary surveys		$92,046.07
Real estate (rights and property): Lands purchased		223,468.69
Buildings:		
Camp construction	$14,514.99	
Office buildings	64.33	
Maintenance of camps	3,911.75	
Plant buildings	3,369.75	
		21,860.82
Wagon roads:		
McCrae Canyon road	483.42	
Eagle road	7,330.03	
Town-site road	6,548.23	
Camp roads	5,244.35	
Engle dam road	397.11	
		20,003.14
Railroad construction:		
Surveys	3,328.11	
Grading	42,239.01	
		45,567.12
Waterworks:		
Concrete tank	5,667.31	
Pipe line	10,049.35	
Pumping plant	282.73	
		15,999.39
Administration of project as a whole: General expense		8,760.26
Plant accounts:		
Sand and gravel pits	907.76	
Crushing and screening plant	1,905.38	
Blacksmith shop	40.75	
		2,855.89
Total building cost as per debit in cost of work in statement of assets and liabilities		430,561.38

NORTH DAKOTA, BUFORD-TRENTON PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Williams.
Township: 152 and 153 N., Rs. 102 to 104 W., fifth principal meridian.
Railroad: Great Northern.
Railroad stations: Buford, Trenton, and Morley, N. Dak.
Average elevation of irrigable area: 1,900 feet above sea level.
Average annual rainfall on irrigable area: 15 inches.
Range of temperature on irrigable area: —49° F. to 107° F.

WATER SUPPLY

Source of water supply: Missouri River.
Area of drainage basin: 155,000 square miles.
Mean run-off of Missouri River near Williston, May to October, 1905 to 1907: 15,000,000 acre-feet.

ENGINEERING DATA FOR COMPLETE PROJECT

Length of canals: No canals with capacities greater than 300 second-feet; 6 miles with capacity from 300 to 50 second-feet; 39 miles with capacities less than 50 second-feet.

Electric power: 1,500 horsepower delivered from Williston steam power station.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 12,500 acres; first unit, 4,060 acres.

Present status of irrigable lands (whole project): 179 acres entered subject to the reclamation act; 281 acres open to entry; 1,400 acres withdrawn from entry; 91 acres of state lands; 10,550 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 4,060 acres.
Area irrigated, season of 1910: 440 acres.
Length of irrigating season: 120 days.
Character of soil of irrigable area: Ranges from sandy loam to heavy clay loam.
Principal products: Small grains, alfalfa, sugar beets, and vegetables.
Principal markets: St. Paul, Minneapolis, and Duluth, Minn.; Chicago, Ill.

LANDS OPENED FOR IRRIGATION

Date of public notice: April 8, 1908.

Location of lands opened: Tps. 152 and 153 N., Rs. 103 and 104 W., fifth principal meridian.

Present status of irrigable lands opened: 179 acres entered subject to the reclamation act; 281 acres open to entry; 91 acres of state lands; 3,498 acres in private ownership.

Limit of area of farm units: Public, 80 acres; private, 160 acres.
Duty of water: 2 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $38.

Annual operation and maintenance charge, $0.70 per acre of irrigable land and $0.50 per acre-foot of water actually used.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.
Construction authorized by Secretary January 23, 1906.
First unit completed November, 1907.

Pumping plant and transmission lines completed for present use in the spring of 1908.
First irrigation by Reclamation Service, season of 1908.
Whole project 38 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Buford-Trenton project provides for the pumping of water from Missouri River by a pumping plant installed on a barge moored in the river lifting water about 30 feet to a settling basin that discharges by gravity into a canal supplying water for the irrigation of low lands along the river between Buford and Trenton, and the pumping of water from the settling basin by means of a pumping plant at a permanent pumping station lifting water 50 feet into a high-line canal for the irrigation of bench lands near the same towns. The pumping plants are operated by electric power generated at a main power station on the Williston project and delivered over a transmission line 28.3 miles in length.

ORIGIN OF PROJECT AND INVESTIGATIONS

During 1903 and 1904 investigations and surveys were made to determine the feasibility of irrigating lands adjacent to Missouri River in North Dakota by means of pumping with locally mined lignite for fuel. The investigations showed that there are extensive beds of lignite throughout this region that could be used economically as a fuel for pumping irrigating water; that the Missouri River contains an almost unlimited supply of water that could be utilized for irrigation; that there are several tracts of land adjacent to the river and at an elevation sufficiently low to make irrigation by pumping feasible. Detailed investigations were made with respect to several possible projects and on November 9, 1904, H. A. Storrs recommended the approval of the Buford-Trenton project for construction. On November 18, 1904, the Secretary of the Interior tentatively approved the Buford-Trenton project and set aside from the reclamation fund $550,000 for the development of pumping projects. Surveys for the project were continued and the landowners formed a water users association and subscribed more than 80 per cent of the lands within the project. Meanwhile plans and estimates were prepared and on September 22, 1905, a board of engineers, consisting of Messrs. A. P. Davis, H. N. Savage, O. H. Ensign, H. A. Storrs, and P. M. Churchill, recommended the setting aside of additional funds for the Buford-Trenton project. On January 23, 1906, the recommendations of the board with respect to this and other projects were approved by the Secretary of the Interior and additional funds set aside for construction purposes. On May 23, 1906, the Buford-Trenton Water Users Association entered into a contract with the Secretary of the Interior to return to the reclamation fund the cost of the project.

CONSTRUCTION

PUMPING PLANTS

There are two pumping plants on the project. The intake pumping station is installed on a barge, which, during the irrigation season, is moored in Missouri River and contains four pumping units designed to take water from the river and deliver it through riveted steel discharge pipes provided with flexible joints into a settling basin adjacent to the river and extending to the second pumping station. Station 2 contains four pumping units designed to take water from the settling basin through a horizontal suction pipe and to discharge it into a riveted steel pipe connected to a concrete-steel pipe leading to a high-line canal. Electric power for the operation of the pumping stations is delivered from the Williston project over a transmission line to a bank of transformers located in station 2. The transformers are 300-kilowatt, 60-cycle, oil-insulated, water-cooled, and step the voltage down from 22,000 to 2,200. The current is delivered to the pumping units at 2,200 volts. The four pumping units for the intake station are centrifugal pumps of 30-second-foot capacity under 30-foot head, direct connected to 3-phase induction motors. The pumping units for station 2 consist of centrifugal pumps of 16-second-foot capacity under 50-foot head, direct connected to 3-phase motors. The motors for two of the units are of the induction type and for the other two units are of the synchronous type. There is installed an exciter unit consisting of an induction motor and a direct current dynamo. The intake pumping station was constructed by force account. Pumping station 2, a concrete structure 63 feet 8 inches by 19 feet 8 inches in plan and about 27 feet in height, was constructed under a contract dated March 26, 1907. Proposals for the construction of this station under specifications No. 127 were opened on March 5, 1907. The equipment for the two stations was furnished under contract dated September 27, 1906. Proposals under specifications No. 107 for the furnishing of this machinery were opened on September 10, 1906. The buildings for the plants were completed and machinery installed in 1907. The transmission line was constructed by force account, being completed in the spring of 1908.

CANALS AND STRUCTURES

Proposals for the construction of canals and structures for the Buford-Trenton project under specifications No. 108 were opened September 11, 1906. But one proposal was received and this was considered excessive and was rejected. A readvertisement was made under specifications No. 127 and proposals were opened on March 5, 1907. The work covered by the specifications was divided as follows: Division A, structures such as bridges, culverts, turn-outs, drops, flumes, and all excavation and embankment required for the high-line canal and laterals and the waste-water ditches on bench lands; division B, similar work required for the low-line canal; division C, the building and furnishing of the pressure pipe leading from pumping station 2 to the high-line canal; division D, the construction of pumping station 2. A contract for division A was entered into on March 26, 1907, and the work of construction was completed in November of the same year. A contract for division B was entered into on May 21, 1907, and the work of construction was completed in September, 1907. A contract for division C was entered into on March 22, 1907, and the work under this contract was completed in October of that year. The contract for division D was dated March 26, 1907, and the work under it was completed in 1907 as stated in connection with the discussion of the pumping plants. A contract for constructing the embankment for the settling basin was executed May 21, 1907, and the work was completed the following September.

SETTLEMENT AND IRRIGATION

Practically all of the land within the Buford-Trenton project is in private ownership, having been settled prior to construction operations by the Reclamation Service. The project is located within the semiarid belt, and in occasional years irrigation is not a necessity. The first unit of the project, consisting of 4,049.64 acres of land, of which all but 460.41 are in private ownership, was opened for irrigation by a public notice dated April 8, 1908. Practically all of the cultivated lands on the project were sown to small grains in the season of 1908. The value of early irrigation was not yet appreciated, and few applications were received for water before July. This resulted in an excessive demand for water on short notice. About 816 acres were actually irrigated, the total amount of water pumped and delivered being 873 acre-feet. The year 1909 was one of exceptional rainfall, and water was delivered to only two water users. On June 30, 1910, there had been delivered to four users since the beginning of the season 211 acre-feet of water.

PROGRESS DURING THE FISCAL YEAR 1910

No additional construction or survey work has been undertaken during the fiscal year, but preliminary plans and estimates have been prepared for the proposed low-line canal system for lands bordering on Missouri River between Buford and Trenton.

The season of 1909 was one of unusual rainfall, and little water was pumped for irrigation. No water was used in 1910 until the latter part of June, and on June 30, 1910, water had been delivered to only four water users for the irrigation of 130 acres of land. The principal crop irrigated has been wheat. Crops on the lands that have received water are in much better condition than those that have not been irrigated.

During the year 3 entries, embracing 85 acres of irrigable land, have been made, 1 farm unit entered in 1908 has been relinquished, and 17 water-right applications for 1,599 acres of land have been received.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Buford-Trenton project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$32,839.77	
Uncollected water-right operation and maintenance charges		6,019.54	
			$38,859.31
Inventories:			
Government animals		160.00	
Equipment in use		5,188.63	
Iron and steel		402.31	
Local products		6.26	
Freight and handling undistributed		18.02	
			5,775.22
Cost of work:			
Building cost		262,912.59	
Less adjustments	$3,316.98		
Less accrued revenues	1,304.89		
		4,621.87	
			258,290.72
Operation and maintenance cost		16,324.34	
Less accrued revenues		31.75	
			16,292.59
Total assets			319,217.84

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$311,132.46		
Transfer vouchers received	64,753.88		
		$375,886.34	
Collection vouchers	2,919.35		
Transfers vouchers issued	94,672.59		
		97,591.94	
			$278,294.40
Accounts payable:			
Unpaid labor		383.18	
Unpaid freight and express		312.19	
Unpaid passenger fares		8.70	
			704.07
Repayments accrued:			
Building		33,519.97	
Operation and maintenance		6,699.40	
			40,219.37
Total liabilities			319,217.84

Feature costs to June 30, 1910, Buford-Trenton project

Power plant:		
Excavation	$971.45	
Concrete	8,751.56	
Reinforcing steel	179.76	
Structural steel	685.91	
Roofing	1,317.04	
Mill work	518.10	
Water conduits	1,042.98	
Cost of machinery, installing, and testing	54,358.87	
Temporary end in boiler room	385.44	
Transmission line	23,380.90	
Pumping barge and ways	32,691.41	
Pumping station	32,277.62	
Boom and scow pontoon	700.98	
		$157,262.02
Distributing system, earthwork and structures:		
Settling basin	6,655.75	
Brush mattress (settling basin)	117.42	
Concrete pressure pipe	19,504.25	
Canals and structures	23,060.62	
Canal B	2,168.10	
Six-mile flume	708.54	
		52,214.68
Examination of project as a whole:		
General preliminary cost	14,542.81	
Surveys	5,737.08	
Soil surveys	90.73	
Investigation, stone quarry	140.90	
Water system	930.98	
Land restoration	49.43	
		21,491.93
Real estate (rights and property): Lands purchased		943.73
Buildings:		
Incidental structures	1,156.16	
Electrician's cottage	332.91	
Engineer's cottage	1,293.93	
Bunk house	343.95	
Coal shed	120.00	
Water-tank house	235.50	
		3,482.45
Administration of project as a whole: General expense		27,434.16
Inventory of unused supplies		83.62
Total building cost		262,912.59
Operation and maintenance:		
Power plant	8,589.74	
Distributing system, earthwork and structures	2,932.43	
Demonstration farm	41.30	
Engineering expenses as a whole	4,760.87	
		16,324.34
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		279,236.93

NORTH DAKOTA, WILLISTON PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Williams.
Townships: 153 to 155 N., Rs. 100 and 101 W., fifth principal meridian.
Railroad: Great Northern.
Railroad station: Williston, N. Dak.
Average elevation of irrigable area: 1,875 feet above sea level.
Average annual rainfall on irrigable area: 15 inches.
Range of temperature on irrigable area: —49° F. to 107° F.

WATER SUPPLY

Source of water supply: Missouri River.
Area of drainage basin: 155,000 square miles.
Mean run-off of Missouri River near Williston, May to October, 1905 to 1907: 15,000,000 acre-feet.

ENGINEERING DATA FOR COMPLETE PROJECT

Length of canals: 3 miles with capacities from 300 to 50 second-feet, 57 miles with capacities less than 50 second-feet.
Electric power: Generated by steam power plant; 1,500 horsepower for Williston project and 1,500 horsepower for Buford-Trenton project.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 12,000 acres; first unit, 8,047 acres.
Present status of irrigable lands (whole project): 23 acres entered subject to the reclamation act, 89 acres open to entry, 67 acres of state lands, 11,800 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 8,047 acres.
Area irrigated, season of 1910: 2,000 acres.
Length of irrigating season: 120 days.
Character of irrigable area: Ranges from sandy loam to heavy clay loam.
Principal products: Small grain, alfalfa, sugar beets, and vegetables.
Principal markets: St. Paul, Minneapolis, and Duluth, Minn.; Chicago, Ill.

LANDS OPENED FOR IRRIGATION

Dates of public notices: April 27 and November 30, 1908; April 30, 1909.
Location of lands opened: Tps. 154 and 155 N., Rs. 100 and 101 W., fifth principal meridian.
Present status of irrigable lands opened: 23 acres entered subject to the reclamation act, 89 acres open to entry, 67 acres of state lands, 7,868 acres in private ownership.
Limit of area of farm units: 160 acres.
Duty of water: 2 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $38.
Annual operation and maintenance charge: $0.70 per acre of irrigable land, and $0.50 per acre-foot of water actually used.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.
Construction authorized by Secretary, January 23, 1906.
Power and pumping plants completed for present use in the fall of 1907. First unit completed in the spring of 1908.
First irrigation by the Reclamation Service, season of 1908.
Power installation: Completed for 2,000 horsepower June 30, 1910.
Whole project 64 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the first unit of the Williston project provides for a central steam-turbine power plant operating pumps and generating electricity for the operation of other pumping plants; a series of motor-driven centrifugal pumps on a barge in Missouri River; a settling basin receiving water from the barge pumping plant; a main canal extending from the settling basin along Little Muddy Creek to the power plant; a pumping station having electrically driven pumps which lift water from the main canal to a high-line canal, and a second pumping station having electrically driven pumps lifting water from this high-line canal to a higher canal; and two sets of steam-driven pumps, located in the central power house, which lift water from the end of the main canal to a high-line canal. The canals leading from the several stations deliver water on land in the valley of Little Muddy Creek in the vicinity of Williston, N. Dak. The power station is conveniently located adjacent to a vein of lignite coal from which fuel is obtained. This station also generates electric power which is delivered over a transmission line to the Buford-Trenton project.

Plans for other units of the project provide for the extension of the canal system of the first unit and the construction of a second intake station and the necessary canals and laterals to supply water to lands bordering on Missouri River near Williston.

ORIGIN OF PROJECT AND INVESTIGATIONS

During 1903 and 1904 investigations and surveys were made to determine the feasibility of irrigating lands adjacent to Missouri River in North Dakota by means of pumping with locally mined lignite for fuel. The investigations showed that there are extensive beds of lignite throughout this region that could be used economically as a fuel for pumping irrigating water; that the Missouri River contains an almost unlimited supply of water that could be utilized for irrigation; and that there are several tracts of land adjacent to the river and at an elevation sufficiently low to make irrigation by pumping feasible. Plans and estimates for the Williston project were prepared in 1905 and on September 22, 1905, a board of engineers consisting of Messrs. A. P. Davis, H. N. Savage, O. H. Ensign, H. A. Storrs, and P. M. Churchill recommended that the Williston and other projects be approved for construction. On January 23, 1906, the Secretary of the Interior approved the recommendations of the board of engineers and authorized the construction of the Williston project. On May 23, 1906, the Williston Water Users' Association entered into a contract to return to the reclamation fund the cost of the project.

CONSTRUCTION

Power for the Williston project is developed in a main power plant designated as station 1, situated about 3 miles north of Williston and close to a lignite coal mine owned and operated by the Reclamation Service. The power house is 90 by 135 feet in plan and contains the following machinery for the combined use of the Williston and Buford-Trenton projects: Eight 250-horsepower Sterling water-tube boilers, with furnaces of the Dutch-oven type equipped with rocking grates and forced-draft apparatus; 4 steel smokestacks, 54 inches in diameter and 110 to 135 feet in height; 2 horizontal steam-turbine units of 300-kilowatt capacity each and one unit of 500-kilowatt capacity, generating 3-phase alternating current at 60 cycles and 2,200 volts; 3 water-cooled transformers of 200-kilowatt capacity and 3 self-cooled transformers of 125-kilowatt capacity, changing the generating voltage of 2,200 to the transmission voltage of 22,000 used only on the Buford-Trenton line. The intake pumping station, known as station 3, is located on a barge moored in Missouri River during the irrigation season. This station is equipped with three pumping units consisting of centrifugal pumps of 30-second-foot capacity under a head of 30 feet, direct connected to 3-phase, 2,200-volt motors. Water is pumped from the intake to a settling basin through discharge pipes with flexible metallic joints. Pumping station 2 is located on the main canal 1 mile from the intake and contains two electrically operated pumping units, one of 15-second-foot and the other of 20-second-foot capacity under a head of 30 feet. Station 4 is located on the high-line canal about 1 mile from station 2 and contains one electrically operated pumping unit with a capacity of 20 second-feet under a head of 28 feet. Pumping station 1 is located at the end of the main canal; is built in connection with the power plant, and contains two steam-turbine pumping units of 20-second-foot capacity each under a head of 56 feet. Three circulating pumps supply water to two surface condensers and one jet condenser, and the water after passing through the condensers may be discharged into a canal 26 feet above the supply canal or may be returned to the equalizing reservoirs. Stations 2 and 4 are operated with current at 220 volts. Proposals under specifications No. 100 for the construction and equipment of the pumping plants were opened on August 14, 1906. The specifications include the following schedules: Schedule A, boiler plant at power station; schedule B, steam-operated pumps at power station; schedule C, electric generating plant at power station; schedule D, transformers, motors, and pumps for station 2; schedule E, transformers, motors, and pumps for station 3; schedule F, 3 miles of transmission line; and schedule G, building for the power station. The work for schedules A, B, C, D, E, and G was let in three contracts, and the transmission line, schedule F, was built by force account. All the work was completed by the fall of 1907.

Proposals under specifications No. 105, for the construction of about 80 miles of canals and laterals, composing the distribution system, and the appurtenant structures, including 2 pumping stations, pressure pipes, 2 canal siphons, 2 canal flumes, bridges, culverts, and turn-outs, were opened on August 30, 1906. The work was let in one contract dated September 26, 1906, and the construction was completed early in 1908.

OPERATION AND MAINTENANCE

The coal mine was opened up in 1907, and mining has been conducted in accordance with the fuel requirements of the power plant. During the fiscal year ending June 30, 1909, 7,708 tons of coal were mined, and during the year ending June 30, 1910, 4,533 tons were taken out.

On April 27, 1908, the Secretary of the Interior issued a public notice opening for irrigation 8,033.31 acres of land, of which all but 180 acres were in private ownership. Delivery of water into the canal system was begun on May 11, 1908, and on or before May 16 all four pumping stations were being operated. During the season of 1908 irrigation was not begun until June, when many demands for water were made. About 2,098 acre-feet of water were delivered during the season to irrigate about 1,050 acres of land. In 1909 water was first pumped on May 12 and was first delivered for irrigation on May 24. About 2,230 acre-feet of water were delivered during the season for the irrigation of 1,450 acres of land. In 1910 pumping was begun on May 23 and the delivery of water on June 14. During the latter part of June many applications for water were received, and it is estimated that about 2,000 acres of land will be watered during the season.

PROGRESS DURING THE FISCAL YEAR 1910

No additional construction or surveys have been undertaken during the fiscal year, but preliminary plans and estimates have been prepared for proposed canal systems for lands along Missouri River near Williston. The season of 1909 was particularly favorable for dry farming, and the best crops ever raised in western North Dakota without irrigation were produced. After August 1 very little rain fell, and irrigation was necessary for the growth of vegetables and the second and third crops of alfalfa. Little water was used in 1910 until the latter part of June, when on account of the dry season and hot winds many demands were made for water. Crops that received water are in excellent condition, but the unirrigated crops will probably not reach half an average yield.. On June 30, 1910, 97 water-right applications for 4,394 acres of land had been received, but it is believed that not more than 2,000 acres of land will be irrigated during the present season.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Williston project

ASSETS			
Accounts receivable:			
Uncollected water-right building charges		$45,538.10	
Uncollected water-right operation and maintenance charges		7,408.75	
			$52,946.85
Inventories:			
Mercantile store		677.30	
Government animals		1,258.32	
Equipment in use	$10,889.83		
Less depreciation	11.97		
		10,877.86	
Storehouse		1,163.96	
Iron and steel		282.88	
Forage		44.69	
Local products		113.73	
Unadjusted transfers		2,990.79	
Freight and handling undistributed		116.63	
			17 526.16
Cost of work:			
Building cost		441,147.3	
Less adjustments	654.93		
Less accrued revenues	4,084.15		
		4,739.08	
			436,408.26
Operation and maintenance cost		81,774.65	
Less accrued revenues		165.00	
			81,609.65
Total assets			588,490.92
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	502,325.67		
Transfer vouchers received	77,468.91		
		579,794.58	
Collection vouchers	8,431.17		
Transfer vouchers issued	43,192.10		
		51,623.27	
			528,171.31

Accounts payable:		
Unpaid labor	$2,699.34	
Unpaid purchases	552.42	
Unpaid passenger fares	7.15	
Unredeemed coupon books	61.87	
Unredeemed meal tickets	174.57	
Unpaid miscellaneous	456.00	
		$3,951.35
Repayments accrued:		
Building	45,880.82	
Operation and maintenance	10,487.44	
		56,368.26
Total liabilities		588,490.92

Feature costs to June 30, 1910, Williston project

Coal-mine development		$12,529.73
Power plant:		
Power house, building and machinery station No. 1	$145,951.00	
Transmission line	14,833.12	
Transformer station at barge	2,446.22	
Pumping barge, station No. 3	35,098.15	
Pumping station 2	12,459.37	
Pumping station 4	7,332.92	
Floating boom at barge	686.03	
Scow pontoon	1,247.23	
		220,054.04
Distributing system (earthwork and structures):		
Canals and laterals	121,371.64	
Equalizing reservoir	1,071.87	
Spillway at reservoir	502.08	
Turn-out at reservoir	217.00	
Diverting structures	565.34	
Sluicing boat	763.32	
Bank protection at settling basin	102.83	
Bank revetment, Missouri River	1,598.63	
		126,192.71
Buildings:		
Incidental structures	4,405.64	
Engineer's cottage at power house	1,385.16	
Storehouse and granary	251.21	
Temporary machine shop	683.07	
Bath house at mine	612.27	
Bunk house at power station	1,211.27	
Coal-storage structure	823.83	
Barn at power station	801.67	
Mess house at power station	162.28	
Office at power station	533.19	
Commissary building at power station	552.38	
		11,421.97
Real estate (rights and property): Lands purchased		4,639.02
Irrigable lands:		
Soil survey	136.96	
Farm-unit survey	5,742.17	
Survey east and west bottom	986.24	
Land restoration survey	691.61	
Town-site surveys	127.60	
		7,684.58
Examination of project as a whole: Preliminary surveys		19,879.08
Administration of project as a whole: General expense		38,746.21
Total building cost		441,147.34
Operation and maintenance:		
Power plant	67,799.79	
Distributing system	7,756.91	
Engineering expense as a whole	6,217.95	
		81,774.65
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		522,921.99

OKLAHOMA, CIMARRON PROJECT

IRRIGATION PLAN

The irrigation plan of the Cimarron project, so far as it can be outlined from the limited investigations and surveys heretofore made, provides for the storage of flood waters of Cimarron River or the utilization of the underflow of the Cimarron River valley, or both, for use in irrigating lands in Beaver and Woodward counties, Oklahoma. The investigations made, however, indicate that the feasibility of such a project is doubtful.

INVESTIGATIONS

In 1902 and 1903 reconnaissance was made of the Cimarron River with special reference to possible reservoir sites. In 1904 a plane table survey was made of a reservoir site on Cimarron River 2½ miles northeast of Kenton, Okla., and other reservoir sites were examined and some investigations of underground waters made. Beginning in 1906 and continuing until 1909, further examinations of reservoir sites and water supply and studies of the underflow of the valley by means of test borings were carried on, and topographic surveys of lands along the Cimarron River were made, resulting in the conclusion that present construction of an irrigation project would not be feasible.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Cimarron project

ASSETS

Inventories: Storehouse			$125.00
Cost of work: Building cost			8,753.99
Total assets			8,878.99

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$8,577.96		
Transfer vouchers received	321.76		
		$8,899.72	
Transfer vouchers issued		26.55	
			8,873.17
Accounts payable: Unpaid passenger fares			5.82
Total liabilities			8,878.99

Feature costs to June 30, 1910, Cimarron project

Examination of project as a whole: Preliminary examination and surveys. $8,753.99

OREGON, CENTRAL OREGON PROJECTS

IRRIGATION PLAN

The Central Oregon projects consist of a number of possible irrigation developments in the State of Oregon, located in the Deschutes, Snake, and Columbia River basins and in the interior basin. The irrigation plan of these projects provides in general for utilization of the waters of various small streams in these drainage basins.

INVESTIGATIONS

A reconnaissance was made in 1903 of some of the streams and irrigable areas of these projects, and stream measurements and investigations of water supply have been carried on since that date.

In 1908 a reconnaissance, covering in part projects previously reported on but much more complete and thorough than investigations previously attempted, was made in central and eastern Oregon. Irrigation projects on Crooked, Ochoco, Tumalo, and Rosland rivers, in the Deschutes River basin; on the Chewaucan, Ana, Pauline, Rock Fort, Silvies, and Blitzen rivers and Silver Creek, in the interior basin; on Powder River, in the Snake River basin; and on the John Day and Umatilla rivers, in the Columbia River basin, were investigated with considerable care; and new gaging stations were established along the more important streams.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Central Oregon project

ASSETS			
Inventories: Equipment in use			$788.73
Cost of work: Building cost			39,344.71
Total assets			40,133.44
LIABILITIES			
Investment of the United States:			
Disbursement vouchers	$40,036.02		
Transfer vouchers received	1,668.91		
		$41,704.93	
Collection vouchers	1,228.58		
Transfer vouchers issued	342.91		
		1,571.49	
			40,133.44
Total liabilities			40,133.44

Feature costs to June 30, 1910, Central Oregon projects

Preliminary examination and survey	$39,344.71

OREGON, UMATILLA PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Umatilla.
Townships: 4 and 5 N., Rs. 28 and 29 E., Willamette meridian.
Railroads: Oregon Railroad and Navigation Company; Northern Pacific.
Railroad stations: Hermiston and Umatilla.
Average elevation of irrigable area: 470 feet above sea level.
Average annual rainfall on irrigable area: 9 inches.
Range of temperature on irrigable area: —28° F. to 115° F. (ordinary minimum, 0° F.).

WATER SUPPLY

Source of water supply: Umatilla River.
Area of drainage basin: 1,610 square miles.
Annual run-off in acre-feet of Umatilla River at Yoakum (1,200 square miles), 1904 to 1908: Maximum, 694,000; minimum, 250,000; mean, 506,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Cold Springs—area, 1,500 acres; capacity, 50,000 acre-feet; length of spillway, 330 feet; elevation of spillway, 90 feet above stream bed.
Storage dam: Cold Springs—type, earth fill; maximum height, 98 feet; length of crest, 3,800 feet; volume, 757,000 cubic yards earth and gravel, 32,500 cubic yards rock fill, and 3,900 cubic yards concrete.
Diversion dam: Type, concrete weir; maximum height, 2.5 feet; length of masonry, 400 feet; length of earth fill, 780 feet.
Length of canals: 25 miles, with capacities greater than 300 second-feet; 13 miles, with capacities from 300 to 50 second-feet; 100 miles, with capacities less than 50 second-feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 25,000 acres; Hermiston unit, 6,975 acres; second unit, 4,392 acres; third unit, 3,952 acres.
Present status of irrigable lands (whole project): 9,936 acres entered subject to the reclamation act, 563 acres open to entry, 2,197 acres withdrawn from entry, 12,304 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 15,319 acres.
Area irrigated, season of 1910: 3,000 acres.
Length of irrigating season: 210 days.
Character of soil of irrigable area: Sandy loam and volcanic ash.
Principal products: Alfalfa, fruits, berries, vegetables.
Principal markets: Portland, Oreg., and Spokane, Wash.

LANDS OPENED FOR IRRIGATION

Dates of public notices and orders relating thereto: December 27, 1907; August 3, 1908; November 12, 1908; April 3, 1909; January 6, 1910 (two).
Location of lands opened: Tps. 4 and 5 N., Rs. 28 and 29 E., Willamette meridian.
Present status of irrigable lands opened: 6,890 acres entered subject to the reclamation act, 563 acres open to entry, 7,866 acres in private ownership.
Limit of area of farm units: Public, 40 acres; private, 160 acres.
Duty of water: 2.8 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $60.
Annual operation and maintenance charge: $1.30 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1905.
Board report October 27, 1905.
Construction authorized by Secretary December 4, 1905.
Diversion dam and feed canal completed August, 1907.
Cold Springs dam completed June, 1908.
Hermiston unit completed June, 1908.
Maxwell Canal system purchased June 4, 1908.
First irrigation by Reclamation Service, season of 1908.

IRRIGATION PLAN

The irrigation plan of the Umatilla project provides for the diversion of water from Umatilla River by a dam about 2 miles above Echo, Oreg., through a feed canal into a storage reservoir controlled by the Cold Springs dam and the diversion of water from the storage reservoir through an outlet canal and from the feed canal by means of a bypass canal connecting the feed and outlet canals and from Umatilla River by the Maxwell canal, heading near Butter Creek, into distributing systems watering lands in the Umatilla and Columbia River valleys near Hermiston, Oreg.

ORIGIN OF PROJECT AND INVESTIGATIONS

The Reclamation Service began to investigate the feasibility of reclamation projects on Umatilla and Columbia rivers in Oregon in 1903. In the summer of 1905 reconnaissance was made of the area included in the present Umatilla project, and during the fall of that year detailed surveys of the reservoir and dam sites were made, test pits were dug and wash borings made along the embankment line of the dam, and preliminary surveys of the storage feed canal were completed. On October 27, 1905, after examination of the project and the plans and estimates for its development, a board of engineers, consisting of Messrs. A. P. Davis, A. J. Wiley, and D. C. Henny, reported that the project was feasible and recommended that its construction be undertaken. The Umatilla project was approved by the Secretary of the Interior on December 4, 1905, and $1,000,000 was set aside from the reclamation fund for its construction.

CONSTRUCTION

DIVERSION DAM AND FEED CANAL

The diversion dam at the head of the feed canal is a low concrete weir on crib work 400 feet long. The closure of the river channel is completed by an earth embankment, with rock-fill protection, 8 feet high above the crest of the weir. The headworks structure of the feed canal is located at the east abutment of the weir. This structure is built of reenforced concrete and contains eight gate openings 6 feet 3 inches wide by 1 foot 9 inches high. The bottom of the canal intake is 654, the crest of the weir is 656, and the high-water level of the river is 659 feet above sea level. The feed canal is designed for a capacity of 300 second-feet and extends from the diversion dam a distance of about 25 miles to Cold Springs reservoir. For about 16 miles the canal is located close to the main line of the Oregon Railroad and Navigation Company, which parallels the course of

Umatilla River. An enlarged riprap section is provided for a quarter of a mile from the intake, and a regulating weir and sand gates at the lower end of this section provide for the deposit and sluicing into the rivers of a large proportion of the sand that enters the canal.

Proposals under specifications No. 92 for the construction of the canal and about 1,300 feet of the by-pass canal, together with appurtenant structures, including the diversion dam, headworks, sand gates, regulating weir, railroad crossing, ditch crossings, bridge piers, and by-pass weir, were opened on June 29, 1906. A contract for the work was executed and work was begun on September 1, 1906, and the construction was completed on August 6, 1907. In addition to the work by contract some work on the structures was done by force account, and because of excessive seepage, 5,800 linear feet of full concrete lining and 3,700 linear feet of side lining were placed in the canal by force account during the seasons of 1908 and 1909.

COLD SPRINGS DAM

Cold Springs dam, located about 6 miles from Hermiston, is an earth and gravel embankment having an extreme length of over 3,800 feet and a maximum height of 98 feet. The maximum depth of water in the reservoir formed by the dam is 88 feet and the spillway crest is at an elevation 61½ feet above the bottom of the outlet conduit. The material used in constructing the dam is loam and coarse sand and gravel mixed in the proportion of about one-third loam to two-thirds sand and gravel. The outlet works consist of a concrete gate tower, two sets of 4-foot by 4-foot gates, an outlet tunnel through the dam about 330 feet in length, an open conduit about 150 feet in length, a bridge from the crest of the dam to the gate tower, a measuring weir, and a spillway.

Plans for the dam were prepared during the winter of 1905–6, and proposals for construction under specifications No. 90 were opened on June 28, 1906. All bids were rejected and the work was readvertised. The bids received under the readvertisement were also considered excessive and were rejected, and the construction of the dam by force account was authorized. Work was begun late in the fall of 1906 and the building of the embankment was commenced on May 11, 1907, and was completed in June, 1908. The sand and gravel for the dam was obtained about half a mile below the dam site. The material was loaded into cars with a Marion steam shovel, hauled to the dam by locomotives, dumped from a trestle built over the dam site, and spread in place with teams and scrapers. The loam was brought to the dam site from near-by locations in dump carts. The materials for the embankment were mixed by harrows and cultivators and thoroughly sprinkled and compacted by rollers and by tamping.

DISTRIBUTION SYSTEM

Water is distributed to the irrigable lands on the Umatilla project by means of two canal systems. The system, the construction of which was undertaken first by the Reclamation Service, consists of a main canal heading at Cold Springs reservoir and also connected to the feed canal by a by-pass, together with the necessary laterals and conduits. The second canal system diverts water from Umatilla River near the mouth of Butter Creek, reaches the irrigable land in a distance of 2½ miles, and in an additional distance of 8 miles completely merges with the reservoir canal system. The canal diverting from the Umatilla River was formerly owned by the Maxwell Land and Irrigation Company and was acquired by the United States through purchase. On account of the topography of the irrigable lands a large number of pressure pipes are used for the distribution of water. These pipes, comprising 21,000 linear feet of 46-inch pipe, 18,000 linear feet of 30-inch pipe, 7,000 linear feet of 16-inch pipe, and over 11,000 linear feet of 12-inch pipe, are built of cement mortar and of reenforced concrete and are operated under heads up to a maximum of 110 feet.

Proposals under specifications No. 114 for the excavation of two schedules of the distribution system, involving the removal of about 245,000 cubic yards of material, were opened on October 1, 1906. A contract for the work under the first schedule, including the excavation of about 130,000 cubic yards of material, was executed in October, 1906. The bids for the second schedule were rejected, the work was subdivided into six sections and readvertised, the proposals being opened on November 30, 1906. The work on the six sections was undertaken under three contracts. The two schedules, involving about 34 miles of canals, were completed in June, 1908. Extension of the lateral system, involving the excavation of about 70,000 cubic yards of material, was contracted for in November, 1907. During the winter of 1908–9, 10 miles of canals and laterals for the distribution of water on the second unit were built by force account. This work involved the excavation of about 60,000 cubic yards of material. During the winter of 1909–10, 7 miles of canals and laterals, involving the excavation of about 30,000 cubic yards of material, were constructed by force account. The concrete pipe was built by force account.

SETTLEMENT AND IRRIGATION

A considerable part of the lands included in the Umatilla project were settled prior to the beginning of the project by the Reclamation Service. Agreements for the subdivision of excess holdings were secured, and much of the land has been disposed of to new settlers. The sale of the lands of the Maxwell Land and Irrigation Company has progressed rapidly during 1910, and it is expected that the holdings of this company within the first two units of the project will soon be sold. Satisfactory progress is being made in the settlement of the project, and the lands are being improved.

By public notice dated December 27, 1907, the Secretary of the Interior announced that water would be available in the spring of 1908 for the first unit of the project, consisting of 6,975 acres. A public notice dated November 12, 1908, opened for irrigation the second unit of the project, consisting of 4,392 acres, and a public notice dated January 6, 1910, announced that water would be available in the spring of 1910 for the third unit of the project, 3,952 acres. The priming of the feed canal was begun in August, 1907, the first water entered the distribution system in December, 1907, and water was first delivered to the reservoir in February, 1908. The feed canal was operated until June 26, 1908, 25,000 acre-feet of water being diverted to the canal and 19,700 acre-feet reaching the reservoir, 600 acre-feet being discharged directly into the distribution system. Delivery of water through the feed canal was resumed November 1, 1908, and was continued until June 6, 1909, a total of 49,000 acre-feet being diverted from the river, 40,000 acre-feet reaching the reservoir, and 1,000 acre-feet passing directly to the distribution system. During the winter of 1909–10, 68,000 acre-feet of water were diverted into the feed canal, 57,500 acre-feet reaching the reservoir. An additional 4,000 acre-feet entered the reservoir from flood run-off and rainfall, and on June 30, 1910, the available storage was 30,900 acre-feet.

The operation of the distribution system was begun in March, 1908, and water service was maintained over the greater part of the first unit during that year, 13,000 acre-feet of water being distributed prior to the discontinuance of service on September 17, 1908. Water was available during the season for 6,823 acres and was delivered to about 2,500 acres of land. In the season of 1909 the delivery of water was begun in March and discontinued on October 15. The Maxwell ditch was cleaned and 2,000 acre-feet of water diverted through it from Umatilla River. During the season 37,000 acre-feet of water were delivered to the distribution system, the area for which water was available being 11,215 acres of land, and the area to which water was delivered being about 5,000 acres. The distribution of water for the season of 1910 was begun in March, water being available for 15,319 acres of land. Water-right applications for 9,000 acres of land have been received, and water has been delivered during the season to about 6,400 acres.

PROGRESS DURING FISCAL YEAR 1910

The lining of the feed canal was continued during 1909. From November 1, 1909, to June 5, 1910, the feed canal was operated for the filling of Cold Springs reservoir, a maximum flow of 300 second-feet having been attained. A total of 68,000 acre-feet was diverted from Umatilla River during this period, 57,500 acre-feet reaching the reservoir and 1,800 acre-feet being discharged into the distribution system through the by-pass canal. A maximum storage in Cold Springs reservoir of 42,000 acre-feet was attained in the spring of 1910. The water surface was then within 5 feet of the spillway crest and the maximum depth of water in the reservoir was 88 feet. The construction of drains in the flat below Cold Springs dam during the fall of 1909 has prevented the appearance of seepage water on the flat this year.

During the winter of 1909–10 laterals involving the excavation of 30,000 cubic yards of material were built. A reenforced concrete pipe line, 46 inches in inside diameter, 9,800 feet long, and acting under a maximum head of 110 feet, was constructed. Two pipe lines of reenforced concrete, 30 inches in inside diameter, one having a length of 5,300 feet and acting under a maximum head of 45 feet, and the other having a length of 1,600 feet and acting under a maximum head of 18 feet, were also constructed. The construction of a drainage ditch 1½ miles long, discharging into Umatilla River and involving more than 40,000 cubic yards of excavation, was undertaken for the draining of a depression near Hermiston. The drainage ditch is 90 per cent completed and over 20 second-feet of water is being discharged through it.

Water service has been maintained throughout the irrigation seasons, and routine operation and maintenance work has been in progress. The final payment for the Maxwell canal system, contract for purchase of which was entered into in October, 1905, was made in the spring of 1910. Repairs have been made to the diversion works, and parts of the main canal have been cleaned. Water service in this canal system has been maintained since the latter part of May. On June 30, 1910, water-right applications had been received for the irrigation of about 9,500 acres of land, and water had been delivered to 6,400 acres of land, about 3,200 acres of which were under actual cultivation. The areas planted to the principal crops on the irrigated lands in 1910 are as follows: Grains, 325 acres; alfalfa and clover, 1,186 acres; fruit, 622 acres.

PUBLIC NOTICE DATED JANUARY 6, 1910

1. Pursuant to the provisions of section 4 of the reclamation act of June 17, 1902 (32 Stat., 388), notice is hereby given as follows:

2. Water will be furnished from the Umatilla project, Oregon, under the provisions of the reclamation act, in the irrigation season of 1910, for the irrigable areas shown on farm unit plats of Tps. 4 and 5 N., R. 28 E., Willamette meridian, approved by the Secretary of the Interior December 17, 1909, and on file in the local land office at La Grande, Oreg.

3. Homestead entries, accompanied by applications for water rights and the first installment of the charges for building, operation, and maintenance, may be made on and after February 10, 1910, beginning at 9 o'clock a. m., under the provisions of said act, for the farm units shown on said plats. Water-right applications may also be made for lands heretofore entered and for lands in private ownership, and the time when payments will be due therefor is hereinafter stated.

4. Warning and notice are hereby expressly given that no person will be permitted to gain or exercise any right whatever under any settlement or occupation begun, or under any filing or entry made or attempted to be made in pursuance of the provisions of the reclamation act or otherwise, prior to February 10, 1910, on any land shown on said plats and heretofore subject to withdrawal under the first form, and all such settlement or occupation, filing or entry is hereby forbidden.

5. The limit of area per entry, representing the acreage which in the opinion of the Secretary of the Interior may be reasonably required for the support of a family on the lands entered subject to the provisions of the reclamation act, is fixed at the amounts shown upon the plats for the several farm units.

6. The limit of area for which water-right application may be made for lands in private ownership shall be 160 acres of irrigable land for each landowner.

7. The charges which shall be made per acre of irrigable land in the said entries and for lands heretofore entered or in private ownership, which can be irrigated by the waters from the said irrigation project, are in two parts, as follows:

(*a*) The building of the irrigation system, $60 per acre of irrigable land, payable in not more than ten annual installments, each payment not less than $6 or some multiple thereof per acre, except that in the case of lands hereafter entered the first installment of the building charge shall be $18 per acre and subsequent installments $6 per acre. Full payment may be made at any time of any balance of the building charge remaining due, after certification by the Commissioner of the General Land Office that full and satisfactory compliance has been shown with all the requirements of the law as to residence, cultivation, and reclamation.

(*b*) For operation and maintenance for the irrigation season of 1910, and annually thereafter until further notice, $1.30 per acre of irrigable land, whether water is used thereon or not. As soon as the data are available the operation and maintenance charge will be fixed in proportion to the amount of water used with a minimum charge per acre of irrigable land whether water is used thereon or not.

8. All entries made hereafter for any of the lands described, whether for lands not heretofore entered, or for lands covered by prior entries which have been canceled by relinquishment or otherwise, shall be accompanied by applications for water rights in due form and by the first installment of the charges for building, operation, and maintenance, not less than $19.30 per acre of irrigable land. The second installment of the building charge, not less than $6 per acre, and the appropriate charge for operation and maintenance, shall become due on December 1 of the following year. Subsequent

installments of the building charge shall become due on December 1 of each year thereafter until fully paid.

9. For lands in private ownership and for lands heretofore entered, the first installment of the charges for building, operation, and maintenance, not less than $7.30 per acre of irrigable land, shall become due on December 1, 1910. The second installment shall be due on December 1, 1911. Subsequent installments shall become due on December 1 of each year thereafter.

10. The first installment of the charges for all irrigable areas shown on these plats, whether or not water-right application is made therefor or water is used thereon, shall be due and payable as herein provided.

11. The public notices of December 27, 1907, and November 12, 1908, contain provisions to the effect that for all applications for water rights filed after June 15 in any year one installment of the charges for building, operation, and maintenance must be paid at the time of filing, but the portion for operation and maintenance shall be credited on account of the installment of said charges for the subsequent year. Such provision occurring in any public notice heretofore issued for the Umatilla project is hereby revoked.

12. The regulation is hereby established that no water will be furnished in any year until the portions for operation and maintenance of all installments then due shall have been paid. Accordingly, no water will be furnished for the irrigation season of 1911 for any lands unless the portion for operation and maintenance of the installment due on or before December 1, 1910, has been paid, and in like manner no water will be furnished in any subsequent irrigation season unless payment has been made of the portions of the installments for operation and maintenance then due and unpaid.

13. The public notices issued November 12, 1908, for the Umatilla project contain provisions to the effect that no water will be furnished in any year unless the portion of the annual installment for operation and maintenance then due shall have been paid on or before April 1. Such provisions are hereby amended to read as follows:

"The regulation is hereby established that no water will be furnished in any year until all operation and maintenance charges then due shall have been paid."

14. Failure to pay any two installments of the charges when due, whether on entires made subject to the reclamation act or on water-right applications for other lands, shall render such entries and the corresponding water-right applications, or the water-right applications for other lands, subject to cancellation, with the forfeiture of all rights under the reclamation act as well as of any moneys already paid.

15. All charges must be paid at the local land office at La Grande, Oreg.

16. The charges may, for the convenience of applicants, be paid to the special fiscal agent of the United States Reclamation Service assigned to the Umatilla project for transmission to the register and receiver of the local land office on or before the date specified for payment at the local land office, but in case this privilege is availed of, the necessary charges for transportation of the cash, as determined by the special fiscal agent, must accompany the payment of the water-right charges.

PUBLIC NOTICE DATED JANUARY 6, 1910

1. Pursuant to the provisions of section 4 of the reclamation act of June 17, 1902 (32 Stat., 388), public notice was given on December 27, 1907, of the furnishing of water from the Umatilla project, Oregon, for lands in T. 4 N., R. 28 E., W. M., with other lands, and setting forth the conditions and charges therefor.

2. In said notice it was provided that homestead entries accompanied by applications for water rights might be made under the provisions of reclamation act for the farm units shown upon the farm unit plats for the above described townships, approved December 23, 1907, by the Secretary of the Interior, and on file in the local land office at La Grande, Oreg.

3. For certain farm units in sections 2 and 3 of said township, as hereinafter listed, homestead entries accompanied by applications for water rights for the total irrigable areas thereof have been filed and accepted in the local land office.

4. During the irrigation seasons of 1908 and 1909 only portions of the irrigable areas within the said farm units could be irrigated from the project system as then constructed, the acreage within such farm units thus capable of irrigation and upon which the first installment of the charges for building, operation, and maintenance became due on December 1, 1908, being as follows: T. 4 N., R. 28 E., W. M.; NE. ¼ sec. 3, farm unit F, 3 acres; NW. ¼ sec. 2, farm unit D, 1 acre; NW. ¼ sec. 2, farm unit C, 4 acres; NW. ¼ sec. 2, farm unit G, 10 acres; NW. ¼ sec. 2, farm unit H, 6 acres; NE. ¼ sec. 2, farm unit E, 2 acres; NE. ¼ sec. 2, farm unit F, 1 acre; NE. ¼ sec. 2, farm unit G, 2 acres; NE. ¼ sec. 2, farm unit H, 4 acres.

5. Notice is hereby given that the farm unit plats have been amended to show the total irrigable acreages of these farm units, that water will be furnished under the pro-

visions of the reclamation act in the irrigation season of 1910 for the remaining portions of irrigable lands therein, and that said remaining portions shall be subject to all the terms and conditions of the public notice of December 27, 1907, and public notices and orders amendatory thereof or supplementary thereto, except that the first installment of the charges for building, operation, and maintenance for said remaining portions of irrigable lands shall become due December 1, 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Umatilla project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$84,588.98	
Uncollected water-right operation and maintenance charges		10,745.03	
			$95,334.01
Inventories:			
Equipment in use		34,220.37	
Storehouse		136.50	
Cement		1,432.15	
Iron and steel		268.22	
Lumber		1,110.36	
Forage		637.30	
Fuel		505.92	
Unadjusted transfers		11,254.48	
			49,565.30
Cost of work:			
Building cost	$1,127,046.30		
Plus adjustments	171.86		
		1,127,218.16	
Less accrued revenues		1,196.82	
			1,126,021.34
Operation and maintenance cost		61,624.91	
Less accrued revenues		1,852.10	
			59,772.81
Total assets			1,330,693.46

LIABILITIES

Investment of the United States:			
Disbursement vouchers	1,259,802.38		
Transfer vouchers received	28,890.80		
		1,288,693.18	
Collection vouchers	100,845.44		
Transfer vouchers issued	31,864.52		
		132,709.96	
			1,155,983.22
Accounts payable:			
Unpaid labor		5,145.41	
Unpaid purchases		1,722.94	
Unpaid freight and express		4,804.59	
Unpaid passenger fares		219.50	
Unredeemed coupon books		7.75	
			11,900.19
Repayments accrued:			
Building		138,480.42	
Operation and maintenance		24,329.63	
			162,810.05
Total liabilities			1,330,693.46

Feature costs to June 30, 1910, Umatilla project

Storage works, Cold Springs dam:		
Storage dam	$362,962.37	
Government buildings	12,772.15	
Inlet works	12,705.97	
Main spillway	32,580.21	
Feed canal, excavation, class 1	2,426.58	
Outlet works	6,764.79	
		$430,212.07
Storage feed canal:		
Diversion works and canal	242,020.09	
Repairing and priming	12,370.84	
Wasteways	7,221.59	
Bridges and crossings	1,283.06	
Concrete lining and cut-off wall	26,770.43	
Government buildings	2,864.40	
		292,530.41

Distribution system:		
Canals and laterals	$71,626.43	
By-pass drops, turn-outs, and miscellaneous structures.	32,136.44	
Pipe lines	170,286.33	
Crossings and bridges	4,867.40	
Priming canals	3,381.84	
Subdivision of lands	1,074.74	
Reconstruction and repairs—old Maxwell system	1,479.06	
Distribution system—drainage	11,242.46	
		$296,094.70
Demonstration farm—barns, other buildings, and fences		3,421.47
Real estate (rights and property)—lands purchased		40,680.00
Buildings at Hermiston		7,150.46
Examination of project as a whole:		
Surveys	20,552.00	
Design	4,404.00	
		24,956.00
West Branch canal		25,729.32
Inventory of unused supplies		6,271.87
Total building cost		1,127,046.30
Operation and maintenance:		
Feed canal and reservoir protection	22,566.30	
Distributing laterals	30,969.53	
Pipe-line protection	497.93	
General expense	7,591.15	
		61,624.91
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		1,188,671.21

OREGON-CALIFORNIA, KLAMATH PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Klamath, Oreg.; Siskiyou and Modoc, Cal.

Townships: 38 to 41 S., Rs. 8 to 14 E., Willamette meridian; 46 to 48 N., Rs. 1 to 8 E., Mount Diablo meridian.

Railroad: California Northeastern.

Railroad stations: Klamath Falls, Midland, and Ady, Oreg.

Average elevation of irrigable area: 4,100 feet above sea level.

Average annual rainfall on irrigable area: 15 inches.

Range of temperature on irrigable area: —5° F. to 100° F.

WATER SUPPLY

Source of water supply: Upper Klamath Lake and Clear Lake.

Area of drainage basin: 3,700 square miles.

Annual run-off in acre-feet, 1904 to 1908: Link River at Klamath Falls—maximum, 2,150,000; minimum, 1,450,000; mean, 1,840,000. Lost River at Clear Lake—maximum, 251,000; minimum, 34,800; mean, 122,000. Lost River at Merrill—maximum, 475,000; minimum, 151,000; mean, 284,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Upper Klamath Lake—area, 60,000 acres; capacity, 200,000 acre-feet. Clear Lake—area, 25,000 acres; capacity, 462,000 acre-feet; length of spillway, 357 feet; elevation of spillway, 24 feet above stream bed.

Storage dam: Clear Lake—type, rock fill; maximum height, 33 feet; length of crest, 790 feet; volume, earth, 23,100 cubic yards; rock, 33,500 cubic yards.

Length of canals now constructed: 10 miles, with capacities greater than 300 second-feet; 34 miles, with capacities from 300 to 50 second-feet; 99 miles, with capacities less than 50 second-feet.

Length of tunnel: 3,300 feet.

Aggregate length of dikes: 2,800 feet, exclusive of marsh reclamation.

Power development: Not determined.

AGRICULTURAL CONDITIONS

Irrigable area: Lower division, 127,000 acres.

Present status of irrigable land (lower division): 44 acres entered subject to the reclamation act, 23 acres open to entry, 42,000 acres withdrawn from entry, 85,000 acres in private ownership.

Area for which the service is prepared to supply water, season of 1910: 30,400 acres.

Area irrigated, season of 1910: 26,000 acres.

Length of irrigating season: 150 days.

Character of soil of irrigable area: Decomposed basalt and rich alluvial deposits.

Principal products: Alfalfa, hay, grain, and vegetables.

Principal markets: Portland, Oreg.; Sacramento and San Francisco, Cal.

LANDS OPENED FOR IRRIGATION

Dates of public notices: November 18, 1908, and December 7, 1908, August 24, 1909, June 9, 1910.

Location of lands opened: Tps. 38 S., R. 9 E.; 39 S., Rs. 8 to 10 E.; 40 S., Rs. 9 to 11 E.; 41 S., Rs. 10 to 12 E., Willamette meridian; and 48 N., R. 5 E., Mount Diablo meridian.

Present status of irrigable lands opened: 44 acres entered subject to the reclamation act, 23 acres open to entry, 30,841 acres in private ownership.

Limit of area of farm units: 160 acres.

Duty of water: 1.8 acre-feet per acre per annum at the farm.

Building charge per acre of irrigable area: $30.

Annual operation and maintenance charge: $0.75 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance made in October, 1903.
Preliminary surveys begun in 1904.
Board report May 1, 1905.
Construction authorized by secretary May 15, 1905.
Canal system of Klamath Falls Irrigating Company purchased July 28, 1906.
Adams canal purchased October 15, 1906.
East branch canal completed to Olene July, 1907.
Main canal completed August, 1907.
First irrigation by Reclamation Service, season of 1907.
Keno canal completed October, 1908.
South branch canal completed March, 1909.
Clear Lake dam completed January, 1910.
Whole project 41 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the lower division of the Klamath project provides for the diversion of water from the east side of Link River, at the lower end of Upper Klamath Lake for the irrigation of lands in the lower part of Lost River Valley, in Klamath Valley, and in the bed of Tule Lake; the diversion of water from Lost River to the Klamath River to reclaim the bed of Tule Lake; the diversion of water from Lower Klamath Lake and adjacent lands by means of dikes and pumping; the diversion of water at the west side of Link River for power purposes for the irrigation and drainage of lands in the Lower Klamath marshes or at other points as may be found desirable. The plan of the upper division of the project provides for storage of water in Clear Lake reservoir to regulate the flow in Lost River and facilitate the diversion of this flow into the Klamath River and the possible diversion of water from Clear Lake reservoir at its southwest extremity for the irrigation of lands in Modoc County, California; also the possible storage of water in Horsefly reservoir to irrigate lands in Langell and Yonna valleys and the construction of the necessary supply and distribution works for that purpose.

ORIGIN OF PROJECT AND INVESTIGATIONS

At the time investigations in the Klamath Valley were begun by the Reclamation Service two private irrigation systems were in existence in the valley. The first of these, owned by the Klamath Falls Irrigating Company, diverted water from Link River just below the lower end of Upper Klamath Lake for the irrigation of about 4,000 acres in the upper portion of the Klamath Valley, immediately below the town of Klamath Falls. The second system, owned by the Little Klamath Water Ditch Campany, and commonly known as the Adams canal system, diverted water from Lower Klamath Lake for the irrigation of about 4,000 acres of land situated along the northwestern and northern sides of Tule Lake.

The first examination of the Klamath project by the Reclamation Service was made during October, 1903, and included the investigation of the lands about Klamath Falls and the Lower Klamath Lake and a reconnaissance of the country about Tule Lake, Clear Lake, and the upper Lost River Valley. At that time it appeared that the most feasible project was to use Clear Lake as a reservoir and make use of the waters stored therein for the irrigation of the lands in the Lost River Valley. The building of a dam from 20 to 30 feet high at the head of Link River, thus converting the Upper Klamath Lake into a storage reservoir for holding back a part or all of the flow of the Klamath River for use in power and irrigation, and the drainage of Lower Klamath Lake and its adjacent marsh lands by means of a cut at Keno were also suggested. In May, 1904, detailed investigations and surveys were begun on the Klamath project. During that year topographic surveys were made of the Clear Lake and Horsefly reservoir sites and of lands along Klamath River near Keno. Surveys were made over various portions of the project to determine preliminary location of canals and the amount of land available for irrigation. During the winter of 1904–5 tentative plans for a complete system of canals were prepared and estimates made of the probable irrigable acreage and cost of construction. The plan of the project as thus outlined was to construct a canal on either side of the Klamath River for the diversion of water from Upper Klamath Lake to the lands of the Klamath Valley, including a portion of the beds of the Lower Klamath and Tule lakes; to construct a channel from Lost River to the Klamath River for diverting the waters of Lost River away from Tule Lake and aid in its reclamation; to lower the Klamath River by means of a cut at Keno, so as to uncover and reclaim the greater part of the Klamath Lake marshes; and to construct dams at Clear Lake and Horsefly reservoir sites for impounding water for irrigation in Langell and Yonna valleys.

The plans for the project were considered by a board of engineers consisting of Messrs. G. Y. Wisner, W. H. Sanders, J. P. Lippincott, O. H. Ensign, Joseph Jacobs, and T. H. Humphreys. This board, in a report dated May 1, 1905, gave favorable consideration to the project and recommended its construction. The project was authorized by the Secretary of the Interior on May 15, 1905, and $1,000,000 allotted for the beginning of construction. During the year 1905 surveys on the project were continued and final plans and specifications for the construction of the first 9 miles of the main canal were prepared.

In order to aid in the development of the project, the legislatures of Oregon and California granted to the United States lands in the beds of the lakes within their respective borders to be uncovered by the operations of the Reclamation Service, and Congress, by an act approved February 9, 1905 (33 Stat., 314), authorized the raising or lowering of the waters of these lakes so as to permit of reclamation by drainage or irrigation.

The Klamath Water Users' Association was organized March 4, 1905, for the purpose of assisting in the development of the project and for obtaining the necessary stock subscription to the lands to be irrigated. On November 6, 1905, a contract was entered into between the Secretary of the Interior and the Klamath Water Users' Association providing for the return of the cost of construction by the landowners under the project.

During 1905 agreements were entered into for the purchase of the irrigation works of the Klamath Falls Irrigating Company and the Little Klamath Water Ditch Company, the rights of the Klamath Canal Company, and the right of way for the Clear Lake reservoir site, and for the acquisition of various other rights of way and water rights existing on the project.

CONSTRUCTION

MAIN CANAL

The main canal heads on the east bank of Link River near the lower end of upper Klamath Lake and extends in a southeast direction about 9 miles to the junction of the east branch and south branch canals. The canal was designed for a capacity of 1,500 second-feet at its head. The earthen portion of the canal is from 40 to 44 feet wide on the bottom and 13 feet deep, with side slopes of 1½ to 1. The upper portion consists of a dredged intake channel from the river to the head gates, with paved slopes immediately above the head gates. From the headworks to the tunnel, a distance of 2,675 feet, the canal is in deep cut, the maximum cut at the upper portal of the tunnel being about 40 feet. The section of this part of the canal is 13½ feet wide on the bottom, with side slopes of ½ to 1, the bottom and sides to a height of 12 feet being lined with concrete 6 inches thick. The tunnel is approximately 3,300 feet long and has a section 13½ feet wide and 14.4 feet high, with an arched roof of approximately 8.5 feet radius. The tunnel is lined throughout with concrete of a minimum thickness of 8 inches. The lower portal cut has a bottom width of 13½ feet and side slopes of ½ to 1 and is concrete lined. A few hundred feet below the tunnel the canal is gradually enlarged to the dimensions of the full earthen section, which is 44 feet wide on the bottom and 13 feet deep, with side slopes of 1½ to 1.

The principal structures on the main canal consist of the main headworks, two reenforced concrete culverts for carrying drainage water under the canal, two paved channels for the diversion of drainage into the canal, five Howe truss combination highway bridges, and the necessary turn-outs for the diversion of water to the distribution system. The main headworks are built of concrete, with six 5 by 11 foot openings, which are closed by structural steel gates. The turn-outs are of concrete. Near its lower end the canal is carried across a depression by means of an earthen fill. In order to give greater stability to the banks the canal in this section is constructed with side slopes of 2 to 1, and the material in the banks was compacted by sprinkling and rolling. About 50,000 cubic yards of material were used in this fill. Plans for the main canal were prepared in 1905, and proposals, under specifications No. 66, were opened December 29, 1905. Two contracts were awarded—one for canal construction and one for highway bridges.

The contract for the main canal included all excavation, the driving and lining of the tunnel, and the placing of all concrete structures. Work on this contract was begun in March, 1906, and completed in July, 1907. The excavation of the canal below the tunnel was done principally by means of teams and scrapers. The portal cuts and that portion of the canal between the tunnel and headworks were taken out principally by means of steam hoists and an orange peel dredge. The work was carried on continuously throughout the winter of 1906–7 under unfavorable weather conditions. The tunnel was excavated from both portals and from three shafts which were, respectively, 68, 104, and 103 feet deep. Timbering in the tunnel was required for a total distance of 2,200 feet. The timbering consisted of bents of 8 by 8-inch red fir posts and roof sections spaced 4 and 5 feet on centers. The work under the contract for bridges was carried on during 1906 and the early part of 1907, the bridges being completed in the spring of 1907.

EAST BRANCH CANAL

The east branch canal at its upper end is 16 feet wide on the bottom and 8 feet deep, with side slopes of 1½ to 1. It was designed for a capacity of 260 second-feet. Proposals for the construction of the east branch canal from the end of the main canal to a few miles from Merrill, Oreg., under specifications No. 96, were invited to be opened on June 21, 1906. No proposals were received, however, and in September, 1906, authority having been obtained, the work was begun by force account. During the latter part of 1906 and the first part of 1907 work on this canal was carried on by force account and excavations completed from the end of the main canal to Olene, a distance of about 4½ miles.

KENO CANAL

The Keno canal heads on the west side of Link River, a short distance below the intake for the main canal, and was designed for a capacity of 635 second-feet, 400 second-feet of which was to be used by the Government for power development and 205 second-feet to be furnished Moore Brothers for power purposes in satisfaction of preexisting water rights and for rights of way; the remainder was intended to be used for irrigation of lands on the west side of the Klamath River below Klamath Falls. The canal has a bottom width of from 15 to 21 feet and a depth of 11 feet, with side slopes ranging from ½ to 1 to 1½ to 1, depending upon the nature of the material. The length of the canal from the head gates to the power-station site is about 6,000 feet. The intake of the canal is excavated in the rock bed of Link River and is protected by means of a rock and concrete overflow weir above the headworks. The principal structures on the canal consist of the main headworks, two power turn-outs, and a spillway of 600 second-feet capacity for a head of 1 foot on the spillway crest. All structures are of concrete. On account of the unfavorable character of material through which the canal is constructed, that portion of it adjacent to the structures is concrete lined, to prevent seepage.

Proposals for the construction of this canal under specifications No. 132 were invited to be opened on April 15, 1907. But one proposal was received, which was considered excessive and was rejected and authority was obtained for doing the work by force account. Construction of the canal was begun in June, 1907, and completed in October, 1908.

SOUTH BRANCH CANAL

The south branch canal extends from the end of the main canal southerly for a distance of about 13.2 miles to a point near Merrill, where it connects with the old Adams canal at the flume crossing Lost River. The capacity of the south branch canal ranges from 300 second-feet at the upper end to 205 second-feet at its lower end, and the bottom width varies from 16 feet at its upper end to 11.5 feet at its lower end.

The main features of this canal, in addition to the ordinary earth sections, are a foundation for a power house at the junction of the main canal, 4,300 feet of wooden flume, and 7,200 feet of high earthen fill with wood lining. At the junction with the main canal there is a drop of about 20 feet, which it is proposed to use for the generation of power. At this point a reenforced concrete structure intended both as a drop and foundation for a power house was constructed. The wooden flume is 11 feet wide and 5½ feet high and is carried on a wooden trestle with a maximum height of about 20 feet and an average height of about 10 feet. The foundation for the trestle consists of rock and concrete piers.

Proposals for construction of the south branch canal, under specifications No. 150, were opened April 1, 1908. The earthwork and wooden flume were constructed under three separate contracts, the work being done during 1908 and the first part of 1909. The foundations for the flume and the wooden lining of the earthen portion of the canal over the high fill were constructed by force account.

DISTRIBUTION SYSTEM

The distribution system under the main, east branch, and south branch canals, known as the first unit of the project, was constructed by force account and under informal contracts. The greater part of the work under the main and east branch canals was constructed during 1906 and was used for irrigation during 1907. The distribution system under the south branch canal was constructed during the season of 1908 and the first part of 1909.

CLEAR LAKE DAM AND DIKES

Clear Lake dam is constructed across Lost River a short distance below where the stream leaves the marshes which border Clear Lake. It is located in California about 55 miles southeast from Klamath Falls, Oreg., the nearest railroad station. The dam is an earth and rock-fill structure with a maximum height of 33 feet above stream bed and a crest length of 790 feet. The elevation of the top of the dam is 4,549 feet above sea level. The spillway has a crest length of 357 feet and is at elevation 4,540 feet above sea level. The dam is 20 feet wide on top and has a downstream slope of 1½ to 1 and an upstream slope of 3 to 1. The rock portion of the dam is 15 feet wide on top and has an upstream slope of 1 to 1. The spillway channel is excavated around the north end of the dam. The material taken from the spillway channel consisted of broken lava rock and was used in forming the rock portion of the dam. The material for the earth fill was taken from the slopes on the opposite side of the stream from the spillway. Under the earthen part of the dam the foundation was prepared by removing all vegetable matter to a depth of about 2 feet and cleaning out all holes which contained soft material. A cut-off trench near the lower toe of the earth embankment was excavated to rock and refilled with selected material, which was carefully compacted. At the lower toe of the rock fill a trench 5 feet wide on the bottom was excavated to rock and refilled with the largest rock obtainable. The earthen portion of the dam was compacted by means of spreading it in thin layers and wetting and rolling. The upstream face is protected by a layer of rock pitching. The outlet works consist of a reenforced concrete gate tower and a concrete outlet conduit 7 feet wide by 7½ feet high and 156 feet long. Water is admitted to this outlet through two openings, each 4 feet wide by 5 feet 3 inches high, which are controlled by outlet gates. The outlet conduit is located near one end of the dam and was constructed in an open cut excavated to grade and afterwards refilled.

The Clear Lake dikes are constructed across a low saddle at the southwest extremity of the lake. The larger of these dikes has a maximum height of about 13 feet and a length of 1,600 feet; the smaller has a maximum height of about 7 feet and a length of 1,650 feet. These dikes are earth and rock-fill dams, 14 feet wide on top with a downstream slope of 1½ to 1 and an upstream slope of 3 to 1, the upstream slope being protected by a layer of rock pitching.

Proposals for the construction of the Clear Lake dam and dikes, under specifications No. 151, were invited to be opened April 15, 1908. Two proposals were received for the work, both of which were considered excessive and were rejected. On August 15, 1908, authority for the doing of this work by force account was granted. Work was begun on the excavation of the channel for the outlet conduit for Clear Lake dam in the fall of 1908 and carried on as late as weather conditions would permit. Work was resumed in May, 1909, and the dam was practically completed before operations were suspended for the following winter. Final completion of the work was accomplished in the spring of 1910. Work was commenced on the Clear Lake dikes on October 6, 1909, and completed December 20 of that year.

RELEASE OF LANDS FROM STOCK SUBSCRIPTION

During the year 1910 the lands in Langell and Yonna valleys, known as the upper project, the lands under the Keno canal extension, and the upland pumping areas have been released from the obligations of the stock subscription contract. These releases were effected by reason of the fact that detailed surveys and estimates have shown that the cost of construction would be very much more than was originally estimated, which made it impracticable to consider construction at the present time.

IRRIGATION AND SETTLEMENT

Irrigation by the Reclamation Service was begun in the spring of 1907, and water was served to about 9,000 acres of land during the seasons of 1907 and 1908, under rental contracts and to satisfy prior water rights. Public notices were issued November 8, 1908, and December 7, 1908, and during the irrigation season of 1909 about 21,000 acres of land were irrigated under the provisions of the public notices and to satisfy prior rights. During the season of 1910 about 26,000 acres are being irrigated. Clear Lake dam was completed in the spring of 1910, and on June 30, 1910, there was stored in the reservoir about 150,000 acre-feet of water less such amount as may have been lost by seepage and evaporation.

Settlement of the project since the Reclamation Service began operations has been progressing steadily and the large holdings on the project are being gradually subdivided. The railroad from the main line of the Southern Pacific at Weed, Cal., was completed to Klamath Falls early in 1909, and is now being extended northward, and it is expected that eventually direct connections with Portland will be established.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year the construction of Clear Lake dam and dikes was completed, the construction and deepening of drains on the first unit of the project were carried on, the opening of outlets at the south end of Tule Lake was continued, surveys in Langell Valley and topographic surveys of Lower Klamath Lake marshes and of the shore line of the lake were made, and preliminary reconnaissance canal lines were run south from Clear Lake to determine roughly the amount of land irrigable in that direction. The operation of canals and the delivery of water for irrigation were carried on without unusual incident and assistance was given to the Department of Agriculture in the operation of a marsh experiment farm. A ditch 1,600 feet long and a flume 1,000 feet long were constructed to supply fresh lake water to the lands that had been drained. Owing to lack of irrigating water during the season of 1909, little information of value was obtained from the operation of the farm during that season, but during the season of 1910, it is hoped to secure valuable data for consideration in connection with possible future operations of the service in the Lower Klamath Lake marshes.

PUBLIC NOTICE DATED AUGUST 24, 1909

In pursuance of the provisions of section 4 of the act of June 17, 1902 (32 Stat., 388), notice is hereby given that water will be furnished from the Klamath project, Oregon, under the provisions of the reclamation act, in the irrigation season of 1909 for the irrigable lands in the E. ½ NE. ¼ sec. 8 and NW. ¼ sec. 9, shown on farm unit plat of T. 40 S., R. 9 E., W. M., Oregon, approved November 16, 1908, as amended August 24, 1909, by the Secretary of the Interior and on file in the local land office at Lakeview, Oreg.

The manner of applying for water rights, the amount of the charges to be assessed, and the time when payments become due will be as set forth in the public notice dated November 18, 1908, and orders and notices supplementary thereto, or amendatory thereof, covering neighboring lands under the Klamath project.

PUBLIC NOTICE DATED JUNE 9, 1910

1. The public notice of November 18, 1908, announcing the irrigability of lands shown on the approved plats of the first unit of the Klamath project, Oregon-California, under the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), provides that for lands thereafter entered the first installment of the charges for building, operation, and maintenance shall be due at the time of entry, the second installment May 1, 1910, and subsequent installments on May 1 of following years; and that for lands in private ownership and for lands theretofore entered the first installment shall be due May 1, 1909, and subsequent installments annually on May 1 in following years.

2. The provisions of said notice are hereby affirmed. As to lands in private ownership or lands theretofore entered all installments of the charges for building, operation, and maintenance due on and after May 1, 1909, must be paid at the time of filing water-right application therefor. All entries made hereafter for any of the lands shown on the approved plats of the said project, whether for lands not heretofore entered or for lands covered by prior entries which have been canceled by relinquishment or otherwise, must be accompanied by applications for water rights in due form and by an amount

equal to the sum of all unpaid (or paid and unassigned) installments for building, operation, and maintenance which have become due for prior years, or which would have become due had the entry or water-right application been made immediately after the public notice issued November 18, 1908, became effective.

3. The first and all subsequent installments of the charges for building, operation, and maintenance for all irrigable areas shown on said plats shall accrue and be due and payable whether or not water-right application is made for said lands or whether or not homestead entries under the provisions of the reclamation act are made thereon. Furthermore, all water-right applications and homestead entries made subsequent to the times and dates when one or more installments of the charges for building, operation, and maintenance shall have accrued thereon, shall be subject to the payment of and be accompanied by all such prior installments as have thus accrued and remain due and unpaid.

4. The public notice of November 18, above referred to, is hereby amended by revoking the following provision, viz:

"For all applications for water rights filed after June 15, 1909, or any subsequent year, one installment of the charges for building, operation, and maintenance, $3.75 per acre, must be paid at the time of filing, but the portion of the installment for operation and maintenance shall be credited on account of the installment of said charges for the subsequent year."

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Klamath project

ASSETS

Accounts receivable:			
Uncollected water rentals		$2,146.50	
Uncollected miscellaneous		31.92	
Collections by General Land Office		20,662.50	
Uncollected water-right building charges		79,018.20	
Uncollected water-right operation and maintenance charges		1,042.50	
			$102,901.62
Inventories:			
Mercantile store		18.06	
Government animals		6,895.35	
Equipment in use	$26,009.35		
Less depreciation	1,802.00		
		24,207.35	
Storehouse		6,363.23	
Cement		516.47	
Lumber		1,017.81	
Explosives		933.07	
Forage		2,211.69	
Fuel		247.89	
Local products		99.82	
Unadjusted transfers		1,351.53	
Freight and handling undistributed		454.14	
			44,316.41
Cost of work:			
Building cost		1,850,987.45	
Less adjustments	226.60		
Less accrued revenues	34,514.59		
		34,741.19	
			1,816,246.26
Operation and maintenance cost		64,327.05	
Less accrued revenues		1,750.00	
			62,577.05
Total assets			2,026,041.34

LIABILITIES

Investment of the United States:			
Disbursement vouchers	1,907,463.74		
Transfer vouchers received	46,721.21		
		1,954,184.95	
Collection vouchers	112,949.16		
Transfer vouchers issued	10,635.40		
		123,584.56	
			1,830,600.39
Accounts payable:			
Unpaid labor		2,010.33	
Unpaid purchases		1,641.22	
Unpaid contract estimates		5.00	
Unpaid freight and express		1,239.79	
Unpaid passenger fares		161.36	
Unpaid land agreements		7,840.00	
			12,897.07
Repayments accrued:			
Building		144,632.40	
Operation and maintenance		37,910.85	
			182,543.25
Total liabilities			2,026,041.34

Feature costs to June 30, 1910, Klamath project

Canal system:		
Main canal	$567,043.23	
East Branch canal	42,694.22	
Keno canal	98,981.09	
South Branch canal	188,116.45	
South Branch laterals	56,466.65	
Poe Valley canals	1,969.47	
Poe Valley laterals	589.20	
West Side canal, upper project	4,252.76	
East Side canal, upper project	5,571.45	
Carr extension of Adams canal and flume	13,162.26	
		$978,846.78
Storage works:		
Clear Lake dam	113,892.30	
Clear Lake dikes	12,803.33	
Horsefly reservoir surveys	593.69	
		127,289.22
Lost River diversion works: Preliminary expense		82.50
Buildings:		
Headquarters	10,808.91	
Gate keepers' and employees' cottages	5,326.21	
		16,135.12
Drainage:		
Upper project	428.16	
Lower project	27,137.94	
Lower lake	9,067.81	
		36,633.91
Telephone system: Construction		17,159.14
Real estate (rights and property): Canals, rights of way, and lands purchased		581,154.56
Examination of project as a whole:		
Preliminary expense	47,149.79	
Hydrography	15,971.94	
Reconnaissance and soil map	252.51	
		63,374.24
Experiment farm: Buildings, etc		13,369.51
Administration of project as a whole: General expense		11,309.14
Plant accounts:		
Rock crushing plant	3,859.72	
Keno power plant	788.51	
South Branch power plant	740.10	
		5,388.33
Inventory of unused supplies		245.00
Total building cost		1,850,987.45
Operation and maintenance:		
General expense	15,818.90	
Property	476.11	
Earthwork	8,785.76	
Structures	7,737.56	
Distribution	4,633.71	
Protection	372.91	
Telephone	1,546.12	
Corral maintenance	3,480.30	
Corral operation	711.04	
Cement pipe construction	186.61	
Expense prior to July 1, 1908	18,767.01	
Gates and fences	460.87	
Experiment farms	884.52	
Keno canal, operation and repairs	465.63	
		64,327.05
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		1,915,314.50

SOUTH DAKOTA, BELLE FOURCHE PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Butte and Meade.
Townships: 6 to 10 N., Rs. 3 to 8 E., Black Hills meridian.
Railroads: Chicago and Northwestern; Chicago, Burlington and Quincy; Chicago, Milwaukee and St. Paul.
Railroad stations: Belle Fourche, Newell, Nisland, Sturgis, and Whitewood, S. Dak.
Average elevation of irrigable area: 2,800 feet above sea level.
Average annual rainfall on irrigable area: 15 inches.
Range of temperature on irrigable area: —20° F. to 95° F.

WATER SUPPLY

Source of water supply: Belle Fourche River.
Area of drainage basin: 4,270 square miles.
Annual run-off in acre-feet of Belle Fourche River at diversion dam (4,270 square miles), 1903 to 1906: Maximum, 433,000; minimum, 311,000; mean, 363,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Belle Fourche—area, 8,010 acres; capacity, 203,770 acre-feet; length of spillway, 314 feet; elevation of spillway, 100 feet above stream bed.
Storage dam: Belle Fourche—type, earth fill; maximum height, 115 feet; length of crest, 6,200 feet; volume, 1,600,000 cubic yards.
Diversion dam: Type, concrete weir; maximum height, 23 feet; length of masonry crest, 400 feet.
Length of canals: 55 miles with capacities greater than 300 second-feet; 85 miles with capacities from 300 to 50 second-feet; 460 miles with capacities less than 50 second-feet.
Length of tunnel: 1,306 feet.

AGRICULTURAL CONDITIONS

Irrigable area: About 100,000 acres.
Present status of irrigable lands (whole project): 21,600 acres entered subject to the reclamation act, 2,900 acres open to entry, 20,000 acres withdrawn from entry, 5,500 acres of state lands, about 50,000 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 47,568 acres.
Area irrigated, season of 1910: 23,500 acres.
Length of irrigating season: 180 days.
Character of soil of irrigable area: North side, clay loam; south side, sandy loam.
Principal products: Grain, alfalfa, potatoes, sugar beets, garden truck, small fruit.
Principal markets: Omaha, Nebr.; Chicago, Ill.; Minneapolis and St. Paul, Minn.; and mining towns in the Black Hills.

LANDS OPENED FOR IRRIGATION

Dates of public notices and orders relating thereto: June 21, 1907; May 29, 1908; January 18, 1909; February 19, 1910.
Location of lands opened: T. 7 N., Rs. 5 and 6 E.; T. 8 N., Rs. 3–7 E; T. 9 N., Rs. 2–5 E.; T. 10 N., Rs. 3 and 4 E., Black Hills meridian.
Present status of irrigable lands opened: 11,616 acres entered subject to the reclamation act, 2,946 acres open to entry, 2,706 acres of state lands, 30,300 acres in private ownership.

Limit of area of farm units: Public, 80 acres; private, 160 acres.
Duty of water: 2 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $30.
Annual operation and maintenance charge: $0.40 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.
Construction authorized by Secretary May 10, 1904.
Diversion dam and inlet canal completed September, 1907.
Belle Fourche dam 97 per cent completed June 30, 1910.
First irrigation, season of 1907.
Whole project 80 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Belle Fourche project provides for the diversion of water from Belle Fourche River, by means of a dam about 2 miles below Belle Fourche, S. Dak., and a short inlet canal into a storage reservoir controlled by Belle Fourche dam on Owl Creek, a small tributary of Belle Fourche River; the distribution of water from the inlet canal to a small area of land; and the distribution of water from the reservoir through two canal systems to lands on both sides of Belle Fourche River.

ORIGIN OF PROJECT AND INVESTIGATIONS

During the summer of 1903 a reconnaissance was made of streams in the western part of South Dakota having their source in or near the Black Hills to determine the most feasible irrigation projects. A number of feasible projects were found and reported on, the one promising the most immediate returns and therefore considered the most suitable for first construction being located in the valley of Belle Fourche River. The public lands, which constitute about one-half of the irrigable area, were withdrawn by the Secretary of the Interior on July 18, 1903, and preliminary surveys were begun July 22. During the season gaging stations were established, reservoir sites located and mapped, and 115 miles of canal lines were run. Preliminary plans and estimates completed during the winter of 1903–4 were reviewed by a board of engineers consisting of Messrs. A. P. Davis, J. H. Quinton, and C. H. Fitch, who reported, under date of April 29, 1904, that it would be feasible to irrigate not less than 60,000 acres of land and recommended that investigations be continued and that plans and specifications be prepared for early construction. On May 10, 1904, the project was approved by the Secretary of the Interior and $2,100,000 set aside from the reclamation fund for its construction.

Field work was resumed in April, 1904. The mapping of reservoir sites and 200 square miles of irrigable lands was continued and borings at dam sites, creek crossings, and canal locations for classification of material were made.

On June 20, 1904, a board consisting of Messrs. F. H. Newell, C. H. Fitch, and Morris Bien visited the project and assisted in the formation by the landowners of a water users' association. Proposed articles of incorporation of the water users' association had been submitted, through Hon. E. W. Martin, to the Secretary on June 1, 1904. The articles of incorporation and rules and regulations were approved by the Secretary on September 8, 1904.

Under date of September 8, 1904, a board of consulting engineers reviewed the plans made to that date and recommended the completion of the topographic sheets and the design of all important structures. Under date of October 28, 1904, a board consisting of Messrs. A. P. Davis, J. H. Quinton, C. H. Fitch, and R. F. Walter gave final approval to the plans and specifications for the first construction work on the project, the diversion dam, headworks, and inlet canal, and recommended that work be commenced as soon as sufficient private land on the project had been subscribed. This requirement was fulfilled on January 5, 1905.

CONSTRUCTION

DIVERSION DAM AND INLET CANAL

The diversion dam is located on the Belle Fourche River about 1½ miles below the town of Belle Fourche. It is a concrete weir 23 feet in height and 400 feet long between abutments. From the south abutment an earth embankment, protected by rock paving on the water slope, extends to high ground. Beyond the north abutment are located a sluiceway provided with three double-leaf gates, each 5 feet wide and 10 feet high, and an intake for the inlet canal which is provided with seven gates 5 feet wide and 10 feet high. The crest of the dam is 1 foot above normal water surface elevation of the canal. The dam rests on shale or slate rock, which at this point extends to a great depth.

The inlet canal, constructed for the purpose of diverting water from Belle Fourche River to a storage reservoir on Owl Creek, is 6½ miles long and has a capacity of 1,600 second-feet. It is located on the north bank of the river and extends from the intake in an easterly direction through the divide to Dry Creek, where the water passes by a 10-foot drop into the reservoir. The canal has a bottom width of 40 feet, a water depth of 10 feet, and side slopes of 1 to 1 and 1½ to 1 in cut and fill, respectively. The maximum cut is 43 feet. About half a mile below the headworks the canal crosses Crow Creek. It is arranged to take the water of this stream into the canal, and to guard against floods a concrete weir 180 feet long is constructed on the lower bank with a sluiceway in which are installed three gates 5 feet wide and 10 feet high. A short distance below this regulating weir and sluiceway a check is constructed in the canal consisting of a concrete structure provided with six sheet steel gates 6 feet wide and 8 feet high. For the purpose of regulating the flow in the canal and delivering the water to the reservoir without causing serious erosion a concrete weir 183 feet long, discharging into a concrete-lined outlet channel was constructed at the end of the canal.

In October, 1904, plans for the diversion dam, inlet canal, and structures were completed and approved, and proposals therefor, under specifications No. 28, were opened April 10, 1905. A contract for schedule 1, consisting of the structures and appurtenances, was executed April 24, 1905, and a contract for schedule 2, consisting of the excavation of the inlet canal, was executed April 26, 1904. The work of construction was begun in May, 1904, and completed in September, 1907.

The dam was built in four sections by diverting the low-water flow of the river with cofferdams constructed of wooden and steel sheet piling and bags filled with sand. The principal plant consisted of a cableway 700 feet long suspended across the river and supported on frames. Excavation within the cofferdam was carried well into the hard shale of the river bed by the aid of picks and bars. The excavated material was loaded into $\frac{3}{4}$-yard buckets and transported by the cableway to the dump. The placing of concrete was begun in August, 1905, the materials being hauled to the mixer in 1-yard cars on a 24-inch-gauge railway and the concrete being deposited in place from buckets carried on the cableway. The headworks and 70 feet of the north end of the dam were completed in 1905; 230 feet of the south end of the dam were finished in July, 1906. This left a space of 100 feet for the passage of the river. A section of the dam 65 feet in length in this gap was completed in August, 1906. While the remaining 35 feet of the dam was being constructed the river was diverted through the sluicing gates. On September 14, 1906, a flood carried away the cofferdam protecting the work on this section, and the closing of the gap was delayed until the spring of 1907. In the meantime the cableway was removed and work on the embankment and other structures under the contract was carried on.

The Crow Creek regulating weir and sluiceway were begun in the fall of 1905 and finished in September, 1907. A cofferdam was used in constructing 50 feet of the structure, but the rest was constructed without the use of a cofferdam. The concrete was handled by the aid of a 24-inch-gauge railway on a trestle over the top of the weir.

The reservoir drop was built during June and July, 1907. The concrete weir, 183 feet in length, and the lined channel, 45 feet in width, were constructed without the use of forms.

The excavation of inlet canal was begun in May, 1905. On account of unfavorable weather conditions in 1905 the progress in excavation was slow. On March 7, 1906, the contractor defaulted and relinquished the work to the United States. A part of the work was readvertised under specifications No. 88, but as no bids were received the Secretary of the Interior authorized the work to be completed by force account. It was finished in September, 1907. The principal plant of the contractor, and which was taken over by the United States, consisted of two steam shovels, with cars and track, elevating graders, wagons, and fresno scrapers. The steam shovels were used in the deep cuts and a tipple car in the deep cut near the lower end of the canal. The rest of the grading was done by fresnos and elevating graders and wagons.

Proposals under specifications No. 87 for furnishing and erecting five combination truss bridges of 72-foot span over the inlet canal were opened May 15, 1906, and a contract was executed June 18, 1906. The bridges were completed in January, 1907.

BELLE FOURCHE DAM

The Belle Fourche dam is located on Owl Creek just below its junction with Dry Creek and about 12 miles northeast of Belle Fourche. It is an earth dam 6,200 feet long on top, 115 feet high at maximum section, 19 feet wide on top, and having slopes in general of 2 to 1. On the water face, however, the slope above the water line is $1\frac{1}{2}$ to 1, and for a short distance at the bottom 5 to 1. The elevation of the top of the dam is 2,990 feet above sea level. The dam will contain on completion 1,570,000 cubic yards of earth and 45,000 cubic yards of gravel and will require 17,820 concrete blocks (6½ by 5 feet and from 6 to 8 inches thick) on the water slope and 15 acres of grass seeding on the lower slope. A wasteway, located in a draw beyond the east end of the dam, has a concrete weir crest 314 feet long at elevation 2,975 or 15 feet below the top of the dam. The outlets consist of two concrete conduits through the dam, the floors of which are at elevation 2,920 or about 45 feet above the lowest point of the reservoir. These conduits conduct the water from the reservoir to the north and south canals. They are controlled by gates, which are operated from gate-houses on the top of concrete shafts built up through the dam near its center line. The outlets are about 2,400 feet apart. They are to be provided with 58-inch balanced valves at the inlet ends to control the entrance of water. On the upstream slope at elevation 2,920 there is a berm 12 feet wide, on which is a concrete footing wall strengthened by a row of round piles driven 3 feet apart. Below this berm the slope of the embankment is 5 to 1 without paving. Above the berm the slope is 2 to 1 to the water level at elevation 2,975, and 1½ to 1 to the top of the dam at elevation 2,990. This slope is covered with 2 feet of gravel, on which rest the concrete paving blocks. On the downstream slope there are two berms 8 feet wide at elevations 2,930 and 2,960, respectively, which contain concrete gutters for drainage purposes. This slope is covered with loam and seeded with grass. A roadway 17 feet 4 inches wide between low retaining walls is to be constructed on the top of the dam. The total width of the top is 19 feet and the total width of the base at its maximum section is 650 feet. The reservoir when filled will form a lake of over 8,000 acres and will have a capacity of over 200,000 acre-feet.

In July, 1905, plans for the construction of the dam and about 18 miles of the outlet canals were reviewed and approved by a board of engineers consisting of Messrs. Chas. E. Wells, J. H. Quinton, C. H. Fitch, and R. F. Walter. Proposals under specifications No. 56 were opened October 26, 1905, and a contract was executed for the entire work, consisting of three schedules. Schedule 1 included the dam and 1¾ miles of the north and south canals adjacent to it. Schedule 2 included over 8 miles of the north canal, and schedule 3 included about 8 miles of the south canal. Work was begun on the dam March 26, 1906, and will probably be completed in December, 1910.

The material on which the dam rests and of which it is constructed consists of a heavy compact clay locally known as "gumbo," which weighs 120 pounds per cubic foot when compacted. Before placing material in the dam the surface was stripped of all sagebrush, cactus, etc., and plowed to a depth of 8 inches. It was then rolled and material added in 6-inch layers and thoroughly wetted and rolled. A cut-off trench 10 feet wide and 5 to 20 feet deep was excavated to firm material along the center line of the dam, and refilled with selected material placed in 4-inch layers wetted and rolled the same as the main body of the dam. Water was obtained by pumping from Owl Creek to pressure reservoirs at each end of the dam, whence it was conducted to the work by a system of iron pipes, laid along the toe of the dam, with valves at intervals of 150 feet to which hose was attached for wetting the embankment as constructed.

In 1906 the contractor placed 220,000 cubic yards of material in the embankment. The material was taken from pits in the bed of the reservoir near the dam. A 75-ton Vulcan steam shovel having a 2½-yard dipper was used in a pit about a half mile from the dam. The material was transported by trains of 10 4-yard cars hauled by 18-ton dinkey engines on a railroad track of 3-foot gauge. Three dumping tracks were used on the dam, so arranged that the material was spread for 50 feet each side by 4-horse fresnos. Two elevating graders were used in other pits, the material being hauled by 1½-yard dump wagons, the average haul being 1,500 feet. The earth was leveled by 4-horse road graders and rolled by a 32-horsepower traction engine. Before dumping, the surface of the dam was well wetted, the work requiring two hose men and a horse to haul the 2-inch hose. During the year the south conduit, a reenforced concrete pipe about 5 feet in diameter, was nearly completed to the base of the gate tower. No work was permitted on the embankment during freezing weather.

In 1907 about 270,000 cubic yards of material were placed in the dam. Two 75-ton steam shovels were operated in a pit on the hill to the east of the dam, and 2 elevating graders in pits south of the dam. The manufacture of concrete paving blocks for the water slope of the dam at a gravel pit 6 miles distant, the construction of the concrete conduit through the dam to supply the north canal, and the footing wall at the lower end of the paving were begun.

On January 19, 1908, the progress not being satisfactory and the contractor being insolvent, the contract was suspended. On April 21, 1908, a contract was executed with the sureties of the previous contractors to complete the work. Work was resumed April 29 with practically the same equipment as was used during the previous season. Three hundred and ninety thousand cubic yards of material were placed in the dam during 1908. A railroad was built to the gravel pit 6 miles distant in order to transport the paving blocks and the gravel which had previously been hauled in 5-cart trains by a 32-horsepower traction engine. The north canal reenforced concrete outlet conduit was about completed during the season.

In March, 1909, a Howe truss bridge, consisting of one 100-foot span and two 60-foot spans, was built across the gap left in the embankment where Owl Creek crosses it, and preparations were made to close the gap after the spring floods. Cofferdams were built; a flume was constructed; the mud and silt in the creek bed were removed to solid material; and the opening was refilled with good earth in layers, wetted, rolled, and bonded to the material already in place. This work was finished by November and the bridge removed. During the season about 530,000 cubic yards of earth was placed in the embankment, the footing wall was nearly completed and enough paving blocks placed to enable water to be stored to elevation 2,922, or 45 feet above the bottom of the reservoir.

On March 16, 1910, work on the embankment was resumed and on June 30, 1910, the total amount of material placed had been brought up to 1,523,000 cubic yards, and only about 30,000 cubic yards of earth were needed to complete the embankment. It is anticipated that the dam will be finished on December 1, 1910, the contract date for completion.

NORTH CANAL

The water required for irrigating about 60,000 acres of land north of the Belle Fourche River and east of Owl Creek will be supplied through the north canal. This canal heads at the north outlet conduit in the Belle Fourche dam and is at present constructed for about 9 miles of its length, but the canal, as designed, will be 45 miles long. Its capacity is 1,600 second-feet to the wasteway channel which it crosses one-half mile from the dam and at which are located spillway gates. Beyond this point the canal will be used entirely for irrigation and has an initial capacity of 650 second-feet, a bottom width of 28 feet, a water depth of 7 feet and side slopes of 1 to 1 and 1½ to 1 in cut and fill, respectively.

About 9 miles of the canal was constructed by the contractor for the dam. Work was begun on March 26, 1906, and finished May 21, 1908. The heaviest work consisted of a cut about a mile from the dam, which has a depth of 40 to 50 feet. A large part of this cut was excavated during freezing weather, when work was closed down on the dam, with the steam shovel at other times used on the dam. The balance of the excavation was performed with fresno scrapers, elevating graders, and wagons. A number of concrete structures were required, and these were completed in July, 1907. The gravel and sand for the concrete were transported from 10 to 15 miles from the pit by trains of carts hauled by 32-horsepower traction engines.

SOUTH CANAL

The south canal is about 45 miles in length and furnishes water for irrigating lands on the north side of the Belle Fourche River west of Owl Creek and on the south side of the river in the vicinity of Vale, S. Dak. The principal structures on the line of the canal are the siphons under the Belle Fourche River, Whitewood Creek, and Anderson Draw, a tunnel 1,306 feet long through a bluff on the south side of the river, and steel flume over Stinking Water Creek.

The first division of the canal, nearly 8 miles in length, extends in a southerly direction from the south conduit of the dam to the Belle Fourche River. It has a capacity at its upper end of 350 second-feet, a bottom width of 18 feet, and a water depth of 5½ feet. As the laterals are taken out the capacity of the canal is gradually decreased. This division was built by the contractor for the dam under specifications No. 56. The work was begun in April, 1906, and finished June 30, 1907. The construction presented no unusual features, the structures consisting of concrete wasteways and culverts and a reenforced concrete arch of 22-foot span.

The second division of the south canal is about 30 miles in length. It crosses to the south side of the Belle Fourche River by a siphon 3,565 feet long and extends in an easterly and southerly direction to a point about 6 miles east of Vale. Proposals under specifications No. 134 were opened April 10, 1907, and all bids were rejected except those for sections 7 and 8, which included 11½ miles of canal in the vicinity of Vale, and for which a contract was executed on May 29, 1907, and the work completed in November, 1907. The balance of the work was readvertised under specifications No. 145 and proposals opened on June 10, 1907. All bids were rejected and authority was granted by the Secretary of the Interior to do the work by force account. Satisfactory informal contracts were made, however, for excavation of sections 2, 4, 5, and 6, leaving all of the structures, including the siphons and tunnel, and several miles of open canal to be constructed by force account. Work was begun in May, 1907, and all of the canal and structures were completed to Cottonwood Creek, near Vale, in the spring of 1909, and the remaining structures on the canal were finished in the spring of 1910.

The Belle Fourche River siphon is a reenforced concrete pressure pipe 3,565 feet long, having an internal diameter of 5 feet with an 8-inch shell reenforced with ½-inch and ⅝-inch square bars for a head of 65 feet. Its construction was begun in August, 1907, and completed in October, 1908. The siphon was constructed in sections in a trench excavated in hard blue shale in the bed of the river, the flow of the river being diverted by cofferdams. Blaw collapsible centering was used for inside forms for the pipe. The siphon is provided with an inlet chamber protected by trash racks, an outlet chamber, and a blow-off with drain.

The tunnel is about 2 miles east of the Belle Fourche siphon and carries the south canal through a high bluff on the south bank of the river. It is 1,306 feet long with a horseshoe-shaped section 9½ feet wide and 10½ feet high and is lined with concrete throughout. Excavation was begun in August, 1907, and completed in May, 1908. The portals were excavated the previous winter by contract. The material encountered in the tunnel consisted of soft, damp, laminated blue shale. The tunnel was driven from both headings by one crew. While the drillers were at work at one end the laborers cleared out the muck at the other end. Hand drills were used, and blasting was done between shifts, so that no ventilating plant was needed. Timbering was required throughout. The placing of concrete lining was begun in May and finished in August, 1908.

The Anderson siphon, which carries the south canal across Anderson Draw under a head of about 45 feet, is of reenforced concrete 8 inches thick and has an internal diameter of 7 feet and a length of 425 feet. It has inlet and outlet chambers and a blow-off with drain. Its construction was begun in the spring of 1908 and finished in September, 1908.

The Whitewood siphon, which carries the south canal across Whitewood Creek under a head of approximately 15 feet, is of reenforced concrete 8 inches thick and has an internal diameter of 6 feet and a length of 350 feet. The excavation for this work through 10 to 15 feet of wet mud was very difficult. The work was begun June 10, 1908, and finished in October, 1908.

LATERAL SYSTEM

Plans for part of the lateral system north of the Belle Fourche River were made during the winter of 1906–7, and proposals were opened for construction under specifications No. 138 on April 30, 1907. Contracts were executed for the earthwork, but as no bids were received for the structures authority was granted to build them by force account. The system under these contracts consisted of the following main laterals:

(1) The Johnson lateral, 16 miles long, taking water directly from the inlet canal above the reservoir and irrigating about 3,000 acres of land on the north bank of the river and west of the south canal.

(2) The Todd, Miller Butte, and Sorenson laterals, heading in the south canal and furnishing water for irrigating the land between it and Owl Creek.

(3) The Ross, Gillette, Indian Creek, Gregory, and La Flemme laterals, heading in the north canal and serving lands east of Owl Creek.

Work was begun on the earthwork contracts in June, 1907, and completed in May, 1908. The building of the structures by force account was begun in August, 1907, and those on the south canal system were completed by June, 1908. Work was then begun on structures for the north canal laterals and they were completed in the spring of 1909.

Plans for a part of the lateral system of south canal south of Belle Fourche River and of a part of the Indian Creek laterals north of the river were prepared in the spring of 1908. Proposals were opened on August 20, 1908, and contracts executed. The work was begun in October, 1908, and completed in the following spring.

Plans for the lateral system at the extreme lower end of the south canal east of Vale were prepared during the winter of 1908–9. Proposals were opened on March 5, 1909, and contracts executed. The work was begun in April and completed in August, 1909. The structures were built by force account, being completed in the spring of 1910.

Proposals were opened for construction of 25 miles of small laterals from the north canal on August 25, 1909. Satisfactory contracts were made and the work was completed in November, 1909.

The south canal is now being extended beyond its present terminus east of Vale by a canal named the Ninemile lateral. The work is being done by force account.

TELEPHONE SYSTEM

A telephone system consisting of 43 miles of line and 16 phones has been constructed. The first section, from Belle Fourche to the diversion dam and thence along the inlet canal to the Belle Fourche dam, a total distance of 16 miles, was built by contract under specifications No. 38 in the fall of 1905. The next section, 18½ miles in length, from the Belle Fourche dam to Vale, along the line of the south canal, was built by force account in 1907. The balance of the system has been built as the demands of the service required.

IRRIGATION AND SETTLEMENT

During 1907 the inlet canal and the temporary Dry Creek canal in the bed of the reservoir were operated to furnish water for wetting the material used in the construction of the dam.

The first water for irrigation was turned into the south canal on April 14, 1908, and during the season 48½ miles of canals and laterals were operated, furnishing water for about 5,000 acres of land. As no water could be stored in the reservoir, water was furnished to the south canal through the Dry Creek canal excavated in the bed of the reservoir, from its upper end near the mouth of the inlet canal to the concrete conduit through the uncompleted dam.

In the season of 1909 the same canal system was in operation as in 1908, and the acreage irrigated was increased to over 8,000 acres.

Water was turned into the canals on April 20 and delivery to water users was continued without serious interruption throughout the season.

In 1910 the storing of water in the reservoir was begun early in March. On April 10 water was turned into the south canal, and on April 21 water passed through the Belle Fourche siphon for the purpose of priming and testing the canal, and early in May its use for irrigation on the south side of the river was begun. On April 28 water was turned into the north canal. The entire system is now in operation, consisting of about 60 miles of main canal and 230 miles of laterals. About 23,500 acres of land are being irrigated. The principal crops are grain, alfalfa, hay, and garden truck.

The first unit of the project was opened to settlement by public notice of June 21, 1907, and the second unit by public notice of February 19, 1910. In the areas opened to settlement there were 208 public-land farm units, and on June 30, 1910, 166 of these had been entered and 42 were still open to entry. Water-right applications have been received for 191 farms in private ownership embracing about one-half of the area of private lands for which water could be supplied and which are subject to assessment. Many private holdings are being divided into small tracts and sold to new settlers. During the year 1910 the Belle Fourche Valley and Northwestern Railroad has been constructed through the project. Two towns, Nisland and Fruitdale, have been located on the railroad and a government town site has also been established along the line, although no lots have yet been appraised or sold. A number of business houses have, however, been built and residents have given the name of Newell to the town.

PROGRESS DURING FISCAL YEAR 1910

The construction by contract of Belle Fourche dam, the first divisions of the north and south canals, and appurtenant structures was continued during the fiscal year with satisfactory progress. Construction by force account of structures on the south canal was completed and the excavation by contract and force account and the installation of structures by force account on the lateral systems of the north and south canals were continued.

The operation of the canals and the delivery of water for irrigation were carried on during the seasons of 1909 and 1910. In 1910, owing to a dry spring and difficulty in early irrigation on sod ground, many fields of grain secured only a thin stand and yields will be comparatively low. The prospects for fair yields of other crops on irrigated land are good. Practically all crops on unirrigated land, however, are failures.

PUBLIC NOTICE DATED FEBRUARY 19, 1910

1. Pursuant to the provisions of section 4 of the reclamation act of June 17, 1902 (32 Stat., 388), notice is hereby given as follows:

2. Water will be ready for delivery for the second unit of the Belle Fourche project, South Dakota, under the provisions of the reclamation act, in the irrigation season of 1910, for the irrigable areas shown on farm unit plats of Black Hills meridian, T. 9 N., R. 2 E.; T. 10 N., R. 3 E.; T. 8 N., R. 4 E.; T. 9 N., R. 4 E.; T. 10 N., R. 4 E.; T. 7

N., R. 5 E.; T. 8 N., R. 5 E.; T. 9 N., R. 5 E.; T. 7 N., R. 6 E.; T. 8 N., R. 6 E.; T. 7 N., R. 7 E.; T. 8 N., R. 7 E., approved by the Secretary of the Interior on February 14, 1910, and on file in the local land office at Belle Fourche, S. Dak.

3. Homestead entries, accompanied by applications for water rights and the first installment of the charges for building, operation, and maintenance may be made under the provisions of said act for the farm units shown on said plats. Water-right applications may also be made for lands heretofore entered and for lands in private ownership, and the time when payments will be due therefor is hereinafter stated.

4. The limit of area per entry, representing the acreage which in the opinion of the Secretary of the Interior may be reasonably required for the support of a family on the lands entered subject to the provisions of the reclamation act, is fixed at the amounts shown on the plats for the several farm units.

5. The limit of area for which water-right application may be made for lands in private ownership shall be 160 acres of irrigable land for each landowner.

6. The charges which shall be made per acre of irrigable land in the said entries and for lands heretofore entered or in private ownership which can be irrigated by the waters from the said irrigation project, are in two parts, as follows:

(*a*) The building of the irrigation system, $30 per acre of irrigable land, payable in not more than ten annual installments, each payment not less than $3 or some multiple thereof per acre. Full payment may be made at any time of any balance of the building charge remaining due after certification by the Commissioner of the General Land Office that full and satisfactory compliance has been shown with all the requirements of the law as to residence, cultivation, and reclamation.

(*b*) For operation and maintenance for the irrigation season of 1910, and annually thereafter until further notice, 40 cents per acre of irrigable land, whether water is used thereon or not. As soon as the data are available the operation and maintenance charge will be fixed in proportion to the amount of water used, with a minimum charge per acre of irrigable land, whether water is used thereon or not.

7. All entries made hereafter for any of the lands described, whether for lands not heretofore entered or for lands covered by prior entries which have been canceled by relinquishment or otherwise, shall be accompanied by applications for water rights in due form and by the first installment of the charges for building, operation, and maintenance, not less than $3.40 per acre. The second installment of the building charge, not less than $3 per acre, and the appropriate charge for operation and maintenance, shall become due on December 1 of the following year. Subsequent installments of the building charge shall become due on December 1 of each year thereafter until fully paid.

8. For lands in private ownership, and for lands heretofore entered, the first installment of the charges for building, operation, and maintenance, not less than $3.40 per acre of irrigable land, shall become due on December 1, 1910. The second installment shall be due on December 1, 1911. Subsequent installments shall become due on December 1 of each year thereafter.

9. The first installment of the charges for all irrigable areas on these plats, whether or not water-right application is made therefor or water is used thereon, shall be due and payable as herein provided.

10. A number of farm units and tracts of private lands are so situated as to be irrigable partly under the first unit, opened to irrigation by public notice of June 21, 1907, and partly under the second unit, and water-right applications have heretofore been filed for the areas under the first unit. In such cases both areas are shown distinctively on the plats, and the added areas, irrigable in 1910, will be subject to all the terms and conditions of this notice, water-right applications being filed therefor as for other irrigable lands in the second unit.

11. The regulation is hereby established that no water will be furnished in any year until the operation and maintenance charges for that irrigation season shall have been paid. Accordingly no water will be furnished for the irrigation season of 1910 for any lands unless the portion for operation and maintenance of the installment due December 1, 1910, has been paid; and in like manner no water will be furnished in any subsequent year unless payment has been made of the portion of the installment for operation and maintenance for that irrigation season.

12. Failure to pay any two installments of the charges when due, whether on entries made subject to the reclamation act or on water-right applications for other lands, shall render such entries and corresponding water-right applications, or the water-right applications for other lands, subject to cancellation, with the forfeiture of all rights under the reclamation act, as well as of any moneys already paid.

13. All charges must be paid at the local land office at Belle Fourche, S. Dak.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Belle Fourche project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
234	Apr. 8, 1909	National Surety Co.	Dam and canals	$693,187.34	$549,412.60	Dec. 1, 1910
286	Apr. 13, 1909	J. E. Hilton	Excavation, lateral system.	10,111.00	[a] 15,241.18	Aug. 20, 1909
294	Sept. 20, 1909	Franklin E. Todd	Excavation, laterals and ditches.	2,496.00	[a] 2,730.00	Dec. 1, 1909
295	Sept. 18, 1909	Percy Ross	Excavation, laterals	1,425.00	[a] 1,052.90	Do.
296	do	Cole Bros	do	1,750.00	[a] 1,508.52	Do.

[a] Completed.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Belle Fourche project

ASSETS

Accounts receivable:			
Uncollected miscellaneous		$2,757.44	
Uncollected water-right building charges		24,902.28	
Uncollected water-right operation and maintenance charges		749.15	
			$28,408.87
Inventories:			
Mercantile store		83.37	
Government animals	$17,095.53		
Less depreciation	12,670.34		
		4,425.19	
Equipment in use	12,358.38		
Less depreciation	457.25		
		11,901.13	
Storehouse		2,371.32	
Cement		22,871.51	
Iron and steel		40.60	
Lumber		853.99	
Forage		396.34	
Fuel		106.93	
Cash in office safe		22.70	
Local products		6,318.61	
Unadjusted transfers		1,119.73	
			50,511.42
Cost of work:			
Building cost	2,394,512.91		
Plus adjustments	1,252.18		
		2,395,765.09	
Less accrued revenues		11,594.05	
			2,384,171.04
Operation and maintenance cost		24,751.49	
Less accrued revenues		32.69	
			24,718.80
Total assets			2,487,810.13

LIABILITIES

Investment of the United States:			
Disbursement vouchers	2,337,372.11		
Transfer vouchers received	54,358.43		
		2,391,730.54	
Collection vouchers	63,527.03		
Transfer vouchers issued	14,678.29		
		78,205.32	
			2,313,525.22
Accounts payable:			
Unpaid labor		5,777.35	
Unpaid purchases		8,812.92	
Unpaid contract estimates		32,674.44	
Unpaid contract holdbacks		45,000.00	
Unpaid freight and express		9,052.19	
Unpaid passenger fares		98.50	
Unpaid land agreements		308.20	
			101,723.60
Repayments accrued:			
Building		54,635.76	
Operation and maintenance		17,925.55	
			72,561.31
Total liabilities			2,487,810.13

Feature costs to June 30, 1910, Belle Fourche project

Diversion dam and structures: Completed cost		$117,322.76
Supply canal and structures:		
Earthwork	$242,923.86	
Crow Creek sluiceway	60,581.98	
Drop at reservoir	4,739.54	
Highway bridges	10,233.05	
Concrete culverts	2,777.04	
Check gates	5,207.87	
Bridge abutments	1,636.21	
Flood expense	2,969.37	
		331,068.92
Storage works:		
Belle Fourche dam and appurtenances—		
Orman & Crook	273,367.40	
National Surety Company	636,172.27	
Belle Fourche reservoir, clearing site	702.51	
		910,242.18
North canal:		
Division A, Orman & Crook	109,843.05	
Division A, National Surety Company	254.60	
Minor structures, bridge 1	274.25	
Division B, survey and design	3,749.59	
Division C, survey and design	4,920.66	
		119,042.15
South canal:		
Division A, Orman & Crook	77,847.04	
Division B—		
Earthwork, class A	37,209.04	
Earthwork, class B	6,214.70	
Earthwork, section 2A and 2B	22,303.78	
Belle Fourche siphon	58,838.48	
Stinking water culvert	7,562.59	
Belle Fourche tunnel	33,230.29	
Anderson Draw siphon	13,095.98	
Reenforced concrete-lined canal	12,926.17	
Excavation for structures	13,292.63	
Concrete structures	26,897.93	
Timber structures	5,068.94	
Division C—		
Section 4, earthwork	29,183.03	
Sections 5 and 6, earthwork	47,499.45	
Sections 7 and 8, earthwork	44,549.93	
Whitewood siphon	16,332.94	
Tunnel portals, earthwork	21,372.39	
Feeder canal to South canal, earthwork	2,863.72	
Flood expense, Whitewood siphon	612.85	
Vitrified pipe structures	110.09	
Canal excavation, class C dry, sec. 2, division B	4,417.51	
Stinking water flume	3,134.52	
Nine-mile extension survey	1,115.30	
South canal sluice gates	766.29	
		486,445.59
Laterals, division A:		
Excavation, contract work	144,718.48	
Structures, force account work	100,978.11	
Bridges built by contract	521.01	
		246,217.60
Laterals, division B: Survey and design		2,952.06
Laterals, division C:		
Excavation, contract work	30,583.08	
Structures, force account work	31,515.81	
Excavation, sublateral, force account	397.42	
		62,496.31
Telephone system:		
Construction	9,391.84	
Maintenance	375.90	
		9,767.74

Real estate (rights and property): Lands purchased		$52,418.25
Irrigable lands: Farm unit subdivision		17,747.28
Buildings:		
Belle Fourche warehouse	$1,483.34	
Buildings at diversion dam	4,327.53	
Buildings at reservoir	11,590.72	
Portable houses	1,356.18	
Inspector's residence, gravel pit	144.42	
Lateral tents	52.97	
Buildings and tents, siphon	313.07	
Buildings at tunnel	266.03	
Whitewood siphon plant buildings and tents	227.76	
Buildings at Vale	1,743.71	
		21,505.73
Experimental farm: Farm building		4,023.45
Reconnaissance: Examination		1,009.64
Cheyenne River project: Examination		336.89
Little Missouri River project: Examination		1,247.41
Plant account: Operating expenses undistributed		1,371.57
Flood expense: 1910, miscellaneous		1,811.19
Ninemile Creek extension:		
Lateral excavation	6,428.83	
18-inch pipe structure	103.32	
24-inch pipe structure	154.28	
Small concrete structures	156.01	
Small timber structures	26.37	
Excavation for structures	28.98	
Miscellaneous grading for structures	52.88	
		6,950.67
Inventory of unused supplies		535.52
Total building cost		2,394,512.91
Operation and maintenance:		
Inlet canal	6,310.56	
South canal	3,534.70	
North canal	1,311.24	
Laterals	11,006.20	
Vale unit, South canal	1,504.58	
Vale unit, laterals, division C	610.20	
Vale unit, laterals, division A	474.01	
		24,751.49
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		2,419,264.40

UTAH, STRAWBERRY VALLEY PROJECT.

LOCATION AND CLIMATIC CONDITIONS

Counties: Utah and Wasatch.
Townships: 8 and 9 S., Rs. 1 to 3 E., Salt Lake meridian.
Railroads: Denver and Rio Grande; San Pedro, Los Angeles and Salt Lake.
Railroad stations: Spanish Fork, Payson, Mapleton, and Salem, Utah.
Average elevation of irrigable area: 4,600 feet above sea level.
Average annual rainfall on irrigable area: 18 inches.
Range of temperature on irrigable area: $-10°$ F. to 95° F.

WATER SUPPLY

Source of water supply: Strawberry and Spanish Fork rivers.
Area of drainage basins: 870 square miles.
Annual run-off in acre-feet: Strawberry River in Strawberry Valley, 1903 to 1906—maximum, 97,000; minimum, 49,200; mean, 63,000. Spanish Fork River at Spanish Fork (670 square miles), 1903 to 1908—maximum, 203,000; minimum, 65,800; mean, 105,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoir: Strawberry Valley—area, 6,800 acres; capacity, 110,000 acre-feet; length of spillway, 100 feet; elevation of spillway, 45 feet above stream bed.
Storage dam: Strawberry—type, rock fill with concrete core wall; maximum height, 67 feet; length of crest, 450 feet; volume, 100,000 cubic yards.
Diversion dam: Spanish Fork—type, reenforced concrete weir; maximum height, 16 feet; length of masonry, 70 feet; length of earth fill, 25 feet.
Length of canals: 3 miles with capacities greater than 300 second-feet; 40 miles with capacities from 300 to 50 second-feet; 50 miles with capacities less than 50 second-feet.
Aggregate length of tunnels: 20,700 feet.
Aggregate length of dikes, 500 feet.
Water power: 1,200 horsepower developed; estimated total, 3,000 horsepower.

AGRICULTURAL CONDITIONS

Irrigable area: 60,000 acres, all in private ownership.
Length of irrigating season: 150 days.
Character of soil of irrigable area: Sandy loam and gravel and black alluvium.
Principal products: Alfalfa, hay, cereals, sugar beets, fruits, and vegetables.
Principal markets: Salt Lake City, Utah, and adjacent mining districts.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.
Construction authorized by Secretary, December 15, 1905.
Power canal completed December, 1908.
Strawberry tunnel 26 per cent completed June 30, 1910.
Whole project 40 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Strawberry Valley project provides for the storage of water in a reservoir on Strawberry River; the discharge of stored water through a tunnel about 3½ miles long into Diamond Fork, a tributary of Spanish Fork River; and the diversion of water from Spanish Fork River into canal systems watering lands on both sides of the river east of Utah Lake. A hydro-electric plant about 3 miles below the diversion dam of the first canal diverting on the south side of the river supplies power for construction and commercial purposes. Some of the power developed will also be used for pumping water for the irrigation of high lands and drainage of low lands.

ORIGIN OF PROJECT AND INVESTIGATIONS

The diversion of Strawberry River into the valley of Spanish Fork River to supplement the streams of that valley in the irrigation of lands in the vicinity of Spanish Fork, Utah, was first investigated in 1902 by the Spanish Fork East Bench Irrigation and Manufacturing Company. Among those prominent in promoting the investigations were State Senator Henry Gardner, H. C. Jex, A. T. Money, Theodore Dedrickson, E. B. K. Ferguson, and Fred Matley, of Spanish Fork, and James McBeth, Hyrum Lemon and Mr. Page, of Payson. An engineer was employed to investigate the project and filings for water were made for reservoir purposes on Strawberry River and for power purposes on Spanish Fork River. The preliminary investigations of the engineer indicated that the project was one involving great expense and was probably too great an undertaking for the company or for the citizens of the valley to accomplish. A committee of citizens requested in January, 1903, that an investigation of the project be made by the Reclamation Service and that its construction be undertaken if feasible. Preliminary surveys and the gaging of streams were made by the service in 1903 and 1904, the possibility of diverting other streams in connection with Strawberry River being considered and rejected as impracticable. In January, 1905, about 1,200 citizens, owning more than 26,000 acres of land in the vicinity of Spanish Fork, petitioned the Reclamation Service for further consideration of the project, including the preparation of estimates of cost, and for construction of the irrigation works if the project were found to be feasible.

The petitioners agreed to comply with the provisions of the reclamation act and to pay for the project an amount not to exceed $40 per acre. Preliminary plans and estimates of the project practically as it is now being developed were prepared and on August 14, 1905, a board of engineers consisting of H. N. Savage, W. H. Sanders, A. J. Wiley, J. H. Quinton and G. L. Swendsen reported the project as feasible and recommended that it be constructed at the earliest practicable date, contingent on the subscription of lands to a water users' association. A water users' association was formed and practically all the lands within the limits of the project were soon subscribed. On October 2, 1905, a board of engineers consisting of A. P. Davis, Morris Bien, J. H. Quinton and W. H. Sanders recommended that construction be authorized as soon as the settlers had fully complied with the requirements of the service. On December 15, 1905, the project was approved by the Secretary of the Interior and $1,250,000 set aside from the reclamation fund for its construction, on the condition that "all of the complications involved be adjusted, including all conflicts that may exist in regard to water rights; that a sufficient acreage be pledged to secure the return to the reclamation fund of the cost of construction· and that a clean-cut feasible reclamation project, free from all complications or difficulties of any kind or character, be secured before a dollar is spent in construction." On March 6, 1906, construction work, including road repairs, erection of buildings, and preliminary work at the tunnel portals, was authorized to be commenced by force account.

CONSTRUCTION

STRAWBERRY TUNNEL

Strawberry tunnel will bring water from the Colorado River drainage basin through the divide into the Great Basin. It will pierce the mountains at a depth of 1,400 feet, will have a total length of 19,200 feet, and will be lined throughout with concrete. The west or lower portal of the tunnel is 7,452 feet and the east portal 7,508 feet above sea level. The plans provide for a capacity of 500 second-feet; a slope of 3 feet in 1,000; and a tunnel section to be excavated 9 feet wide by 10½ feet high but with dimensions inside the concrete lining of 7 feet wide by 6½ feet high on the sides with an arched roof having a 2-foot rise.

Preliminary investigation of the location of the tunnel line was made during the summer of 1905. Proposals to be opened August 30, 1906, under specifications No. 86, for the construction of the tunnel were advertised for, but none were received, and the work of excavation from both portals by force account was authorized by the Secretary of the Interior.

A substantial camp was constructed at the west portal of the tunnel during the months of September, October, and November, 1906. A small power house was constructed and electric drills were installed in the heading. These drills were furnished with power by small direct-current motors driven by gasoline engines. This temporary installation was for the purpose of opening up the tunnel in order that the nature of the material that would be encountered might be shown. Work was continued with two shifts during the winter of 1906 and 1907, fair progress being made. The material encountered in the heading was limestone of medium hardness that disintegrated slowly on exposure to the air. Timbering sets 8 inches square, placed from 3 to 6 feet on centers and lagged overhead, were put in for the entire distance excavated. On July 20, 1907, after 1,565 feet of tunnel had been excavated, work was suspended to await the development of electric power, and the camp was left in the care of two watchmen.

Nothing more was done on this feature until September 1, 1908, when the installation of a power plant or substation to be used in the construction of the tunnel was begun at the lower portal. By December 9 a well equipped modern, electrically operated plant had been installed, with ample power to supply compressed air for drills in the heading and electric current for lighting and power purposes. The machinery in the substation consists of one bank of three 60-kilowatt transformers, and one bank of three 40-kilowatt transformers that receive current from the power line at 22,000 volts and step it down to 2,200 volts; one 175-horsepower induction motor generator set; one 125-horsepower induction motor generator set; and one 430-cubic-foot Ingersoll-Rand compound air compressor, belt driven from the 175-horsepower motor set; together with horn switches, lightning arresters, switchboards, etc. The generators in the substation furnish 250-volt direct current for lighting, hauling, and ventilation in the tunnel. A carpenter shop, machine shop, and blacksmith shop were constructed and supplied with the necessary apparatus, including a motor-driven band saw, a drill press, a 20-inch machine lathe, a small air hammer, and two small blowers.

The work at the heading was resumed on December 9, 1908, with one shift. The work has been prosecuted as rapidly as possible, three shifts being employed since March 15, 1909; and on June 30, 1910, 7,963 linear feet of the tunnel had been excavated, timbering being placed whenever necessary. The material encountered has been a combination of sandstone and limestone, lying in very badly broken strata. Small streams of water have been encountered.

The tramming has been done with an electric locomotive and 2-yard muck cars, the cars being unloaded at the dump with an electrically operated, 7½-ton, stiff-legged derrick. The track has a gage of two feet and consists of 25-pound rails laid on 4-inch by 5-inch ties. Three and one-fourth-inch Sullivan rock drills are being used in the heading. The tunnel is ventilated by means of an electrically driven blower, having a displacement of 4,000 cubic feet of air per minute, that removes the foul air through a 14-inch riveted steel pipe extending to within about 60 feet of the heading.

WAGON ROAD AND TELEPHONE LINE

During the summer and fall of 1906 a wagon road 30 miles long, extending from Diamond Switch, the United States Reclamation Service shipping point on the Denver and Rio Grande Railway, to both portals of the tunnel was constructed by force account. The maximum grade of the road is 7 per cent, and for 85 per cent of its length the maximum grade is less than 5 per cent. During the winter and spring the road is impassable on account of mud, except for light rigs, and heavy freighting has to be done during the summer months. There are 14 small bridges on the road, and during the construction it was necessary to change the course of Diamond Creek in a number of places. The labor was performed by men and teams from the district that is to be irrigated. The road follows Diamond Fork Canyon for 16 miles, and on this section a great deal of difficult rockwork was necessary that increased the cost of the road and greatly reduced progress.

A telephone line, approximately 38 miles in length, was built by contract from Spanish Fork to the east portal of the Strawberry tunnel. The line was begun in June and completed during the latter part of November, 1906.

In addition to the main telephone line from Spanish Fork, several short service lines have been constructed by force account.

POWER TRANSMISSION LINE

A power-transmission line, extending from the power house in Spanish Fork Canyon to the west portal of Strawberry tunnel, was constructed by contract during the summer of 1908. The location of the line and the engineering work were begun in 1907, but were stopped when work was suspended at the tunnel in July of that year. In the spring of 1908 the location was resumed and completed, and a contract for the erection of the line was entered into with a local contractor. Construction work was begun April 1 and the line was completed September 1, 1908. The transmission line is 26 miles long and consists of a three-wire circuit of No. 6 B. & S. medium hard-drawn copper wire. The poles are of native fir, 30 and 35 feet in length, spaced about 40 to the mile. The insulators are made of porcelain in two pieces. Multiplex lightning arresters have been installed at both ends of the line. The wires are spaced 48 inches apart in the form of an equilateral triangle. The capacity of the line is 500 kilowatts, with a loss of from 8 to 10 per cent, with a power factor of 85 per cent. This line will be used during the period of construction of the project and then taken down and erected in the valley for the purpose of transmitting power to pumping plants that are to be installed for the purpose of irrigating land above the gravity canals.

During October and November, 1909, a transmission line, 3½ miles long, was constructed from the power house to Spanish Fork for the purpose of supplying that city with electric current for lighting and other purposes. The design and construction is the same as for the line between the power house and Strawberry tunnel, with the exception that Idaho cedar instead of native fir poles were used.

DIVERSION DAM AND CANAL HEADWORKS

Spanish Fork dam is located on the Spanish Fork River and was constructed for the purpose of diverting 500 second-feet of water into the power canal. All work on the dam was done by force account except the hauling of cement, which was done by contract. The dam is constructed of rubble concrete, is 16 feet in height above the bed of the stream, and has a 40-foot overflow weir, with two sluice gates 5 feet wide by 10 feet high.

The main section of the dam, which has an ogee shape, rests on a reenforced concrete bedplate, 20 feet wide and 5 feet thick, connected to a 2-foot apron that extends 50 feet downstream. Reenforced concrete cut-off walls were built at either edge of the bedplate and at the downstream edge of the apron.

The end of the dam next to the canal is founded on rock and the other end is founded on gravel and large bowlders.

The concrete in this structure was mixed with a No. 2 Smith mixer and put in the forms very wet. The sand and gravel used for the concrete was hauled from a gravel pit 1½ miles away. Rock from 1 to 3 cubic feet in volume were placed in the concrete and formed about 24 per cent of its volume. This rock was a hard limestone obtained from the excavation for the foundations. Excavating for the foundation of the dam was commenced in October, 1907, and the concrete work was completed July 1, 1908.

The gates in the dam were closed on December 6, 1908, and inside of ten hours the water had filled the reservoir and was running over the top. No leaks have appeared, and the dam has been in operation constantly since that date. Spanish Fork River is subject to floods at almost any time, and during these floods a great deal of débris is carried; hence it is necessary to keep a gate tender at the dam to regulate the flow in the canal and keep the dam clear of débris. The raising of the water 16 feet in the river by the diversion dam backs the water up almost three-quarters of a mile in the canyon and floods an area of 8.2 acres. On account of possible danger to the Denver and Rio Grande Railroad from backwater it was necessary to widen and protect the railroad embankment.

The intake to the power canal was constructed at one end of the dam on a hard, blue limestone foundation. The water enters the canal through six openings, $4\frac{1}{2}$ feet by 8 feet. The sills of these openings are 2 feet above the top of the sluice gates so that only the top or clearer part of the water is drawn into the canal. Before it enters the canal the water passes at slow velocity through a double-compartment sand box in which the heavier particles of silt are deposited. The sediment is sluiced from the bottom of the sand box through seven 12-inch round valves. This arrangement at the intake is made necessary by the fact that Spanish Fork River carries a heavy load of suspended matter when at high-water stage.

POWER CANAL

The power canal takes 500 second-feet of water from Spanish Fork River at the diversion dam and conveys it $3\frac{1}{4}$ miles along the foot of the mountains to the intake of the high-line canal. At this point 250 second-feet of water will be turned into the high-line canal, 60 second-feet will be diverted with a fall of 127 feet through the power house into the Salem canal, and the remaining 190 second-feet will be diverted with a fall of 166 feet through the lower power house into Spanish Fork River.

The canal is constructed over a rather rough country and includes two tunnels, two rock cuts, one aqueduct, and the open excavation work was about equally divided between lined and earth sections.

Construction of the power canal by force account was authorized on December 4, 1906; work was begun in May, 1907, and pursued with all possible diligence until October 1, 1907; a small force was employed on the excavation of tunnel No. 1 during the winter of 1907–8. The excavation was completed and the concrete work commenced in the spring of 1908. Water was first turned into the canal December 13 and through the pressure pipe December 15, 1908.

Open excavation was done with teams, plows, and scrapers, except at the portal cuts to the tunnels and the rock cuts, where wheelbarrows and small cars hauled by mules were used. The tramming for the tunnel excavation was done with mules and cars. On the concrete work the gravel and sand were hauled to the mixers with 4-horse teams and 2-yard Watson dump wagons, and the tramming from the mixers was done with cars pushed by hand. The concrete work in the tunnels was done from one setting of the mixer at one portal for each tunnel. In the canal lining 1,000 feet of canal was lined from one setting of the mixer.

Approximately 6,000 feet of the power canal are constructed with an earth section of the following dimensions: Bottom width, 19 feet; side slopes, $1\frac{1}{2}$ to 1; depth of water, 6.2 feet; velocity of water when canal is running full, 3 feet per second; capacity of canal at a depth of 6.2 feet, 550 second-feet; width of roadway on lower bank, from 10 to 14 feet.

About 8,264 feet of the canal were lined with plain concrete 6 inches thick placed without forms. The section is 4 feet wide on the bottom, has 1 to 1 side slopes, and was designed to carry a 6.2-foot depth of water at a velocity of 8 feet per second with a slope of 1 in 1,000. The lining extends 1 foot higher than the maximum water surface on tangents and 2 feet higher than the maximum water surface on curves.

Where a change is made from the lined section with a velocity of 8 feet per second to the earth section with a velocity of 3 feet per second the concrete lining extends 100 feet along the earth section, and the surface of the last 40 feet of the lining is roughened by small bowlders embedded in it to destroy eddies caused by the change in velocity. Where a change is made from earth section to lined section 55 feet of the earth section is lined, and the bottom width decreased gradually from 19 feet for the earth section to 4 feet for the lined section.

Approximately 900 feet of the canal lining were placed during the fall of 1907 and the remainder during the summer and fall of 1908. The gravel and sand used in the concrete were secured in part from several different gravel pits in the bed of Spanish Fork River and in part from a gravel pit leased from the Denver and Rio Grande Railroad Company.

A reenforced concrete aqueduct extends from station 47 plus 07 to station 54 plus 57 on the power canal. It is 750 feet long, and the alignment contains a number of curves. This part of the canal was designed for the regular concrete-lined section, but when the excavation had been 75 per cent completed a body of loose sand and gravel was encountered that made a different form of construction necessary. A rectangular aqueduct section was designed, having a width of 8 feet, a height of 10 feet, a wetted area of 68 square feet, a slope of 1 foot in 1,000, and a velocity of 7.6 feet per second and a capacity of 516 second-feet when running full. The concrete on the bottom is 8 inches thick and on the sides and top 12 inches thick. The concrete work on this structure was done during October and November, 1908, and the weather during the latter part of the time was very cold. A well equipped mixing plant was installed at the site of the aqueduct, and the gravel for concrete was secured in the bed of Spanish Fork River less than 1,000 feet distant.

Tunnel No. 1 on the power canal is 800 feet long and extends from station 6 to station 14, the alignment being straight. The tunnel was excavated to a 10-foot by 11½-foot section, the dimensions inside the 12-inch concrete lining being 8 feet by 7 feet, with an arched roof having a 2¼-foot rise. The tunnel has a capacity of 500 second-feet, estimated from a velocity of 9 feet per second, and a slope of 1.6 feet in 1,000 feet. The tunnel was timbered throughout with 8-inch by 8-inch timbers placed 2 to 4 feet on centers. The material encountered in the tunnel was a mixture of sand and gravel and large bowlders in the first 280 feet, a mixture of loose sand and gravel in the next 220 feet, and a mixture of earth and slate rock in the last 300 feet.

Excavation was commenced on the tunnel July 1, 1907, and completed February 29, 1908, and the lining was placed in May and June, 1908.

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Tunnel No. 2 extends from station 725 on the power canal a distance of 705 feet, its alignment having curves at both ends. This tunnel has the same section as tunnel No. 1 and is lined throughout with concrete 12 inches thick. The material encountered was a mixture of sand, red clay, and bowlders, sufficiently hard and compact to permit the heading to be driven from 5 to 6 feet ahead of the timbering. Some powder was used to loosen the material in the center of the face and the timbering was set 3 feet on centers. Work was commenced on this tunnel June 15 and completed October 9, 1907, Only one culvert was necessary on the power canal and this was built at station 138+97. It was constructed of reenforced concrete. The inside dimensions are 3½ feet by 3½ feet, and the total length of the culvert is 125 feet, its center line crossing the canal diagonally on account of the nature of the ground. It was built during April and May, 1908. The top of the culvert is 3 feet below the bottom of the canal, and a collar around the barrel of the culvert in the lower bank of the canal was extended into a core wall 70 feet long on account of the presence of unsatisfactory material in the canal bank at this point.

Six highway bridges were built in connection with the canal construction—one across Spanish Fork River, just below the diversion dam; one across the canal 1½ miles from the intake; one across the canal at mile 2½; and the other three across the tailrace and wasteway in the vicinity of the power house. The bridges across the canal are 3-panel truss bridges with a clear span of 37 feet. They are 14 feet wide and are double floored with 2-inch planks. The other highway bridges are wooden stringer bridges constructed in accordance with the standard plans of the Reclamation Service.

At the end of the power canal concrete diversion works provide a waste weir and wasteway channel, an intake for a high-line canal, and a power-house intake. These structures are built on a foundation composed of sandy, silty material, and the concrete is heavily reenforced throughout.

The waste weir has a length of 92 feet and the wasteway has sufficient capacity to carry the whole flow of the power canal. The wasteway is constructed of reenforced concrete 6 inches thick, is 835 feet long, 6 feet wide on the bottom and 4 feet deep, has side slopes of 1 to 1, and carries water at a velocity of 40 to 45 feet per second.

The wasteway has a fall of 127 feet to the crossing of the Salem canal, where a pool has been constructed to reduce the velocity of the water and to provide for diverting water to Salem canal when necessary. At the end of the wasteway another checking pool reduces the velocity of the water so that it may pass into Spanish Fork river without eroding the banks. The fall from Salem canal pool to the end of the wasteway is 46 feet.

Water passes directly from the power canal to the high-line canal, but the water diverted to the power house first goes through a double compartment sand box similar to that installed at the diversion dam. The flushing water from the sand box is carried under the canal bank through a reenforced concrete pipe 2 feet in diameter into the wasteway below the weir.

POWER PLANT

A hydro-electric power plant in Spanish Fork Canyon, with sufficient installation to develop 1,200 horsepower, was built primarily for the purpose of furnishing power for construction purposes on the project. The power-house site consists of a tract of 10 acres of land, about 3½ miles from the city of Spanish Fork, extending from 50 feet above the power canal to 100 feet beyond Spanish Fork River. Water is delivered from the power canal to the plant under a static head of 125 feet through a riveted steel pressure pipe 5½ feet in diameter and 346 feet in length from the pressure chamber to the nearest turbine. The generating equipment consists of two 425-kilowatt, rotating-field, 11,000-volt, three-phase generators, direct connected to 30-inch new American turbines of the horizontal type, with Lombard governors. Two 45-kilowatt direct-current generators, direct connected to 13-inch turbines similar to those of the main units, furnish exciting current for the main generators. The switchboard is equipped with double busses throughout. All switching is done at 11,000 volts by means of hand-operated oil switches mounted in cells behind the switchboard and controlled with the usual arrangement of bell cranks, rods, etc. A bank of three 100-kilowatt oil-cooled transformers deliver current at 22,000 volts to the transmission line leading to the substation at the west portal of the Strawberry tunnel. A panel has been provided for a 11,000-volt distributing circuit that at present supplies power to Spanish Fork.

The transmission line and the pressure pipe were constructed under contract. The remainder of the installation and construction was accomplished by force account.

The excavation for the power house was commenced May 19, and finished June 6, 1908.

Concrete work was commenced June 17 and finished July 7, 1908. Gravel hauled from the river bed was used without screening, one part of cement being used with 7.5 parts of gravel, and the mixing being done by hand.

Work on the power plant superstructure was commenced July 17, and the main part of the carpenter work was finished September 6, though the interior was not completed until about December 1, 1908. The building is 35 feet by 65 feet in plan and is constructed of corrugated iron on the outside of a frame made of 2 by 6 inch timbers, and plaster over metallic laths on the inside. The machinery was delivered on the Denver and Rio Grande Railroad about 8 miles up the canyon from the power house. The work of installation was begun August 5, when the main gate valves were raised into position, and the major part of the installation was completed by November 10, although a small amount of work was in progress up to December 15, 1908.

Work on the pressure pipe was commenced September 1 and completed November 23, 1908. The steel for the pipe arrived as loose sheets, rolled and punched. These were fitted and riveted into sections approximately 27 feet long and then hoisted to their approximate positions. The turbine feeder or lower end of the pressure pipe was placed in position first and then the sections of pipe were fitted together, the joints being bolted without riveting. The whole pipe was then carefully lined up, anchored, and riveted, and after thorough testing covered with earth to a minimum depth of 1 foot.

Water was first turned into the pressure pipe December 15, 1908. The transmission line was energized for the first time on January 7, 1909, when the motor-generator set at the substation was started and run for about two hours, and on January 8 the air compressor was started. On January 15 the operation of the whole power system was begun. Power is being furnished for the construction work at the west portal of the Strawberry tunnel, and for lighting and other purposes at the city of Spanish Fork. On the completion of the construction work the power that is developed will be used for lighting the several small towns on the project and for pumping water to lands lying above the gravity canals.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year 4,587 linear feet of excavation was accomplished at Strawberry tunnel, the total excavation to June 30, 1910, being 7,963 linear feet. Limestone and sandstone are the materials that have been encountered. During the early part of the fiscal year water was encountered in sufficient quantity to materially impede the progress of excavation. Practically all necessary machinery for excavating the tunnel has been installed and a part of the machinery for the concrete plant at the west portal has been delivered.

The canal power, power plant, and transmission lines have been operated throughout the fiscal year. A power transmission line $3\frac{1}{4}$ miles in length has been constructed from the power house to Spanish Fork, and current for lighting and other purposes has been supplied to Spanish Fork during the latter half of the fiscal year. The streams within the project and the existing canal systems have been gauged.

A number of orchards have been set out, and considerable improvement to the lands on the project has been made, although the water supply is still insufficient for thorough irrigation.

PRINCIPAL CURRENT CONTRACT

The following statement contains data relating to the principal contract in operation during the fiscal year ended June 30, 1910: No. 284; date April 21, 1909; contractor, General Electric Company, for electric locomotives, estimated value, $2,700; estimated earnings, June 30, 1910, $2,700; completion due, April 25, 1910.

FINANCIAL STATUS

Assets and libilities on June 30, 1910, Strawberry Valley project

ASSETS

Inventories:			
Mercantile store		$2,045.30	
Government animals	$2,333.75		
Less depreciation	1,308.75		
		1,025.00	
Equipment in use	21,387.85		
Less depreciation	6,721.74		
		14,666.11	
Storehouse		47,302.12	
Lumber		3,927.80	
Fuel		84.75	
Cash in office safe		134.35	
Unadjusted transfers		[a] 18,342.39	
Freight and handling, undistributed		412.45	
			$51,255.49

[a] Credit amount.

Cost of work:			
Building cost		$907,682.51	
Less adjustments	$42.92		
Less accrued revenues	26,867.31		
		26,910.23	
			$880,772.28
Total assets			932,027.77

LIABILITIES

Investment of the United States:			
Disbursement vouchers	943,073.83		
Transfer vouchers received	26,549.79		
		969,623.62	
Collection vouchers	50,034.85		
Transfer vouchers issued	6,410.86		
		56,445.71	
			913,177.91
Accounts payable:			
Unpaid labor		7,817.29	
Unpaid purchases		6,120.39	
Unpaid contract holdbacks		683.22	
Unpaid freight and express		4,055.51	
Unpaid passenger fares		126.60	
Unredeemed coupon books		46.85	
			18,849.86
Total liabilities			932,027.77

Feature costs to June 30, 1910, Strawberry Valley project

Storage works: Storage reservoir examination		$3,131.00
Strawberry tunnel:		
Heading No. 2	$301,811.26	
Tunnel surveys, alignment, and levels	982.14	
Surveys, reconnaissance	722.39	
Heading No. 2, tramway and concrete plant, equipment and installation	10,022.08	
East portal cut survey	120.00	
		313,657.87
Tunnel plant:		
Power-house tunnel	2,447.91	
Electric power-house construction	4,845.55	
Hauling and storing machinery	14,158.95	
		21,452.41
Power canal:		
Excavation, classes 1, 2, 3, and 4	136,028.18	
Driving and lining, tunnels Nos. 1 and 2	49,458.45	
Lining canal, resloping and cleaning	48,668.62	
Structures (aqueduct, culvert, station 139-03, wasteway and sand box), excavation and concrete	40,629.74	
Spanish Fork reservoir	4,492.68	
Spanish Fork diversion dam	39,695.90	
Spanish Fork River improvement	5,455.64	
Bridge over wasteway	273.52	
Bridge over tailrace	143.01	
Bridge 2a	563.57	
Bridge 3b	548.57	
Power canal improvements	6,166.92	
Upper bridge over wasteway	458.72	
Sidewalks and footbridges	785.16	
River bridge, canal diversion dam	2,524.60	
		335,893.28
Hydro-electric power plant:		
Excavation for building, concrete foundation, construction of buildings, and machinery installation	47,184.56	
Penstock construction	8,241.13	
Transmission line	24,277.98	
Spanish Fork power line	4,204.35	
Pumping plant, improvements	2,363.35	
Operation and maintenance during construction	1,350.00	
		87,621.37
High-line canal:		
Earth and rock work	8,863.21	
Head gates and diversion	481.19	
		9,344.40

Wagon roads:		
Diamond Fork, construction	$36,013.65	
Diamond Fork, maintenance	14,579.38	
		$50,593.03
Telephone system:		
Construction	13,643.04	
Maintenance	2,429.70	
		16,072.74
Real estate (rights and property): Lands purchased		7,705.50
Buildings:		
Camp Quinton, construction	32,237.36	
Diamond Switch camp, construction	5,425.85	
Power-house camp, construction	10,261.53	
Hammock Grove building, construction	919.20	
Camp construction, diversion dam	129.66	
Camp construction, Sulphur Springs	526.79	
		49,500.39
Irrigable lands:		
Topographic surveys	4,229.27	
Investigation of water rights	1,314.41	
		5,543.68
Examination of project as a whole: Hydrography		3,876.25
Inventory of unused supplies		3,290.59
Total building and operation and maintenance cost during construction, as per debit in cost of work in statement of assets and liabilities		907,682.51

WASHINGTON, OKANOGAN PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Okanogan.
Townships: 32 to 34 N., R. 25 to 27 E., Willamette meridian.
Railroad: Great Northern.
Railroad station: Oroville, Wash., 50 miles from project.
Average elevation of irrigable area: 1,000 feet above sea level.
Average annual rainfall on irrigable area: 8 inches.
Range of temperature on irrigable area: —10° F. to 105° F.

WATER SUPPLY

Source of water supply: Salmon Creek.
Area of drainage basin: 152 square miles.
Annual run-off in acre-feet of Salmon Creek at Jones ranch near Malott (152 square miles), 1904 to 1908: Maximum, 56,500; minimum, 24,600; mean, 37,200.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Salmon Lake—area, 200 acres; capacity, 2,000 acre-feet. Conconully—area, 460 acres; capacity, 13,000 acre-feet; length of spillway, 180 feet; elevation of spillway, 56 feet above stream bed.

Storage dam: Conconully—type, hydraulic earth fill; maximum height, 64 feet; length of crest, 1,000 feet; volume, 336,000 cubic yards.

Diversion dam: Salmon Creek—type, concrete weir; maximum height, 4 feet; length of masonry, 50 feet; length of earth fill, 80 feet.

Length of canals: None with capacities greater than 300 second-feet; 12 miles with capacities from 300 to 50 second-feet; 29 miles with capacities less than 50 second-feet.

Length of tunnel: 395 feet.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 10,000 acres; first unit, 2,047 acres; second unit, 6,108 acres.

Present status of irrigable lands (whole project): 1,234 acres entered subject to the reclamation act, 8,766 acres in private ownership.

Area for which the Service is prepared to supply water, season of 1910: 9,500 acres.
Area irrigated, season of 1910: 5,200 acres.
Length of irrigating season: 123 days.
Character of soil of irrigable area: Volcanic ash, sand, gravel.
Principal products: Fruit, hay, grain, and vegetables.
Principal markets: Local.

LANDS OPENED FOR IRRIGATION

Dates of public notices: November 12, 1908; March 12, 1910; April 8, 1910.

Location of lands opened: Townships 33 and 34 N., R. 26 E.; 34 N., R. 27 E., Willamette meridian.

Present status of irrigable lands opened: 1,234 acres entered subject to the reclamation act, 6,921 acres in private ownership.

Limit of area of farm units: Public, 40 acres; private, 40 acres.
Duty of water: $2\frac{1}{2}$ acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $65.
Annual operation and maintenance charge: $1.50 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.
Construction authorized by Secretary December 2, 1905.
Salmon Lake inlet and outlet completed July, 1908.
Conconully dam 99 per cent completed June 30, 1910.
Whole project 98 per cent completed June 30, 1910.

IRRIGATION PLAN

The irrigation plan of the Okanogan project provides for the storage of water in Salmon Lake and in Conconully reservoir controlled by Conconully dam on Salmon Creek about 2 miles below Conconully, Wash.; the control of Salmon Lake reservoir by a short inlet canal from Salmon River and concrete outlet works; the control of Conconully reservoir by means of an outlet tunnel discharging into Salmon Creek below the storage dam; and the diversion of water from Salmon Creek by a dam about 12 miles below the reservoir into a canal system watering lands in the valley of Okanogan River between Riverside and Okanogan, Wash.

ORIGIN OF PROJECT AND INVESTIGATIONS

Irrigation has been carried on in the valley of Okanogan River for a number of years in a small way, but the summer flow in recent years has been insufficient for satisfactory watering of the lands in cultivation. It became apparent, therefore, that storage would have to be resorted to before the reclamation of any considerable additional area could be provided for. After the passage of the reclamation act numerous petitions and requests were made by citizens of Okanogan County for an examination by the Reclamation Service as to the feasibiltiy of irrigating lands on the west side of the Okanogan River with water supply from Salmon Creek. In 1903 a reconnaissance was therefore made, lands were withdrawn from entry, and preliminary surveys were begun. A gaging station was established at Malott, Wash., on Salmon Creek. From May to November, 1903, two reservoir sites were surveyed, test pits were dug at the dam sites, topographic surveys were made of 11,000 acres of land, and a canal line located. During the winter of 1903 and 1904 maps were completed and the irrigable lands classified. Field surveys were resumed in 1904 and 1905, and two additional reservoir sites were surveyed and additional canal lines located. Other investigations were carried on and estimates of cost of construction made. A board of engineers consisting of Messrs. A. P. Davis, A. J. Wiley, D. C. Henny, and T. A. Noble considered the results of the investigations and surveys, and on April 27, 1905, recommended that the project be constructed if detailed investigations should establish the fact that the rough estimates of cost would not be materially exceeded, and provided that satisfactory arrangements could be made with the landowners and satisfactory adjustments of water rights effected. On October 9, 1905, a board of engineers consisting of Messrs. A. J. Wiley, Morris Bien, D. C. Henny, and Christian Andersen recommended that funds be allotted for construction of the project and that work be commenced as soon as formal agreements for water rights could be executed, that the organization of a water users' association and subscriptions of land be required, and that the limit of irrigable area of farm units be fixed at 40 acres and that contracts for disposal of excess lands be required from landowners holding more than 40 acres of lands. A water users' association was organized in October, 1905, and the other conditions having been complied with, the construction of the project was authorized by the Secretary of the Interior on December 2, 1905.

CONSTRUCTION

SALMON LAKE RESERVOIR

Salmon Lake is a narrow body of water 3½ miles long located on a tributary of the North Fork of Salmon Creek. It is utilized to store water between elevations 2,285 and 2,295 feet above sea level. An inlet canal 1,200 feet long, with a capacity of 13 second-feet, conducts water from the North Fork of Salmon Creek to the lake. The outlet from the lake consists of a simple concrete structure with an opening 3 feet wide and having its bottom at elevation 2,285. The structure extends 12 feet above this elevation, or 2 feet above the proposed maximum water surface in the lake. The water is discharged into the natural outlet channel of the lake and thence into the North Fork of Salmon Creek, near the upper end of Conconully reservoir. Plans for the inlet canal to Salmon Lake and the outlet works were included with the general plans for storage works and canals of the project, and were reviewed and approved in February, 1906, by a board of engineers consisting of Messrs. A. J. Wiley, D. C. Henny, E. G. Hopson, and Christian Andersen. Proposals for these works were advertised, to be opened on June 27, 1906. Only one proposal was received, however, and the bids being considered excessive, it was rejected. The storage works were readvertised under specifications No. 111, proposals to be opened on September 1, 1906. Only one proposal was received at this time, and it was also rejected and the construction of the works by force account authorized by the Secretary of the Interior. The inlet canal was constructed in 1906 and the outlet structure for Salmon Lake was built in 1907; the channel below the outlet was deepened and widened and in part riprapped in 1909.

CONCONULLY DAM

Conconully reservoir is formed by an earth dam 1,000 feet long and 64 feet high built across Salmon Creek a short distance below the confluence of its north and west forks and 2 miles from Conconully, Wash. The dam was constructed by the hydraulic-fill method, and is the only one so far constructed in that manner by the Reclamation Service. The dam has a top width of 20 feet and its crest is at elevation 2,297. On its upper face the dam has a slope of 3 to 1 from the base to a berm at elevation 2,270 and a slope of 2½ to 1 from the berm to the top. On the lower face the slope is 2 to 1. The outer portion of the dam on the lower side and the outer portion on the upper side to the height of the berm are composed of loose rock. The center of the embankment consists of sand and silt, with a puddled core of selected material; the remainder of the structure consists of rock, gravel, and sand. The main part of the dam rests on a foundation of well-compacted sand and silt and clay extending to a depth of at least 60 feet, as indicated by borings made during the investigations of the site. On the sidehills at the ends of the dam solid rock was found quite near the surface. In order to prevent percolation, a line of wooden sheet piling, 70 feet upstream from the center line of the dam, was driven to a depth of 33 feet, and at the ends of the dam cut-off trenches were excavated to bed rock and filled with puddled material along with the puddled core of the dam. A tunnel 8 feet square and 394½ feet long through a granite hill at the east end of the dam provides an outlet for the reservoir; a part of the tunnel amounting to 215 feet in length is lined with concrete about 12 inches thick, the inside dimensions being: Width, 6 feet; height at sides, 5 feet 2 inches; height in center, 6 feet. Near the upper end of the tunnel is a gate shaft, surmounted at the elevation of the top of the dam by a concrete gate house, from which a 36-inch gate controlling the discharge of the tunnel and a similar emergency gate are operated. Through a rock ridge 300 feet beyond the west end of the dam is a spillway with a concrete crest 180 feet long, at elevation 2,287, 10 feet below the crest of the dam. A concrete-lined rock channel on a slope of 2½ to 1, with bottom width of 14.3 feet, top width of 31 feet, and depth of 9½ feet, leads from the spillway to the channel of Salmon Creek, several hundred feet below the dam. The construction of Conconully dam, spillway, and outlet works was provided for in specification No. 89, and was readvertised under specification No. 111. After the rejection of the bids received under these specifications the work was authorized to be done by force account.

Construction work was begun on the dam in April, 1907, but on opening the cut-off trenches it was found that the material below the surface was unsuitable for a foundation; and on the recommendation of a board of engineers, who examined the work in May, 1907, a new site for the dam was selected 3,300 feet farther upstream. The change in site also involved extensive changes in the plans for the outlet works and spillway.

Work was begun at the new site in July, 1907, and during the season the dam site was cleared and grubbed; drainage and cut-off trenches were excavated; the outlet tunnel and gate shaft were driven; the excavation of the spillway was begun; sheet piling was driven by the aid of a water jet; crib dams were built on the south and west forks of Salmon Creek; and work was begun on over 3 miles of water supply flume to two borrow pits one-quarter mile south of the dam site; and nearly three-fourths of a mile of steel-lined sluicing flume, supported on trestles with bents from 30 to 96 feet high, was constructed to the dam site and along its entire length. During the winter of 1907–8 parts of the tunnel were lined with concrete, excavation of the spillway was continued, and the first-stage flumes for water supply and for sluicing material into the dam were completed.

Sluicing operations were begun in April, 1908, and during the season, with an available water supply averaging 15½ second-feet, about 100,000 cubic yards of material were sluiced into place. The water was delivered to the giants in the pits under a head of about 140 feet, and the grade of the sluicing flumes was 4 per cent. The lateral flumes on the dam were spaced 200 feet apart, and by this arrangement a pond or settling basin was formed on the dam which was drained at its ends into the reservoir. By a suitable arrangement of doors and screens in the flumes the coarse material was deposited on the outside of the dam and the fine material toward the center.

Sluicing was suspended on October 15, 1908. During the winter of 1908–9 the flumes were enlarged to 25 second-feet capacity, and the dirt flumes changed from curved to trapezoidal section and lined with high carbon steel. Preparations were also made to erect the second-stage flumes 30 feet above the first stage and with laterals 100 feet apart on the dam.

In 1909 about 177,000 cubic yards of material was placed in the embankment. During the flood season three shifts were employed, an electric-light plant being installed for night work with incandescent lights 50 feet apart above the flumes and three arc lights in each of the borrow pits. On account of the increased coarseness of the material in 1909 a puddled core 8 feet wide was begun at elevation 2,252 and carried up to elevation 2,291, 6 feet below the crest of the dam. The material for this core was transported by wheel scrapers from the bed of the creek below the dam to a platform at one end of the dam, from which it was sluiced into place between wooden diaphragms 8 feet apart along the center line of the embankment.

In 1910 about 49,000 cubic yards of material was placed in the dam, which was completed on June 30, except for cleaning up, dressing the slopes, and dismantling the trestles.

The excavation of the spillway and spillway channel, involving the removal of 26,000 cubic yards of limestone, soapstone, and decomposed granite, was completed in July and the placing of concrete in these structures was completed in September, 1908. The gate shaft was lined with concrete, and concrete lining in the tunnel was completed in October, 1908. In the spring of 1909 a temporary wooden gate was installed in the gate chamber for the purpose of controlling a small amount of water stored in the reservoir for irrigation during the season. In the fall of 1909 the permanent cast-iron gates with operating rods and floor stands were installed and in the spring of 1910 a reenforced concrete gate house with a corrugated galvanized iron roof was erected over the gate shaft.

CANAL SYSTEM

About 12 miles below the Conconully reservoir a concrete weir, 50 feet long and 4 feet high, and a low earth embankment 80 feet long across the channel of Salmon Creek serve to divert its waters into the inlet of the main canal on the north bank of the stream. The intake is a plain rectangular opening 6 feet wide between concrete wing walls and is regulated by means of flash boards.

The main canal has a capacity of 100 second-feet and extends for about 2 miles in a southeasterly direction to the junction of the main high-line and main low-line canals. The main high-line canal extends in a northeasterly direction for about 11 miles and furnishes water to the upper bench lands. The main canal and main high-line canal were constructed in part on a bench blasted from the face of the cliff, the outer bank consisting of a concrete wall or a rubble wall lined with concrete. A drop of 105 feet passes water to the main low-line canal, which is about 8 miles in length, and furnishes water to the lower bench lands of the project extending in a northeasterly direction nearly to the Okanogan River. The distributing system consists of about 21 miles of laterals and sublaterals.

Plans and specifications for the construction of the main canal and the main high-line canal were included in specifications No. 89, bids under which were rejected. The grading for the main canal and main high-line and low-line canals was done under nine informal contracts and the work was begun in September, 1906, and finished November 13, 1907, about 240,000 cubic yards of material being excavated. The structures were built and the concrete lining was placed by force account. The diversion dam was built in the fall of 1906 and the other concrete structures and concrete canal lining between June and November, 1907. The distributing laterals and sublaterals, involving the excavation of about 90,000 cubic yards of material, were built under twelve informal contracts during the summer and fall of 1907 and the early spring of 1908.

Wooden measuring devices, consisting of rating flumes and Cippoletti weirs with galvanized iron edges, were constructed during the past year at the entrances to all turnouts from all canals and laterals.

IRRIGATION AND SETTLEMENT

In the season of 1908 the low-water flow of Salmon Creek was delivered to lands having old water rights and a small amount of flood water was delivered under rental contracts to other lands under the newly constructed government canals. By a public notice dated November 12, 1908, the first unit of the project, containing 2,047 acres of irrigable land, was opened to irrigation for the season of 1909, and during that season about 4,000 acre-feet of stored water was utilized in addition to the delivery of the low-water flow to the lands covered by old water rights and the delivery of flood water to other lands under rental contracts. By a public notice dated March 12, 1910, a second unit of the project, containing 6,108 acres of irrigable land, was opened to irrigation. On May 1, 1910, the delivery of water to the first and second units of the project and to old water-right lands was begun and continued without interruption until the end of the fiscal year. On June 30 the reservoirs contained 8,000 acre-feet of water. During the season of 1909, 3,473 acres of land, of which about 1,350 acres were under old water rights, were irrigated, and during the season of 1910 about 5,000 acres are being served with water. The rotative system of irrigation has been adopted, and deliveries of water are made in periods of 8 days with intervals of 8 days between. This plan is found to be effective in economizing the use of water and in giving opportunities to water users to properly cultivate their lands in the periods when water is not available.

The development of the project has been rapid. There were few settlers when the Government first began operations, and there are now located on the project about 300 families, making a population of about 1,200 people. A branch of the Great Northern Railroad is being constructed through the valley of Okanogan River, and when completed will aid in the development of the project.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year 124,000 cubic yards of material, including a greater part of the puddled core of 11,600 cubic yards, was placed in the Conconully dam, permanent gates were installed in the outlet tunnel, a concrete gate house was constructed, the outlet channel from Salmon Lake reservoir was deepened and widened for a distance of 900 feet, measuring devices were installed, examinations, surveys, and estimates were made for the enlargement of Salmon Lake reservoir to a capacity of 9,000 acre-feet by the construction of an earth dam at the lower end of the lake, and the reservoirs and canals have been maintained and operated for the irrigation of lands on the project.

In addition to new orchards planted during the year, containing 70,240 trees, of which 48,500 are apple trees, a number of other crops, principally alfalfa, timothy, and fruit were raised in 1909 and found a ready market. The yields secured were generally very good, and the prospects for good crops during the season of 1910 are excellent.

PUBLIC NOTICE DATED MARCH 12, 1910

In pursuance of the provisions of section 4 of the reclamation act approved June 17, 1902 (32 Stat., 388), notice is hereby given that water will be furnished in the irrigation season of 1910 for lands included in the extension of the irrigable area of the Okanogan project, Washington, shown on farm unit plats of Willamette meridian, T. 34 N., R. 26 E.; T. 34 N., R. 27 E., approved by the Secretary of the Interior February 28, 1910, and on file in the local land office at Waterville, Wash.

Homestead entries, applications for water rights, the charges, time, and manner of payments will be governed by the terms of the existing public notices and orders issued affecting the said project, except that for lands hereafter entered the second installment shall be due on May 1 of the year after that in which entry is made, and subsequent installments shall be due on May 1 of each year thereafter until fully paid.

For lands in private ownership and for lands heretofore entered, the first installment shall be due May 1, 1910, and subsequent installments on May 1 of each year thereafter until fully paid.

PUBLIC NOTICE DATED APRIL 8, 1910

The public notice of November 12, 1908, announcing the irrigability of lands in the Okanogan project, Washington, constructed under the provisions of the reclamation act of June 17, 1902 (32 Stat. 388), contains a provision to the effect that for all applications for water rights filed after June 15 in any year, one installment of the charges for building, operation and maintenance must be paid at the time of filing, but the portion for operation and maintenance shall be credited on account of the installment of said charges for the subsequent year.

Such provision is hereby revoked so far as it may affect any entries or water-right applications hereafter made for irrigable lands in said project, leaving in effect all other provisions of the public notices and orders heretofore issued for said project.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Okanogan project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$52,224.33	
Uncollected water-right operation and maintenance charges		3,001.50	
			$55,225.83
Inventories:			
Government animals		480.00	
Equipment in use		7,296.12	
Cement		804.25	
Lumber		231.59	
Fuel		39.60	
Local products		573.37	
Unadjusted transfers		31.43	
Freight and handling undistributed		387.92	
			9,844.28
Cost of work:			
Building cost	$555,637.49		
Plus adjustments	106.25		
		555,743.74	
Less accrued revenues		2,466.50	
			553,277.24
Operation and maintenance cost		12,659.72	
Less accrued revenues		2,316.87	
			10,342.85
Total assets			628,690.20

LIABILITIES

Investment of the United States:			
Disbursement vouchers	$557,740.31		
Transfer vouchers received	17,885.19		
		$575,625.50	
Collection vouchers	31,662.05		
Transfer vouchers issued	5,682.04		
		37,344.09	
			$538,281.41
Accounts payable:			
Unpaid labor		5,624.53	
Unpaid purchases		2,228.54	
Unpaid freight and express		349.61	
Unpaid passenger fares		414.71	
Unpaid land agreements		70.00	
Unpaid miscellaneous		121.00	
			8,808.39
Repayments accrued:			
Building		66,297.40	
Operation and maintenance		15,303.00	
			81,600.40
Total liabilities			628,690.20

Feature costs to June 30, 1910, Okanogan project

Salmon Lake reservoir:		
Inlet canal	$1,619.25	
Outlet works	2,703.93	
		$4,323.18
Conconully reservoir:		
Real estate	27,781.32	
Clearing reservoir site	6,776.84	
Conconully dam	178,600.26	
Spillway	30,607.35	
Outlet works	19,844.98	
		263,610.75
Diversion system:		
Diversion weir	3,517.07	
Main canal, main lateral, and sublaterals	179,435.12	
		182,952.19
Roads and highways: Roads to dam site		903.50
Buildings:		
Construction	3,502.31	
Maintenance	4,223.64	
		7,725.95
Telephone system:		
Construction	2,881.70	
Maintenance	7.50	
		2,889.20
Irrigable lands: Farm-unit subdivision		1,596.11
Examination of project as a whole:		
Preliminary examination	35,438.15	
Hydrography	238.93	
		35,677.08
Administration of project as a whole: General expense		53,731.10
Inventory of unused supplies		2,228.43
Total building cost		555,637.49
Operation and maintenance:		
Diversion system	11,540.84	
Buildings	913.75	
Telephone system	205.13	
		12,659.72
Total building and operation and maintenance cost as per debit in cost of work in statement of assets and liabilities		568,297.21

WASHINGTON, YAKIMA PROJECT

LOCATION AND CLIMATIC CONDITIONS

Counties: Yakima, Benton, and Kittitas.

Townships: 8 to 21 N., Rs. 11 to 28 E., Willamette meridian.

Railroad: Northern Pacific; Chicago, Milwaukee and St. Paul.

Railroad stations: Grandview, Sunnyside, Outlook, Granger, Mabton, Byron, Ellensburg, Thorp, Yakima, North Yakima, Naches, Alfalfa, Toppenish, and Parker, Washington.

Average elevation of irrigable area: 1,000 feet above sea level.

Average annual rainfall on irrigable area: 8 inches.

Range of temperature on irrigable area: —21° F. to 110° F.

WATER SUPPLY

Source of water supply: Yakima River and its tributaries.

Area of drainage basin: 5,050 square miles.

Annual run-off in acre-feet of Yakima River at Union Gap (3,300 square miles), 1896 to 1908: Maximum, 4,370,000; minimum, 2,440,000; mean, 3,500,000.

ENGINEERING DATA FOR STORAGE, SUNNYSIDE, TIETON, AND WAPATO UNITS

Reservoirs: Bumping Lake—area, 1,300 acres; capacity, 34,000 acre-feet; length of spillway, 235 feet; elevation of spillway, 40 feet above stream bed. Lake Clealum—area, 5,000 acres; capacity, 426,000 acre-feet; length of spillway, 407 feet; elevation of spillway, 130 feet above stream bed. Lake Kachess—area, 4,800 acres; capacity, 210,000 acre-feet; length of spillway, 250 feet; elevation of spillway, 58 feet above stream bed. Lake Keechelus—area, 2,600 acres; capacity, 142,000 acre-feet; length of spillway, 287 feet; elevation of spillway, 54 feet above stream bed. McAllister Meadows—area, 1,800 acres; capacity, 115,000 acre-feet; length of spillway, 250 feet; elevation of spillway, 150 feet above stream bed.

Storage dams: Bumping Lake—type, earth fill; maximum height, 50 feet; length of crest, 3,500 feet; volume, 231,000 cubic yards. Lake Clealum—type, earth fill; maximum height, 140 feet; length of crest, 1,200 feet; volume, 660,000 cubic yards. Lake Kachess—type, earth fill; maximum height, 68 feet; length of crest, 1,400 feet; volume, 250,000 cubic yards. Lake Keechelus—type, earth fill; maximum height, 64 feet; length of crest, 6,400 feet; volume, 480,000 cubic yards. McAllister Meadows—type, rock fill; maximum height, 160 feet; length of crest, 900 feet; volume, 450,000 cubic yards.

Diversion dams: Sunnyside—type, concrete ogee weir; maximum height, 8 feet; length, 500 feet. Tieton River—type, concrete and rock-filled crib; maximum height, 3 feet; length of masonry, 110 feet; length of earth and rock fill, 320 feet. Wapato—type, concrete weir; maximum height, 8 feet; length of masonry, 500 feet.

Length of canals: Sunnyside unit—50 miles with capacities greater than 300 second-feet; 33 miles with capacities from 300 to 50 second-feet; 400 miles with capacities less than 50 second-feet. Tieton unit—12 miles with capacities greater than 300 second-feet; 34 miles with capacities from 300 to 50 second-feet; 240 miles with capacities less than 50 second-feet. Wapato unit—30 miles with capacities greater than 300 second-feet; 50 miles with capacities from 300 to 50 second-feet; 178 miles with capacities less than 50 second-feet.

Aggregate length of dikes: Sunnyside unit, 1,600 feet; Tieton unit, 1,150 feet; Wapeto unit, 2,000 feet.

Aggregate length of tunnels: Tieton unit, 11,000 feet.

Water power: 2,000 horsepower developed on Sunnyside unit; estimated total of 4,000 horsepower on Tieton unit and 9,000 horsepower on Wapato unit.

AGRICULTURAL CONDITIONS

Irrigable area: Benton unit, 150,000 acres; Kittitas unit, 62,000 acres; Sunnyside unit, 100,000 acres; Tieton unit, 35,000 acres; Wapato unit, 116,000 acres.

Present status of irrigable lands: Benton unit—none entered subject to the reclamation act or open to entry, 43,000 acres withdrawn from entry, 15,000 acres of state lands, 92,000 acres in private ownership. Kittitas unit—none entered subject to the reclamation act or open to entry, 5,500 acres withdrawn from entry, 6,500 acres of state lands, 50,000 acres in private ownership. Sunnyside unit—1,085 acres entered subject to the reclamation act, 6,710 acres withdrawn from entry, 2,880 acres of state lands, 89,000 acres in private ownership. Tieton unit—none entered subject to the reclamation act or open to entry, 2,200 acres withdrawn from entry, 2,300 acres of state lands, 30,500 acres in private ownership. Wapato unit—116,000 acres of Indian lands.

Area for which the service is prepared to supply water, season of 1910: Sunnyside unit—50,000 acres; Tieton unit—10,000 acres.

Area irrigated, season of 1910: Sunnyside unit—48,600 acres; Tieton unit—2,000 acres; Wapato unit—15,000 acres from Indian canals.

Length of irrigating season: Sunnyside and Wapato units—210 days; Tieton unit—150 days.

Character of soil of irrigable area: Sandy loam, gravel, and volcanic ash.

Principal products: Forage, hops, fruits, and vegetables.

Principal markets: Seattle, Tacoma, and Spokane, Wash.; eastern cities.

LANDS OPENED FOR IRRIGATION, SUNNYSIDE UNIT

Dates of public notices: November 18, 1908; March 2, 1909; April 18, 1910; April 19, 1910; May 2, 1910.

Location of lands opened: Tps. 8 to 11 N., Rs. 20 to 25 E., Willamette meridian.

Present status of irrigable lands opened: 1,085 acres entered subject to the reclamation act, none open to entry, 227 acres of state lands, 18,543 acres in private ownership.

Duty of water: 3 acre-feet per acre per annum at the farm.

Limit of area of farm units: Public, 80 acres; private, 160 acres.

Building charge per acre of irrigable land: $52.

Annual operation and maintenance charge: $0.95 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnaissance and preliminary surveys begun in 1903.

Board report October 16, 1905.

Construction authorized by Secretary: Sunnyside and Tieton units, December 12, 1905; Wapato unit, June 16, 1906.

Sunnyside canal purchased June 23, 1906.

Lake Kachess dam (temporary crib) purchased December 12, 1906.

Lake Keechelus dam (temporary crib) completed April, 1907.

Sunnyside diversion dam: Reconstruction completed October, 1907.

Lake Clealum dam (temporary crib) completed November, 1907.

Tieton diversion dam completed December, 1908.

First irrigation by Reclamation Service: Sunnyside unit, season of 1907; Tieton unit, season of 1910.

Tieton main canal completed in 1909.

Bumping Lake dam 40 per cent completed June 30, 1910.

Per cent completed June 30, 1910: Storage unit, 11; Sunnyside unit, 45; Tieton unit, 73.

IRRIGATION PLAN

The irrigation plan of Yakima project provides for the storage of flood waters of Yakima River and its tributaries in Kachess, Keechelus, Clealum, and Bumping lakes and in a reservoir at McAllister Meadows; the diversion of water from Yakima River near Prosser for the irrigation of 150,000 acres of land lying along the west bank of Columbia River and on both sides of Yakima River, comprising the Benton unit; the diversion of water from Yakima River for the irrigation of 62,000 acres of land on both sides of the river in the vicinity of Ellensburg, comprising the Kittitas unit; the diversion of water from the east bank of Yakima River near Parker for the irrigation of 100,000 acres of land watered by means of the old Sunnyside canal as improved and extended by the Reclamation Service, comprising the Sunnyside unit; the diversion of water from Tieton River below McAllister Meadows for the irrigation of 35,000 acres of land lying between Naches River and Atanum Creek in the vicinity of North Yakima, comprising the Tieton unit; and the diversion of water from the west bank of Yakima River near Parker for the irrigation by means of the canal system of the Yakima Indian Reservation, as improved and extended by the Reclamation Service, of 100,000 acres of land by gravity and 16,000 acres of land by pumping with power developed at drops in the canals, comprising the Wapato unit. The plan also provides for the development of power from drops on the main canals and laterals of the Sunnyside and Tieton units, to be used for pumping irrigation water and for other purposes.

ORIGIN OF PROJECT AND INVESTIGATIONS

Irrigation in Yakima Valley was begun in 1867, since which date water has been appropriated and canals have been built from time to time until at the time of passage of the reclamation act filings had been made for the entire flow of Yakima River and about 50,000 acres of land were being irrigated. The first examination of the project by the Reclamation Service was made early in 1903 and although many petitions from residents of the valley requesting irrigation development in the Yakima basin by the Government had been received, the water rights of the existing irrigation systems were so conflicting and the general plan of irrigation development so chaotic that it was not considered advisable for the Reclamation Service to undertake a project until a settlement of conflicting rights could be effected. During 1904 and the greater part of 1905, general investigations relating to water supply and irrigable areas were made and a unified plan for the development of the valley as a whole by means of storage and various diversions was developed. By the latter part of 1905 the settlement of conflicting rights had proceeded so far that it was feasible for the Reclamation Service to undertake construction. On April 22, 1905, a board of engineers consisting of Messrs. A. P. Davis, D. C. Henny, A. J. Wiley, and T. A. Noble, after examination of the project and the plans that had been developed, recommended that detailed surveys for the storage unit be made; that investigation of the possibilities for the enlargement and extension of the Sunnyside canal with the view to securing this system and its water rights for the development of the Lower Yakima Valley be undertaken; that preliminary surveys and investigations relative to the feasibility and cost of the Kittitas, Tieton, and Benton units be continued; that the proposed contract between the irrigators of the Yakima basin and the Secretary of the Interior, limiting the existing water rights to present use, be approved, and that the agreement of the irrigators thereto be obtained as a preliminary to undertaking any work in Yakima basin; and that before any considerable expenditures are incurred, a written agreement be secured from the owners of the Northern Pacific Railway grant insuring a satisfactory disposal of the railway lands within the project.

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On June 9, 1905, a board of engineers consisting of Messrs. D. C. Henny and T. A. Noble submitted a report on the status of the project and on October 16 a board of engineers consisting of Messrs. A. P. Davis, A. J. Wiley, Morris Bien, D. C. Henny, and Joseph Jacobs recommended the construction of the Tieton unit, including the necessary storage development. On October 31, 1905, a board of engineers consisting of Messrs. A. P. Davis, A. J. Wiley, and D. C. Henny recommended the purchase of the Sunnyside canal system and the development of the Sunnyside unit, subject to the securing of satisfactory agreements with the water users, and that the Benton and Kittitas units receive consideration when funds should become available for their construction. On December 12, 1905, the Secretary of the Interior authorized the construction of the Sunnyside and Tieton units on condition that conflicting claims of water appropriators be adjusted, that pending litigation tending to restrict the development of the project be settled and that the settlement, termination, and disposition of any other difficulties, conflicts, litigation, complications, or controversies that would in any way tend to embarrass or restrict the operation and use of waters necessary for the irrigation of lands under the Yakima project and in the Yakima Indian Reservation be secured and that a sufficient acreage be pledged to secure the return to the reclamation fund of the cost of construction.

CONSTRUCTION

STORAGE RESERVOIRS

Bumping Lake, located at the head of Bumping River, a tributary of Naches River, at an altitude of 3,400 feet above sea level, will have a surface area of 1,300 acres and a storage capacity of 34,000 acre-feet. The reservoir will be formed by an earth-fill dam having a maximum height of 50 feet, a crest length of about 3,500 feet, and a volume of 231,000 cubic yards. A spillway 235 feet long, about 40 feet above the stream bed, is provided for the disposal of excess flood water. The first attempt at the construction of a dam at this location was made by the Northern Pacific, Yakima and Kittitas Irrigation Company in 1894. Timber for the construction of a crib dam was cut, but lack of funds prevented further development. Proposals under specifications No. 118 for the construction of the earthen dam described above were requested by the Reclamation Service for opening on November 15, 1906. No proposals were received and the work was readvertised under specifications No. 144, to be opened July 1, 1907, but no proposals were received at that time. A road to the dam site was begun in the summer of 1906 by the state and county organizations and was completed by the Reclamation Service by force account on December 10, 1908. About the same time a telephone line to the dam site was completed. Preparatory work at the dam site, including the clearing of the site and building of camp structures, and purchase and hauling of equipment and supplies was begun as soon as the road was completed. Construction work on the dam was begun May 17, 1909. The placing of concrete in the outlet conduit was begun on August 6, 1909, and was completed prior to the suspension of work for the season in the latter part of November. At that time 55,000 cubic yards of material had been placed in the embankment. Work was resumed in the spring of 1910 and is being continued.

Lake Kachess is located on the headwaters of Kachess River, a small tributary of Yakima River, at an altitude of 2,200 feet above sea level. The lake will be developed by an earth-fill dam with a maximum height of 68 feet, a crest length of 1,500 feet, and a volume of about 250,000 cubic yards and will have a surface area of 4,800 acres and a storage capacity of 210,000 acre-feet. A spillway 250 feet long and 58 feet above stream bed provides for the discharge of excess water. Surveys for water storage at Lake Kachess were made by the Northern Pacific, Yakima and Kittitas Irrigation Company and the Yakima Development Company, but construction was not undertaken by these companies. On May 30, 1903, the Cascade Canal Company commenced the construction of a crib dam at the mouth of the lake, this work being completed on June 1, 1904. An agreement with the Cascade Canal Company was made by the Reclamation Service and the Service assumed control of this dam on April 1, 1907. Further developments at Lake Kachess will be undertaken by easy stages. The first stage consists of strengthening the present crib dam and excavating the outlet, taking water from the lake to about 10 feet below its present low-water level. The second stage includes a further excavation of this outlet to about 25 feet below the present low-water level, and the third stage includes the construction of an earth dam raising the water level of the lake about 33 feet. The dredging of the narrows of the upper end of the main lake and the construction of a feeder canal to Lake Keechelus may be undertaken.

Lake Keechelus is located at the headwaters of Yakima River at an altitude of 2,500 feet above sea level. An earth-fill dam with a maximum height of 64 feet, a crest length of 6,400 feet, and a volume of about 480,000 cubic yards will be built at the outlet of the lake, increasing its area to 2,600 acres and its storage capacity to 142,000 acre-feet. A spillway 287 feet long and 54 feet above the stream bed provides for the discharge of surplus water. Early attempts were made to obtain storage at this lake by the Northern Pacific, Yakima and Kittitas Irrigation Company followed by the Cascade Lumber Company, which constructed a small dam for logging purposes. In order to provide temporary storage at Lake Keechelus, the construction of a crib dam by the Reclamation Service was authorized. Advertisement for proposals for this work was twice made but no satisfactory bids were received and the construction was undertaken by force account in the fall of 1906, and was completed on April 19, 1907. This dam is of the crib overflow type with three 4-foot by 6-foot openings controlled by flashboards and raises the lake level about 10 feet, thus providing a storage capacity of approximately 15,000 acre-feet. Further investigations for the construction of permanent works will be undertaken during the summer of 1910.

Lake Clealum is located on Clealum River at an altitude of 2,100 feet above sea level, and an earth-fill dam with a maximum height of 140 feet, a crest length of 1,200 feet, and a volume of about 660,000 cubic yards will be built at the outlet of the lake, increasing its area to 5,000 acres and its storage capacity to 426,000 acre-feet. A spillway 407 feet long will be provided at an elevation of 130 feet above the stream bed. Surveys and cutting of timber for the construction of a dam at Lake Clealum were undertaken by the Northern Pacific, Yakima and Kittitas Irrigation Company and by the Washington Irrigation Company. In March, 1905, the construction of a low crib dam was begun by the Union Gap Irrigation Company; but this dam was destroyed by the Washington Irrigation Company. Agreements with these companies were made by the Reclamation Service and plans were prepared for a temporary crib dam similar to that at Lake Keechelus. No satisfactory proposals for the work being received, construction was begun by force account in the fall of 1906 and completed November 9, 1907. This dam is of the crib overflow type with a spillway 200 feet long and five 4-foot by 6-foot openings controlled by flashboards and raises the level of the lake about 12 feet, thus providing a storage capacity of about 23,000 acre-feet. The construction of the large permanent dam will be undertaken when funds are available and the storage capacity is required.

McAllister Meadows is located on Tieton River at an altitude 2,800 feet above sea level. A reservoir with an area of 1,800 acres and a capacity of 115,000 acre-feet can be formed by means of a dam 160 feet high and having a crest length of 900 feet. Plans for this dam have not been adopted, but the studies so far made seem to show a rock-fill type of dam to be most feasible. The estimated amount of material required for a rock-fill dam of the dimensions given is 450,000 cubic yards. The preliminary plans also provide for a spillway 250 feet long at an elevation 150 feet above the bed of the stream.

SUNNYSIDE CANAL SYSTEM

The Sunnyside canal system was acquired by purchase from the Washington Irrigation Company in December, 1905. The system at that time consisted of a movable diversion dam and wooden headworks structure, a main canal about 57 miles long, two main laterals having an aggregate length of about 25 miles, about 50 miles of smaller laterals, headquarters buildings, a telephone system 58 miles in length and a wasteway at Zillah. The first construction undertaken by the Reclamation Service was the building of a new diversion dam and headworks. The old dam consisted of a series of steel-hinged brackets fastened to a concrete foundation and spaced 6 feet apart across the entire length of the crest. The brackets extended 6 feet above the concrete floor of the dam and served to support flashboards placed on the inclined upstream face of the brackets. During periods of high water the flashboards were removed and the brackets laid flat on the concrete foundation. At the north end of this dam near the shore of the river a masonry gatehouse served as one abutment to the dam and between the gatehouse and the river bank were located timber headworks resting on a concrete floor. The new dam is a concrete ogee weir 8½ feet high and 20 feet wide, including the apron. The total length of the weir between abutments is 500 feet or 140 feet longer than the old structure. The old gate house was retained but was raised 6 feet and enlarged by a wooden addition. The old headworks were replaced by a concrete structure in which six cast-iron gates 6 feet square were installed. Emergency gates of the Taintor type were also installed just below the cast-iron gates. The head-gate openings were designed for a capacity of about 1,075 second-feet, or about 65 per cent greater flow than was provided for by the old gate openings. A fish ladder was constructed on the south side of the gatehouse and 25 feet from this ladder a 6-foot sluice opening of the full height of the weir and controlled by flashboards was provided. A dike on the south side of the river 10 feet wide on top and extending upstream for nearly a mile prevents the overflow of adjacent lands during high-water stages of the river. The dam and headworks were constructed by force account, work being commenced in October, 1906. The first concrete was placed in the headworks on February 8, 1907, and they were finished about March 1, 1907. The fish ladder and paving were completed during March and April, and the entire construction work was completed on October 15, 1907. Most of the material excavated for the weir and abutment was saturated and the use of a 12-horsepower gasoline engine and a 6-inch centrifugal pump was constantly required. A concrete mixing plant, consisting of a 4-horsepower gasoline engine and a ¼-yard mixer was installed at the south end of the dam. Raw materials for concrete were hauled in wagons to a platform above the mixer and were then shoveled into bins from which chutes led into measuring boxes, which could be emptied into the mixer. The concrete was dumped from the mixer into cars running on a narrow-gage track built on a wooden trestle just above the dam so that the cars could be dumped directly into the forms. The dam was constructed in 24-foot lengths within cofferdams built of sacks, forming inclosures 75 feet to 100 feet in length and 30 feet in width. A Smith tilting concrete mixer operated by an 8-horsepower gasoline engine was installed on the north side of the river, and during the latter part of the construction work this plant furnished all of the concrete used.

About 17 miles below the head gates the main canal approaches to within 2,200 feet of Yakima River and at this location the former owners of the Sunnyside canal had built a wooden wasteway structure with flashboard control and had excavated a channel to the river. The works were known as the Zillah wasteway and about 500 feet of the channel was a covered concrete conduit, but the greater part was an open earth cut that eroded to such an extent that the use of the wasteway was discontinued several years before the Government acquired the system. The construction of a new wasteway at this location was begun by the Reclamation Service in the spring of 1907 and completed February 1, 1908. The wasteway as constructed consists of a concrete headworks structure about 879 feet long and a trapezoidal channel with a 6-inch concrete lining extending to the 500-foot concrete conduit previously constructed. This conduit discharges into a wooden flume 7 feet wide, 6 feet deep, and 700 feet long extending to Yakima River. The headworks structure consists of a drop chamber 20 feet by 50 feet in plan with an average depth of 8 feet. On the upstream side of this chamber and practically on the center line of the main canal is a weir wall 48 feet long having its crest approximately 4 feet above the bottom of the canal and being divided into 8 bays by brackets located 6 feet apart and anchored to piers back of the main canal weir wall. Each of these brackets has a set of flashboard grooves on the upstream face. The downstream wall of the drop is an unobstructed weir having its crest about 2 feet lower than that of the upstream wall. On the side of the canal, opposite the outlet gates and parallel to the center line of the main canal, is the north abutment of the spillway head-gates structure, consisting of a concrete wall 27 feet long, 18 inches thick at the top, and $4\frac{1}{2}$ feet thick at the base, and having at either end a concrete wing wall 17 feet long extending well into the bank of the canal. Water is admitted into the wasteway through four 4 by 5-foot gate openings. The fall from the water surface in the main canal to the bottom of the wasteway channel is about 15 feet and is utilized to run a turbine for the operation of the gates. The wasteway is designed for a capacity of 1,000 second-feet, the velocity of the waste water increasing from 13 feet per second at the headworks to about 40 feet per second at the river.

Sulphur Creek wasteway is a combined wasteway and drainage channel to carry surplus water from the main canal and to drain lands in the vicinity of Sunnyside. This wasteway heads about 37 miles from the headworks of the canal and about 20 miles from Zillah wasteway. The outlet from the main canal is a reinforced concrete structure similar to that at the Zillah wasteway. The capacity of Sulphur Creek wasteway is 515 second-feet. In the first mile the channel is lined with concrete and the velocity of the waste water increases from 10 to about 22 feet per second. At the end of the lined section a check basin reduces the velocity of the water and discharges it into an earth section 7 miles in length in which are installed 21 concrete drops. Proposals for the excavation of the lower part of the wasteway were opened on July 15, 1908, and a contract for the work executed on August 15, 1908. Fair progress was made by the contractors on the excavation but practically nothing was done on the concrete drops. The contractors abandoned work in June, 1909, and the contract was suspended on June 19. The work was readvertised and a contract for its completion was entered into on June 30, 1909. The excavation was about 75 per cent completed and 2 of the 21 concrete drops were nearly finished when the new contractor abandoned the work on June 27, 1910. The contract was suspended a few days later and plans made to complete the work by force account. A subchannel lined with wood is being constructed by force account throughout the lower section of the wasteway, about 3 miles having been completed by June 30, 1910. A wooden outlet drop, discharging water into Yakima River, 7 of the 14 wooden highway bridges over the wasteway, and the headworks structures have been built by force account. Proposals for the lined section of the wasteway were opened on July 30, 1909, and a contract for the construction was executed. The contractor began work in September and on June 30, 1910, about 80 per cent of the excavation had been completed and 600 feet of concrete lining had been placed.

The main Sunnyside canal acquired by the Reclamation Service required enlargement and improvements to enable it to meet the requirements of the new system. The construction of 14 concrete drops was accomplished in the winter of 1907–8. During the winter of 1908–9 nine concrete culverts, out of a total of 18 that had been planned from the tenth to the fortieth mile, were constructed to provide for the passage of cross drainage. The turn-outs on the old canal, of which there were about 200, were constructed of wood and are gradually being replaced with permanent concrete structures. Eleven new turn-outs were built during the winter of 1908–9. The final profile and cross section of the main canal were determined during the summer of 1908. The work of enlargement was begun during the winter of 1908–9 and has been continued at intervals since that date. A contract for an extension of the main canal was entered into in January, 1908. This work, consisting of about 3½ miles of canal excavation, was completed in the spring of 1908. One of the principal laterals from this extension of the main canal was constructed by force account during 1908 and the entire extension sublateral system was constructed during the following year under cooperative contracts.

The Mabton division of Sunnyside unit is located on the opposite side of Yakima River from the Sunnyside canal. Water is carried to this division through an open feeder canal 1½ miles long and a reinforced concrete and wooden stave pipe line about 3 miles long. The river crossing is accomplished by 48-inch wooden stave pipe beneath the river bed, operating under a maximum head of about 170 feet. The distribution is accomplished by means of a main lateral running the full length of the division and the necessary sublaterals. The capacity of the supply line is about 100 second-feet. The construction of Mabton division was authorized on April 27, 1908. The work was divided into several parts, each of which was advertised separately. The bids received were considered excessive and the work was done by force account, being completed prior to the irrigation season of 1909.

TIETON CANAL SYSTEM

The diversion dam for the Tieton unit is located on Tieton River below McAllister Meadows. It is a concrete weir 3 feet high and 110 feet long. At the east abutment of the dam is located the headworks structure of the Tieton main canal. This structure is built of reinforced concrete and contains three 4 by 5-foot gate openings, each controlled by a cast-iron sluice gate. On the opposite side of the river the weir terminates in a low retaining wall, with a top elevation 5 feet above the weir crest. Sloping from the top of this wall to an elevation 7 feet greater is the paved face of an earth embankment which extends for a distance of about 400 feet to high ground. The embankment has an average height of about 3 feet, a top width of 8 feet, and side slopes of 3 to 1. About midway is a relief spillway 50 feet long protected by a heavy paving of bowlders. The diversion dam and headworks were included in specifications No. 116 for the Tieton main canal under which proposals were opened on November 15, 1906. No proposals for the construction of this feature were received, however, and the construction was executed by force account, work being commenced on July 30, 1908, and completed in December of the same year. The diversion dam was constructed about 75 feet upstream from its original location and the excavation of the main canal, to join the original heading location, was made in connection with the building of the dam and headworks.

The main canal has a capacity of 300 second-feet and is 12 miles long; its construction was provided for by specifications No. 116. The original plans accompanying the specifications provided for 11 tunnels on the main canal, but as constructed only 6 tunnels were required: Steeple tunnels, Nos. 1 and 2, 100 feet; Trail Creek tunnel, 3,120 feet; columnar tunnel, 1,200 feet; Tieton tunnel, 2,730 feet; and North Fork tunnel, 3,810 feet long. After the failure to receive proposals in November, 1906, tunnel work was begun in a small way during February, 1907, by force account. The work of driving the Steeple tunnels was begun on July 11, 1907, the drilling being done by hand, and the work was completed on August 23, 1907. At Trail Creek tunnel, located about 5 miles below the headworks, tunneling operations were commenced on July 26, 1907, the work being done by force account. An informal contract for the driving of columnar tunnel was entered into on May 17, 1907, the contractor commencing work on July 15, 1907, completing the tunnel on April 22, 1908. Tieton tunnel, near the lower end of the main canal, was driven by force account and was completed on September 25, 1908. North Fork tunnel, at the lower end of the canal and penetrating the divide between Tieton River and the North Fork of Cowiche Creek, was also constructed by force account in 1908.

After making four attempts to secure contracts for the open excavation of the main canal, the construction of this feature was undertaken by force account. The original plans provided for lined and unlined sections but the material encountered was such that it was decided to line the entire canal except for about a quarter of a mile below the headworks and a short stretch in the deep portal cut below North Fork tunnel. In addition to force account work, two small contracts were finally entered into on the main canal, one for the excavation of about 3,000 cubic yards of material between stations 456 and 467 and the other for the excavation of about 7,000 cubic yards of material between stations 366 and 373 and stations 391 and 395. The work under the contracts was finished on August 13, 1908, and the force account work, involving approximately 300,000 cubic yards of excavation, was completed on May 25, 1908.

The concrete lining for the main canal was constructed in sections at convenient locations and transported to the canal and set in place. The manufacture and placing of these sections of lining was included in specifications No. 116 and a contract for the work was entered into on January 5, 1907. The manufacture of the lining was begun in March, 1907. On February 1, 1908, unsatisfactory progress having been made, the contract was suspended. The work was then undertaken by force account and the manufacture and laying of shapes was completed on October 12, 1909. The structures along the main canal, consisting of 1 combined transition, spillway, and sand box, 5 automatic wasteways equipped with electrical signals, 8 transitions at inlets and outlets of principal tunnels, 20 culverts, 64 rock walls and dry stone fills, 24 overhead flumes, and 103 drain-tile outlets, were built by force account. The construction of culverts, rock walls and dry-stone fills was accomplished in connection with the open canal excavation and the remainder of the work was done in the latter part of 1908 and in 1909.

The distribution system of the Tieton unit consists of three branches, watering approximately 10,000 acres each, as follows: Naches branch, watering lands lying between North River and the north fork of Cowiche Creek; Cowiche-Yakima branch, watering lands lying in Cowiche Valley and the Yakima ridge to the south side of Cowiche Creek; and the Wide Hollow branch, watering the southern portion of the project from Cowiche mountain to Atanum Creek. A contract for the main laterals of the Naches branch was entered into in the fall of 1909, the contractor beginning work on October 2. The sublaterals and the structures for this branch were built by force account, the work being undertaken in the fall of 1909. The work on the Naches branch was completed in the spring of 1910. A contract for the laterals of the Cowiche-Yakima branch was entered into in the spring of 1910, the contractor beginning work in May. Sublaterals and structures are being constructed by force account, and it is expected that this branch will be completed prior to the irrigation season of 1911. It is proposed to construct a distribution system for the Wide Hollow branch during 1911.

SETTLEMENT AND IRRIGATION

Although Yakima Valley was first entered by settlers many years ago, progress in development has been most rapid during the past ten years and more particularly since the beginning of government operations.

Settlement and general development of the Sunnyside unit have been very satisfactory. The North Coast Railway and a branch of the Northern Yakima and Valley Railroad are being constructed and rights of way for the extension of the Northern Pacific Railway have been secured. This railway extension work, when completed, will provide three parallel railway lines throughout the Sunnyside unit and will materially improve the shipping facilities. The Yakima-Pasco Power Company has completed a 66,000-volt transmission line in the valley and is furnishing light and power for the towns and for irrigation pumping plants. The towns of Sunnyside and Mabton have recently completed municipal water-supply systems.

The Reclamation Service began operation of the storage reservoirs in 1907, control of Lake Kachess being assumed on April 1 of that year. Stored water was delivered from Lakes Kachess and Keechelus during 1907 and has been delivered from Lakes Clealum, Kachess and Keechelus in subsequent years.

The Reclamation Service assumed control of the Sunnyside system on July 26, 1906, but irrigation for the remainder of the season of 1906 was in charge of the Washington Irrigation Company. Operation of the system by the Reclamation Service was begun on April 1, 1907, and from that date until the end of the fiscal year on June 30, 1907, a total of 74,822 acre-feet of water had been delivered for the irrigation of about 40,000 acres of land. In 1908 about 42,000 acres, and in 1909 about 47,000 acres were irrigated. In 1910 water is being delivered to 49,500 acres of land. The following table gives a summary of the water service for the season of 1909 and the early part of 1910:

Water service, Sunnyside canal

	Apr. 1–Oct. 31, 1909	Apr. 1–June 30, 1910
Maximum flow at intake, second-feet	703	731
Average flow at intake, second-feet	607	637
Total at intake, acre-feet	260,016	114,933
Total delivered to land, acre-feet	167,636	60,914
Acreage served	47,000	49,500
Acre-feet per acre at intake	5.5	2.3
Acre-feet per acre delivered to the land	3.6	1.2

On November 18, 1908, there was issued a public notice opening for irrigation 3,916 acres to be watered from the extension of the main canal below Prosser, and 2,489 acres in the Mabton division. On March 2, 1909, there was issued a public notice opening for irrigation 5,467 acres of irrigable land which had received water under rental contracts during the season of 1908. Public notices dated April 18 and May 2, 1910, opened for irrigation additional lands.

Irrigation on the Tieton unit was begun on May 1, 1910, and water is being delivered under rental contracts at the rate of $1.50 per acre of irrigable land. On June 30, 1910, applications for water for 2,351 acres of irrigable land had been approved and water had been delivered to 1,660 acres of land.

PROGRESS DURING THE FISCAL YEAR 1910

BENTON, KITTITAS, AND WAPATO UNITS

No work was done on the Benton unit. On the Kittitas unit preliminary investigations for the purpose of making estimates of cost and plans for development were made during 1909. On the Wapato unit investigations for the purpose of making estimates of cost and plans for construction were completed during 1909, the canal and drainage system having been located and topographic maps and preliminary sketches of the more important structures having been made.

STORAGE UNIT

At lakes Clealum and Keechelus necessary repairs to the temporary crib dams have been made and stored water has been released as required. At Bumping Lake, where construction of the permanent dam was begun on May 17, 1909, work was continued until November 24, when operations were suspended for the winter. Construction was resumed on May 13, 1910, and has been in progress since that date. On June 30 the river section had been closed, the cut-off trench had been finished, the embankment was 40 per cent completed, the concrete wasteweir and channel were practically completed, the timber and planking for the flume had been prepared, excavation for the concrete piers had been commenced, and all clearing and grubbing necessary for construction purposes had been completed. It is expected that all construction work at Bumping Lake will be completed early in the fall of 1910.

The construction by force account of a drainage channel at Lake Kachess to make available an additional storage capacity of 40,000 acre-feet, was authorized by the Secretary of the Interior on February 14, 1910. Work was begun on April 26, 1910, and on June 30 a camp to accommodate 75 men had been constructed, the crib dam had been planked for use as a bridge, 11 acres of land had been cleaned and grubbed, and 5,000 cubic yards of earth had been excavated and placed in a cofferdam embankment.

The cutting of timber within the reservoirs at lakes Keechelus, Kachess, and Clealum has been conducted slowly under contract.

SUNNYSIDE UNIT

An office building has been constructed and miscellaneous building operations have been in progress at Sunnyside. The distribution system for lands opened for irrigation in 1910 was completed and put in operation early in April, 1910. Fifteen turn-outs for the main canal were built or renewed and 6 drops were constructed. The contract for construction of the lower section of Sulphur Creek wasteway was suspended and a contract for the completion of this work was let on September 10, 1909. Under this contract all but 2,300 linear feet of the excavation was completed, 8 drops were practically completed, and the necessary sheet piling was placed for 6 additional drops. The contractor abandoned the work on June 27, 1910, and the contract was formally suspended a few days later. The work of the contract will be finished by force account. The building of the cunette for the wasteway by force account has been continued throughout the year. Several highway bridges and farm crossings over the wasteway have been constructed by force account. The lined section for the first mile of the wasteway is being constructed under contract.

On the lower portion of the main canal considerable enlargement work has been done with teams and scrapers. A Lidgerwood excavator has been enlarging the canal above mile 43 and has excavated to full capacity all but 1 mile of that portion of the canal between miles 30 and 43. A Bucyrus dredge of the continuous-bucket type was placed in operation at the headworks of the canal in October, 1909, and by June 30, 1910, had enlarged the canal as far as mile 7.

Investigations of the flow of ground and drainage water for the purpose of planning a drainage system for the Sulphur Creek basin and the Outlook and Granger districts have been practically completed. Surveys and investigations in connection with the distribution system at Mabton and for the spillway at the end of the main lateral of the Mabton division have been made. General surveys and plans have been practically completed for the enlargement of the Snipes Mountain lateral and some preliminary work has been done in connection with the Outlook and Snipes Mountain pumping plant. Surveys for the revision of farm-unit plats for the entire Sunnyside unit have been nearly completed.

During 1909 the fruit crop in Yakima Valley was about 30 per cent of normal in yield. All other crops were above the average. The prospects are good that excellent crops will be harvested in 1910.

The operation of the main canal and distribution system has been conducted successfully and without serious accident during the fiscal year.

TIETON UNIT

The manufacture and laying of concrete shapes in the main canal was completed by force account in October, 1909. Five automatic wasteways on the main canal were completed by force account in 1909 and the automatic opening devices are being installed in 1910. Construction of the Naches branch, commenced in 1909, was completed in time for the irrigation season of 1910. Work is now in progress on the Cowiche-Yakima branch, which, it is expected, will be completed for the irrigation season of 1911. The main laterals are being excavated by contract and the structures and sublaterals are being built by force account. Flood water is being served on the Naches branch on a rental basis, and continuous water service has been given since May 1, 1910.

Many landowners are dividing their holdings into small tracts. The areas in acres planted to the principal crops during 1910 are as follows: Fruit, 820; potatoes, 333; alfalfa, 305; wheat, 296 .

PUBLIC NOTICE DATED APRIL 18, 1910

Notice is hereby given that water will be furnished from the Sunnyside project, Washington, under the provisions of reclamation act of June 17, 1902 (32 Stat., 388), for the irrigable lands shown on the following amended township plats, viz: Willamette meridian. T. 11 N., R. 20 E.; T. 11 N., R. 21 E.; T. 9 N., R. 22 E.; T. 10 N., R. 22 E.; T. 9 N., R. 23 E.; T. 10 N., R. 23 E.; T. 8 N., R. 24 E.; T. 9 N., R. 24 E.; approved April 4, 1910, and on file in the local land office at North Yakima, Wash.

The additional lands for which water will be furnished in 1910 are shown on a supplemental list on file in the local land office at North Yakima, Wash.

The charges and the time and manner of payment thereof, for building, operation, and maintenance for the additional lands shown on this list shall be determined in accordance with the provisions of the public notice of March 2, 1909, for the said project, except that for the added areas, opened to irrigation in 1910, the first installment of the said charges shall become due May 2, 1910. The second installment shall become due on March 1, 1911, and subsequent installments on March 1 of each succeeding year until fully paid.

PUBLIC NOTICE DATED APRIL 19, 1910

The public notice of November 18, 1908, announcing the irrigability of lands in the Sunnyside project, Washington, constructed under the provisions of the reclamation act of June 17, 1902 (32 Stat., 388), contains a provision to the effect that for all applications for water rights filed after June 15 in any year, one installment of the charges for building, operation, and maintenance, must be paid at the time of filing, but the portion for operation and maintenance shall be credited on account of the installment of said charges for the subsequent year.

Such provision is hereby revoked so far as it may affect any entries or water-right applications hereafter made for irrigable lands in said project, leaving in effect all other provisions of the public notices and orders heretofore issued for said project.

PUBLIC NOTICE DATED MAY 2, 1910

In pursuance of the provisions of section 4 of the reclamation act approved June 17, 1902 (32 Stat., 388), notice is hereby given that water will be furnished in the irrigation season of 1910 for the additional lands under the Sunnyside project, Washington, shown on the amended plat of T. 8 N., R. 23 E., W. M., approved by the Secretary of the Interior April 15, 1910, and on file in the local land office at North Yakima, Wash.

Homestead entries, applications for water rights, the charges, time and manner of payments shall be governed by the terms of the public notice of November 18, 1908, and public notices and orders amendatory thereof, or supplementary thereto, except that for lands in private ownership and for lands heretofore entered the first installment of the charges for building, operation and maintenance, shall become due on May 18, 1910, and in all cases the second installment shall be due March 1, 1911. Subsequent installments shall be due on March 1 of each year thereafter until fully paid.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Yakima project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due—
270	Feb. 1, 1909	Flanagan Mining Co.	Purchase of timber, Lake Keechelus reservoir site.	$82,159.34	[a] $1,000.00	Feb. 1, 1919
276	Feb. 6, 1909	F. C. Westcott	Purchase of timber, Lake Kachess reservoir site.	15,310.91	....	Feb. 6, 1919
277	Feb. 17, 1909	Jos. F. Walsh	Purchase of timber, Lake Clealum reservoir site.	40,434.78	[a] $1,000.00	Feb. 17, 1919
287	May 3, 1909	The Bucyrus Co	Steam dredge	28,005.00	28,265.94	Sept. 1, 1909
292	Aug. 28, 1909	Geo. Cooke & Sons	Wasteway	26,248.06	19,715.97	Apr. 1, 1910
293	Sept. 10, 1909	H. W. Hawley	Masonry structures	65,062.00	41,116.36	Apr. 1, 1910
297	Sept. 17, 1909	D. H. Traphagen	Excavation, laterals	31,500.00	35,995.23	Apr. 15, 1910

[a] Payments received to June 30, 1910.

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Yakima project

ASSETS

Accounts receivable:			
Uncollected freight refunds		$2,378.81	
Uncollected water rentals		6,000.00	
Uncollected water-right building charges		78,704.59	
Uncollected water-right operation and maintenance charges		7,089.09	
			$94,172.49
Inventories:			
Mercantile store		8,396.68	
Government animals	$53,080.20		
Less depreciation	5,741.87		
		47,338.33	
Equipment in use	177,298.46		
Less depreciation	10,676.82		
		166,621.64	
Storehouse		39,601.99	
Cement		17,360.95	
Iron and steel		3,978.54	
Lumber		10,779.37	
Explosives		7,164.39	
Forage		8,487.88	
Fuel		1,679.85	
Cash in office safe		498.07	
Local products		13,347.72	
Unadjusted transfers		[a] 17,790.47	
Freight and handling undistributed		7,684.59	
			315,149.53
Cost of work:			
Building cost		3,474,331.79	
Less adjustments	6,840.34		
Less accrued revenues	28,475.76		
		35,316.10	
			3,439,015.69
Operation and maintenance cost		194,457.43	
Less accrued revenues		200,831.36	
			[a] 6,373.93
Total assets			3,841,963.78

LIABILITIES

Investment of the United States:			
Disbursement vouchers	3,461,833.45		
Transfer vouchers received	493,900.19		
		3,955,733.64	
Collection vouchers	411,848.40		
Transfer vouchers issued	127,551.76		
		539,400.16	
			3,416,333.48
Accounts payable:			
Unpaid labor		51,680.50	
Unpaid purchases		51,789.05	
Unpaid contract estimates		42,758.74	
Unpaid contract holdbacks		10,128.42	
Unpaid freight and express		9,120.71	
Unpaid passenger fares		2,143.78	
Unredeemed coupon books		524.60	
			168,145.80

[a] Credit amount.

Repayments accrued:		
Building	$234,167.70	
Operation and maintenance	23,316.80	
		$257,484.50
Total liabilities		3,841,963.78

Feature costs to June 30, 1910, Yakima project

BENTON UNIT

Preliminary examination and surveys	$11,167.45

KITTITAS UNIT

Preliminary examination and surveys	$19,251.68

STORAGE UNIT

Bumping Lake reservoir:		
Dam	$187,574.74	
Real estate, legal expense	5.00	
General expense	10,176.29	
		$197,756.03
McAllisters Meadows: Survey of dam site		8,963.79
Lakes Clealum, Keechelus, and Kachess:		
General expense	33,500.60	
Real estate, land submerged	20,996.07	
Crib dams, construction and maintenance	92,233.16	
Permanent dams, construction	4,808.67	
		151,538.50
Wagon roads and highways, construction and maintenance:		
Bumping Lake	56,970.66	
Tieton Valley	1,819.88	
		58,790.54
Telephone system, construction and maintenance:		
Telephone line, Bumping Lake	5,919.47	
Telephone line, Lakes Clealum, Keechelus, and Kachess	345.83	
		6,265.30
Buildings:		
Camp at Bumping Lake, construction and maintenance	17,653.52	
Camp at McAllister Meadows, construction and maintenance	765.80	
Camps at Lakes Clealum, Keechelus, and Kachess, construction and maintenance	148.90	
		18,568.22
Examination: Reservoir reconnaissance		1,924.88
Inventory of unused supplies		4,105.63
Total building cost		447,912.89

SUNNYSIDE UNIT

Diversion works: Diversion dam and canal headworks		$49,579.10
Canal system:		
Purchase price	$248,690.64	
Main canal	409,375.54	
Zillah wasteway	30,711.55	
Mabton pipe line	212,310.30	
Sulphur Creek wasteway	247,123.36	
Prosser extension to main canal	17,318.14	
Prosser pipe line	2,975.01	
Mabton wasteway (preliminary expense)	329.12	
		1,168,833.66
Distributing system:		
Mabton division	36,628.46	
Prosser extension to main canal	17,871.24	
Snipes Mountain lateral system	4,488.67	
		58,988.37

Pumping propositions:		
Outlook pumping, examination	$7,491.82	
Euclid pumping, examination	663.60	
Section 26-9-23, examination	69.31	
		$8,224.73
Buildings:		
Office, warehouse, and machine shop	3,238.53	
Patrol house	3,784.45	
Warehouse site and building	4,842.02	
		11,865.00
Irrigable lands: Mabton division		5,062.75
Drainage investigations: Engineering		5,875.62
Preliminary examination of unit as a whole		47,190.69
Inventory of unused supplies		5,688.79
Telephone line: North Yakima to Sunnyside unit		5,636.95
Total building cost		1,366,945.66
Operation and maintenance:		
Operation	36,154.56	
Diversion dam and headworks	1,031.59	
Main canal	36,586.75	
Laterals	42,601.54	
Spillways	848.28	
General expense	77,234.71	
		194,457.43
Total cost of the unit		1,561,403.09

TIETON UNIT

Diversion system:		
Diversion dam	$11,711.99	
Canal headworks	3,300.14	
		$15,012.13
Tieton main canal:		
Earthwork, open canal	256,313.25	
Driving tunnels, and cost of power house, tramway, pipe and transmission line, construction and maintenance	287,444.55	
Manufacturing and placing open canal and tunnel shapes	191,024.27	
Other structures, masonry, sand box, spillways, safety appliances, etc	79,503.60	
		814,285.67
Tieton main canal—Schedules 6A and 7A:		
Manufacturing shapes for canal and tunnels	119,455.31	
Laying and joining shapes for canal and tunnels	93,153.65	
Plant for making tunnel sections and open canal shapes	15,899.75	
Plant for laying tunnel and open canal shapes	20,098.98	
Extra work, including lining Trail Creek tunnel	23,886.30	
		272,493.99
Distributing system:		
General expense, valley division	57,412.21	
Diversion dam, North Fork, No. 2	9,733.06	
Laterals	127,456.02	
Sublaterals	180,411.45	
		375,012.74
Wagon roads and highways, construction and maintenance:		
Tieton main canal	43,751.66	
Valley division	2,384.91	
		46,136.57
Telephone system, construction and maintenance: Telephone line, main canal		12,628.30
Real estate (rights and property): Lands purchased for Tieton main canal		2,768.60

Buildings, construction and maintenance:		
Patrol houses	$11,184.80	
Distributing system camp	23,905.94	
		$35,090.74
Administration of project as a whole: Examination (Canyon division).		18,638.00
Inventory of unused supplies		4,896.69
Total building cost		1,596,963.43

WAPATO UNIT

Examination of project as a whole: Preliminary surveys	$27,414.14
Real estate (rights and property): Legal expense	58.45
Preliminary investigations	4,618.09
Total building cost	32,090.68

RECAPITULATION BY UNITS

Building cost:		
Benton	$11,167.45	
Kittitas	19,251.68	
Storage	447,912.89	
Sunnyside	1,366,945.66	
Tieton	1,596,963.43	
Wapato	32,090.68	
		$3,474,331.79
Operation and maintenance cost: Sunnyside unit		194,457.43
Total building and operation and maintenance cost, as per debit in cost of work in statement of assets and liabilities		3,668,789.22

WYOMING, SHOSHONE PROJECT

LOCATION AND CLIMATIC CONDITIONS

County: Big Horn (Park after January 1, 1911).
Townships: 52 to 58 N., Rs. 97 to 105 W., sixth principal meridian.
Railroad: Chicago, Burlington and Quincy.
Railroad stations: Cody, Corbett, Ralston, Powell, Garland, Mantua, and Frannie, Wyo.
Average elevation of irrigable area: 4,500 feet above sea level.
Average annual rainfall on irrigable area: 8 inches.
Range of temperature on irrigable area: —30° F. to 95° F.

WATER SUPPLY

Source of water supply: Shoshone River.
Area of drainage basin: 1,380 square miles.
Annual run-off in acre-feet of Shoshone River near Cody (1,380 square miles), 1902 to 1908: Maximum, 1,420,000; minimum, 976,000; mean, 1,150,000.

ENGINEERING DATA FOR COMPLETE PROJECT

Reservoirs: Shoshone—area, 6,600 acres; capacity, 456,000 acre-feet; length of spillway, 300 feet; elevation of spillway, 233 feet above stream bed. Ralston—area, 200 acres; capacity, 2,100 acre-feet.
Storage dam: Shoshone—type, rubble concrete arch; maximum height, 328 feet; length of crest, 200 feet; volume, 75,000 cubic yards.
Diversion dams: Corbett—type, reenforced concrete weir; maximum height, 18 feet; length of masonry, 400 feet; length of earth fill, 450 feet. Eagle Nest—not designed.
Length of canals now constructed: 12 miles, with capacities greater than 300 second-feet; 23 miles with capacities from 300 to 50 second-feet; 156 miles with capacities less than 50 second-feet.
Aggregate length of tunnels: 19,000 feet.
Power development: Not determined.

AGRICULTURAL CONDITIONS

Irrigable area: Whole project, 155,000 acres; first and second units, 31,000 acres.
Present status of irrigable lands (whole project): 16,552 acres entered subject to the reclamation act, 12,882 acres open to entry, 116,000 acres withdrawn from entry, 7,680 acres of state lands, 2,000 acres in private ownership.
Area for which the service is prepared to supply water, season of 1910: 31,000 acres.
Area irrigated, season of 1910: 16,500 acres.
Length of irrigating season: 200 days.
Character of soil of irrigable area: Light sandy and clay loams.
Principal products: Alfalfa, grain, vegetables, and fruits.
Principal markets: Omaha, Nebr.; Chicago, Ill.; Pacific coast cities, and local.

LANDS OPENED FOR IRRIGATION

Dates of public notices and orders relating thereto: November 25, 1907; April 3, 1908; and May 8, 1909.
Location of lands opened: Tps. 55 and 56 N., Rs. 98 to 100 W., sixth principal meridian.
Present status of irrigable lands opened: 16,552 acres entered subject to the reclamation act, 12,882 acres open to entry, 505 acres of state lands, 960 acres in private ownership.

Limit of area of farm units: Public, 80 acres; private, 160 acres.
Duty of water: 3 acre-feet per acre per annum at the farm.
Building charge per acre of irrigable land: $45 and $46.
Annual operation and maintenance charge: $1 per acre of irrigable land.

CHRONOLOGICAL SUMMARY

Reconnoissance made and preliminary surveys begun in 1903.
Construction authorized by Secretary February 10, 1904.
Corbett diversion dam completed June, 1907.
Corbett tunnel completed November, 1907.
Garland canal completed in 1909.
Shoshone dam completed January, 1910.
Whole project 52 per cent completed June 30, 1910; first and second units completed.

IRRIGATION PLAN

The irrigation plan of the Shoshone project provides for the storage of flood waters of Shoshone River in a reservoir, controlled by Shoshone dam, about 8 miles above Cody, Wyo.; diversion of water from Shoshone reservoir into a high-line canal system supplying water to lands in the vicinity of Cody, Corbett, Eagle Nest, and Ralston; the diversion of water from Shoshone River, by a dam at Corbett, about 16 miles below the reservoir, and through the Corbett tunnel into a canal system supplying water to lands on the north side of the river in the vicinity of Ralston, Powell, Garland, Mantua, and Frannie; and the diversion of water from Shoshone River by a dam near Eagle Nest, about 21 miles below the reservoir, and through a tunnel into a canal system watering lands in Shoshone River valley on the south side of the river.

ORIGIN OF PROJECT

The State of Wyoming secured under the Carey Act the segregation for irrigation purposes of lands in Big Horn County, including a tract of about 60,000 acres north of Shoshone River and a tract of about 24,000 acres south of the river. On May 29, 1899, Col. W. F. Cody and Mr. Nate Salisbury acquired from the State the right to appropriate a part of the waters of Shoshone River for the reclamation of the 60,000-acre tract on the north side of the river. On account of the magnitude of the enterprise, however, they were unable to secure sufficient capital to undertake the construction of the necessary works.

On January 26, 1903, Governor Richards, of Wyoming, in a letter addressed to the Director of the Geological Survey, wrote:

> I am authorized by the state board of land commissioners who have in charge all lands segregated for irrigation purposes under the Carey Act, to say that if the General Government will take over and accept for the purposes of reclamation a tract of land in Big Horn County lying on the north side of the Shoshone River, commonly known as the Cody and Salisbury tract, that the commissioners will be glad to relinquish this land to the United States.

Requests were also made by various citizens and other officials of Wyoming that the Reclamation Service undertake the construction of an irrigation project on these lands. On December 29, 1903, correspondence was begun with Governor Chatterton, of Wyoming, relative to the relinquishment of the lands segregated by the State under the Carey Act, and later all of the rights of the State in the lands north of Shoshone River were relinquished to the United States by the state land board. On February 13, 1904, Col. W. F. Cody, the surviving partner of Cody & Salisbury, transferred to the Secretary of the Interior the rights of Cody & Salisbury to appropriate water from Shoshone River. In the year 1905 the rights of the State in the 24,000 acres of land segregated on the south side of the river were also relinquished to the United States by the state land board.

INVESTIGATION

In May, 1903, field investigations of the feasibility of utilizing the water of Shoshone River for reclaiming the lands north of the river in the vicinity of Cody were begun. Topographic surveys of the canyon and of irrigable lands and surveys and investigations of a dam site at the head of Shoshone Canyon were made, the latter with a view to storing a portion of the flood waters of the river. These surveys were completed in November, 1903, about 200 square miles having been mapped.

A topographic survey of about 24,000 acres of land on the south side of the river was begun in May and completed in September, 1905.

Preliminary plans and estimates completed early in 1904 were reviewed by a board of engineers consisting of Messrs. A. P. Davis, J. H. Quinton, L. H. Taylor, and J. B. Lippincott, who reported under date of February 1, 1904, that it would be feasible to store water and construct canals for irrigating about 90,000 acres of land in the vicinity of Cody, Wyo., at a cost not greater than a price at which the land would be readily taken by settlers. The report states that many details were still to be investigated and that modifications in the proposed project would probably be found advisable, but that the project as a whole was feasible and its early construction was recommended.

On February 10, 1904, the Secretary of the Interior set aside $2,250,000 of the reclamation fund for the construction of the project—

> *Provided,* That satisfactory rights to the lands and water be secured, and provided that further consideration of the details on the ground by consulting engineers results in favorable reports.

Since the approval of the project and while the construction work has been in progress further studies and investigations have been made relating to the storage of water, to the location of possible canal lines, and to the determination of areas capable of irrigation. These investigations have shown the feasibility of eventually irrigating over 150,000 acres of land, about 30,000 acres being on the south side of the river and the remainder on the north side.

CONSTRUCTION

ROADS

In order to prepare for the construction of Shoshone dam it was found desirable to have a road through the canyon by which to gain easy access to the cliffs above the elevation of the top of the dam. The construction of such a road on the north side of the canyon was begun by force account in 1904, and early in 1905 the road was completed for a distance of 4 miles from the mouth of the canyon to the site of the dam. For the greater part of this distance the road was cut into the solid rock of the walls of the canyon.

On account of the fact that a road formerly used in entering Yellowstone Park passed through the site of the reservoir, the canyon road has been extended for a distance of 14 miles from the site of the dam around the flow line of the reservoir until it joins a newly constructed county road that connects with other roads entering the park. Surveys for this extension, known as the Shoshone Reservoir highway, were made in 1908, and its construction was begun in 1908 and completed in 1910.

SHOSHONE DAM

The Shoshone dam is located on Shoshone River a short distance below the confluence of its north and south forks and near the upper end of Shoshone Canyon. The dam is a monolithic rubble concrete structure of the arch type, the radius of the center line of the top of the dam being 150 feet. The maximum height from the rock foundation to the top of the parapet is 328 feet. The elevation of the main crest of the dam is 5,370, of the top of the parapet, 5,373, and of the bed of the stream at the site of the dam, 5,127 feet above sea level. The crest width of the dam is 10 feet. Above the bed of the stream the upper face of the dam has a batter of 15 per cent and the lower face a batter of 25 per cent. Below the stream bed the faces of the dam are vertical, except for small footing projections. The width of the canyon at the elevation of the top of the dam is 200 feet and at the elevation of the river bed 70 feet. The concrete of which the dam is constructed is composed of 1 part cement, 2½ parts sand, and 5 parts broken stone. In freshly deposited concrete sound, clean granite rocks weighing from 25 to 200 pounds each were placed and well rammed, care being taken that no rock should be in contact with another and none within 6 inches of either face or abutment of the dam. These rocks form about 25 per cent of the total volume of the masonry. Two cast-iron outlet pipes 42 inches in diameter were embedded in the dam, with their inverts at elevation 5,134, and one cast-iron pipe 16 inches in diameter was placed with its invert at elevation 5,154.

The main outlet of the reservoir formed by the dam is a concrete-lined tunnel 498 feet in length, having a section 10 feet wide by 10 feet high at the sides with an arched roof of 16-inch rise. The tunnel was driven through the granite cliff on the south side of the canyon. The elevation of the floor of the tunnel at its upper end is 5,140, and at its lower end 5,137. The tunnel has a secondary inlet about 50 feet from its upper end cut through the rock at right angles to the line of the tunnel and with the floor of its outer opening at elevation 5,155. In a widened portion of the tunnel, about on a line with the south abutment of the dam, are installed three high-pressure gates.

A second outlet tunnel, also on the south side of the canyon, has its inlet floor at elevation 5,250. It is 10 feet square in section, has a length of 300 feet, and is unlined. No gates will be placed in this tunnel at present, but whenever it becomes desirable to utilize the discharge of the tunnel for power purposes or to control it for irrigation, suitable gates will be installed.

On the north side of the reservoir, several hundred feet upstream from the dam, there is a concrete spillway weir 300 feet long, discharging at elevation 5,360 into an open channel and thence into an unlined tunnel excavated to a section 20 feet wide and 20 feet high at the sides with a roof arch having a rise of 2 feet 8 inches. The spillway tunnel is 405 feet in length, has a slope of 10 feet in 100, and discharges through an open channel into the river about 300 feet below the dam.

In connection with the construction of the dam, spillway, and main outlet tunnel, there was also required on the north side of the canyon an unlined road tunnel 166 feet in length with a cross-section 9 feet wide by 12 feet high.

Plans for the construction of Shoshone dam, spillway, and outlet, spillway and road tunnels, were prepared in 1905 and considered in June of that year by a board of engineers consisting of Mssers. A. P. Davis, G. Y. Wisner, A. J. Wiley, J. H. Quinton, D. C. Henny, and H. N. Savage. Proposals, invited under specifications No. 48, were opened September 5, 1905, and contract was executed September 23, 1905. Work on the outlet tunnel was begun November 21, and the construction of temporary diverting works was begun December 12, 1905. In May, 1906, work on the outlet tunnel was discontinued on account of high water in the river, and in June of that year the temporary dam was partly destroyed.

In August, 1906, it became necessary to suspend the contract on account of the failure of the contractor to prosecute the work satisfactorily. On September 10 a new contract was executed by the bondsmen of the first contractor and reconstruction of the temporary dam was begun in November of that year.

In April, 1907, the excavation of the outlet tunnel was resumed and it was completed May 10. The material encountered in driving this tunnel was hard, seamy granite, difficult to drill and break. No. D–32 Ingersoll-Rand drills were used, mounted on horizontal bars and driven by steam. The entire section of the tunnel was driven as heading and the material was loaded into push cars by hand labor. A large part of the muck was screened to secure sand and broken rock for the concrete lining. Concrete was mixed in proportions of 1 part cement, 2½ parts sand, and 5 parts broken stone.

The temporary works required for diverting the flow of the river during the construction of Shoshone dam consisted of a rock-filled crib dam, 300 feet long and 18 feet high, a timber flume 1,340 feet long, 13 feet wide, and 8 feet high, discharging into the outlet tunnel, and another flume 400 feet long, 10 feet wide, and 8 feet high, heading at the lower end of the outlet tunnel. At the head of the upper flume and at the south abutment of the temporary dam were three wooden head gates, each 5 feet wide and 7 feet high. The capacity of the flume was 2,000 second-feet. The portions of the temporary dam and flume destroyed by flood in June, 1906, were reconstructed in November of that year. The dam was repaired again in April, 1907, and the upper flume connected with the outlet tunnel, the flume being finally completed on May 18, 1907. The lower flume was constructed in the fall of 1907. The excavations for both the dam and the flume were in heavy gravel, a small portion being wet excavation. Some of this work was carried on when the ground was frozen and required blasting.

Excavation for the foundation of the Shoshone dam was begun December 2, 1907, and completed April 1, 1908. This work included excavation to solid rock in the bed of the stream and the removal of seamy and disintegrated rock from the walls of the canyon to secure suitable solid rock abutments for the dam. The abutments in the canyon walls were prepared by blasting the unsafe material from the face of the cliff and then removing it from the bottom of the gorge by means of cableways. Air pipes were hung to the canyon walls and with the aid of ropes and ladders the drill men worked against the face of the cliff with light pneumatic hammer drills, and in some cases with standard Burleigh drills. In the bed of the river were found large bowlders and huge fragments of talus rock embedded in firmly compacted gravel and sand. The larger stones were broken by drilling and blasting. Large rock fragments were slung in chains from cableways for removal, and small rocks, gravel, and sand were shoveled into skips carried on the cableways. During the floods of the summer of 1908 a large amount of material was washed into the foundation pit. This material, amounting in quantity to about one-third of the original excavation, was taken out in August and September, 1908.

The placing of concrete in the dam was begun March 30, 1908, and completed January 16, 1910. The work of placing concrete was interrupted for considerable periods of time on account of high stages of the river and severe winter weather. The interruptions were from May 2 to September 25, 1908; from November 30, 1908, to March 16, 1909; and from March 29 to September 1, 1909. A total of 202 working days were employed in placing the concrete. The work was carried on in three eight-hour shifts or in two ten-hour shifts per day—mostly the latter. Electric lights were supplied for night work and power was furnished from a central station. Belt conveyors were used to deliver concrete material to the mixers, which were installed on a temporary bridge across the canyon close to the upper face of the dam. The concrete, after being mixed, was spouted directly into place for a portion of the foundation, but the greater part was spouted into bottom-dump buckets which were swung into dumping position by large derricks set high up on the cliffs. From a single setting for each of three boom derricks was deposited all of the concrete required in 75,000 cubic yards of masonry in a wall 328 feet in height. Cableways of 1,250-foot span were used in placing loose rock in the dam and for other purposes.

The excavation of the road tunnel was begun May 12, 1906, and completed January 17, 1907. The excavation of this tunnel was partly in hard, seamy granite, but nearly half the section was disintegrated trap rock requiring little blasting to break it down. Nearly all of the drilling was done by hand labor, power drills becoming available only at the last for taking out a small quantity of the bench excavation. The muck was easily disposed of with short haul in push cars, which were dumped over the cliff.

The open-cut excavation for the spillway was begun in April, 1906, and completed in April, 1909; and the driving of the spillway tunnel was begun September 3, 1908, and completed in April, 1909. Both the open-cut and tunnel excavation were in hard granite. In the open-cut excavation drilling was done by Burleigh drills and by pneumatic-hammer hollow steel drills. The muck was intended to be used in the crusher for making broken rock and sand for concrete, but a large part of it was wasted into the river instead. In the tunnel excavation Burleigh drills were used for the heading and bench work and pneumatic-hammer drills for trimming. The muck was hauled up the 10 per cent grade of the tunnel with a hoisting engine in order that it might be used as crusher stock. The work was carried on in three eight-hour shifts per day.

Construction of the upper outlet tunnel for the reservoir was begun December 20, 1909, by force account. At the end of May, 1910, the driving of the tunnel had been completed except for the excavation of a part of the bench in the lower end, the removal of which was deemed unnecessary at the present time and was therefore postponed. The material encountered in driving this tunnel was similar to that found in the main outlet tunnel, but on account of the smaller head of water and the absence of gates it is considered unnecessary to line the upper tunnel.

HIGH-PRESSURE GATES

In the gate chamber near the discharge end of the outlet tunnel of the Shoshone reservoir are installed three cast-iron gates each 7½ feet high by 4½ feet wide and controlling a waterway 7 feet high by 3 feet 8 inches wide. The gate chamber is in an enlarged portion of the tunnel and is separated into three passageways by means of two concrete piers that in conjunction with the side walls of the chamber serve as supports for the framework of the gates. Surrounding the piers and attached to the side walls of the chamber are massive gray iron castings forming the gate frames. The gates are made of gray cast iron with the contact portion of the faces covered with bronze strips to facilitate sliding on corresponding bronze surfaces attached to the gate frames. The total weight of each gate, including lifting rod and piston, is estimated to be about 10,000 pounds. Directly above each gate is a recess into which it rises on being opened. Immediately above the gate recesses and separated therefrom by a 24-inch concrete floor is a power-house chamber excavated from solid rock and which contains the operating machinery for the three gates. The operating mechanism consists of an oil cylinder for each gate, a piston rod, which is attached to the gate, a large oil-supply tank, a pipe system connecting the oil-supply tank and cylinders, a power plant, consisting of a 15-horsepower gasoline engine direct connected to a direct-current 10-kilowatt dynamo wound for 220 volts, and a pumping unit consisting of a 7½-horsepower electric motor wound for 220 volts, and a triplex pump having a capacity of 19 gallons per minute with fifty strokes under a pressure of 600 pounds per square inch. By proper manipulation of throttle valves in the piping the oil pressure produced by the pump can be applied to either the top or the bottom of the piston and thus close or open the gate. Designs for the gates, operating mechanism, gate chamber, and power-house chamber were prepared in 1906 and reviewed on July 16 and 17, 1906, by a board of engineers, consisting of Messrs. O. H. Ensign, A. J. Wiley, W. H. Sanders, L. C. Hill, and H. N. Savage. After certain changes proposed by the reviewing board had been made in the designs, plans and specifications were prepared and were approved by the department on October 26, 1906. Proposals for supplying and installing the gates and operating mechanism, under specifications No. 122, were opened on December 20, 1906, and a contract was executed February 14, 1907. The contractor was required to erect the gate frames and install the gates and operating mechanism, but the excavating required and the placing of the necessary concrete were done by the United States. The contractors installed in the power house a 4-ton trolley crane, with two hoisting blocks and tackles for handling the large castings during installation. This apparatus was left in place for use in removing the cylinders and stems of the gates whenever repairs are required. The manufacture of the gates was begun by the contractor soon after the execution of the contract, and the delivery at the project of the gates, gate frames, and operating mechanism was made in May and June, 1908, and the installation was completed in August, 1908.

CORBETT TUNNEL

In the plans for diverting water from Shoshone River for irrigation of lands on the north side, an important feature is the Corbett tunnel, heading at the Corbett diversion dam, about 16 miles below the Shoshone dam and 8 miles from Cody, Wyo. The length of the tunnel is 17,354.7 feet, and its section is horseshoe shaped with an area of about 104 square feet, the maximum width being 11½ feet and the maximum height 10¾ feet. The tunnel is lined with concrete throughout, some portions of it being lined directly on the rock face of the excavation and other portions being timbered back of the lining. The elevation of the floor of the tunnel at the upper end is 4,612.5 and at the lower end 4,588.18 feet above sea level. The controlling gates at the head of the tunnel were installed in connection with the Corbett dam, but at the outlet of the tunnel there was constructed in connection with it a settling basin, from which the main canal receives its water supply. For the settling basin an embankment about 50 feet high and 150 feet long was required between the sides of a draw in which the settling basin is located. This dam has a width of 10 feet on top and a slope of 3 to 1 on its upper face and 2 to 1 on its lower face. A spillway for the settling basin, with crest at elevation 4,598, was excavated in rock near the east end of the dam and a sluicing tunnel was built from the settling basin to the river. The intake floor of this tunnel is at elevation 4,563 and the outlet floor at elevation 4,558, and the cross section is a rectangle 4 feet wide by 3 feet high surmounted by a semicircular arch of 2-foot radius. The tunnel is 245 feet long and is lined with concrete 8 inches thick. Its discharge is controlled by a circular cast-iron gate 36 inches in diameter, installed in a shaft about 50 feet deep surmounted by a small concrete gate house.

Specifications No. 49, for the construction of the Corbett tunnel and settling basin, were prepared in 1905, and reviewed and recommended by a board of engineers, consisting of Messrs. A. P. Davis, A. J. Wiley, and H. N. Savage. Proposals for the work were opened September 6, 1905, a contract was executed September 27, and work was begun November 3, 1905. On August 4, 1906, it became necessary to suspend the operation of the contract on account of the failure of the contractor to prosecute the work satisfactorily. On August 17, 1906, the work of construction was taken up by the Reclamation Service under force account. The driving of the tunnel was completed August 2, 1907, and the whole work of the contract was finished November 20, 907.

The excavation for the tunnel was carried forward from both portals; from three adits, located, respectively, at stations 33 + 57.2, 91 + 8.4, and 121 + 52.6; and from a shaft at station 155 + 0. Changes in the alignment of the tunnel made after the publication of the specifications, but before the beginning of the construction work, include the following:

1. Location of the intake portal 100 feet farther downstream to secure a better site for the diversion dam.

2. Location of tunnel line 100 feet nearer to the river near adit No. 3, thus shortening both the tunnel and the adit.

3. Location of the outlet portal 500 feet farther up the draw, thereby securing a shorter tunnel and a better site for the portal.

Adit No. 1 was completed January 14, 1906, and the excavation of the tunnel proper was then begun. Adits Nos. 2 and 3 were completed March 10, 1906. Excavation at the intake was begun in May and at the outlet portal December 8, 1906. Excavation at the shaft was begun June 9 and reached the tunnel section in September, 1906.

The material encountered in the tunnel was mainly sandstone, with some shale and clay. During the greater part of the time the work was carried on with three eight-hour shifts per day, electric lights being supplied from the power plants when needed. Nearly all of the tunnel was excavated by means of a heading along the roof and later excavation of the bench. Thirty-eight feet of the tunnel in the upper heading from adit No. 3 caved in on June 25, 1906, and occasioned considerable extra work in removing débris and retimbering. Two smaller cave-ins in the upper heading from adit No. 2 occurred later.

Two power plants were constructed by the contractor, one near adit No. 1 and the other near adit No. 3. In the first plant six and in the second plant four 40-horsepower locomotive-type boilers were installed. Later two of the boilers from the first plant were withdrawn and the installation of the second plant increased to seven boilers. The power plants were supplied with air compressors, air receivers, blowers, electric-light apparatus, and other necessary equipment. The ventilation of the tunnel during construction was effected partly by suction fans located at the power plants and acting through 16-inch and 12-inch sheet-iron pipes, and partly by the use of compressed air supplied from the power plants. Three air shafts were also sunk from the ground above the tunnel for ventilation purposes.

Rock-crushing and concrete-mixing plants were built by the contractor on the bluffs adjoining the entrances to adits 1 and 3 and were connected by track through the adits into the tunnel. These plants consisted each of a gyratory rock crusher, a gravel crusher, revolving screens, sand and gravel bins, and mechanical mixers. The material after being placed in the rock crushers was handled by machinery, being dropped from the crushers to the screens, and thence into the sand and gravel bins and from there to the mixers, which discharge, directly into cars that could be drawn into the tunnel. In June, 1907, a third concrete plant was constructed by the Reclamation Service near the outlet portal of the tunnel. This plant consisted of a trap platform and inclined screens discharging sand and gravel into separate bins and rejecting through a chute into the river any material over size. The materials for concrete were mixed in a gravity dry and wet mixer and were discharged into cars for transporting into the tunnel. A track about 300 feet in length extended from a gravel pit, where cars were loaded with teams and scrapers dumping through a trap, to the platform of the concrete plant.

The forms used in placing concrete lining consisted partly of tongue-and-grooved and oiled lagging and partly of plain, sized lagging, supported in both cases by 16-pound steel rails bent to the required shape of arch and sides of the finished tunnel. The excavation of the tunnel was in general considerably in excess of the required gross excavation. Small excess excavations were back-filled with concrete and larger excess excavations were back filled with excavated material or with concrete aggregate without the cement.

Alignment and grade of the tunnel and of the permanent timbers placed were checked daily by surveying parties; and lines and grades were seldom prolonged by construction foremen for more than 30 feet, in which distance a careful foreman could usually carry the line in good ground without a greater deviation than 1 inch.

In March, 1906, the contractor began excavating for the puddled trench of the earth dam for the settling basin. After excavating the trench to a depth of 4 feet, the work was suspended until August 1, when it was resumed by a subcontractor. When the main contract was suspended, the subcontractor continued work on the dam for the settling basin, and the Reclamation Service later made a contract with him for the completion of the work. The material for the dam was excavated from the spillway and from the hill above the west end of the dam. Only selected material, carefully puddled and compacted, was used in the upstream portion of the dam. In addition to the trench required by the drawings, two trenches for puddled material were excavated throughout the length of the dam.

The excavation of the sluicing tunnel for the settling basin was begun January 10, 1906, and completed May 1. The lining of the tunnel with concrete and the construction of the gate house, gate-house shaft, and intake and outlet portals were completed, and the gate was installed in March, 1907. The material encountered in the tunnel was dry sandstone, which required no timbering. The sluicing tunnel was constructed on a line 7 feet lower than that shown in the contract drawings.

CORBETT DAM

For the purpose of diverting water from Shoshone River into the Corbett tunnel the Corbett dam, located about 8 miles from Cody, Wyo., was constructed. This dam is a reenforced concrete weir of the buttressed type, having a deck 30 inches thick with a slope of 1:1. The deck rests on buttresses 2 feet thick, spaced 14 feet from center to center. The structure is founded on gravel and shale and has a reenforced concrete platform 2 feet thick resting on the foundation and extending from the deck wall downstream a distance of about 40 feet. Beneath the deck of the dam and this platform are three cut-off walls running lengthwise of the dam and extending into the shale beneath. The crest of the weir is at elevation 4,625.5 feet above sea level. The height of the dam from the bottom of the buttress walls to the crest of the weir is 18½ feet and its length between abutments is 400 feet. Beyond the south abutment an earth embankment about 450 feet in length extends from the dam to the bluff on the south side of the river. At the north end of the dam is located a sluiceway provided with three sluice gates each 4 feet wide by 5 feet high. Adjoining the sluiceway and separated from it by a concrete wall 7 feet high is an intake basin supplying water to the intake portal of the Corbett tunnel, in which are installed two gates 5 feet wide by 10 feet high.

Plans for the Corbett diversion dam were reviewed in May, 1906, by a board of engineers consisting of Messrs. A. J. Wiley, H. N. Savage, Jeremiah Ahern, and C. P. Williams, and specifications No. 98, recommended by the board, were approved by the department. Proposals under these specifications were opened July 10, 1906, and a contract for the work was executed August 6, 1906. The work of construction was begun in the fall of that year and completed in June, 1907.

The ends of the dam were constructed during ordinary stages of the river without diverting the flow of the river from its channel. After the construction of the sluiceway a temporary dam was built from the end of the sluiceway wall diagonally across the river; and by means of this dam the entire low-water flow of the river was diverted through the sluiceway while the central portion of the dam was being built. A rock crusher and concrete mixer were installed about 400 feet from the south abutment of the dam. The sand and broken stone required for concrete were made by crushing rock. Concrete was hauled from the mixer to central points on the dam by means of cars drawn by horses and then conveyed in small hand carts to the places of deposit.

GARLAND CANAL AND DISTRIBUTION SYSTEM

The main part of the water required for irrigating the lands on the north side of the Shoshone River will be supplied through the Garland canal, heading at the settling basin at the mouth of the Corbett tunnel. The headworks of the canal are built of reenforced concrete and have six gate openings, each 4 feet wide by 8 feet high. The canal extends in a northeasterly direction a distance of about 8 miles, discharging into Ralston reservoir, from which the canal is extended a farther distance of about 10 miles to supply various laterals for conveying the water to the lands to be irrigated. Throughout division 1 of the canal, from the headworks to Ralston reservoir, its capacity is 1,000 second-feet, and for the first part of the canal after leaving Ralston reservoir the capacity is the same. As the laterals are taken out the capacity of the canal is gradually decreased. In the first part of the canal its section where excavated in loose earth has a bottom width of 20 feet, a water depth of 9.7 feet, and side slopes of 2 to 1. Where the excavation is through rock the bottom width is 26 feet, the water depth 9.7 feet, and the side slopes $1\frac{1}{4}$ to 1. After the first 5 miles of the canal, sections in earth excavation, as far as the capacity remains at 1,000 second-feet, have bottom widths of 40 feet, water depths of $6\frac{1}{2}$ feet, and side slopes of 2 to 1. Most of the structures so far built on the canal are made of reenforced concrete. A few wooden structures are, however, used, as well as some vitrified pipe culverts and steel and combination bridges.

Ralston reservoir, located at the end of division 1 of the Garland canal, is a small reservoir, having an area of about 200 acres, formed in a natural depression by the construction of an earth dam 2,200 feet in length with a maximum height of 40 feet and an average height of about 10 feet. This dam is built with a slope of 3 to 1 on its upper face and of 2 to 1 on its lower face. The upper face is protected by riprap. Through the dam is built a reenforced concrete culvert, 2 feet wide by 3 feet high. By means of the culvert, which is controlled at its upper end by a sluice gate, installed in a gate tower that is connected with the upper part of the embankment with a footbridge, it is possible to aid in the regulation of the reservoir and to sluice out silt or to empty the reservoir when desired. The principal outlet of Ralston reservoir is the controlling works of division 2 of Garland canal, which are built of reenforced concrete and contain seven gates, each 4 feet wide by 6 feet high. The elevation of the top of the reservoir embankment is 4,599. The intended maximum elevation of the water surface in the reservoir will be at elevation 4,594.5, which provides a storage capacity above the bottom of the outlet into the canal (elevation 4,582.65) of about 2,100 acre-feet, or a capacity above the maximum water surface of the canal below the reservoir (elevation 4,589.15) of over 1,000 acre-feet.

Designs for the construction of division 1 of the Garland canal were reviewed in March, 1906, by a board consisting of Messrs. A. P. Davis, A. J. Wiley, and H. N. Savage. Specifications No. 84 for the excavation of this division and for the erection of a part of the structures thereon, recommended by the board, were approved by the department and advertisement was issued inviting proposals to be opened May 24, 1906. Only one proposal was received, and that was rejected as unsatisfactory, and the work readvertised with a change in the date for required completion. The proposals received under this readvertisement were opened July 11, 1906; a contract for the work was executed November 2, 1906; and the work was completed August 10, 1908. Specifications No. 106 for the erection of other structures on division 1 of the Garland canal, reviewed and recommended by the same board, were approved by the department July 3, 1906, and advertisement was issued inviting proposals to be opened August 23, 1906. No proposals were, however, received. On March 18, 1907, an informal proposal, modified as to dates and requirements, was received, a contract was executed April 9, 1907, and the work was completed in February, 1908.

Plans for the construction of divisions 2, 3, and 4 of Garland canal and of lateral systems diverting water therefrom for the irrigation of about 40,000 acres of land were reviewed in January, 1907, by a board of engineers consisting of Messrs. A. J. Wiley, H. N. Savage, and R. S. Stockton. Specifications No. 128 for the excavation of these canals, recommended by the board, were approved by the department on January 8, 1907. Proposals were opened March 12, 1907, and four contracts for different parts of the work were awarded. The contracts were executed on April 8, April 12, April 13, and April 27, respectively, and the larger part of the work under all of the contracts was completed by March, 1908, and all of it by November, 1908. On divisions 5, 6, 7, and 9 of the laterals, comprising what is known as the Frannie canal, all bids were rejected and the work of constructing the major part of these laterals postponed, although a small amount of work was done by force account in excavating to part section the first 2 or 3 miles of the Frannie canal and in completing the laterals served by this part of the canal.

Plans for structures on canals the excavation of which was provided for by specifications No. 128 were reviewed in February, 1907, by a board of engineers consisting of Messrs. A. J. Wiley, H. N. Savage, and Jeremiah Ahern, and specifications No. 135 for the erection thereof, recommended by the board, were approved by the department on February 20, 1907, and advertisement was issued inviting proposals to be opened April 17, 1907. No proposals were received, and the building of these structures by force account was authorized on May 1, 1907. The work was begun promptly and carried on systematically. In June, 1908, the structures for a first unit of about 15,000 acres of irrigable land had been completed, and in May, 1910, the structures for a second unit of about 16,000 acres were completed.

In the fall of 1909 the excavation on the Ralston unit of laterals and waste-water ditches diverting water from the first division and the upper part of the second division of the Garland canal was undertaken by contract and completed in June, 1910. The structures for this unit, which will irrigate about 1,800 acres of land, are being built by force account.

In the fall of 1909 and during the early part of the season of 1910 preparations have been carried on for continuing the construction of the Frannie canal. The construction will be commenced in the fall of 1910 and carried to completion as rapidly as possible on about 12 miles of the main canal and the laterals diverting therefrom. By this construction about 10,000 acres can be added to the irrigable area, and further extensions of Frannie canal and its lateral system will eventually irrigate about 40,000 acres more.

Proposals under specifications No. 141 for supplying the metal work for two steel-truss 60-foot span highway bridges were opened May 15, 1907, and a contract was executed July 22, 1907. The delivery of this material was completed in October, 1907, and the bridges were erected by force account, the erection being completed in February, 1908.

SETTLEMENT AND IRRIGATION

By public notice of November 25, 1907, the first unit of the project, comprising 276 farms, with an aggregate area of over 15,000 acres of irrigable land, was opened to irrigation. For the season of 1909, by public notice of May 8, 1909, a second unit, comprising 217 farms, with an aggregate area of nearly 16,000 acres, was opened. Settlement progressed at a satisfactory rate, and on June 30, 1910, 278 farms, aggregating 16,552 acres of irrigable land, had been entered, subject to the reclamation act, and water-right applications had been, received for 960 acres of land in private ownership. On May 25, 1909, the government town site of Powell was opened and lots placed on sale at public auction. On June 30, 1910, 59 lots had been sold.

Water was first turned through the Corbett tunnel into the Garland canal on April 27, 1908, and the canals of the first unit had been successfully primed and water was delivered to settlers for irrigation in June of that year. During the year about 2,600 acres of land were irrigated and no difficulty was experienced in distributing the water therefor.

In the season of 1909 water was turned into the canal on May 5 and delivery to water users was continued without serious interruption throughout the season. No attempt was made to store water in Shoshone reservoir, but in June and July an unusually large flood discharge of the river raised the water in the reservoir until on July 3 it overtopped the partially constructed dam. During the season

13,500 acres of land in 292 farms were irrigated and 23,000 acre-feet of water delivered therefor. The principal crops raised were wheat, oats, and alfalfa, and the crop returns were very satisfactory.

Water was first stored in Shoshone reservoir in the season of 1910, and on June 30 the reservoir contained about 150,000 acre-feet of water. The delivery of water for irrigation was begun April 17, and about 16,500 acres of land are being irrigated. The prospects of good crops for the season are excellent. A first cutting of alfalfa has been harvested, yielding in many cases 2½ tons per acre. A large number of fruit trees have been planted, and the farmers are, in general, sowing large areas to alfalfa, which will aid effectively in increasing the productiveness of the land.

PROGRESS DURING FISCAL YEAR 1910

During the fiscal year the construction of Shoshone dam by contract was completed, the construction of the upper outlet tunnel was sufficiently completed for present use, the reservoir site was cleared, 14 miles of the Shoshone reservoir highway were built, including the erection of a 130-foot steel bridge across the North Fork of Shoshone River, the concrete structures for the distributing system of the second unit, and the excavation and structures of the Ralston unit were completed, and preparations were made for beginning the construction of 12 miles of the Frannie canal and 6 miles of canal A, together with their distributing systems. Water had been stored in the reservoir, and delivery of water for irrigation was begun April 15 and continued without interruption to the end of the fiscal year, a maximum of 210 second-feet of water being carried in the main canal.

PRINCIPAL CURRENT CONTRACTS

The following table contains data relating to the principal contracts in operation or completed during the fiscal year ending June 30, 1910:

Principal contracts, Shoshone project

No.	Date	Contractor	Description	Estimated value	Estimated earnings June 30, 1910	Completion due
130	Sept. 10, 1906	United States Fidelity and Guaranty Co.	Shoshone dam	$469,479.12	$502,027.19	Jan. 31, 1910
314	Feb. 8, 1910	Des Moines Bridge and Iron Co.	Steel highway bridges.	3,828.00	3,828.00	Mar. 31, 1910

FINANCIAL STATUS

Assets and liabilities on June 30, 1910, Shoshone project

ASSETS

Accounts receivable:			
Uncollected water-right building charges		$26,631.59	
Uncollected water-right operation and maintenance charges		2,085.35	
			$28,716.94
Inventories:			
Mercantile store		579.84	
Government animals	$2,250.66		
Less depreciation	127.38		
		2,123.28	

Inventories—Continued.			
Equipment in use	$27,549.49		
Less depreciation	3,163.97		
		$24,385.52	
Storehouse		5,369.36	
Cement		11,865.63	
Iron and steel		1,154.95	
Lumber		939.11	
Fuel		59.65	
Local products		1,502.02	
Unadjusted transfers		675.52	
Freight and handling undistributed		238.46	
			$48,893.34
Cost of work:			
Building cost	3,502,195.09		
Plus adjustments	3,245.94		
		3,505,441.03	
Less accrued revenues		18,187.42	
			3,487,253.61
Operation and maintenance cost			36,331.20
Total assets			3,601,195.09

LIABILITIES

Investments of the United States:			
Disbursement vouchers	3,472,081.92		
Transfer vouchers received	93,925.32		
		3,566,007.24	
Collection vouchers	150,960.47		
Transfer vouchers issued	36,658.90		
		187,619.37	
			3,378,387.87
Accounts payable:			
Unpaid labor		6,905.00	
Unpaid purchases		10,898.90	
Unpaid contract estimates		74,416.03	
Unpaid contract holdbacks		16,164.03	
Unpaid freight and express		962.96	
Unpaid passenger fares		187.30	
			109,534.22
Repayments accrued:			
Building		94,915.51	
Operation and maintenance		18,357.49	
			113,273.00
Total liabilities			3,601,195.09

Feature costs to June 30, 1910, Shoshone project

Storage works:		
Lands submerged by reservoir	$184,458.23	
Shoshone dam and appurtenances	861,046.62	
Outlet tunnel and appurtenances	20,975.96	
Sluice gates	70,369.52	
Upper outlet tunnel	18,303.57	
		$1,155,153.90
High-line canal: Survey and examination		21,340.15
Corbett diverting works:		
Corbett dam	97,467.80	
Corbett tunnel	1,166,101.20	
Settling basin—dam, spillway, gatehouse, sluicing tunnel	25,314.16	
		1,288,883.16
Garland canal and laterals:		
Survey and examination	5,786.44	
Earthwork	549,065.94	
Structures	246,571.43	
		801,423.81
Frannie canal, extension and laterals: Survey and examination		1,924.94
Willwood diverting system:		
Diversion dam surveys	225.00	
Tunnels, surveys	811.00	
		1,036.00
Willwood canal and laterals: Surveys and examination		8,213.00
Wagon roads:		
Highway (Shoshone reservoir)	50,425.02	
Canyon road	54,788.10	
Garland Flats	471.49	
		105,684.61

Telephone system:		
Construction	$1,515.99	
Maintenance	88.43	
		$1,604.42
Highway bridges:		
Steel	7,286.50	
Wood	5,827.82	
Concrete pipe culverts	5,027.27	
		18,141.59
Buildings: Construction		30,438.14
Irrigable lands: Subdivision and soil examination		4,452.58
Examination of project as a whole		62,045.46
Inventory of unused supplies		1,853.33
Total building cost		3,502,195.09
Operation and maintenance:		
Operation Garland canal, divisions 1 to 19	12,559.15	
Maintenance Garland canal	19,107.51	
Corbett tunnel	122.69	
Sluicing tunnel	93.75	
Highway bridges, concrete, steel, and wood	63.93	
Buildings	493.62	
Demonstration farm	3,248.77	
Shoshone dam, reservoir, and appurtenances	641.78	
		36,331.20
Total building and operation and maintenance as per debit cost in cost of work in statement of assets and liabilities		3,538,526.29

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