

FEDERAL RECLAMATION BY IRRIGATION

MESSAGE

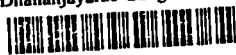
FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

**A REPORT SUBMITTED TO THE SECRETARY OF
THE INTERIOR BY THE COMMITTEE OF
SPECIAL ADVISERS ON RECLAMATION**

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APRIL 21, 1924.—Read; referred to the Committee on Irrigation and Reclamation and ordered to be printed with illustrations

APRIL 24 (calendar day, MAY 2), 1924.—Action of April 21, 1924, rescinded and document ordered to be printed without illustrations

38073

SUBMITTED BY MR. McNARY

IN THE SENATE OF THE UNITED STATES,
April 24 (calendar day, May 2), 1924.

Ordered, That the order to print as a Senate document the message of the President of the United States, with accompanying report and illustrations, relative to the necessity of revising the present reclamation law, transmitted to the Senate on April 21, 1924, be rescinded, and that the said message and accompanying report be printed without the illustrations.

Attest:

GEORGE A. SANDERSON,
Secretary.

J:1:11, 73

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CONTENTS

	Page
Message of President	ix
Letter of transmittal	xi
Recommendations	1
Origin and purpose of the inquiry	24
Summary of the committee's activities	27
Functions of Reclamation Service	29
Land and crops	29
Land new State created by irrigation	29
Settlement	30
Engineering structures	30
Organization	31
Organization and supervision of the Reclamation Service	31
Organization	31
Action on findings	34
Legislative enactments	34
Need for Federal aid	34
The reclamation act	36
Errors in the reclamation act as developed by experience	36
The Curtis Act	39
The Warren Act	39
The extension act	39
Emergency acts	39
Other legislation	40
Conclusion	40
Recommendations	40
Departmental rulings	40
Necessity	40
Volume	40
Variability	41
Conclusions	41
Recommendations	41
Choice of projects	41
Early studies of water supply	41
First locations	43
Investigations of conditions	44
Effects of early selections	45
Law of selection	46
Recommendations	47
Secondary projects	47
Meaning	47
How financed	47
Nature of secondary projects	48
List of secondary projects	48
Need of continued investigation	48
Scope of investigations	49
Frequent review of findings	49
Shall the reclamation fund pay for secondary project investigations?	49
Recommendations	49
Public notice	50
Importance	50
Delivery of water	51
Delayed public notices	51
Conclusions	52
Recommendations	52

	Page
The acre cost.....	53
How determined.....	53
Present acre cost.....	54
Use of noninterest-bearing money.....	54
Compared with acre incomes.....	55
Compared with original estimates.....	56
Need of adjustments.....	57
Recommendations.....	57
Operation and maintenance.....	59
Meaning.....	59
Cost of operation and maintenance.....	59
Supervision of operation and maintenance by water users.....	59
Protection of major structures.....	60
Conclusions.....	60
Contracts for supplemental irrigation.....	60
Private-project lands.....	60
Extent.....	61
Recommendations.....	61
Soils and climate.....	62
Introduction.....	62
Climate.....	62
Soils.....	64
Water.....	65
Crop yields on projects.....	66
Future projects.....	66
Recommendations.....	67
Seepage, alkali, and drainage.....	68
Seepage.....	68
Alkali.....	68
Drainage.....	69
Canals.....	70
Conclusions.....	70
Recommendations.....	72
Markets and transportation facilities.....	73
Need of markets.....	73
Project markets.....	73
Transportation facilities.....	73
Importance of concentrated crops.....	74
Consumption on the farm.....	74
Prices received by project farmers.....	75
Conclusions.....	75
Irrigation practice.....	76
Water, the real issue.....	76
Relation of water to crops.....	76
Methods of irrigation.....	76
Systems of irrigation.....	77
Duty of water.....	77
An approved system of irrigation practice.....	79
Conclusions.....	79
Recommendations.....	79
✓ Agricultural conditions and practices.....	80
Crops grown.....	80
Livestock on project farms.....	81
Systems of agriculture.....	82
The livestock situation.....	84
Acre yields of crops.....	86
Prices of crops.....	87
Cash returns per acre.....	88
✓ Cost of production.....	89
Crop and livestock census.....	89
Conclusions.....	89
Settlement and settlers.....	91
Conditions of settlement.....	91
Density of population.....	92
Nationality of settlers.....	92
Experience of settlers.....	93
Previous occupation of settlers.....	95

CONTENTS

	Page
Settlement and settlers—Continued	
Turnover of settlers.....	95
Tenantry.....	95
Conclusions.....	96
Recommendations.....	97
Soldiers' preference right	97
Provisions of the law.....	97
Method of settlement.....	97
Places of settlement.....	97
Results.....	97
Conclusions.....	98
Technical aid to farmers	98
Irrigation a specialized art.....	98
Irrigation as a science.....	99
Need of experimental stations.....	99
Need of demonstration help.....	100
Help from project manager.....	100
Closer relationship with Department of Agriculture.....	101
The need of definite agricultural systems.....	101
Agricultural literature.....	101
Conclusions.....	102
Recommendations.....	102
Water-users' organizations	103
Legal requirement.....	103
Present status.....	103
Water users should be responsible.....	106
Shall water users control the whole project?.....	106
Water-users' association versus irrigation district.....	107
Conclusions.....	107
Recommendations.....	107
Social conditions of settlers	108
Importance.....	108
Railroads.....	109
Roads.....	109
Schools.....	109
Churches.....	110
Clubs.....	110
Women's organizations.....	110
Theaters and amusement halls.....	111
Miscellaneous.....	111
Conclusions.....	111
Homesteader versus speculator	111
Purpose of reclamation act.....	111
Classes of land transfers.....	112
Result of land transfers.....	113
Weakness of original act.....	113
Private land holdings.....	114
Cooperation.....	114
Conclusions.....	115
Recommendations.....	116
Financial condition of settlers	116
Class of settlers.....	116
Conditions of agricultural success.....	116
Original capital.....	117
Available financial aid.....	117
Accumulated debts.....	118
Accumulated profits.....	118
The economic survey of 1922.....	119
Relief applications of 1923.....	119
Net income of farmers.....	120
Prosperity of farmers.....	121
Results.....	121
Why Government obligations are not met.....	121
Policy.....	122
Conclusions.....	123
Recommendations.....	123

	Page
Agricultural and economic needs of the settler.....	124
Changed conditions.....	124
Influence of variations in soil on settler's success.....	125
The capital a settler should have and the credit scheme needed for the improvement and equipment of farms.....	125
Conditions confronting settlers.....	128
Preparing the land for irrigation should be made part of project cost.....	128
The prevention of speculation in the reclamation of privately owned land.....	131
Project power plants.....	134
Origin.....	134
Number and location.....	134
Other power possibilities.....	134
Conclusions.....	135
Accounting system.....	135
Integrity of accounts.....	135
Project control at Washington.....	135
Repayment control.....	135
Other records in the Washington office.....	135
Project accounting.....	136
Organization.....	137
Weaknesses of present system.....	137
Statistical data.....	138
Collections.....	138
Methods employed.....	138
Present status.....	138
Reasons for increases in uncollected accounts.....	139
The project manager.....	139
Passive assets.....	140
Meaning.....	140
Land.....	140
Water.....	140
Problem of passive assets.....	140
Completion of projects.....	141
Conclusions.....	141
Summary of losses.....	142
A plan of repayment.....	143
The present plan.....	143
Results of the 20-year plan.....	143
Causes of failure.....	144
Productive power of land.....	145
Acre costs and acre incomes.....	146
Acre income the basis of repayment charges.....	147
Net or gross income.....	147
Crop income to be used.....	147
Percentage to be employed.....	151
Land classification.....	151
Recommendations.....	151
The Bureau of Reclamation under the proposed reorganization.....	152
Changes in titles.....	153
Duties of officers.....	153
Project data and recommendations.....	154
Salt River.....	154
Yuma.....	156
Yuma auxiliary.....	159
Orland.....	160
Grand Valley.....	162
Uncompahgre.....	163
King Hill.....	165
Minidoka.....	167
Boise.....	169
Garden City.....	170
Huntley.....	171
Milk River.....	173
Sun River.....	175
Lower Yellowstone.....	177
North Platte.....	179

CONTENTS.

VII

Project data and recommendations—Continued	Page
Newlands.....	181
Carlsbad.....	183
Hondo.....	185
Rio Grande.....	186
Williston.....	188
Umatilla.....	189
Klamath.....	191
Belle Fourche.....	193
Strawberry Valley.....	195
Okanogan.....	197
Yakima.....	198
Riverton.....	200
Shoshone.....	201
Proposed legislation.....	203
Exhibits: ¹	
1. Tables for printed report.....	208
2. Agricultural, financial, and miscellaneous tables.....	()
3. Plan of inquiry—Reports by projects.....	()
4. Reports of Salt Lake hearing and exhibits.....	()
5. Reports of field commissioner and inspectors for Secretary of the Interior.....	()
6. Reports of special auditors.....	()
7. Financial statements from chief accountant, Bureau of Reclamation.....	()
8. Reports from Federal land banks.....	()
9. Newspaper clippings.....	()
10. Reclamation legislation.....	()
11. Analyses of history of reclamation projects compiled by special investigators.....	()
12. Census tabulations.....	()
13. Special statistical tables.....	()
14. Special relief.....	()
15. Correspondence to and from Bureau of Reclamation.....	()
16. Summary of relief applications.....	()
17. Private projects.....	()
18. List of publications, Bureau of Reclamation.....	()
19. Secondary and private projects, file.....	()
20. Reclamation articles from Engineering News-Record.....	()
21. Manual of Reclamation Service.....	()
22. Freight rates.....	()
23. Charts.....	()
24. Special stenographic reports of testimony of some of the witnesses in Washington.....	()
25. Letters from water users by projects.....	()
26. Committee's calendar and minutes of proceedings.....	()
27. Miscellaneous.....	()

¹ Exhibits other than No. 1 are not included in this document.

MESSAGE

To the Congress of the United States:

I would respectfully urge on Congress the immediate necessity of revising the present reclamation law.

The Secretary of the Interior appointed a special advisory committee of six members to study reclamation and make report to him. That committee has completed its work and has made its report to the Secretary of the Interior and he has transmitted that report to me. I herewith transmit it to you.

Many occupants of our reclamation projects in the West are in financial distress. They are unable to pay the charges assessed against them. In some instances settlers are living on irrigated lands that will not return a livelihood for their families and at the same time pay the money due the Government as it falls due.

Temporary extensions of time and suspension of these charges serve only to increase their debts and add to their hardships. A definite policy is imperative and permanent relief should be applied where indicated. The heretofore adopted repayment plan is erroneous in principle and in many cases impossible of accomplishment. It fixes an annual arbitrary amount that the farmers must pay on the construction costs of projects regardless of their production.

In its place should be substituted a new policy providing that payments shall be assessed by the Government in accordance with the crop-producing quality of the soil.

The facts developed by the special advisory committee show that of the Government's total investment, \$18,861,146 will never be recovered. There will be a probable loss of an additional \$8,830,000. These sums represent expenditures in the construction of reservoirs, canals and other works for the irrigation of lands that have proven unproductive. I recommend that Congress authorize the charging off of such sums shown to be impossible of collection.

Because of high rates of interest and other agricultural difficulties existing, farmers are often unable to borrow money for temporary relief. The establishment of a credit fund by the Government from which farmers on projects may secure capital to make permanent improvements, buy equipment and livestock, should be considered.

More than 30,000 water users are affected by the present serious condition. Action is deemed imperative before the adjournment of Congress that their welfare may be safeguarded.

The probable loss and the temporary difficulties of some of the settlers on projects does not mean that reclamation is a failure. The sum total of beneficial results has been large in the building up of towns and agricultural communities and in adding tremendously to the agricultural production and wealth of the country. Whatever legislation is necessary to the advancement of reclamation should be enacted without delay.

CALVIN COOLIDGE.

THE WHITE HOUSE,
April 21, 1924.

LETTER OF TRANSMITTAL

DEPARTMENT OF THE INTERIOR,
Washington, April 10, 1924.

Hon. HUBERT WORK,
Secretary of the Interior, Washington, D. C.

SIR: The situation that has developed on the Federal reclamation projects is serious. Three projects have been abandoned, and unless remedial measures, of a permanent character are applied, several more of the projects will fail; and the Federal reclamation experiment conceived in a spirit of wise and lofty statesmanship, will become discredited.

The net construction cost of the projects, subject to repayment as of June 30, 1923, is, in round numbers, \$143,000,000. Of this amount about \$101,000,000 are covered by active water-right contracts; \$39,000,000 are unsecured by water contracts. The water users, holding water-right contracts, have repaid, during the existence of the Reclamation Service, 10.9 per cent of the total construction cost subject to repayment. On June 30, 1923, of the construction charges then due, 14.2 per cent or \$2,537,222.46 remained unpaid, and of the operation and maintenance charges then due, 17.6 per cent or \$2,423,649.06 remained unpaid.

We believe it possible, without departing from the intent of the reclamation act, and by using the results of the experience of the last 21 years, to correct conditions on the projects so that impending disaster may be replaced by lasting success. This will require prompt action; for the present situation has grown to such proportions throughout two decades, that it can no longer be met by temporary relief measures. The causes of dissatisfaction and failure must be eliminated.

The law required expenditures to be made in the 16 States mentioned therein in proportion to the sales of public land within those States; and insistent demands were made for immediate selections in each of those States. Studies of water flow and reservoir sites had been made, and some consideration given to soil conditions, before the passage of the law, yet sufficient accurate information regarding agricultural and economic feasibility had not been obtained upon which to justify the selection of each of the 24 projects which were located within four years after the passage of the law. Some projects were authorized which should not have been undertaken. The simultaneous construction of more than 20 projects, involving the expenditure of nearly \$150,000,000, provided no background of experience for the construction of the projects, such as would have been acquired by a more gradual and orderly program of development. This huge construction program soon exhausted the reclamation fund and made necessary a loan of \$20,000,000 from Congress to keep the work

moving. Thus, construction was done piecemeal and over many years. The delayed construction and the irremediable errors in the original locations increased the project costs and the burden of the water users, who were to repay construction costs from crop incomes.

The construction costs are in almost every instance larger, in some cases several times larger, than the original estimates. This fact, while regrettable, can not be charged to any one cause. One principal cause was including works not provided for in the original estimates, such as larger dams, also lateral ditches and drainage works. Many of these works are of a monumental character such as high dams and long tunnels, in which unforeseen obstacles were encountered. Whatever the reason may have been, many farmers feel they have been called upon to pay more than they expected to pay and more than they were told they would have to pay. This has become a source of constant attack upon the Reclamation Service and of discontent among water users. Estimates should be made with such care, and construction pushed with sufficient rapidity, to secure reasonable agreement between estimates and costs.

Success can come to future Federal reclamation ventures only if projects are authorized upon a thoroughly scientific consideration of the probable power of the project to enable the farmer to repay construction costs and to win a living from the irrigated lands. Community and political demand to secure projects should be considered only after full knowledge of the feasibility of a proposed project has been secured. Once a project is located the errors in the choice are felt to the last day. The relief that can now be afforded on existing projects is to classify the lands upon the basis of a scientific survey and place equitable charges upon each class in proportion to its power to produce.

Delayed payments or no payments and the present plight of settlers are not due wholly, however, to increased project costs. Reclamation by irrigation is the result of the joint efforts of the engineer and the farmer. The engineer builds the irrigation works; the farmer must pay for the works and make a living from the reclaimed lands. The major part of the engineer's task is soon over; the farmer's task lasts while the works endure. There can be no irrigated farm without the competent engineer; but there will be no payment for the works nor community development under them without the successful farmer. The engineering structures of the Federal irrigation projects have been substantially built and maintained; but the farmer's needs have been incompletely met. A fundamental error was made in believing that the construction of irrigation works would of itself create irrigated agriculture. The reclamation act was based on that assumption. Attention has been centered almost entirely on engineering features. Settlers were accepted without capital or experience. They were not organized to work together, but were left to struggle without sufficient aid or direction to complete what the Government had only begun. It has been demonstrated that the Government can build irrigation structures of the highest quality; but how farmers on the Federal irrigation projects can repay the cost of these structures within reasonable time limits is yet to be demonstrated. The overemphasis of the engineering side of reclamation by irrigation is one cause of project difficulties.

The project settlers, particularly on the public lands, were unselected as to fitness by experience or financial ability to undertake irrigation farming. Many entered on the venture with little conception of the expenses or physical obstacles they would meet in creating a farm. It was a situation which made the agricultural needs of this heterogeneous body of water users the most important factor in this development. The inexperienced farmer should have been given more and better information and advice; the poor farmer, with honest courage but little or no capital, should have been provided with proper credit facilities; the farm with a rough, rolling surface, should have been leveled; the greedy owner of private lands, ready to trade upon the natural desire of vigorous, hard-working men, for independent homes, should and could have been squelched; the good farmer, with small business capacity, should have been given the assistance of cooperative organizations for buying and selling; all should have been supplied with intimate advice, from competent official advisors, on all farm matters; and by every effort, the way should have been made easier for the water user, who not only profits by the labor and skill of the engineer, but who also absorbs engineering mistakes and pays engineering bills. Such singleness of purpose in winning project success by helping the farmer would have brought greater success to the projects, avoided the present danger, and would early have uncovered needed changes in policy or methods.

The Reclamation Service has retained the full management of all but two of the projects. This has not been satisfactory. The project management and the Washington office have become targets for criticism. A dependence on Federal paternalism has settled down upon nearly all the projects, and a corresponding bureaucratic tendency has grown up within the Reclamation Service. The water users have come to look upon themselves as wards of the Government, a specially favored class with special claims upon governmental bounty; and the Reclamation Service has been tempted to accept this definition of the water users. Nothing could be more detrimental to the progress of a venture which demands, first of all, individual courage and independence of the people concerned. The extension act provides that the operation and maintenance of the project may be turned over to the water users. This should be done at the earliest possible date. Whether the water users organize as an irrigation district or as an incorporated water users' association is of little consequence. Any benefits that may be devised for the aid of the water users should be contingent upon their willingness to take over the responsibility of operating and managing all but a few of the less-settled projects. When this is done, a large proportion of Federal reclamation difficulties will disappear.

It is also a question whether the State in which a project is located should not be required to meet a part of the expense and become an active partner in agricultural development. The partnership of State and Nation in good roads and agricultural education has worked well. State participation in selections of projects and in their development would lessen political pressure for projects of doubtful merit and help to lessen the danger of centralized control.

The plan of repayment of construction costs of Federal irrigation projects, as established in the reclamation act and subsequent amendments is inelastic and unscientific. After the first few years, an

annual repayment charge of 6 per cent of the acre cost is made for all projects, yet the acre cost and crop producing power vary greatly among projects.

It is idle to assume that lands of equal fertility can bear widely different annual construction payments, or that all lands—good, indifferent, or poor—under a single project can bear the same annual construction payments, yet the existing plan of repayment was based upon that assumption. Neither time nor an arbitrarily fixed per cent of cost is a sound basis for determining annual payments. Whether the total construction cost be great or small it can only be paid out of the produce of the lands; hence, productivity is the only safe and fair basis for fixing annual payments. The expense of changing rough, desert land into irrigated fields, and of adding the new implements and improvements needed, involves a large outlay of money which must be won from the products of the farm. The acre income becomes the basis of any scientific method of repaying construction costs. The more fertile the soil is, the higher may be the annual charge; and the more intelligently the farmer cultivates the soil, the sooner will title to his water right pass to him. The present method of repayment can not and does not insure a steady return on the investment by the Government in irrigation structures, and can not be met by the projects with lower productive capacity. It will be necessary to put into effect a new plan of repayment of construction costs of the Federal irrigation projects—in our opinion one based upon the inherent power of the soil, under intelligent cultivation, to produce crops.

Federal water users were tempted, as were other farmers, by the financial riot at the time of high prices during and immediately after the Great War; and they have been caught, with farmers everywhere, by the agricultural depression of the last few years. Meanwhile, many project farmers are still struggling to convert raw, unwilling land into fertile fields, and in this laborious and expensive labor, they are worthy of special help.

Numerous minor causes of project distress will be found mentioned in the attached reports; but if (1) the lands of the existing projects are scientifically studied, classified and valued, (2) aid and direction given in agricultural development, (3) the project management assumed by the water users, and (4) a scientific and adequate plan of repayment adopted, all other elements of project discord and difficulty become of relatively slight importance.

In many of the projects the cost of the works built by the Government, including drainage, is more than \$100 an acre. The chief engineer of the bureau has testified before a congressional committee that he knows of no new project where water can be provided at less than \$100 an acre. Experience and investigations show that from \$100 to \$200 an acre, in addition to project costs, must be expended by the farmer in improving and equipping the farm. Plans and policies must be formulated which will insure competent investigations of all the conditions which affect the value of a project both to the Government and the settler. It must fix conditions as to the qualifications of settlers as to capital and experience, which will help create communities able to meet the great demands on them in the way of money for development and ability to use soil, water, and climate as success in irrigation requires. Without these things,

Government irrigation in the future will provide temptations rather than opportunities.

The old pioneer settlement with its primitive farming is impossible under present conditions. Capital, technical knowledge, credit, and technical advice are all needed to make farming profitable under these costly projects. The farmers' needs must be kept in mind in rewriting this act if Federal reclamation is to succeed.

There is no feeling on the projects for repudiation of the debt to the Government. The Federal water users are true Americans. They recognize that the sum invested in the Federal irrigation enterprise is not large as congressional appropriations go, but, they ask, not alms, but that the requirements made of them be proportioned to their power to win means from the soil.

The integrity of the financial operations of the service is unquestioned. The honesty, zeal, and technical skill of the engineering staff are worthy of the highest commendation. The greater attention which is now properly being given to the agricultural and economic features of Federal reclamation will require a further reorganization of the bureau. Our recommendations relative to the organization of the bureau are in the attached report. The investment of the United States in irrigation projects will not be wholly recovered. Large losses running into millions of dollars will have to be assumed by the reclamation fund. A part of the investment will be repaid. Another part, after being held in suspense for some years, may be repaid. This result comes from the location of projects without recognizing the limitations of soil and climate and available markets.

The accompanying report contains a summary of all recommendations, tables, and exhibits in which the matters touched upon in this letter, and many others, are more fully elaborated. To report in detail upon the accumulated transactions of a complicated reclamation venture, covering 20 years, would not be possible with the time at our disposal. The principles which are set forth in this letter and in our report are fundamental, well confirmed, and would not be greatly affected by any further study of the history of the United States Reclamation Service.

Water users, private citizens, officials of the Bureau of Reclamation and of the Government departments, Members of Congress, and your own office staff have given us ready, willing, and abundant assistance. To all of them we extend our thanks. To you, also, for your courtesy and assistance and the opportunity of an adequate, unhampered investigation, we express our gratitude.

The activities of the Reclamation Service have been investigated frequently. The reports and findings of these investigations are buried in the files and have apparently been given but little consideration. The time has now come when carefully considered recommendations, based upon investigation, should be given prompt and effective administrative and legislative action, if reclamation is to succeed.

There is no doubt about the successful outcome of the Federal experiment in irrigation, if the experience now gained is applied to existing and coming projects. During the last few years these projects have produced annually on about 1,200,000 acres crops valued at fifty to seventy-five millions of dollars, and as the vacant lands are brought under cultivation and the farmed lands are cultivated better

this annual income will increase. Besides, 1,101,700 acres of land are receiving a partial water supply under the terms of the Warren Act from the Federal irrigation projects and producing greatly increased crops therefrom. Thousands of happy families are growing up in the open country under influences that have always fashioned men and women of strength. Moreover, these projects have helped in the conquest for human good, of the more difficult places of our country and thereby have shown the great value of the arid and semi-arid region, as a part of the domain, which in the providence of God has been given to our country.

This letter, the attached recommendations, the accompanying report, tables, and exhibits are herewith.

Respectfully submitted.

THOMAS E. CAMPBELL,
JAMES R. GARFIELD,
OSCAR E. BRADFUTE,
CLYDE C. DAWSON,
ELWOOD MEAD,
JOHN A. WIDTSOE.

Committee of Special Advisers on Reclamation.

FEDERAL RECLAMATION BY IRRIGATION

SUMMARY OF RECOMMENDATIONS

1. Immediate relief for water users.
2. Authorization of new projects or project extensions.
3. Secondary projects.
4. Care in making estimates of costs.
5. Drainage to be included in original estimates.
6. Construction cost spread over whole acreage.
7. Equitable adjustment of construction cost.
8. Equitable apportioning of acre costs.
9. Cost of leveling land charged to construction.
10. Drainage, a part of construction cost.
11. Two public notices at opening and for repayment.
12. Disposition of private lands in excess of farm unit.
13. Survey and classification of project lands.
14. Exchange of infertile lands.
15. Suspension of payments on infertile lands.
16. Lands not to be included in irrigable area.
17. Settlers selected according to ability.
18. Title to major works.
19. Projects taken over by water users.
20. Profits of project power plants, grazing lands, farm lands, and town sites.
21. Board to hear water users' complaints.
22. Penalty reduced.
23. Repayment plan based on acre income.
24. Disposition of unpaid dues under new plan of repayment.
25. Payment of operation and maintenance and construction charges.
26. Statistical survey.
27. The economical use of water.
28. Dissemination of agricultural knowledge.
29. Agricultural advisers provided.
30. The New Reclamation Era and the agricultural press.
31. A credit fund for farm equipment.
32. Disposition and rights of surplus waters.
33. Supplementary water contracts.
34. Compilation of legislative enactments.
35. Codification of bureau regulations.
36. Losses to be assumed.
37. Salt River project.
38. Yuma project.
39. Yuma project.
40. Yuma auxiliary project (Mesa division of the Yuma project).
41. Orland project.
42. Grand Valley project.
43. Uncompahgre project.
44. King Hill project.
45. Minidoka project.
46. Boise project.
47. Huntley project.
48. Milk River project.
49. Sun River project.
50. Lower Yellowstone project.
51. North Platte project.
52. Newlands project.
53. Carlsbad project.
54. Rio Grande project.
55. Williston project.
56. Umatilla project.
57. Klamath project.
58. Belle Fourche project.
59. Strawberry Valley project.
60. Okanogan project.
61. Yakima project.
62. Riverton project.
63. Shoshone project.
64. Buford-Trenton and Hondo projects.
65. Extensions and new projects.
66. Administrative charges, Washington office.

1. IMMEDIATE RELIEF FOR WATER USERS

Pending any delay caused by putting into effect the recommendations herein contained, or substitutes therefor, it is the sense of this

commission that Congress should, from time to time, grant such temporary relief to settlers on the various projects as the ascertained facts will warrant.

2. AUTHORIZATION OF NEW PROJECTS OR PROJECT EXTENSIONS

New projects or extensions of existing projects should be authorized only after full information has been secured concerning the water supply, engineering features, soil, climate, transportation, markets, land prices, probable acre cost of development, and other factors upon which the success of the project must depend. All such information should be secured by designated representatives of the Departments of the Interior, Agriculture, and Commerce, who should, after a careful investigation, make to the Secretary of the Interior a report upon the feasibility of the project or the extension of a project, having in mind primarily the creation of opportunities for actual settlement and farm homes upon the project, and repaying the total investment made by the Government. This report should accompany the recommendation of the Secretary of the Interior for new projects or extensions of existing projects.

3. SECONDARY PROJECTS

The Reclamation Service has examined at considerable expense many proposed reclamation projects, not yet authorized, which are known as secondary projects. Some of these appear to have excellent agricultural possibilities, which in the interest of national development, should at some future time be undertaken by private or public enterprise. To keep these projects in mind the data relative to the secondary projects should be examined, at least annually, in the light of existing conditions, with the view of testing their present feasibility; and proper publicity should be given the conclusions reached, for the information of those interested in reclamation development.

Other proposed projects should be examined as in the past, until full knowledge is obtained concerning the reclamation possibilities of the United States, and the reclamation law should be so amended as to enable the Government, by expenditure of funds to be appropriated out of the general fund, to obtain information necessary to determine how arid, swamp, and cut-over lands may best in the future be developed to meet the growing agricultural needs of the Nation.

4. CARE IN MAKING ESTIMATES OF COSTS

The data and evidence before the committee disclose that in almost every project undertaken by the Reclamation Service the ultimate cost of the project greatly exceeded the estimates as to what the cost would be.

It is true that much in the way of added cost was caused by rising prices extending over the years of construction, and often by the inclusion of additional features not originally contemplated, which additions were agreed to or desired by the settlers; but aside from these factors it is undoubtedly true that estimates for some projects were much lower than was justified and that the ultimate cost was more than the value of the water to the land.

Those underestimates were allowed to become known, and the settlers in large measure relied upon them, to their ultimate disappointment and distress. In so far as conditions justify, we have tried to recommend appropriate readjustments upon various projects.

The solvency of future enterprises will depend upon prompt settlement of the land, improvement of farms, and purchase of water rights. Settlers should be informed at the outset what the project costs are to be.

We therefore most emphatically recommend that in the future great care be taken in the preparation of the estimated costs, accompanied by a definite statement of what these costs include, and that when once announced they shall be binding alike on the Government and the settler.

5. DRAINAGE TO BE INCLUDED IN ORIGINAL ESTIMATES

At the time of planning an irrigation project and of making the original estimates studies should be made of the probable rise of ground water resulting from irrigation, and that estimates for drainage construction should then be included as a part of the project construction cost.

6. CONSTRUCTION COST SPREAD OVER WHOLE ACREAGE

The total net construction cost of any project should be spread equitably over the whole acreage for which the major storage or diversion works and the distribution system have been constructed.

A. In the event the storage or diversion works or main canals are increased in capacity for the purpose of supplying lands in addition to those then supplied, the construction charges should be readjusted and equitably apportioned in accord with the area actually supplied with water.

B. In the event the area of the lands for which storage or diversion works or main canals have been constructed shall be decreased by excluded lands found not suitable for irrigation, then the construction charges imposed upon such excluded lands should not be charged against the remaining lands but should be held in suspense and shall be ultimately charged off, unless by subsequent agreement all or some portion of such suspended charges may be imposed upon lands restored to irrigation, or other lands for which it is found suitable to supply water.

7. EQUITABLE ADJUSTMENT OF CONSTRUCTION COST

If, after a proper survey of construction costs and classification of soils have been made by a competent commission, it be ascertained that the present construction costs per acre are more than some or all of the classes of land within the project can bear, a fair and equitable adjustment should be made which will fix the charge per acre at a sum the land can reasonably bear.

8. EQUITABLE APPORTIONING OF ACRE COSTS

In fixing the construction cost upon lands under projects, the Secretary of the Interior should take into consideration the classes of

land, determined in accordance with Resolution No. 13 and may fix different construction costs upon different classes under the same project, for the purpose of so equitably apportioning the total cost that the lands may bear the burden of cost more nearly in proportion to their productive value.

9. COST OF LEVELING LAND CHARGED TO CONSTRUCTION

Hereafter the expense of leveling project lands and building suitable distribution systems for efficient and economical irrigation should be made a part of the construction costs.

10. DRAINAGE, A PART OF CONSTRUCTION COST

Whenever drainage construction not included in the primary construction cost becomes necessary on an irrigation project, such drainage cost, as approved by the water users of the project, should be made a part of the construction cost of the project.

11. TWO PUBLIC NOTICES: AT OPENING AND FOR REPAYMENT

When a new project or the extension of an existing one is ready for settlement, public notice to that effect should be issued by the Secretary of the Interior, fixing the project cost and the date when the project, or a division thereof, will be open to settlement, and when the agricultural development of a project or the extension of a project has advanced sufficiently to warrant construction repayments, a second public notice to that effect should be issued by the Secretary of the Interior; all construction repayments to begin on the date set in the second public notice.

12. DISPOSITION OF PRIVATE LANDS IN EXCESS OF FARM UNIT

That no reclamation project should hereafter be authorized until all privately owned land in excess of a single homestead unit for each owner shall have been acquired by the United States or by contract placed under control of the Bureau of Reclamation for subdivision and sale to settlers at a price approved by the Secretary. This price to be considered in determining what land and water will cost settlers and hence the feasibility of the project under the payment conditions of the law.

13. SURVEY AND CLASSIFICATION OF PROJECT LANDS

The Secretary of the Interior should undertake at once a comprehensive and detailed survey of the physical and economic features of the Federal reclamation projects, to secure information upon which the project lands may be classified with respect to their power, under a proper agricultural program, of supporting the farmer and his family and of repaying the construction costs of the project. This survey should be in sufficient detail to enable the grouping of the farm units, under each project, into divisions or zones, each of approximately equal productive power. All lands which at the time of the survey do not possess a productive power sufficient to support the farmer's family and to repay construction costs should be grouped in one class,

and all lands which are just coming into agricultural production and not yet ready to begin repayments should be grouped in another class, both of these classes of lands to be exempt from requirements of repayment of construction costs.

Such surveys of the project lands should be made periodically as the progress of knowledge may suggest, and for the purpose of determining any changes that may have accompanied the continued cultivation and irrigation of the lands.

14. EXCHANGE OF INFERTILE LANDS

Homesteaders who have located on project lands which have been classified as unable to support the farmer and his family and to repay construction costs should be given the privilege of exchanging their lands for other lands on the same or on other projects; and ex-service men have the preference in making such exchanges.

15. SUSPENSION OF PAYMENTS ON INFERTILE LANDS

The construction costs of lands found by classification in accordance with resolution No. 13 to be unsuited to immediate cultivation and unable to pay said costs be suspended until such time as the lands are found suitable for cultivation or as the owners thereof apply for water under the charges fixed by the classification, and that until such time no water be supplied to these lands.

16. LANDS NOT TO BE INCLUDED IN IRRIGABLE AREA

The acreage of railroad, canal, lateral, drain, and waste ditch rights of way, of public highways, and of steep, rocky, broken, or alkali lands, classified as unfitted for agricultural purposes, should not be classed as parts of the irrigable area of a project, and not be subject to water-right charges, for construction or for operation and maintenance unless requested by the owner. Existing contracts, which impose charges for construction and for operation and maintenance upon such exempted acreages, should be modified accordingly, and the water rights for such exempted acreages should be sold for use on other lands: *Provided*, That the water users from whose contracts such exempted lands are withdrawn should have the first right to purchase such water right for use upon their remaining or additional lands.

17. SETTLERS SELECTED ACCORDING TO ABILITY

Owing to the increased cost of water rights and greater expense of developing farms it is no longer possible for average settlers without capital to succeed in improving and paying for farms on these projects. Loans for development should be made a part of the reclamation policy.

This can not wisely be attempted unless consideration is given to the qualifications of settlers, which would include industry, experience, character, and possession of a part of the capital needed in improving their farms. Only those who have reasonable prospects of succeeding should be approved.

18. TITLE TO MAJOR WORKS

Title to the major project structures, such as storage or diversion dams, or main canals that deliver water to the project distribution systems, should be retained by the United States of America; but all benefits and profits that may be derived from the sale, rental, or use of water so stored or diverted should be credited to the project or that part of a project to which the construction cost of furnishing water has been charged.

19. PROJECTS TAKEN OVER BY WATER USERS

Whenever two-thirds of the irrigable area of any project shall be covered by water-right contracts between the water users and the Government, said project should be required, as a condition precedent to receiving the benefits of the relief measures herein recommended, to take over, through a legally authorized water users' association or irrigation district, the care, operation, and maintenance of all or any part of the project works, subject to such rules and regulations as the Secretary of the Interior may prescribe, and thereafter the Government, in its relations to said project, should deal with said water users' association or irrigation district; and when the water users assume control of a project, the operation and maintenance charges for the year then current should be covered into the construction account to be repaid as part of the construction repayments.

20. PROFITS OF PROJECT POWER PLANTS, GRAZING LANDS, FARM LANDS AND TOWN SITES

When the water users take over the management of a project, under contract with the United States, the total accumulated profits derived from the operation of project power plants, leasing of project grazing and farm lands, and the sale or use of town sites should be credited to the construction cost of the project; and that, thereafter, the income from project power plants and power possibilities, grazing and farm lands and town sites may be used as the water users direct for the benefit of the project. No dividend should be paid out of any such profits before all obligations to the Government shall have been fully paid.

21. BOARD TO HEAR WATER USERS' COMPLAINTS

Many of the difficulties attending the operations of the Reclamation Service have resulted from the failure to make regular collections or to furnish relief according to a uniform policy. Pressure from outside sources in behalf of a project or of water users has often nullified the steady operations of approved regulations. We recommend therefore that a suitable board of reference should be maintained by the Secretary of the Interior to which all complaints and requests for relief may be referred for recommendation of action by the Secretary of the Interior.

22. PENALTY REDUCED

The rate of penalty (1 per cent) provided in section 3 and section 6 of the act of August 13, 1914 (36 Stat. 686) should be reduced for the future to one-half of 1 per cent.

23. REPAYMENT PLAN BASED ON ACRE INCOME

Experience has demonstrated that the present method for repayment of project-construction costs, based upon time and percentages of cost, instead of the ability of the several classes of lands to produce, is unscientific and difficult of fulfillment. Productive power should be the basis for the annual repayments of construction costs, and for this purpose productive power of the lands should be defined to be the average gross annual acre income from the irrigated lands of a project or division thereof for the preceding 10 years, or for all years of record, if fewer than 10 years are available, and that the annual acre repayment charge should be 5 per cent of the productive power of the lands as hereinabove defined.

24. DISPOSITION OF UNPAID DUES UNDER NEW PLAN OF REPAYMENT

Whenever a new policy of repayment of construction costs is adopted all unpaid and due charges for construction and for operation and maintenance, including interest and penalties, should be added to the construction accounts of the respective farm units. The new total thus established should be the construction cost to be repaid by the water user.

25. PAYMENT OF OPERATION AND MAINTENANCE AND CONSTRUCTION CHARGES

Whenever the new method of repayment goes into effect, all annual operation and maintenance charges should be payable in advance, on January 1; and that the construction charges for any calendar year should be payable on July 1 of the following calendar year.

26. STATISTICAL SURVEY

The proper supervision and development of an irrigation project requires correct knowledge of the conditions of the project from year to year. A careful statistical survey should be made annually to show acreages and acre yields of the various crops grown, the farm animals maintained, the average prices received for all farm products, the markets on which such products were sold, the quantity of water used in irrigation, and such other information as may be found desirable for the welfare of the project. The statistical information should be kept on file at the project managers' and the commissioner's offices.

27. THE ECONOMICAL USE OF WATER

The economic future of the irrigated section will depend in great part upon the care with which expensive and valuable irrigation water is used in irrigation.

1. All available information concerning the duty of water should be assembled and placed at the disposal of the water user. Federal and State experimental agencies should undertake researches of the duty of water with the view of promoting the economical use of water in irrigation, and that by demonstration farms and farm advisers, water users may be made thoroughly familiar with the methods to be employed in securing a high duty of irrigation water.

2. A survey should be made of the sources of loss of water on projects, such as leaky canals, shallow soils, porous subsoils, other large wastage, and the same be corrected.

3. The Bureau of Reclamation and the Federal water users should unitedly work to establish on the Federal irrigation projects an economical as well as a beneficial duty of water.

28. DISSEMINATION OF AGRICULTURAL KNOWLEDGE

The officials of the Bureau of Reclamation should take steps, in cooperation with the United States Departments of Agriculture and Commerce, and the State agricultural colleges and experiment stations, to secure, first, a wider dissemination of modern agricultural knowledge among the water users on the Federal irrigation projects; second, the formulating and conducting of scientific research into the problems of irrigation agriculture; and, third, the type of agriculture best adapted to the various projects in consideration of climatic, soil, and economic environment.

29. AGRICULTURAL ADVISERS PROVIDED

The conditions which confront settlers on reclamation projects require them to use better tools and to adopt a better agricultural program in order to meet payments on land, improvements, and water rights. This requires the employment on the projects of trained agricultural and economic advisers who will give sound agricultural and business advice to enable settlers to increase their farm incomes and to organize for cooperation in business and social affairs.

Such advisers will also be needed in carrying out the credit system recommended.

A brief experience has been had on some of the projects in the employment of such advisers. It showed their value, but the plan was abandoned because such employment was held to be unauthorized by the reclamation act.

The law should be so amended as to give unquestioned authority for the employment of such advisers.

30. THE NEW RECLAMATION ERA AND THE AGRICULTURAL PRESS

The New Reclamation Era, formerly known as the Reclamation Record, should be made essentially a periodical for the education and encouragement of the water user and that the agricultural press in the irrigated section should be requested to give special attention to the problems of irrigation farming confronting water users on private and public irrigation projects.

31. A CREDIT FUND FOR FARM EQUIPMENT

Project settlers are in need of relief from paying high interest rates on short-time loans. They are often unable to borrow money with which to improve and equip their farms. A credit fund should be provided under competent control, from which settlers on the projects can borrow money with which to make permanent improvements or to buy needed equipment and livestock. Loans for permanent improvements, secured by the land, should run not to exceed 30 years; loans for equipment and livestock not to exceed 5 years. The rate of interest should be 5 per cent; payments of principal should be amortized; the making or refusing of loans should be at the discretion of the credit authorities.

32. DISPOSITION AND RIGHTS OF SURPLUS WATERS

If stored or diverted water of a project is in excess of the needs of the project lands, such surplus water should be charged with its proportion of the construction costs of the major project structures, and the lands which may contract for the surplus water should repay the construction cost so charged. Lands that have contracted for such surplus water rights should pay their proportion of the annual operation and maintenance charges for the protection of the works and for the delivery of the water to the headgates of the distribution system. Any profits that may be derived from the sale or rental of such surplus water should be credited to the project or part of the project to which the construction cost has been charged.

33. SUPPLEMENTARY WATER CONTRACTS

Water users having contracts under the Warren Act (February 21, 1911) should be governed by the following principles:

1. Under each project the holders of Warren Act contracts should be required to form a water users' association, or to become a part of the project water users' association, through which the United States may deal in all matters of policy and management of the water rights in question.

2. The holders of water right contracts under the Warren Act should have the privilege of repaying construction costs according to the plan of repayment, based upon the acre returns. If sufficient crop statistics, for this purpose have not been accumulated, the crop average for the project with which the Warren Act contracts are associated, should be taken as the basis of repayment.

3. Contracts for Warren Act water rights should participate in the assets of the project.

34. COMPILATION OF LEGISLATIVE ENACTMENTS

That all legislative enactments pertaining to Federal irrigation projects should be compiled, arranged, indexed, and digested for easy references, and this compilation should be kept up to date for the benefit of the water users and the officials of the bureau.

35. CODIFICATION OF BUREAU REGULATIONS

The rulings of the Reclamation Service and the Bureau of Reclamation should be fully revised, simplified, and compiled and published for the use of all concerned with the Federal irrigation projects; and such use-books for construction, operation, and maintenance and other phases of project activity should be prepared for the use of those on the projects who are directly engaged in project development.

36. LOSSES TO BE ASSUMED

When it shall be definitely determined that any lands within any project are unsuitable for cultivation by irrigation, and can not by cultivation pay project costs, the amount of the project costs held in suspension against such land should be definitely charged off as a loss to the reclamation fund.

37. SALT RIVER PROJECT

The Salt River project should be granted the option to amend the existing contract entered into between the United States of America and the Salt River Valley Water Users' Association, dated September 6, 1917, in accord with the legislation recommended regarding the method of repaying construction costs.

The item of \$382,000, deducted from the construction account of the Salt River project by Secretary Lane, upon the recommendation of the central board of review, should be charged off as a loss to the reclamation fund.

38. YUMA PROJECT

Notwithstanding it has been held under existing law that all moneys received and to be received under a certain contract, dated October 23 1918, between the United States and the Imperial Irrigation District, should be paid into the reclamation fund, we recommend appropriate legislation directing that such moneys be credited to the Yuma project, including the mesa division, upon an equitable basis.

We understand the term "equitable basis" to mean taking into consideration the differences in soil, topography, and location of each farm unit on a project, with a special reference to the influence of these and all other essential factors upon the ability of each such unit to produce crops of value, as compared with other farm units upon the same project.

39. YUMA PROJECT

This committee finds that this project was authorized to provide water for the irrigation of certain lands on both sides of the Colorado River, in the vicinity of the town of Yuma, Ariz.

CONTRACT LANDS

The land in California is in an Indian reservation. The lands in Arizona were destined to be irrigated partly by gravity and partly by a pumping plant. The lands now included under water-right contracts embrace the following:

	Acres
Indian reservation lands in California disposed of to white settlers.....	6, 100
Reservation lands in California remaining with the Indians.....	8, 100
Valley lands in Arizona.....	48, 800
Mesa lands in Arizona. (There are mesa lands having a total area of about 34,000 acres, susceptible of irrigation by works yet to be completed).....	6, 000

COST OF WATER RIGHTS

The project cost of water rights in California has been fixed by notice at \$55 to \$66 per acre. The project cost of water rights in Arizona, in the Yuma Valley, has been fixed by public notice at \$75 per acre. The project cost of water rights on mesa lands in Arizona is estimated at \$200 an acre.

EXPENDITURES NOT INCLUDED IN THE FIXING OF PROJECT COSTS AND WHICH ARE NOT NOW REPRESENTED BY ANY ASSETS WHICH CAN BE CHARGED TO SETTLERS

The original plans for this project provided for a main canal starting from the Laguna Dam, to divert water from the Colorado River, which was to extend down to the Yuma area on the east side of the river, crossing in its course the Gila River. After \$580,936 had been spent it was found that this route was not feasible and it was abandoned. There are no assets to balance this expenditure and it has not been included in fixing the cost of water rights.

In order to protect the farms on both sides of the river from flooding and erosion, it became necessary to build a levee and in some places to rip-rap the banks. The building of this flood-protection system had developed until the costs stand at present as follows:

Indiana reservation levee.....	\$867, 287. 12
Yuma Valley levee.....	1, 374, 122. 93
Gila Valley levee.....	405, 363. 97
Yuma City levee.....	¹ 12, 666. 20
Imperial Valley irrigation district.....	¹ 56, 512. 29
Total.....	2, 715, 952. 51

The cost of this levee system has not been included in the estimates on which the different project costs of water were fixed. It is an expenditure which settlers could not afford to pay and which has not been charged against them. It needs to be disposed of definitely and the committee makes a recommendation with regard to it.

In fixing the project costs that settlers were required to pay the entire expenditure on the Laguna Dam was included. Subsequently a right to use this dam has been sold to the Imperial irrigation district in California for \$1,600,000. The question has arisen as to whether this sum when paid shall be placed in the general reclamation fund or credited on water-right contracts of settlers under the Arizona-California-Yuma project.

¹ Reimbursed.

With regard to these different matters the committee recommends:

(1) That the \$580,936 expended on the Arizona main canal, which was subsequently abandoned, be deducted from the general reclamation fund as money lost beyond recovery.

(2) That the levee system be regarded as a public work of the United States, similar in character to other protection works built under the rivers and harbors act along navigable streams, because the United States holds that the Colorado River is a navigable stream, and in pursuance of that holding the Government has built protection works at Yuma and a levee on the California side of the stream in Mexico known as the Ockerson Levee, at an expenditure of \$1,000,000. These have been treated as improvements under the rivers and harbors act, no charge for repayment having been made against anyone.

The committee recommends, therefore, that legislation be secured under which the expenditure for the construction, operation, and maintenance of these levees by the reclamation fund shall be treated as an expenditure of the General Government, similar to expenditures under the rivers and harbors act, and that the reclamation fund be reimbursed by an appropriation equal to the amount of this expenditure.

The committee recommends that expenses incurred in the maintenance and operation of the levee system be provided for under some cooperative agreement between the States of California and Arizona and the War Department, similar to other cooperative agreements for the maintenance of levees on the Mississippi and other rivers, and that no part of this cost be included in the operation and maintenance expenses of this project.

We further recommend:

1. All excess holdings of lands in form units should be disposed of to bona fide settlers.

2. Disposition of all unpaid charges in accordance with resolution No. 24.

3. Adoption of the new plan of repayment in accordance with Resolution No. 23.

40. YUMA AUXILIARY PROJECT (MESA DIVISION OF THE YUMA PROJECT)

This division was constructed under the provisions of an act of Congress approved January 25, 1917, known as "An act to provide for an auxiliary reclamation project in connection with the Yuma project in Arizona (39 Stat. 868)." The drastic provisions of this act are impossible of fulfillment and only a few of the settlers have been able to meet their contracts. They, too, will soon fail, as the charge for water will bankrupt them.

The committee recommends:

That an early study be made by the Bureau of Reclamation of this division, with a view of making recommendations to Congress for financial relief, or the disposal of the division if adequate relief is not feasible.

41. ORLAND PROJECT

We commend the water users of the Orland project for their strict compliance with the regulations of the Bureau of Reclamation, and congratulate them upon the success that has attended their agricultural operations, as evidenced by the full and prompt payments of construction and operation and maintenance charges.

The Orland project should be under the full management of the water users, and we recommend, therefore, that a suitable contract to this end be drawn; and that, when the water users assume control of the project, the operation and maintenance charge for the year then current be covered into the construction account to be repaid as part of the construction repayments. (Resolution No. 19.)

42. GRAND VALLEY PROJECT

It appears from the hearings and data before the committee that the Grand Valley project in Colorado was built within the estimated cost, yet the acre charge against the settler has been practically doubled over the original estimate.

This increase was brought about by the necessary exclusion of large bodies of land originally embraced within the project, by reason of the fact that subsequent investigations and soil surveys showed the excluded lands to be so lacking in fertility as to make them unfit for agricultural settlement.

It further appears that a considerable portion of the land included within the project is of such a character as to require several years cultivation before profitable returns can be had.

The situation above set forth has led to a request from project settlers for a complete review of their situation upon which shall be based an equitable adjustment of the project cost to the settlers.

We believe the request justified and that such a review should speedily be had, and should take into consideration topography, location, and difference in soil upon each farm unit, which factors are necessarily controlling as to the crop value of the lands, and furnish the true measure of the charge that each farm unit within the project is able to bear.

Pending such review and readjustment, we recommend that "Public Notice" be not given and that only such rental charge for water be made as the land in cultivation can reasonably bear.

43. UNCOMPAGRE PROJECT

From the record the committee does not feel justified in recognizing the claim of the Uncompagre Water Users' Association that the charge against them should be established as \$25 per acre.

With respect to the acreage of the Uncompagre project liable to payment of project costs, the committee finds the annual report of the Reclamation Service for 1916 gives this irrigable acreage as 140,000 acres. The annual report for 1917 gives this irrigable acreage, when completed, as 100,000 acres, with no explanation of the reason for the reduction.

The public notice, which is dated April 12, 1922, fixes the total irrigable area subject to project costs as 129,942 acres, which is classified, 97,410 acres being placed in class 1 and 32,532 acres in

class 2. The entire project cost is charged against the lands of class 1, no part of the charge being imposed on the lands in class 2.

The committee recommends that the project costs be spread equally over the entire area included in classes 1 and 2, and that class 1 lands be entirely relieved of payment of any part of project costs thus allocated to class 2 lands, for the reason that project costs were incurred to serve both classes of land, and to impose these charges solely on class 1 lands loads them with a greater burden than they can or should bear, and unfairly relieves the lands in class 2 of any burden.

The committee further recommends that a classification of the lands within this project be made in accordance with the principles laid down in general resolutions Nos. 7 and 13 adopted by the committee, and that that part of project costs as above allocated to class 1 lands be in accordance with said resolutions, and that none of said lands shall be charged with more than \$70 an acre as fixed by public notice.

The item of \$47,000, deducted from the construction account of the Uncompahgre project by Secretary Lane upon the recommendation of the central board of review should be charged off as a loss to the reclamation fund.

44. KING HILL PROJECT

The committee recommends:

1. The Bureau of Reclamation should retain the management of the project until conditions on the project are improved.
2. The Bureau of Reclamation should make a careful study of conditions prevailing on the project with reference to possible repayment of construction costs.
3. The Bureau of Reclamation should require the breaking up of the larger holdings into smaller units for the benefit of home makers.
4. The present available funds should be held in suspense until definite plans based upon the investigation of project conditions have been formulated.
5. The proposed power plant should not be constructed until there is assurance that the money already expended on the project will be returned.

45. MINIDOKA PROJECT

The committee recommends—

1. Additional pumping facilities should be added as may become necessary from time to time.
2. There should be a definite settlement of the problems of power, excess water, town sites, grazing and farm lands, in accordance with Resolution No. 20.
3. The district should assume the management of the project and be advanced one year's operation and maintenance, as provided in Resolution No. 19.
4. The new repayment plan should be put into force according to Resolution No. 23.
5. Drainage should be added as necessary and should be made mandatory for the entire area.
6. All recommendations should be embodied in a contract with the water users.

46. BOISE PROJECT

With respect to the Boise project we recommend:

1. That a survey be made of the lands of the project for the purpose of determining equitable acre charges under Resolutions Nos. 13, 7, and 8.
2. That the water users take over the management of the project as under Resolution No. 19.
3. That drainage costs be included in the supplemental construction costs.

47. HUNTLEY PROJECT

The committee recommends that—

1. The amount charged to operation and maintenance in early years of the project, and which was, according to the statements of the water users, over and beyond the amount for which they had received a receipt in full, should be charged to the reclamation fund as a loss, provided the statements of the water users are found to be correct.
2. A contract should be entered into with the water users along the general lines of the pending contract but subject to Resolution No. 16.
3. Drainage as necessary should be undertaken under supervision of the Bureau of Reclamation.
4. The water users should take over the management of the project. (Resolution No. 19.)

48. MILK RIVER PROJECT

The committee recognizes that there will be a material loss upon the Milk River project and makes the following recommendations:

1. That the lands be classified, project costs fixed, and repayments made in accordance with Resolutions Nos. 13, 7, and 23.
2. That the pending contract with settlers be not made unless the following conditions be fulfilled:
 - (a) Private landowners shall contract for absolute sale of excess holdings at acre prices, the maximum to be approved by the Secretary of the Interior.
 - (b) Private landowners shall enter into contracts with the Government for operation and maintenance charges, pending disposition of excess lands.
 - (c) A time limit for the execution of contracts (a) and (b) be fixed not later than April 1, 1925.
3. That if the above contracts are not then made, the Government should cease operation of the project.
4. That a special examination should be made for the purpose of determining what portion of the total construction cost should be assumed by the United States and repaid to the reclamation fund by reason of the fact that the project was originally selected and expenditures authorized in order to safeguard international water rights asserted by Canada.

49. SUN RIVER PROJECT

The conditions on this project affecting repayments are unsatisfactory, due mainly to the low acre income from the crops produced. There is an ample water supply on the Fort Shaw division, but there is undoubted need for a comprehensive drainage plan, which will

ultimately increase the present cost by \$10 to \$20 per acre. The water supply of the Greenfields division is inadequate. It fails about July 10. To remedy this will require the construction of a reservoir, the cost of which, with the completion of the distribution system, would add \$41 to the present cost of \$44 per acre. The committee therefore recommends:

FORT SHAW DIVISION

1. The district should take over the management of the division. (Resolution No. 19.)
2. Drainage, as necessary, should be done by the Bureau of Reclamation.
3. Excess operation and maintenance charges prior to 1913 should be adjusted.

GREENFIELDS DIVISION

1. Drainage now planned should be completed.
2. Before any storage or extensions are made Resolution No. 2 should be applied.
3. Public notice should be delayed until the project is ready for profitable operation.

50. LOWER YELLOWSTONE PROJECT

As to this project, the committee has sufficient information before it to justify the making of definite recommendations as to the charges settlers upon the project should be required to pay.

There have been at our disposal the reports of the local board of review and of the central board of review made in 1916 upon this project, together with that of the reclamation commission, supplemented by our own investigations. The board which have heretofore made a study of this project have in every instance unanimously recommended that the charge against the settlers should be fixed at a lower figure than that of \$60 per acre, which by contract they are now required to pay. We believe this position is justified.

(1) The project is in the semiarid or dry-farming area, where good crops without irrigation have not been unusual and where grazing has been profitable. The prices of dry-farming land outside the irrigable area are about the same as for irrigable lands within the project, which indicates that the productive value of water under the project is low and that a high charge for water right is not justified. Nothing can be gained by making a water-right charge for more than the water is actually worth in irrigation, as shown by the crops raised over a series of years.

(2) The data before us show that the productivity of the land within the project under irrigation will not reasonably bear a charge of \$60 per acre for water.

(3) It further appears that there were some excessive and unwarranted costs incurred in the construction of the project, which careful planning and consideration might have foreseen and possibly avoided.

For the foregoing reasons we recommend that the charge against the lands included within the project should not be in excess of \$45 per acre in any instance, as of June 30, 1923, and that the charge

to be fixed upon each farm unit should be in accordance with the provisions of Resolution No. 13, and that whatever legislation may be necessary to permit the Secretary of the Interior making an adjustment in accordance with the above recommendation should be enacted.

In this connection we wish to point out that in the future no new project should be authorized without the careful investigation provided for by the terms of Resolution No. 2, in order that the mistakes attendant upon the adoption and development of this project may be avoided.

51. NORTH PLATTE PROJECT

The committee recommends:

1. That the North Platte project be immediately turned over to the water users' association in accordance with our Resolution No. 19 and that the tentative pending contract be made the basis of such transfer.

2. That the terms of the contract shall be in accordance with the Resolutions No. 13 as to classification of lands, No. 20 as to power, and No. 23 as to repayments.

3. We recommend the further investigation and commencement of construction of the Guernsey Reservoir and incidental operations.

52. NEWLANDS PROJECT

The Newlands project was among those first selected and authorized after the passage of the reclamation law.

The engineering features were carefully considered, the water supply based upon the use of storage in Lake Tahoe, and the agricultural study of soils made in accordance with then known scientific methods. It seemed to offer climatically, agriculturally, and physically an opportunity for a successful project.

The original possible area was thought to be about 450,000 acres; that was early reduced to 397,000 acres and later to 206,000 and finally to 73,000, when it was found, as a result of years of legal controversy, that the expected use of the water of Lake Tahoe was not available.

The unexpected failure of storage is the underlying cause of the difficulties from which the project has suffered. Unusual drainage and seepage conditions and the existence of 20,000 acres, held by a few owners with a prior water right, which became important because of the failure of the expected storage, added to the difficulties of the project.

To in measure meet those difficulties the Lahontan Storage Dam was constructed and drainage was begun. Of necessity, the costs increased out of proportion to the irrigable acreage. Exhaustive engineering examinations have been made for the purpose of providing the needed quantity of water and increasing the irrigable acreage.

It is believed that the irrigable acreage can be increased to 159,000 by the construction of the Spanish Springs reservoir and the distributing systems to the added areas.

It is apparent that a large amount has been spent for original work which, because of the conditions before mentioned, should not be charged to the project when completed as now proposed.

The committee is satisfied that the proper course to pursue is the construction of the Spanish Springs reservoir, otherwise, the interests of both the settlers and the Government will be seriously jeopardized.

We recommend:

1. That the construction of the Spanish Springs extension be authorized subject to Resolutions Nos. 2 and 8.
2. That items included in present construction charges which are found to be nonbeneficial to the project be charged off and proper credits given equitably to the whole project.
3. That acre charges and repayments be fixed in accordance with Resolution No. 23.
4. That further examination be made of the 20,000 acres of private lands with prior water rights, for the purpose, if feasible, of either acquiring said lands or obtaining an agreement for their subdivision and sale at a fixed price, and finally bringing them definitely under the project as other lands.
5. That the drainage plans as now proposed be carried out.
6. That whatever legislation may be necessary to permit the Secretary of the Interior making an adjustment in accordance with the above recommendation should be enacted.

53. CARLSBAD PROJECT

A serious situation confronts this project created by the rapidly silting up and leakage from the main storage reservoir (Lake McMillan) and the ultimate failure of the project is certain unless additional storage is provided at an early date.

The committee recommends:

1. An expert engineering survey to secure additional feasible storage.
2. The plan of repayment provided by Resolution No. 23.
3. The provisions of Resolution No. 12 should be enforced.

54. RIO GRANDE PROJECT

The questions raised regarding this project are:

- (1) The proportion of construction cost assessed by the United States in order to fulfill its treaty obligations with Mexico.
- (2) The credit claimed by water users for lands used for the construction of drainage ditches.

The committee recommends:

1. That no further appropriation by the United States is required to cover the expenditure made to fulfill treaty obligations for the reason that the original appropriation of \$1,000,000 has been found to be ample.
2. That the lands taken for drain ditches be treated in accordance Resolution No. 16.
3. The plan of repayment provided by Resolution No. 23.
4. That lands be classified as provided by Resolution No. 13.
5. The operation and maintenance of the storage works and diversion dams should remain under the control and management of the bureau, which should complete the drainage system.

6. Each irrigation district should take over the operation and management of the distributing systems within their respective districts in accordance with Resolution No. 19.

7. The bureau should continue investigations for dam sites with a view to future power development.

55. WILLISTON PROJECT

The history and prospects of this project do not justify its further operation by the Bureau of Reclamation. The committee recommends:

The Williston project be appraised and sold and the losses incurred charged to the reclamation fund.

56. UMATILLA PROJECT

The committee recommends:

1. That the construction cost of each division be spread equally over the entire area for which works have been constructed.
2. That the lands be classified as under Resolution No. 13.
3. That a type of agriculture and system of irrigation practice suitable for this project be devised and put into operation. (Resolutions Nos. 27 and 28.)
4. That the water users, through their irrigation districts, take over the full control of the operation and maintenance of the project. (Resolution No. 19.)
5. That the proposed plan of repayment, Resolution No. 23, be applied to such lands as are not relieved from payment under Resolutions Nos. 7 and 8.

57. KLAMATH PROJECT

The claim of the settlers on the Tule Lake division of the Klamath project, that there should be a reduction in the charge of \$90 per acre as established by public notice of September 29, 1922, but subsequently withdrawn, is well founded.

There is available much information bearing on this subject, but we are of the opinion that a satisfactory recommendation concerning an equitable acreage charge can be determined only after a detailed survey of Tule Lake lands has been made.

We recommend, therefore,

1. That a survey of the Tule Lake division of the Klamath project in accordance with Resolution No. 13 be authorized.
2. That upon the completion of this survey a board of review be appointed to formulate conclusions upon the findings of this survey and upon the large amount of information already in the possession of the Bureau of Reclamation.
3. That this board of review consider the reduction of the present acre cost by adjusting the main items set up by the water users and the engineers who have examined the estimates, namely:
 - (a) The determination of the full acreage of Tule Lake lands that may ultimately be irrigated and which should share in the division construction costs.
 - (b) The allocation of the cost of the main canal in accordance with Resolution No. 6.

(c) The allocation of the cost of the diversion canal from Lost River to Klamath River, based on the benefits of this canal to the project as a whole.

(d) An equitable allocation of the costs of the Clear Lake and Gerber Reservoirs.

4. That the drainage estimates be not included in the acre charge, but, as needed, appear as supplementary construction.

5. That all project costs incurred for lower Klamath Lake lands, or other lands, later eliminated, shall be deducted from the construction costs on all project lands, which have been fixed or may be fixed, since such elimination occurred. Such deducted amounts shall be held in the suspense account.

58. BELLE FOURCHE PROJECT

The combined expenses of providing water on this project, which included construction cost, operation, and maintenance, and payments on project construction costs of necessary drainage, have been greater than the value of water in irrigation, which has resulted in accumulated arrears. These have been adjusted under a contract entered into between the district and the United States.

It is believed that under the plan of repayment recommended by the committee settlers can meet their payments, but there will be a large deficit until the unoccupied lands are settled and brought under cultivation.

The committee recommends:

1. Classification and equitable valuation of lands in accordance with resolutions Nos. 13, 7, and 8.

2. The disposition of all adjusted unpaid charges in accordance with Resolution No. 24.

3. Adoption of the plan of repayment in accordance with Resolution No. 23.

59. STRAWBERRY VALLEY PROJECT

The management and operation of the Strawberry Valley project should be taken over at once by the water users. Nearly half of the lands of the project receive a part of their full water right from the project works, and the remaining part from private irrigation companies which operate canals from Spanish Fork River. The water rights of these private irrigation companies are among the oldest in the United States, dating back to the first years of the Utah settlement. It is practically impossible to mingle the control of the rights of the private canals and the Government project. A contract with the United States, similar to the contract with the Salt River project, would enable the Strawberry Valley water users to assume control of the project and to operate it satisfactorily. At the time of making transfer of the management and operation the accrued and future receipts from grazing lands and power plants should be disposed of as directed by Resolution No. 20.

There is a surplus of available water above the present needs of the project. The contract with the water users should include all the stored water.

The repayment requirements of the project should be proportioned to the productive capacity of the project lands under the proposed repayment plan. (Resolution No. 23.)

60. OKANOGAN PROJECT

The committee recommends:

1. That the entire cost, as of January 10, 1919, be spread equally over the entire area for which works had then been constructed.
2. That a competent survey be made (Resolution No. 13), and that upon the findings of this survey the lands susceptible of profitable cultivation shall be relieved of payment of any part of project costs allocated to lands, including those heretofore excluded, that shall be determined to be unsuited for profitable cultivation.
3. That the cost of the power plants built in canals to furnish power for pumping be charged to the project only if it is shown that power can be furnished as originally planned.
4. That the cost of the Salmon Lake and Conconully Reservoirs be deducted from the construction costs charged to the water users, and that water from these reservoirs be sold hereafter to the water users on a rental basis.
5. That a study be made of possible sources of irrigation water for the lands of the project.

61. YAKIMA PROJECT

The record indicates that the difficulties confronting the water users of the Yakima project are chiefly those due to adverse marketing conditions and freight rates, high taxes, and a large interest-bearing indebtedness. The favorable agricultural nature of the project and the high quality and successful experience of the water users justify the belief that, under the following recommendations and all others having general application, this project will retain its position of leadership among the projects.

The committee recommends:

1. That the operation and maintenance of the Yakima project be taken over at once by the water users under a contract in accordance with Resolution No. 19.
2. That the proposed plan of repayment apply to such divisions of the Yakima project as may elect to accept them. (Resolution No. 23.)

62. RIVERTON PROJECT

This project was authorized in 1917. The estimated cost is \$8,000,000, of which about \$1,000,000 has been expended. The acreage is estimated to be 100,000.

The committee recommends that in the future development of this project the Bureau of Reclamation apply the principles contained in the resolutions of this committee applying to the construction of new projects.

63. SHOSHONE PROJECT

This is one of the projects in which the construction costs were greater than the value of water in irrigation. The three divisions vary greatly in agricultural value. The major portion of the lands of the Garland division have an agricultural value which justifies a proportionate share of the project costs. The lands on the Frannie division are of such low agricultural value as to make it impossible for them to pay the cost of operation and maintenance of the irrigation works,

much less to return the construction costs. The prospect of repayment of project costs by the Willwood division, now under development, are not promising.

The committee recommends:

GARLAND DIVISION

1. The management of the division to be taken over by the water users. (Resolution No. 19.)
2. Classification and equitable valuation of the lands under Resolutions Nos. 13, 7, and 8.
3. Adoption of the new plan of repayment under Resolution No. 23
4. Disposition of all unpaid charges under Resolution No. 24.
5. Segregation of operation and maintenance charges among the divisions of the project in such a manner as to make each division liable only for its own operation and maintenance costs.
6. Power profits should be credited to the power construction account until final adjustment of costs is made upon the several divisions.
7. Income from grazing lands and town sites under Resolution No. 20.

FRANNIE DIVISION

The committee believes that the Frannie division should be abandoned in whole or in part, but under such conditions as will be just to the settlers; hence it is recommended:

1. That the Bureau of Reclamation immediately make an examination of the division and make detailed recommendations to the Secretary of the Interior, providing for such whole or partial abandonment.
2. That pending such recommendations, the construction costs allocated to the division and all charges for construction and operation and maintenance against the settlers be held in suspense, without interest or penalty, that water be supplied to settlers now actually irrigating their lands at a rental to be agreed upon, and that no additional lands be irrigated.
3. That in the event the division is not wholly abandoned, the recommendation of the Bureau of Reclamation for the operation of lands not abandoned shall be in harmony with the resolutions of this committee regarding classification of lands, repayments, and such others as may be applicable.

64. BUFORD-TRENTON AND HONDO PROJECTS

These projects have proven to be failures and operation by the bureau has been discontinued. The committee recommends:

The Buford-Trenton and Hondo projects be appraised and sold and the losses incurred charged to the reclamation fund.

65. EXTENSIONS AND NEW PROJECTS

Having under consideration the suggested legislation authorizing appropriations for the Guernsey Reservoir (North Platte project), Spanish Springs (Newlands project), Owyhee and Vale (Oregon), Salt Lake Basin (Utah), and Kittitas (Washington).

EXTENSIONS

The committee recommends that appropriations for the following should be authorized:

1. The Guernsey Reservoir, an extension of the North Platte project. This extension has long been under consideration. Approximately \$100,000 has been authorized and expended for the purchase of lands within the site. The extension will be of immediate benefit to the North Platte project and give additional assurance of repaying the entire investment. The expenditure of funds for construction and development should be made in accordance with principles embodied in general resolutions of this committee.

2. The Spanish Springs Reservoir, an extension of the Newlands project. The reasons for this extension have been given in this report dealing with the Newlands project. It is necessary in order to safeguard the interests of the United States and the settlers, to assure the quantity of water needed for available irrigable lands, and materially lessen the losses which will inevitably be sustained. The expenditure of funds for construction and development should be made in accordance with the special recommendations relating to the Newlands project and appropriate general resolutions of the committee.

NEW PROJECTS

As to the proposed new projects, Owyhee, Vale, Salt Lake Basin, and Kittitas, the committee has not sufficient information upon which to make specific recommendations. Attention is called to the fact that the estimated costs of construction are nearly all in excess of \$120 an acre. The committee is of the opinion, based upon the reports of annual production from lands now under irrigation, that projects requiring such acre cost as above suggested should be constructed only after it is clearly shown that the lands, when irrigated, can produce annual crop values sufficient to enable the settlers to repay costs from production, and within a reasonable time.

It is understood that the above projects are those which offer the most favorable conditions for present investigation, and hence the committee is of the opinion that the appropriations therefor should be authorized, but with the provision that further investigation should be made of their feasibility, and that, if finally selected, they should be constructed and developed in accordance with the general resolutions of this committee.

66. ADMINISTRATIVE CHARGES—WASHINGTON OFFICE

Since the organization of the Reclamation Service there have been constant and insistent protests from the project settlers against the policy of the service in charging the expenses of the Washington office and general investigations to the various projects. Our investigation of these expenditures leads us to concur in the justice of these complaints and we feel that said charges should not be allocated to and made a charge against the various projects but be a charge against the reclamation fund; therefore we recommend that all such charges made in the past should be properly credited to the various projects and in the future all such charges be made to the reclamation fund.

THE ORIGIN AND PURPOSE OF THE INQUIRY

Under date of September 8, 1923, Hon. Hubert Work, Secretary of the Interior, sent the following letter to Julius H. Barnes, Washington, D. C.; Oscar E. Bradfute, Xenia, Ohio, with headquarters at Chicago, Ill.; Thomas E. Campbell, Phoenix, Ariz.; James R. Garfield, Cleveland, Ohio; Elwood Mead, Berkeley, Calif.; and John A. Widsote, Salt Lake City, Utah:

The purpose of this letter is to invite you to serve, with six other men having national confidence, on a fact-finding commission to make an intensive study of the policy, application, and operation of Government methods of reclaiming arid lands by irrigation, which has become a matter of national concern.

It is generally reported that relatively few of the original settlers on projects now remain on them as water users. One hundred thirty-four millions of Government money have been expended. Fourteen millions have been returned and six millions are due and unpaid as of December 31, 1922, to which must, very soon, be added computations for the present calendar year.

Time extensions for payment of both construction and maintenance charges have been asked which, if granted, would multiply deferred annual payments, it is feared, beyond the ultimate ability of the settler to pay, entailing probable loss of his home and to the Government the loss of the investment.

The purpose of this inquiry, in which I very much hope you may participate, is to have the processes of administration of this trust reviewed by men of affairs, applying their best thought to this important governmental agency.

Reclamation has done much toward the development of the West, but it now clearly requires to be adapted to existing conditions, so that its future success may be achieved and the possibility of home ownership be assured to settlers.

Your commission will of course be provided with suitable offices, necessary data, and the courteous assistance of the Bureau of Reclamation.

As the work progresses you will be supplied with itemized statements and complaints coming in, of which I must take cognizance and which may serve to indicate the direction the commission may be prompted to take in its inquiries.

Although only recently charged with the responsibility of reclamation, I am not a stranger to the irrigation of arid lands, but prefer, however, not to suggest procedure and would not expect to advance opinions to this commission unless requested, asking only that the questions be treated with publicity and that I may transmit your report to Congress.

Awaiting your prompt reply and hoping for your cooperation, I remain,

HUBERT WORK.

On September 17, 1923, the following telegram was sent to Clyde C. Dawson, Denver, Colo., by Secretary Work:

Could you serve intermittently on my fact-finding committee? Have you water-power attachments that would embarrass such service? If you feel you should not serve, suggest another member chamber of commerce Barnes could appoint.

WORK.

All the persons so addressed expressed their willingness to assist in the proposed investigation. However, Doctor Mead was abroad and did not join the committee until December 18, 1923, and the duties of Mr. Barnes made it impossible for him to attend the hearings regularly. D. W. Davis, Commissioner of the Bureau of Reclamation, who was on the original list, requested, in view of his official connection with the bureau, a release from the appointment.

On October 15, 1923, the opening meeting of the committee occurred in the office of the Secretary of the Interior at Washington, D. C. On that occasion Secretary Work expressed himself as follows:

Soon after I was called upon to act as Secretary of the Interior in March, 1923, my attention was particularly directed to conditions relating to the reclamation projects constructed or being constructed by the department in the Western States and among which I have lived for 35 years.

Through complaints from organizations of water users, individual water users, reports of agents, inspectors, official records of the department, and Congress, it appeared that nearly all of the projects were in such condition that some radical reforms or improvements must be had if they were to be saved, farmers protected from loss of their homes, and the return of the money advanced by the Government for their construction and maintenance was to be secured.

The complaints and criticisms cover a variety of points, too numerous to be described here, but included charges that in many of the projects the original estimates under which settlers were induced to go upon the projects were from 50 to 100 per cent too low, and that the actual cost has been so great that it is impossible for the farmers to pay out within the time and manner fixed by law, or even at all; that mistakes, engineering and otherwise, had been made which added materially to the cost of constructed projects; that others had been undertaken that should never have been started; that the overhead costs of the service and many of the individual projects, all borne by water users, were burdensome and excessive.

Under the system used in the Reclamation Service I have been unable to get figures that appear to be dependable as to the cost of individual projects or the total money expended on all projects.

It is represented, taken from the records of the bureau, that the Government's total investment to June 30, 1923, in round numbers is \$181,000,000, and its total receipts about \$46,000,000, leaving a balance invested and unpaid of \$135,000,000.

The Reclamation Service, for which this department is responsible, apparently requires reorganization. Annual reports on some projects indicate their insolvency and pending failure. Out of the 28 projects only one has met its obligations as they fell due. Long extensions of time for payments due are being urged individually and by projects. The original 20-year period for payment is expiring on certain projects and an additional 20-year extension is being asked. In one instance, such extension is to be preceded by a 5-year moratorium.

Reclamation of arid lands by irrigation from Government funds, as heretofore practiced, is failing on a majority of projects as a business procedure and must be promptly readjusted as to methods of reimbursement for funds appropriated and for the purpose of securing to the settler a permanent home.

Your committee is requested to survey the whole subject in its entirety, give to the bureau your opinions concerning our operating methods that we may avoid errors, and finally your recommendations which Congress may study and which should ultimately preserve the sanctity of contract, secure to farmers safety for their investments already made, and insure a return of invested funds. I want to improve and extend the service in every way possible, and solicit your suggestions and recommendations.

Government reclamation has accomplished much. There is a great field for its future. Reclamation in the West by private enterprise was begun 30 years before the Government began this work and has largely redeemed the West. Government reclamation should make a comparable showing, relieved as it is, from interest charges, which is the basis of calculation in all enterprises employing private capital. I am anxious that a policy may be developed that will safeguard the future of Government reclamation, which is my only concern in this inquiry.

At the opening meeting on October 15, 1923, the committee organized under the name of "Committee of special advisers on reclamation," with Thomas E. Campbell as chairman and John A. Widtsoe as vice chairman and secretary. Thereafter, the committee held daily meetings. The committee had at its disposal, from the beginning, a financial statement, which had been prepared for Secretary Work, exhibiting the financial problems of the Bureau of Reclamation. (Appendix, Exhibit 1, Table 1.)

In addition, the complaints coming in from the projects and the requests for relief were available and witnesses appeared before the committee. The financial analysis, the relief requests, and the complaints from the projects set the problem before the committee. In brief, the financial analysis (1-11), and the other sources of information above mentioned, indicated:

(1) That 18 projects had had an available water supply for 15 to 18 years; 3 projects from 13 to 14 years; 2 projects, 9 years; 1 project, 3 years; 3 projects have been abandoned; and 1 project is under construction.

(2) That the original estimated cost of these 28 projects was \$93,453,641, and the net construction cost to June 30, 1923, was \$141,787,005.74.

(3) That the original estimated area to be reclaimed was 3,056,427 acres, as against 1,692,700 acres actually reclaimed.

(4) That of the 1,692,700 acres for which the bureau was prepared to supply water in 1922, only 1,202,130 acres were irrigated.

(5) That of the net construction cost of \$141,787,005.74, a sum of \$15,592,842.48, or about 11 per cent, had been repaid by the settlers on the projects.

(6) That the average estimated cost per acre was \$30.57 as against \$83.76 actual cost per acre, for the acreage for which the bureau was prepared to supply water, and \$117.94 actual cost per acre on the basis of the area actually receiving irrigation.

(7) That in every case the acre cost under public notice is higher than the original estimated acre cost.

(8) That in many cases the aggregate charge to settlers per acre under public notice is less than the actual acre cost, based on acreage which the bureau is prepared to supply with water.

(9) That of the total cost \$17,059,231.85, of operation and maintenance, \$5,688,487.76 remain unpaid.

(10) That \$180,137.23 of delinquent water rentals remain unpaid.

(11) That the contracts for water service from the bureau total \$101,253,015.85, leaving \$39,442,026.09 of inactive assets.

(12) That complaints from the water users are continually coming to the offices of the bureau and of the Secretary of the Interior.

(13) That 3,224 applications for relief have been filed from the 31,792 water users on the projects.

(14) That relatively few of the original settlers on the projects now remain on them as water users.

(15) That there is a general demand for an extension of the time and rate of payment as required under the present laws.

(16) That 131,194 persons live on farms on the projects and 332,650 persons live in towns in association with the projects.

It was thus deemed by the committee its duty to determine whether these statements reflected the true and accurate conditions of the service, whether the complaints were well founded in whole or in part, and then to make such suggestions and recommendations as, in its judgment, the facts as developed might warrant.

The committee was further requested to consider the following questions and others that might occur in the course of the investigation:

(1) Have the methods and policy of administration of the Reclamation Service been adapted to the needs of the present day?

(2) Is the Bureau of Reclamation organized for most efficient service?

(3) Is the accounting system of the Bureau of Reclamation adequate and easily understood?

(4) Are the systems of irrigation practice maintained on the projects modern and satisfactory?

- (5) Were the methods of settling the land conducive to the successful development of the projects?
- (6) Were the conditions under which farms were developed in accord with the needs of the settlers and approved practices?
- (7) Has the Bureau of Reclamation supplied water as agreed?
- (8) Have any projects been adopted that should have been rejected?
- (9) Are the rates of payment required by law possible, based upon the receipts from the land?
- (10) Have delinquencies of payment been unavoidable?
- (11) Can a plan for the future be formulated, which if followed will lead the projects to success and will assure to bona fide settlers the realization of home ownership?

The problem as thus presented to the committee is of a twofold nature. First, it deals with the engineering history of the projects, involving estimates, costs, and administration; and, secondly, with the settlers who have undertaken to make homes upon the project lands. From another angle the problem consists in the determination and adjustment of existing contracts between the settlers and the Government, and in the study of the best disposition of the project lands not now under contract.

SCOPE OF THE COMMITTEE'S ACTIVITIES

The multitude of facts connected with the history of the Reclamation Service during the 21 years of its existence was examined with sufficient care to determine the principles which have guided the Reclamation Service in the past and which must guide the Bureau of Reclamation in the future.

During the course of our labors we have examined the published reports of the Reclamation Service; the reports of congressional hearings and investigations; the files of the Bureau of Reclamation, including the financial records, as available in Washington; special files sent to us from the Denver and other field offices; such files of the office of the Secretary of the Interior as had a bearing on the reclamation problem; the investigations of the board of Army Engineers in 1910, both in manuscript and printed form; the manuscript hearings before Secretary Lane in 1914, and before other Secretaries; the manuscript and printed reports of the central and local boards of review in 1915 and 1916; the reports of special accountants of the Department of Justice who made thorough reports on the accounting system; the findings of special project inspectors and of the field commissioner; the great number of letters from water users and others; and many books, reports, and statistical statements.

There was a noticeable lack of information concerning some matters of interest to the committee; therefore a form of inquiry was devised which, with a circular of instructions, Circular Letter 1268, was sent out by the Bureau of Reclamation to each project manager. The replies gave the committee a great deal of information not formerly accessible. Later the committee called for up-to-date answers by the project managers to the questions propounded by the board of Army Engineers in 1910, which was done under a supplemental order of instructions, Circular Letter 1274.

The committee heard in Washington 124 witnesses on various phases of the reclamation problem. They represented the official forces of the Secretary's office and bureaus of the Department of the

Interior (notably the Bureau of Reclamation), Department of Agriculture, Department of Commerce, Department of Justice, the Federal Farm Loan Board, the Federal Reserve Board, Members of Congress, governors of States, State departments, Federal and private water users, and interested citizens representing many phases of activity, who appeared voluntarily or at the call of the committee. Stenographic reports were made of the testimony of witnesses who possessed information that should be made permanently available.

Very able assistance was rendered to the committee by the accounting, engineering, and drafting divisions of the Bureau of Reclamation by the preparation of tables and charts covering many phases of the inquiry.

It was deemed advisable to hear the settlers' side of the story. The committee therefore called a meeting of water users, officers of water users' associations, and districts, and others interested, to convene in Salt Lake City, Utah, on January 17, 1924. At this hearing, which lasted from January 17 to January 27, 1924, inclusive, all the projects were represented by delegates, with the exception of Orland and Williston. Orland was represented by a letter setting forth the views of its settlers with respect to the future of the project. Williston sent in a brief after the committee had returned to Washington. All delegates were given full opportunity to present their views. This conference was perhaps the largest gathering of Federal water users in the history of Federal reclamation. The stenographic report of the proceedings covers 1,764 pages, and 165 exhibits are attached.

Dr. Elwood Mead made a personal visit to the Newlands project, and submitted a written report of his findings.

After this accumulation of material had been examined the committee made an individual study of each one of the projects, in the light of the facts obtained. All these materials, excepting those drawn from the files, are herewith submitted.

Material assistance in the search for information was rendered by a subcommittee appointed by the Secretary of the Interior, which searched the files and submitted information by projects in a convenient form.

The calendar of the committee, showing attendance of members, by days, and witnesses appearing before them, together with the minutes, is submitted in two volumes.

A great deal of publicity was given to the investigation, and the accumulation of newspaper clippings forms part of our records.

Early in the committee's investigation it was apparent that agricultural statistics were not only incomplete but difficult to procure. The Secretary of Agriculture detailed Mr. A. C. Cooley, agriculturist in charge of demonstration work on the reclamation projects under the Department of Agriculture, to assist in this work. The cooperation of Mr. Cooley throughout the whole course of our investigation has been of great value. Mr. P. I. Taylor, of the engineering division of the Bureau of Reclamation, was also detailed to the service of the committee. Mr. Taylor's intelligent and constant aid has greatly lightened the work of the committee.

Miss M. A. Schnurr served as chief clerk to the committee, and her admirable supervision of the office materially aided the labors of the committee.

THE ACHIEVEMENTS OF THE RECLAMATION SERVICE

The Reclamation Service undertook its work in 1902 with little previous experience, excepting that which had been won on private irrigation projects and on the few commercial ventures in irrigation. The activities of the service under the law of 1902 and succeeding laws form a unique experience in the history of reclamation. There was little experience for use in developing national reclamation under the terms prescribed in the act of organization. So much more interesting, as well as commendable, are the results obtained. Now, after two decades, it is possible to measure the success of the venture and to read the lessons of experience, which should help avoid difficulties and mistakes in the future.

During the existence of the Reclamation Service 29 projects were undertaken; many others known as secondary projects were examined and are held in suspension for further consideration. Of the 29 projects, 4 have been abandoned and one is beginning construction. The others, more or less completely in operation, are located in 15 of the Western States. In addition, the Reclamation Service has built three projects for the Indian Service—the Blackfeet, Flathead, and Fort Peck, all in the State of Montana.

LAND AND CROPS

On June 30, 1923, 21 years after the passage of the reclamation act, a volume of water had been impounded in reservoirs or diverted from regular stream channels sufficiently large to irrigate 1,692,700 acres of project lands, and to furnish supplemental irrigation under the Warren Act to 1,101,700 acres of land, not usually under a sufficient water right for full crop production. Of this irrigable acreage, 1,202,130 acres of project lands were irrigated, and of this irrigated area, 1,169,100 acres were cropped during the season of 1922. The average acre value of the crops produced during 1922 was \$43.08, or a total crop value for all the projects of \$50,360,850. This represents more than one-third of the total cost of construction on all the reclamation projects. During the existence of the Reclamation Service more than \$500,000,000 worth of crops have been produced on the projects.

A NEW STATE CREATED BY IRRIGATION

The 25 irrigation projects of the bureau, the development of which has advanced to the stage of producing crops, comprise some 34,000 farms and a cropped area of approximately 1,175,000 acres, and produce annually crops having a gross value of more than \$50,000,000. This is practically equivalent to the agricultural situation in the State of Massachusetts. According to the census of 1920, this State reported 32,001 farms which produced crops having a gross value in 1919 of \$53,700,925. Among the New England States, Maine was the only one which reported a greater number of farms than are found in these irrigated projects of the bureau, and each of the States of New Hampshire and Connecticut contained only about two-thirds as many.

SETTLEMENT

This land, brought under irrigation by the efforts of the Reclamation Service, not including the land which receives supplemental irrigation, has been divided into 34,276 farms, on which live 131,194 individuals, or not quite four persons to the farm. In addition, there are 205 towns and cities on or adjacent to the projects, with a population of 332,650, a considerable part of whom derive their support indirectly from the activities of the Federal reclamation projects. There are also on the projects 557 schools, 593 churches, 190 banks, and a great variety of manufacturing enterprises which make use of the products of the projects.

ENGINEERING STRUCTURES

The skill displayed in the building of the engineering structures of the Reclamation Service is of the highest order. Monuments to this skill will stand throughout the years to come in the form of great dams and water distribution systems. Some of these structures are already famous throughout the world, as for instance such outstanding structures as the Elephant Butte Dam in New Mexico, the Roosevelt Dam in Arizona, the Pathfinder and Shoshone Dams in Wyoming, the Arrowrock Dam in Idaho, and the Tieton Dam in Washington.

Up to June 30, 1923, the engineering structures of the service, including those on the three Indian projects, were capable of impounding 10,038,698 acre-feet of water. The diversion dams supplied another large quantity of water. To distribute this water, 12,111 miles of canals have been built, some carrying more than 1,200 second-feet, which is larger than the flow of many of the rivers of the West. The waste ditches and drains have a length of 2,363 miles. One hundred and three tunnels have been built, with a total length of 145,810 feet. The volume of the dams themselves is 15,503,195 cubic yards; and of the dykes and levees, 5,002,681 cubic yards. There have been built 9,093 bridges, with a total length of 216,682 feet; 11,013 culverts, with a total length of 389,306 feet; and 3,156,798 feet of pipe have been laid. The flumes of various kinds number 3,814, with a total length of 746,175 feet; 394.2 miles of canal have been concrete lined. The buildings constructed on the projects by the service number 1,573.

To afford means of communication, 83 miles of railroad and 1,038 miles of roads have been built, as well as 3,284 miles of telephone and 1,157 miles of transmission lines for carrying power. The power plants maintained in connection with the projects develop 64,159 horsepower. The total excavation necessary for the many structures equals 216,019,844 cubic yards, and the amount of concrete poured is equal to 3,270,895 cubic yards.

Drainage which is always a concomitant of irrigation, has required the making of 1,337.38 miles of open drains and 448.99 miles of closed drains. By this system of drainage, 535,807 acres of land have been protected against water-logging. Eighteen power plants, one steam electric the others hydroelectric, have been built by the service and are in full operation; and 46 pumping plants, using 18,087.5 horsepower, are pumping water from wells and rivers to the barren lands.

Such figures indicate the achievements of the Reclamation Service and suggest the many and varied difficulties with which the bureau has contended to accomplish such stupendous results.

ORGANIZATION

Necessarily an enterprise so huge in its conception and execution has required many workers. The corps of assistants was not ready-made for the needs of the service.

When the reclamation law went into effect on June 17, 1902, there existed a small corps of engineers comprising what was known as the division of hydrography of the Geological Survey. These men, trained through years of practical experience, became the nucleus of the Reclamation Service. (Reclamation Service, third Ann. Rept., p. 39.)

It was necessary at the beginning to secure men who could be trained for the work contemplated.

The men employed in the Reclamation Service are primarily those who have been investigating the extent to which the arid lands can be reclaimed by irrigation, as authorized by act of Congress of October 2, 1888. These men have spent the greater part of their lives in the West in the consideration of problems of water storage, stream measurements, and irrigation development. The additional men secured through the Civil Service Commission have been selected from the lists of those persons eligible to appointment as irrigation engineers or assistants, or as junior civil engineers or assistant topographers. An excellent class of well-educated, efficient, and energetic young men is available. There have been many applications for employment without preliminary tests, but it is deemed absolutely essential for the success of the work to select assistants by competitive examination and to advance all of the men solely on the basis of merit and ability. (Reclamation Service, first Ann. Rept., p. 16.)

Not the least of the responsibilities of the early days in the service appears to have been the training of these men for the work that they were required to do. Some of the men who entered the service as youths are still with the service, and look back upon a lifetime of experience with the special problems of the Reclamation Service.

ORGANIZATION AND SUPERVISION OF THE RECLAMATION SERVICE

ORGANIZATION

The original reclamation act was approved on June 17, 1902. It provided that the proposed work be supervised directly by the Secretary of the Interior. This has not been changed since that time, except that in June, 1910, provision was made that new projects after favorable recommendation by the Secretary of the Interior must receive the approval of the President of the United States; and in August, 1914, that all proposed expenditures by the Reclamation Service should, from year to year, be submitted to the Appropriations Committees of Congress and receive the approval of Congress as parts of the appropriation bills.

The reclamation act became a law while Hon. E. A. Hitchcock was Secretary of the Interior. Secretary Hitchcock continued in office until March 4, 1907, so that during his administration all the reclamation projects, except Grand Valley, Orland, King Hill, and Riverton, were authorized and initiated. He was succeeded by James R. Garfield, who served until March 5, 1909, and authorized the Orland project. Richard A. Ballinger served until March 12, 1911; Walter

L. Fisher until March 4, 1913, and authorized the Grand Valley project; Franklin K. Lane until February 29, 1920; John Barton Payne until March 4, 1921; and Albert B. Fall until March 4, 1923. The department is now in charge of Dr. Hubert Work, upon whose initiative this investigation was undertaken.

Secretary Hitchcock placed the proposed reclamation work under the Geological Survey. Dr. C. D. Walcott, the director, organized the Reclamation Service, now known as the Bureau of Reclamation, and appointed Dr. F. H. Newell, the chief hydrographer of the survey, to be chief engineer in charge. In March, 1907, the Reclamation Service was separated from the Geological Survey, with Dr. F. H. Newell as director and chief engineer. On December 13, 1913, a board of control was organized consisting of F. H. Newell, director; Arthur P. Davis, chief engineer; Will R. King, chief counsel; W. A. Ryan, comptroller; and I. D. O'Donnell, supervisor of irrigation. On December 10, 1914, A. P. Davis succeeded F. H. Newell, the offices of director and chief engineer being combined. Sydney B. Williamson was appointed chief of construction. The board with Mr. Williamson as a member remained in charge of the service until June 1, 1915. The board was then superseded by a commission comprising Arthur P. Davis, director and chief engineer; Will R. King, chief counsel; and W. A. Ryan, comptroller, which had supervision until June 30, 1917, when Mr. Ryan resigned; and the commission then functioned with two members until August 14, 1918, on which date the service was placed under the supervision of Arthur P. Davis, director and chief engineer, who continued in office until June 30, 1923. At that time Secretary Work created the Bureau of Reclamation with Hon. D. W. Davis as commissioner and abolished the office and title of director. The organization was further modified to meet more definitely the conditions that had developed on the reclamation projects.

It is evident in the study of the history of the Federal reclamation activities that the policies of the service were modified from time to time, as changes in the secretaryship of the Interior occurred. This appears to be especially so because the Bureau of Reclamation is nowhere recognized by law, but represents a duty imposed upon the Secretary of the Interior.

From the beginning of its operations the Reclamation Service has been investigated. It was recognized from the outset that the work of reclamation would be attended with many new and difficult problems. From time to time, therefore, the condition of the work was examined, with a view of detecting errors and devising betterments. The official list of congressional hearings and reports, dating from 1902 to 1923, number 550. During these hearings and investigations every phase of the activities of the service was examined. Official statements and tabulations were submitted, all of which are available in the printed files of congressional hearings and reports. This voluminous body of literature shows that the service has been continuously under consideration by Congress.

In addition to the investigations conducted in Washington by congressional committees, the service has been investigated in the field. For example, in 1909, when the service was only seven years old, the Senate authorized a visit to the projects, which was actually undertaken by the Senate Committee on Irrigation. This committee,

after a full hearing at Washington, visited 26 of the reclamation projects, representing all then authorized, in addition to the three Indian projects, and several proposed projects which have not yet been adopted. It was the first thorough examination of the projects by a body outside of the service itself. The report made by this committee may still be referred to with profit by those interested in the development of the reclamation experiment of the United States. (61st Cong., 3d sess., Rept. No. 1281.)

In 1910 it was found that a large number of projects, yet in process of building, were requiring more money than was yielded by the annual accretions to the reclamation fund. Consequently, it was proposed that Congress lend the Reclamation Service \$20,000,000, to be repaid in annual installments of \$1,000,000, beginning in 1920. This was approved, with the provision that a board of Army engineers should examine the projects and make recommendations as to the distribution of the loan among the projects. This board of engineers, consisting of Lieut. Col. John Biddle, Lieut. Col. W. C. Langfitt, Maj. Wm. W. Harts, Maj. C. W. Kutz, and Maj. H. Burgess first collected information regarding the Reclamation Service from the officers of the service, and then made personal examinations of the projects in question. Their observations and conclusions were published in 1911. (H. Doc. No. 1262, 61st Cong., 3d sess., "Fund for reclamation of arid lands, message from the President of the United States transmitting a report of the Board of Army Engineers in relation to the reclamation fund.") This was a thorough-going examination into the conditions on the projects, especially from the engineering side, and contains very valuable material for the study of the history of the reclamation movement. On the basis of this report, the \$20,000,000 loan was distributed among the projects.

In 1907, Hon. James R. Garfield, who had just assumed the Secretaryship of the Interior, undertook an exhaustive study of Federal reclamation conditions, by personal visits to the projects and by discussions with the reclamation employees and the settlers on the projects. The results of Secretary Garfield's investigations have not been published, but the files of the Secretary's office indicate that very thorough consideration was given to the problems then existing, and that definite recommendations were made as to the future. Secretary Garfield's term of office expired before all of his recommendations had been put into effect.

Secretary Ballinger also made some investigations into conditions on the reclamation projects. Secretary Fisher undertook to make himself personally familiar with the reclamation problem, but the results of his investigations have not been published.

Franklin K. Lane, when he became Secretary in 1913, found himself confronted, as his predecessors had been, with complaints from the settlers on the reclamation projects. He undertook to hear the complainants, and invited the various projects to send representatives to Washington to make statements before him. These hearings of 1913, which have not been published, give clearly, though voluminously, the point of view of the representatives of the projects at that time.

Two years later, in 1915, the complaints from projects having continued, Secretary Lane established what were known at the time as local and central boards of review. A committee of three, consisting of a representative of the Reclamation Service, a representative of the water users on the project in question, and a person connected neither with the Reclamation Service nor with the project, was appointed to investigate fully the conditions on each project. Full records were made of the hearings. The local board of review made its recommendations, usually a majority and a minority set, and these findings and conclusions were submitted to a central board of review, consisting of Elwood Mead, W. L. Marshall, and I. D. O'Donnell, who examined carefully into the records of the hearings, made personal trips to the projects, if it seemed advisable, and, in turn, presented their conclusions and recommendations to the Secretary of the Interior. The records of these hearings constitute a most excellent basis of information relative to the history and conditions, up to that time, of all the reclamation projects. The congressional hearings, the manuscript reports of Secretary Garfield's studies of the projects, the report of the Senate committee trip in 1909, the Board of Army Engineers' report of 1911, the manuscript Lane hearings of 1913, and the reports, largely manuscript, of the local and central boards of review of 1916 furnish complete statements, from almost every point of view, of the successes, failures and difficulties, and blessings of the reclamation development, together with a great variety of suggestions as to future improvements. No formal investigations have been made since 1916 until the appointment of this body by Secretary Work in 1923.

ACTION ON FINDINGS

The continuous and exhaustive investigations of the affairs of the Reclamation Service, almost from its inception, form an excellent commentary on the manner in which our national activities are subjected to scrutiny. Certainly the Reclamation Service has not suffered from underinvestigation. Nevertheless, though the investigations have been numerous and exhaustive, it is significant that, with a few notable exceptions, vigorous action has not been taken as the result of recommendations made either by Congress, the Secretaries of the Interior, or the officers of the Reclamation Service. Instead the recommendations made by competent investigators, after long and painstaking study, appear to have been filed and forgotten, and no steps appear to have been taken to keep vividly before those in authority the recommendations made from time to time by disinterested outside investigators. Criticism from the outside, when made in good faith, is nearly always helpful to a great cause if acted upon.

LEGISLATIVE ENACTMENTS

NEED FOR FEDERAL IRRIGATION AID

The reclamation act of June 17, 1902, which initiated the Government's experiment in Federal reclamation, was an outgrowth of long consideration of the best methods of utilizing the natural resources of the great arid and semiarid region of the United States. This region

was rich in mineral wealth, in forests, and in water power, and its soils were generally of high fertility, lacking only irrigation to produce large and steady yields of all crops. It had further been demonstrated that the development of this region, with its great potential wealth, would be possible only as irrigated centers were established at suitable points, with which activities in mines, forests, and range might be connected. In short, a civilization involving the utilization of natural resources could not be built upon the basis of mining or logging camps, or of cattle or sheep camps, but would require the existence of near-by areas of populated land, subject to the plow and supporting homesteads. It was important for our growing and expanding Nation, which had need of the resources of the West, to help provide such centers of population as would make the development of all the resources more rapid and certain and which would bring the West, as a whole, under human subjection.

Irrigation at that time was already an established practice. Its benefits and its permanence had been demonstrated. However, in the earlier days, when the first pioneers entered the intermountain country, water was diverted for irrigation in the easy places. The pioneer, practically without capital, was able, chiefly with the labor of his hands, to provide the ditch that would take the small stream to his land. By cooperative methods larger ditches were built with the outlay of little money. When these easier opportunities had been exhausted, capital undertook to provide for the taking out of water in the more difficult places, where large sums of money were necessary to effect the building of the irrigation structures. During the following period of commercial irrigation development many notable irrigation projects were established.

Unfortunately these commercial undertakings were rarely profitable to the original investors. As the more accessible projects were utilized, the failures became more numerous, until at last it appeared that irrigation development with private capital was for the time being at an end, with yet great volumes of water running to waste in a region which depends, primarily for its success as a place in which human beings can dwell, upon the artificial application of water to the land. The Reclamation Service recognized the situation as shown by the following quotation:

The irrigation works already constructed may be divided somewhat arbitrarily into two classes, on the one hand being the small ditches built by individuals or associations, and on the other the larger works constructed as an investment for outside capital and not planned or owned by the irrigators themselves. The works of the first class have, as a rule, been successful. The land-owning irrigators have built and maintained systems of water supply, some of these being consolidated and extended until they are of great magnitude. On the other hand, the works planned on an elaborate scale, built with the use of money borrowed from investors and intended to sell water rights, have almost without exception been financial failures. Without entering into a discussion of the reasons it may be said that the whole matter hinges largely upon the principle of cooperation. Wherever men owning land in small tracts have cooperated in constructing and maintaining irrigation systems, they have succeeded. Whenever, on the other hand, they have become tenants or would-be purchasers, there has been general disappointment. The lesson to be drawn is that in future works the principle of cooperation of the landowners should be made a prime requisite. (Reclamation Service, 1st Ann. Rept., p. 32.)

Among the various suggestions offered for the reclamation of the West, the Carey Act became a law, which had for its purpose the

equivalent of a cooperation between the State and the farmer in the development of irrigation. This and similar suggestions were found to be insufficient. Therefore, in consonance with the policy of the Nation to develop and to make available all of its resources, the reclamation act was passed, which makes possible the utilization of the water of the arid and semiarid region, even in very difficult places, for irrigation, and yet under such terms as seemed to enable the farmer to reap the benefit of his efforts, as was the case in the early irrigation days.

Moreover, the act aimed to provide a method by which thousands of families with a love for the land, but with little capital, might find opportunity to establish homesteads upon the land and to live the wholesome life of the open country, and to increase the number of the important home-owning, land-owning, home-loving, and land-loving men and women of the Republic. It was a great dream, nobly conceived. It was a new experiment in reclamation by irrigation, and one worthy, because of its purpose, of the attention and support of every lover of the country. Upon the Reclamation Service was placed the duty of working out the ideals embodied in the reclamation act.

THE RECLAMATION ACT

Certain definite fundamental principles are embodied in the original reclamation act, which have not been changed or modified by subsequent legislation. The act provides that the moneys used by the Reclamation Service for reclaiming arid and semiarid land by irrigation shall not be raised by taxation. They were at first derived from the sale of public lands in the States to be benefited, to which were added, later, such moneys as are derived from the royalties from oil and potash lands.

The provision for reclamation implies that the lands of the arid and semiarid region shall be made susceptible for larger public use, especially by making possible upon these lands the maintenance of homesteads. In fact the family, with its life and requirements, is the chief concern of the original reclamation act.

Meanwhile, since the task is a national one, not to be accomplished in one or two generations, and since each generation will bring its own quota of families, eager to give their strength to the development of land, that they may possess it, the act provides that the moneys in the fund shall not be lost, but shall be of a revolving character, so that the service of the fund may be continuous. This is accomplished by the provision that those who settle upon the reclaimed lands shall be required to repay, in installments and without interest, the money which has been expended in the building of the engineering structures necessary to make water available to the farmer.

At first the time of repayment was 10 years; by the extension act of 1914 this was extended to 20 years. The money repaid is to be covered into the reclamation fund, and to be used to reclaim more land.

ERRORS IN THE RECLAMATION ACT AS DEVELOPED BY EXPERIENCE

The reclamation act embodies certain weaknesses which have had a determinative effect upon the work of the Reclamation Service, and

which are in part responsible for the difficulties that have arisen in connection with the Federal irrigation projects.

The original act provided that the moneys of the reclamation fund should be expended within the respective States in proportion to the sum derived from the sale of lands within each State. This provision assumed, first, that each State offered equally attractive projects for reclamation, or that in each State could be found a sufficient number of desirable reclamation projects to absorb the money derived from the sale of public lands within that State. This was not the case. The arid and semiarid area covers a great variety of climatic and soil conditions. Marketing and transportation conditions also differ greatly. In undertaking so vast an experiment as that contemplated by the reclamation act, the easier and more desirable projects should have been attacked first. On the contrary, in obedience to the provision in the original act, projects were authorized in every State designated in the original act, except Oklahoma.

A review of Federal reclamation impresses one with the bad effect that this provision of the law has had upon the progress and success of the work. The law was so modified on June 25, 1910 (sec. 9 repealed), that the reclamation fund may now be used in any of the States contributing to the fund, irrespective of the proportion derived from each State; but for years to come this modification will have little effect, since, in accordance with the original provision, so huge a program was undertaken almost immediately upon the passage of the act, that for some time the income of the reclamation fund will be largely consumed in completing the projects first authorized.

Another error lurked in the provision that the cost of construction must be repaid by the farmer in 10 years, and later, in 20 years. That is, all projects, regardless of location or cost, should pay out in the same length of time. This provision was based upon the assumption that the cost per acre to the farmer, under the most difficult conditions, would be so low as to enable him easily to make the required payments. This assumption proved erroneous. The acre cost has increased greatly beyond the early contemplated costs. Since the projects are under varying conditions of climate and soil, their productive power varies greatly from project to project. The acre costs are likewise variable. So great is this variation that a 20-year repayment period may be ample for one project or division of a project and too short for another. The failure to recognize in the fundamental law the differing acre costs and the varying earning powers of the lands under the projects to be established has been the prime cause of discontent among the project settlers.

Of great importance also, in explaining the difficulties of the Reclamation Service, is the failure of the original act to provide such control over the transfer of rights as to require at the time of each transfer a proper proportion of increased value to be paid upon the construction charges. As a result, existing construction charges have been ignored when transfers were made, thus leaving the last purchaser burdened with the increased land value as well as the construction cost. This combined burden of indebtedness made it difficult and in some instances impossible for the settler to meet his annual obligations to the Government.

Likewise, it was difficult, under the law, to prevent the owner of surplus land under a project from placing exorbitant values upon his

land, to the detriment of settlement. The law authorized no selective power with respect to the intending settlers which would insure the placing on these farms of men equipped by experience, character, and financial ability to succeed.

Settlers were allowed on land before the size of the unit necessary for a homestead had been fixed by the Secretary of the Interior and before public notice of the opening of the project had been given. This necessarily resulted in a great deal of hardship being imposed upon those who attempted to cultivate land under limited rainfall for a number of years before water was available. Likewise no provision was made for the economic supervision of the settlers. The building of the projects, including the engineering problems of the main canals and the reservoirs, and their costs, was supervised with extreme care, but the more difficult task of reclaiming the land under the completed irrigation structures and building homesteads upon the lands was imposed upon the farmer without sufficient technical aid to guide him in overcoming difficult conditions with which he was often unfamiliar, and all too frequently without sufficient capital in the form of implements or cash to enable him to make a fair start toward success.

Moreover, the Reclamation Service was restricted to the construction of the more formal irrigation structures, in the form of dams, main canals, and lateral systems, when much of the land under these irrigation systems was of a rough, rolling character, which needed leveling and smoothing, really an engineering problem, before water could be applied to them successfully. It is well to remember that the most effective help that can be given settlers is at the beginning of their operations rather than later on.

When the reclamation act was passed it was believed that it would apply mainly, if not wholly, to the public domain. It was at first a question whether its provisions could be applied legally to land in private ownership. When, however, the locations for projects came under consideration, the advantages of those where the land was in private ownership were vigorously pressed, and it was found in some instances that a project where the land was in private ownership afforded greater opportunities for development and better settlement conditions than could be found on the public domain. As a result, some of the projects include only privately owned land, and on nearly all the projects a considerable percentage of the land was privately owned. Although the Reclamation Service attempted to compel the subdivision of these privately owned lands into the units fixed by law, yet the legal enforcement was found difficult; and what was still worse, in many cases the owners of the land capitalized the Government expenditures and the liberality of its terms of repayment by selling the lands to the settlers at much higher prices than could otherwise have been obtained. The benefits of the reclamation act, therefore, went in such cases almost entirely to these speculative owners, and an obligation of paying interest on inflated land prices was imposed upon the settler, in addition to his other burdens.

Finally, the provision in the original act for taking over the management of the projects by the settlers could not become effective until the settlers had paid the major part of the construction charges. This act was modified in 1914, but the water users on most of the projects had then become somewhat accustomed to operating their

farms under Government control, and it seemed easier for them to continue to let the Government carry the burden of management even after the settlement was well under way. This made the service subject to much criticism that might have been avoided if the settlers themselves had had control of the project.

The analysis of the present condition of the Federal irrigation projects requires that weaknesses in the original law be corrected, since they are largely responsible for the difficulties that have arisen and are still apparent in the execution of the reclamation act.

THE CURTIS ACT

In February, 1911, it was provided by Congress that the Secretary of the Interior may withdraw or suspend public notice and may modify any existing contracts with respect to the projects under way before that time. The effect of this act was to extend leniency and relief to all projects that seemed unable to meet the obligations placed upon them by the reclamation act.

THE WARREN ACT

The main intention of the original reclamation act was to supply water to public lands, for the homestead entry is mentioned particularly and pointedly. It was soon found, however, that under the projects that had been irrigated were large areas of land which had been taken up by earlier settlers, and some of which were already under irrigation from smaller private irrigation systems. It became necessary, therefore, from the very beginning to provide water not only to public, but to private lands lying under the projects authorized. It was found that on some projects a surplus of water had been developed over and above that needed by the lands formally belonging to the project, which was needed by partially irrigated lands under private irrigation systems. Consequently, the so-called Warren Act was passed in February, 1911. This provides that such surplus waters may be sold, for supplementary purposes, to adjacent and near-by lands. This was an extension, both in practice and in principle, of the original act, but kept in mind the essential purpose.

THE EXTENSION ACT

In 1914, after Secretary Lane had heard representatives from all the water users' organizations, the so-called extension act was passed. The effect of this was to cover all then existing obligations to the Government, if desired by the water users, into a new construction account of which 2 per cent were to be paid each of the first four years, 4 per cent for each of the next two years, and 6 per cent for each of the following 14 years, making a total graduated payment of 20 years.

It will be observed that this act also failed to take into account the varying acre costs or the different productive capacities of the projects, or of different classes of lands within the projects.

LENIENCY ACTS

In spite of the apparently easy provisions of the extension act, the projects found it difficult, especially after the Great War, to make the

required payments. Congress, therefore, on May 17, 1921, March 31, 1922, and February 28, 1923, passed the so-called leniency acts, which provided that the Secretary of the Interior might defer the payments then due, but afforded no permanent remedy.

OTHER LEGISLATION

A large number of other acts relative to the Reclamation Service have been passed at various times by the Congress. A list of these acts is found in Exhibit 10. The essential ones, however, are those mentioned in this section.

CONCLUSION

Running through nearly all of the legislation supplemental to the original reclamation act, is evidenced the belief that the settlers were in need of relief. Thus far this has been restricted to extensions in time of payment. There has been no serious constructive attempt to remedy the defects in the act, or to solve the difficult problems of administration and settlement, which have arisen.

RECOMMENDATIONS

Compilation of legislative enactments.—That all legislative enactments pertaining to Federal irrigation projects should be compiled, arranged, indexed, and digested for easy references, and this compilation should be kept up to date for the benefit of the water users and the officials of the bureau.

DEPARTMENTAL RULINGS

NECESSITY

Federal reclamation had scarcely begun before interpretations of the fundamental law were required. This was ordinarily due to special cases, questions, or interests which needed somewhat different treatment under the law from that accorded the majority of problems. At first, such questions were disposed of by special direct ruling, usually by letter, but as similar cases recurred, the former rulings became gradually established as regulations of the service.

These regulations are of three general classes—those pertaining to the legal aspects of the work or interpretations of the law; second, regulations directing the work of the officials in charge of construction or the operation of projects, which, although not direct interpretations of the law, must be in harmony with the law; and third, regulations regarding the system of accounting.

VOLUME

In the course of the work of the Reclamation Service, the departmental regulations increased rapidly, until at the present time, the number of them is so large as to make it confusing and difficult to apply them. The legal regulations have been compiled by Mr. Ottamar Hamel, entitled "Federal reclamation laws, annotated, as of January 1, 1920," published by the House Committee on Irrigation of Arid Lands, now out of print.

The regulations governing the construction and operation of projects and the system of accounting appear in a loose-leaf volume, steadily growing in size, which is entitled "The Reclamation Service Manual." Volume 2 of this manual is devoted entirely to accounting.

The files of the bureau contain a large collection of circular letters, through which these regulations have first been stated to those concerned in the work.

VARIABILITY

These regulations have in the main been well formulated and are well adapted to the work in hand.

However, it does not appear that, in every case, a simple guiding principle was employed in formulating the regulations. Frequently expediency or an independent individual judgment seems to have been the basis of the regulation. This has only resulted in confusion.

CONCLUSIONS

There should be a complete revision of the regulations. The regulations should be codified and vigorously pruned in harmony with a few leading principles to which each regulation might be referred. Each retained regulation should refer by number or otherwise to the files of the bureau for the benefit of those who may desire to go into the matter historically. The regulations should conform to present needs, new standards must be set up, which have land settlement and use, as well as the construction and repayment, in view.

RECOMMENDATIONS

Codification of bureau regulations.—The rulings of the Reclamation Service and the Bureau of Reclamation should be fully revised, simplified and compiled, and published for the use of all concerned with the Federal irrigation projects; and such use books for construction, operation, and maintenance and other phases of project activity should be prepared for the use of those on the projects who are directly engaged in project developments.

THE CHOICE OF PROJECTS

EARLY STUDIES OF WATER SUPPLY

Irrigation under modern conditions had been practiced in the United States since 1847, and in 1902 much was known concerning the nature and importance of irrigated settlements in the arid and semiarid region. Much was known, also, concerning western water and irrigable land resources.

Among the men who had given special attention to the reclamation of the arid region, Maj. J. W. Powell stands out foremost. To quote from the first annual report of the Reclamation Service (p. 34):

The preliminary examination of arid public land was carried on by Major Powell under the auspices of the Smithsonian Institution and later under an organization or bureau of the Department of the Interior known as the United States Geographical and Geological Survey of the Rocky Mountain region. In 1879 this and other surveys maintained by various departments of the Government were discontinued and in their place a single bureau, the present United

States Geological Survey, was created. The first director was Clarence King, who was succeeded after a few months by John W. Powell, who continued, in connection with other interests, to give particular attention to matters pertaining to the reclamation of the West.

From the beginning of the labors of the Geological Survey in 1879, in obedience to the organic law, the Director of the Geological Survey undertook a study of all the resources of the United States. Water and land resources were given consideration, and from the beginning of this work the maps prepared by the Geological Survey gave the locations of streams, towns, roads, railroads, canals for irrigation and transportation, the drainage areas of streams, the relative elevations of catchment basins and irrigable lands, and other topographic features favorable to water conservation, the contour lines, and many other details of importance to the development of water power, and of irrigation or the reclamation of arid lands.

Major Powell, as early as 1879, declared in public documents that the irrigation of the arid West was of necessity a problem of the General Government. The subject grew in interest, and in 1887-88 Congress authorized the investigation of arid lands. The so-called Powell irrigation survey resulted about 1889. Interest was aroused sufficiently so that the next census included irrigation studies. About that time the hydrographic surveys of the Geological Survey were begun in a systematic manner. These measurements lie at the foundation of all later irrigation enterprises. Dr. F. H. Newell, later the first Director of the Reclamation Service, was in charge of this hydrographic work from its beginning.

In 1896 surveys for the location and construction of reservoirs and other irrigation structures were authorized by Congress. The resulting report, made by Col. H. M. Chittenden, was published in 1897. During the period from 1879 to the publication of the Chittenden report popular interest in irrigation had greatly increased. One evidence of this increased interest was the organization of the irrigation congress in Salt Lake City in 1890, and the later formation of the irrigation association, both of which undertook propaganda in behalf of national reclamation by irrigation. When, therefore, the reclamation act was passed on June 17, 1902, a great body of information concerning the irrigation possibilities of the West was available. In fact, all or nearly all possible reservoir sites were known, and the volumes of the contributing streams that might be used for irrigation purposes had been fairly well determined.

The best evidence of this extensive information is given in the first annual report of the Reclamation Service, published within six months of its organization. Practically every irrigation project later authorized is discussed more or less completely in this report; in addition many others which have not yet been undertaken. On page 15 of the first annual report the statement is made that on June 28, 11 days after the passage of the act, a list of possible projects in six different localities was submitted, as follows:

Nevada.....	Truckee-Carson survey.
California and Arizona.....	Colorado River survey.
Arizona.....	Salt River survey.
Colorado.....	South Platte survey.
Colorado-Utah.....	Grand River survey.
Wyoming.....	Bighorn survey.

Certain lands to be benefited had previously been temporarily withdrawn by order of the Secretary of the Interior, viz., in Montana, under the St. Mary (Milk River) project; in Arizona, under the San Carlos project; and in Colorado, under the Gunnison project. It will be noted that the above list includes some of the more elaborate and expensive projects constructed under the Reclamation Service. Moreover, the Director of the Reclamation Service makes the following statement in the third annual report (p. 48):

Nearly every possibility of reclamation has been under consideration by somebody at some time, and while every effort should be made to avoid interference it is not fair to the communities concerned nor to the Commonwealth for the Reclamation Service to step aside in favor of speculative enterprises, especially when they would only partly develop the opportunities.

FIRST LOCATIONS

With this knowledge in the possession of the Geological Survey, it was not to be expected that a great length of time would elapse before some selections were made. Indeed, the selections went on with extreme rapidity. Within one year after the passage of the reclamation act four projects had been authorized, viz., Salt River, Milk River, Newlands, and North Platte.

In 1904 seven other projects were authorized, viz, the Yuma, Uncompahgre, Minidoka, Lower Yellowstone, Hondo, Belle Fourche, and Shoshone. In 1905 nine projects were authorized, three in 1906, and one in 1907, making a total of 24 projects authorized within five years of the passage of the reclamation act. The three which have been selected and authorized since 1907 are: Grand Valley, 1912; Riverton, 1917; and King Hill, 1918.

Federal irrigation projects—Date of authorization by Secretary

State	Project	Year of authorization					
		1903	1904	1905	1906	1907	1912
Arizona	Salt River	1903					
Arizona-California	Yuma		1904				
California	Oriand					1907	1912
Colorado	Grand Valley						
Do	Uncompahgre		1904				
Idaho	King Hill						1917
Do	Minidoka		1904				
Idaho-Oregon	Boise			1905			
Kansas	Garden City			1906			
Montana	Huntley			1906			
Do	Milk River	1903					
Do	Sun River				1906		
Montana-North Dakota	Lower Yellowstone		1904				
Nebraska-Wyoming	North Platte	1903					
Nevada	Newlands	1903					
New Mexico	Carlsbad					1906	
Do	Hondo		1904				
New Mexico-Texas	Rio Grande			1905			
North Dakota	Williston				1906		
Oregon	Umatilla			1905			
Oregon-California	Klamath			1905			
South Dakota	Belle Fourche		1904				
Utah	Strawberry Valley			1905			
Washington	Okanogan			1905			
Do	Yakima			1905			
Wyoming	Riverton						1917
Wyoming-Montana	Shoshone		1904				
		4	7	0	3	1	3

It is not wholly clear why this wholesale selection of projects was undertaken so soon after the passage of the reclamation act; but

it is not unlikely that it was due to the provisions of the law which required that the moneys derived from the sale of public lands should be spent in the respective States for irrigation and reclamation, in the proportion contributed from land sales within the States. This implied that an irrigation project would be established in each of the States concerned in the reclamation law, and that those contributing the largest sums would have the largest expenditures within their boundaries. Demand was made by each State that these projects should be undertaken at once. Political pressure was felt, as is evident by the following statement in the Second Annual Report of the Reclamation Service (p. 34):

The unfortunate condition exists that the States and Territories having the largest fund at present are those in which irrigation is of least importance and value. There the chief interest is not so much in reclamation as it is in having the funds spent in the State to promote general prosperity and improve business conditions. On the other hand, the States and Territories having the smallest fund have greatest need and possibilities of development and widest opportunities of making prosperous, self-supporting homes.

Whatever the cause, it is a matter of record that nearly all of the Federal reclamation projects were undertaken almost at once. It is particularly peculiar that this should have been done, in view of the words contained in the first message to Congress by President Roosevelt, in December, 1901, in which he discusses at considerable length the benefits and responsibilities of Federal reclamation, and in which he says, with reference to Federal irrigation and reclamation:

It would be unwise to begin by doing too much, for a great deal will doubtless be learned, both as to what can and what can not be safely attempted, by the early efforts, which must of necessity be partly experimental in character. (First Annual Report, p. 44.)

INVESTIGATIONS OF CONDITIONS

The investigations relative to the irrigation possibilities of the arid West have been confined almost wholly to the determination of river flow and of basins that might be used for storage purposes. In the Powell irrigation survey it is specifically stated (U. S. Geological Survey, Tenth Annual Report, pt. 2, p. 33) that:

It is necessary to segregate the irrigable lands. In almost every valley of the arid region there is more irrigable land than the waters are able to serve, and it becomes necessary in making the selection to choose the best lands and those that can be most economically served by the waters. A topographic survey reveals all the essential facts necessary for wise selection and collects and assembles the facts in the cheapest and most thorough manner.

This quotation from Major Powell indicates that his chief concern was a topographic survey, and that no study was made of differences in climate and soil as bearing upon the fitness of an irrigation project for settlement; yet to-day it is, or should be, elementary knowledge that there is very great variation in the physical conditions of various localities which determine the fitness for settlement. The climate, with respect to the highest and lowest temperatures, rain-fall, relative humidity, sunshine, winds, length of the growing season, and the soils under these various climatic environments very greatly from place to place. The productivity of a piece of land is determined not merely by the water which is available for it, but by the climate

and the soils which are characteristic of it. This information, now rated as of first importance in determining whether a diversion or storage possibility justifies the authorization of an irrigation project, was not given the necessary weight in the selection of the early Federal irrigation projects. The usual method employed by the Reclamation Service was to convene a board of engineers to study the data available on a proposed project and report on its feasibility before approval by the director and authorization by the Secretary.

Likewise, there is a great variation in the social and economic conditions surrounding an irrigation project. A project, otherwise excellent both as to climate and soil, but which has poor transportation facilities or is far from markets, or which lacks the social advantages required by modern man, is at a great disadvantage in competition with projects more favorably placed with regard to economic and social factors. An examination of the reports and documents pertaining to the beginning of the Reclamation Service would lead to the conclusion that relatively little attention, if any, was given at the outset to these very important conditions, which outweigh the engineering feasibility of an irrigation project.

The apparent haste with which nearly all the projects of the service were authorized precluded, of course, a careful, thorough, exhaustive, and scientific survey of these conditions. The time allowed was barely sufficient to determine the engineering feasibility of the projects, to make preliminary calculations as to the nature and cost of the structures to be erected, and to make reconnaissance studies of other conditions. The failure to make such investigations is very remarkable, since the Roosevelt message, to which reference has already been made, and which led to the passage of the reclamation act, contains the following statement:

Our aim should be not simply to reclaim the largest area of land and provide homes for the largest number of people, but to create for this new industry the best possible social and industrial conditions, and this requires that we not only understand the existing situation, but avail ourselves of the best experience of the time in the solution of its problems. A careful study should be made both by the Nation and the States, of the irrigation laws and conditions here and abroad. Ultimately, it will probably be necessary for the Nation to cooperate with the several arid States in proportion as these States by their legislation and administration show themselves fit to receive it.

These words of warning are as valuable to-day as they were in 1901. Not only did the Chief Executive of the Nation recognize the need of such thorough investigations, but the Director of the Reclamation Service, Doctor Newell, in the first annual report, page 69, issues a similar warning:

In many cases some of the lands will be less favorably situated for cultivation than others, the soil in some places will be less capable of raising valuable crops, and the water supply will be more regular or more abundant in some parts of the reclamation area than in others. These considerations will involve a careful balancing of the possibilities in cultivating the land, and they require a thorough investigation of the location of the lands and a careful study of the various soils found in different parts of the irrigable area reclaimed by each project.

EFFECTS OF THE EARLY SELECTIONS

The selection of a large number of reclamation projects, some of gigantic proportions, almost at the same time, not only consumed the full strength of the forces behind the Reclamation Service in caring

for the details connected with the building of the projects, but, as the building of these structures went on simultaneously, there was little opportunity to build one project upon the experience gained in the building of another. Experience was, of course, gained in the overcoming of the difficulties that arose from time to time, but it was practically impossible to utilize this body of knowledge for the benefit of the system as a whole. Moreover, once having begun these structures, the organization was forced to continue the large program, and the money available had to be divided among the projects. It became a piecemeal construction. One of the effects was the request in 1910 for a loan of \$20,000,000 with which to complete the projects more rapidly than the natural increments of the reclamation fund would allow.

LAW OF SELECTION

Modern irrigation in this country began with the settlement in the Great Salt Lake Valley in 1847. These settlers were far from the nearest white settlement of any consequence. Only by methods of industry and cooperation could they be saved from disaster, and the practice of such principles ultimately made them examples to be followed by those who later came into the West. The Greeley settlement of 1870 was placed somewhat similarly, at considerable distance from neighbors, and was obliged to work out its irrigation destiny under handicaps. That it succeeded came about largely, as in the Salt Lake experiment, from a spirit of cooperative enterprise which is seldom found in larger communities, unless held together by a common motive. The original reclamation act and the first ventures in construction under the act were planned with these early irrigation experiences in memory. Apparently little or no attention was given to the problems under changed conditions of settling successfully the lands to be reclaimed. It was assumed that once water were available the settler could easily do the rest.

The development of pioneer communities under irrigation has shown that an irrigation community may grow more readily if it extends from the original area of settlement by way of the easy stages. When an irrigation venture is established near an older irrigation settlement, there is a greatly increased possibility of early success. If an irrigation venture is established far from any other community of the kind, it will be under many handicaps, especially if the climatic, soil, and social environment is not as favorable as that prevailing in the older settlement. In any case the climatic, soil, and economic environment will determine largely the success of an irrigation enterprise.

Whether it be by private or public means, the selection of irrigation projects should, where practicable, proceed outward from established settlements and should follow the more fruitful opportunities for settlement. Many generations will elapse before all the water in the arid West has been put to beneficial use upon the land. It is the business of each succeeding generation to reclaim that which is the easiest and best for it to reclaim, for as time goes on, new methods and new means will be developed for the conquest of the more refractory places. In the selection of the Federal irrigation projects, this matter was not fully thought through; and many of the difficulties

which the service now faces may be traced, directly or indirectly, to this initial haste and vastness of program. This does not mean that projects should be located only in regions of mild climate and densely settled population; but it does mean that, as the different parts of the arid West are studded with reclamation projects, they should move outward in each State from the small centers of population already established on the best soils, under the best climates, and with the best facilities for transportation, marketing, and social intercourse. Moreover, political pressure to secure the location of irrigation projects, irrespective of their present fitness for development, must be avoided if success is to be expected in the Federal irrigation venture.

RECOMMENDATIONS

Authorization of new projects or project extensions.—New projects or extensions of existing projects should be authorized only after full information has been secured concerning the water supply, engineering features, soil, climate, transportation, markets, land prices, probable acre cost of development, and other factors upon which the success of the project must depend. All such information should be secured by designated representatives of the Departments of the Interior, Agriculture, and Commerce, who should, after a careful investigation, make to the Secretary of the Interior a report upon the feasibility of the project or the extension of a project, having in mind primarily the creation of opportunities for actual settlement and farm homes upon the project, and repaying the total investment made by the Government. This report should accompany the recommendation of the Secretary of the Interior for new projects or extensions of existing projects.

SECONDARY PROJECTS

MEANING

The passage of the reclamation act made it necessary to discover suitable project sites, with water, susceptible of proper storage or diversion, within reasonable proximity of sufficient irrigable land. Enough such information was available in 1902 to permit the authorization of several Federal irrigation projects.

The reclamation act provided that the money invested in the projects should be repaid by the water users, to be used again for the construction of other projects. It was anticipated that the principal projects would soon be completed and that other projects would then be undertaken. Therefore, the search for suitable project sites was promoted vigorously. In this work local communities gave much help; for people located near a probable project site were desirous of having it given thorough examination, in the hope that at some time it might become an authorized irrigation project. This kind of work has been continued from the beginning of the service. Projects examined for their feasibility for reclamation purposes but not authorized are known as secondary projects.

HOW FINANCED

The cost of investigating secondary projects has been paid by the reclamation fund, though local communities, having special interest

in proposed sites, have often contributed to the expenses of the investigations. States have also given monetary assistance to the investigation of sites of state-wide interest. Congressional appropriations have been made also for the purpose of studying possible project sites.

NATURE OF SECONDARY PROJECTS

Many of the secondary projects would become excellent primary irrigation projects. The present irrigation projects are not, in every instance, the best available. Some of the secondary projects offer greater promise of ultimate agricultural success than some of the projects that have been authorized, and upon which large sums of money have been expended. As this work continues, many of the secondary projects will no doubt be undertaken as regularly authorized Federal irrigation projects.

LIST OF SECONDARY PROJECTS

The accompanying table shows that 152 projects have been investigated by the Reclamation Service, but not undertaken. The total expense has been over \$2,000,000, of which about 23 per cent has been contributed by local, State, or Federal agencies.

Secondary project investigations, Bureau of Reclamation

State	Number of projects	Total cost to June 30, 1923	Contributed funds
Arizona.....	10	\$71,985.00	\$24,728.11
Arizona-California.....	13	492,017.79	141,000.00
California.....	13	217,641.60	100,721.08
Colorado.....	8	18,800.81	.....
Colorado-Utah.....	1	11,340.83	7,000.00
Idaho.....	11	69,886.78	12,660.00
Montana.....	19	73,382.01	7,471.93
Montana-North Dakota.....	(5)	9,296.90	.....
Nebraska.....	3	35,103.32	20,400.00
Nevada.....	3	14,711.00	252.08
New Mexico.....	0	74,719.01	12,200.00
North Dakota.....	9	57,594.80	.....
Oklahoma.....	4	83,412.56	.....
Oregon.....	20	273,599.24	53,001.17
South Dakota.....	1	6,874.31	3,542.61
Texas.....	3	63,863.60	36,502.84
Utah.....	11	127,861.42	40,943.22
Washington.....	4	171,931.47	.....
Wyoming.....	20	36,168.74	.....
Miscellaneous.....		101,795.64	.....
Grand total.....	152	2,001,956.83	463,491.90

¹ Includes Colorado River Basin investigations.

² Surveys.

³ Of the contributed funds \$33,344.29 is uncollected.

NEED OF CONTINUED INVESTIGATION

The revolving nature of the reclamation fund and the outlook for the success of reclamation make it certain that Federal reclamation will long continue in the United States. It is indispensable, therefore, that the Bureau of Reclamation continue its study of all available irrigation projects, with the view of having at hand ample data whenever money is available for new project authorizations.

If such studies are continued consistently, there will be available, ultimately, a fund of information covering all the available water resources of the arid and semiarid portion of the United States. This should be the ultimate object of the study of secondary projects. The sooner this object is attained, the better for the general development of the irrigation projects of the arid region.

SCOPE OF INVESTIGATIONS

These investigations should concern themselves with the study of the quantity of water susceptible of storage or diversion, the proper sites for dams and reservoirs, the acreage of land that may be irrigated, the discovery of the productive capacities of the lands to be irrigated, the classification of lands on the basis of productive power, the probable costs of reclaiming the land from the point of view of the husbandman, the most likely markets, the most suitable type of agriculture to be followed, the opportunities for an attractive social life, and such other factors as should be considered before large sums of money are invested in an irrigation enterprise, under public or private funds.

FREQUENT REVIEWS OF FINDINGS

The results of the investigations of secondary projects should be reviewed by a competent board from time to time, for the purpose of keeping alive, in the minds of those charged with administrative responsibility, the irrigation possibilities of the arid region, and the relative promise of the projects that have been investigated but not undertaken. The results of such periodic reviews should be given wide publicity, for the information of the people generally, and in particular for the benefit of private capital concerned in the development of the irrigation possibilities of the country.

SHALL THE RECLAMATION FUND PAY FOR SECONDARY PROJECT INVESTIGATIONS

The study of secondary projects really has the effect of a stock-taking of the water resources and irrigation possibilities of the country. The cost of the work should not be wholly borne by the reclamation fund, but should be treated as are other general investigations of the resources of the country. Congress should make an appropriation reimbursing the reclamation fund for the money it has expended in the study of secondary projects, and a fund should be set aside for the continuation of this work and for a study of all waste lands of the Nation, with a view of their ultimate reclamation.

RECOMMENDATIONS

The Reclamation Service has examined at considerable expense many proposed reclamation projects, not yet authorized, which are known as secondary projects. Some of these appear to have excellent agricultural possibilities, which in the interest of national development, should at some future time be undertaken by private or public enterprise. To keep these projects in mind the data relative to the

secondary projects should be examined, at least annually in the light of existing conditions, with the view of testing their present feasibility; and proper publicity should be given the conclusions reached, for the information of those interested in reclamation development.

Other proposed projects should be examined as in the past, until full knowledge is obtained concerning the reclamation possibilities of the United States, and the reclamation law should be so amended as to enable the government, by expenditure of funds to be appropriated out of the general fund, to obtain information necessary to determine how arid, swamp and cut-over lands may best in the future be developed to meet the growing agricultural needs of the nation.

PUBLIC NOTICE

IMPORTANCE

The original reclamation act of 1902 makes definite statement as to the public notice to be issued by the Secretary of the Interior at various times. The language of the act follows:

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 lands in private ownership which may be irrigated by the waters of the said irrigation project, and the number of annual instalments, 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. (Act of 1902.)

Provided further, That entry may be made whenever water is available as announced by the Secretary of the Interior and the initial payment be made when the charge per acre is established. (Act of 1914.)

That no increase in the construction charges shall hereafter be made, after the same have been fixed by public notice, except by agreement between the Secretary of the Interior and a majority of the water-right applicants and entrymen to be affected by such increase, whereupon all water-right applicants and entrymen in the area proposed to be affected by the increased charge shall become subject thereto. Such increased charge shall be added to the construction charge and payment thereof distributed over the remaining unpaid instalments of construction charges. (Section 4, act of 1914.)

The public notice to be issued by the Secretary of the Interior sets the price per acre for the water rights of the project. This price may not be changed thereafter, except with the consent of the water users. The public notice also fixes the size of the farm unit, which is supposed to measure the area of land that under good agricultural practice may be made to provide a living for the farmer and his family and the repayment of the cost of water right. Under the homestead law, by which the public lands are acquired, the farm unit must not exceed 160 acres in area, and if less than 160 acres, may be reduced by the subtraction of 40-acre tracts. The farm units on the Federal irrigation projects may be 40, 80, 120, or 160 acres in area; or by a later law units smaller than 40 acres may be authorized. Private holdings under the projects must be reduced to the homestead acreage to acquire water-right contracts.

On the projects the farm units have been fixed, in most cases, as of 80 or 40 acres. To make farm units in multiples of 40 acres has not helped the reclamation cause, for frequently an intermediate area between 40 and 80 acres or an area less than 40 acres would have been much more useful to the farmer, who, after all, must bear the charges for construction and for operation and maintenance on the area which he takes up.

As agricultural methods improve on the project farms there will be an increasing acre income, and as this development progresses it will be found that there is a larger margin of profit in the intensive cultivation of a small farm than in the extensive cultivation of a large one. Farm units should be proportioned to the productive possibilities of the land and the location. The present law provides that the Secretary of the Interior may declare farm units of less than 40 acres.

Another effect of public notice is that the annual charges for construction and for operation and maintenance accrue from the date of issuance. Before that date any water used by the water user is paid for on a rental basis, but the capital cost of the project is allowed to stand without repayment requirement.

The supposition is that when public notice is issued the project is ready for the farmer. For that reason, in many cases there has been a succession of public notices, representing the opening of different districts of the projects, which have become available as new canal systems and other irrigation structures have been extended or completed.

DELIVERY OF WATER

Settlement had taken place on many project lands long before the project was undertaken. In the early years of the Reclamation Service lands under a project could be taken up before the project was completed and public notice issued. Consequently, as soon as water was available, before construction was completed, such water was in demand. The Reclamation Service made it a practice to deliver such water as soon as available to those who desired it, and charged therefor certain rentals. These rentals accumulated to considerable sums, which in every instance were credited to the construction account of the project from which they were derived. In that manner and to that degree there was a reduction to the ultimate water user in the cost of construction.

DELAYED PUBLIC NOTICES

An essential consideration in the history of public notices for the Federal irrigation projects is that in some instances there is a considerable difference between the time water was first available and the time of issuing public notice. This difference was supposed to allow the farmers to get the project into working agricultural shape. Under irrigation, farm lands must be leveled, ditches must be dug, and preparations made for the proper and ready delivery of water to the crops. Nevertheless, on 10 of the projects public notice was issued a short time in advance of the first delivery of water, undoubtedly upon the theory that the work was so far along as to be in a state of completion by a certain date, and also, probably, under the assumption that conditions on the projects made the immediate

application of water possible. On 16 of the projects public notice was issued in the year that water became available. In contrast with these 16 projects, one year elapsed on 2 projects between the time that water was first delivered and the time of public notice; on 1 project, two years; on 1, three years; on 1, six years; on 1, seven years; on 2, eight years; and on 3 of the projects, public notice has not yet been issued, although, on 2 of these water has been available for a number of years.

This irregular treatment with respect to public notice has not reacted favorably upon the development of the Federal irrigation projects. In some cases where conditions were difficult public notice might well have been delayed, and in some of the cases where delay has been long it might, with benefit to the project, have been issued several years ago.

CONCLUSIONS

In the study of this phase of Federal reclamation one is inclined to draw the conclusion that interference, perhaps from outside sources, has often succeeded in delaying public notice. Pressure from congressional bodies, such as probably hurried the location of projects before sufficient information concerning them had been fully gathered, was no doubt used to delay public notice. It is notable that such delays do not seem dependent upon project needs. The issuance of public notice should depend upon certain clear-cut conditions with respect to the project. First, the project should be reasonably complete, so that there will be no need on the part of the Government to request the water user for additional construction contracts because of the lack of knowledge of the final cost of the major structures of the project; second, there should be a sufficient number of settlers under the project to operate the major part of it; that is, to make the project a going concern; third, the water users under the project should have had time enough to level their lands, build laterals and ditches, and sow their crops for a season or two.

Should such suggestions guide Federal reclamation attempts it might become necessary to issue two classes of public notices for each project: One when the structural part of the project is complete and a price can be fixed for the water right, as well as the size of the farm unit; and another when the project, from the point of view of settlement and agricultural fitness, is ready to begin to make repayments. Settlement would date from the first and repayments from the second public notice.

RECOMMENDATIONS

Two public notices, at opening and for repayment.—When a new project or the extension of an existing one is ready for settlement, public notice to that effect should be issued by the Secretary of the Interior, fixing the project cost and the date when the project or a division thereof will be open to settlement, and when the agricultural development of a project or the extension of a project has advanced sufficiently to warrant construction repayments, a second public notice to that effect should be issued by the Secretary of the Interior; all construction repayments to begin on the date set in the second public notice.

THE ACRE COST

HOW DETERMINED

The effective acre construction cost, under the law, is that which is decided upon by the Secretary of the Interior and issued under public notice. All statements of acre costs before the issuance of public notice are merely estimates, not legally binding upon the Secretary of the Interior.

The construction cost at the time of public notice is made up of two kinds of expenses. First, the original construction cost, and secondly, the charges for operation and maintenance which have accumulated during the course of construction, when water has been allowed to flow through the system to try it out, and also to serve such settlers as were already under the project. After public notice has been issued other supplemental construction costs may appear: First, for new construction, decided upon by the water users and undertaken only with their consent; second, for drainage construction that may be needed from time to time, also with the consent of the water users; and third, for unpaid operation and maintenance charges, accumulated after public notice, and apparently beyond the power of the water users to pay, which have in a few cases been classified as construction charges.

During the time of construction certain revenues flow into the treasury of the project from water rentals and other activities connected with the work of construction. These are credited to the construction account, so that the water user is responsible only for the net construction cost. It is upon this net cost, in connection with the estimated acreage, that the acre cost is given by public notice.

The following table shows how these various costs affect the total construction costs for all the Federal irrigation projects up to June 30, 1923:

Cost at public notice:	
Original construction.....	\$138, 993, 745. 20
Operation and maintenance previous to public notice.....	8, 837, 760. 45
Total original construction.....	\$147, 831, 505. 65
Supplemental cost:	
Supplemental construction.....	4, 793, 658. 48
Unpaid operation and maintenance transferred to project account.....	960, 279. 63
Unpaid operation and maintenance transferred to individual account.....	233, 903. 81
Total supplemental cost.....	5, 987, 841. 92
Unadjusted cost items.....	24, 654. 19
Total cost.....	153, 844, 001. 76
Revenue during construction.....	10, 789, 930. 61
To be repaid by water users.....	143, 054, 021. 15

It will be observed that although nearly \$148,000,000 have been expended in original construction and in operation and maintenance previous to public notice, and nearly \$6,000,000 for supplemental construction, including new additional construction, drainage, and unpaid operation and maintenance charges which have been trans-

ferred to construction accounts, the revenues during construction, of nearly \$11,000,000, have reduced the net amount which the farmer is expected to repay to something over \$143,000,000. Meanwhile, improvements and extensions are made, and drainage may become necessary, so that there will be a constantly increasing construction cost until the whole area is protected by drains. An irrigation project, like any other structure of the kind in constant use, is therefore continually increasing in cost.

PRESENT ACRE COSTS

There is a great variation in the average acre costs, without the supplemental charges, ranging from \$96 to \$29 per acre. Not only does this variation occur among the projects, but on different divisions of the same project, opened at different times, the cost per acre varies. The average acre costs of the Federal irrigation projects are relatively high when the original plans, as given in the reports of the bureau, are considered. Three projects have acre costs between \$90 and \$95, seven between \$70 and \$90, five between \$50 and \$70, nine between \$30 and \$50, and only one under \$30, yet in the early reports of the Reclamation Service common reference is made to acre costs ranging from \$12 to \$15 per acre. However, it is only fair to call attention to the fact that on several projects the original estimates contemplated only storage works and the main canals.

It is clear that the original conception of the Federal reclamation program did not anticipate the probable great variation in the acre costs of the different projects, or, if anticipated, it was assumed to be so slight as to be negligible; yet, the variation in acre costs on the different projects is to-day one of the most fruitful causes of discontent and difficulty. Especially is this so in view of the fact that the highest acre charges do not coincide with the highest productive power of the project, but that quite frequently the reverse is the case.

THE USE OF NONINTEREST-BEARING MONEY

In considering the acre cost of water right under the Federal irrigation projects, it must be remembered that the cost under public notice is, after all, an apparent cost. The real cost is considerably less. This results from the fact that the repayment period covers many years (under the extension act 20 years) and that during the period of repayment there are no interest charges except against overdue payments. The use of Government money without interest for a relatively long period of time has a direct cash value to the farmer.

At 4 per cent the interest on the moneys advanced by the Government under the repayment period would amount to more than one-third of the capital invested. The acre charge is therefore really only two-thirds of what it appears to be. Considering the active reclamation projects as a whole, had the equivalent in simple interest at 4 per cent been charged on all moneys due from the water users, under the law during the history of the service it would have amounted to \$57,151,835 on the net investment of \$133,650,498.63. It is altogether too common to consider the acre costs on the Federal reclamation projects without reference to the advantage resulting

from use of Federal money without an interest charge, when in fact the water user is requested to pay annually an amount equal to 5 per cent on the acre cost and then at the end of the 20-year period is forgiven the capital charge.

COMPARED WITH ACRE INCOMES

The outstanding feature in the analysis of the acre costs of the reclamation projects is that there is no proportional relationship between the acre cost and the productivity per acre as established during the last decade of annual census taking. It has already been observed that the less productive land may often carry the highest acre charge. This is brought out in the following table:

Table showing average annual production for each dollar of acre cost

State	Project	Average acre cost	Average acre income ¹	Average annual production for each dollar of acre cost
Washington	Yakima-Sunnyside	\$52	\$89.36	\$1.71
Do.	Okanogan	94	148.05	1.57
Idaho	Minidoka, Gravity	29	35.19	1.21
Arizona	Salt River	60	61.75	1.03
California	Orland	44	45.15	1.03
Montana	Huntley	34	31.22	.92
Arizona-California	Yuma	71	63.82	.90
New Mexico	Carlsbad	49	41.98	.86
Washington	Yakima-Tieton	96	76.78	.80
North Dakota	Williston	38	27.97	.74
Idaho	Minidoka, South Side pumping	57	39.00	.67
Montana	Sun River-Fort Shaw	33	21.17	.64
Nevada	Newlands	41	25.82	.62
Utah	Strawberry Valley-High Line	82	50.67	.62
Oregon	Umatilla	70	41.33	.59
Colorado	Uncompahgre	70	40.85	.58
Oregon-California	Klamath	35	19.35	.55
New Mexico-Texas	Rio Grande	90	47.37	.53
Nebraska-Wyoming	North Platte-Interstate	55	27.39	.50
Idaho-Oregon	Boise	78	36.16	.47
Wyoming-Montana	Shoshone-Garland	82	24.58	.47
South Dakota	Belle Fourche	33	15.58	.47
Montana-North Dakota	Lower Yellowstone	45	20.79	.46
Wyoming-Montana	Shoshone-Frannie	80	17.23	.22

¹ All years of record.² Entire project.

The first column shows the average acre cost under each project; the second column shows the average acre income as based in most cases on a 10 or 11 year record, ending with 1922; the third column shows the average annual production for each dollar of acre cost. A more nearly equal opportunity for the water users would exist if the figures in the third column were all nearly alike. On the contrary, five projects or divisions of projects, during this 10-year period, have yielded between \$1.03 and \$1.71 for each dollar of acre cost, five have yielded between 74 cents and 92 cents for each dollar of acre cost, nine have yielded between 50 cents and 67 cents for each dollar of acre cost, and five have yielded less than 50 cents per dollar of acre cost. One of these has yielded as little as 22 cents per dollar of acre cost. These inequalities of cost relationship between acre costs and acre productivity place a handicap upon one group of water users which is not felt by another group, and is a real cause of difficulty on the Federal irrigation projects.

COMPARED WITH ORIGINAL ESTIMATES

Much has been said and written about the difference between the original estimated cost per acre and the final cost, as established by public notice. This will be found by referring to the appendix, Table 1, Exhibit 1, columns 9 and 12. In some cases the charge to the water users is from two to three times the original estimated cost under which many settlers took up the lands and began the business of homestead making.

One cause of supplemental costs is the rising of the ground water, the consequent water-logging of the land, and the ultimate need of drainage to correct this condition. Such water-logging, in the light of general experience, might have been expected, and, indeed, the published reports of the service indicate that it was expected, and the farmers themselves might well have looked forward to the time when they would be obliged to spend money for the drainage of their lands.

The original estimates, as published in Table 1, Exhibit 1, were all made officially by the Reclamation Service to the Secretary of the Interior, and upon these estimates construction work was undertaken. Meanwhile, the feeling among the public that a certain acre cost was to prevail was not in every case chargeable directly to activities of the Reclamation Service. Naturally, the engineers of the service would make statements to the prospective settlers or to people living near the projects, which, in turn, would be communicated from person to person. The local press would publish such estimates along with other information bearing upon the future development. In these and many other ways the estimated costs would become the common property of those interested in the project. The reported estimated costs, thus passing from mouth to mouth, were not always the estimated costs presented to the Secretary of the Interior.

The facts appear to be that the Reclamation Service itself made some estimates of acre costs which were far exceeded when actual construction was completed.

In the eleventh annual report, which reviews the achievements of the decade, the question of acre costs is discussed as follows:

In looking back over the history of the 10 years it is interesting to note the outgrowth of many fallacies which were entertained when the work was initiated. The first, and perhaps the most striking, is the idea concerning the low cost of reclamation by irrigation. The early ideas of cost were based upon the results obtained by the pioneer. The first settlers, acting singly or in communities, built comparatively cheap and temporary canals in the localities where the engineering problems were least difficult and provided a supply of water which, without storage and without protection against floods, was frequently unreliable. The average cost per acre was estimated at an extremely low figure because of the fact that the actual cost was not recorded and the acreage which might be irrigated was, as a rule, highly exaggerated, no allowance being made for imperfect water supply nor for lands which for one reason or another could not be cultivated.

In another place in the eleventh annual report the further statement is made:

The increase of cost of the works over the anticipated amount rises from two principal causes: First, because, as above stated, a very large number of additional structures have been provided; and, secondly, because of the increased cost of labor and materials. When the plans were made, during the years from

1902 to 1905, prices were relatively low. Since that date, as shown by the testimony of western railroad builders, contractors, etc., it appears that wages have increased probably 50 per cent or more, and that materials and the cost of subsisting the men have increased in many cases upward of 60 per cent above the amount assumed in earlier years. * * *

There are other factors which have led to increased cost over the early estimates, some of these being due to legislative and related causes. For example, the passage of the workmen's compensation act of May 30, 1908, has added notably to the expenditures.

In the thirteenth annual report, page 24, a further explanation is made as follows:

There has been in many instances a notable increase in the actual cost per acre of reclaiming lands over that which was assumed a dozen years ago. It has been explained frequently that this increase in cost is due in part to the general increase in cost of labor and material such as has taken place throughout the country.

The principal increase above the original assumption is due to a still more obvious fact, namely, that the projects as built have been quite different in conception from those at first considered. To put the matter in the briefest possible terms, the Government has provided for the water user, generally upon his petition, many facilities which he would otherwise have been compelled to secure for himself at large outlay and personal sacrifice. These have consisted in distributing systems and in numerous structures which were not believed to be within the necessary province of the Government to build when the works were first discussed.

It was stated by the department from the beginning that the effective acre-cost should be that fixed in the public notice of the Secretary of the Interior.

NEED OF ADJUSTMENTS

Since the acre-costs, in most cases, do not seem to be excessively high, adjustments of cost should be made where errors have occurred, of a kind that should not be borne by the water user, or where definite agreements were made which have not been carried out or where the earning power of the land does not justify the costs. Cost reductions, however, involve great difficulties of determination. After a long period, it may be practically impossible to sift the details with such fairness as to make a just recommendation concerning reductions in cost. On the contrary, it may be much the better method, in view of the fact that the present costs are reasonable, to devise a method of repayment that will make the annual burden on the farmer so slight as to make it relatively easy for him to meet the charges imposed. The views of the committee with respect to individual projects will be found under the project headings.

RECOMMENDATIONS

Care in making estimates of costs.—The data and evidence before the committee disclose that in almost every project undertaken by the Reclamation Service the ultimate cost of the project greatly exceeded the estimates as to what the cost would be.

It is true that much in the way of added cost was caused by rising prices extending over the years of construction, and often by the inclusion of additional features not originally contemplated, which additions were agreed to or desired by the settlers; but aside from these factors it is undoubtedly true that estimates for some projects

were much lower than was justified and that the ultimate cost was more than the value of the water to the land.

Those underestimates were allowed to become known and the settlers in large measure relied upon them, to their ultimate disappointment and distress. In so far as conditions justify, we have tried to recommend appropriate readjustments upon various projects.

The solvency of future enterprises will depend on prompt settlement of the land, improvement of farms, and purchase of water rights. Settlers should be informed at the outset what the projects costs are to be.

We therefore most emphatically recommend that in the future great care be taken in the preparation of estimated costs, accompanied by a definite statement of what these costs include and that when once announced they shall be binding alike on the Government and the settler.

Construction cost spread over whole acreage.—The total net construction cost of any project should be spread equitably over the whole acreage for which the major storage or diversion works and the distribution system have been constructed.

A. In the event the storage or diversion works or main canals are increased in capacity for the purpose of supplying lands in addition to those then supplied, the construction charges should be readjusted and equitably apportioned in accord with the area actually supplied with water.

B. In the event the area of the lands for which storage or diversion works or main canals have been constructed shall be decreased by excluded lands found not suitable for irrigation, then the construction charges imposed upon such excluded lands should not be charged against the remaining lands but should be held in suspense and shall be ultimately charged off, unless by subsequent agreement all or some portion of such suspended charges may be imposed upon lands restored to irrigation, or other lands for which it is found suitable to supply water.

Equitable adjustment of construction cost.—If after a proper survey of construction costs and classification of soils have been made by a competent commission it be ascertained that the present construction costs per acre are more than some or all of the classes of land within the project can bear, a fair and equitable adjustment should be made which will fix the charge per acre at a sum the land can reasonably bear.

Equitable apportioning of acre costs.—In fixing the construction cost upon lands under projects the Secretary of the Interior should take into consideration the classes of land, determined in accordance with Resolution No. 13, and may fix different construction costs upon different classes of land under the same project, for the purpose of so equitably apportioning the total cost that the lands may bear the burden of cost more nearly in proportion to their productive value.

Cost of leveling land charged to construction.—Hereafter the expense of leveling project lands and building suitable distribution systems for efficient and economical irrigation should be made a part of the construction costs.

OPERATION AND MAINTENANCE

MEANING

The great structures built by the Reclamation Service represent a huge outlay of money, but a greater value in the service they will render in reclaiming the arid lands of the Nation. These structures, durably and well built, must be cared for in the best manner possible. Dams and canals must be watched over with extreme care, and the necessary repairs and improvements made from year to year. It is dangerous to delay any necessary maintenance improvement. Expenditures for such purposes are known as the maintenance costs of the Federal irrigation projects. In addition, the water stored or diverted by the great dams requires careful and proper distribution to the farmers. The distribution of water causes the annual operation cost. The maintenance charges and the operation charges, or O. and M. charges, are usually grouped together because the services overlap and the same organization looks after both.

COST OF O. AND M.

A record of the O. and M. cost to the farmers does not appear to be available before 1909, but in Table 2, Exhibit 1, the data for the different projects with respect to operation and maintenance charges are given for each year up to 1922. It will be observed that, leaving out the Williston project, a pumping project under peculiar conditions, the O. and M. varies from 59 cents to \$16.10 per acre. The highest O. and M. charges in 1909 was on the Lower Yellowstone which then was in process of building.

The average O. and M. charge for 1909 was \$3.60; in 1910 the highest charge was \$12.29, and the lowest \$1.80. In the succeeding years there was a similar wide variation, though on each project the range was just about the same. The annual O. and M. charge has not decreased since the year 1909. There has been an increase on many of the projects. This may be due, of course, to the changes in prices of labor and the commodities required in the O. and M. work.

There is a definite correlation between the annual O. and M. charge and the acreage irrigated. The smaller the acreage the larger the O. and M. charge. This is only to be expected, for the major costs of distributing water are borne by a smaller number of acres.

SUPERVISION OF O. AND M. BY WATER USERS

As a general principle, it would seem advisable to have the Federal irrigation projects operated by the water users just as soon as feasible. If this be done, the O. and M. charge will probably be reduced somewhat. The farmers, without a large overhead organization, will use more direct methods, and being themselves responsible for the work, will be content with a service which would not be acceptable from the Reclamation Service. The complaint is frequently made that the O. and M. is higher than it would be if the project were in the hands of the farmers. The farmer should be urged to take over the work, so that such complaints could be met by their own body. This matter is further discussed in the section on water users' association.

PROTECTION OF MAJOR STRUCTURES

The major structures of the reclamation projects, as already indicated, represent large sums of money and untold possibilities of service from the reclamation point of view. Only expert workers should be allowed to care for these major works.

CONCLUSIONS

The Bureau of Reclamation might well, after these many years of experience, formulate a handbook for the operation of irrigation systems. This could be used by ditch riders and all others who may be in any way responsible for the operation and maintenance of reclamation projects. It would seem very proper also that a special course of instruction might be provided by the agricultural colleges of the several Western States for the prime purpose of training water masters. In the operation of irrigation systems, engineering skill is, in part, required, but a thorough knowledge of the relationships between water and soils and plants is of equal importance. No man can fairly and satisfactorily distribute water among the farmers and understand the full possibilities of the system for which he is responsible unless he has an acquaintanceship with the fundamental scientific and economic principles upon which rest safely the farmers' activities under the irrigation ditch. The agricultural colleges so far have not worked steadily and singly to this kind of training. The reclamation projects employ staffs of men large enough to justify either short or long courses of instruction for the special purpose of the ditch rider and the water master, and when the great numbers of similar workers on private reclamation projects are considered, the agricultural colleges could certainly be of very great service by establishing such courses of instruction. The man who distributes irrigation water should be required to take such courses of instruction.

CONTRACTS FOR SUPPLEMENTAL IRRIGATION

PRIVATE PROJECT LANDS

In the development of Federal reclamation it was found that settlement had occurred to some degree over the whole arid region. Easily available water had been used by some settlers for irrigation purposes and small communities had grown up around the many water sources. These irrigated settlements had become centers for other activities, chiefly the range livestock industry.

Nearly all proposed irrigation projects covered lands that were mainly in private ownership. One of the first questions before the Reclamation Service was whether such lands should be allowed the benefits of the reclamation act. It was answered affirmatively, not only because private and public lands in the arid region had become inextricably mingled, but also because the real purpose of the reclamation law, that of home making and of reclaiming arid lands, could be accomplished by furnishing water to privately owned lands. Of the 1,293,906 acres of lands now under water-right contract with the Government, approximately two-thirds were in private the remainder in public ownership at the time the projects were constructed.

Later another question presented itself. Large areas of land, brought under irrigation by private ventures, had an insufficient water supply for full-crop production. Usually this insufficiency was due to a water shortage at the critical growing period. These partially irrigated lands soon made application for a partial water-right contract, to be supplied from the unused waters of the projects. In response to this demand, in 1911 the so-called Warren Act was enacted, which provided that such contracts might be executed. Ordinarily the contract provides that these lands shall pay a certain total sum for a specified partial water right, based upon the construction cost of the project, and that repayment shall be made under the general reclamation acts. The contracts further provide that a proper portion of the operation and maintenance charges incurred by the use of the major works shall be charged to these so-called Warren Act lands.

Through the authority of the Warren Act, the Reclamation Service has been enabled to extend greatly the reclamation of arid lands and the establishment of irrigated farm homes. The fundamental principle of the Reclamation Act has been fully conserved in operations under the Warren Act.

EXTENT

Warren Act contracts exist under 12 of the Federal irrigation projects, notably on the Boise, North Platte, Minidoka, and Strawberry Valley projects. Warren Act and other special contracts provided a partial water supply in 1922 to 1,101,700 acres and the contract value was approximately \$11,200,000. The total receipts from this source in 1923 amounted to \$782,246, of which \$187,912 was applied to operation and maintenance and \$594,334 to construction.

RECOMMENDATIONS

Disposition of and rights to surplus waters.—If stored or diverted water of a project is in excess of the needs of the project lands, such surplus water should be charged with its proportion of the construction costs of the major project structures, and the lands which may contract for the surplus water should repay the construction cost so charged. Lands that have contracted for such surplus water rights should pay their proportion of the annual operation and maintenance charges for the protection of the works and for the delivery of the water to the head-gates of the distribution system. Any profits that may be derived from the sale or rental of such surplus water should be credited to the project or part of the project to which the construction cost has been charged.

Supplementary water contracts.—Water users having contracts under the Warren Act (February 21, 1911) should be governed by the following principles:

1. Under each project the holders of Warren Act contracts should be required to form a water users' association, or to become a part of the project water users' association through which the United States may deal in all matters of policy and management of the water rights in question.

2. The holders of water right contracts under the Warren Act should have the privilege of repaying construction costs according to the plan of repayment based upon the acre returns. If sufficient crop statistics for this purpose have not been accumulated, the crop average for the project with which the Warren Act contracts are associated should be taken as the basis of repayment.

3. Contracts for Warren Act water rights should participate in the assets of the project.

SOILS AND CLIMATE

INTRODUCTION

The final test of the success of any irrigation project is the possibility under that project to produce a comfortable living, under satisfactory environment, for the family on the farm and at the same time to meet all the financial obligations of life, including the cost of reclamation and development of the land. This implies that the land must have a crop productivity sufficient to justify the farmer and his family in their labors and in their investment of reclaiming and developing the land. Productivity, therefore, is one of the main considerations in the selection and development of an irrigation project.

Project productivity is determined primarily, providing proper human skill is applied, by the soils which the farmer cultivates, the water which he uses for irrigation, and the climatic environment. The soil and the climate sometimes act in conjunction with each other for increased productivity; at other times they appear to act in opposition to each other. For example, a good soil with a favorable growing season will produce very abundantly; but the same soil under an unfavorable growing season may produce so little as to yield unprofitable returns. Similarly, a poor soil with a favorable growing season may yield satisfactorily, whereas that same poor soil under an unfavorable growing season may be utterly incapable of giving a proper return for the farmer's labors. Moreover, under conditions of irrigation, it must always be remembered that the use of water is definitely influenced by the nature of the soil and the climatic environment. Much or little water, the frequency of application, and the quantity in each irrigation are all determined by the soil and the climate of the project.

CLIMATE

The Federal irrigation projects, located in 15 of the 17 Western States, represent a great variety of climatic conditions. They are located at greatly varying elevations above sea level. For example, Grand Valley has an elevation of 4,700 feet; Shoshone, Strawberry Valley, North Platte, and Newlands are between 4,000 and 4,600 feet; Umatilla has an elevation of 470 feet; Okanogan 1,000 feet; and Yuma 110 feet. These differences in elevation naturally have a determining effect upon the climatic conditions of the projects. Moreover, the Federal irrigation projects are located from the States of the Pacific seaboard to those of the foothills of the Great Plains. Over this territory there is a seasonal change in the total quantity and distribution of rainfall. Some of these States receive less than 20 inches

of precipitation annually, yet the time when the major part of this precipitation occurs varies greatly with the different projects, so that the agricultural value of this precipitation is not the same. In general, on the Pacific seaboard, the heaviest precipitation occurs in winter; going eastward, it occurs in the Mountain States in early spring, and on the Great Plains in midsummer.

The time at which the major precipitation occurs is of high agricultural importance. If it should come during the growing season it has a higher crop-producing value than if it falls when it has to be stored in the soil to be used later by the growing crops. Moreover, in certain parts of the West there appear to be wet and dry cycles; that is, a succession of years with a very low rainfall, followed by a succession of years with a relatively high rainfall. The greater the maximum and minimum of these cycles, the greater the opportunity in the wet cycle to grow crops without irrigation. This explains the temptation on some of the Federal irrigation projects where such wet years come occasionally to refuse to buy irrigation water, for the hope is always uppermost that the following year will be one of the wet years.

Snowfall likewise has an important agricultural bearing. If the winter precipitation comes in the form of snow, subtle changes occur in the soil which tend to increase crop production the following summer. In short, a knowledge of all facts relative to the natural precipitation are necessary to determine the degree of aridity of any section; and, of course, aridity alone compels the artificial application of water, known as irrigation.

An examination of Table 9, Exhibit 1, shows that the annual average precipitation varies greatly on the projects, from 3.4 inches at Yuma to 22.2 inches at Belle Fourche. About one-half of the projects receive more than 10 inches per annum. The difference between the highest and lowest rainfall varies greatly and explains why some projects are still attempting to carry a fairly large proportion of land under dry-farming methods. The Federal irrigation projects, so far as the natural precipitation is concerned, represent true arid and semiarid conditions, and as such are subject to improvement by irrigation.

Perhaps of greater importance than differences in the average rainfall, since all the projects are under arid or semiarid conditions is the length of the season during which plant growth may continue; that is, the number of days between the last killing frost in the spring and the first killing frost in the fall. The Federal irrigation projects represent almost every extreme with respect to this feature. The Yuma project has a growing season covering 335 days, the Salt River project 289 days, and the Orland project 264 days. At the other extreme, the Milk River project has a growing season of 113 days, the Shoshone 122 days, the Strawberry Valley 123 days, and the Williston 124 days. It is not to be expected that the same variety of crops or that the same crop yields, even though all other factors were the same, could be produced on lands differing so widely in the length of the growing season.

Not only is the length of the growing season of greatest importance in measuring the productive power of the Federal irrigation projects, but the climatic conditions during this growing season are of equal importance. If the temperature is high, the sunshine abundant, the winds not too heavy, plant growth is favored; whereas under the

opposite conditions it is retarded. It is conceivable, therefore, with a short growing season, that good crops may be produced if the conditions favorable for plant growth exist during the growing season. In this respect the Federal irrigation projects differ greatly. The mean maximum temperature varies from 115° on the Yuma, 112° on the Orland, and 108° on the Okanogan project, to 101° on the Milk River, 98° on the Shoshone project, and 95° on the Uncompahgre project.

These climatic factors have a very definite effect on the duty of water. If the relative humidity is low—that is, if the air is dry—and the temperature is high and sunshine abundant, the plant transpires water at a greater rate than in a humid atmosphere with a low temperature and little sunshine. Although this effect may not be so noticeable in the earlier years of the project, yet, as time goes on and water is applied more carefully to larger areas, it may become of paramount importance. In fact, cropping systems must be planned and carried out very largely in harmony with the climatic environment of the project. There is a definite relationship between climate and human life. Some persons seem to respond better to a warm climate; others seem to do better in the colder climate. From that point of view, therefore, no mistake was made in placing projects under different climatic conditions, providing these conditions are not so extreme as to make the making of a livelihood from the soil too precarious an undertaking.

The evidence presented does not indicate that any adequate study of the climatic environment in its relation to agriculture of each project was made before it was authorized. In the future the climatic factor should be carefully considered before final decision as to establishing the project is made.

SOILS

There is a direct relationship between the soil and plant growth. A favorable physical condition of the soil enables the plant roots to penetrate the soil easily and to forage for food. A high fertility of the soil offers to the plant an abundance of food to which the plant responds by a more rapid and a larger growth. On nearly all of the Federal reclamation projects there is a deficiency, characteristic of arid soils, in the element nitrogen, which, however, may be supplied by the growing of leguminous crops which, when plowed into the soil, supply this pivotal element of plant production. That explains the necessity of planting such crops as alfalfa first, and other crops later on the plowed-up alfalfa fields. It may be observed that this practice, which determines the productive power of the soil, seems to be well understood by the project farmers and is nearly everywhere being followed.

The physical and chemical composition of the soil has a direct effect on the water consumption of plants. The richer the soil is in plant food, the smaller the quantity of water required to produce a unit weight of the crop. This effect is so great that, measured in units of water, it may mean the saving of a very large proportion of the water ordinarily required for crop production under irrigation. A project, therefore, on fertile soils will use less water for a given crop production, or permit a larger crop production with a given

amount of water, and from either point of view, increase the irrigation wealth of the project.

The soluble matter contained by soils is of very great importance, and especially so under conditions of irrigation, for it is these soluble salts, washed downward into the subsoil and the subsurface water, that become alkali, to the injury of the land in lower-lying places, and requiring the establishment of expensive and elaborate drainage systems. Every irrigation project should be given primary consideration with regard to the amount of soluble salts in the soil and to probable drainage requirements. The quantity of water to be applied to an irrigation project should be proportioned to the existing soil conditions so determined. The question of soil composition is answered by corresponding systems of agriculture. Every irrigation farmer, to achieve success, must make his system of agriculture correspond to the climate and soil possibilities under which he labors.

As has already been shown under section "Choice of projects," all but four of the projects had been authorized before 1907, yet no soil investigation in formal cooperation with the Reclamation Service appears to have been made by the Bureau of Soils of the Department of Agriculture until long after the projects were authorized. This again seems to have been, in part at least, a result of the haste with which the early projects were selected after the reclamation act had passed. There was no time in the space of the few years during which the major projects were authorized and begun for the making of such complete soil surveys as should have been made and must be made hereafter on irrigation projects. A notable student of soils was employed by the service in its early years to give assistance, but the time at his disposal made possible only general examinations instead of the detailed studies which are indispensable in forming correct conclusions as to the value of an irrigation project, and many of these were made after the projects had been authorized.

The United States Department of Agriculture, as early as 1897 and 1898, had perfected methods of soil survey which have been in use since that time, so that the absence of methods was not the excuse for such an omission. Moreover, the Director of the Reclamation Service, in various reports, calls attention to the danger of alkali in connection with irrigation, establishing thereby the fact that the service was conscious of the need of soil studies. Why this knowledge and apprehension did not lead to thorough soil surveys is not known.

WATER

The quality of the water used in irrigation influences agricultural production. Waters carry in solution a variety of substances. Some are rich in lime; others are almost free from lime but carry other soluble materials. It would seem from recent investigations by the Department of Agriculture that the composition of irrigation water has the power to effect thoroughgoing physical changes in the soils to which it may be applied. These changes sometimes convert granular, easily worked soils into heavy soils that are worked with difficulty. In other cases the reverse occurs. This new field of experimentation is yet in its infancy; but it is surprising that a great Government organization, expending tens of millions of dollars on

irrigation enterprises, did not, directly or indirectly, through the large system of governmental and State agricultural research, initiate investigations that would secure information concerning this and related matters. Here again any later examinations would have lesser value, in that the projects were authorized before sufficient time had elapsed to apply such information as was in possession of agricultural experts to the determination of the economic value of proposed projects.

Perhaps a more serious effect of the use of improper water for irrigation is that which results from the application of water so rich in mineral ingredients that the soil solution becomes too concentrated for plant growth. Apparently such alkali determinations of irrigation water were made in considerable regularity in connection with the investigations of waters to be impounded or diverted for irrigation use by the Reclamation Service.

CROP YIELDS ON PROJECTS

Table 11, Exhibit 1, shows crop yields for 10 to 11 years on the reclamation projects.

It will be observed that the seven standard crops used in the study vary definitely and regularly on the various projects. If the yields be correlated with the length of the growing season, or with other major climatic features, or with such knowledge of the soil conditions as is already in our possession, it will be found that the variation is largely dependent upon these climatic and soil factors. Although, undoubtedly, human skill applied to any soil, good or poor, may increase the yield materially, yet, under unfavorable conditions, the best human skill can reach only a certain standard.

If there be a specific factor of crop yield for any one project or division of a project, it follows clearly that the financial prosperity of the farmer may be measured largely by this factor. All other conditions being the same, the higher the crop return for his labors the greater his financial prosperity. This very important matter of correlating crop yields or land productivity with a system of repayment will be taken up more fully in the section on "Repayment."

FUTURE PROJECTS

Exhaustive studies must be made of the climate, waters, and soils of any proposed future projects before a decision be reached with respect to them. Those offering the highest probable returns should be the first undertaken, and the more difficult ones left for later years when the progress of science will have taught means and methods by which conditions now appearing to be refractory may be overcome. The present projects also should be carefully soil-surveyed, and expert workers secured to interpret the results of the surveys with a view of giving advice to project farmers.

Certain parts of a project are often less productive than other parts. These areas should be located and classified so that they may be considered in any future determination of questions of equitable acre costs or repayment or technical assistance needed by the farmers.

An examination of Table 11 shows, for instance, that the Frannie division of the Shoshone project has uniformly a much lower acre-

yield than the Garland division of the same project. Such a constant difference between the two sections of the one project can mean only one thing, that these physical conditions differ on these two divisions and that, consequently, greater efforts must be put forth on the one than on the other to obtain the same results.

RECOMMENDATIONS

Survey and classification of project lands.—The Secretary of the Interior should undertake at once a comprehensive and detailed survey of the physical and economic features of the Federal reclamation projects, to secure information upon which the project lands may be classified with respect to their power, under a proper agricultural program, of supporting the farmer and his family and of repaying the construction costs of the project. This survey should be in sufficient detail to enable the grouping of the farm units under each project into divisions or zones, each of approximately equal productive power. All lands which at the time of the survey do not possess a productive power sufficient to support the farmer's family and to repay construction costs should be grouped in one class, and all lands which are just coming into agricultural production and not yet ready to begin repayments should be grouped in another class, both of these classes of lands to be exempt from requirements of repayment of construction costs.

Such surveys of the project lands should be made periodically as the progress of knowledge may suggest and for the purpose of determining any changes that may have accompanied the continued cultivation and irrigation of the lands.

Exchange of infertile lands.—Homesteaders who have located on project lands which have been classified as unable to support the farmer and his family and to repay construction costs should be given the privilege of exchanging their lands for other lands on the same or on other projects; and ex-service men have the preference in making such exchanges.

Suspension of payments on infertile lands.—The construction costs of lands found by classification in accordance with Resolution No. 13 to be unsuited to immediate cultivation and unable to pay said costs should be suspended until such time as the lands are found suitable for cultivation or as the owners thereof apply for water under the charges fixed by the classification, and that until such time no water be supplied to these lands.

Lands not to be included in irrigable area.—The acreage of railroad, canal, lateral, drain, and waste ditch rights of way, of public highways, and of steep, rocky, broken, or alkali lands, classified as unfitted for agricultural purposes, should not be classed as parts of the irrigable area of a project and not be subject to water-right charges for construction, or for operation and maintenance unless requested by the owner. Existing contracts which impose charges for construction and for operation and maintenance upon such exempted acreages should be modified accordingly, and the water rights for such exempted acreages should be sold for use on other lands, provided that the water users from whose contracts such exempted lands are withdrawn should have the first right to purchase such water right for use upon their remaining or additional lands.

SEEPAGE, ALKALI, AND DRAINAGE

SEEPAGE

Whenever an irrigation system is established, the ground water soon rises because of excessive irrigation or because of seepage from leaky canals and ditches. As the ground water approaches the surface, the deeper plant roots become bathed in water and, in the effort to free themselves from this excess of moisture, transpire excessively large quantities of water, often dangerously rich in mineral salts. Soon the plant roots are injured, crop growth is stunted, and a less profitable crop is won by the farmer. If crops are later planted on such water-logged lands, the roots penetrate the soil down to the wet zone and there cease their growth. The feeding area of the roots, therefore, becomes very much restricted, which again affects directly the growth of the plant. If the water rises high enough, crops can not be grown on the land.

Water-logged lands are unprofitable for agricultural purposes. Every precaution must be taken to prevent such water-logging from occurring. This is so well understood that there is little excuse in our day for methods of irrigation agriculture which permit controllable water-logging. Nevertheless, it must be said that under the best of conditions the conformation of soil and subsoil and the nature of the lands through which the canals run may be such as to make the gradual water-logging of the irrigated area unavoidable.

The Federal irrigation projects at an early date felt the effect of the rise of ground waters, and large areas from this cause were unfitted for agricultural purposes. In 1915 the accumulation of water-logged lands totaled 78,950 acres. Twenty thousand acres were water-logged under the Rio Grande project; 15,000 under the Uncompahgre; 11,000 under the Boise. Fourteen of the projects showed a relatively large area of water-logged lands in that year. Though drainage had been instituted and continued, about 103,000 acres of land were injured in 1923 by water-logging. This represented a seepage damage, considering only the irrigated acreage of 1922, of about 9 per cent. This, in terms of the cost of construction and agricultural reclamation, is a large sum and justifies all efforts to prevent or delay the evil.

It is usually easier to prevent damage from water-logging than to correct it after it has occurred. As far as known, there is only one permanent remedy for water-logging, namely, drainage, which is always expensive unless the causes of water-logging are removed and the ground water allowed to retreat.

ALKALI

Under irrigated conditions, along with injury from water-logging, comes another injury to the land, due to the alkali which usually accompanies seepage. Soils of the arid and semiarid region are rich in soluble materials, accumulated through long ages of weathering and not washed out of the soil because of the low rainfall. Soils in the humid regions contain a much smaller percentage of such soluble materials, as the heavier rainfall is sufficient to wash out the salts and to carry them away in the waters of the subsoil. When an exces-

sive quantity of these soluble materials enters the soil solution, plant nutrition is interfered with seriously and the death of the crop or serious crop reduction results.

As seepage is a concomitant of irrigation, so under arid conditions alkali is usually a concomitant of seepage. The excess irrigation water passing downward through the soil dissolves the soluble soil substances and carries them into the lower-lying soil strata, to increase the concentration of the ground water. When this alkali water is drawn to the surface by capillarity and evaporated at the surface, soluble salts are left on or near the surface as a white crust, generally known as alkali.

Damage from alkali is commonly observed in connection with seepage on all irrigation projects. Studies of the alkali evil on the reclamation projects have been made.

DRAINAGE

The building of drainage works on the Federal irrigation projects has now been in progress for a number of years. It has been expensive, ranging often as high as \$30 an acre, but there has been no choice between laying drains or abandoning the lands. When drainage has been done by the service, the drainage costs have been added to the construction costs. The extent of the project drainage systems is shown in Table 8, Exhibit 1. There have been built for purposes of drainage 1,337 miles of open drains and 446 miles of closed drains. These drains, according to the estimates of the Reclamation Service, will protect 45 per cent of the lands now irrigated under the Federal irrigation projects, and it is estimated that when the present authorized drainage is completed, 58 per cent of the irrigated acreage will be protected from water-logging.

This is a large percentage of seeped lands, considering the length of time that the service has been in operation, and it would indicate that the water user and the water deliverer did not from the beginning sense the stern necessity of adopting methods of water use that would prevent or delay the need for such extensive drainage. The effect on the farmer is to increase seriously his financial burden and also to limit him to a certain extent in his agricultural operations, for the depth to the drain is the depth of soil in which he can operate profitably, so that deep-rooted crops frequently are eliminated from consideration.

The urgency of this condition demands that steps be taken to make the necessary investigations of soils, geology, and methods of water application to reduce this danger to its lowest limits. There are those who declare in all sincerity that no civilization built upon irrigated lands can endure, because, in spite of the greatest precautions, the ground water will rise to water-log the lands, alkali will be carried up into the root zone, and ultimately crop growth will be impossible. Although this view is not tenable when our present knowledge of soils and agricultural mechanics is considered, yet it may be freely admitted that the careless use of water, which permits the rise of the underground water, may become a most serious menace to the prosperity of communities living on irrigated lands. On the other hand, it may be as freely said that our modern knowledge justifies us in the belief that this injury may both be prevented and

corrected. The major factors in the water-logging of land are, first, an excessive use of water, and, second, leaky transmission systems, meaning leaky canals, laterals, and reservoir bottoms. All of these may be controlled.

CANALS

Although the misuse of water by the farmer is great and should be corrected, it is probable that the leaky canal contributes seriously to the formation of water-logged lands. On the various projects nearly as much water is lost in transit between the diversion head gate and the farmer's head gate as is applied to the fields. Most of this great loss is due to percolation, since the evaporation surface of the water in the canals is comparatively small. The dangerous canal is more particularly the one that at certain intervals crosses permeable strata or rocks with cracks in them, through which the water is poured into the subsoil.

It should be the duty of those responsible for an irrigation enterprise to search out such places and to make them as nearly as may be impervious. The lined canal is one of the best safeguards against water-logging. When it is considered that the water saved by the lined canal may be used to reclaim other lands, and also that the lined canal prevents or reduces the danger of water-logging, it seems that it is nearly always a profitable investment. Certainly there should be no argument about the wisdom of lining on all Federal irrigation projects all places where pervious strata permit a rapid loss of water. On the Federal irrigation projects there is a considerable distance of lined canals. In 1914 there were 87 miles of lined canals. This has gradually grown until to-day there are 392 miles, but against this are to be placed 10,650 miles of unlined canals through which percolation occurs more or less freely.

A special survey should be made of the canal system of the projects to determine the leaky places and to make recommendations relative to the lining of the canals on the basis of which a program of canal lining should be formulated.

CONCLUSIONS

The danger from seepage and alkali and the necessity of drainage, as well as of the economical use of water to prevent the rise of the ground water, were understood by the officials of the Reclamation Service, as indicated in the first four annual reports. There is no further reference until the eleventh report, from which the following quotations are made:

Another oversight in the earlier years was the neglect of full consideration of drainage and the importance of providing this to prevent much of the more valuable land from being destroyed by swamping or alkali. When large irrigation systems are constructed covering extensive areas, and the water has been applied for several years, it has followed that 10, 15, or even 20 per cent of the total irrigated lands have been destroyed. To keep the lands in a condition of irrigability expensive drains must be provided. (Reclamation Service Eleventh Annual Report, p. 3.)

Since the beginning of irrigation the rise in the ground waters on the various projects has been marked. On some of the projects the water plane has risen over considerable areas to such an extent as to render the lands unfit for cultivation, and in a few cases limited areas have actually been submerged. The cause of this excessive rise in ground water is evidently due, first, to the adequate

supply of water furnished; and, second, to the excessive use of water on the part of the settlers, many of whom were in the beginning without experience in irrigation. In addition to excess irrigation waters, there are also some unavoidable losses from canals and laterals which reach the subsoil and contribute to some extent in raising the water plane.

Where the irrigation is confined to small areas or narrow valleys with open subsoil conditions, the rise in ground waters is not ordinarily sufficient to interfere with agricultural operations, the excess waters which are put on the land during the irrigation season being in general drained out and carried away before the next season's irrigation is begun. Where, however, large areas are being irrigated and where the ground water must travel for a considerable distance before finding any natural outlet, a general rise in the water plane ordinarily occurs. The keeping down of the water plane to the required depth below the surface can be accomplished by the construction of drainage works and by reducing the quantity of water used in irrigation to a minimum.

In order to maintain the irrigability of the land, investigations are being carried on relative to the elevation of ground waters, and wherever necessary the construction of drainage works is being undertaken. On account of the varying conditions of soils and topography encountered on the different projects various plans for drainage are required. The general purpose, however, in each case is the same, this being the removal from the subsoil of excess waters which have been carried into it through overirrigation and unavoidable seepage from canals and laterals. (Reclamation Service Eleventh Annual Report, p. 14.)

The rise of the water table and tendency toward water-logging and seepage of lands, except where protected by drainage works, has continued over portions of most of the projects during the past year. In some cases this rise has been sufficient to render the land unproductive and unfit for cultivation. In others it is sufficiently high to threaten the irrigability of the land at an early date if not controlled. In a few instances the water plane has fallen during the year. These cases are generally confined to small areas, and the lowering of the water plane over them generally appears to be the result of the use of less water in the vicinity for irrigation. Field investigations and studies of the rise of ground water lead to the conclusion that it is due both to excess use of water in irrigation and to unavoidable losses from earthen canals. How much each of these causes contributes it is generally impossible to determine. In some individual cases, where small areas are involved, the source of seepage water can be directly traced.

The excess water of irrigation which contributes most largely to seepage is what may be termed underground waste. It is caused by applying more water to the surface at a single irrigation than the soils can retain within the zone of plant growth. A part of it consequently sinks into the lower and more porous soil strata. Gradually the subsoils become filled to an extent that water is brought to the surface on the low areas or on the lower portion of slopes down which the ground water may be slowly percolating. The economical remedy against seepage of this kind is to reduce the amount of water applied to the soil at any one time to that which it can retain and beneficially use for the growing of plants. This requires careful preparation of the land for irrigation as well as careful handling of the water. Especial attention must be given to the use of heads large enough to go over the land quickly and before an excessive amount is allowed to sink into the soils. Reducing the underground waste in irrigation will reduce the amount of drainage required and also make it more easily possible to determine the location of losses from canals and to provide against them in an economical manner. In cases where seepage is evidently caused by losses from canals, consideration is now being given to lining or otherwise making the canals water-tight.

In order to reduce the amount of drainage that will be required to a minimum too great attention can not be given to the economic use of water. The ample water supply furnished by the service, the unfavorable conditions of many of the lands for economic distribution of water, and the lack of experience in irrigation of many of the settlers are all factors directly affecting seepage and drainage. Until the processes of irrigation are perfected to an extent that it can be carried on without excessive underground waste, and until excessive losses from canals can be reduced, extensive drainage works will undoubtedly be required to maintain the irrigability of portions of the lands. If these works are not provided, large areas will become unfit for cultivation, through being water-logged and, in most cases, eventually become alkaline through capillary action and surface evaporation. Drains, to be effective in protecting land against seepage and becoming alkaline, must be deep enough to hold the water plane below

the depth from which any considerable amount of water can reach the surface through capillary action. They must also be excavated into the more porous or water-bearing materials. Closed drains, as a rule, are more effective than open ones. This is due largely to the possibility of maintaining a closed drain in working condition at all times and its consequent efficiency in holding down the water plane. With open drains there is a constant tendency to filling above the grade, due to obstructions which enter them. For this reason closed drains are favored except where the quantity of water to be removed is too great or the slopes too flat to make them practicable.

During the year 1912-13 drainage studies and investigations were carried on over 17 of the projects. On some of these—namely, Yuma, Boise, Minidoka, North Platte, Klamath, and Shoshone—the work of constructing drains for the relief of wet areas was in progress. On the Sun River, Lower Yellowstone, Truckee-Carson, and Carlsbad projects plans were prepared for drains intended for the relief of the most seriously affected areas. On the Salt River, Rio Grande, Belle Fourche, Strawberry Valley, and Uncompahgre Valley projects investigations of seepage conditions were begun. On the last-named projects the rise of ground water has been sufficient to threaten portions of the irrigable area, and the investigations which have been begun are for the purpose of collecting the necessary data for planning drainage works when required. The amount expended on drainage construction during the year 1912-13 is estimated at about \$300,000. The amount required for this work during the year 1913-14, in order to afford relief to lands that are already wet and to prevent seepage spreading to adjacent areas, is estimated at from \$300,000 to \$400,000.

It is the intention to so locate drains on the various projects that they will serve as main outlets and also provide for holding down the water plane and affording protection to as large an area as is possible. The value of these drains as protection measures for land not yet seeped is, in many cases, it is believed, as great or greater than their value for reclaiming areas already too wet for cultivation. It is sometimes the case, especially where a small area requires drainage that the cost of adequate works is as much or even more than the value of the land over which seepage has occurred. (Reclamation Service Twelfth Annual Report, p. 20.)

It seems that the supposed necessity of completing and extending the projects already undertaken overshadowed the need for this very vital protection, for the records do not show that serious steps were taken to prevent the seepage and alkali evil by making proper soil surveys, and insisting upon the economical use of water. Rather, when injury had been done, remedial steps were taken by instituting large drainage enterprises. Definite steps should be taken to line all leaky spots in the canals, and ultimately to line all the canals where it seems desirable. Further, a campaign of instruction among the water users, concerning the proper use of water in irrigation, should be undertaken. Unless this is done the creeping danger of seepage, alkali, and drainage will continue to increase and may be the deciding factor in determining the permanent success of the Federal experiment in reclamation by irrigation. As it is, the damage done by seepage accounts for a part of the difficulties that have been voiced by the Federal water users.

RECOMMENDATIONS

Drainage a part of construction cost.—Whenever drainage construction not included in the primary construction cost becomes necessary on an irrigation project, such drainage cost, as approved by the water users of the project, should be made a part of the construction cost of the project.

MARKETS AND TRANSPORTATION FACILITIES**THE NEED OF MARKETS**

Farm crops are either consumed by the farm household or sold. The type of agriculture determines the relative proportion consumed or sold. Under a system of diversified farming, more of the products are consumed than under a single crop system. Some of the farmer's crops must, of necessity, be marketed. Since a large proportion of the farmer's products must be sold, marketing becomes of the highest importance. The nature of the available markets, their distances from the farm, transportation rates, and all the complex factors that connect the producer and the consumer determine in a large measure the profitableness of farming.

PROJECT MARKETS

Most of the Federal irrigation projects are well located with respect to markets. The projects near the Pacific coast have easy access to Los Angeles, San Francisco, Portland, and Seattle; in the intermountain country, to Denver, Salt Lake City, Spokane, and Butte; and toward the foothills of the Great Plains, to El Paso, Fort Worth, Kansas City, and Omaha. The Twin Cities are the principal markets for grain and livestock for the northern projects. These cities are large markets which purchase all kinds of foodstuffs. If the organization of agriculture throughout the irrigated section were made to conform with the needs of these large markets, it would greatly benefit the farmer's financial condition. In addition to these large markets there are many smaller ones, such as mining and lumber camps and smaller towns which are excellent markets, with prevailing high prices. Many of these mining-camp markets are within easy reach of the Federal irrigation projects. Then, as a project develops, and villages and towns are built upon it, the local market is increased and in time becomes of considerable consequence; but, as at present constituted, the Federal irrigation projects are mainly dependent upon the larger markets in the East or on the Pacific seaboard.

TRANSPORTATION FACILITIES

The majority of Federal irrigation projects are well provided with transportation facilities. Good roads cross most of the projects, and every project is reached by one or more railroads having transcontinental connections.

Since the projects are largely dependent upon the larger distant markets, freight rates assume great importance in making farming profitable on the Federal irrigation projects. One of the chief complaints of the Federal water users is that because of high freight rates it is impossible for them to ship their farm products to the larger markets of the Nation with any profit to themselves. A number of experiences have been cited to illustrate the large degree to which freight rates consume the prices of the products shipped. Most of the Federal irrigation projects are far from the large markets. Clearly farms near the great consuming centers can place their products on the markets at a lower cost than the farms located far away.

IMPORTANCE OF CONCENTRATED CROPS

Any discussion of the influence of markets and transportation facilities upon the farm profits must consider the nature of the crop which the farmer places on the market. Some of the projects make a business of shipping alfalfa; others feed the alfalfa on the project and ship butter, meat, or eggs. Farm profits increase when the farmer sells his farm products in a concentrated or manufactured form.

If concentrated crops were shipped more generally from the projects, the question of freight rates would be of less importance. For instance, consider the relative effect of shipping alfalfa or butter or sheep from the Idaho projects. Portland, Oreg., is the nearest large market to Boise, Idaho. It costs \$78 to ship 11 tons of alfalfa hay from Boise to Portland. If it be assumed that the farmer receives on the Portland market \$25 a ton for the alfalfa hay—an unusually high figure—the 11 tons would yield him \$275. The freight from Boise to Portland would then represent 28 per cent of the total amount received by the farmer on the Portland market. If, on the other hand, the farmer shipped a carload of 20,000 pounds of butter from Boise to Portland at the rate of \$253 and received 50 cents a pound on the Portland market, there would be \$10,000 worth of butter in the shipment, and the freight rate would be only 2.5 per cent of the amount received. If a carload of sheep were shipped from Boise to Portland, assuming that the Portland market paid 10 cents a pound, the freight would form only 5.5 per cent of the amount received for the carload.

Such comparisons illustrate the advantage in shipping concentrated instead of raw farm products. A further calculation of the number of tons of alfalfa hay required to produce a carload of 20,000 pounds of butter or a carload of 23,000 pounds of sheep would show that to ship bulky raw farm products is always an unprofitable undertaking. Changing the type of agriculture so that more concentrated products are sold will largely overcome the handicap of the long haul and the high freight rate.

CONSUMPTION ON THE FARM

Where specialized crops are grown, such as cotton, apples, or lettuce, there is a tendency to depend upon the cash income from these specialized crops for the purchase of the foods needed by the family and to omit a sufficient diversification to supply the major food needs of the family. This is a practice of doubtful value. The farmer's dependence upon markets and the prevailing prices of the commodities he must buy; that is, the purchasing power of the crops raised, would make it advisable to adopt a system of crop diversification that would supply the family with, as nearly as possible, all needed foodstuffs. After this has been provided for the remainder of the acreage could be planned for cash crops. The future of irrigation farming as perhaps of all successful farming, depends upon the development of the self-supporting farm home by the products of the farm. Were this practice more generally adopted, it would lessen the dependence of the farmer upon freight rates and market prices.

PRICES RECEIVED BY PROJECT FARMERS

The prices received by the project farmers during the last decade, and a comparison of these prices with the prices of the commodities that the farmer is obliged to purchase, show that the purchasing power of the farmer's crop plays the fundamental part in determining farm prosperity. Table 11, Exhibit 1, gives in detail the prices received for various crops on the Federal irrigation projects since about 1912. The following table shows a summary of the results from the year 1912, when these statistics first were gathered systematically. The projects were then emerging from the hard pioneer days into the beginnings of developed agriculture. High acre yields could not be expected. During the years 1912 to 1915, the average crop value per acre stood steadily in the neighborhood of \$25. From 1916 it rose steadily until 1919, when the average crop acre income was \$79.88. Since 1919, the crop income per acre has been steadily falling, until in 1921 it was only \$42.85, and in 1922, \$43.08. The increased price was due largely to war conditions and the decrease to the agricultural depression which followed.

Acre and total incomes (not including Warren act lands)

Year	Average crop value per acre	Total value of crop	Year	Average crop value per acre	Total value of crop
1912.....	\$22.60	\$14,479,368	1918.....	\$63.60	\$66,821,396
1913.....	24.50	15,732,215	1919.....	79.88	83,974,137
1914.....	23.50	16,475,517	1920.....	58.36	66,171,650
1915.....	24.00	18,164,452	1921.....	42.85	49,620,300
1916.....	38.25	32,815,972	1922.....	43.08	50,360,850
1917.....	58.40	56,462,313			

During this period, 1912-1923, the project lands had been brought into better condition and the cultural methods had improved. Experience had demonstrated the advantage of certain types of agriculture and kinds of crops. Yet under a more systematic and intelligent practice of agriculture, resulting in larger acre yields, the crop incomes per acre have been falling during the last few years. At the same time, the purchasing power of most farm products is lower than it was 8 or 10 years ago. When this condition, which lies at the foundation of most of the financial difficulties of the project farmers, is corrected, the remaining difficulties will be disposed of easily. In the face of the agricultural depression, there is a larger acreage of cropped land on the Federal irrigation projects than ever before. Since 1912 the total crop value of the Federal irrigation projects has increased more than fourfold.

CONCLUSIONS

The project difficulties resulting from marketing conditions and transportation facilities may be overcome by (a) securing legislation to equalize freight rates; (b) making every farm household more nearly self-supporting; (c) growing concentrated instead of bulky crops for shipment.

IRRIGATION PRACTICE

WATER THE REAL ISSUE

The great structures of the Bureau of Reclamation were built for the purpose of storing or diverting water for agricultural purposes. Each Federal irrigation project is based upon a more or less definite water supply which may be used for irrigation purposes. There is in the West, and under most of the projects, much more land than water. Under the most extensive system of water storage and the most careful use of water, only a small portion, perhaps less than one-fifth, of the arid region may be brought under irrigation. The test of the fitness of engineering structures on the Federal irrigation projects is the quantity of water which they make available.

The wise and economical use of water must be the main concern of all interested in the development of the projects, as well as in the development of the arid and semi-arid area of the country. In fact, it is not the quantity of water secured by irrigation structures that determines the area of irrigated land, but rather the manner in which the available water is used. The extent of reclamation, the character of agriculture under the ditch, and the permanence of a civilization built upon irrigation depend upon the use of irrigation water; that is, upon irrigation practice.

RELATION OF WATER TO CROPS

It is an erroneous idea that the greater yields of crops obtained by the addition of large quantities of water increase the profits of the farmer. The returns from the use of a certain quantity of water are a safer basis on which to found our irrigation practice than the yield per acre, especially when land without water is very cheap and water for that land is very expensive. The true measure of the proper use of irrigation water is the water cost of the crop produced. How many tons of water were required to produce a ton of alfalfa or a bushel of wheat? Such questions are too often left unanswered by the farmer, but are of fundamental importance in the building of an irrigation practice which will help make our Federal irrigation projects as well as other irrigation projects prosperous and permanent.

The quantity of water used in irrigation affects definitely the growth of the plant. By varying the quantity of water, it is possible to increase the total yield; to change the relative proportions of leaves, stems, roots, and seeds; to control measurably the composition of the crops produced, or to hasten or retard ripening. Under the most favorable conditions the irrigation farmer carries a burden above that of farmers in humid districts, since he has to pay for water and for its application. Any power to vary the growth or composition of the irrigated crop may be the determining factor in competition with the humid area. This indicates the importance of an intelligent system of irrigation practice on the Federal irrigation project.

METHODS OF IRRIGATION

The rational use of water considers not only the total quantity of water applied, but the methods of application. For example, irrigation water may be applied by the flooding method, by which

all the land is covered by water. This in turn is accomplished by one of several modifications, such as the border, check, or basin method. Or, water may be applied by the furrow method of irrigation which means that only a part of the land is covered with water, the other part remaining dry. Each method has decided advantages under certain conditions. The intervals between irrigation are of definite importance in determining the effect of the water upon the plant. The time of irrigation, keeping in mind the stage of crop development, is likewise of importance. Our best knowledge with regard to the methods of irrigation should be applied to win a permanent and successful civilization under the ditch.

SYSTEMS OF IRRIGATION

Of almost equal importance with the total quantity of water applied and the method of its application, is the system under which irrigation water is applied. By the constant-service system each water user receives a constant stream of water, small or great according to his water right. There are disadvantages inherent in this system, although it is very popular with the water user who has not thought the thing out. The other, and more satisfactory system, is that of rotation, by which the farmer receives at regular intervals as large a stream of water as he can handle for a limited time. When irrigation is finished, the water is taken by his neighbor, and he proceeds to other farm duties. This system is not so readily accepted by the farmer who has not been educated in irrigation practice. Meanwhile, on the Federal irrigation projects, which should be models for all other irrigation enterprises, such irrigation systems should be devised as will lead to the best results. The Bureau of Reclamation, or the controlling water users' associations should distribute water only in accordance with the best-known principles of irrigation practice.

DUTY OF WATER

The duty of water indicates the quantity of water used for the production of crops. It is ordinarily measured in the depth of water over the acre during the growing season. The gross duty of water is the quantity of water diverted for agricultural purposes at the intake from the stream or river; the net duty of water is the quantity of water actually delivered to the farmer's head gate, and which is applied to the land. The difference between the two indicates the loss in transit from leaky canals and from evaporation.

The Federal irrigation projects have kept a record of the duty of water from the year 1909. (Exhibit 1, Table 6.) During the period of 14 years there has not been a substantial change in the duty of water on most of the projects. There is, however, a wide difference between the quantity of water supplied the different projects. In 1910, the Umatilla project used more than 10 acre-feet. In 1922, the latest records available, the Uncompahgre project used a depth of $6\frac{1}{2}$ acre-feet, and the Milk River project a depth of just a trifle over half a foot. Such variations need explanation.

The plant requires small quantities of water for crop production. The water transpired by the plant would not, under average condi-

tions, measure more than an acre-foot for most crops. The water applied to the soil is lost in part by evaporation under the influence of low humidity, high temperature, and steady winds. Differences in soils also tend to increase or diminish the duty of water. On sandy soils, like Umatilla, the farmer is inclined to add more water than he should, because it disappears so quickly, and he is under the impression that he must add more in order to supply the soil with the necessary moisture. On clayey soils, like those of Milk River, on the other hand, the duty of water is likely to be higher, because the farmer feels that a smaller quantity will keep the soil saturated and supply the necessary quantity for plant growth. When the surface soil is underlaid, within root growth, by a gravel bed, as on Uncompahgre, the soil too frequently is merely a sieve through which the irrigation water is poured, to be lost in the country drainage, with little benefit to the crop. Water beyond the reach of plant roots is of no value to the crop.

All these conditions explain in part at least the great variation in the duty of water on the lands of the reclamation projects. Meanwhile, the factors of loss may all be controlled. Evaporation may be checked by tillage; seepage losses may be reduced by applying water in accordance with our knowledge of the soil—that is, a sandy, shallow soil would receive small, frequent irrigations, and a deep clayey soil infrequent, heavy irrigations. Such knowledge, which should be possessed by every irrigation farmer, rests upon systematic soil surveys, backed by the intelligent teachings of irrigation experts.

While in the year 1922 upward of one-half of the projects can not be said to have used water excessively on the farmers' fields, yet the other one-half used quantities of water, which, undoubtedly, were largely in excess of the needs of crops. It is illuminating to note that in several instances the projects with large areas of water-logged lands are projects on which the duty of water is low. Information concerning the proper use of water in irrigation should be disseminated among the water users and, if necessary, compulsory steps should be taken to prevent the excessive use of water in irrigation, as a means of making the water user protect himself against his own wasteful practices. Water rights should never be established except upon the basis of a definite quantity of water.

It is a well-established fact that wherever much water is available, the duty of water is low; wherever little water is available, the duty of water is high, and this without affecting materially the yield per acre. It is also a matter of common knowledge that under pioneer conditions the duty of water is low, whereas on older settled projects the duty of water is high. There is good reason to believe, therefore, that as restrictions are placed upon the use of water the duty of water will be increased; that is to say, less water will be used on each acre of land, and as the projects become older the general experience of farmers will lead them to use less water. A great deal of information has been accumulated relative to the proper duty of water. This should be compiled and applied to the Federal irrigation projects. This is important because the success of reclamation depends primarily upon our success in avoiding a waste of water and preventing-seepage.

AN APPROVED SYSTEM OF IRRIGATION PRACTICE

The Bureau of Reclamation should set up a system of irrigation practice for each project, or for groups of projects, which should be properly printed and circulated and be modified as experience dictates.

CONCLUSIONS

The Bureau of Reclamation should secure from the most competent sources available present-day information regarding the best systems of irrigation practice for the soils of the projects. This should be compiled and sent out for the guidance of the water users. The employees of the Bureau of Reclamation who come in touch with the farmers should be given the special training necessary to enable them to give to the water users accurate advice in harmony with the system of irrigation practice decided upon. Full control of the distribution of irrigation water should be maintained, either by the Reclamation Bureau or the water users' associations. Every possible endeavor should be taken to prevent the waste of water. Water should be used in such a way as to produce the largest yield for the quantity used and to prevent the damage from excessive use. Agreements for water should specify a definite quantity of water per acre; if the water user desires more he should be required to pay for it. The use of water must be determined and controlled by the Bureau of Reclamation or by the organization for project control. It can not with safety be left to the discretion of the individual water user, though the experience and advice of water users should be fully considered in establishing regulations for the use of water.

RECOMMENDATIONS

The economical use of water.—1. All available information concerning the duty of water should be assembled and placed at the disposal of the water user. Federal and State experimental agencies should undertake researches of the duty of water with the view of promoting the economical use of water in irrigation, and that by demonstration farms and farm advisers water users may be made thoroughly familiar with the methods to be employed in securing a high duty of irrigation water.

2. A survey should be made of the sources of loss of water on projects, such as leaky canals, shallow soils, porous subsoils, other large wastage, and the same be corrected.

3. The Bureau of Reclamation and the Federal water users should unitedly work to establish on the Federal irrigation projects an economical as well as a beneficial duty of water.

AGRICULTURAL CONDITIONS AND PRACTICES

CROPS GROWN

All standard crops may be grown on the Federal irrigation projects. Note the following table:

Summary of crop reports on reclamation projects in 1922

[These figures are limited to irrigated crops shown by the crop census on projects, excluding dry-farm crops and Warren Act areas]

Crops	Acreage cropped		Crops	Acreage cropped	
	Total	Per cent of cropped acreage, all crops		Total	Per cent of cropped acreage, all crops
Cereals:			Vegetables and truck—Con.		
Barley.....	32,272	2.8	Onions.....	1,502	0.1
Corn.....	53,732	4.6	Potatoes, white.....	78,507	6.7
Oats.....	42,030	3.6	Potatoes, sweet.....	866	
Rye.....	1,263	.1	Truck.....	23,510	2.0
Wheat.....	159,573	13.6	Total.....	108,477	9.2
Total.....	288,870	24.7	Fruits and nuts:		
Other grain and seed:			Apples.....	20,747	2.3
Alfalfa seed.....	21,557	1.9	Peaches.....	1,997	.1
Clover seed.....	9,657	.8	Pears.....	4,201	.4
Grain sorghum.....	22,795	1.9	Prunes.....	1,236	.1
Flaxseed.....	290		Citrus fruits.....	2,278	.2
Millet seed.....	87		Small fruit.....	2,156	.2
Total.....	54,386	4.6	Miscellaneous.....	2,901	.3
Hay and forage:			Total.....	41,816	3.6
Alfalfa hay.....	448,446	38.4	Miscellaneous:		
Clover hay.....	10,770	.9	Sugar beets.....	29,654	2.6
Other hay.....	22,180	1.9	Cotton.....	147,340	12.6
Corn fodder.....	4,120	.4	Cottonseed.....	2,636	.2
Other forage.....	3,713	.3	Cane.....	6,415	.6
Pasture.....	107,303	9.1	Other crops.....		
Total.....	696,432	51.0	Total.....	186,045	16.0
Vegetables and truck:			Duplication.....	106,626	9.1
Beans.....	4,102	.4	All crops.....	1,169,100	100.0

Alfalfa, the cereals, including corn, grasses, fruits, etc., may all be grown successfully upon the various projects, according to the location and the soil conditions. Many specialized crops may also be grown on the projects, the particular crop varying with the environment of the project itself. Cotton and citrus fruits are grown with great profit on the New Mexico and Arizona projects; apples and other hardy fruits, cantaloupes, and other such specialized crops on projects farther to the north. There is practically no limit to the variety of general or specialized crops that may be grown on these projects, since they represent a wide range of soil and climatic conditions. The acreages of the different crops for the year 1922 are shown in the above table.

These acreages have been won gradually from the desert and represent the result of the farmers' activities during a period of a decade and a half. As a rule alfalfa is the first crop grown, not only because of the intrinsic value of alfalfa hay, but also because alfalfa, more than any other standard crop, helps to reclaim raw land. It is especially valuable to supply the land with the element nitrogen, indispensable in plant growth, and which is usually deficient in the soils

of arid and semiarid regions. After the first pioneer days the alfalfa land is in part broken up and then becomes excellent land for almost any other crop suitable to the prevailing climatic conditions. Changes from one type of agriculture to another are usually slow but steady.

Occasionally special-crop epidemics sweep over the country, when the farmer, usually at great sacrifice and often with great loss, plants a very large acreage in crop which for the moment holds out the promise of very high returns. Such ventures have usually been disastrous to the farmer.

LIVESTOCK ON THE PROJECT FARMS

The great variety of domestic animals recognized in our agriculture may also be maintained under the environment of the Federal irrigation projects. Horses, mules, beef and dairy cattle, sheep, hogs, poultry, and bees predominate, and there are smaller numbers of the kinds of livestock which are not so generally in demand on the markets. The number of livestock on all projects is summarized in the following table:

Livestock totals on Federal irrigation projects for the year 1922

Horses.....	76, 750	Cattle, beef and dairy ¹	33, 687
Mules.....	8, 857	Sheep.....	157, 698
Horses and mules ¹	4, 405	Hogs.....	116, 934
Cattle, beef.....	50, 103	Fowls.....	1, 564, 623
Cattle, dairy.....	77, 807	Bees, hives.....	55, 192

The total number of horses and mules, representing the animals used for power purposes on the 34,000 farm units under water contract, is nearly 90,000, and the beef and dairy cattle total nearly 160,000, more than half of which are dairy cattle. The total value of the livestock maintained on the projects is \$15,769,085 as for the year 1922. Some years ago it was somewhat higher, but the conditions occasioned by the late war are now being overcome, and livestock numbers are again steadily increasing.

Value of livestock on Federal irrigation projects, 1922

State	Projec.	Amount	State	Project	Amount
Arizona.....	Salt River.....	\$373, 763	Nebraska-Wyoming.	North Platte—	\$917, 070
Arizona-California.	Yuma.....	654, 371		Interstate.....	
California.....	Orland.....	540, 955		Fort Laramie.....	145, 465
Colorado.....	Grand Valley.....	143, 719	Nevada.....	Newlands.....	1, 110, 063
Do.....	Uncompangre.....	1, 094, 903	New Mexico.....	Carlsbad.....	259, 358
Idaho.....	King Hill.....	156, 862	New Mexico-Texas.	Rio Grande.....	1, 249, 450
Do.....	Minidoka.....	690, 495	North Dakota.....	Williston.....	59, 646
	Gravity.....	416, 907	Oregon.....	Umatilla.....	390, 092
	South side pumping.	416, 907	Oregon-California.....	Klamath.....	406, 778
Idaho-Oregon.....	Boise.....	1, 726, 419	South Dakota.....	Belle Fourche.....	901, 855
Montana.....	Huntley.....	258, 919	Utah.....	Strawberry Valley.....	655, 859
Do.....	Milk River.....	402, 066	Washington.....	Okanogaa.....	93, 125
Do.....	Sun River.....	178, 009	Do.....	Yakima—	
	Greenfields division.	117, 291		Sunnyside.....	1, 646, 448
Montana-North Dakota.	Fort Shaw division.	324, 613		Tieton.....	460, 114
	Lower Yellowstone.		Wyoming-Montana	Shoshone.....	394, 451
			Total.....		15, 769, 085

¹ Not including Chinook division.

² Includes \$667 on dry farms

³ Not segregated.

The changes in the livestock statistics from year to year may, in the main, be explained by the very abnormal conditions that existed during and after the close of the recent war; but in spite of these changes there has been a steady increase of livestock on the project farms. The number of animals on a 40-acre farm has been calculated, and it is interesting to note the general livestock variations on the projects. The following maximum and minimum statement for the year 1922 illustrates well the range over which the number of units of livestock per 40-acre farm moves from project to project:

	Maximum	Minimum
Horses.....	2.9	1.3
Mules.....	.97	.01
Beef cattle.....	6.1	0.2
Dairy cattle.....	6.5	.75
Sheep.....	22.0	0.4
Hogs.....	7.9	0.9
Fowls.....	197.8	8.3
Bees, hives.....	7.0	.02

The above table shows the very great variation in the livestock situation on the different projects and is not to be explained merely on the basis of the adoption on the different projects of different systems of agriculture, but rather by the fact that the projects are still struggling from a condition of pioneering, into more permanent systems of agriculture, better adapted to the needs of the people, and of which livestock forms a chief element. In 1922, using the figures for all of the projects, the average numbers of farm animals on a 40-acre farm were as follows:

Horses and mules.....	2.2	Hogs.....	3.1
Beef cattle.....	2.1	Fowls.....	43.0
Dairy cattle.....	2.7	Bees, hives.....	1.3
Sheep.....	4.8		

A 40-acre farm may support a larger number of farm animals than indicated above, and the relative proportions are not the best. It is in this direction that progress should be made in the near future.

The above statement is also most interesting because it furnishes a basis of comparison with the production of field crops on a 40-acre farm which, under the present conditions of agriculture, should be fed to livestock on the farm.

SYSTEMS OF AGRICULTURE

When the returns for the field crops grown on the Federal irrigation projects and the livestock maintained on them are more carefully examined it is possible to arrive at some idea of the type of agriculture followed on the average farm considering the reclamation venture as a whole. The following table shows the proportion of the different crops grown on the projects, first in percentages merely, and, secondly, on the basis of a 40-acre farm:

	Percentage	Acres basis
Cereals.....	24.7	9.9
Other grain and seed.....	4.6	1.7
Hay and forage.....	51.9	18.7
Vegetables and truck, including potatoes.....	9.2	3.4
Fruits and nuts.....	3.6	1.3
Miscellaneous, including sugar beets.....	16.0	5.9
Total.....	100.1	40.9
Less duplication.....	0.1	
	100.0	

Of the cereals, wheat predominates, and represents 13.6 per cent of the total crop acreage. Among other grain and seed, alfalfa and sorghum predominate with 1.9 per cent each. Of the hay and forage, alfalfa predominates, with 38.4 per cent. Of the vegetables and truck, garden stuff, potatoes predominate, with 6.7 per cent. Of the fruits and nuts, apples predominate, with 2.3 per cent, and of the miscellaneous crops, cotton represents 12.6 per cent and sugar beets 2.6 per cent of the total crop acreage.

A casual examination of this table shows that the type of agriculture on the Federal irrigation projects is not yet of an intensive character. It represents fairly good diversification; but, when taken in connection with the number of farm animals on a 40-acre farm, especially of dairy cows, it becomes deficient in livestock, so that a large proportion of the field crops must be sold off the farm. Such a type of agriculture may be satisfactory on a soil of high productive power, but where the acre yield is relatively small, it is of the utmost importance that the farmer convert the products of his soil into the most profitable animal products, so that he may retain for himself as much as possible of the profit residing in the operation of his farm.

The project farmer needs to learn that he must not grow too large a proportion of crops that are perishable, because of the possible failure to market such crops at the right time, and that he must place his main dependence upon manufactured crops, such as are represented by livestock fed on the farm, and by such crops as may be sold to agricultural manufacturing establishments, such as the sugar and canning factories. It will be noted that quite a large acreage in project farms is devoted to the growing of wheat when the information available shows that wheat as a commercial crop is not usually profitable on an irrigated farm except as a nurse crop. Finally, he must avoid what may be spoken of as speculative crops, which sweep the country from time to time and throw out of balance the system of agriculture which has been gradually and patiently built up under normal conditions, and which throughout the years is the safe system to follow.

Irrigation agriculture has to compete with other forms of agriculture, with the handicap of having to maintain the overhead cost of the irrigation system and the annual cost of maintaining that system and of applying the water to crops. Irrigation agriculture therefore must be made intensive and must make use of every opportunity to increase profits if it is to survive in competition with agriculture in humid regions. It has the advantage of relatively steady yields from year to year because of the constant supply of water and relatively large yields if the soil is well tilled and irrigation is practiced properly. Under the most favorable conditions it is of importance that definite plans be laid for the establishment in each locality of systems of agriculture that may promise the largest returns to the farmer. For that reason it might be well for those in control of the reclamation venture as a whole, as well as for the organizations responsible for the welfare of each project, to undertake careful planning with respect to the specialized and diversified crops that may be grown profitably on each project, and then to develop on the projects proper organizations, especially of a cooperative character, for advancing the system that may be decided upon. Intensive agriculture, under a close

cooperative organization, is the only safe agricultural road to success under irrigation.

THE LIVESTOCK SITUATION

Where the acre yield is smallest the use of livestock as a manufacturing agency is of greatest importance. It is indispensable that on lands of a low productive capacity animal husbandry be developed intensively. Probably this may in part explain the fact that in northern regions, where the soils are somewhat less productive and the climatic environment less favorable, a larger proportion of livestock is maintained on the farm. When farm animals are considered with these thoughts in mind, the dairy cow always becomes the center of consideration. Except in a few localities, livestock activities should center upon the dairy cow. Where the climate is unfavorable for the development of a dairy industry, which is very seldom indeed, or where adjacent ranges offer good pasturage, making the beef cattle industry very attractive, or where special markets make the growing of other livestock particularly desirable, the dairy cow should be made the main concern of the farmer. Dairying is a stabilizing force in any system of agriculture, not only from the financial point of view but in taking up the labor possibilities of the farm and through its by-products in the utilizing to the highest degree of the products of the farm. It is well to bear in mind that success depends upon keeping the farm labor profitably employed throughout the year, and that there is no other industry that enables one to do this so well as does the dairy industry. Where dairy cows are maintained, there is no tendency for beef cattle or sheep to diminish on the farm; the hogs and fowls also increase. This is shown by the following table, in which the livestock statistics on the various projects have been grouped together according to the number of dairy cows maintained on a 40-acre farm:

Influence of the dairy cow (on 40-acre tracts), 1922

	Project	Dairy cows	Beef cattle	Sheep	Hogs	Fowls
6 or 7 cows	Orland	6.5	1.3	2.3	2.2	197.6
4 or 5 cows	Umatilla	4.8	.2	7.4	8.8	54.3
3 or 4 cows	Boise	8.0	.9	5.1	2.7	34.1
	Williston	3.2	2.4	.8	4.7	33.2
	Yakima	2.6	1.4	1.9	4.6	85.4
Average		3.3	1.9	2.6	4.3	50.9
2 or 3 cows	Uncompahgre	2.1	5.1	2.2	4.3	39.9
	King Hill	2.7	7.1	2.6	3.6	54.8
	Huntley	2.9	2.1	2.0	2.4	34.4
	Lower Yellowstone	2.6	1.8	2.9	2.2	19.8
	Newlands	2.9	2.6	4.5	1.6	31.6
	Belle Fourche	2.1	2.7	22.0	7.6	15.3
	Okanogan	2.5	1.1		1.8	52.3
Average		2.5	3.2	7.0	3.3	35.9
1 or 2 cows	Yuma	1.7	.7	1.0	2.0	33.5
	Sun River	1.6	1.2	4.1	1.9	19.7
	Shoshone	1.3	.5	1.6	1.7	34.4
Average		1.5	.8	2.2	3.3	29.2
Less than 1 cow	North Platte	1.0	1.4	.3	3.2	27.9
	Carlsbad	.8	2.0	2.0	1.8	18.9
Average		.9	2.2	4.1	2.5	22.9
No cows	Milk River	1.0	2.1	6.4	.9	2.3

Influence of the dairy cow on (40-acre tracts), 1922—Continued.

SUMMARY (40-ACRE TRACTS), 1922

Class	Number of projects	Dairy cows	Beef cattle	Sheep	Hogs	Fowls
A	1	6.5	1.3	3.3	5.2	187.5
B	1	4.8	.2	7.4	5.8	54.3
C	3	3.3	5.7	2.6	4.3	50.9
D	7	2.5	3.2	7.0	3.3	35.9
E	3	1.5	.8	2.2	3.3	29.2
F	2	.9	2.2	4.1	2.5	22.9
G	1	.0	3.1	6.4	.9	8.3

It will be noted that as the number of dairy cows decreased from 3.3 to none, the beef cattle showed no regular corresponding variation, nor did the sheep, but that hogs and poultry diminished steadily as the number of dairy cows decreased. The effect of the dairy cow upon the prosperity of an agricultural region has been so thoroughly demonstrated that no further comment is needed here. However, it may be asked if the Federal irrigation projects at the present time have reached, approximately, a state of first-class livestock efficiency with respect to the dairy cow. In the oldest irrigated section, the Great Salt Lake Valley, a survey was recently made of the farm conditions there existing. It was shown that, for a mixed type of farming, such as is represented by the average of the Federal irrigation projects an average of 3.8 cows was kept on each 40-acre farm. The Federal irrigation projects maintain only about one-half of this number.

Here is one of the most important places in which a project farmer may be assisted by those in authority. Here also lies one of the most usual causes of financial distress. Prosperity on reclamation projects can not be expected, nor will it come, so long as the farmers on these projects fail to feed the larger part of the products of the soil to suitable farm animals. The Federal irrigation projects to-day need more livestock.

One phase of the question of livestock on the project farm, not now of the largest importance, will in the course of time, perhaps soon, determine the final success of these projects. A homestead which maintains a proper number of farm animals, and which feeds practically all of the field crops, sells off the land not only the most profitable manufactured product of the farm, but that which has cost least in actual plant fertility. The elements in the soil which make the soil fertile and enable crops to grow, are present in a somewhat limited quantity, at least in an available form. These crops sold off the farm will soon reduce the quantity of easily available plant food to a degree that will reduce materially the acre yield. When the crops raised on the land are fed to animals, the manure of the animals may be returned to the land, and in that way the fertility taken from the soil is largely replaced, thus maintaining the fertility of the soil indefinitely. The experience of the older countries teaches this lesson forcefully.

ACRE YIELDS OF CROPS

The acre yields of the different crops vary greatly on the different projects. The range is shown in the following table of average yearly yields:

	Highest	Lowest		Highest	Lowest
Alfalfa..... tons..	4.5	1.2	Cotton..... pounds..	367.0	244.0
Wheat..... bushels..	7.8	11.6	Sugar beets..... tons..	12.5	3.9
Potatoes..... do....	241.3	38.5	Apples..... pounds..	7,406.0	700.0
Corn..... do.....	48.0	14.2			

This is a large variation, sometimes as high as tenfold. Both the highest and the lowest yields are in some cases affected by special conditions. The fact remains that from project to project the yields for the standard crops vary greatly. The averages, as above given, are in most cases for 10 to 11 years and represent a considerable variety of seasons. It may be asked if the projects which are highest in one year are highest in another, or if the records show that as the seasons change, a high project may become a low project, or vice versa? Without serious variation, the group of high projects is high throughout the 10 years of the study, and the group of low projects is low. The variation from this rule is so slight as not to interfere with the general conclusion. There is an intrinsic property of a project which determines its productive power, or its acre yields. This factor of productivity is, of course, derived from a number of smaller factors, such as climate, soil, fertilizers, the need of applying irrigation water and perhaps of equal importance, the human factor, for even a poor soil well cultivated will yield fairly well.

The following table shows the average yields per acre of alfalfa and wheat, from year to year, for each of the projects.

Average alfalfa yield per acre on Federal irrigation projects

[Unit of yield is tons. Bureau of Reclamation data]

Project	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Salt River.....		4	3	3	4	4.2	3.5	4	4	4	5
Yuma.....	3.73	3.69	3.12	2.57	2.58	3.30	3.21	2.66	2.23	2.64	2.13
Orland.....		4.27		4.4	5.4	4.8	4.3	5.8	2.5	4.2	4.1
Grand Valley.....					3.1	2.8	2.8	2.4	3	2.64	2.66
Uncompahgre.....		2.7	2.9	2.6	2.6	2.8	2.3	2.9	3.2	2.6	2.4
King Hill.....						5.16	2.81	2.6	2.5	4.13	4.2
Mindoka:											
Gravity.....		3.04	3.26	2.5	2.5	2.7	2.95	2.8	2.5	3.2	3.1
South side pumping.....		3.02	3.1	3	3.1	3.4	3.8	2.9	2.9	2.6	2.6
Boise.....	3.73	2.5	3.57	2.82	4.44	3.90	4.4	4.31	4.32	4.56	4.6
Huntley.....	2.6	3.45	2.9	2.82	2.66	2.34	2.55	2.65	2.27	2.28	1.73
Milk River.....	3.1	1.6	1.9	2.2	2.5	1.6	2.2	2.1	1.9	1.7	1.6
Sun River:											
Fort Shaw.....	1.68	2.25	2.08	2.1	1.83	1.7	1.94	2.06	2.08	1.8	1.6
Greenfields.....								0.26	1.26	1.9	2.1
Lower Yellowstone.....	2.07	2.3	2.5	2.3	2.35	2.2	2.1	2.2	2	1.8	3
North Platte:											
Interstate.....	2.18	2.3	2.2	2	1.8	1.7	1.8	2.1	2.1	1.7	1.7
Fort Laramie.....	2.60	3.23	3.28	2.93	3.16	3.57	3.60	3.64	3.5	3.27	3.21
Newlands.....	1.5	1.6	2.5	2.1	1.8	1.8	1.97	3.03	2.9	3.04	2.61
Carlsbad.....	3.25	2.1	3.58	3.16	2.5	2.47	2.8	2.7	3.03	3.04	3.17
Rio Grande.....	.07		2.56					1.38	1.15	2	2.05
Williston.....	3.4	3.96	3.7	3.8	3.8	3.7	3.6	3.6	3.7	3.7	3.8
Umatilla.....	2.2	2.2	2.4	2.3	2.2	3.1	2.76	2.65	2.87	2.95	2.72
Klamath.....	2.06	2.1	2.1	2.2	2.6	1.81	2.06	2.21	1.87	1.7	1.87
Belle Fourche.....								2.4	2.8	3.1	3.2
Strawberry Valley.....			3.4	2.8	2.4	1.5	1.75	1.22	2.2	2.2	1.9
Okanogan.....											
Yakima:											
Sunnyside.....	5.5	5	5	4	4.8	4.5	4.3	4.25	4.25	4.25	4
Tieton.....	2.46	3.4	3.5	3.5	3.25	3.1	2.3	3.4	3.2	3.1	3
Shoshone:											
Garland.....	1.66	2.31	2.35	2.19	2.36	2.24	2.2	2.69	2.19	1.81	1.74
Frankie.....							1.5	2.07	1.97	1.81	1.68

Average wheat yield per acre on Federal irrigation projects

[Unit of yield is bushels. Bureau of Reclamation data]

Project	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Salt River		28	30	18	25	23.3	34.2	80	28.3	23.3	31.7
Yuma		20.1	22.3	17.8	18.8	19		21	17.4	17.3	18.2
Oriand								14.7	17	14.7	27.3
Grand Valley				14.0	15.3	14	16.4	21	20.3	15.4	
Unoompahgns		21.7	27.1	24.5	26.1	23.8	26	25.5	23.7	23.3	
King Hill						25.8	4	18.2	15	16.3	18.7
Minidoka:											
Gravity		22.8	18.9	27.6	23.2	23.1	26.8	27.2	31.4	29.1	29.1
South side pumping		21.1	17.3	21.5	19.6	19.8	26.0	24.4	31.8	26.9	28.6
Boise	19.4	16.8	18.6	23.9	25.8	21.2	24	27.8	32	34	32
Huntley		18.2	23.5	19.8	11.9	19.3	21.9	15.8	16.4	19.9	17.1
Milk River		11.7	15	27	16.4	6.4	9	7.7	9.4	12	11.3
Sun River:											
Fort Shaw	17	19	21.9	22	18.9	18.7	14.5	13.4	14	15.5	13.8
Greenfields								8.85	11.5	15.7	18.1
Lower Yellowstone	18.4	17.6	19.6	18.2	13.8	14.1	15.8	13.7	18.4	11.4	18.5
North Platte:											
Interstate	17.2	18	16.4	18	10.8	15.2	14.6	17	16.2	14	17
Fort Laramie								10.4	17	12	11.1
Northport											12.7
Newlands	16.3	19	20.1	20.9	20.2	17.1	10.7	15.4	25.5	27.4	20.9
Carlsbad		30	15	23	26	9.4	9	19	25.7	10.8	
Rio Grande	30	13.2	30.2	30.2	36	22.3	33	20.1	20	14.5	17.1
Williston	23.8	12.4	18.2					6.8	15.3		15.2
Umatilla			38.7	28.9		16.7	11.5	13.3	12	11.6	23.6
Klamath	20.1	15.8	18.6	18.4	8.7	14.1	11.1	14.5	16.3	31.3	18.3
Belle Fourche	17.6	14.9	13.8	17.2	5.1	13.1	15.7	11.1	5.1	10.3	15.5
Strawberry Valley					19.3	23.9	22.7	21	27.9	27.4	29
Okanogan				20.0	12.0	12.7	2.7				
Yakima:											
Sunnyside				20.0	20	20	20	26	53	28	35.1
Tieton		32.4	21	25	27	20.9	21.2	24.6	27.5	27.1	23.1
Shoshone:											
Garland	14.5	14.1	15.3	18.9	18.3	19.6	23.2	20	20.9	22.2	21.6
Frannie							13.8	12.3	9.8	8.6	18.2

A remarkable steadiness of production is exhibited on each project from year to year in spite of varying climatic conditions. The averages as obtained undoubtedly have high value in indicating the relative acre productive power of the different projects.

Great improvements will be made in the methods of agriculture as at present practiced on the reclamation projects. The soil will improve as it is more wisely cultivated, it will be better prepared for crops, and a more rational use of irrigation water will prevail, all of which will combine to increase the acre yields of crops. Nevertheless, after such and other improvements are made there will still remain that individual difference between the projects to which attention has here been called. The productive capacity of these projects, or of divisions of them, is inherent in the nature of the soil and the climatic environment.

PRICES OF CROPS

The prices of the crops raised on the reclamation projects have followed the general trend of prices for agricultural products in the irrigated section. The following table shows the range of prices, using the yearly averages for the years under investigations:

	Highest	Lowest		Highest	Lowest
Alfalfa, per ton	\$16.97	\$8.23	Cotton, per pound	\$0.32	\$0.21
Wheat, per bushel	1.67	.75	Sugar beets, per ton	9.46	5.00
Potatoes, per bushel	1.36	.59	Apples, per 100 pounds	4.00	1.50
Corn, per bushel	1.55	.76			

The difference between the highest and the lowest price received on the different projects is very considerable, and must have had a definite influence in determining the acre income of the farm. If by any chance the highest price of a crop should occur on a project with a high acre yield, the result would be a good profit to the farmer; if, on the other hand, the lowest price should coincide with the low acre productivity the result might be disastrous to the farmer. In determining the profitableness of agriculture, the price that the farmer receives for his products is quite as important as the acre yield. The different Federal irrigation projects not only have specific differences of productivity but their locations, systems of agriculture, transportation facilities, markets, and other factors determine the prices at which the farmer must sell his crops. In planning a system of agriculture for a project, the location with respect to the price level must be carefully considered along with the other factors of productivity.

Undoubtedly, just as the acre yields of a project may be increased by wiser soil tillage and a better use of the irrigation water, so also the unit price may be held higher by a more careful study of the marketing opportunities surrounding the project and by a better adaptation of the crop system to the economic environment of the project. In short, a careful study needs to be made of this matter from year to year and placed at the disposal of the farmer for his guidance. The farmer himself is quite unable to do this work for himself. The work on his farm engages his attention and leaves him little time for these somewhat abstruse questions.

CASH RETURNS PER ACRE

To the water user the main concern after all is the cash return per acre, for to him that is the productive power of his land. The cash return per acre combines the acre yield with the complex question of marketing and all that it comprises.

In Exhibit 1, Table 11 are found the annual cash returns per acre for all of the Federal irrigation projects over a period of approximately 10 years, together with the average for the period available. In this matter also there is a great variation among the projects. For instance, note the following tabulation of the cash returns for the five highest and the five lowest projects:

Five highest projects:		Five lowest projects:	
1.....	\$148.05	1.....	\$14.89
2.....	86.45	2.....	15.58
3.....	63.82	3.....	19.35
4.....	61.14	4.....	20.34
5.....	50.67	5.....	20.79

A cursory examination of Table 11 and of the above tabulation will show the very wide difference among projects in the cash returns per acre. Certainly, success or failure, comfort or discomfort, may well be derived from one or the other of these groups. A farmer placed on one of the projects with the higher acre income naturally has an easier opportunity of achieving financial independence.

The major part of the applications for relief in the year 1922 came from the projects having the smaller acre income. An average of 9.4 per cent of the water users on projects having acre incomes of \$40 or more per annum applied for relief, whereas 30.4 per cent, or

over three times as many, applied from the projects having less than \$40 per acre incomes per annum. This is a very significant correlation, and points to the conclusion that the essential difficulty confronting the water user is, after all, his inability to win from the land which he cultivates a sufficient income to meet the obligations which deliberately or inadvertently he has assumed.

Projects of high average acre incomes have, as a rule, been the high ones in the individual years; and those having low average incomes have had low average incomes in the individual years.

✓ COST OF PRODUCTION

It would be interesting were it possible to secure reliable data relative to the cost of producing crops on the irrigation projects, so that the net income to the farmer might be estimated. Such investigations are fraught with innumerable difficulties. The governmental and State agencies charged with such work have not yet acquired sufficient data to arrive at definite conclusions with regard to the matter. It would take a longer period than is at the disposal of those engaged in the preparation of this report to arrive at satisfactory conclusions as to the cost of production on the different Federal irrigation projects.

The Federal Bureau of Reclamation, which has the opportunity to obtain such information with relative accuracy and low cost, should give itself to collecting such information, with the view of assisting the farmer. ✓

CROP AND LIVESTOCK CENSUS

The information gathered each year by the Bureau of Reclamation in its crop and livestock census is very important and should receive more careful attention by those collecting and compiling the same. The present data should be made more complete; for example, information is not available on the number and quantity of shipments of farm products that leave the projects, the number of purebred sires for each class of livestock, and the number of stock fed for market. In reporting hogs and sheep the number of brood sows and breeding ewes should be given separately. The acreage given as pasture should be divided into native grass and tame grass pastures. Poultry should be classified into chickens, turkeys, and other fowls. These are a few of the improvements that suggest themselves and there are undoubtedly others.

It is recommended that the present forms used in collecting these data be carefully studied and revised to make the information gathered in the annual crop and livestock census as complete as possible. The importance of making this information complete and accurate is at once apparent when it is considered that the ability of the settler to meet his obligations with the Government should be based upon this information.

CONCLUSIONS

First, a careful survey should be made of the adaptability of the lands and climatic conditions of the Federal irrigation projects to ✓

different classes of crops, so that, upon the basis of such information advice may be given as to the most profitable type or system of agriculture to be proposed to the farmer.

There should be a definite and concerted movement on the part of all connected officially with the reclamation movement to develop for each project an agricultural program in which livestock plays an important part. Dairying should receive special consideration. Considering present production of dairy products on reclamation projects, there will be no present danger of overproduction. Along with the encouragement of dairying should come a similar encouragement of the maintenance of hogs, fowls, and other farm animals that consume the by-products of dairying and that use the farm products which the dairy cow does not consume. Sheep could be kept on many farms to very great advantage and could be made to utilize much material that now goes to waste. While the winter feeding of sheep may be very desirable, perhaps the greatest benefit to the farmer would come from the maintenance of a small flock of sheep on the farm both summer and winter. Poultry is always a profitable adjunct of animal husbandry. Bees might well be kept where conditions are favorable, and the beef-cattle industry should be developed only where good range facilities adjoin a project. In such places a definite cooperative plan should be set up by which the various water users could be made to build their system of agriculture with respect to the farm unit and the available range. This, too, would have to be done in cooperation with the officials of the Bureau of Reclamation.

As a result of the new information relative to the projects and the encouragement of livestock, a limited number of profitable systems of agriculture adapted to the various projects, should be carefully worked out by the best experts available in the country. As the farmer develops the system adopted, he should be given such intimate help as he may need so that success will attend his efforts. While the farmer is of an independent turn of mind and is used to battling against wind and weather and does not care to have his plans interfered with too greatly, yet he is entitled to help and will be responsive to it, for, in the end, as a result of such helpful activity on the part of the Bureau of Reclamation, work on the projects will be systematized and made to fit into the varying conditions surrounding the projects. Every farmer will then feel the beneficent effects of such consistent labor.

Along with the setting up of proper systems of agriculture, more attention should be given to the discovery of the inherent acre yield capacities of the different projects. This would mean a more complete examination of the soils of each project, or a more careful study of the data already available. Upon the basis of such studies, there should be established certain agricultural practices with respect to the tillage of the soil, the maintenance of soil fertility, the time for the various agricultural operations, the method and time of irrigation, and the quantity of water to be used. These findings and conclusions would, of course, lie at the basis of the operations of the farmer under the system of agriculture adopted.

Likewise, an exhaustive and thorough study of the economic factors prevailing on the various projects should be made. Not only should the prevailing prices from year to year be considered, but the relation-

ship of marketing and transportation facilities, the availability of credit facilities, or any other factor that modern economic study has set up as of importance. This should be fostered by the formation of cooperative enterprises.

Finally, by securing full and frequent statistics, a careful study should be made of the cost of production of the standard or specialized crops involved in the system of agriculture for each project. At present, with practically no such information at the command of the student, the important factor of net cost can not be given its proper weight.

As a main conclusion, relative to the agricultural condition of Federal irrigation projects, the Bureau of Reclamation and those associated with it, should give themselves to a complete and detailed study of all the factors concerned in agricultural production and marketing. This would involve surveys of soils and agricultural systems, of marketing conditions, and of all other things of concern to the farmer. Such efforts would soon lead to an increased financial prosperity on the Federal irrigation projects. Whatever measures Congress may adopt to make successful the splendid experiment of the American Government in the reclamation of its arid and semiarid lands by irrigation, will be largely fruitless, unless it is possible for the farmer, with the application of reasonable energy and intelligence, to win from his farm a sufficient income to meet such obligations as he has incurred, or which, of necessity, will appear from year to year. This is perhaps the first duty of the Bureau of Reclamation.

SETTLEMENT AND THE SETTLERS

CONDITIONS OF SETTLEMENT

The settlers or water users on the lands of the Federal irrigation projects, from the point of view of acquiring the lands, fall into three distinct classes. First, the lands in private ownership under the project before the project was undertaken. The original settlers on these lands were, in some cases, dry farmers; in other cases, irrigators depending for irrigation water upon private irrigation structures which, usually, by contract, were absorbed by the Federal irrigation projects. Second, homesteaders who, after the project had been authorized, exercised their homestead rights under the project. After 1908, the lands were withdrawn so that public project lands could not be homesteaded until after public notice had been issued, when, by the drawing of lots or similar methods, the selections of lands were made. Third, the settlers who, after the project was under way and the lands were taken up, bought the rights or holdings of earlier settlers belonging to one or the other of the preceding two classes. There were no restrictions placed upon the settlers who decided to sell out their holdings before their payments had been completed; neither did the Government have the power to make any selection of those who applied for homestead privileges under the reclamation law.

DENSITY OF POPULATION

During the time of the development of the Federal reclamation projects, the population has been steadily increasing.

Table of total population, by years

Year	Irrigated acreage	Population	Persons per 40-acre tract
1918.....	1,119,566	104,144	2.7
1919.....	1,187,255	114,938	3.9
1920.....	1,228,480	122,416	4.0
1921.....	1,227,500	128,590	4.1
1922.....	1,202,130	131,194	4.4

During 1922, on the 1,202,130 acres of irrigated lands there were 131,194 persons living, in addition to the population of the cities and towns connected with the projects. This means a density of population equivalent to 4.4 persons per 40 acres of land actually irrigated. This is not a density indicating intensive culture of the project lands. On the contrary, such a population would indicate that although the land is under fair cultivation, there is a large room for improvement.

There is a great variation in the density of population on the various projects. The greatest is 9.8 persons per 40 acres on the Okanogan project, 8.4 persons on the Strawberry Valley project, and 7.1 persons on the Salt River project. Four other projects have more than five persons per 40-acre unit; the remaining 17 projects have a density of population of less than five persons per unit of 40 acres. The lowest density of population occurs on the Milk River project, where there are only 1.4 persons to each 40-acre tract of irrigated land; the Sun River is the next lowest with 1.9 persons; and five projects have between two and three persons per unit of 40 acres.

More people are needed to make the best use of the lands made available by the Federal irrigation projects.

NATIONALITY OF SETTLERS

There is a feeling that citizens not born in America constitute the major portion of settlers upon the reclamation projects. The contrary is true. An average of 80 per cent of all water users on the Federal irrigation projects are American born. About 9½ per cent were born in northwestern Europe; that is, of English or Scandinavian descent. Only 4.1 per cent of foreign-born settlers were born outside of Europe.

Data taken from special report prepared by Bureau of Census

Project	Born in America	Born in Europe				Other countries
		North-western	Central and eastern	Southern	Other parts	
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Salt River	90	3	4	0	0	3
Yuma.....	96	3	2		0	2
Orland ¹	77	13	7	3	0	0
Grand Valley.....	81	4	8	4	1	2
Uncompahgre ² King Hill ³						
Minidoka.....	86	8	3	1		2
Boise.....	90	5	2		1	2
Frontley.....	62	10	21	1	5	1+
Milk River.....	80	9	11			
Sun River ⁴	65	27	8			
Lower Yellowstone ⁵	57	30	13			
North Platte ⁶	74	8	14		1	3
Newlands ⁷	69	10	4	11	1	5
Carlsbad.....	94	3	1	2	0	
Rio Grande.....	94	3	1+		0	2
Williston.....	82	18				
Umatilla ⁸	86	7	5			2
Klamath.....	66	9	9	4	10	2
Belle Fourche ⁹	66	14	17			3
Strawberry Valley.....	91	6			0	3
Okanogan.....	86	7	3			4
Yakima: Sunnyside.....	81	10	5	1	0	3
Tieton.....	82	9	5	1	0	3
Riverton ¹⁰						
Shoshone ¹¹	64	3	4		1	28
Average.....	80	9.5	7	2.8	2.9	4.1

- ¹ Tehama, Siskiyou, and Modoc Counties, Calif., not covered.
- ² Montrose and Delta Counties, Colo., not covered.
- ³ Elmore, Owyhee, and Twin Falls Counties, Idaho, not covered.
- ⁴ Lewis and Clark and Choteau Counties, Mont., not covered.
- ⁵ Dawson County, Mont., not covered.
- ⁶ North Platte Canal and colonization and Sioux County, Nebr., not covered.
- ⁷ Lyon, Washoe, and Storey Counties, Nev., not covered.
- ⁸ Morrow and Malheur Counties, Oreg., not covered.
- ⁹ Mead County, S. Dak., not covered.
- ¹⁰ Fremont County, Nebr., not covered.
- ¹¹ Carbon County, Mont., and Big Horn County, Wyo., not covered.

The percentage of American-born settlers varies greatly on the different projects, indeed from 94 to 57 per cent; those born in north-western Europe vary from 30 per cent to 3 per cent. This difference is due in part to the propaganda for settlers carried on at various times by the Reclamation Service and others. Certain groups of people have moved in larger numbers to certain projects than have others, because of the natural tendency of our citizens to move in groups. It may be said that, as far as the evidence goes, the Federal irrigation projects are settled essentially by American-born or American-spirited citizens, law-abiding and eager to contribute all that they can to the upbuilding of a greater Republic. In fact, many water users find much satisfaction in the thought that by their pioneer labors they are helping reclaim for human good land that otherwise might remain in a desert condition.

EXPERIENCE OF SETTLERS

The charge is frequently made that many of the difficulties encountered in Federal reclamation work are due to the agricultural inexperience of the settlers. The data at hand do not confirm this view.

In an economic survey made by the Reclamation Service in 1922, it was shown that 79 per cent of 24,418 farmers had good farming experience and 74 per cent of this great body of farmers were successful farmers, subject to the varying conditions that influence agricultural success. The last census also collected data bearing on this subject, a summary of which follows:

Farm experience of water users

[In percentage of total water users. Based on U. S. Census data]

Project	1-5 years	Project	5-15 years
	<i>Per cent</i>		<i>Per cent</i>
Williston.....	46	Huntley.....	52
Yuma.....	37	Belle Fourche.....	44
Grand Valley.....	32	Umatilla.....	44
Carlsbad.....	30	Shoshone.....	43
North Platte.....	29	Newlands.....	43
Shoshone.....	29	Okanogan.....	43
Strawberry Valley.....	28	Sun River.....	42
Newlands.....	26	Minidoka.....	42
Salt River.....	25	Boise.....	42
Rio Grande.....	23	Lower Yellowstone.....	42
Orland.....	21	North Platte.....	41
Belle Fourche.....	21	Uncompahgre.....	41
Minidoka.....	19	Yakima-Tieton.....	40
Yakima-Sunnyside.....	19	Yakima-Sunnyside.....	39
Boise.....	18	Klamath.....	36
Yakima-Tieton.....	18	Salt River.....	34
Uncompahgre.....	16	Rio Grande.....	34
Klamath.....	16	Orland.....	34
Lower Yellowstone.....	16	Carlsbad.....	32
Huntley.....	15	Strawberry Valley.....	32
Okanogan.....	14	Grand Valley.....	30
Milk River.....	13	Yuma.....	30
Sun River.....	12	Milk River.....	26
Umatilla.....	12	Williston.....	9

The farmers on the projects, with from one to five years' experience, vary from 12 to 46 per cent and those who have had from 5 to 15 years' experience vary from 9 to 52 per cent. This tends to confirm the estimates made by the economic survey. A further summary is as follows:

	<i>Per cent</i>
1 to 5 years' experience.....	23
6 to 10 years' experience.....	20
11 to 15 years' experience.....	17
16 to 20 years' experience.....	14
Over 20 years' experience.....	23
Not reported.....	3
Total.....	100

In other words, this means that on all the projects, those who have had from 1 to 15 years' experience number 60 per cent, and that those with 15 to 20 years and over, 37 per cent, with 3 per cent not reported.

An examination of the farm experience table with respect to projects shows that the most successful projects are not always those which have the largest percentage of old, experienced farmers. In fact, the data would lead to the conclusion that projects with newer settlers, even though they have somewhat less farm experience, are prospering more. This may be due to the difference in age between the more and less experienced settlers, or it may be due to the settled habits into which the older residents in any sec-

tion tend to fall, and which make it difficult for a readjustment to fit the new conditions that arise when a Federal irrigation project is established. Meanwhile, it can be reasonably inferred that agricultural inexperience on the part of the settlers under the reclamation projects is not chargeable in any large degree with the difficulties that beset the service, though it may have contributed to the debt loads.

PREVIOUS OCCUPATION OF SETTLERS

It is very difficult, without making a special survey of the 30,000 or more water users, to determine the occupations from which the settlers were drawn. Dr. F. H. Newell has collected statistics, as of 1922, which lead him to the conclusion that out of 20,665 farmers reporting on the reclamation projects, there were 12,000 farmers, 2,000 farm laborers, 10 foresters, 420 gardeners and nurserymen, 700 stockmen and poultrymen, or 15,130 water users who were followers of some form of agriculture before entering upon the reclamation projects. That is, about 73 per cent of the population on the reclamation projects had had previous farm experience before entering on project life. This checks with the 73 per cent of successful farmers on the projects, according to the estimates of the project managers. The 27 per cent of the project population who did not have previous agricultural experience were drawn from practically all the professions known to man.

There is ample evidence to show that many men coming out of other professions than that of agriculture and settling on the projects have been exceedingly successful, in spite of the lack of previous experience. After all, given a reasonable familiarity with the business of farming, a liking for it, and the necessary capital, the test of success lies in the man himself, a test which might be applied to any other pursuit.

TURNOVER OF SETTLERS

No careful records from year to year have been kept of the settlers who have remained for a certain length of time on the homesteads which they took up under the projects. A survey was made in 1919 of six typical projects. All the original settlers were accounted for. It was found that 65.2 per cent of those who had settled on the project were still on the homesteads. In other words, about one-third had moved off, usually by selling out to incoming farmers. The disturbed conditions since 1919, however, have retarded land transfers.

TENANTRY

A more serious matter than the permanence of the original settlers is the presence of considerable tenantry. The tenant is not desirable on the Federal irrigation projects, for the reason that these projects were authorized with the home-building idea as the central consideration. It was hoped that those who entered upon the projects would do so with the purpose of making permanent homes for themselves and their families. Under a system of tenantry, the farm merely becomes a long-distance investment, the profits from which, if any,

are used to maintain the family in the city or at least at considerable distance from the farm. The exceptions to this rule are few.

There has always been a large percentage of tenants on the reclamation projects. It rose steadily from 21 per cent in 1912 to 32 per cent in 1917 and 1918, then fell to 24 per cent in 1920, rose to 26 per cent in 1921, and fell again to 24 per cent in 1922. The maximum number of tenants on the projects at any one time was 7,764 in 1917, or 32 per cent. In 1921 there were 7,220 tenants or 26 per cent of the total farming population. The projects differ widely in the percentage of tenantry. Certain crops and climates seem to be more adapted to tenantry than others. An easy climate and specialized crops lead to an increased tenantry. A severe climate and diversified farming seem to lead to a decrease in tenantry. Thus, in 1920, 74 per cent of all the farmers on the Carlsbad project were in the tenant class. This was the maximum at any time on any project. The minimum number of tenants was 0.4 per cent, which occurred in 1914 on the Okanogan project. The economic survey, conducted in 1922, showed 74 per cent of all the farms operated by the owners of the farms, and 69 per cent of the acreage under irrigation tilled by the owners. It may be that no better conditions with respect to tenantry could be expected under the conditions of American life. The tenantry on the projects, although large, can not be more than a contributing cause of the difficulties on the projects.

CONCLUSIONS

There can be no question about the need for more people to till satisfactorily the lands of the projects. However, as far as possible, only those should be encouraged to enter upon project settlement who are desirous of making homes on the land. The nationality, experience, or previous occupation of settlers can not be said to be important factors in the success or failure that has attended the development of Federal reclamation. The turnover of the settlers undoubtedly has played its part, since those who have left the original homesteads usually sold out at an advanced price to those who succeeded them, and the present third of the farmers, as of 1919, are, therefore, carrying a larger burden than the original settler, and if one-third of the project is under adverse conditions, it reacts upon the success of the whole project.

Likewise, tenantry, although not excessively large, is a factor of disturbance, because the figures as obtainable indicate that about one-fourth of the population is not permanent, has no continued interest in the building up of homes on the project lands, and that an equal number of owners are giving only indirect attention to the business of building up their farms. It is more than likely that these two factors, the removal of the original settlers and the maintaining of a fairly large proportion of tenantry, are measurably responsible for some of the difficulties which the reclamation projects have had to meet.

In the future steps should be taken to make life on the project lands more desirable, so that the settlers now there will continue to remain in a larger percentage than heretofore and to cultivate the lands themselves, instead of depending upon the tenant to produce some slight income from the project lands. Moreover, in the settlement

of future projects some process of selection should be applied by which the bona fide homesteader is given the preference in securing project lands.

RECOMMENDATIONS

Settlers selected according to ability.—Owing to the increased cost of water rights and greater expense of developing farms it is no longer possible for average settlers without capital to succeed in improving and paying for farms on these projects. Loans for development should be made a part of the reclamation policy.

This can not wisely be attempted unless consideration is given to the qualifications of settlers which would include industry, experience, character, and possession of a part of the capital needed in improving their farms. Only those who have reasonable prospects of succeeding should be approved.

SOLDIERS' PREFERENCE RIGHT

PROVISIONS OF THE LAW

In 1920 Congress passed a soldiers' preference law. This provides that ex-service men may make entry upon lands under reclamation projects to the exclusion of other citizens. This right, however, is to endure for only 90 days after public notice has been issued. After that time, all citizens may exercise their homestead rights.

METHOD OF SETTLEMENT

The lands were disposed of to ex-service men under the usual regulations for opening project lands. The ex-service men were allowed to state their preferences, accompanying their requests with a deposit; then the entryman for each farm unit was determined by lot. Many more ex-service men applied for land and water under the soldiers' preference law than the Reclamation Service could provide, and many disappointments resulted.

PLACES OF SETTLEMENT

Practically all of the public lands under the older divisions of the reclamation projects have long since been taken up. The lands available to ex-service men, were therefore, almost altogether those available under new openings. Such openings occurred on the North Platte, Shoshone, Newlands, and the Klamath projects, on all of which ex-service men exercised their rights. Some also found lands not entered on the Boise project, and on a few others. On the North Platte project, ex-service men settled chiefly on the Fort Laramie division; on the Shoshone project, Frannie division; and on the Klamath project, Tule Lake division.

RESULTS

The results of the exercise of the soldiers' preference right on reclamation projects bring home, as perhaps no other event, the fundamental necessity of knowing in detail the economic feasibility of the projects before settlers are invited. True, in the great majority of

cases the ex-service men came on the projects with little capital, which of itself would mean a period of such hardship and sacrifice as few men in this day are willing to give, even for the ownership of land and home. Undoubtedly many ex-service men exercised their right with the intention of using the lands for speculative purposes; but more undertook to reclaim the farm units, in perfectly good faith, as homesteaders. The ex-service men have succeeded as well as the average settler who undertakes the conquest of raw land; but on one project the experiment appears to have been a pathetic failure. The Frannie division, parts 3 and 4, of 7,753 acres, was opened on January 18, 1920, and July 19, 1921, and 95 ex-service men secured units thereon. When agricultural operations began it was found that the soil and climate were of such a character as to make it extremely difficult, time consuming, and expensive so to cultivate the soil as to make it sufficiently productive to supply the farmer's needs and to enable him to meet his financial obligations. Undoubtedly a proper study of the Frannie division before the lands were opened, by means of our modern knowledge of agriculture, would have enabled the Reclamation Service to foretell these difficulties. Such knowledge would have delayed, for some time at least, the experiment of settling this part of the Shoshone project. The openings on the Fort Laramie division of the North Platte project were more successful, where 80 farm units comprising 5,079 acres were opened to entry under public notice of January 15, 1920, and 224 covering 18,500 acres under public notice of July 14, 1921—all of which units were taken by ex-soldiers.

There is no question about the probability that even the difficult lands under the projects may ultimately be reclaimed; but in some cases it will require larger knowledge than now possessed, and in every case the difficult lands should be delayed in their development until the easier lands have been won for the use of man. Only by this means will financial prosperity and human happiness wait upon the Federal irrigation projects.

CONCLUSIONS

The ex-service men should be given exchange privileges under such liberal provisions as will carry out more fully the intent of the Government to assist and to benefit the men who volunteered their lives in the service of the Nation than has been the case on some lands of the Federal irrigation projects.

TECHNICAL AID TO SETTLERS

IRRIGATION A SPECIALIZED ART

The settler under the irrigation canal needs special knowledge of soils and crops with respect to their relationship to water, in addition to their general behavior for agricultural purposes. Without such specialized and general knowledge of agriculture the irrigation farmer is not likely to achieve high or lasting success. The reclamation problem, as presented by the Federal irrigation projects, is essentially one of irrigation agriculture. Important and indispensable as the engineering structures are, they only make the fundamental contribution to the success of a civilization under the ditch. The

real test of success depends upon the ability of the man under the ditch, through a long succession of years, to win from the soil and the water a comfortable and satisfactory living for himself and his family and to pay his obligations. It is of first and foremost importance to train him for his work, so that he will not fail because of the lack of knowledge with which to accomplish his task. This has been a potent cause of the difficulties that have beset the Federal reclamation experiment.

IRRIGATION AS A SCIENCE

The art of irrigation dates back to the beginning of written history. A great succession of civilizations, notable and extensive, have flourished on irrigated soils. Irrigation, therefore, is no modern discovery. All that we have learned to do in this later day is to place our modern civilization safely under the irrigation ditch. The irrigation practices of ancient peoples were necessarily primitive. Their engineering structures were often excellent, considering the time of their building; the laws and regulations regarding the distribution and use of water, were also very satisfactory as based upon long experience; though the record of these achievements, especially as to the use of water, has come down to us in an imperfect manner. The use of water on irrigated lands was not based, in ancient days, upon scientific principles, but rested merely upon regulations, some of which were wholly contrary to the best modern knowledge.

Those who made the first discoveries and applications, fundamental in modern agricultural practice, lived and labored under a humid sky, consequently no direct studies of irrigation were made by these early investigators. It is only within the last few decades that serious scientific study of irrigation has been made, and within the last few years has our best knowledge of the principles underlying the art of irrigation been developed and assembled.

Much experimentation is yet needed before we understand properly and fully the relationships existing among water, soils, and crops. The newness of this body of knowledge makes it highly important that those who undertake irrigation agriculture, under the changing economic conditions of to-day, be made as familiar as possible with the body of knowledge available to them in their work.

NEED OF EXPERIMENTAL STATIONS

The study of the Federal irrigation projects has emphasized the great variety of soils and climatic conditions under which irrigation is or may be practiced in the United States. The proper methods of applying water in irrigation, and the results likely to follow such application, vary from place to place, as soils and climatic conditions vary. In fact, any system of agriculture on an irrigated farm must be determined with respect to prevailing conditions. Such careful experimental studies of the different projects have not yet been made. There should be, on each project, a small experimental station, under Federal or State control, supported by means not taken from the reclamation fund, for the experimental study of soil and crop conditions, on the project, under irrigation practice. On the basis of such findings, which should be correlated with those

obtained elsewhere, different systems of agriculture for each project should be laid out and urged upon the water user. A good beginning has been made in this work. The Department of Agriculture maintains such stations on seven of the projects, and on five others experimental stations are maintained by other public agencies. The number, however, should be increased, because of the great variety of conditions surrounding the projects.

NEED OF DEMONSTRATION HELP

Even with ample experimental work, the farmer needs additional assistance, for experience has demonstrated abundantly that the farmer, as a rule, does not go to the experimental station to seek the information that he needs, nor does he always know how to apply the truths that the station gives him. Therefore, to make the information that the irrigation farmer needs, available and effective, it becomes necessary to place demonstration agents on the projects, who can act as direct advisers to the farmer. These demonstrators take information, won by experimental stations, and bring it to the farmer, with suggestions as to how it should be applied. Such demonstration work is an indispensable part of the technical aid needed by the farmer.

The Department of Agriculture has also made an excellent beginning in this work. At the present time the appropriations made for this purpose enable the department to maintain a demonstrator on eight of the reclamation projects, though two of these men are on part time only. There should be at least one demonstrator on each project.

It will be necessary, as has been done in the past, to have experts travel over the projects to give special information. Such men, trained in animal husbandry and in other subjects that do not vary greatly from project to project, have contributed much help to the project farmer, but a larger appropriation for this purpose is needed and would greatly stimulate project agriculture.

The States and the counties also maintain 20 county agricultural agents and 15 home demonstration agents, until practically all the projects are given some sort of technical assistance, but there is yet need for more such help.

HELP FROM PROJECT MANAGER

The project irrigation farmer, to make his work thoroughly satisfactory to himself and the Government, will require for some time to come much help on a great variety of subjects. Some one on the project having an intimate knowledge of the farmers' affairs should act as an intimate counselor on various matters that arise to vex the farmer in his work. The nearest approach to such assistance at the present is that given by the project manager, the ditch rider, and such members of the engineering force as may be stationed on the projects. The engineers have special duties assigned to them and can not take the time necessary to give such careful advice, even if they were in possession of the needed information. The ditch riders could be of greater assistance if they were specifically instructed and trained to give such matters their attention, but they also have

special duties to perform which must be done in a proper time and season. The project manager would seem to be the best person to act as chief adviser to the farmer. However, it is practically impossible under present conditions for the project manager to do this, for on the majority of the projects there are too many water users for one man's intimate supervision.

It is very doubtful if any one person can give the kind of personal help that is almost indispensable if the projects are to attain success if there are more than 400 water users to look after. With a larger number the counselor loses efficiency, and the farmers receive less assistance than they need. It might be well, therefore, to divide each project into divisions, each division to have not more than 400 water users, and to place a good man at the head of each of these divisions as an assistant and responsible to the project manager. In this man it might be possible to combine the assistant project manager and the agricultural expert. However accomplished, it would result in good.

CLOSER RELATIONSHIP WITH THE DEPARTMENT OF AGRICULTURE

Since the reclamation problem is always essentially an agricultural, economic, and settlement problem, steps should be taken to bring the projects into the closest of association with the State and Federal Departments of Agriculture. Some organic relationship should be effected between the Federal irrigation projects and the Department of Agriculture by which the department could be made to feel direct and special interest in the projects.

THE NEED OF DEFINITE AGRICULTURAL SYSTEMS

There is a crying need for the formulation of definite systems of agriculture for the different reclamation projects. Competent experts should be called in to devise such plans, considering in each instance the water, soils, markets, and other factors of agricultural success. These agricultural systems should be printed and made available to the farmer and followed up by the encouragement of the demonstrator and the project officers.

AGRICULTURAL LITERATURE

The printed page is quite as effective on the farm as in the city, provided it carries the right message. The results of experimental work in behalf of irrigation agriculture should be published in intelligible bulletins and placed within the reach of the water user. The demonstrator should state his findings in terse sentences that can be grasped in a few moments of reading, and these should be supplied plentifully to the projects. Definite steps should be taken to encourage the water users to purchase modern books on agriculture and to build up their agricultural libraries, and every water user encouraged to take one or more agricultural journals. The Reclamation Record, now the New Reclamation Era, should adopt a more definite policy of being a practical aid to the farmer and should be made the most attractive and valuable journal entering the homes of the water users.

CONCLUSIONS

Under the conditions at present prevailing on the Federal irrigation projects, scientific aid to the farmer is indispensable. Some excellent work in behalf of such aid has already been done, but much more needs to be done. The fact that the reclamation problem is to-day essentially an agricultural and economic problem, justifies those in charge of the work to give special attention to the development of a program for scientific aid that will result in giving each water user on the project intimate and expert help with respect to the problems that his farm unit presents. This task is not insurmountable. There are many agencies at work in behalf of the farmer in the Federal, State and county Governments. By an intelligent study of the problem, and the proper correlation of the forces already at work, with some added appropriations for the purpose from Congress and State legislatures, it will be possible, without great difficulty, to give the help which is needed by the water users.

RECOMMENDATIONS

Dissemination of agricultural knowledge.—The officials of the Bureau of Reclamation should take steps, in cooperation with the United States Department of Agriculture and Commerce, and the State agricultural colleges and experiment stations, to secure first, a wider dissemination of modern agricultural knowledge among the water users on the Federal irrigation projects; second, the formulating and conducting of scientific research into the problems of irrigation agriculture; and third, the type of agriculture best adapted to the various projects in consideration of climatic, soil, and economic environment.

Agricultural advisers provided.—The conditions which confront settlers on reclamation projects require them to use better tools and to adopt a better agricultural program, in order to meet payments on land, improvements and water rights. This requires the employment on the projects of trained agricultural and economic advisers who will give sound agricultural and business advice, to enable settlers to increase their farm incomes and to organize for cooperation in business and social affairs. Such advisers will also be needed in carrying out the credit system recommended.

A brief experience has been had on some of the projects in the employment of such advisers. It showed their value, but the plan was abandoned because such employment was held to be unauthorized by the reclamation act.

The law should be so amended as to give unquestioned authority for the employment of such advisers.

The New Reclamation Era and the agricultural press.—The New Reclamation Era, formerly known as the Reclamation Record, should be made essentially a periodical for the education and encouragement of the water users and that the agricultural press in the irrigated section should be requested to give special attention to the problems of irrigation farming confronting water users on private and public irrigation projects.

WATER USERS' ORGANIZATIONS

LEGAL REQUIREMENT

In the original reclamation act of 1902 provision is made for turning over the management of the projects to the water users, in the following language:

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 or organization and under such rules and regulations as may be acceptable to the Secretary of the Interior.

This was later amended, in 1914, to read as follows:

Provided, That whenever any legally organized water users' association or irrigation district shall so request, the Secretary of the Interior is hereby authorized, in his discretion, to transfer to such water users' association or irrigation district the care, operation, and maintenance of all or any part of the project works, subject to such rules and regulations as he may prescribe.

This provision presupposes some sort of organization among the water users, with which the Government may deal. In practice, this has resulted in the formation of water users' associations. These associations have been in existence from the beginning of the reclamation venture, though, unfortunately, as hereinafter discussed, have seldom functioned as they might have done for the benefit of the reclamation projects.

PRESENT STATUS

The number of existing water users' associations and irrigation districts representing the several projects, with their form of organization and the essential clause in the contract with the Government as taken from the Fifteenth Annual Report of the Reclamation Service, page 600, is herewith presented.

ARIZONA, SALT RIVER PROJECT

Salt River Valley Water Users' Association, incorporated February 9, 1903. Contract with Secretary of the Interior June 25, 1904, guaranteeing repayment cost of system.

ARIZONA-CALIFORNIA, YUMA PROJECT

Yuma County Water Users' Association (Inc.). Contract with Secretary of the Interior May 31, 1906, guaranteeing repayment cost of system.

CALIFORNIA, ORLAND PROJECT

Orland Unit Water Users' Association, incorporated March 27, 1907. Contract with Secretary of the Interior April 3, 1909, guaranteeing repayment cost of system.

COLORADO, GRAND VALLEY PROJECT

Grand Valley Water Users' Association, incorporated February 7, 1905. Contract with Secretary of the Interior February 13, 1913, guaranteeing repayment cost of system.

COLORADO, UNCOMPAGRE VALLEY PROJECT

Uncompahgre Valley Water Users' Association, incorporated May 11, 1903. Contract with Secretary of the Interior December 3, 1904, guaranteeing repayment cost of system.

IDAHO, BOISE PROJECT

Payette-Boise Water Users' Association, incorporated September 9, 1904. Contract with Secretary of the Interior February 13, 1906, guaranteeing repayment cost of system.

IDAHO, MINIDOKA PROJECT

South Side Minidoka Water Users' Association (Ltd.), incorporated January 20, 1908. No contract.

Minidoka irrigation district, formed July 22, 1913. Contract with Secretary of the Interior October 21, 1915, to act as fiscal agent.

KANSAS, GARDEN CITY PROJECT

Finney County Water Users' Association, incorporated October 18, 1905. Contract with Secretary of the Interior December 28, 1905, guaranteeing repayment cost of system.

MONTANA, HUNTLEY PROJECT

Huntley Project Water Users' Association, not incorporated. No contract.

MONTANA, MILK RIVER PROJECT

Lower Milk River Water Users' Association, incorporated April 27, 1905. Contract with Secretary of the Interior February 10, 1909, guaranteeing repayment cost of system.

Upper Milk River Water Users' Association, incorporated June, 1907. No contract guaranteeing repayment.

MONTANA, SUN RIVER PROJECT

Fort Shaw Water Users' Association. Not incorporated. No contract.

MONTANA-NORTH DAKOTA, LOWER YELLOWSTONE PROJECT

Lower Yellowstone Water Users' Association, incorporated January 12, 1905. Contract with Secretary of the Interior October 25, 1905, guaranteeing repayment cost of system.

NEBRASKA-WYOMING, NORTH PLATTE PROJECT

North Platte Valley Water Users' Association, incorporated May 25, 1905. Contracts with Secretary of the Interior April 25, 1906, and June 23, 1909, guaranteeing repayment cost of system.

NEVADA, TRUCKEE-CARSON PROJECT

Truckee Carson Farmers' Association. Not incorporated. No contract.

NEW MEXICO, CARLSBAD PROJECT

Peyote Water Users' Association, incorporated October 15, 1904; articles of incorporation amended January 14, 1915. Contracts with Secretary of the Interior March 19, 1906, February 21, 1912, and March 12, 1915, guaranteeing repayment cost of system. Contract with Secretary of the Interior August 30, 1915, to act as fiscal agent.

NEW MEXICO, HONDO PROJECT

Rio Hondo Reservoir Water Users' Association, incorporated June 18, 1904. Contract with Secretary of the Interior December 31, 1904, guaranteeing repayment cost of system.

NEW MEXICO-TEXAS, RIO GRANDE PROJECT

Elephant Butte Water Users' Association, incorporated January 12, 1905. Contract with Secretary of the Interior June 27, 1906, guaranteeing repayment cost of system.

El Paso Valley Water Users' Association, incorporated June 17, 1905. Contract with Secretary of the Interior June 27, 1906, guaranteeing repayment cost of system.

NORTH DAKOTA, NORTH DAKOTA PUMPING PROJECT

Williston Water Users' Association, incorporated May 22, 1905. Contract with Secretary of the Interior May 23, 1906, guaranteeing repayment cost of system.

Buford-Trenton Water Users' Association, incorporated in 1905. Contract with Secretary of the Interior May 23, 1906, guaranteeing repayment cost of system.

OKLAHOMA, LAWTON PROJECT

Lawton Water Users' Association, incorporated September 23, 1914. No contract.

OREGON, UMATILLA PROJECT

Umatilla River Water Users' Association, incorporated in 1906. Contract with Secretary of the Interior April 25, 1906, guaranteeing repayment cost of system.

OREGON-CALIFORNIA, KLAMATH PROJECT

Klamath Water Users' Association, incorporated. Contract with Secretary of the Interior November 6, 1905, guaranteeing repayment cost of system.

SOUTH DAKOTA, BELLE FOURCHE PROJECT

Belle Fourche Valley Water Users' Association, incorporated June 27, 1904. Contracts with Secretary of the Interior April 29, 1905, and January 24, 1911, guaranteeing repayment cost of system.

UTAH, STRAWBERRY VALLEY PROJECT

No water users' association or irrigation district.

WASHINGTON, OKANOGAN PROJECT

Okanogan Water Users' Association, incorporated October 28, 1905. Contracts with Secretary of the Interior April 16, 1906, and May 11, 1912, guaranteeing repayment cost of system.

WASHINGTON, YAKIMA PROJECT

Tieton Water Users' Association, incorporated March 10, 1906. Contract with Secretary of the Interior April 12, 1906, guaranteeing repayment cost of system. Contract October 29, 1915, to act as fiscal agent and take over operation and maintenance.

Sunnyside Water Users' Association, incorporated March 10, 1906. Contract with Secretary of the Interior May 7, 1906, guaranteeing repayment cost of system.

WYOMING, SHOSSHONE PROJECT

Shoshone Water Users' Association, not incorporated. No contract.

The above table and the files of the Reclamation Service show that on all but one project water users' organizations are incorporated under the laws of the several States in which Federal irrigation projects are located. Stock is issued to the stockholders, usually on the basis of the acreage to be brought under water. The organizations are maintained as legal entities with which the Government

may do business. The powers of such water users' organizations have not been fully defined because of the failure of these associations to function in behalf of the projects. However, it is generally believed that these organizations as they stand may legally make contracts with the Bureau of Reclamation, take over the management of the projects, as indicated in the fundamental reclamation laws, make collections from individual stockholders, make payments to the Government, impose penalties upon such members as are delinquent, and in every way carry on the work intended under the reclamation law.

One such water users' organization, namely, that of the Orland project, without having assumed management of the project, is taking the full responsibility of making collections and, in behalf of the farmers, dealing with the Reclamation Service. Another such organization, that of the Salt River project, has entered into a contract with the Government, by which it is in full control of the project, operating and maintaining it and dealing, in behalf of the farmers, with the Reclamation Service.

WATER USERS SHOULD BE RESPONSIBLE

A fundamental principle of success in the handling of reclamation projects is to place the management of the project in the hands of the water users, just as soon as the project is in a suitable condition for such transfer. All the disadvantages of paternalism are either removed or modified when the water users control the irrigation project, and the dangers of bureaucracy are likewise greatly lessened. The placing of the responsibility for the upkeep and the general maintenance of the project encourages individual and united effort, which is invariably beneficial. Not a few of the ills which have beset the Federal irrigation projects may be traced to the feeling that they are essentially governmental ventures for which the farmer has little or no responsibility, and that in any event the Government will protect the farmer from serious consequences, even of his own neglect. The management of all projects should be turned over to water users' associations just as soon as two-thirds of the units under the project, or division of a project, have been covered by water contracts with the Federal Government.

SHALL WATER USERS' ASSOCIATIONS CONTROL THE WHOLE PROJECT

In general, it is inadvisable to retain any part of an irrigation project for immediate Federal control, as against water users' control. The system below the major works and the water flowing into it should be completely and wholly under the management of the water users' organization, acting under the contract with the Federal Government; and, if the contract so provides, the major works may be cared for by the water users.

In connection with some of the Federal projects, electric power plants have been constructed; and grazing and farm lands and town-site lands were bought by the Government, charged to the construction account of the project, and are to be paid for by the water users. The income from such power plants, grazing and farm lands, and town-site lands should be credited to the water users' organization, and

should by them be disposed of as they see fit in helping to satisfy the annual charges against the project.

WATER USERS' ASSOCIATION VERSUS IRRIGATION DISTRICT

An irrigation district differs essentially from a water users' association in that all the lands belonging to the district are jointly liable for the project debts and that the district may make its collections in the same manner as taxes are collected. It is generally held that in a water users' association, properly organized under the laws of the respective States, resides the power to do any or all acts that would lead to the carrying out of the terms of the contract of the association with the Federal Government. The farmer usually hesitates to agree to the forming of an irrigation district, because of his fear that since the district assumes the district obligations, he, personally, may become liable for payments overdue from his neighbors. In certain other cases old water rights furnish a complicated problem for district solution, and the water users' association in such cases seems the simpler form of organization. There is not much real difference between the two organizations as they would work out the problems of the Federal irrigation projects.

CONCLUSIONS

It is difficult, after these many years, to understand why the water users' organizations of the respective Federal irrigation projects were not made to function from the very beginning, and to take upon themselves their share of responsibility for the work of reclamation. One of the requests of the water users in the hearings before Secretary Lane was that the management of the projects be turned over to the water users of the respective projects upon their request. Only one such request has been made. Unquestionably, on most of the projects there would have been a very different feeling toward the whole Federal reclamation program had the water users themselves been responsible from year to year for the management of the projects.

The projects should not continue, as at present, under the direct management of the Bureau of Reclamation when properly formed water users' associations exist which are languishing because real responsibility has not been assumed by them. The water users' associations should be awakened, and should be required, where conditions are proper, under satisfactory contracts, to take over the management of the projects, and to carry the full responsibility for operation and maintenance.

RECOMMENDATIONS

Title to major works.—Title to the major project structures, such as storage or diversion dams, or main canals that deliver water to the project distribution systems, should be retained by the United States of America; but all benefits and profits that may be derived from the sale, rental, or use of water so stored or diverted should be credited to the project or that part of a project to which the construction cost of furnishing water has been charged.

Projects taken over by water users.—Whenever two-thirds of the irrigable area of any project shall be covered by water-right contracts between the water users and the Government, said project should be required, as a condition precedent to receiving the benefits of the relief measures herein recommended, to take over, through a legally authorized water users' association, or irrigation district, the care, operation, and maintenance of all or any part of the project works, subject to such rules and regulations as the Secretary of the Interior may prescribe, and thereafter the Government, in its relations to said project, should deal with said water users' association or irrigation district, and, when the water users assume control of a project, the operation and maintenance charges for the year then current, should be covered into the construction account to be repaid as part of the construction repayments.

Profits of project power plants, grazing lands, farm lands, and town sites.—When the water users take over the management of a project, under contract with the United States, the total accumulated profits derived from the operation of project power plants, leasing of project grazing and farm lands, and the sale or use of town sites, should be credited to the construction cost of the project; and that, thereafter, the income from project power plants and power possibilities, grazing and farm lands and town sites, may be used as the water users direct for the benefit of the project. No dividend should be paid out of any such profits before all obligations to the Government shall have been fully paid.

Board to hear water users' complaints.—Many of the difficulties attending the operations of the Reclamation Service have resulted from the failure to make regular collections or to furnish relief according to a uniform policy. Pressure from outside sources in behalf of a project or of water users has often nullified the steady operations of approved regulations. We recommend therefore that a suitable board of reference should be maintained by the Secretary of the Interior to which all complaints and requests for relief may be referred for recommendation of action by the Secretary of the Interior.

SOCIAL CONDITION OF SETTLERS

IMPORTANCE

The physical condition of the Federal irrigation projects is of fundamental importance but does not of itself lead to success. The people living on the projects must find contentment under existing conditions, through varying seasons, some with large and some with small crop returns. Contentment is perhaps the first requisite of project success. Naturally, such contentment depends largely on the physical conditions that lead to material prosperity; but it is also dependent upon other factors of a more subtle character. After a reasonable satisfaction of the physical requirements of man has been won, contentment depends primarily upon the prevailing social conditions.

The water users are social beings, and the fact that they have undertaken to reclaim vast deserts does not change their natures to such an extent as to make them able to continue happily in their work unless proper social conditions prevail. Especially is this so

with the women on the projects, who are kept more constantly within the walls of the home. Unless the women are provided with proper social relaxation they are likely to develop discontent, which will be felt through all the concerns of the water users. The children must also be provided with proper means for arriving at a social maturity in terms of modern understanding. This presupposes schools and other educational facilities, without which it is difficult to provide properly for the development of youth. All these conditions leading to social contentment must be somehow provided if the farmer is to do his work well and to make reclamation successful.

RAILROADS

One of the first considerations in the social as well as in the economic well-being of an irrigation project is the existence of railroads by which the people as well as the crops of the projects may be carried easily from place to place. Railroads as a means of communication between man and man are a prime factor in social well-being. It will be seen that nearly every project is entered by a railroad, in some cases by several, and that some of the projects in addition have interurban facilities.

ROADS

Quite as important as the railway are the roads on the project. Every project is traversed by one or the other of the leading highways of western America. No statistics are available as to the miles and kinds of roads that connect with these highways within the various projects and along which the water user travels with his automobile and wagon, but so far as can be learned there is an excellent supply of roads on most all the projects which is being constantly extended and improved. So far as facilities for human communication by means of roads are concerned, the projects are well supplied, thereby meeting one very important element in the development of human contentment.

SCHOOLS

The number and character of the schools on the project determine the educational advantages offered to the children, which in turn react upon the contentment of the family. The ultimate chief concern of the family is the rational education of the children and their preparation for life. Where schools are available and easily accessible there is certain to be a higher degree of contentment than where more primitive conditions prevail. Undoubtedly most of these schoolhouses have more than one room, but unfortunately statistics now available do not show the number of rooms in the buildings used on the projects for educational purposes. However, there is a total of 557 school buildings, which supply a population of 131,194. This is equivalent to about one schoolhouse for every 235 persons on the projects, and since most of the houses used have two or more rooms, it would appear that the school needs of the projects are fairly well supplied. Not all the projects are equally favorably placed with respect to school facilities, but in no instance does there seem to be a serious lack of educational opportunity for the young people of the

projects. The American citizen will probably provide school facilities for his children at any sacrifice to himself. As to the character of the work done in these schools, no direct information is available, but since the projects come under the general supervision of the State departments of education, it is only fair to assume that the work is being well done and in accordance with the standards set up by the respective States. No statistics are available as to the total school population on the projects, so that there is no means of comparing the percentage of the project population attending school with the percentage attendance of the country as a whole. However, the evidence at hand indicates that the people living on the projects patronize their schools quite as well as do their neighbors throughout the country, and that this high degree of excellence has been achieved in a few years, as against the several generations of educational development in the older sections of the country.

CHURCHES

On every project there are several churches, and although the proportion of churches to the population is greatly variable on the various projects, there seem in all cases to be abundant church facilities. For the project population of 131,194 there are 593 churches, making one church building for every 221 persons.

As a factor in promoting social contentment, the church is of high importance, not only because it satisfies the spiritual requirements of human nature, but because it affords a meeting place for groups of men and women with very much the same philosophy of life as concerns the higher ideals of man, and from which radiate all manner of group activities which help to satisfy the social needs of the community.

CLUBS

Clubs, chiefly of a commercial nature, and other commercial organizations exist on the projects. A large number of live organizations seem to be watching over the industrial welfare of the projects. There are also many organizations devised primarily for social purposes concerning which no statistical information is available.

WOMEN'S ORGANIZATIONS

Woman's part in conquering the desert is usually underestimated. The experience of agricultural settlements is that if the women fail to cooperate with the men, the desired results in settlement may not be achieved. For that reason educational propaganda in behalf of training of women for rural life has been well received by all thinkers on the subject. The rural-minded man must have a rural-minded wife if the two are to succeed in the building of a household on the land. If a man lives the life of a farmer and a woman longs for the life of the city, sooner or later economic disaster will overwhelm the two and they will not add permanently to the conquest of the desert. With this thought in mind it is interesting to find, though no full statistics are available, that women's clubs and organizations are plentiful on most of the projects. The project women not only consider matters of art, literature, history, science, and other subjects

that help keep them in touch with the progress of the world, but they also give themselves frequently to a systematic consideration of the special problems that confront them as builders of a commonwealth. A very wholesome and patriotic spirit pervades the activities of women on the projects. This contributes in no small degree to social contentment.

THEATERS AND AMUSEMENT HALLS

Available statistics show the number of theaters and amusement halls on the projects to be 230, or about 9 to the project. The moving-picture house is present at practically all of the villages of all the projects, and is within reach of most of the population. The schoolhouses and in some cases the churches are also used for social gatherings, so that there is a sufficient supply of gathering places to satisfy the needs of the projects.

MISCELLANEOUS

Statistics relative to the project homes and their furnishings have not been gathered. Nevertheless, the testimony presented indicates that most of the water users are possessed of the ordinary comforts of life, and that many of them enjoy some of the luxuries. Naturally, the farmer prospers best who has most of these home conveniences and comforts, which contribute so much to his own and his family's contentment and to permanent life on the reclamation projects. The project homes are in the main attractive, well kept, and there is a general tendency to improve the conditions as rapidly as the measure of prosperity permits. The projects report 24,056 automobiles on 33,768 irrigated farms for the year 1922 or 0.71 per farm.

CONCLUSIONS

The difficulties which have arisen on the projects are not traceable to the prevailing social conditions. On the contrary, the fact that the water users have given vigorous attention to the social needs of themselves and their families, without going to undue excesses, has contributed much to the well-being of the projects and the people living on them. More direct care should be given hereafter to the study of the social conditions on the projects and to the devising of means by which they may be improved. More complete census and photographic statistics should be kept, so that a background of experience may be built on which to base recommendations for the years to come.

HOMESTEADER VERSUS SPECULATOR

THE PURPOSE OF THE RECLAMATION ACT

A main purpose of the reclamation act was to provide opportunities for homestead making for rural-minded people. Making a homestead, a place able to support a family and desirable for family life, must remain the central thought of every activity connected with Federal reclamation.

It was hoped that the homesteader under the Federal irrigation works would settle upon the land with a strong determination to subdue the soil, to build a home, and to add another rural farmstead to the thousands which form the stable foundation of our Republic.

CLASSES OF LAND TRANSFERS

It is regrettable that no provision was made for selecting project settlers who really intended to make a homestead. It was not to be expected that every person who settled on the projects could remain to carry out the homestead idea. The exigencies of life are too many and human nature too variable, but the larger the proportion of settlers with real home-making intentions, the larger, naturally, would be the number of original settlers on the projects after a few years.

Numerous land transfers, or assignments of water-right contracts, have occurred since the project lands were settled. Unfortunately, no complete record of these transfers has been made, and the time within which this report must be completed makes it impossible to obtain such a record. There are several classes of land transfers, or transfers of water-right contracts, on the Federal irrigation projects.

First, those due to such conditions as may enter into every life, ill health, death, etc.

Second, those that result from the restlessness of the settler. There is a large class of people, even in our latter day civilization, who are born pioneers and who seldom remain long in any one place. They plow the virgin soil, clear the land, grow a few crops, make the land a little more easily handled by the succeeding farmer, and then start out in search of a similar opening somewhere else. These restless pioneers, born to the life, have been of great service in the building of the West and in the conquest of the desert. They are not rovers; they are discoverers, limited in this day to the conquest, successively, of a few acres of land, separated by a few hundred miles at the most. This type of settler, however, has been the cause of a number of land transfers.

Third, those who, without intending to move, find an unusually good opportunity to sell out at a good profit, and yield to the temptation. Such farmers usually go to the city after the new deal has been consummated, but only for a short time, for they generally return to farm life and use what is left of their money for the building of another farm homestead.

Fourth, those who, although farmers in good faith, for some reason or another have become weary of farm conditions and without transferring title to the lands move into the city and depend upon tenants to make some money for them out of the farm.

Fifth, those who made use of the opportunity offered by the Government to secure land and water on most easy terms, and with the intention to hold them until the unearned increment would enable them to sell out at a large profit. Such men are seldom farmers. They are always seeking for an opportunity to sell the lands at a good profit to themselves. These are the speculators.

Those who buy from any of the above classes are mostly bona fide farmers, who intend to try to make a living from the farm. The percentage of those who buy with a view of selling again at a profit is relatively small and can almost be ignored in this discussion.

As for the absentee water users, the tenantry table discussed in a previous section (see Exhibit 1, Table 13) would be a fair indication of the numbers in that class.

THE RESULT OF LAND TRANSFERS

It seems quite certain that if the projects had been supplied more completely with individual expert advice to farmers a great many of the transfers that have occurred might have been avoided. It is not reasonably possible for one project manager to care for more than 400 to 500 individual farmers, and in many instances the number has been two or three times that number. Besides, the very unnatural economic conditions of some few years ago, when prices were inflated, led to more transfers than will probably ever again be experienced in the history of the present generation.

The transfers of land and water-right contracts remain one of the serious problems confronting the reclamation endeavors of the country. The transfers or assignments were generally made at advanced prices—that is, the farmer sold his equity in the farm unit and the water contract at a price over and above the money he had actually paid out. The purchaser was under the obligation of paying to the Government the usual annual installments, and in addition the premium paid to the former owner. After several such transfers have occurred, each one at a price above the cost to the previous owner, the ultimate purchaser often carries an obligation to the respective purchasers which overshadows in magnitude the obligations to the Government. When the pressure of this heavy obligation weighs upon him, he is likely to blame his condition to the Government reclamation plan, when, as a matter of fact, the project construction and the operation and maintenance charges are small compared with the other obligations that he has to meet. Such a pyramiding of costs is most unfortunate, for it is nearly always disastrous to the credit and to the peace of mind of the farmer.

THE WEAKNESS OF THE ORIGINAL ACT

Attention has been called to the fact that the original reclamation act provided no selective control over prospective settlers. There was great eagerness to settle on the reclaimed land under the Government projects. Yet the Reclamation Service officials were anxious as to the success of the experiment, and used every effort to place people on the land without giving due consideration to the results that unavoidably would follow settlement by an unselected group.

The law provided no authority to control the assignments of filings on lands and of contracts for water rights. Such control might have been established by bureau regulation; and if done, would have enabled the officials of the Reclamation Service to avoid many difficulties that later beset the work. At least, demand should always have been made for the payment of existing dues before the record could show the transfer.

PRIVATE LAND HOLDINGS

A closely related type of speculation has influenced the financial condition of many farmers. Large holdings of private land which became part of the project lands, but without water, had very little value before the project was authorized. When water became available their value immediately rose. The public lands were soon exhausted and the later settler attempted to secure his homestead by purchase from the large land holder. These private lands were often held at a very high figure, and the settler, full of hope, frequently agreed to pay a high price for the land, in addition to the construction cost included in his water-right contract. This added greatly to the farmer's burdens. It should be remembered, however, that, although two-thirds of the lands now under water contract with the Government were in private ownership at the time water was ready for delivery, not all of these private lands were in large holdings and susceptible of this type of land speculation. Such private land, when held for speculative purposes, only added to the difficulties of the farmer who was engaged in winning a homestead from the desert. The following table shows the public and private lands on the different projects at the time the projects were authorized and now under water contract.

Areas under water-right contract, June, 1923 (not including Warren Act)

Project	Public	Private	Total
1. Salt River ¹	16,000	197,000	213,000
2. Yuma ²	12,362	44,276	56,558
3. Orland		19,308	19,308
4. Uncompahgre	13,643	61,324	74,967
5. Boise	59,460	37,135	96,595
6. King Hill ³	516	10,472	10,988
7. Minidoka	96,262	23,692	119,954
8. Huntley	28,746	4,725	33,472
9. Sun River	11,971	947	12,918
10. Lower Yellowstone ⁴	16,048	43,462	59,510
11. North Platte	83,558	25,245	108,803
12. Newlands	32,525	16,253	48,778
13. Carlsbad	45	24,945	25,000
14. Rio Grande ¹		85,000	85,000
15. Williston ²		7,658	7,658
16. Umatilla ³	6,413	18,940	24,253
17. Klamath	5,979	39,354	45,293
18. Belle Fourche	27,195	39,462	66,657
19. Strawberry Valley	1,953	30,048	32,001
20. Okanogan ⁴	116	8,559	8,675
21. Yakima	8,471	60,044	68,515
22. Shoshone	64,056	1,950	66,006
Total	489,250	804,656	1,293,906

¹ Repayment contract is with Salt River Valley Water Users' Association.

² Private land includes 7,488 acres Indian land.

³ Repayment contracts are with irrigation districts.

⁴ Acreage includes about 1,200 acres sand land to be eliminated.

Statement does not include lands to which water is being furnished under the Warren Act, nor certain other areas covered by contracts for partial water rights.

COOPERATION

Any discussions relative to the financial ability of the farmer must consider the complexity of farming as a business. Variations in climatic conditions, interference by insect and other pests, widely

varying economic environments, and many similar factors not only make agriculture a difficult and somewhat precarious occupation, but also one that tends to absorb all the energies of the farmer. Moreover, it requires, if success is to be attained, an individual with a great diversity of gifts. This, of course, is one reason, if not the main one, why through governmental and other channels aid must be extended to the farmer of a kind not required by workers in other fields. The actual production of crops from the soil and the feeding of these crops to livestock require such constant daily attention that the average farmer is especially handicapped when the business of disposing of the crop becomes necessary.

In this field of the farmer's activity, perhaps no better assistance can be given than that possible through cooperative organizations. If the farmer keeps in touch with expert information relative to the production of his farm—and every farmer must be the master of his own homestead—it is usually desirable and advisable to secure some one acting for a group of farmers who may give expert advice with respect to the marketing of the crops. Cooperative enterprises maintained for the purpose of giving the farmer aid, and not to force unseasonable issues, may be prime means of securing financial success for farming communities. Such cooperative associations need not concern themselves alone with marketing. The buying of the things that the farmer needs, at the best prices for known quality, may be almost as important. The farmer can not be an expert in buying, manufacturing, and selling, and also a pioneer in the most complex of the activities of man. He must depend on others in fields where his individual knowledge is insufficient. If the farmer is informed in detail concerning agricultural operations on the farm, he can well afford to content himself with a general knowledge of buying and selling, and operate through organizations maintained by agricultural communities for these purposes.

Irrigation lends itself in a remarkable degree to the spirit of cooperation. A whole community is dependent for its economic success upon the canal which carries water to the fields of the community. If there is a break in the canal, it is the concern of every member of that community. If one farmer misuses the water, he injures the whole community. By the common interest in the supply of irrigation water, communities are made to act as units. This feeling, which is developed and fixed as successive generations live under the ditch, is carried over into the social and spiritual life of the people, and makes possible, better than under any other conditions, the successful fostering of cooperative enterprises that are intended to give the reasonable help that the community needs.

On the Federal irrigation projects cooperative enterprises should be undertaken and fostered by those in charge of the project, so that the farmer may give more attention to the production of crops, which is peculiarly his work; and that he, nevertheless, may be so protected in buying materials for himself and his family and in selling his crops that he may enjoy as the results of his efforts the highest degree of prosperity.

CONCLUSIONS

If the work of Federal reclamation is to proceed successfully, some power of selecting settlers must be authorized. Intention to build

homes upon the land may be made a test. Unpaid water-right contracts should not pass to nonresident landowners except under special permit. There should be some good reason why a project settler, while receiving the benefits of Government help, should leave his homestead in the hands of a tenant. If conditions demand, he should be permitted to be a nonresident owner, but only under such regulations as may be set up by the bureau. It would seem also the simple part of wisdom to require authorization before any transfer or assignment of unpaid water rights is made. Such authority given to those in charge would materially reduce the difficulties that will surround such future projects as may be authorized.

RECOMMENDATIONS

Disposition of private lands in excess of farm unit.—That no reclamation project should hereafter be authorized until all privately owned land in excess of a single homestead unit for each owner shall have been acquired by the United States or by contract placed under control of the Bureau of Reclamation for subdivision and sale to settlers at a price approved by the Secretary. This price to be considered in determining what land and water will cost settlers and hence the feasibility of the project under the payment conditions of the law.

FINANCIAL CONDITION OF SETTLERS

CLASS OF SETTLERS

The great majority of the prospective settlers had little capital, but a great desire for a homestead, much courage, and a full willingness to do everything required to found a home upon the lands to be redeemed. Only 39 per cent of all the lands now under water-right contract with the Reclamation Service, excluding Warren Act lands, were in public ownership at the time the projects were opened. The other 61 per cent were in private ownership, and not available to incoming settlers desirous of making homesteads. This condition was not foreseen by the makers of the reclamation act, but came about as a necessity, since in practically every desirable irrigation locality small beginnings in irrigation had occurred, and some settlers were established on lands which naturally came under the projected Government works. In spite of this, the Federal irrigation projects did offer to vigorous young people splendid opportunities for securing lands for homesteads.

CONDITIONS OF AGRICULTURAL SUCCESS

In the earlier homestead days taxes were low, costs were low, and the standard of living was lower than it is to-day. The cost of agricultural development has increased since the passage of the reclamation act, taxes are higher, the cost of implements has risen; settlers insist on more comfortable homes. It was the common thing in the earlier homestead days for the homesteader to spend his life in conquering the land and in building a home on which his children thrive. The feeling to-day is that the rewards of pioneer-

ing must come in the space of a few years so that the pioneer himself may reap the larger rewards of his efforts.

The modern farmer requires a capital which was not so necessary in the earlier days. The capital required of the modern agricultural pioneer varies with the location and nature of the homestead, the manner of agriculture he enters upon, and other elements of the undertaking. It has been estimated that to start out well, an irrigation farmer, undertaking to reclaim raw land under the Federal irrigation projects, should have \$1,500 in cash or its equivalent, plus reasonable credit facilities, and that he would do much better if he had \$2,500 or more. Clearly, the more capital he has, the easier will be the completion of his task. Other countries, instituting similar experiments, have found it indispensable to give the farmer some financial assistance from the very beginning for land preparation and for the purchase of machinery, livestock, etc., or to insist that he come with adequate capital of his own. This Nation, resting upon the principle of equal opportunity, has held that no man shall be barred from the benefits that will come from a Federal irrigation project because he has no capital. Our country still looks with favor upon the courageous young man who stands ready with all his strength to win a future for himself. Nevertheless, it is now clear that the man with no capital, who enters the business of homestead making on the Federal irrigation projects does not enjoy a fair opportunity to succeed, but undertakes an almost impossible task.

ORIGINAL CAPITAL

Most of the settlers who came in on the reclamation projects were without capital; a small percentage came in with considerable capital. Quite a large number of professional people invested the savings of a lifetime in their homesteads. Business men and others who had accumulated capital and who longed for the freedom of agricultural life undertook to settle as water users under the Federal irrigation projects. The older settlers, already established on lands receiving the benefits of the projects, had accumulated the necessary implements and livestock to give them a fair start in the larger agricultural development. Attention is called in the section on "Settlement and settlers," to the great variety of people who settled upon the projects. Diverse as were their former occupations, just so diverse were their financial abilities as they entered upon the work of reclamation.

AVAILABLE FINANCIAL AID

At the time that the reclamation projects were undertaken there were no Federal agencies, as now, providing loans to farmers at easy rates of interest and methods of repayment. The water user was largely dependent upon the money lender or the banks in his locality. In 1922, 190 banks served the 131,194 water users, together with city customers, within the area represented by the projects. The Federal farm loan banks were established to make it easier for the farmer to secure help in his agricultural operations; but unfortunately the conditions on the Federal irrigation projects made it more difficult for the farmer on these projects to obtain help from the Federal land bank than for the outside farmer. The objections to project loans are incomplete title, methods of repayment, delinquencies, etc.

ACCUMULATED DEBTS

The consequence of this situation was that the pioneer farmer went into debt to secure his start for farming operations. This was the beginning of his debt. Those who came with some capital began perhaps on a larger scale, went into debt, and found themselves in about the same condition as the pioneer without capital. Then the farmer, who is only a human being, was tempted to engage in various speculative enterprises, perhaps not to a large extent but sufficient to add to the burden of debt which he was already bearing for the legitimate purpose of farm development. If the matter had stopped here, the financial troubles of the farmer, serious enough, would not have been quite so severe, but frequently the original settler found an opportunity to sell at an advanced price—a price that would cover not only his accumulated debts but leave a marginal profit besides. The purchaser, usually with insufficient capital, undertook to carry not only the debt burden of his predecessor and to pay him his margin, but in addition to go to the expense of further developing the farm. Thus, his accumulation of debts became greater. This purchaser, often, repeated the operations of his predecessor. The last buyer carried a still larger debt. Often, too, the settler secured his homestead by purchase from the owner of land, which had come under the project and for which he agreed to pay a large price in addition to the price of his water-right contract. If this process continued through three, four, or five transactions, the last purchaser was under a financial burden often beyond the capacity of the farm to repay. In these transactions little or no attention was paid to the obligations to the Government. Such titles or equities as existed changed hands without reference to the fact that obligations to the Government were overdue, or that for years to come annual payments would fall due before a clear title could be had.

ACCUMULATED PROFITS

The net profits of farming are nearly always small. If the farmer practices a wise system of diversified farming, he is able usually to feed his family very well and to find sufficient means to clothe and to house them properly, and to lay aside a small margin with which to meet outside obligations, such as those just discussed. Ordinarily, however, when the net result of his operations is compared with his time, he has received a small wage for his efforts.

Usually the farmer does not take into consideration the food consumed by his family or other benefits that would be cash expenses if he lived in the city. At the end of the farmer's life, even if he has had only average success, he possesses a homestead and the memory of a life of independent action which has developed and fixed his character and made him one of the strong men of the earth.

There has been necessarily an increased value of the land tilled on the Federal irrigation projects. Even where the construction costs have been the highest, they have not gone above market values. On most of the projects the market value of the lands is above the construction cost, without consideration of the reduced cost when noninterest-bearing money is used. This increment in value, if it had accrued to the original holder, would mean a great deal to the

homesteader; to the man who bought at times of high prices the situation is quite different.

THE ECONOMIC SURVEY OF 1922

To arrive at some understanding of the farmer's situation, the Reclamation Service in 1922 carried on an economic survey, the results of which are interesting. The following summary contains some very suggestive figures:

Value of farm land and improvements.....	\$183, 887, 584
Value of town property and merchandise.....	63, 509, 874
Bank deposits.....	76, 615, 517
Other property or investments.....	35, 433, 770
Total.....	359, 446, 745

The estimated value of farm land and improvements on irrigation projects was about \$184,000,000. Additional values include sixty-three and one-half millions of town property and merchandise, seventy-six and one-half millions of bank deposits, and thirty-five and one-half millions of other property or investments, making a total valuation of \$359,446,745. This has resulted from the initial investment of the \$143,000,000 of Government money in these reclamation projects, although about 90 per cent of that sum is yet to be returned. It must be kept in mind that no such table is absolutely accurate; it is merely a survey made as carefully as conditions permitted.

RELIEF APPLICATIONS OF 1923

The relief applications of 1923 may give some clue to the question of how much of the above valuation is covered by obligations. According to the tabulated relief applications, averages of 50 applications taken at random from each of 14 projects, the average results are:

Average size of farm.....	acres.....	72
Average cropped area.....	do.....	59
Average cost per acre.....		\$75
Average value per acre.....		\$118

In addition to these fundamental figures, other answers to questions were made which may be summarized as follows:

	Values	Obligations
Purchase price of farm.....	\$5, 387	
Improvements.....	2, 649	
Increased value of farm.....	3, 075	
Encumbrances.....		\$3, 763
Other real estate.....	7, 933	
Encumbrances.....		4, 444
Personal property.....	1, 948	
Lien against personal property.....		1, 832
Additional debts.....		978
Total.....	20, 992	11, 016

The values placed by the relief applicant upon his farm average \$20,992 against which there were obligations amounting to \$11,016. A further analysis of the above summary would lead to the conclusion

that the applicant has really lost money since he purchased his farm, for the money which was actually put into the farm is considerably more than the difference between his valuation and his obligations. Only about 10 per cent of the water users have applied for relief under delinquent accounts, and therefore it may be a fairly safe conclusion that only one-tenth of the water users under the projects, who were not otherwise relieved, are in as serious condition as would be indicated in the above summary of relief applicants.

NET INCOME OF FARMERS

It is equally difficult to obtain any accurate statement of the net income of the farmers under the reclamation projects. As for the gross income, the annual report for 1922 estimates the value of the crops raised to be \$50,360,850, whereas the Economic Survey for the same year makes an estimated value of the crops as \$37,280,737. This difference may be due to a less complete survey or to a different season of the year when certain crops have been disposed of and were not taken into consideration. Meanwhile, following the estimates of the Economic Survey, the following is of interest:

Gross value of crops.....	\$37, 280, 737
Fed on farm (value).....	10, 064, 667
Livestock at beginning of year (value).....	15, 935, 272
Marketed during year (value).....	3, 883, 209
On hand at end of year (value).....	15, 756, 623

Twenty-two per cent of the crops remained on the farmer's hands at the end of the year, and only 27 per cent of the farm products were fed on the farm. The livestock at the beginning of the year was 43 per cent of the total gross value of the crops. This is a most wholesome sign of agricultural prosperity on the projects.

The relief applications of 1923 would indicate that the average total income per applicant varied from \$2,488 to \$2,058 during the years 1920 to 1922, but that 43 per cent of this total income was obtained from sources other than the farm, probably from wages earned by the farmer and his family outside the farm at times when the farm did not demand attention. The data with respect to those who fed livestock indicate that the purchase and feeding of livestock to be sold again as soon as the feeding season is over is usually a profitable feature. The relief applications show that those who bought and fed livestock had an additional cash income of \$806 to \$2,130 during the years 1920 to 1922. Note the following tabulation:

Relief applications, 1923

	1920	1921	1922
Income from sources other than farm.....	\$1, 063	\$899	\$911
Cash returns from crop sales.....	924	829	790
Cash returns from livestock sales.....	491	330	262
Total.....	2, 488	2, 058	2, 063
Per cent of income from other sources than farm.....	43 +	43 +	43 +
Those who fed livestock bought for feeding, additional cash income.....	\$2, 130	\$806	\$1, 067

However, in such feeding there is a speculative element which must be carefully considered, and is in itself an element of danger.

THE PROSPERITY OF FARMERS

Another manner in which to approach this subject of the financial condition of the farmer would be to inquire into the general prosperity of the farmers and to class them accordingly. This was attempted in the economic survey in 1922. As a result, the following percentages were obtained with respect to the prosperity of farmers:

	Per cent
Prospering.....	13.8
Broke even.....	31.2
Not broke even.....	34.4
Very poor.....	21.6
Total.....	100.0

If this statement is accepted, 56 per cent of all the farmers were unable under the conditions of 1922 to make a profit on their agricultural operations.

RESULTS

The net result of the financial situation on the Federal irrigation projects is that there are many complaints because of the burden which the farmers are obliged to bear. In comparison with these other parts of the farmer's financial burden the Government claim is small, and leniency has been extended to the water users from time to time to make it possible for them to place their affairs on the sound financial foundation which determines the success of the whole Federal reclamation enterprise.

WHY GOVERNMENT OBLIGATIONS ARE NOT MET

From these various considerations the conclusion might be drawn that there is no profit in farming; yet it must be kept in mind that the many obligations of the project farmers are only in part those derived from the water-users' contract. Moreover, the year 1922 was one of very unsettled conditions and may not be a fair year in which to judge the condition of the water users on reclamation projects. As far as the Government obligations are concerned, the following table will show the status of each project:

Projects	Percentage paid of construction charges due June 30, 1923, for each project	Percentage paid on the net construction cost for each project	Projects	Percentage paid of construction charges due June 30, 1923, for each project	Percentage paid on the net construction cost for each project
Salt River.....	100	8.4	Carlsbad.....	91.7	28.0
Yuma.....	83.7	12.1	Rio Grande.....	100	0.6
Orland.....	100	22.0	Williston.....		1.8
Uncompahgre.....	29.8	1.5	Umatilla.....	87.7	13.1
Boise.....	80.5	11.0	Klamath.....	94.0	13.5
Minidoka.....	89.9	35.5	Belle Fourche.....	83.8	13.4
Garden City.....	100	13.2	Strawberry Valley.....	83.2	11.45
Huntley.....	91.8	24.5	Okanogan.....	96.6	3.9
Milk River.....		0.16	Yakima.....	94.7	25.6
Sun River.....	87.9	4.0	Shoshone.....	76.3	7.4
Lower Yellowstone.....	100	1.13			
North Platte.....	72.2	12.45	Subtotal.....	85.8	10.9
Newlands.....	98.5	7.5			

This table shows that although only an average of 10.9 per cent of the total construction costs have been returned to the Government, yet the average of the projects have paid up 85.8 per cent of amounts due. This is to be explained by the extension act of 1914 which amounted practically to starting over again, for at that time all the obligations of the farmers were covered into the construction fund and payments begun from that date under the 20-year repayment plan except for such projects as had not had public notice announced to them at that time. In addition, on some projects certain changes, which were first otherwise listed and subject to immediate repayment, were later classed with the construction charge. Then the Secretary of the Interior, who has such power under various congressional authorizations, extended leniency for certain lengths of time to settlers in distress. All these facts together have reduced the amount due the Government to-day from the water users.

Overdue payments, therefore, mean payments which are overdue in accordance with various laws and regulations that at various times have affected the construction and the operation and maintenance accounts of the respective projects. This is one reason why the Government obligations are not more completely met.

Of the one hundred and forty and more millions of dollars expended for the Federal irrigation projects, only one hundred and one millions are covered by water users' contracts, leaving an item of about thirty-nine millions of dollars which may be called "frozen assets." This is made up chiefly as shown in Exhibit 1, Table 5, of unsold water rights, which may gradually be released and made active but which for the present are in an inactive state. This is an important consideration for the future. The active assets—that is, those covered by the one hundred and one millions of water users' contracts—are of first importance now, for the people who have entered into these contracts find themselves in difficulty and some of them in distress, and it is all important that these water users find ways and means by which they may make enough out of the irrigation enterprise to live comfortably and to pay their debts.

POLICY

As has been pointed out, it was an error to fix an arbitrary time within which construction costs should be repaid. The problem is not one of time but ability to pay out of gross income.

Consideration must be given to annual obligations other than water charges which the settler must meet. The problem is not merely reducing raw land to cultivation, providing buildings, implements, and stock, but in addition creating new social communities. Roads, telephones, schools, churches, often villages or towns—all the agencies necessary for modern life—had to be provided for at one time. Thus unusual immediate burdens had to be assumed by project settlers.

Hence, in fixing the annual water charge the Government should determine what portion of the annual gross income should properly be allotted to other necessary annual charges. The policy heretofore followed, i. e., failing to insist upon payments and granting relief from payment of water charges has resulted in making the Government shoulder any deficit between gross income and gross annual expense. Settlers have grown to believe that water charges are the last of

annual charges to be paid, and they attribute their financial failures to the amount of the water charges. This is not true. The water charges are in most cases the smallest of all annual charges. The use of water is the basis of earning power and hence should be first paid. If, instead of an arbitrary amount determined by dividing the total construction cost by a fixed number of years, we require the payment of a certain per cent of average gross income, we place repayments upon a sound business principle, and the settler pays regularly for that which makes income possible. If he farms intelligently, he increases his gross income, thereby making it easier to meet all his obligations and more quickly completes his total payment to the Government.

CONCLUSIONS

The analysis of the financial condition of the farmer on the Federal irrigation projects points out the path for the future:

(a) The obligation to the Government must be recognized as the basis of success.

(b) Payment must be based upon productivity—not time.

(c) The per cent of gross income to be paid on construction charges must be fixed—taking into consideration the other fixed annual obligations of the farmer.

(d) The farmer must learn to take advantage of every technical and practical aid for increasing gross income by intensive, diversified agriculture.

(e) Government, Nation, and State must aid in providing technical advice and demonstration.

(f) A system of credit based upon sound business principles must be provided, and cooperative methods of buying and selling must be adopted.

(g) The farmer must practice thrift and avoid useless expenditure.

RECOMMENDATIONS

Immediate relief for water users.—Pending any delay caused by putting into effect the recommendations herein contained or substitutes therefor, it is the sense of this commission that Congress should from time to time grant such temporary relief to settlers on the various projects as the ascertained facts will warrant.

Penalty reduced.—The rate of penalty (1 per cent) provided in section 3 and section 6 of the act of August 13, 1914 (36 Stat. 686), should be reduced for the future to one-half per cent.

A credit fund for farm equipment.—Project settlers are in need of relief from paying high interest rates on short-time loans. They are often unable to borrow money with which to improve and equip their farms. A credit fund should be provided under competent control from which settlers on the projects can borrow money with which to make permanent improvements or to buy needed equipment and livestock. Loans for permanent improvements secured by the land should run not to exceed 30 years; loans for equipment and livestock not to exceed 5 years. The rate of interest should be 5 per cent; payments of principal should be amortized; the making or refusing of loans should be at the discretion of the credit authorities.

THE AGRICULTURAL AND ECONOMIC NEEDS OF THE SETTLER
CHANGED CONDITIONS

The reclamation act gave a unique opportunity for working out colonization plans which would provide for the fundamental needs of settlers. These would insure good lands and adequate water for irrigation and would include whatever aid and direction were needed by settlers in finding out what land and water were worth when measured by the value of the crops which could be grown. The estimates of costs of canals and reservoirs would have been supplemented by equally careful estimates of what the settler would have to spend to improve and equip his farm; and where the settler did not have this money, the plans would have provided some source from which it could have been borrowed at reasonable rates and long-time payments.

The important features of the original act were estimates of cost of main canals and reservoirs and the area of land they would irrigate. All the complex questions of how land was to be made ready for irrigation, what it would cost to improve and equip a farm, what crops could be grown, and where they could be sold were left to be worked out by individual settlers, without information, plan, or direction by anyone. When development shifted from public to private land, no adequate measures were taken to curb the selfish inflation of prices, so that unwary and oversanguine settlers have paid as high as \$200 an acre for unimproved sagebrush land.

The importance of these features was soon manifest after the act went into operation. But they were contrary to pioneer methods and ideas, and the act was framed to continue pioneer procedures so far as agricultural development was concerned. With the great increase in costs of things a farmer must buy and the low prices of what he has to sell, they can no longer be ignored.

Twenty-five years ago the farmer could dig in and in some way succeed with little or no capital, because water rights cost from \$5 to \$15 an acre and land was free. He can not do it when water rights cost from \$50 to \$150 an acre and settlers have to pay high prices for raw land.

The situation created by the inclusion of privately owned land in Government projects deserves more attention than it has received. About 60 per cent of all land now being irrigated from Government works was privately owned at the time of opening. More than half of all the land included in projects was private land when the projects were authorized. These lands have been furnished a water supply at the expense of the reclamation fund and without any interest charge on deferred payments on water rights. This action confers a special privilege on these favored landowners. It places private irrigation projects at a serious disadvantage and has enabled the non-resident speculative owner to defeat the desirable economic and social intentions of the reclamation act. If the reclamation act is to continue to be used to reclaim private land, then the Government should either acquire all land so owned in excess of a homestead or fix the price at which the owner must sell before work begins.

When the reclamation act was passed it was believed that the acre cost of water would rarely exceed \$10 or \$12. In the discussions of

this act in Congress there was talk of \$25 an acre as a maximum. It was assumed that settlers would have no difficulty in paying these modest sums within a period of 10 years. It was also assumed that settlers would get free land and that the method of the pioneers in creating farms under small, cheap ditches could be continued under the Government system.

INFLUENCE OF VARIATIONS IN SOIL ON SETTLERS' SUCCESS

In the hearings before the committee at Salt Lake City representatives of the Okanogan project had nothing but praise for the excellence of the soil on 6,000 acres of the area. They agreed that the yield and quality of fruit grown in the orchards of this part of the project are unsurpassed in any part of the country. But on this same project there are 2,000 acres with soil so worthless that nothing of value can be grown. The Government's investment in canals to water this worthless land is a loss, and the settlers feel that they should have been warned against attempting to make farms on it.

Representatives of the Shoshone project called attention to the wide difference in their conditions, due to difference of soil between the Garland and Frannie divisions of that project. The first-named division grows good crops and has good soil, whereas the second has poor soil and on the worst portions the crops do not pay the cost of cultivation.

Testimony from other projects was of the same character. It showed that settlers on some parts of a project are prospering, whereas other areas have been abandoned. It showed that a soil survey is as much needed as an engineering survey. Soil surveys are needed to fix the boundaries of projects and what settlers can afford to pay for land and water rights. Where variations in soil have been ignored, some settlers get water rights at bargain prices; others pay more than they are worth, which creates a sense of unfairness by reason of these differences.

THE CAPITAL A SETTLER SHOULD HAVE AND THE CREDIT SCHEME NEEDED FOR THE IMPROVEMENT AND EQUIPMENT OF FARMS

Since the reclamation act went into effect a revolutionary increase has taken place in the expenses of everything needed to change a tract of raw land into a farm. In the 10 years from 1910 to 1920 the average selling price of irrigated land in the arid States has more than doubled. The cost of constructing irrigation works has nearly doubled. Similar increases took place in taxes and in the cost of houses, of farm implements, and of labor needed in development. Where water rights cost from \$50 to \$100 an acre, where raw land costs from \$50 to \$100 an acre, where lumber costs three times as much as 10 years ago, speed in bringing a farm into production and money to do this promptly become far more important than they were 25 years ago.

Other countries have found it necessary to include planned settlement, credit for development, and expert agricultural and business advice to settlers as essential features of the reclamation scheme. These features were not included in the act, because when it was passed everything connected with western agriculture and irrigation development was primitive and cheap. The amount of money a settler needed was only a small fraction of what is now required.

Now, farms must be equipped for intensive cultivation. The primitive tools and poor stock which answered when everything was cheap will not provide sufficient money to meet increased expenses. The family must be able to live under better conditions, the farmer must have more science and skill, and the farm must be provided with the following: A house, buildings to shelter livestock and implements, one or more cows and a team of horses, furniture for the house and implements for the farm, the land must be leveled for irrigation, small lateral ditches to distribute water, boundary and subdivision fences, and money for living expenses until a crop can be grown.

In the hearings of this committee at Salt Lake City repeated references were made to the large amount of money which had been spent in making farms ready for cultivation, of the struggle to pay high interest rates on borrowed money, and the plight of settlers unable to get money for improvements. Much attention has been given to these costs in recent years. A large body of reliable data has been secured. The cost of improving and equipping an 80-acre farm on the Newlands project, as shown by the records of a careful and competent settler, was:

Leveling land, building checks and small ditches.....	\$3, 000
House and barn.....	1, 500
Work team and farm implements.....	1, 000
Living expenses, one year.....	500
Taxes, operation and maintenance charges, and incidentals.....	300
Initial payment on water right.....	200
Dairy herd of 20 cows, or other livestock to eat fodder crops.....	2, 000
Total.....	8, 000

(Report of central cost review board.)

During 1922 the University of California gathered actual cost data on the expense of changing grain and brush land into small irrigated farms. The average development expense on 70 of these farms, which varied in size from 20 to 40 acres, was as follows:

Cost per acre of improvement and equipment:

	Acre cost
Clearing, leveling, and building laterals.....	\$78
House.....	25
Barns, outbuildings, and fences.....	18
Farm implements.....	11
Livestock, including horses and cows.....	16
Total.....	148

For the 40-acre farm this meant an investment of \$6,840, and these expenses were incurred by poor men. There was nothing included that was not needed and they do not include the cost of planting a crop. Where the land was prepared and planted to alfalfa, the additional cost was:

	Acre cost
Checking and bordering.....	\$16
Seeding and seed.....	8
Total.....	24

Where orchards were planted, the expense included the following:

	Acre cost
Preparation of the land.....	\$15
Trees.....	30
Planting and care.....	10
Total.....	55

The average development cost of the acres planted to alfalfa was, therefore, \$170 an acre, and of the land planted to orchards \$201 an acre. This does not include the price paid for the land or the construction cost of the water right.

The conditions under which farms are carved out of new irrigated areas in Australia are similar to those in the United States. Building material costs more in Australia and livestock less. Labor costs are about the same.

Last year one of the Australian States gathered all the information available about what it would cost to improve and equip irrigated farms varying in size from 15 to 40 acres. The Government wished to secure definite, reliable information to be used in fixing the capital a settler should have to give him a fair chance to succeed, and to determine how much money would have to be loaned settlers who did not have the necessary amount to enable them to complete improvements and to earn a living while carrying on this development. The statistics gathered show that the development expenses varied from \$7,000 to \$10,000 per farm. The expense on American reclamation projects can be made less than this, but it will not be less than \$4,000 for a 40 to 80-acre farm, and it is often twice this sum.

Experience has shown that in the majority of cases the settler can not succeed without the establishment of some credit scheme which will enable him to borrow the necessary money, on long-time payments, at a lower rate of interest than local banks can afford to give. As yet no such credit scheme has been provided by the Government. Such loans are provided in other countries through their rural credit banks as a part of the colonization and reclamation policies. In Australia a settler who takes 40 acres of land is required to have a capital of his own of \$1,500 to \$2,500. The State then lends whatever is needed to complete the farm's development up to a maximum limit of \$3,000 to \$5,000. Some countries require a settler to have a capital equal to one-tenth of the cost of the farm after it is improved. Requiring the settler to have some capital has proven to be an advantage to both the Government and the settler. Wherever possible the settler is required to buy his perishable equipment with his own money. This includes farm machinery and livestock. Permanent improvements, like houses and leveling lands, may be made security for loans. The interest rate in other countries on these development loans varies from 3½ to 5½ per cent. The period of repayment runs from 20 years where secured by houses and other permanent improvements, up to 70 years where the land is the security. Loans run up to 90 per cent of the value of the improved farm and up to 70 per cent on permanent improvement. Aiding the settler to get his farm into full production increases his income and thus promotes all repayments to the Government.

The delays, anxieties, and waste of time and effort of settlers under irrigation projects in the United States who have spent all their own money before their farms have been made going concerns, and who have been unable to go on because money to complete development could not be borrowed, make it important that credit as a means of relief to present settlers, and as one of the agencies for insuring happier results in the future, be made a part of the national reclamation policy.

Accepting settlers without capital or experience, or information about what it will cost to make a farm out of a tract of raw land, has brought privation and bitterness and loss of time and money to a large number of hard working, but oversanguine, people to whom the conditions of the West were new and strange, and it is one of the reasons why money due the Government has not been repaid. Accepting a settler without money, knowing that the obstacles that confront him are unsurmountable, is indefensible from a humane standpoint and foolish from a business one. It is time that all friends of the reclamation policy have a clear conception of what confronts the settler who pioneers on one of the Government reclamation projects.

CONDITIONS CONFRONTING SETTLERS

Aside from the irrigation works and the unformed dirt roads, everything required to transform the desert into productive farms remains to be done. The land must be cleared. The farm unit must be fenced. A house for the family and a stable for the work animals have to be built, and provision has to be made for a water supply for household use. Not being familiar with local conditions, settlers are not able to buy to advantage, as they are under pressure to buy quickly. Many are victimized with bad horses and poor cows.

Settlers are often unable to procure cows or horses locally. Many have to be shipped long distances, and whoever renders that service usually, though not always, charges a heavy commission. There is always danger that the newcomer, looking for cows, will be sold the culls from dairy herds and starts under a heavy handicap.

Until a house can be built, the settler's family has either to live in a tent or board in town. Illness often results, while costly living expenses and delay in beginning productive employment contribute to make all concerned homesick and discouraged.

The land has to be prepared for irrigation before a crop can be grown. To do this so that water will flow evenly over the surface requires knack and experience. Lacking these, money and time are wasted and the final result is often so unsatisfactory that the work has to be done over again. Few settlers can afford to buy special equipment for leveling land cheaply; hence the actual cost is increased and completion delayed.

PREPARING THE LAND FOR IRRIGATION SHOULD BE MADE A PART OF THE PROJECT COST

To leave this costly preparatory work to be done by the settler who lacks team strength, implements, and practical skill involves a ruinous waste of money and time. Nothing could be more inefficient. Careful consideration should, we believe, be given to whether the leveling of land and making it ready for the application of water is not as essential a part of reclamation as building the canals and reservoirs.

It has now come to be realized that the preparation of land for irrigation is a task which requires the knowledge of the engineer and not that of the farmer. It requires tools for which the farmer has no use after the farm has been made ready for the proper distribution of water. The only safe basis for doing this work properly

is an accurate contour survey. The size and direction of channels or borders can only be determined wisely by men with more knowledge and experience than the average farmer possesses. Leaving the inexperienced beginner to struggle along without aid or direction has wasted more money, brought more discouragement, and driven more settlers off their farms in the early years of development than can be realized by anyone except those who have lived on these settlements.

INVESTMENT BY IRRIGATOR

To attain success a larger investment must be made by the irrigator than was assumed by many at the time of the passage of the reclamation act. On the basis of \$20 per acre for storing and turning water into the main-line canals the investment by the Government in the reclamation of a 40-acre tract would be \$800. It was generally understood that the investment to be made by the settler would be correspondingly small. As conditions have developed, however, it has become apparent that the Government must bring the water nearer the land; and although this reduces the immediate investment by the settler, and one that otherwise would have been made by him in providing the distribution system, yet, nevertheless, he must invest a far larger amount of money than anticipated in providing necessary equipment.

The present cost of storing, diverting, and distributing water for irrigation averages not far from \$50 per acre, or \$2,000 for a 40-acre irrigated farm. This is the amount of money, which in one sense, the Government advances for the benefit of the settler and which he is to repay to the Government without interest at some future time. This advance or loan is by no means sufficient to put the settler on his feet. On his part he must be able to provide, directly or indirectly an equal or larger sum to be used in building a house, a barn, and in procuring livestock, tools, and other equipment, and in the leveling of the ground. * * *

On an average it may be said that at least \$2,500 to \$3,000 must be invested by the settler within the first two or three years on a small farm, not including the purchase price of the land. * * *

One of the most important items in connection with development of the irrigated land has been the ability of the settler to secure an advance of money or a loan to enable him to develop his land. In the case of homestead entries there is little real security offered to the money lender, and the interest rates are correspondingly high, being from 8 to 12 per cent or even more. (Extract from Twelfth Annual Report of U. S. Reclamation Service of 1912-13, p. 6.)

If our own experience is not sufficient we ought to study the conclusions reached by other irrigated countries where land settlement is carried out by the government. Within the last 50 years the money spent on irrigation works by the Government of India has run into hundreds of millions of dollars. These works are built in an irrigated county with experience and traditions in irrigation practice, which make agricultural development a much simpler matter than it is here, though we have advantages in the greater energy and ambition of our people. The significant fact of recent Indian development is the inclusion, in the estimates of cost, of money for aid and advice given settlers in the preparation and improvement of their farms. They have come to believe that money thus spent is of as great importance as that spent on any element necessary to make a developed farm.

Within the last half century the Australian States have spent over a hundred million dollars building Government irrigation works. In the earlier years of this development nothing was done for the settlers except building the canals and reservoirs. These were years of continued financial losses both to the Government and to settlers. Settlers left to struggle alone with the expenses of leveling land and

doing other things needed to create the irrigated farm could not and did not meet their payments. Then the Government awoke to the fact that it was the farmer who repaid project costs and that irrigation development was only justified if it was an economic success and the people who cultivated the land were contented and prosperous. A system of aid and direction for new settlers was inaugurated under which those of limited means could borrow money needed to enable them to live in better houses, own better stock, work with better tools, obtain larger returns, and thus meet obligations to the Government. The result is a new and better agriculture and a more hopeful and prosperous rural population.

If money for development is provided, its expenditure must be watched. Inexperienced beginners must not be allowed to waste it. The modern conception of reclamation includes experts in agricultural practices and the business of agriculture as well as expert engineers. People drawn from widely separated parts of the country must be brought to know each other and work together, in order that they may cooperate in doing things which the community can do better than the individual. These include the purchase of livestock, material for houses, the working out of an agricultural program that will lead to the planting of crops suited to the soil and climate, teamwork in buying, and arranging for marketing of their products in such manner that the man on 40 acres inside the project can do business on equal terms with the man with 1,000 acres outside. These are not fanciful theories; they are a part of modern methods and modern progress in building up prosperous and successful communities under irrigation in other countries. The reclaimed areas of the arid West afford one of the finest opportunities for their introduction into this country.

Two efforts, if not more, have been made by project managers to help settlers plan out cultivation and marketing programs for their farms. One plan was to employ a man familiar with local conditions and possessed of more than average business ability to meet with the settlers, talk over their situation, and decide what crops to grow and the livestock they should include in their farm equipment. Although it was tried only a short time, the beneficial effects were clearly apparent. It gave the farmers new courage, removed doubts and anxieties, increased their income, and gave greater certainty of future success. This beneficent activity had to be suspended because of a ruling that the reclamation act does not authorize such expenditure.

Nothing is more discouraging for a project manager than to see industrious, worthy settlers wasting their time by misdirected effort, or unable to cultivate a part of their farm for lack of money to prepare the land for irrigation. The need for these things has been repeatedly mentioned in reports of the service.

There has been considerable debate in the public press and in correspondence as to the best course to be pursued with reference to securing larger credit for the pioneer irrigator and further loans at reasonable rates of interest. One suggestion has been made that the Government not only advance, as has been done, the capital for providing the water, approximately \$2,000 for a 40-acre farm, or \$4,000 for an 80-acre tract, but in addition break up and level the land and even make loans of cash or credit to procure farm equipment. It has been pointed out that this is done in other countries. (Extract from Twelfth Annual Report of U. S. Reclamation Service of 1912-13, p. 7.)

THE PREVENTION OF SPECULATION IN THE RECLAMATION OF PRIVATELY-OWNED LAND

When the reclamation act was passed it was generally believed that its sole field of operation would be on the arid public lands. It was stated repeatedly in the discussions of this measure that its purpose was to reclaim public lands and thus enable settlers to make homes on what was then an unproductive part of the public domain. It was thought that the settler would, through a homestead filing, obtain his land free of cost, and that would make easy the repayment to the Government of the money spent on canals and reservoirs. When, however, the service came to select locations for these works it found that there were many meritorious private projects which were in trouble. These schemes usually needed a better water supply or were in debt and unable to complete the works. There were many cogent reasons why the service should look with favor on a policy which would rescue these enterprises from threatened disaster. In some cases they had marked advantages over any new works on public land.

It happened, therefore, that among the first, if not the very first, project approved was Salt River, where a number of large private canals had been built, where nearly all the land was privately owned but where storage was needed to provide an adequate water supply. The relief first contemplated for this project was for the Reclamation Service to build only a reservoir which would provide for filling the privately-owned canals when the river was low; but with a better understanding of what was needed, the original scheme was expanded to include a complete reconstruction of all existing works, which, after purchase by the Government, were enlarged and practically rebuilt. A similar development took place on the Uncompahgre, Yakima, Rio Grande, North Platte, Boise, Newlands, and other projects. Existing works were taken over, enlarged, extended, or entirely rebuilt.

In other cases the best opportunities were found not on Government land but on land partly or wholly in private ownership. The Orland project was wholly on privately-owned land, as were the Carlsbad, Rio Grande, Strawberry Valley, and Okanogan projects. On all of the projects there was some land in private ownership.

Changes in the methods of colonization and in the cost of farms resulting from the private ownership of project land render it desirable that statistics of the areas of public and private land on each project be included.

These lands belong in two divisions, those under Government projects and under Warren Act projects. The following table shows the areas of public and private land under Government projects when the projects were authorized, which now have contract water rights:

Table of areas under water-right contract, June, 1923 (not including Warren Act)

Project	Public	Private	Total
1. Salt River ¹	16,000	197,000	213,000
2. Yuma ²	12,362	44,206	56,568
3. Orland.....		19,398	19,398
4. Uncompahgre.....	13,643	61,324	74,967
5. Boise.....	59,490	37,135	96,625
6. King Hill ³	816	16,372	17,188
7. Minidoka.....	96,262	23,692	119,954
8. Huntley.....	28,746	8,728	37,474
9. Sun River.....	11,971	947	12,918
10. Lower Yellowstone ⁴	16,048	43,462	59,510
11. North Platte.....	83,558	25,248	108,806
12. Newlands.....	32,525	16,253	48,778
13. Carlsbad.....	45	24,995	25,040
14. Rio Grande ¹		85,000	85,000
15. Williston ¹		7,653	7,653
16. Umatilla ¹	5,413	18,940	24,353
17. Klamath.....	5,909	39,354	45,263
18. Belle Fourche.....	37,196	39,462	76,658
19. Strawberry Valley.....	1,953	30,048	32,001
20. Okanogan ⁴	116	8,550	8,666
21. Yakima.....	3,471	60,044	63,515
22. Shoshone.....	64,056	1,950	66,006
Total.....	489,250	804,056	1,293,306

¹ Repayment contract is with Salt River Valley Water Users' Association.

² "Private land" includes 7,488 acres Indian land.

³ Repayment contracts are with irrigation districts.

⁴ Acreage includes about 1,200 acres sand land to be eliminated.

NOTE.—Statement does not include lands to which water is being furnished under the Warren Act, nor certain other areas covered by contracts for partial water rights.

Some of the land, public and private, has not been provided with water. The table which follows shows the public land and the private land for which water rights have not been purchased:

Public and private lands under projects for which water rights have not been purchased

Project	Public	Private	Total	Project	Public	Private	Total
Yuma.....	540	6,066	6,606	Rio Grande ¹	2,300	62,700	65,000
Orland.....		776	776	Klamath.....	6,523	698	7,211
Uncompahgre.....	7,264	13,813	21,077	Belle Fourche.....	256	5,299	5,545
Boise.....	147	2,282	2,409	Yakima.....	9	3,264	3,273
Minidoka.....	449	1,163	1,612	Shoshone.....	1,886	3,331	5,217
Sun River.....	284	840	1,124	Total.....	23,913	105,616	129,529
North Platte.....	143	4,553	4,696				
Newlands.....	4,112	871	4,983				

¹ Not on farm unit plats but covered by irrigation district contracts.

The largest area of private land supplied with water is under Warren Act contracts. All this land was in private ownership when the Government sold it water rights. It had to be in private ownership in order for its owners to make contracts.

Total area entitled to water under Warren Act contracts, 1922

Related project:	Irrigable acres
Grand Valley.....	18, 400. 00
Uncompahgre.....	962. 00
Boise.....	225, 460. 44
Minidoka-Jackson Lake.....	636, 840. 00
North Platte.....	124, 623. 00
Klamath.....	58, 666. 74
Belle Fourche.....	54. 80
Strawberry Valley.....	29, 060. 00
Yakima.....	242, 079. 20
	1, 336, 146. 20

Bringing these areas of public and private land together shows that the principal activity of the act has been to improve conditions on private land. The extent to which this is true is shown by the following table:

Publio	Private
489, 250	804, 666. 00
23, 912	105, 618. 00
-----	2, 041, 715. 20
513, 163	2, 951, 987. 20

Attention is called to this matter, not to criticize the inclusion of private land, because agricultural results have justified this action, but to point out the need for new legislation that will ensure that desirable social and economic results of the reclamation act shall go to settlers. This means that the act should be amended to prevent the activity of speculators which has marred its operation in the past. Where land was held in large tracts, or where speculators acquired options on large areas, before the projects were settled, it gave an opportunity of inflating the unirrigated value at which the land could be bought before the Government entered the field, to prices based on irrigated values, under the generous terms of the act.

It seems certain that the aid of the Government will be sought in the future to rescue meritorious but distressed private projects, and that the percentage of privately owned land included in Government projects will tend to increase rather than diminish.

The reclamation act was subsequently amended to require the holders of more than a homestead unit to sell the surplus. This amendment is specific in its terms, but attempts on the part of the Reclamation Service to enforce the law have proved fruitless, and it is evident that the amendment is now practically disregarded:

Many of these settlers are land-poor, in that they have attempted to pay for more land than they can possibly cultivate. Many instances might be cited where a man with adequate funds to cultivate 20 or even 40 acres and to support his family in comfort has spread out his capital over 160 acres and then found, after he had tied himself up, that he could not sell any portion of this 160 acres at the rate per acre which he had agreed to pay. (Thirteenth Annual Report of Reclamation Service, pp. 27-28.).

¹The American Falls reservoir, about to be built, will supply additional lands; in 1922 contracts had been made for 705,569 acres, including some of the areas already contracted for Jackson Lake water.

One of the witnesses at Salt Lake who was asking for relief admitted the ownership of 320 acres and the leasing of an additional homestead area. He was cultivating three times the acreage he was permitted to have under the act. Another, who appeared to ask for postponement of payments, admitted the ownership of several farms within a single project. Another admitted the ownership of 1,200 acres, where 160 is the maximum for a farm. It is evident that the act needs to be amended either by the repeal of the limitation to a single homestead, or by putting teeth in it which will enable it to be enforced. This ownership of surplus land should be taken into account in granting relief. The claim for relief made by a settler living on and cultivating his homestead is more entitled to consideration than the claim of the owner of several farm units, or that of the nonresident owner whose land is cultivated by tenants.

Whenever occasion arises that amelioration of terms of payment for water may be considered, it is of the highest importance that this be granted only to the man who is living on his land and who is cultivating it in good faith, making his principal occupation that of tilling the soil. (Twelfth Annual Report of Reclamation Service, p. 5.)

PROJECT POWER PLANTS

ORIGIN

In the construction of the Federal irrigation projects it was found that the power required for construction could best be secured by the construction of power plants, usually hydroelectric plants. When construction was completed the cost of these power plants, yet in good working condition, was included in the construction cost of the project. Usually these power plants, after having served as adjuncts to construction, have been left on the projects. The power produced by them has been used for pumping water to higher lands, or for drainage, and the excess over and above the needs of project operation has been sold for general industrial purposes.

NUMBER AND LOCATION

On 11 of the projects there are 18 power plants, which have cost the reclamation fund \$3,825,905.20. These power plants had an output, during the fiscal year 1922-23, of 177,038,638 kilowatt-hours. A part of this power, 93,660,469 kilowatt-hours, was sold to consumers, and another part, about 37,067,575 kilowatt-hours, was used for irrigation purposes. The net revenue for the fiscal year ending June 30, 1923, was \$584,930.94. The service of these plants has not yet reached its full possibilities; neither has the possible service of power on the respective projects been fully developed.

Several of these power plants are operated by canal water during the irrigation season and are therefore idle in the winter. During the growing season, when the canals are filled with water, the output of power is therefore greatest, which permits a larger use for pumping purposes to supply high-lying lands with water.

OTHER POWER POSSIBILITIES

In addition to the project power plants already constructed there are many power possibilities that will be used in the future. The

building of irrigation works, implying the diverting of water from high-lying to lower-lying lands, necessarily furnishes power opportunities. On some projects these power opportunities are very large. The increasing need for power on the farm throughout the year and on the project for pumping purposes during the summer, makes it very certain that, as time goes on, these many power possibilities will be more carefully scrutinized with a view of constructing additional power plants.

CONCLUSIONS

The place of power in modern agriculture has been well established. The electric current has become the servant of the farmer, by the aid of which one man is enabled to do several times the work that the farmer of old could do. The need for power on an irrigated farm is as legitimate as the need for water. Any future policy relative to the development of Federal reclamation should keep the power problem in mind. The water users, when they take over a project, should be allowed to operate the whole project as a unit, including the power plants that may be constructed; and, further, no reservations should be made regarding possible power sites, except as to the permanent retention of existing power possibilities for the use of the project population.

ACCOUNTING SYSTEM

INTEGRITY OF ACCOUNTS

The books of the bureau show correctly the total receipts and expenditures of the reclamation fund, and the net investment by projects.

PROJECT CONTROL AT WASHINGTON

The accounting system as now in use provides for the control of all expenditures and collections by projects and is handled through a general set of books in the Washington office. The books are primarily a cash account, showing cash with the Treasurer and with special fiscal agents, the total disbursements and collections divided by projects, and the total receipts from the sale of public lands, town-site lots, potassium and oil-lease royalties, and from Federal power leases. There are a few other receipts, namely, judgments Court of Claims, Rio Grande Dam appropriation, increase of compensation, and appropriations for the Riverton project. All are reimbursable to the United States Treasurer, excepting Rio Grande appropriation.

REPAYMENT CONTROL

In addition to this set of books there is maintained in the Washington office a set controlling the repayments, arranged to show the total contracted, total repaid in accordance with the contracts, and the amount due and unpaid at the end of each month.

OTHER RECORDS IN THE WASHINGTON OFFICE

In addition to the two sets mentioned, a general control ledger, prepared from the Washington and project balance sheets, is maintained. This is merely a copy of the balance sheets to summarize all

accounts and is not supported by original records. If any supporting data are desired as to these accounts, it is necessary to go to the original records in the field, also certain reports giving details of a few of the accounts, such as costs and repayments. The actual disbursements and collections can be checked with the Washington office original books.

PROJECT ACCOUNTING

On each project there is maintained a separate set of accounts for the project, divided into the following general headings:

Cash.	Construction (cost).
Inventory, stock on hand.	Operation and maintenance (cost).
Plant and equipment.	Accounts payable (current).
Accounts receivable (current uncollected).	Deferred and contingent obligations.
Accounts receivable (deferred).	Reserves.
Unearned value of contracts.	Net investment.

Under each of these general headings are subaccounts showing the division; as an illustration, under inventory there are subaccounts showing miscellaneous stores, cement, steel, and iron, lumber, explosives, etc.; and under accounts receivable (current uncollected), construction water-right charges, operation and maintenance charges, operation and maintenance supplemental construction charges, rentals from grazing and farming lands, etc. All of the accounts referred to are carried in the general ledger and each of the accounts is supported by subsidiary records.

Under the general head "cash" there is a control of this through a regular cash book; under inventories each class of supplies is supported by bin cards showing the amount of supplies of the different classes on hand, the unit price, and the total value. Under "plant equipment," cards showing the original cost and present value; accounts receivable (current uncollected) are supported by detail account with each water user or other person or firm indebted to the service.

"Construction cost of work performed by the United States" is supported by a detailed cost ledger, which in turn is supported by a classification book giving reference to the original source of entry, such as requisitions, time books, invoices, bills of lading, etc. The same applies to the operation and maintenance costs. Accounts payable are supported by unpaid labor items; unpaid purchases by the personal ledger; unpaid transportation by cards giving Government bill of lading numbers and reference to railroad company expense bills. The deferred and contingent obligations are supported by records especially prepared for this information; reserves are supported by reference to particular accounts or registers on which the detail is shown, totals being carried forward. In the investment group the accounts are supported by voucher registers, which in turn are supported by copies of original disbursement and collection vouchers.

Inspectors familiar with reclamation methods and procedure are employed to examine all of the field accounts, correct errors in procedure, and report their findings.

The three main accounts are as follows: Net investment, cost keeping, and repayments. The first, net investment, is to hold an absolute control of the total expenditures and receipts in connection with

each project; the second, cost keeping, is very important to the man in charge of the construction work; and the third, repayments, is also very important because it has to do with the return of the Government investment by the individual water users.

ORGANIZATION

The accounting organization is as follows: The chief accountant outlines the system to be followed, but all instructions are given the project offices over the signature of the commissioner. After a procedure has been approved, accounting matters are handled with the project by the chief accountant.

On each project is a chief clerk who has charge of all accounts for that particular project. He reports directly to the project manager. Under the chief clerk are usually a bookkeeper, purchasing agent, special fiscal agent, cost keeper, and the necessary clerical organization to take care of the stenographic work, handling of correspondence, timekeepers, storekeepers, and property inspectors. All these employees generally report to the chief clerk, but he is not empowered to employ or discharge anyone under his direction without the approval of the project manager.

The project manager can not require a chief clerk to handle his account other than in accordance with the instructions as given in the manual or in circular letters covering accounting matters. The chief clerk is required to purchase any material or supplies the project manager may order, subject, of course, to the authority delegated to project managers by the commissioner or the Denver office, and to approve payments to those employed at the rates shown on the contract of employment. He must satisfy himself that supplies ordered have been received and personal services rendered before he passes an account for payment; he sees that accounts due the bureau are prepared and mailed to water users covering construction and operation and maintenance charges, but is not empowered to use any means of hastening collection other than sending out "follow-ups."

WEAKNESSES OF PRESENT SYSTEM

The present system is weak in that there is not the close distinction between original construction, additional construction, supplemental construction, and operation and maintenance costs that should be required. Under construction is carried cost of work performed by the United States and often referred to as original construction. In this account is carried cost to be repaid within the 20-year period. This account should be divided to show separately the cost of original construction as originally contemplated, and any additional work requested by the water users should be carried in a separate account although it would be paid within the 20-year period. Under supplemental construction is included not only additional work voted after public notice was announced, but delinquent operation and maintenance accruals covered by agreements to repay after the 20-year period. This account should include only actual supplemental construction work.

Under cost of operation and maintenance is included a small amount covering construction work which the water users agreed to repay

to show the regular operation and maintenance cost and a separate account set up for the additional work. There has not been a great deal of this and it would not be difficult to make this separation.

A very vexing problem is the one dealing with contracted and not contracted returns, areas under different divisions whether public or private, and whether for a full water right or a partial water right. A better control of these is necessary.

The titles assigned some of the general accounts need changing to give one not familiar with the accounting system a better understanding of the nature of the account.

Definite instructions are needed as to the accounts that should be carried; and when decided, no official financial figures should be published or furnished that can not be taken from the books. Any other information furnished should be prefaced by the statement "Information not carried in regular accounts but the following data were secured from _____ source".

In the Washington office a more complete statistical record should be maintained, and although this will entail additional expense for clerical help, it would be money well spent in order to give information at any time to the Secretary, Congressmen, and others.

STATISTICAL DATA

The study of the statistical data compiled by the Bureau of Reclamation, as published in its annual and other reports, reveals the need of a careful review being made with the purpose of revising and simplifying them. They should be made more comprehensive; for instance, the irrigable area of each project should be classified into lands under water-right contracts, water rentals, Warren Act, special contracts, irrigated, cropped, etc. Many of the data such as financial, operation, agricultural, and settlement are incomplete, and not readily available. It is essential that project managers be impressed with the importance of such data, which should be brought up to date at once. In the future more attention should be given to the importance of gathering complete and accurate data and having these properly recorded and always available.

COLLECTIONS

METHOD EMPLOYED

The present practice in reference to collections is that bills are issued by the accounting office at the end of each irrigation year for the construction and operation and maintenance charges. Under the extension act there is requirement that no water can be delivered to a water user who is more than one year in arrears. If the water user does not pay the amount when due a penalty of 1 per cent per month is assessed. After the issuance of the bills follow-up letters are sent to the water user calling for payment of the account, but no harsh methods are used in case he does not make the payment.

PRESENT STATUS

Under recent legislation a water user can be more than one year in arrears and still secure water. With the increasing of the construction charges from 2 to 4 per cent and 4 to 6 per cent, and with

the increasing acreage coming in, the accounts receivable have increased materially in the last four years even though the amount of payments by the water users has been as much as or more than previous to that date. This is illustrated by the following:

On June 30, 1920, there was uncollected about \$1,476,000; on June 30, 1921, \$3,503,000; June 30, 1922, \$4,631,000; and June 30, 1923, \$5,319,000. The total collections during the fiscal year 1920 amounted to \$4,902,000; 1921, \$4,192,000; 1922, \$4,295,000; and 1923, \$5,144,000. Note from this tabulation that while the accounts receivable increased each year the actual collections of the projects were more during the fiscal year 1923 than during any of the preceding years.

REASONS FOR INCREASES IN UNCOLLECTED ACCOUNTS

There are three main reasons for the increase in the uncollected accounts: (1) The general depression in the country, (2) increase in the amounts to be charged on all of the projects, and (3) the recent legislation granting relief to water users on all projects where relief could be granted under the relief act.

(1) *General depression.*—The farmers on reclamation projects have experienced the same depression as other farming communities with the high cost of production and the slump in the prices of crops sold, making it impossible for many of them to meet their obligations.

(2) *Increase of charges.*—This increase is due to the issuance of public notice on additional acreages on the several projects, and to the fact that some of the projects have gone from a 2 per cent to a 4 per cent basis and some from 4 to 6 per cent. The reason for the increase in charges and the lack of payments is that the water users have not all their land in cultivation and the bureau is attempting to collect the construction charge on the entire area whether cultivated or not.

(3) *Recent legislation.*—The recent legislation granting the delivery of water, even though a water user was more than one full year in arrears, took away from the bureau a strong lever to force collections. There are many who could and would pay if they were not laboring under the impression that some legislation would be passed granting them either immediate or permanent relief.

THE PROJECT MANAGER

Another vital factor in the collection of accounts is the nonsupport of the project manager when he attempts to force collections. Any attempted drastic action, though entirely within the law, results in the one affected taking up the matter immediately with his Senator or Representative in Congress or some other influential friend, and orders are then issued by those in authority to the project manager to extend the time. This affects not only the particular case but other cases. This breaks down the morale. In this respect he is in the position of a bluffer and the water users feel that he can not make his threats good and so disregard any appeal or any threat that he may use in trying to force collections. This of course has its effect on the project manager also and he is inclined to be lenient and not force the issue if there is a possible chance that he will not be supported in

carrying out instructions laid down. The collections would be materially increased and there would be fewer outstanding accounts if no authority to grant any kind of relief would be given except by act of Congress.

PASSIVE ASSETS

MEANING

The Federal irrigation projects, when ready to deliver water for irrigation, have made contracts under the terms of the reclamation act with the prospective water users for the sale of water rights. Upon the basis of these contracts repayments of construction and other costs have been made; and upon the fulfillment of these contracts the revolving nature of the reclamation fund depends.

On June 30, 1923, there had been invested in the Federal irrigation projects, subject to repayment, the sum of \$143,054,021.15. On the same date the value of the contracts for water rights amounted to \$103,611,995.06. The difference, a sum of \$39,442,026.09, is not yet contracted for and represents a passive asset of the Government's reclamation venture.

LAND

The present irrigable acreage under the Federal reclamation projects, excluding Warren Act lands, is 1,874,970 acres. Of this acreage the contracts above referred to cover 1,293,906 acres. This leaves 581,064 acres, to 325,346 of which the bureau was prepared to supply water which are not yet covered by contracts with water users, and which correspond to the inactive sum of about \$39,000,000 mentioned above. Under the pending legislation \$10,856,000 are requested for the projects, for the fiscal year 1925, which will increase the area to be contracted for by approximately 100,000 acres.

WATER

From another point of view the passive assets of the Bureau of Reclamation are represented by water stored or subject to diversion which has not yet been contracted for. It is exceedingly difficult to arrive at actual figures with respect to water quantities, varying as they do from season to season, yet there are approximately 661,000 acre-feet of water not yet under contract.

PROBLEM OF THE PASSIVE ASSETS

The sum of \$39,000,000, or about 27 per cent of the \$143,000,000 invested in irrigation projects and repayable by the water users, includes the costs of the Grand Valley, Milk River, North Platte (Fort Laramie division), and Sun River (Greenfields division), which are not yet under public notice and on which, therefore, only water-rental contracts exist. The problem of the passive assets is a large one, especially in view of the fact that the projects on which public notice has not been issued have serious problems of settlement to be solved before recovery of the invested funds can be expected.

The problem of securing contracts for the available water rights is one of settlement. There is not now a great movement to the farm. Those who go out in search of homesteads are likely to exercise greater care than in the past in making their selections. Many localities are bidding for intending settlers. The Government must undertake a carefully thought-out plan by which the vacant lands under the irrigation projects may be settled and brought under water-right contracts.

Private land holders must be made to understand that their own and the community welfare are dependent upon the elimination of the land speculator from irrigation ventures, and that the large private holdings must be divided according to the established unit on the project at the earliest possible date. The intending settler must be given such assistance, technical and otherwise, as will make him reasonably certain of success, should he enter into a contract with the Government for water rights. These problems should be solved soon, though it is better to allow some of the large sums invested in Federal irrigation enterprises to remain in suspense for some years than to undertake a hasty settlement before the time is ripe, which may lead to the difficult situations that have formerly arisen on the Federal irrigation projects.

COMPLETION OF PROJECTS

Practically all existing Federal irrigation projects have requested one or more extensions for the completion of the projects. This proposed extension work has been examined in detail by the Bureau of Reclamation. In some cases, unless these extensions are authorized, the work already done will be insufficient to provide the water for which the structures were designed, and, therefore, considerable financial loss will ensue. The cost of the proposed work for the respective Federal irrigation projects has been roughly estimated to be \$107,369,215. However, this added work will bring under water 1,063,147 acres of land which are not now included in the irrigable area of the projects. Should these extensions be authorized, it would mean that the total construction cost of the existing irrigation projects would be in the neighborhood of \$250,000,000, and that this sum has been expended upon relatively few projects, authorized at the beginning of the service, and which, at that time, were expected to be completed within a few years.

CONCLUSIONS

It is evident that the whole matter of passive assets and of extensions and completions of projects should be subjected to careful scrutiny before work is undertaken, whether of construction or settlement.

The first duty of the Bureau of Reclamation is to help the water users, already under contract with the Government, to succeed upon their farm units. The second duty is to make active the present large inactive sum under the heading of passive assets. Only then should serious attention be given to proposed extensions of the older projects, unless, indeed, these show themselves to be of high economic attractiveness.

SUMMARY OF LOSSES

It has been found not just to require, and in some instances not possible to obtain, the total repayment of costs of investigation, construction, operation, and maintenance charged against the projects.

Hence the reclamation fund must suffer depletion to the extent that such costs should not or can not be repaid either by the water users or by the United States. There are two classes of projects—secondary and primary.

Costs charged against secondary projects cover all expenditures for preliminary reconnaissances, surveys, and examinations. If a secondary project is selected and construction authorized such preliminary expenditures become part of total construction—if a secondary project is not selected and authorized such preliminary costs are carried in suspense account. If a secondary project is definitely abandoned the reclamation fund must suffer a permanent depletion in the amount of such preliminary expenditure.

Total costs charged against primary projects cover preliminary expenditures, all expenditures for construction, operation, and maintenance during construction, before public notice, and accumulated unpaid expenditures for construction, operation, and maintenance, interest, and penalties which have been added to the total costs by authority of law.

The committee has found that such total costs on some projects are in excess of what water users can or should be required to repay. The reclamation fund must suffer depletion to the extent that water users can not repay and should suffer depletion to the extent water users should not repay such costs. The reports upon the special projects contain the facts regarding costs and the reasons for recommending reductions of charges to water users. The following table shows the actual and probable reductions which the committee recommends.

Under the head "definite loss" items are listed which must result in actual depletion of the fund.

Under the head "probable loss" items are listed which are estimated, the amounts depending upon the acreages now not capable of profitable cultivation, but which may hereafter be restored to or found capable of profitable cultivation. Under this head are also listed items which may be restored to the fund by congressional action.

Project	Resolution No.	Probable loss	Definite loss
Salt River.....	37		\$382,067
Yuma Auxiliary.....	40	None.	None.
Yuma.....	38-39	\$2,700,000	1,351,000
Orland.....	41	None.	None.
Grand Valley.....	42	1,000,000	
Uncompahgre.....	43	1,500,000	47,370
King Hill.....	44		1,000,000
Minidoka.....	45	None.	None.
Boise.....	46	None.	None.
Garden City.....			334,475
Huntley.....	47	400,000	100,000
Milk River.....	48		2,000,000
Sun River:			
Fort Shaw division.....	49	130,000	70,000
Greenfields division.....			1,850,000
Lower Yellowstone.....	50		1,000,000
North Platte.....	51	600,000	None.
Newlands.....	52		2,600,000

Project	Resolution No.	Probable loss	Definite loss
Carlsbad.....	53	None.	None.
Hondo.....	54		\$371,886
Buford-Trenton.....	54		294,318
Williston.....	55		600,000
Rio Grande.....	64	None.	None.
Umatilla.....	56		600,000
Klamath.....	57	\$500,000	250,000
Belle Fourche.....	58	750,000	None.
Strawberry Valley.....	59	None.	None.
Okanogan.....	60	500,000	275,000
Yakima.....	61	None.	None.
Shoshone, Frannie division.....	63	750,000	2,325,000
Riverton.....	62	(¹)	(¹)
Secondary.....	65	None.	1,200,000
		8,830,000	18,561,146

¹ Under construction.

A PLAN OF REPAYMENT

THE PRESENT PLAN

The original reclamation act of 1902 provided that the money invested by the Government in irrigation works should be returned by the water users within 10 years after the execution of the contracts. The Secretary of the Interior interpreted this to mean that the construction charge should be repaid in 10 equal installments. This plan did not prove successful. Therefore the extension act of 1914 provided that the repayment shall be made in 20 annual graduated payments. The water user is required to pay, each year, 2 per cent of the full acre cost during the first 4 of the 20 years; 4 per cent for each of the fifth and sixth years, and 6 per cent for each of the remaining 14 years. The Federal irrigation projects, for which public notice has been issued, are now operating under this plan.

RESULTS OF THE 20-YEAR PLAN

The 10-year and the 20-year repayment plans have both been unsuccessful. Soon after the projects were opened the water users complained that they could not meet the annual repayment charge of one-tenth of the construction cost, along with their other obligations. Under the extension act, in the fall of 1914, all accrued charges were covered into the construction account of each water user, and a new start made under the 20-year plan. While the 2 per cent charge prevailed all of the projects, then under public notice kept up their payments very well.

Percentage uncollected of construction charges due

[Statistics from Accounting Division, Bureau of Reclamation]

Project	1918	1920	1923	Project	1918	1920	1923
Yuma.....	36.3	7.9	6.3	Umatilla.....	8.1	5.1	12.3
Minidoka.....	1.9	1.7	10.4	Klamath.....	.6	5.4	5.4
Huntley.....	2.2	1.5	8.2	Belle Fourche.....	5.5	6.8	36.2
Sun River.....	3.1	2.2	12.1	Okanogan.....	8.2	129.0	3.4
North Platte.....	12.9	10.4	27.8	Yakima.....	2.4	1.5	5.3
Newlands.....	1.5	1.0	4.5	Shoshone.....	.8	1.4	23.7
Carlsbad.....	4.0	2.6	8.3				

¹ Repayments suspended by special order

At the end of the four years of 2 per cent annual repayment, on June 30, 1918, the average percentage of uncollected construction charges, for all the projects that were under public notice in 1914, excepting Lower Yellowstone and Williston, was less than 7 per cent, which would have fallen to nearly 4 per cent had the indebtedness of the Yuma project, due to temporary conditions, been omitted.

During the following two years of 4 per cent annual repayments, the percentage of uncollected construction charges was reduced on all the projects, excepting Klamath, Belle Fourche, Okanogan, and Shoshone, where increases occurred, Okanogan only being of consequence. The average per cent of uncollected charges on June 30, 1920, was 5.9 per cent as against 6.7 per cent of two years before.

It is true that this 4 per cent period included the prosperous years of 1918 and 1919, yet from the fact that the percentage of uncollected accruals was reduced during this period, it may be safe to infer that even if prices had remained normal there would not have been any marked increase in the percentage of uncollected charges.

From this time on, the annual charge of 6 per cent became operative. After three years, on June 30, 1923, every project, excepting the Klamath, Okanogan, and Yuma projects, showed a considerable increase in the percentage of uncollected charges. On that date the average uncollected charges amounted to 12.6 per cent of the charges due, or three times as much as on the corresponding date of three years before. This period was marked by great economic disturbances, resulting in an unusual agricultural depression, and the fact that this abnormal period coincided with the period when the maximum annual construction charge of 6 per cent became effective undoubtedly determined the increased delinquency.

Allowance must be made for the many conditions that have influenced agriculture during the last two decades, yet one is forced to conclude that, in fairly prosperous times, an annual payment of 10 per cent and in times of depression 6 per cent of the acre construction cost are too high for the average project farmer to bear, under the present development of project agriculture.

CAUSES OF FAILURE

It is worse than idle to assume that lands of equal fertility can bear widely different annual construction payments, or that all lands—good, indifferent, or poor—under a single project can bear the same annual construction payments, yet the existing plan of repayment was based upon that assumption. Neither time nor an arbitrarily fixed percentage of cost is a sound basis for determining annual payments. Whether the total construction cost be great or small, it can only be paid out of the produce of the lands; hence, productivity is the only safe and fair basis for fixing annual payments.

To illustrate, the average acre costs, exclusive of later drainage costs and special contracts, vary on the different projects from \$29 to \$96. On the projects costing \$96 per acre, the 6 per cent charge would be \$5.76, whereas on the \$29 land only \$1.74. Assuming an equal productivity power of the two projects, one farmer would have to pay three times as much as the other. With a small crop and many obligations this may mean failure to the farmer. When, as frequently happens, the more expensive land has the lower crop-producing power

the weakness of this method of repayment becomes more apparent. Certainly the present method of repayment is not based upon a scientific consideration of the problem.

THE PRODUCTIVE POWER OF LAND

The farmer must or should repay the cost of project construction and meet his other farm expenses from the revenue derived from the farm. The question ever before the farmer is: Will the crop income of this year meet my obligations? The power of the land, under given economic and physical conditions, to produce a revenue is the only safe basis upon which to build a rational method of repayment of construction charges. It is this factor which appears to have been ignored in the mass of legislation pertaining to Federal reclamation except in the phrase, "shall be apportioned equitably," as stated in section 4 of the original act of 1902.

A comparison of the percentage of accrued charges as of June 30, 1923, with the average crop value per acre indicates a definite correlation between the farmer's income per acre and his ability to repay construction costs. In the following table the 13 projects that were under public notice and agriculturally active in 1914 have been arranged in the order of the per cent of the charges due but uncollected on June 30, 1923. In the last column is given the average crop value per acre for each of the projects.

Effect of acre income upon unpaid charges

Project	Per cent of charges due but uncollected, June 30, 1923	Average acre crop value during period of 10 to 11 years	Project	Per cent of charges due but uncollected, June 30, 1923	Average acre crop value during period of 10 to 11 years
Okanogan.....	3.4	\$148.05	Minidoka.....	10.4	\$36.38
Newlands.....	4.5	25.62	Sun River.....	12.1	20.34
Yakima.....	5.3	86.45	Umatilla.....	12.3	41.33
Klamath.....	5.4	19.35	Shoshone.....	23.7	28.29
Yuma.....	6.3	63.82	North Platte.....	27.6	32.24
Huntley.....	8.2	31.22	Belle Fourche.....	36.2	15.68
Carlsbad.....	8.3	41.98			

When the many and varying factors are considered that have entered into the making of the financial history of the Federal irrigation projects, this is a remarkable correlation between delinquency and acre income. When the crop income is high, the percentage of unpaid charges is low; as the acre income diminishes, the delinquency increases. The project with the highest acre income has the lowest percentage of unpaid charges, and the project with the lowest acre income has the highest percentage of unpaid charges. The most notable departure from the rule is the Newlands project, which during the three years of agricultural depression had an acre income higher than its average of the last 11 years of record. The only other departure of consequence, that of the Klamath project, is also explain-

able by unusual local conditions. A combination of the figures as in the following table brings out this correlation even more distinctly:

Average per cent of charges due but uncollected	Average crop value
4.7	\$65.60
7.6	45.67
11.6	32.68
25.8	20.27
36.2	15.68

Clearly the crop value per acre is the factor of prime importance in determining the financial success of an irrigation project. Any devices that tend to increase the acre income should be of first concern to the water user and the project builder. A scientific method of repayment of the construction costs of the Federal irrigation projects must be proportional to the acre value of the crop produced.

ACRE COSTS AND ACRE INCOMES

The comparison of acre costs and acre incomes of the Federal irrigation projects brings out still more clearly the weakness of the present method of repayment which takes into account neither the varying acre construction cost nor the varying acre income. In the following table, which has already been used in the section on acre costs, the value of the average annual crop production for each dollar of construction cost, using the average acre cost under the project, has been calculated.

Table showing average annual production for each dollar of acre cost

State	Project	Average acre cost	Average acre income ¹	Average annual production for each dollar of acre cost
Washington	Yakima-Sunnyside	852	\$99.36	\$1.71
Do	Okanogan	94	148.05	1.57
Idaho	Minidoka-Gravity	20	35.19	1.21
Arizona	Salt River	60	61.14	1.02
California	Orland	44	45.15	1.03
Montana	Huntley	34	31.22	.92
Arizona-California	Yuma	71	63.82	.90
New Mexico	Carlsbad	49	41.98	.86
Washington	Yakima-Tieton	96	76.78	.80
North Dakota	Williston	38	27.97	.74
Idaho	Minidoka-South Side pumping	57	38.00	.67
Montana	Sun River-Fort Shaw	33	21.17	.64
Nevada	Newlands	41	25.62	.62
Utah	Strawberry Valley-High Line	82	\$ 50.57	.62
Oregon	Umatilla	70	41.23	.59
Colorado	Uncompahgre	70	40.85	.58
Oregon-California	Klamath	35	19.25	.55
New Mexico-Texas	Rio Grande	90	47.27	.53
Nebraska-Wyoming	North Platte-Interstate	55	27.39	.50
Idaho-Oregon	Boise	76	36.10	.47
Wyoming-Montana	Shoshone-Garland	52	24.38	.47
South Dakota	Belle Fourche	33	15.56	.47
Montana-North Dakota	Lower Yellowstone	45	20.79	.46
Wyoming-Montana	Shoshone-Frannie	80	17.23	.22

¹All years of record.

²Entire project.

The annual crop value for each dollar of construction cost varies from \$1.71 on the Yakima project, Sunnyside division, to \$0.22 on the Shoshone project, Frannie division. To require an annual repayment based upon the same proportion of the construction costs of the different projects would be manifestly unfair. This requirement has been and is a real cause of difficulty on Federal irrigation projects.

ACRE INCOME THE BASIS OF REPAYMENT CHARGES

It follows from the above discussion that a scientific method of repaying the construction charges of the projects should be based upon the acre income from the land. That is, a definite proportion of the annual income from each acre should be applied to the payment of the construction charges. The effect of such a method of repayment would be to make a different annual repayment charge upon each project or division of a project, in accordance with their varying productive capacities. This would have the effect of enabling a project with a low acre cost to pay out in fewer years than one of high acre cost, assuming the acre income to be the same; or, if two projects had the same acre cost, but different annual acre incomes, the one with the highest acre income would pay out first. The principle of a definite period of repayment, as contained in the reclamation acts, would be replaced by the principle of a varying period of repayment, depending upon the acre cost of water rights and the productive capacity of the land.

NET OR GROSS INCOME

If such a principle be adopted as a basis for construction repayment, shall the net or gross acre income be used as a basis for collecting accrued charges? There are many arguments in favor of employing the net income, but the final argument against it is that under present conditions of agricultural practice a correct net cost of agricultural production can not be secured. Earnest attempts were made in cooperation with eminent workers in the field of agricultural economics to secure data that might be used in determining the net acre incomes of the Federal irrigation projects. All such endeavors were unsuccessful. The construction repayments must therefore be based upon the average gross acre incomes, which can be determined with considerable accuracy. On projects where specialized crops, like cotton, apples, or lettuce, are grown over large acreages, and which often involve a proportionately larger cost item per acre, an adjustment may be necessary.

CROP INCOME TO BE USED

Crop yields on the same soil vary considerably from year to year. Market conditions show a similar variation. If annual repayment charges were based upon the acre income of each preceding year, there would be a marked variation in the annual construction repayments. Such fluctuations should be so small that the farmer may be able to foretell, within narrow limits, the charge that he will have to meet from year to year. This can be accomplished by using the average acre income of the preceding 10 years as a basis for calculat-

ing the repayment charge for any year. With each successive year the first year of the last average would be dropped off and the new year added. In such manner each succeeding year, with its high or low acre income, would affect the basic average, but not sufficiently at any one time to cause a wide departure from preceding payments. Any one of the 10 years would affect the repayment charge only one-tenth, but its influence would be felt.

Reliable crop statistics have been gathered by the Reclamation Service from the Federal irrigation projects since 1912. Should the plan of repayment here proposed be adopted, an even more complete crop survey should be made from season to season. Such statistics, while furnishing a basis for the annual construction charge, would serve other purposes in directing agricultural development upon the projects.

The data already available are sufficient to permit the compilation of 10-year averages of crop yields on most of the projects. This table, corrected if need be by a review of the existing records, can be used as the basic table in determining the first annual repayment charges on the projects.

Average crop returns per acre, 1913-1922

Salt River.....	\$64.26	North Platte—Interstate divi-	
Yuma.....	65.71	sion.....	\$29.07
Orland.....	46.99	Newlands.....	26.90
Uncompahgre.....	41.70	Carlsbad.....	44.38
Minidoka—Gravity division.....	35.19	Rio Grande.....	45.62
Minidoka—South Side pump-		Umatilla.....	43.06
ing division.....	38.01	Klamath.....	19.68
Boise.....	38.11	Belle Fourche.....	16.23
Huntley.....	31.63	Okanogan.....	159.20
Milk River.....	14.95	Yakima—Sunnyside division..	91.35
Sun River—Fort Shaw divi-		Yakima—Tieton division.....	81.66
sion.....	22.06	Shosone—Garland division....	25.81
Lower Yellowstone.....	19.65		

FEDERAL RECLAMATION BY IRRIGATION

Table showing construction repayments in per cent of crop returns on Federal irrigation projects

[Crop returns from Bureau of Reclamation annual reports; construction repayments from Bureau of Reclamation Accounting. Irrigable acreage under water-right contracts (public notice) used in computing "Construction repayment per acre" furnished in part by Accounting and part from "Summary of construction results" a semiannual report by the projects.

State	Project and division	Average construction cost per acre	6 per cent of average construction cost per acre	5 per cent of average crop returns per acre, 1913-1922	Actual construction repayments by projects in per cents of crop returns per acre			Remarks
					Fiscal years 1915-1922	Fiscal years 1920-1922, crop years 1919-1921	Fiscal year 1922, crop year 1922	
Arizona	Salt River	\$60	\$3.60	\$3.21	Per cent 1.84	Per cent 1.23	Per cent 2.02	Water rental. Contract with irrigation district.
Arizona-California	Yuma	71	4.26	3.29	3.80	3.52	4.33	
California	Orland	44	2.64	2.35	3.78	3.45	7.10	
Colorado	Grand Valley			2.28				
Do	Uncompahgre	70	4.20	2.09	1.06	.87	1.75	
Idaho	King Hill			1.97				
Do	Minidoka			1.82	2.83	2.72	4.80	
	Gravity	29	1.74	1.76				
	South Side pumping.	57	3.42	1.90				
Idaho-Oregon	Boise	76	4.56	1.91	4.38	3.20	6.68	
Montana	Huntley	34	2.04	1.58	1.61	1.71	1.77	Water rental.
Do	Milk River			.75				
Do	Sun River			1.02				
	Fort Shaw	33	1.98	1.10	2.24	2.49	2.60	
Montana-North Dakota	Lower Yellowstone	45	2.70	.98				
Nebraska-Wyoming	North Platte			1.61	4.04	4.41	4.79	
	Interstate	55	3.30	1.45				
	Fort Laramie			.97				
	Northport	70	4.20	1.05				
Nevada	Newlands	41	2.46	1.34	2.75	2.31	2.07	
New Mexico	Carlsbad	49	2.94	2.22	3.17	2.49	4.48	
Do	Rio Grande	90	5.40	2.28			1.70	
North Dakota	Williston	38	2.28	1.50				
Oregon	Umatilla	70	4.20	2.15	2.67	1.88	5.40	
Oregon-California	Klamath	35	2.10	.98	4.06	3.68	8.35	
South Dakota	Belle Fourche	33	1.98	.81	3.75	3.36	1.94	
Utah	Strawberry Valley, High Lins.	82	4.92	2.53	2.90	3.06	7.67	Crop returns for entire project used.
Washington	Okanogan	94	5.64	7.96	.85	.37	.61	
	Yakima			4.45				
	Sunnyside	52	3.12	4.57	1.12	1.07	1.78	
	Tieton	96	5.76	4.08	3.62	2.89	4.52	
Wyoming	Riverton							
	Shoshone			1.45	3.01	3.23	2.29	
	Garland	52	3.12	1.29				
	Frannie	80	4.80	.86				

Table showing construction repayments in per cent of crop returns on Federal irrigation projects

State, and project and division	Average construction cost per acre		Average construction repayment per acre fiscal year 1916-1923	Average crop returns per acre 1913-1923 (unless otherwise noted)	Construction repayment in per cent of crop returns	Average construction repayment per acre fiscal year 1920, 1921, 1922	Average crop returns per acre 1919, 1920, 1921	Construction repayment in per cent of crop returns	Average construction repayment per acre fiscal year 1923	Average crop returns per acre 1922	Construction repayment in per cent of crop returns	Per cent of average crop returns 1913-1922
	Cost	Per cent										
1	2	3	4	5	6	7	8	9	10	11	12	13
Arizona: Salt River.....	\$60	\$3.60	\$1.18	\$64.26	1.84	\$1.11	\$94.05	1.23	\$1.36	\$67.20	2.02	\$3.21
Arizona-California: Yuma.....	71	4.26	2.53	65.71	3.80	2.76	78.39	3.52	2.15	49.70	4.33	3.20
California: Orland.....	44	2.64	1.77	46.99	3.78	1.90	55.01	3.45	3.40	47.92	7.10	2.35
Colorado: Grand Valley.....	(¹)	(¹)		45.58			48.09			30.88		8.28
Uncompahgre.....	70	4.20	.44	41.70	1.06	.44	50.39	.87	.44	25.14	1.78	2.09
Idaho: King Hill.....	(²)	(²)	(²)	39.39			41.83			36.33		1.97
Mindoks.....	29	1.74	1.03	36.38	2.83	1.22	44.95	2.72	1.45	30.25	4.80	1.82
Gravity.....	57	3.42		35.19						27.18		1.76
Idaho-Oregon, Boise.....	76	4.56	1.67	38.11	4.38	1.60	50.00	3.20	2.46	36.98	6.68	1.91
Montana: Huntley.....	34	2.04	.51	31.63	1.61	.57	33.38	1.71	.52	29.33	1.77	1.56
Milk River.....	(¹)	(¹)		14.95						11.14		.75
Sun River.....	(¹)	(¹)										1.02
Fort Shaw.....	33	1.98	.49	22.06	2.24	.64	25.73	2.49	.40	15.38	3.60	1.10
Montana-North Dakota: Lower Yellowstone.....	45	2.70	(²)	19.65						21.68		.98
Nebraska-Wyoming: North Platte.....	55	3.30	1.31	32.24	4.04	1.61	36.49	4.41	.91	18.99	4.79	1.61
Interstate.....	(¹)	(¹)		29.07			40.31			21.74		1.45
Fort Laramie.....	70	4.20		19.32			22.82			15.42		.97
Northport.....				21.05						21.05		1.05
Nevada: Newlands.....	41	2.46	.74	26.90	2.75	.77	33.36	2.31	.67	32.43	2.07	1.34
New Mexico: Carlsbad.....	49	2.94	1.41	44.38	3.17	1.63	65.44	2.49	2.39	53.41	4.48	2.22
New Mexico-Texas: Rio Grande.....	90	5.40	(²)	45.62			48.24		.90	53.06	1.70	2.28
North Dakota: Williston.....	38	2.28		30.02			29.64			33.26		1.50
Oregon: Umatilla.....	70	4.20	1.15	43.06	2.67	.97	51.48	1.88	2.12	39.24	5.40	2.15
Oregon-California: Klamath.....	35	2.10	.80	19.68	4.06	.80	21.72	3.68	1.36	16.30	3.35	.96
South Dakota: Belle Fourche.....	33	1.98	.61	16.23	3.75	.65	19.37	3.26	.20	10.29	1.94	.81
Utah: Strawberry Valley High Line.....	82	4.92	1.47	50.67	2.90	1.70	55.50	3.06	2.30	30.00	7.67	2.53
Washington: Okanogan.....	94	5.64	1.35	159.20	.85	1.03	280.10	.37	2.03	332.45	.61	7.96
Yakima.....				89.06			125.40			62.48		4.45
Sunnyside.....	62	3.12	1.02	91.35	1.12	1.32	123.07	1.07	1.39	74.13	1.76	4.57
Tieton.....	96	5.76	2.96	81.66	3.62	3.63	132.63	2.89	4.33	95.60	4.52	4.66
Wyoming: Riverton.....	(²)	(²)										
Wyoming-Montana: Shoshone.....			.87	28.91	3.01	.93	28.78	3.23	.43	18.80	2.29	1.45
Garland.....	62	3.12		25.81			31.83			20.50		1.29
Frannie.....	80	4.80		17.23			16.25			12.96		.86

¹ Water rental.² Contract with irrigation district.³ Payment suspended.⁴ Payments deferred.⁵ Under construction.

Crop returns from Bureau of Reclamation annual reports. Construction repayments from Bureau of Reclamation, accounting. Irrigable acreage under water-right contracts (public notices) used in computing "Construction repayment per acre" furnished in part by accounting and part from "summary of construction results" a semiannual project report.

THE PERCENTAGE TO BE EMPLOYED

The percentage to be applied to the average acre yield to determine the actual annual acre charge for repayment must of necessity be somewhat arbitrarily established; yet it must come within the ability of the farmer to live and to meet his various obligations. Unless this is done, the plan fails of its purpose. To arrive at a basis for such a percentage the following table has been constructed. The third column shows the amounts equal to 6 per cent of the average acre construction charge on the various projects. The sixth, ninth, and twelfth columns show the average construction payments for the period 1916-1923; for 1920-1922, and for 1923, in percentages of the average acre crop value for the 10 years 1913-1922. The last column gives the amounts equal to 5 per cent of the average acre crop returns for the 10-year period.

In 1923, during a period of severe agricultural depression, when the charge of 6 per cent of the construction cost had been reached, five projects paid on construction more than 5 per cent of the average acre crop income; five, between 4 and 5 per cent; four, between 2 and 3 per cent; five, between 1 and 2 per cent, and one under 1 per cent. On every project, excepting Yakima (Sunnyside division), Okanogan, and Minidoka (Gravity division), an annual charge for construction of 5 per cent of the average acre crop returns for the last 10 years would be smaller than the charge of 6 per cent of the construction cost, which is now the legal requirement. The water users in their Salt Lake City resolutions of January, 1924, suggested an annual construction charge not to exceed 5 per cent of the average acre income for 10 years, as a charge that can be paid by the water users. This opinion agrees with our findings from our study of the situation on the Federal reclamation projects.

LAND CLASSIFICATION

A corollary of this plan of repayment is that the lands on the projects be classified carefully, according to their probable acre incomes, and that each class on each project be treated as a unit in fixing the annual repayment charge.

RECOMMENDATIONS

Repayment plan based on acre income.—Experience has demonstrated that the present method for repayment of project construction costs, based upon time and percentages of cost, instead of the ability of the several classes of lands to produce, is unscientific and difficult of fulfillment. Productive power should be the basis for the annual repayments of construction costs, and for this purpose productive power of the lands should be defined to be the average gross annual acre income from the irrigated lands of a project or division thereof for the preceding 10 years, or for all years of record, if fewer than 10 years are available, and that the annual acre repayment charge should be 5 per cent of the productive power of the lands as hereinabove defined.

Disposition of unpaid dues under new plan of repayment.—Whenever a new policy of repayment of construction costs is adopted, all

unpaid and due charges for construction and for operation and maintenance, including interest and penalties, should be added to the construction accounts of the respective farm units. The new total thus established should be the construction cost to be repaid by the water user.

Payment of operation and maintenance and construction charges.—Whenever the new method of repayment goes into effect, all annual operation and maintenance charges should be payable in advance, on January 1; and that the construction charges for any calendar year should be payable on July 1 of the following calendar year.

Statistical survey.—The proper supervision and development of an irrigation project requires correct knowledge of the conditions of the project from year to year. A careful statistical survey should be made annually, to show acreages and acre yields of the various crops grown, the farm animals maintained, the average prices received for all farm products, the markets on which such products were sold, the quantity of water used in irrigation, and such other information as may be found desirable for the welfare of the project. This statistical information should be kept on file at the project manager's and the commissioner's offices.

THE BUREAU OF RECLAMATION UNDER THE PROPOSED REORGANIZATION

Below is given a chart showing duties and authority of the principal officers of the bureau under the proposed reorganization. The purpose is to secure a clear division of duties of those intrusted with the different activities of the bureau.

The Division of Engineering has no functions except those of construction, operation, and maintenance. This relieves the engineers of all duties outside of their special training and experience, permits of a better selection of members of the staff, and avoids contact with the settlers on financial matters, which has been a source of friction in the past.

The Division of Finance will coordinate and supervise the large routine expenditures for supplies and equipment, and, what is equally desirable, will provide continuous attention to the collection of the immense sums due from settlers.

The Division of Farm Economics will help settlers organize to work together in accomplishing those things which can be done better by a community than by separate individuals, will help settlers work out programs of cultivation, and arrange for cooperation in business and social affairs. An influence of this kind is sorely needed to help overcome the discouragements which have beset the farmers on these projects in recent years, and to encourage them to adopt agricultural methods which will increase the income from farms and strengthen the ability of settlers to meet their obligations to the Government. This division will also have charge of the important investigations needed in the classification of land and in promoting the settlement of unoccupied land, which is to-day one of the large unproductive assets of the bureau.

CHANGES IN TITLES

The following changes in titles in the Bureau of Reclamation are hereby announced, effective this date:

A new position to be known as "director of finance," has been created.

The "director of agriculture" is designated "director of farm economics."

The engineer formerly in charge of cost and property is designated "general superintendent of construction."

Project managers are designated "superintendents of ditches."

A new position of "chief field counsel" at Denver has been created.

The chief clerk at Denver is designated the "Denver office manager."

Project chief clerks are designated "chief clerks of irrigation districts."

The order of November 1, 1923, assigning the duties of the officers of the Bureau of Reclamation, has been changed to read as follows:

DUTIES OF OFFICERS

Commissioner.—Under the supervision of the Secretary of the Interior, the Commissioner of the Bureau of Reclamation, with office at Washington, D. C., shall have charge of all work of the bureau. The commissioner shall report to the Secretary of the Interior.

Chief engineer.—Under the supervision of the commissioner, the chief engineer, with office at a point designated by the Secretary of the Interior (now Denver), shall have charge of the operation of irrigation works and all engineering work, including reconnaissance, investigation, design and construction, and such other work as may be assigned. The chief engineer shall report to the commissioner.

Director of finance.—Under the supervision of the commissioner, the director of finance, with office at a point designated by the Secretary of the Interior (now Denver), shall have general supervision of the collection of water charges and all other financial matters in the bureau pertaining to and including irrigation works; field counsel; chief clerks of irrigation works and their forces; and traveling fiscal inspectors. The director of finance shall report to the commissioner.

Director of farm economics.—Under the supervision of the commissioner, the director of farm economics, with office at a point designated by the Secretary of the Interior (now Denver), shall have charge of crop production, handling and marketing; improvement of farm conditions; industrial betterment; and settlement of lands. The director of farm economics shall report to the commissioner.

Chief counsel.—Under the supervision of the commissioner and the Solicitor for the Department of the Interior, with office at Washington, D. C., shall be the principal legal adviser of the commissioner and perform such other legal duties as may be assigned.

District counsels.—Under the supervision of the commissioner and director of finance, with offices at points designated by the commissioner, shall have charge of all legal work in their respective districts. District counsels shall report to the director of finance.

Superintendent of ditches.—Under the supervision of the commissioner and chief engineer, superintendents of ditches, with offices at

points designated by the commissioner, shall have charge of the work relating to irrigation only in their respective districts, with the exception of financial matters, including accounting, bookkeeping, and purchasing. Superintendents of ditches shall report to the chief engineer.

Chief clerks of irrigation districts.—Under the supervision of the commissioner and director of finance, chief clerks of irrigation districts with offices at points designated by the commissioner, shall have charge of the accounting, bookkeeping, purchasing, and all clerical work and employees in their respective districts. Chief clerks of irrigation districts shall report to the director of finance.

Denver office manager.—Under the supervision of the commissioner, with office at Denver, Colo., shall have charge of quarters, equipment, and supplies, and supervision of all stenographers, accountants, bookkeepers, purchasing agents, fiscal agents, messengers, janitors, telephone operators, and all other employees engaged in routine clerical work in the Denver office. His force shall function for the offices of the chief engineer, the director of finance, and the director of farm economics, and he shall be responsible to the commissioner for keeping all work and other matters at the highest point of efficiency, and shall supply upon demand from the chief engineer, the director of finance, and the director of farm economics such necessary clerical services as may be required by them.

PROJECT DATA AND RECOMMENDATIONS

SALT RIVER PROJECT

1. LOCATION

State: Arizona.
 Counties: Maricopa and Gila.
 Project headquarters: Phoenix.
 Railroads: Santa Fe, Prescott & Phoenix; Arizona Eastern.
 National highways: Old Spanish Trail, Bankhead Highway.

2. HISTORY

Authorized: May 14, 1903 (conditionally).
 Construction began: 1905.
 Water available: May 15, 1907.
 First public notice: January 18, 1917.
 Changes in original plans: Height of Roosevelt Dam increased from 190 to 225 feet; distribution system acquired, improved, and extended; drainage.

3. WATER SUPPLY

Sources: Salt and Verde Rivers and wells.
 Available storage, 1922: 1,367,305 acre-feet.
 Water diverted, 1921-22: 1,231,031 acre-feet.
 Water delivered to land, 1921-22: 534,526 acre-feet.
 Water delivered per acre, 1921-22: 3.29 acre-feet.

4. LANDS

Acreege for which bureau was prepared to supply water, 1922: 213,168.
 Acreege irrigated, 1922: 203,347.
 Acreege cropped, 1922: 189,184.
 Ultimate irrigable acreege (estimated): 213,168.
 Public land entered to June 30, 1923: 16,170 acres.
 Public land vacant June 30, 1923: None.

Lands under water-right contracts June 30, 1923: Public, 16,000 acres; private, 197,000 acres; total, 213,000 acres.

Acreage damaged by seepage, 1923: 5,000.

Acreage protected by drains, 1923: 70,000.

Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, grain, cotton, citrus and deciduous fruits, livestock.

Average crop returns per acre, 1913-1922: \$64.26.

Average crop returns per acre, 1922: \$67.20.

Total crop value, 1922: \$15,497,141.

Size of farm unit: 40 acres.

Character of soil: Sandy loam with clay in places.

Average yield per acre, three principal crops: Alfalfa, 3.8 tons; wheat, 25.6 bushels; cotton, 312 pounds.

Livestock per 40-acre farm, 1922: Dairy cows, 4.4; hogs, 1.7; poultry, 61.5.

Elevation, 1,200 feet.

Annual rainfall, 8 inches.

Length of growing season, 289 days.

Temperatures: Maximum, 117°; minimum, 16°; average, 1922, 69°.

Principal markets: Phoenix and other Arizona towns, Pacific coast cities, and Eastern cities.

6. SETTLEMENT

Population, 1922: Towns, 44,000; farms, 36,000.

Total number of farms, 1922: 5,000.

Number of irrigated farms, 1922: 5,000.

Roads: Well drained and graded roads on every section line and some half-mile lines, 315 miles of which are paved.

Number of public schools, 1922: 60.

Number of churches, 1922: 65.

Number of banks, 1922: 20; amount of deposits, \$21,331,600.

Nationality of settlers: American born predominate; foreign born negligible.

Settlers with previous farming experience: About 90 per cent.

Technical aid to settlers: County agent, home demonstration agent, State experiment station.

7. FINANCES

Original construction cost: \$12,744,222.59.

Supplemental construction: None.

Operation and maintenance before public notice and miscellaneous: \$2,362,719.51.

Total cost of construction: \$15,106,942.10.

Revenues: \$4,558,822.82.

Net amount to be repaid as construction June 30, 1923: \$10,548,119.28.

Construction cost repaid to June 30, 1923: Amount, \$886,961.32; per cent, 8.4.

Construction charges due but uncollected: None.

Construction cost per acre: Highest, \$60; lowest, \$60; average, \$60; supplemental, none.

Operation and maintenance: Average annual charge per acre, 1913-1916, \$1.74.

Farmers' indebtedness per acre, 1922, other than to United States: \$42.33.

8. RECOMMENDATIONS

The Salt River project should be granted the option to amend the existing contract entered into between the United States of America and the Salt River Valley Water Users' Association, dated September 6, 1917, in accord with the legislation recommended regarding the method of repaying construction costs.

The item of \$382,000, deducted from the construction account of the Salt River project by Secretary Lane, upon recommendation of the central board of review, should be charged off as a loss to the reclamation fund.

YUMA PROJECT

1. LOCATION

State: Arizona-California.
 Counties: Yuma, Ariz.; Imperial, Calif.
 Project headquarters: Yuma, Ariz.
 Railroads: Southern Pacific, Yuma Valley, San Diego & Arizona.
 National highways: Old Spanish trail, Bankhead Highway.

2. HISTORY

Authorized: May 10, 1904.
 Construction began: July 19, 1905.
 Water available: 1907.
 First public notice: January 12, 1910.
 Changes in original plans: Laguna Dam paved with concrete instead of rock; location main canal changed; irrigable area decreased; changes in levee construction and maintenance; lateral system built; drainage.

3. WATER SUPPLY

Source: Colorado River.
 Available storage, 1922: None.
 Water diverted, 1922: 546,634 acre-feet.
 Water delivered to land, 1922: 140,307 acre-feet.
 Water delivered per acre, 1922: 2.59 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 67,200.
 Acreage irrigated, 1922: 55,770.
 Acreage cropped, 1922: 53,970.
 Ultimate irrigable acreage (estimated): 65,000.
 Public land entered to June 30, 1923: 12,270 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 12,362 acres; private, 41,206 acres; total, 56,568 acres.
 Acreage damaged by seepage, 1923: 20,000.
 Acreage protected by drains, 1923: 38,000.
 Acreage furnished partial water supply under Warren Act and special contracts: 4,000.

5. AGRICULTURE

Principal products: Cotton, grain, alfalfa, and livestock.
 Average crop returns per acre, 1913-1922: \$65.71.
 Average crop returns per acre, 1922: \$49.70.
 Total crop value, 1922: \$2,682,500.
 Size of farm unit: 40 acres.
 Character of soil: Bottom land, rich alluvium.
 Average yield per acre; three principal crops: Cotton, 367 pounds; wheat, 18.9 bushels; alfalfa, 2.9 tons.
 Livestock per 40-acre farm, 1922: Dairy cows, 1.7; hogs, 3; poultry, 33.5.
 Elevation: 80 to 140 feet.
 Annual rainfall: 3.1 inches.
 Length of growing season: 335 days.
 Temperature: Maximum, 115°; minimum, 28°; average, 72°.
 Principal markets: Los Angeles, San Francisco, and Arizona towns.

6. SETTLEMENT

Population, 1922: Towns, 6,700; farms, 4,200.
 Number of irrigated farms, 1922: 1,216; operated by owners, 63 per cent; operated by tenants, 37 per cent.
 Roads: Graded earth roads on most sections lines and 57 miles of asphaltic concrete roads being completed.
 Number of public schools, 1922: 20.
 Number of churches, 1922: 24.
 Number of banks, 1922: 5; amount of deposits, \$3,095,800.

Nationality of settlers: 90 per cent Americans.
 Settlers with previous farming experience: 98 per cent.
 Settlers with previous irrigation experience: 93 per cent.
 Technical aid to settlers: Two experiment stations and county agent.

7. FINANCES

Original construction cost: \$8,716,895.32.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: \$722,166.74.
 Total cost of construction: \$9,439,062.06.
 Revenues: \$412,489.22.
 Net amount to be repaid as construction June 30, 1923: \$9,026,572.84.
 Construction cost repaid to June 30, 1923: Amount, \$1,081,702.98; per cent, 12.
 Construction charges due but uncollected: Amount, \$73,436.24; per cent, 6.3.
 Construction cost per acre: Highest, \$90; lowest, \$55; average, \$71; supplemental, none.
 Operation and maintenance: Amount due June 30, 1923, \$1,120,280.38; uncollected June 30, 1923, amount, \$179,259.29; per cent, 16; average annual charge per acre, \$5.88; 1922, \$5.

8. RECOMMENDATIONS

Notwithstanding it has been held under existing law that all moneys received and to be received under a certain contract, dated October 23, 1918, between the United States and the Imperial irrigation district, should be paid into the reclamation fund, we recommend appropriate legislation directing that such moneys be credited to the Arizona-California Yuma project, including the Mesa division, upon an equitable basis.

We understand the term "equitable basis" to mean taking into consideration the differences in soil, topography, and location of each farm unit on a project, with a special reference to the influence of these and all other essential factors upon the ability of each such unit to produce crops of value, as compared with other farm units upon the same project.

This committee finds that this project was authorized to provide water for the irrigation of certain lands, on both sides of the Colorado River, in the vicinity of the town of Yuma, Ariz.

CONTRACT LANDS

The land in California is in an Indian reservation. The lands in Arizona were destined to be irrigated partly by gravity and partly by a pumping plant. The lands now included under water-right contracts embrace the following:

	Acres
Indian reservation lands in California disposed of to white settlers.....	6, 100
Reservation lands in California remaining with the Indians.....	8, 100
Valley lands in Arizona.....	48, 800
Mesa lands in Arizona (mesa lands having a total area of about 34,000 acres, susceptible of irrigation by works yet to be completed).....	6, 000

COST OF WATER RIGHTS

The project cost of water rights in California has been fixed by notice at \$55 to \$66 per acre. The project cost of water rights in Arizona, in the Yuma Valley, has been fixed by public notice at \$75 per acre. The project cost of water rights on mesa lands in Arizona is estimated at \$200 an acre.

EXPENDITURES NOT INCLUDED IN THE FIXING OF PROJECT COSTS AND WHICH ARE NOT NOW REPRESENTED BY ANY ASSETS WHICH CAN BE CHARGED TO SETTLERS

The original plans for this project provided for a main canal starting from the Laguna Dam, to divert water from the Colorado River, which was to extend down to the Yuma area on the east side of the river, crossing in its course the Gila River. After \$580,936 had been spent it was found that this route was not feasible, and it was abandoned. There are no assets to balance this expenditure and it has not been included in fixing the cost of water rights.

In order to protect the farms on both sides of the river from flooding and erosion, it became necessary to build a levee and in some places to riprap the banks. The building of this flood-protection system had developed until the costs stand at present as follows:

Indian reservation levee.....	\$867, 287. 12
Yuma Valley Levee.....	1, 374, 122. 93
Gila Valley Levee.....	405, 363. 97
Yuma City Levee.....	1 12, 666. 20
Imperial Valley irrigation district.....	1 56, 512. 29
Total.....	2, 715, 952. 51

The cost of this levee system has not been included in the estimates on which the different project costs of water were fixed. It is an expenditure which settlers could not afford to pay and which has not been charged against them. It needs to be disposed of definitely and the committee makes a recommendation with regard to it.

In fixing the project costs that settlers were required to pay the expenditure on the Laguna Dam was included. Subsequently a right to use this dam has been sold to the Imperial irrigation district in California for \$1,600,000. The question has arisen as to whether this sum when paid shall be placed in the general reclamation fund or credited on water-right contracts of settlers under the Arizona-California-Yuma project.

With regard to these different matters the committee recommends:

(1) That the \$580,936 expended on the Arizona main canal which was subsequently abandoned be deducted from the general reclamation fund as money lost beyond recovery.

(2) That the levee system be regarded as a public work of the United States, similar in character to other protection works built under the rivers and harbors act along navigable streams, because the United States holds that the Colorado River is a navigable stream, and in pursuance of that holding the Government has built protection works at Yuma and a levee on the California side of the stream in Mexico, known as the Ockerson Levee, at an expenditure of \$1,000,000. These have been treated as improvements under the rivers and harbors act, no charge for repayment having been made against anyone.

The committee recommends, therefore, that legislation be secured under which the expenditure for the construction, operation, and maintenance of these levees by the reclamation fund shall be treated as an expenditure of the General Government, similar to expenditures under the rivers and harbors act, and that the reclamation fund be reimbursed by an appropriation equal to the amount of this expenditure.

¹ Reimbursed.

The committee recommends that expenses incurred in the maintenance and operation of the levee system to be provided for under some cooperative agreement between the States of California and Arizona and the War Department, similar to other cooperative agreements for the maintenance of levees on the Mississippi and other rivers, and that no part of this cost be included in the operation and maintenance expenses of this project.

We further recommend:

1. All excess holdings of lands in farm units should be disposed of to bona fide settlers.
2. Disposition of all unpaid charges in accordance with resolution No. 24.
3. Adoption of the new plan of repayment in accordance with resolution No. 23.

YUMA AUXILIARY PROJECT (MESA DIVISION OF YUMA PROJECT)

1. LOCATION

State: Arizona.

County: Yuma.

Project headquarters: Yuma.

Railroads: Southern Pacific; San Diego & Arizona.

National highways: Old Spanish Trail; Bankhead Highway.

2. HISTORY

Authorized: June 8, 1920.

Construction began: September 27, 1920.

Water available: May 1, 1922.

First public notice: October 3, 1919.

Changes in original plans: None.

3. WATER SUPPLY

Sources: Colorado River (pumping).

Available storage, 1922: None.

Water delivered to land, 1922: 251 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 2,449.

Acreage irrigated, 1922: 220.

Ultimate irrigable acreage (estimated): 45,000.

Public land entered to June 30, 1923: 5,223 acres.

Public land vacant June 30, 1923: 853 acres.

Lands under water-right contracts June 30, 1923: None.

Acreage damaged by seepage, 1923: None.

Acreage protected by drains, 1923: None.

Acreage furnished partial water supply under Warren Act and special contracts: 177.

5. AGRICULTURE

Principal products: Semitropical fruit.

Size of farm unit: Not over 40 acres.

Character of soil: Fresno gravelly sand.

Elevation: 130 to 215 feet.

Annual rainfall: 3.1 inches.

Length of growing season: 335 days.

Temperature: Maximum, 115°; minimum, 28°; average, 72°.

Principal markets: Los Angeles, Calif., Arizona towns, and eastern markets.

6. SETTLEMENT

Population 1922: Towns, none; farms, 25.
 Irrigated farms operated by owners: 100 per cent.
 Irrigated farms operated by tenants: None.
 Roads: Two main highways to Yuma; other roads limited.
 Number of public schools 1922: None.
 Number of churches 1922: None.
 Number of banks 1922: None.
 Amount of deposits: None.
 Nationality of settlers: 90 per cent American.
 Settlers with previous farming experience: 32 per cent.
 Technical aid to settlers: State experiment station and county agent.

7. FINANCES

Original construction cost: \$782,078.65.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: None.
 Total cost of construction: \$782,078.65.
 Revenues: \$1,237.74.
 Net amount of construction June 30, 1923: \$780,840.91 (includes \$252,000 due Yuma project).
 Construction cost repaid to June 30, 1923: \$723,581.85 (also \$28,543.36 operation and maintenance).
 Construction charges due but uncollected: \$536,364.72 (includes \$65,419.60 land and \$1,350.57 miscellaneous).
 Construction cost per acre: Highest, \$225; lowest, \$225; average, \$225; supplemental, none.
 Operation and maintenance: Amount due June 30, 1923, \$59,059.93; uncollected June 30, 1923, \$30,691.05.

8. RECOMMENDATIONS

This division was constructed under the provisions of an act of Congress approved January 25, 1917, known as "An act to provide for an auxiliary reclamation project in connection with the Yuma project in Arizona" (39 Stat. 868). The drastic provisions of this act are impossible of fulfillment and only a few of the settlers have been able to meet their contracts. They, too, will soon fail, as the charge for water will bankrupt them.

The committee recommends that an early study be made by the Bureau of Reclamation of this division, with a view of making recommendations to Congress for financial relief or the disposal of the division if adequate relief is not feasible.

ORLAND PROJECT

1. LOCATION

State: California.
 Counties: Glenn and Tehama.
 Project headquarters: Orland.
 Transportation: Southern Pacific Railroad and steamers on Sacramento River.
 National highway, Pacific Highway.

2. HISTORY

Authorized: October 5, 1907.
 Construction began: 1908.
 Water available: 1910.
 First public notice: April 26, 1916.
 Changes in original plans: Construction of East Park feed canal and structures, lining of canals and laterals.

3. WATER SUPPLY

Source: Stony Creek.
 Available storage, 1922: 63,460 acre-feet.
 Water diverted, 1922: 76,632 acre-feet.
 Water delivered to land, 1922: 50,589 acre-feet.
 Water delivered per acre, 1922: 3.34 acre-feet.

4. LANDS

Acreeage for which bureau was prepared to supply water, 1922: 20,665.
 Acreeage irrigated, 1922: 15,119.
 Acreeage cropped, 1922: 11,803.
 Ultimate irrigable acreeage (estimated): 20,665.
 Lands under water-right contracts June 30, 1923: Public, none; private, 19,398 acres; total 19,398 acres.

5. AGRICULTURE

Principal products: Alfalfa, milo, citrus, other fruits and nuts, dairy and poultry.
 Average crop returns per acre, 1913-1922: \$46.99.
 Average crop returns per acre, 1922: \$47.92.
 Total crop value, 1922: \$565,500.
 Size of farm unit: 40 acres.
 Character of soil: Sandy and gravelly loam, silt and clay loam.
 Average yield per acre, three principal crops: Alfalfa, 4.3 tons; corn, 25.3 bushels; almonds, 480 pounds.
 Livestock per 40-acre farm, 1922: Dairy cows, 6.5; hogs, 5.2; poultry, 197.5.
 Elevation: 250 feet.
 Annual rainfall: 18.4 inches.
 Length of growing season: 264 days.
 Temperatures: Maximum, 112°; minimum, 26°; average, 64°.
 Principal markets: San Francisco, Calif.; Portland, Oreg.; and eastern markets.

6. SETTLEMENT

Population, 1922: Towns, 1,700; farms, 2,275.
 Total number of farms 1922: 968.
 Number of irrigated farms, 1922: 693; operated by owners: 82 per cent; operated by tenants: 18 per cent.
 Roads: Two paved State highways through project and many county roads.
 Number of public schools, 1922: 10.
 Number of churches, 1922: 7.
 Number of banks, 1922: 2; amount of deposits, \$995,000.
 Nationality of settlers: Americans, 70 per cent; Scandinavian, 10 per cent; miscellaneous, 20 per cent.
 Settlers with previous farming experience: 96 per cent.
 Settlers with previous irrigation experience: 89 per cent.
 Technical aid to settlers: County farm adviser; county horticultural commissioner and cow tester.

7. FINANCES

Original construction cost: \$927,339.96.
 Supplemental construction: \$190,217.38.
 Operation and maintenance before public notice and miscellaneous: \$107,189.80.
 Total cost of construction: \$1,224,797.14.
 Revenues: \$133,001.27.
 Net amount to be repaid as construction June 30, 1923: \$1,091,795.87.
 Construction cost repaid to June 30, 1923: Amount, \$235,229.42; per cent, 21.
 Construction cost per acre: Highest, \$44; lowest, \$44; average, \$44; supplemental, \$11.
 Operation and maintenance, amount due June 30, 1923: \$210,932.07.
 Uncollected June 30, 1923: Amount, \$218.62; per cent, 0.1.
 Average annual charge per acre: \$3.30; 1922, \$2.33.

8. RECOMMENDATIONS

We commend the water users of the Orland project for their strict compliance with the regulations of the Bureau of Reclamation and congratulate them upon the success that has attended their agricultural operations, as evidenced by the full and prompt payments of construction and operation and maintenance charges.

The Orland project should be under the full management of the water users, and we recommend, therefore, that a suitable contract to this end be drawn; and that, when the water users assume control of the project, the operation and maintenance charge for the year then current be covered into the construction account to be repaid as part of the construction repayments. (Resolution No. 19.)

GRAND VALLEY PROJECT

1. LOCATION

State: Colorado.

County: Mesa.

Project headquarters: Grand Junction.

Railroads: Denver & Rio Grande; Grand River Valley.

National highways: Pikes Peak and Ocean to Ocean Highways.

2. HISTORY

Authorized: September 23, 1912.

Construction began: September, 1912.

Water available: 1915.

Changes in original plans: Distribution system built, also project power plant; drainage.

3. WATER SUPPLY

Source: Colorado River.

Available storage, 1922: None.

Water diverted, 1922: 166,404 acre-feet.

Water delivered to land, 1922: 46,290 acre-feet.

Water delivered per acre, 1922: 3.74 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 38,400.

Acreage irrigated, 1922: 20,672.

Acreage cropped, 1922 (project only): 11,844.

Ultimate irrigable acreage (estimated): 55,000.

Public land entered to June 30, 1923: 13,442 acres.

Public land vacant June 30, 1923: 403 acres.

Acreage damaged by seepage, 1923: 600.

Acreage protected by drains, 1923: 3,660.

Acreage furnished partial water supply under Warren Act and special contracts: 8,400.

5. AGRICULTURE

Principal products: Alfalfa, sugar beets, grain, fruit, vegetables, and livestock.

Average crop returns per acre, 1913-1922: \$45.58.

Average crop returns per acre, 1922: \$30.88.

Total crop value, 1922: \$365,760.

Size of farm unit: 40 to 80 acres.

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

Average yield per acre, three principal crops: Alfalfa, 2.9 tons; wheat, 16.9 bushels; sugar beets, 9.3 tons.

Livestock per 40-acre farm, 1922: Beef and dairy cows, 2.1; hogs, 2.2; poultry, 37.9.

Elevation: 4,700 feet.

Annual rainfall: 8.3 inches.

Length of growing season: 183 days.

Temperature: Maximum, 99°; minimum, -7°; average, 52°.

Principal markets: Denver, Colo.; Salt Lake City, Utah; and eastern cities.

6. SETTLEMENT

Population, 1922: Towns, 11,246; farms, 1,134.
 Total number of farms, 1922: 825.
 Number of irrigated farms, 1922: 387; operated by owners, 56 per cent; operated by tenants, 44 per cent.
 Roads: Main Federal aid highway through project, 5 miles of which concrete, balance graveled surface, connecting north and south roads.
 Number of public schools, 1922: 24.
 Number of churches, 1922: 28.
 Number of banks, 1922: 7; Amount of deposits, \$3,520,500.
 Nationality of settlers: Americans, 82 per cent; Germans, 6 per cent; others, 12 per cent.
 Settlers with previous farming experience: 75 per cent.
 Settlers with previous irrigation experience: 52 per cent.
 Technical aid to settlers: County agent.

7. FINANCES

Original construction cost: \$3,942,716.22.
 Operation and maintenance before public notice and miscellaneous: \$350,127.50.
 Total cost of construction: \$4,292,843.72.
 Revenues: \$274,921.74.
 Net amount to be repaid as construction June 30, 1923: \$4,017,921.98.
 Average annual charge per acre: \$6.27; 1922, \$3.40.

8. RECOMMENDATIONS

It appears from the hearings and data before the committee that the Grand Valley project in Colorado was built within the estimated cost, yet the acre charge against the settler has been practically doubled over the original estimate.

This increase was brought about by the necessary exclusion of large bodies of land originally embraced within the project by reason of the fact that subsequent investigations and soil surveys showed the excluded lands to be so lacking in fertility as to make them unfit for agricultural settlement.

It further appears that a considerable portion of the land included within the project is of such a character as to require several years' cultivation before profitable returns can be had.

The situation above set forth has led to a request from project settlers for a complete review of their situation upon which shall be based an equitable adjustment of the project cost to the settlers.

We believe the request justified and that such a review should speedily be had, and should take into consideration topography, location, and difference in soil upon each farm unit, which factors are necessarily controlling as to the crop value of the lands and furnish the true measure of the charge that each farm unit within the project is able to bear.

Pending such review and readjustment we recommend that "public notice" be not given and that only such rental charge for water be made as the land in cultivation can reasonably bear.

UNCOMPAHGRE PROJECT

1. LOCATION

State: Colorado.
 Counties: Montrose and Delta.
 Project headquarters: Montrose.
 Railroad: Denver & Rio Grande.
 National highway: Rainbow Route.

2. HISTORY

Authorized: June 7, 1904.

Construction began: January 11, 1905.

Water available: 1908.

First public notice: April 12, 1922.

Changes in original plans: Distribution systems acquired and reconstructed.

3. WATER SUPPLY

Sources: Gunnison and Uncompahgre Rivers.

Available storage, 1922: None.

Water diverted, 1922: 427,706 acre-feet.

Water delivered to land, 1922: 422,398 acre-feet.

Water delivered per acre, 1922: 6.5 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 97,410.

Acreage irrigated, 1922: 64,730.

Acreage cropped, 1922: 61,691.

Ultimate irrigable acreage (estimated): 97,410.

Public land entered to June 30, 1923: 19,543 acres.

Public land vacant June 30, 1923: 1,364 acres.

Lands under water-right contracts June 30, 1923: Public, 13,643 acres; private, 61,324 acres; total, 74,967 acres.

Acreage damaged by seepage, 1923: 16,200.

Acreage protected by drains, 1923: 9,200.

Acreage furnished partial water supply under Warren Act and special contracts: 600.

5. AGRICULTURE

Principal products: Alfalfa, grain, fruit, sugar beets, potatoes, vegetables.

Average crop returns per acre 1913-1922: \$41.70.

Average crop returns per acre, 1922: \$25.14.

Total crop value, 1922: \$1,550,900.

Size of farm unit: 80 acres.

Character of soil: Red sandy gravel, adobe, and clay loam.

Average yield per acre, three principal crops: Alfalfa, 2.8 tons; wheat, 25.9 bushels; potatoes, 176.1 bushels.

Livestock per 40-acre farm, 1922: Dairy cows, 2.1; hogs, 4.3; poultry, 39.8.

Elevation: 5,500 feet.

Annual rainfall: 9.5 inches.

Length of growing season: 146 days.

Temperatures: Maximum, 95°; minimum, -13°; average, 48°.

Principal markets: Denver, Omaha, Kansas City, Missouri River, and Texas points.

6. SETTLEMENT

Population, 1922: Towns, 7,450; farms, 6,149.

Total number of farms, 1922: 1,624.

Number of irrigated farms, 1922: 1,624; operated by owners, 58 per cent; operated by tenants, 42 per cent.

Roads: State highway through project; good system of roads, many of which are graveled.

Number of public schools, 1922: 27.

Number of churches, 1922: 27.

Number of banks, 1922: 7; amount of deposits, \$2,930,700.

Nationality of settlers: American, 78 per cent; foreign, 22 per cent.

Settlers with previous farming experience: 100 per cent.

Settlers with previous irrigation experience: 98 per cent.

Technical aid to settlers: County agent and agriculturist, office of demonstrations, reclamation project.

7. FINANCES

Original construction cost: \$6,437,064.03.
Operation and maintenance before public notice and miscellaneous: \$1,490,405.65.
Total cost of construction: \$7,927,469.68.
Revenues: \$1,212,395.27.
Net amount to be repaid as construction June 30, 1923: \$6,715,074.41.
Construction cost repaid to June 30, 1923: Amount, \$43,595.96; per cent, 0.7.
Construction charges due but uncollected: Amount, \$102,665.34; per cent, 70.2.
Construction cost per acre: Highest, \$70; lowest, \$70; average, \$70.
Average annual charge per acre: \$2.34; 1922, \$1.46.

8. RECOMMENDATIONS

From the record the committee does not feel justified in recognizing the claim of the Uncompahgre Water Users' Association, that the charge against them should be established as \$25 per acre.

With respect to the acreage of the Uncompahgre project liable to payment of project costs, the committee finds the annual report of the Reclamation Service for 1916 gives this irrigable acreage as 140,000 acres. The annual report for 1917 gives this irrigable acreage, when completed, as 100,000 acres, with no explanation of the reason for the reduction.

The public notice, which is dated April 12, 1922, fixes the total irrigable area subject to project costs as 129,942 acres, which is classified 97,410 acres being placed in class 1, and 32,532 acres in class 2. The entire project cost is charged against the lands of class 1, no part of the charge being imposed on the lands in class 2.

The committee recommends that the project costs be spread equally over the entire area included in classes 1 and 2 and that class 1 lands be entirely relieved of payment of any part of project costs thus allocated to class 2 lands for the reason that project costs were incurred to serve both classes of land, and to impose these charges solely on class 1 lands loads them with a greater burden than they can or should bear and unfairly relieves the lands in class 2 of any burden.

The committee further recommends that a classification of the lands within this project be made in accordance with the principles laid down in General Resolutions Nos. 7 and 13 adopted by the committee, and that that part of project costs as above allocated to class 1 lands be in accordance with said resolutions, and that none of said lands shall be charged with more than \$70 an acre as fixed by public notice.

The item of \$47,000, deducted from the construction account of the Uncompahgre project by Secretary Lane upon the recommendation of the central board of review, should be charged off as a loss to the reclamation fund.

KING HILL PROJECT

1. LOCATION

State: Idaho.
Counties: Elmore, Gooding, Owyhee, Twin Falls.
Project headquarters: King Hill.
Railroads: Oregon Short Line.
National highway: Oregon Trail.

2. HISTORY

Authorized: July 2, 1917.
 Construction began: 1918 (reconstruction).
 Water available: First irrigation, King Hill Irrigation Co., 1909.
 First public notice: None.
 Changes in original plans: Supplemental contracts for \$600,000 and \$400,000 in addition to original contract of \$1,000,000.

3. WATER SUPPLY

Sources: Malad River, fed by numerous large springs.
 Water diverted, 1922: 61,326 acre-feet.
 Water delivered to land, 1922: 35,875 acre-feet.
 Water delivered per acre, 1922: 5.57 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 13,648.
 Acreage irrigated, 1922: 6,440.
 Acreage cropped, 1922: 6,050.
 Ultimate irrigable acreage (estimated): 16,888.
 Public land entered to June 30, 1923: 516 acres.
 Public land vacant June 30, 1923: 71 acres.
 Lands under water right contracts June 30, 1923: Public, 516 acres; private, 16,372 acres; total, 16,888 acres.
 Acreage protected by drains 1923: 800.

5. AGRICULTURE

Principal products: Alfalfa, early vegetables, grains, fruit, and stock.
 Average crop returns per acre, 1913-1922: \$39.39 (six years).
 Average crop returns per acre, 1922: \$36.20.
 Total crop value, 1922: \$219,900.
 Character of soil: Ranges from light to heavy sandy loam; heavy clay.
 Average yield per acre, three principal crops: Alfalfa, 3.9 tons; apples, 790 pounds; wheat, 16 bushels.
 Livestock per 40 acre farm, 1922: Dairy cows, 2.7; hogs, 3.6; poultry, 54.8.
 Elevation: 2,750 feet.
 Annual rainfall: 9 inches.
 Length of growing season: 186 days.
 Temperatures: Maximum, 107°; minimum, -6°; average, 51°.
 Principal markets: Portland, Boise, and small towns in southern Idaho.

6. SETTLEMENT

Population, 1922: Towns, 2,052; farms, 599.
 Total number of farms, 1922: 260.
 Number of irrigated farms, 1922: 175; operated by owners, 75 per cent; operated by tenants, 25 per cent.
 Roads: Two highways run through the project; condition of roads, good.
 Number of public schools, 1922: 6.
 Number of churches, 1922: 5.
 Number of banks, 1922: 1; amount of deposits, \$275,000.
 Settlers with previous farming experience: 100 per cent.
 Settlers with previous irrigation experience: 80 per cent.
 Technical aid to settlers: Specialists from the State university agricultural extension service available.

7. FINANCES

Original construction cost: \$1,884,984.64
 Operation and maintenance before public notice and miscellaneous: \$60,163.18.
 Total cost of construction: \$1,945,147.82.
 Revenues: \$63,756.37.
 Net amount to be repaid as construction June 20, 1923: \$1,881,391.45.
 Construction charges due but uncollected: Amount, \$127,416.97; per cent 100.

8. RECOMMENDATIONS

The committee recommends:

1. The Bureau of Reclamation should retain the management of the project until conditions on the project are improved.
2. The Bureau of Reclamation should make a careful study of conditions prevailing on the project with reference to possible repayment of construction costs.
3. The Bureau of Reclamation should require the breaking up of the larger holdings into smaller units for the benefit of home makers.
4. The present available funds should be held in suspense until definite plans based upon the investigation of project conditions have been formulated.
5. The proposed power plant should not be constructed until there is assurance that the money already expended on the project will be returned.

MINIDOKA PROJECT

1. LOCATION

State: Idaho-Wyoming.
 Counties: Minidoka, Cassia, Idaho; Lincoln, Wyoming.
 Project headquarters: Burley, Idaho.
 Railroad: Oregon Short Line.
 National highway: Oregon Trail.

2. HISTORY

Authorized: April 23, 1904.
 Construction begun: 1904.
 Water available: 1907.
 First public notice: March 9, 1907.
 Changes in original plans: Government took over and rebuilt entire lateral system; Gravity division, drainage.

3. WATER SUPPLY

Sources: Snake River, supplemented by storage.
 Available storage, 1922: 942,180 acre-feet.
 Water diverted, 1922: 712,975 acre-feet.
 Water delivered to land, 1922: 107,573 acre-feet.
 Water delivered per acre, 1922: 2.38 acre-feet (South Side only).

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 121,562.
 Acreage irrigated, 1922: 105,580.
 Acreage cropped, 1922: 99,805.
 Ultimate irrigable acreage (estimated) 236,562.
 Public land entered to June 30, 1923: 96,258 acres.
 Public land vacant June 30, 1923: 449 acres.
 Lands under water right contracts June 30, 1923: public, 96,262 acres; private, 23,692 acres; total, 119,954 acres.
 Acreage damaged by seepage, 1923: 1,000 (Gravity).
 Acreage protected by drains, 1923: 30,000 (Gravity).
 Acreage furnished partial water supply under Warren Act and special contracts, 630,000.

5. AGRICULTURE

Principal products: Alfalfa, grasses, wheat, oats, beet seed, clover seed, sugar beets, potatoes.
 Average crop returns per acre, 1913-1922: \$36.38.
 Average crop returns per acre, 1922: \$30.25.

Total crop value, 1922: \$3,019,350.

Size of farm unit: 40-80 acres.

Character of soil: North side of river sand and sandy loam—about one-third of the area is clay loam; south side of the river is a disintegrated ash.

Average yield per acre, three principal crops: Gravity division: Alfalfa, 3.4 tons; wheat, 25 bushels; sugar beets, 10.7 tons. South side pumping division: Alfalfa, 3.0 tons; wheat, 23.2 bushels; potatoes, 184.2 bushels.

Livestock per 40-acre farm, 1922: Beef and dairy cows, 2.7; hogs, 4.1; poultry, 36.8.

Elevation: 4,225 feet.

Annual rainfall: 11.71 inches.

Length of growing season: 138 days.

Temperatures: Maximum, 99°; minimum, 12.7°; average, 47.8°.

Principal markets: Pocatello, Idaho; Salt Lake, Utah; Butte and Helena Mont.; Portland, Ore.; Kansas City, Mo.; Omaha, Nebr.

6. SETTLEMENT

Population, 1922: Towns, 8,170; farms, 8,301.

Total number of farms, 1922: 2,451.

Number of irrigated farms, 1922: 2,451; operated by owners, 76 per cent; operated by tenants, 24 per cent.

Roads: 300 miles of graveled highways.

Number of public schools, 1922: 22.

Number of churches, 1922: 29.

Number of banks 1922: 5; amount of deposits, \$1,100,000.

Nationality of settlers: 80 per cent native born.

Settlers with previous farming experience: 67 per cent.

Technical aid to settlers: County agent, home demonstration agent, and agriculturist from United States Department of Agriculture.

7. FINANCES

Original construction cost: \$7,574,048.31.

Supplemental construction: \$749,429.74.

Operation and maintenance before public notice and miscellaneous: \$342,867.76.-

Total cost of construction: \$8,666,145.81.

Revenues: \$599,168.69.

Net amount to be repaid as construction June 30, 1923: \$8,066,977.12.

Construction cost repaid to June 30, 1923: Amount, \$2,654,165.98; per cent, 34.

Construction charges due but uncollected: Amount, \$307,796.60; per cent, 10.4.

Construction cost per acre: Highest, Gravity, \$40; South Side, \$57.50; lowest, Gravity, \$22; South Side, \$56.50; average, Gravity, \$29; South Side, \$57; supplemental, \$12 (Gravity division, 65,600 acres).

Operation and maintenance: Amount due June 30, 1923: \$1,359,542.28.

Uncollected June 30, 1923: Amount, \$176,992.97; per cent, 13.

Average annual charge per acre: Gravity, \$1.60; South Side, \$2.27.

8. RECOMMENDATIONS

The committee recommends:

1. Additional pumping facilities should be added as may become necessary from time to time.

2. There should be a definite settlement of the problem of power, excess water, town sites, grazing and farm lands, in accordance with Resolution No. 20.

3. The district should assume the management of the project and be advanced one year's operation and maintenance as provided in Resolution No. 19.

4. The new repayment plan should be put into force according to Resolution No. 23.

5. Drainage should be added as necessary and should be made mandatory for the entire area.

6. All recommendations should be embodied in a contract with the water users.

BOISE PROJECT

1. LOCATION

State: Idaho-Oregon.
 Counties: Ada, Boise, Canyon, Elmore, Idaho; and Malheur, Oreg.
 Project headquarters: Boise, Idaho.
 Railroads: Oregon Short Line; Boise, Nampa & Owyhee, and Idaho Northern (branch of Oregon Short Line); Idaho Traction; Caldwell Traction; and Intermountain.
 National highways: Oregon Trail.

2. HISTORY

Authorized: March 27, 1905.
 Construction began: Spring, 1906.
 Water available: 1906.
 First public notice: July 2, 1917.
 Changes in original plans: Payette division not undertaken as originally planned. Entire distribution system constructed. Drainage.

3. WATER SUPPLY

Source: Boise River.
 Available storage, 1922: 457,000 acre-feet.
 Water diverted, 1922: 748,570 acre-feet.
 Water delivered to land, 1922: 536,300 acre-feet.
 Water delivered per acre, 1922: 3.46 acre-feet.

4. LANDS

Acreege for which bureau was prepared to supply water, 1922: 283,411 (including partial service to vested water-rights land.)
 Acreege irrigated, 1922: 155,000 (served with full water supply).
 Acreege cropped, 1922: 108,500.
 Ultimate irrigable acreege (estimated): 353,941.
 Public land entered to June 30, 1923: 67,468 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 59,460 acres; private, 37,135 acres; total, 96,595 acres.
 Acreege damaged by seepage, 1923: 6,050.
 Acreege protected by drains, 1923: 98,400.
 Acreege furnished partial water supply under Warren Act and special contracts: 140,280.

5. AGRICULTURE

Principal products: Alfalfa, wheat, oats, clover, potatoes, apples, prunes, and small fruits.
 Average crop returns per acre, 1913-1922: \$38.11.
 Average crop returns per acre, 1922: \$36.80.
 Total crop value, 1922: \$3,992,600.
 Size of farm unit: Public, 80; private, 160 acres.
 Character of soil: Clayey loam, light sandy loam, and sandy loam.
 Average yield per acre, three principal crops: Alfalfa, 4.1 tons; wheat, 25 bushels; potatoes, 174.1 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 3; hogs, 3.7; poultry, 34.1.
 Elevation: 2,500 feet.
 Annual rainfall: 13.73 inches.
 Length of growing season: 177 days.
 Temperature: Maximum, 102°; minimum, 2°; average 51°.
 Principal markets: Boise, Nampa, Caldwell, Meridian, Idaho; Portland, Oreg.; and eastern cities.

6. SETTLEMENT

Population, 1922: Towns, 36,170; farms, 14,700.
 Total number of farms, 1922: 4,998 (excluding V. W. R. lands excepting 21,500 acres New York Canal Co.).
 Number of irrigated farms, 1922: 3,559; operated by owners, 81 per cent; operated by tenants, 19 per cent.

Roads: Project covered with network of good roads, many of which are sanded or graveled.

Number of public schools, 1922: 28.

Number of churches, 1922: 56.

Number of banks, 1922: 16; amount of deposits, \$16,707,000.

Settlers with previous farming experience: 94.6 per cent.

Settlers with previous irrigation experience: 74.4 per cent.

Technical aid to settlers: County agent, home-demonstration agent, and experimental farm.

7. FINANCES

Original construction cost: \$12,473,602.23.

Supplemental construction: None.

Operation and maintenance before public notice and miscellaneous: \$1,096,914.02.

Total cost of construction: \$13,570,516.25.

Revenues: \$839,106.52.

Net amount to be repaid as construction June 30, 1923: \$12,731,409.73.

Construction cost repaid to June 30, 1923: Amount, \$1,399,269.52; per cent, 11.

Construction charges due but uncollected: Amount, \$338,554.61; per cent, 19.5.

Construction cost per acre: Highest, \$80; lowest, \$80; average, \$80; supplemental, none.

Operation and maintenance: Amount due June 30, 1923, \$1,841,318.12.

Uncollected June 30, 1923: Amount, \$403,525.81; per cent, 21.9.

Average annual charge per acre: \$1.83; 1922, \$1.58.

8. RECOMMENDATIONS

With respect to the Boise project we recommend:

1. That a survey be made of the lands of the project for the purpose of determining equitable acre charges under Resolutions Nos. 13, 7, and 8.

2. That the water users take over the management of the project, as under Resolution No. 19.

3. That drainage costs be included in the supplemental construction costs.

GARDEN CITY PROJECT

(Project abandoned 1910)

1. LOCATION

State: Kansas.

County: Finney, Kearney.

Project headquarters: Garden City.

Railroads: Atchison, Topeka & Santa Fe.

National highways: No report.

2. HISTORY

Authorized: October 5, 1905.

Construction began: June, 1906.

Water available: 1908.

First public notice: March 6, 1908.

Changes in original plans: Change from coal-burning to oil-burning plant.

3. WATER SUPPLY

Sources: Shallow wells near Arkansas River and natural flow of river.

Available storage: None.

Water diverted 1909: 8,071 acre-feet (also 7,555 pumped).

Water delivered to land: No report.

Water delivered per acre: No report.

4. LANDS

Irrigable acreage of lands opened 1910: 10,677.
 Acreage irrigated: No report.
 Acreage cropped: No report.
 Ultimate irrigable acreage (estimated): No report.
 Public land entered: None.
 Public land vacant: None.
 Lands under water-right contracts 1909: Public, none; private, 6,976 acres;
 total, 6,976 acres.
 Acreage damaged by seepage 1909: None.
 Acreage protected by drains 1909: None.
 Acreage furnished partial water supply under Warren Act and special contracts:
 None.

5. AGRICULTURE

Principal products: Alfalfa, sugar beets, melons, sweet potatoes, small fruits.
 Average crop returns per acre: No report.
 Total crop value 1922: No report.
 Size of farm unit: Private land, average, 93 acres.
 Character of soil: Fertile black sandy loam.
 Average yield per acre—three principal crops: No report.
 Livestock per 40-acre farm, 1909: No report.
 Elevation: 2,925 feet.
 Annual rainfall: 19 inches.
 Length of growing season: 114 days.
 Temperature: Maximum, 105°; minimum, 20°; average, no report.
 Principal markets: Garden City, Kans.; Kansas City, Mo.; Chicago, Ill.

6. SETTLEMENT

Population, 1917: Towns, 3,700; farms, no report.
 Total number of farms: No report.
 Number of irrigated farms: No report; operated by owners, no report; oper-
 ated by tenants, no report.
 Roads: Good roads on each section line.
 Number of public schools, 1922: No report.
 Number of churches, 1922: Several in Garden City.
 Number of banks, 1922: No report; amount of deposits, no report.
 Nationality of settlers: No report.
 Settlers with previous farming experience: No report.
 Settlers with previous irrigation experience: No report.
 Technical aid to settlers: None.

7. FINANCES

Original construction cost: \$342,963.68.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: \$52,868.10.
 Total cost of construction: \$395,831.78.
 Revenues: \$10,180.71.
 Net amount to be repaid as construction June 30, 1923: \$385,651.07.
 Construction cost repaid to June 30, 1923: Amount, \$51,176.11; per cent, 13.3.
 Construction charges due but uncollected: None.
 Construction cost per acre: Average, \$37.50.
 Operation and maintenance: None.
 Average annual charge per acre: No report; 1909, \$2.75.

HUNTLEY PROJECT

1. LOCATION

State: Montana,
 County: Yellowstone.
 Project headquarters: Ballantine.
 Railroads: Northern Pacific; Chicago, Burlington & Quincy.
 National highways: Yellowstone Trail.

2. HISTORY

Authorized: April 18, 1905.
 Construction began: 1905.
 Water available: 1908.
 First public notice: May 21, 1907.
 Changes in original plans: Changes in lengths of tunnels and Pryor Creek crossing; auxiliary pumping plant and Highline Canal enlargement; lateral F. G. L. constructed; drainage.

3. WATER SUPPLY

Sources: Yellowstone River.
 Available storage, 1922: None.
 Water diverted, 1922: 72,245 acre-feet.
 Water delivered to land, 1922: 18,768 acre-feet.
 Water delivered per acre, 1922: 0.96 acre-foot.

4. LANDS

Acreage for which bureau was prepared to supply water in 1922: 32,000.
 Acreage irrigated, 1922: 19,523.
 Acreage cropped, 1922: 19,523.
 Ultimate irrigable acreage (estimated): 32,473.
 Public land entered to June 30, 1923: 26,176 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 28,746 acres; private, 3,726 acres; total, 32,472 acres.
 Acreage damaged by seepage, 1923: 1,300.
 Acreage protected by drains, 1923: 21,500.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, oats, sugar beets, and wheat.
 Average crop returns per acre, 1913-1922: \$31.62.
 Average crop returns per acre, 1922: \$29.33.
 Total crop value, 1922: \$572,000.
 Size of farm unit: 160 acres.
 Character of soil: Ranges from heavy clay to light sandy loam.
 Average yield per acre, three principal crops: Alfalfa, 2.6 tons; wheat, 18.4 bushels; sugar beets, 9.1 tons.
 Livestock per 40-acre farm, 1922: Dairy cows, 2.9; hogs, 2.4; poultry, 34.4.
 Elevation: 3,000 feet.
 Annual rainfall: 13.06 inches.
 Length of growing season: 132 days.
 Temperatures: Maximum, 100.9°; minimum, -34.3°; average, 41.3°.
 Principal markets: Billings, Mont., St. Paul and Minneapolis, Minn., Denver, Colo., Kansas City, Mo., Seattle, Wash.

6. SETTLEMENT

Population, 1923: Towns, 673; farms, 1,682.
 Total number of farms, 1922: 690.
 Number of irrigated farms, 1922: 590.
 Operated by owners: 66 per cent.
 Operated by tenants: 34 per cent.
 Roads: 30 miles, graveled.
 Number of public schools, 1922: 8.
 Number of churches, 1922: 7.
 Number of banks, 1922: 2; amount of deposits, \$156,000.
 Nationality of settlers: 70 per cent American.
 Settlers with previous farming experience: 61 per cent.
 Settlers with previous irrigation experience: 48 per cent.
 Technical aid to settlers: Experiment station and county agricultural agent.

7. FINANCES

Original construction cost: \$1,124,134.45.
 Supplemental construction: \$371,413.02.
 Operation and maintenance before public notice and miscellaneous: None.
 Total cost of construction: \$1,492,035.11.
 Revenues: \$16,411.66.
 Net amount to be repaid as construction June 30, 1923: \$1,475,623.45.
 Construction cost repaid to June 30, 1923: Amount, \$360,347.57; per cent, 25.
 Construction charges due but uncollected: Amount, \$32,297.46; per cent, 8.2.
 Construction cost per acre: Highest, \$60; lowest, \$30; average, \$34; supplemental, highest, \$15; lowest, \$4; average, \$13.
 Operation and maintenance: Amount due June 30, 1923, \$424,162.62; uncollected June 30, 1923, amount, \$102,729.78; per cent, 24.2.
 Average annual charge per acre: \$2.78; 1922, \$2.10.

8. RECOMMENDATIONS

The committee recommends that:

1. The amount charged to operation and maintenance in early years of the project, and which was, according to the statements of the water users, over and beyond the amount for which they had received a receipt in full, should be charged to the reclamation fund as a loss, provided the statements of the water users are found to be correct.
2. A contract should be entered into with the water users along the general lines of the pending contract, but subject to Resolution No. 16.
3. Drainage as necessary should be undertaken under the supervision of the Bureau of Reclamation.
4. The water users should take over the management of the project. (Resolution No. 19.)

MILK RIVER PROJECT

1. LOCATION

State: Montana.
 Counties: Glacier, Hill, Blaine, Phillips, and Valley.
 Project headquarters: Malta (St. Mary storage, Browning, Mont.).
 Railroads: Great Northern and Canadian Pacific.
 National highways: Theodore Roosevelt International Highway.

2. HISTORY

Authorized: March 14, 1903 (conditionally).
 Construction began: July 27, 1906.
 Water available: 1911.
 First public notice: None.

Changes in original plans: Lateral and waste water ditch construction on Malta and Glasgow divisions; Chinook division built by irrigation districts. St. Mary Lake's storage abandoned and Sherburne Lakes utilized. Bowdoin Lake plans abandoned and Nelson Reservoir constructed. St. Mary Canal location changed. Two diversion dams on Chinook division. Two diversion dams on Malta and Glasgow divisions. Nelson Reservoir, North Canal, and Vandalia North Canal abandoned.

3. WATER SUPPLY

Sources: St. Mary Lakes, Swiftcurrent Creek, Milk River.
 Available storage, 1922: 132,800 acre-feet.
 Water diverted, 1922: 102,832 acre-feet (including 27,655 Chinook division).
 Water delivered to land, 1922: 6,068 acre-feet (not including Chinook division).
 Water delivered per acre, 1922: 0.51 acre-foot (not including Chinook division).

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 96,500 (includes 30,000 Chinook division).
 Acreage irrigated, 1922: 46,370 (includes 28,200 Chinook division).
 Acreage cropped, 1922: 43,150 (includes 25,000 Chinook division).
 Ultimate irrigable acreage (estimated): 154,101.
 Public land entered to June 30, 1923: 31,056 acres.
 Public land vacant June 30, 1923: None.
 Lands under water right contracts June 30, 1923: None.
 Acreage damaged by seepage, 1923: 2,500.
 Acreage protected by drains, 1923: 100.
 Acreage furnished partial water supply under Warren Act and special contracts: 33,900.

5. AGRICULTURE.

Principal products: Alfalfa, native blue joint hay, and other forage crops, grain and vegetables.
 Average crop returns per acre, 1913-1922: \$14.95 (not including Chinook Division).
 Average crop returns per acre, 1922: \$11.14 (not including Chinook division).
 Total crop value, 1922: \$202,110 (not including Chinook division).
 Size of farm unit: Not announced.
 Character of soil: Sandy loam, clayey loam, and some gumbo.
 Average yield per acre, three principal crops: Alfalfa, 2.1 tons; wheat, 13.5 bushels; hay, bluejoint, 0.7 tons.
 Livestock per 40-acre farm, 1922: Beef cows, 3.1; hogs 0.94; poultry 8.3.
 Elevation: 2,200 feet.
 Annual rainfall, 12.93 inches.
 Length of growing season: 113 days.
 Temperatures: Maximum, 101°; minimum, -42°; average, 41°.
 Principal markets: Minneapolis and St. Paul, Minn., Great Falls, Mont., and local.

6. SETTLEMENT

Population, 1922: Towns, 7,100 (including Chinook division); farms, 1,057 (including Chinook division).
 Total number of farms, 1922: 298.
 Number of irrigated farms, 1922: 209.
 Operated by owners: 62 per cent.
 Operated by tenants: 38 per cent.
 Roads: Steady progress in betterment, especially last two years.
 Number of public schools, 1922: 38 (including Chinook division).
 Number of churches, 1922: 25 (including Chinook division).
 Number of banks, 1922: 23 (including Chinook division).
 Amount of deposits: \$4,350,000.
 Nationality of settlers: 70 per cent American.
 Settlers with previous farming experience: 75 per cent.
 Settlers with previous irrigation experience: 11 per cent.
 Technical aid to settlers: County agricultural agent.

7. FINANCES

Original construction cost: \$6,491,443.98.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: \$507,238.63.
 Total cost of construction: \$6,998,682.61.
 Revenues: \$236,599.36.
 Net amount to be repaid as construction June 30, 1923: \$6,762,083.25.
 Construction cost repaid to June 30, 1923: None.
 Construction charges due but uncollected: None.
 Construction cost per acre: Not announced.
 Operation and maintenance: None.
 Average annual charge per acre: \$3.28; 1922, \$3.64.

8. RECOMMENDATIONS

The committee recognizes that there will be a material loss upon the Milk River project and makes the following recommendations:

1. That the lands be classified, project costs fixed and repayments made in accordance with Resolutions Nos. 13, 7, and 23.

2. That the pending contract with settlers be not made unless the following conditions be fulfilled:

(a) Private land owners shall contract for absolute sale of excess holdings at acre prices, the maximum to be approved by the Secretary of the Interior.

(b) Private land owners shall enter into contracts with the Government for operation and maintenance charges, pending disposition of excess lands.

(c) A time limit for the execution of contracts *a* and *b* be fixed not later than April 1, 1925.

3. That if the above contracts are not then made, the Government should cease operation of the project.

4. That a special examination should be made for the purpose of determining what portion of the total construction cost should be assumed by the United States and repaid to the reclamation fund by reason of the fact that the project was originally selected and expenditures authorized in order to safeguard international water rights asserted by Canada.

SUN RIVER PROJECT

1. LOCATION

State: Montana.

County: Cascade, Chouteau, Lewis and Clark, and Teton.

Project headquarters: Great Falls.

Railroads: Chicago, Milwaukee & St. Paul and Great Northern.

National highways: Park to Park Highway.

2. HISTORY

Authorized: February 26, 1906.

Construction began: 1906.

Water available: 1909.

First public notice: March 26, 1908.

Changes in original plans: Irrigable area Fort Shaw division decreased from 16,300 to 9,970. Drainage both on the Fort Shaw division and Greenfields division.

3. WATER SUPPLY

Sources: Sun River and tributaries, Deep Creek, Bowl Creek, Basin Creek.

Available storage, 1922: 20,223 acre-feet.

Water diverted, 1922: 64,683 acre-feet.

Water delivered to land, 1922: 24,200 acre-feet.

Water delivered per acre, 1922: 1.17 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 42,465.

Acreage irrigated, 1922: 20,537.

Acreage cropped, 1922: 19,881.

Ultimate irrigable acreage (estimated): 115,086.

Public land entered to June 30, 1923: 42,348 acres.

Public land vacant June 30, 1923: None.

Lands under water-right contracts June 30, 1923: Public, 11,971 acres; private, 947 acres; total, 12,918 acres.

Acreage damaged by seepage, 1923: 3,771.
 Acreage protected by drains, 1923: 1,840.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Hay, grain, vegetables, livestock, and dairy products.
 Average crop returns per acre, 1913-1922: \$22.06 (Fort Shaw only).
 Average crop returns per acre, 1922: \$16.35.
 Total crop value, 1922: \$380,690.
 Size of farm unit: 160 acres.
 Character of soil: Sandy loam, clay, adobe, and alluvium.
 Average yield per acre, three principal crops: Alfalfa, 1.9 tons; wheat, 16.9 bushels (Fort Shaw division); alfalfa, 1.4 tons; wheat, 12.2 bushels (Greenfields division).
 Livestock per 40-acre farm, 1922: Dairy cows, 1.6; hogs, 1.9; poultry, 19.7.
 Elevation: 3,700 feet.
 Annual rainfall: 10.9 inches.
 Length of growing season: 130 days.
 Temperatures: Maximum, 96°; minimum, -33°; average, 44°.
 Principal markets: Great Falls, Seattle, St. Paul, Minneapolis, and Chicago.

6. SETTLEMENT

Population, 1922: Towns, 401; farms, 1,000.
 Total number of farms, 1922: 500.
 Number of irrigated farms, 1922: 393; operated by owners, 70 per cent; operated by tenants, 30 per cent.
 Roads: Gravel highway through project with fair secondary roads.
 Number of public schools, 1922: 17.
 Number of churches, 1922: 11.
 Number of banks, 1922: 3.
 Amount of deposits: \$158,000.
 Nationality of settlers: Fort Shaw, 87 per cent American; Greenfield, 30 per cent American and 65 per cent Scandinavian.
 Settlers with previous farming experience: Fort Shaw, 60 per cent; Greenfields, 78 per cent.
 Settlers with previous irrigation experience: Greenfields, 12 per cent; Fort Shaw, 15 per cent.
 Technical aid to settlers, county agricultural agent, and part-time agriculturist from United States Department of Agriculture.

7. FINANCES

Original construction cost: \$4,169,734.42.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous, \$164,769.08.
 Total cost of construction: \$4,334,503.50.
 Revenues: \$86,141.66.
 Net amount to be repaid as construction June 30, 1923: \$4,248,361.84.
 Construction cost repaid to June 30, 1923: Amount, \$140,997.03; per cent, 3.
 Construction charges due but uncollected: Amount, \$19,360.17; per cent, 12.1.
 Construction cost per acre, Fort Shaw division: Highest, \$60; lowest, \$30; average, \$33; supplemental, none.
 Operation and maintenance: Amount due June 30, 1923, \$162,915.30; uncollected June 30, 1923, \$37,426.19; per cent, 22.9.
 Average annual charge per acre: Fort Shaw, \$2.03; Greenfields, \$3.15. 1922, Fort Shaw, \$1.82; Greenfields, \$2.03.

8. RECOMMENDATIONS

The conditions on this project affecting repayments are unsatisfactory, due mainly to the low acre income from the crops produced. There is an ample water supply on the Fort Shaw division, but there is undoubted need for a comprehensive drainage plan, which will

ultimately increase the present cost by \$10 to \$20 per acre. The water supply of the Greenfields division is inadequate. It fails about July 10. To remedy this will require the construction of a reservoir, the cost of which, with the completion of the distribution system, would add \$41 to the present cost of \$44 per acre. The committee therefore recommends:

FORT SHAW DIVISION

1. The district should take over the management of the division. (Resolution No. 19.)
2. Drainage, as necessary, should be done by the Bureau of Reclamation.
3. Excess operation and maintenance charges prior to 1913 should be adjusted.

GREENFIELDS DIVISION

1. Drainage now planned should be completed.
2. Before any storage or extensions are made Resolution No. 2 should be applied.
3. Public notice should be delayed until the project is ready for profitable operation.

LOWER YELLOWSTONE PROJECT

1. LOCATION

State: Montana-North Dakota.
 Counties: McKenzie, N. Dak.; Richland and Dawson, Mont.
 Project headquarters: Savage, Mont.
 Railroads: Northern Pacific and Great Northern.
 National highways: Theodore Roosevelt International Highway.

2. HISTORY

Authorized: May 10, 1904.
 Construction began: Summer of 1905.
 Water available: 1909.
 First public notice: December 21, 1908.
 Changes in original plans: Minor changes in Yellowstone Dam; drainage.

3. WATER SUPPLY

Sources: Yellowstone River.
 Available storage, 1922: None.
 Water diverted, 1922: 49,280 acre-feet.
 Water delivered to land, 1922: 18,411 acre-feet.
 Water delivered per acre, 1922: 1.17 acre-feet.

4. LANDS

Acreeage for which bureau was prepared to supply water, 1922: 40,200 (district lands only).
 Acreeage irrigated, 1922: 15,599.
 Acreeage cropped, 1922: 15,400 (irrigated lands only).
 Ultimate irrigable acreeage (estimated): 59,529.
 Public land entered to June 30, 1923: 13,636 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 16,048 acres; private, 43,462 acres; total, 59,509 acres.

Acreage damaged by seepage, 1923: 1,800.
 Acreage protected by drains, 1923: 1,600.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Grain, forage crops, and vegetables.
 Average crop returns per acre, 1913-1922: \$19.65 (irrigated lands only).
 Average crop returns per acre, 1922: \$21.68 (irrigated lands only).
 Total crop value, 1922: \$334,100.
 Size of farm unit: Public, 80 acres; private, 160 acres.
 Character of soil: Deep sandy loam predominates; some alkali and gumbo.
 Average yield per acre, three principal crops: Alfalfa, 2.2 tons; wheat, 16.6 bushels; oats, 30.7 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 2; hogs, 2.2; poultry, 19.8.
 Elevation: 1,900 feet.
 Annual rainfall: 14.87 inches.
 Length of growing season: 124 days.
 Temperatures: Maximum, 103°; minimum, -35°; average, 42°.
 Principal markets: Minneapolis, St. Paul, and Duluth, Minn.

6. SETTLEMENT

Population, 1922: Towns, 2,805; farms, 1,591.
 Total number of farms, 1922: 575.
 Number of irrigated farms, 1922: 370; operated by owners, 69 per cent; operated by tenants, 31 per cent.
 Roads: Main highway extends through project, with very good earth roads leading to outlying districts.
 Number of public schools, 1922: 13.
 Number of churches, 1922: 15.
 Number of banks, 1922: 7.
 Amount of deposits: \$1,425,000.
 Nationality of settlers: American, 65 per cent; Scandinavian, 30 per cent.
 Settlers with previous farm experience: 90 per cent.
 Settlers with previous irrigation experience: 10 per cent.
 Technical aid to settlers: County agricultural agent.

7. FINANCES

Original construction cost: \$3,075,459.28.
 Supplemental construction: \$77,306.38.
 Operation and maintenance before public notice and miscellaneous: \$521,906.98
 Total cost of construction: \$3,674,672.64.
 Revenues: \$41,723.37.
 Net amount to be repaid as construction June 30, 1923: \$3,632,949.27.
 Construction cost repaid to June 30, 1923: Amount, \$41,135.10; per cent, 11.
 Construction charges due but uncollected: None.
 Construction cost per acre: Highest, \$45; lowest, \$42.50; average, \$45; supplemental, \$18 (covering 58,248.11 acres).
 Operation and maintenance: Amount due June 30, 1923: \$194,102.80; uncollected June 30, 1923, \$131,738.89; per cent, 67.9.
 Average annual charge per acre, \$6.09; 1922, \$2.10.

8. RECOMMENDATIONS

As to this project, the committee has sufficient information before it to justify the making of definite recommendations as to the charges settlers upon the project should be required to pay.

There has been at our disposal the reports of the local board of review and of the central board of review, made in 1916, upon this project, together with that of the Reclamation Commission, supplemented by our own investigations. The boards which have heretofore made a study of this project have in every instance

unanimously recommended that the charge against the settlers should be fixed at a lower figure than that of \$60 per acre, which by contract they are now required to pay. We believe this position is justified.

(1) The project is in the semiarid or dry-farming area, where good crops without irrigation have not been unusual, and where grazing has been profitable. The prices of dry-farming land outside the irrigable area are about the same as for irrigable lands within the project, which indicates that the productive value of water under the project is low, and that a high charge for a water right is not justified. Nothing can be gained by making a water-right charge for more than the water is actually worth in irrigation, as shown by the crops raised over a series of years.

(2) The data before us shows that the productivity of the land within the project under irrigation will not reasonably bear a charge of \$60 per acre for water.

(3) It further appears that there were some excessive and unwarranted costs incurred in the construction of the project, which careful planning and consideration might have foreseen, and possibly avoided.

For the foregoing reasons, we recommend that the charge against the lands included within the project should not be in excess of \$45 per acre in any instance, as of June 30, 1923, and that the charge to be fixed upon each farm unit should be in accordance with the provisions of Resolution No. 13 and that whatever legislation may be necessary to permit the Secretary of the Interior making an adjustment, in accordance with the above recommendations should be enacted.

In this connection, we wish to point out that in the future no new project should be authorized without the careful investigation provided for by the terms of Resolution No. 2, in order that the mistakes attendant upon the adoption and development of this project may be avoided.

NORTH PLATTE PROJECT

1. LOCATION

State: Nebraska-Wyoming.
 Counties: Sioux, Scotts Bluff, Banner, and Morrill, Nebr.; Natrona, Carbon, Converse, Goshen, and Platte, Wyo.
 Project headquarters: Mitchell, Nebr.
 Railroads: Chicago, Burlington & Quincy, Union Pacific, Chicago and North Western, and Colorado & Southern.
 National highways: Lincoln Highway; Park to Park Highway.

2. HISTORY

Authorized: March 14, 1903 (conditionally).
 Construction began: January, 1905.
 Water available: 1908.
 First public notice: July 29, 1907.
 Changes in original plans: Interstate division, extension, enlargement, and betterment of distribution system; improvements and additions of the Pathfinder outlets; drainage; flood water disposal channels to the river; canal enlargement; replacement of structures in entire distribution system; power development and supplemental storage at Guernsey. Fort Laramie division, enlargement of distribution system, section of tunnel No. 3, and main canal principal structures.

3. WATER SUPPLY

Sources: North Platte River.
 Available storage, 1922: 1,151,400 acre-feet.
 Water diverted, 1922: 747,198 acre-feet (Interstate and Fort Laramie divisions).
 Water delivered to land, 1922: 277,920 acre-feet.
 Water delivered per acre, 1922: Interstate, 2.55 acre-feet; Fort Laramie, 2.15 acre-feet; Northport, 3.02 acre-feet.

4. LANDS

Acres for which bureau was prepared to supply water, 1922: 162,239.
 Acres irrigated, 1922: 111,247.
 Acres cropped, 1922: 110,835.
 Ultimate irrigable acreage (estimated): 236,933.
 Public land entered to June 30, 1923: 134,886 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: public, 83,558 acres; private, 25,245 acres; total, 108,803 acres.
 Acres damaged by seepage, 1923: 3,490.
 Acres protected by drains, 1923: 7,100.
 Acres furnished partial water supply under Warren Act and special contracts: 122,400.

5. AGRICULTURE

Principal products: Alfalfa, cereals, corn, sugar beets, and potatoes.
 Average crop returns per acre, 1913-1922: Interstate, \$29.07.
 Average crop returns per acre, 1922: Interstate, \$21.74; Fort Laramie, \$15.42; Northport, \$21.05.
 Total crop value, 1922: \$2,263,000.
 Size of farm unit: Public, 80 acres; private, 160 acres.
 Character of soil: The soil varies from the sandy soils on portions of Interstate division to heavier or gumbo soils of the Fort Laramie, greater part of soil sandy loam.
 Average yield per acre, three principal crops: Interstate division, alfalfa, 2 tons; corn, 18 bushels; sugar beets, 11.2 tons; Fort Laramie division, alfalfa, 1.7 tons; corn, 21.2 bushels; sugar beets, 8.9 tons.
 Livestock per 40-acre farm, 1922: Dairy cows, 0.97; hogs, 3.2; poultry, 27.
 Elevation: 4,100 feet.
 Annual rainfall: 14.74 inches.
 Length of growing season: 132 days.
 Temperatures: Maximum, 98°; minimum, -24°; average, 47°.
 Principal markets: Omaha, Nebr.; Kansas City and St. Joseph, Mo.; Denver, Colo.; central Wyoming.

6. SETTLEMENT

Population, 1922: Towns, 20,800; farms, 7,186.
 Total number of farms, 1922: 2,263.
 Number of irrigated farms, 1922: 1,710; operated by owners, 58 per cent; operated by tenants, 42 per cent.
 Roads: About 100 miles of State highway and about 15 miles of project roads are properly graded.
 Number of public schools, 1922: 67.
 Number of churches, 1922: 47.
 Number of banks, 1922: 26.
 Amount of deposits: \$6,578,000.
 Nationality of settlers: Americans, 75 per cent; balance a mixture.
 Settlers with previous farming experience: 84.6 per cent.
 Settlers with previous irrigation experience: 50.2 per cent.
 Technical aid to settlers: Agriculturist United States Department of Agriculture, county agricultural agents, and two experiment stations.

7. FINANCES

Original construction cost: \$13,098,978.93.
 Supplemental construction: \$135,767.94.
 Operation and maintenance before public notice and miscellaneous: \$1,008,133.47.

Total cost of construction: \$14,242,877.34.
 Revenues: \$231,303.07.
 Net amount to be repaid as construction June 30, 1923: \$14,011,574.27.
 Construction cost repaid to June 30, 1923: Amount, \$1,742,168.45; per cent, 8.1.
 Construction charges due but uncollected: Amount, \$670,279.46; per cent, 27.8.
 Construction cost per acre: Highest, \$75; lowest, \$45; average, Interstate, \$55; Northport, \$70; supplemental, \$16 (covering 108,388.46 acres Interstate division).
 Operation and maintenance: Amount due June 30, 1923, \$1,792,629.38; uncollected June 30, 1923, amount \$438,317.73; per cent, 24.4.
 Average annual charge per acre: Interstate division, \$2.39; 1922, \$1.71; Fort Laramie division, \$3.90; 1922, \$2.79.

8. RECOMMENDATIONS

The committee recommends that:

1. The North Platte project be immediately turned over to the water users' association in accordance with our resolution No. 19 and that the tentative pending contract be made the basis of such transfer.
2. That the terms of the contract shall be in accordance with the Resolutions No. 13 as to classification of lands, No. 20 as to power, and No. 23 as to repayments.
3. We recommend the further investigation and commencement of construction of the Guernsey Reservoir and incidental operations.

NEWLANDS PROJECT

1. LOCATION

State: Nevada.
 Counties: Churchill, Storey, Lyon, and Washoe.
 Project headquarters: Fallon.
 Railroad: Southern Pacific.
 National highway: Lincoln Highway.

2. HISTORY

Authorized: March 14, 1903 (conditionally).
 Construction began: September 11, 1903.
 Water available: February 5, 1906.
 First public notice: May 6, 1907.
 Changes in original plans: Reduction of irrigable area from 375,000 to 159,000.
 Lake Tahoe storage plans modified. Drainage.

3. WATER SUPPLY

Sources: Truckee and Carson Rivers.
 Available storage, 1922: 350,000 acre-feet.
 Water diverted, 1922: 499,508 acre-feet.
 Water delivered to land, 1922: 141,972 acre-feet.
 Water delivered per acre, 1922: 3.15 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 73,747.
 Acreage irrigated, 1922: 44,963.
 Acreage cropped, 1922: 42,393.
 Ultimate irrigable acreage (estimated): 159,000.
 Public land entered to June 30, 1923: 32,525 acres.
 Public land vacant June 30, 1923: 4,112 acres.
 Lands under water-right contracts June 30, 1923: Public, 32,525 acres; private, 16,253 acres; total, 48,778 acres.

Acres damaged by seepage, 1923: 10,200.
 Acres protected by drains, 1923: 57,857.
 Acres furnished partial water supply under Warren Act and special contracts:
 None.

5. AGRICULTURE

Principal products: Alfalfa, small grain, sugar beets, potatoes, melons, garden truck, and dairy products.
 Average crop returns per acre, 1913-1922: \$26.90.
 Average crop returns per acre, 1922: \$32.43.
 Total crop value, 1922: \$1,374,710.
 Size of farm unit: 40 to 160 acres.
 Character of soil: Exceedingly variable; sandy loam, adobe clay, and volcanic ash.
 Average yield per acre, three principal crops: Alfalfa, 3.3 tons; wheat, 20.2 bushels; barley, 26.2 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 2.9; hogs, 1.8; poultry, 31.6.
 Elevation: 4,000 feet.
 Annual rainfall: 4.58 inches.
 Length of growing season: 136 days.
 Temperature: Maximum, 101°; minimum, -6.1°; average 49.4°.
 Principal markets: Nevada and Pacific coast cities.

6. SETTLEMENT

Population, 1922: Towns, 2,500; farms, 2,450.
 Total number of farms, 1922: 906.
 Number of irrigated farms, 1922; 778; operated by owners, 88 per cent; operated by tenants, 12 per cent.
 Roads: National highway passes through project. Other roads used as feeders are being improved by county.
 Number of public schools, 1922: 11.
 Number of churches, 1922: 8.
 Number of banks, 1922: 1. Amount of deposits, \$680,700.
 Nationality of settlers: American, 48 per cent; Germans, 20 per cent; Scandinavians, 10 per cent.
 Settlers with previous farm experience: 80 per cent.
 Settlers with previous irrigation experience: No record.
 Technical aid to settlers: Agriculturist, United States Department of Agriculture; county agricultural agent and experiment station.

7. FINANCES

Original construction cost: \$6,556,463.79.
 Supplemental construction: \$590,095.89.
 Operation and maintenance before public notice and miscellaneous: \$2,959.91.
 Total cost of construction: \$7,149,519.59.
 Revenues: \$159,020.74.
 Net amount to be repaid as construction June 30, 1923: \$6,990,498.85.
 Construction cost repaid to June 30, 1923: Amount, \$520,780.61; per cent, 7.4.
 Construction charges due but uncollected: Amount, \$24,589.44; per cent, 4.5.
 Construction cost per acre: Highest, \$80; lowest, \$22; average, \$41; supplemental, \$8 (covering 87,500 acres).
 Operation and maintenance: Amount due June 30, 1923, \$804,999.26; uncollected June 30, 1923—amount, \$92,139.19; per cent, 11.4.
 Average annual charge per acre, \$1.64; 1922, \$2.53.

8. RECOMMENDATIONS

The Newlands project was among those first selected and authorized after the passage of the reclamation law.

The engineering features were carefully considered, the water supply based upon the use of storage in Lake Tahoe, and the agricultural study of soils made in accordance with then known scientific

methods. It seemed to offer, climatically, agriculturally, and physically, an opportunity for a successful project.

The original possible area was thought to be about 450,000 acres; that was early reduced to 397,000 acres and later to 206,000 and finally to 73,000, when it was found, as a result of years of legal controversy, that the expected use of the water of Lake Tahoe was not available.

The unexpected failure of storage is the underlying cause of the difficulties from which the project has suffered. Unusual drainage and seepage conditions and the existence of 20,000 acres, held by a few owners with a prior water right, which became impotent because of the failure of the expected storage, added to the difficulties of the project.

To in measure meet those difficulties the Lahontan storage dam was constructed and drainage was begun. Of necessity, the costs increased out of proportion to the irrigable acreage. Exhaustive engineering examinations have been made for the purpose of providing the needed quantity of water and increasing the irrigable acreage.

It is believed that the irrigable acreage can be increased to 159,000 by the construction of the Spanish Springs reservoir and the distributing systems to the added areas.

It is apparent that a large amount has been spent for original work which, because of the conditions before mentioned, should not be charged to the project when completed as now proposed.

The committee is satisfied that the proper course to pursue is the construction of the Spanish Springs reservoir; otherwise, the interests of both the settlers and the Government will be seriously jeopardized.

We recommend:

1. That the construction of the Spanish Springs extension be authorized subject to Resolution No. 8.
2. That items included in present construction charges which are found to be nonbeneficial to the project be charged off and proper credits given equitably to the whole project.
3. That acre charges and repayments be fixed in accordance with Resolution No. 23.
4. That further examination be made of the 20,000 acres of private lands with prior water rights for the purpose, if feasible, of either acquiring said lands or obtaining an agreement for their subdivision and sale at a fixed price, and finally bringing them definitely under the project as other lands.
5. That the drainage plans as now proposed be carried out.
6. That whatever legislation may be necessary to permit the Secretary of the Interior making an adjustment in accordance with the above recommendations should be enacted.

CARLSBAD PROJECT

1. LOCATION

State: New Mexico.

County: Eddy.

Project headquarters: Carlsbad.

Railroads: Atchison, Topeka & Santa Fe.

National highways: None.

2. HISTORY

Authorized: February 24, 1906.
 Construction began: March, 1906.
 Water available: March 25, 1907.
 First public notice: December 17, 1907.
 Changes in original plans: At Avalon Dam, concrete core wall substituted for sheet steel piling, design of gates at spillway No. 1 changed, spillway capacity increased by two new tunnels, reinforced concrete overflow weir dam constructed; drainage.

3. WATER SUPPLY

Sources: Pecos River.
 Available storage, 1922: 52,000 acre-feet.
 Water diverted, 1922: 116,700 acre-feet.
 Water delivered to land, 1922: 56,687 acre-feet.
 Water delivered per acre, 1922: 2.36 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 24,991.
 Acreage irrigated, 1922: 24,076.
 Acreage cropped, 1922: 22,430.
 Ultimate irrigable acreage (estimated): 24,991.
 Public land entered to June 30, 1923: 45 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 45 acres; private, 24,995 acres; total, 25,040 acres.
 Acreage damaged by seepage, 1923: 5,500.
 Acreage protected by drains, 1923: 5,031.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, cotton, grain crops, melons, peaches, pears, and miscellaneous fruits.
 Average crop returns per acre, 1913-1922: \$44.38.
 Average crop returns per acre, 1922: \$53.41.
 Total crop value, 1922: \$1,197,980.
 Size of farm unit: Principally 160 acres.
 Character of soil: Sandy loam with large lime content.
 Average yield per acre, three principal crops: Alfalfa, 2.3 tons; cotton, 248 pounds; wheat, 18.7 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 0.75; hogs, 1.8; poultry 18.9.
 Elevation: 3,100 feet.
 Annual rainfall: 14.38 inches.
 Length of growing season: 213 days.
 Temperatures: Maximum, 112°; minimum, -7°; average, 63°.
 Principal markets: Carlsbad, N. Mex.; Denver, Colo.; Chicago, Ill.; Kansas City, Mo.; Texas cities; New Orleans, La.; New York, N. Y.

6. SETTLEMENT

Population 1922: Towns, 3,440; farms, 1,580.
 Total number of farms, 1922: 796.
 Number of irrigated farms, 1922: 333; operated by owners, 55 per cent; operated by tenants, 45 per cent.
 Roads: State highway 25 miles, and dirt roads 125 miles.
 Number of public schools, 1922: 10.
 Number of churches, 1922: 12.
 Number of banks, 1922: 3; amount of deposits, \$1,106,300.
 Nationality of settlers: Nearly all Americans.
 Settlers with previous farm experience: 85 per cent.
 Settlers with previous irrigation experience: 20 per cent.
 Technical aid to settlers: None, except as outside specialists visit the project.

7. FINANCES

Original construction cost: \$1,418,696.90.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: \$1,934.
 Total cost of construction: \$1,420,630.90.
 Revenues: \$24,702.11.
 Net amount to be repaid as construction June 30, 1923: \$1,395,928.79.
 Construction cost repaid to June 30, 1923: Amount, \$390,447.79; per cent, 28.
 Construction charges due but uncollected: Amount, \$35,428.54; per cent, 8.3.
 Construction cost per acre: Highest, \$69; lowest, \$31; average, \$49.
 Operation and maintenance: Amount due June 30, 1923: \$447,736.24; uncollected June 30, 1923, amount, \$50,225.74; per cent, 11.2.
 Average annual charge per acre: \$1.86; 1922, \$2.36.

8. RECOMMENDATIONS

A serious situation confronts this project created by the rapidly silting up and leakage from the main storage reservoir (Lake Mc Millan) and the ultimate failure of the project is certain unless additional storage is provided at an early date,

The committee recommends:

1. An expert engineering survey to secure additional feasible storage.
2. The plan of repayment provided by Resolution No. 23.
3. The provisions of Resolution No. 12 should be enforced.

HONDO PROJECT**1. LOCATION**

State: New Mexico.
 County: Chaves.
 Project headquarters: Carlsbad.
 Railroads: Atchison, Topeka & Santa Fe.

2. HISTORY

Authorized: September 6, 1904.
 Construction began: December, 1904.
 Changes in original plans: None.

3. WATER SUPPLY

Sources: Hondo River.

4. LANDS

Project abandoned.

5. AGRICULTURE

Principal products: Alfalfa, fruits.
 Character of soil: Rich alluvium.
 Average yield per acre, three principal crops, 1912-1916: Alfalfa, 1.9 tons; corn, 25 bushels.
 Elevation: 3,750 feet.
 Annual rainfall: 15 inches.
 Length of growing season: 213 days.
 Temperature: Maximum, 100°.
 Principal markets: Roswell, N. Mex.; Kansas City, Mo.; Chicago, Ill.; and Texas cities.

6. SETTLEMENT

Population, 1916: Towns, 7,500; farms, 101.
 Total number of farms, 1916: 28.
 Number of irrigated farms, 1916: 28; operated by owners, 64 per cent; operated by tenants, 36 per cent.
 Roads, poor.
 Number of public schools, 1922: 3.
 Number of churches, 1922: 9.

7. FINANCES

Original construction cost: \$339,491.68.
 Operation and maintenance before public notice and miscellaneous: \$42,081.71.
 Total cost of construction: \$381,573.39.
 Revenues: \$9,706.22.
 Net amount to be repaid as construction June 30, 1923: \$371,867.17.

8. RECOMMENDATIONS

This project has proven to be a failure and operation by the bureau has been discontinued. The committee recommends:
 The Hondo project be appraised and sold and the losses incurred charged to the reclamation fund.

RIO GRANDE PROJECT

1. LOCATION

State: New Mexico-Texas.
 County: El Paso, Tex.; Socorro, Sierra, and Dona Ana, N. Mex.
 Project headquarters: El Paso, Tex.
 Railroads: Atchison, Topeka & Santa Fe; El Paso Southwestern; Southern Pacific; Texas & Pacific.
 National highways: Lee Highway, Old Spanish Trail, and Bankhead Highway.

2. HISTORY

Authorized: December 2, 1905.
 Construction began: Not given.
 Water available: 1908.
 First public notice: Water rental.
 Changes in original plans: El Paso division included in project. Drains and laterals for entire project constructed by Government. Elephant Butte Dam increased in height. Percha, Mesilla, and Mexican diversion dams constructed.

3. WATER SUPPLY

Sources: Rio Grande River.
 Available storage, 1922: 2,638,860 acre-feet.
 Water diverted, 1922: 998,728 acre-feet.
 Water delivered to land, 1922: 204,452 acre-feet.
 Water delivered per acre, 1922: 2.28 acre-feet.

4. LANDS

Acres for which bureau was prepared to supply water, 1922: 116,000.
 Acres irrigated, 1922: 89,589 (includes 5,369 acres outside project limits).
 Acres cropped, 1922: 84,412 (includes 5,369 acres outside project limits).
 Ultimate irrigable acreage (estimated): 150,000.
 Public land entered to June 30, 1923: 1,500 acres.
 Public land vacant June 30, 1923: 100 acres.
 Lands under water-right contracts, June 30, 1923: Public, none; private, 85,000 acres; total, 85,000 acres.

Acreage damaged by seepage, 1923: 17,000.
 Acreage protected by drains, 1923: 123,000.
 Acreage furnished partial water supply under Warren Act and special contracts:
 Data not available.

5. AGRICULTURE

Principal products: Alfalfa, corn, wheat, melons, fruit, vegetables, and dairy products.

Average crop returns per acre, 1913-1922: \$45.62.

Average crop returns per acre, 1922: \$53.06.

Total crop value, 1922: \$4,479,670 (includes 5,369 acres outside project).

Size of farm unit: Principally 160 acres.

Character of soil: Fertile valley alluvium and sandy loam.

Average yield per acre, three principal crops: Alfalfa, 3 tons; corn, 21.3 bushels; cotton, 362 pounds.

Livestock per 40-acre farm, 1922: Dairy and beef cows, 3.1; hogs, 2.4; poultry, 41.4.

Elevation: 3,500 to 4,100 feet.

Annual rainfall: 10.03 inches.

Length of growing season: 246 days.

Temperature: Maximum, 102°; minimum, 6°; average, 59°.

Principal markets: Local towns, Eastern cities, Middle West stockyards, New Mexico and Arizona mining towns.

6. SETTLEMENT

Population, 1922: Towns, 110,442; farms, 11,267.

Total number of farms, 1922: 3,534.

Number of irrigated farms, 1922: 3,534; operated by owners, 84 per cent; operated by tenants, 16 per cent.

Roads: Excellent road system throughout project.

Number of public schools, 1922: 49.

Number of churches, 1922: 110.

Number of banks, 1922: 13; amount of deposits, \$30,000,000.

Nationality of settlers: 44 per cent Americans and 56 per cent Mexican, mostly American citizens.

Settlers with previous farming experience: Not given.

Settlers with previous irrigation experience: Not given.

Technical aid to settlers: Agricultural college and experiment station; home demonstration agent and county agricultural agent; El Paso Chamber of Commerce maintains a soil chemist.

7. FINANCES

Original construction cost: \$12,426,694.45.

Supplemental construction: None.

Operation and maintenance before public notice, and miscellaneous: \$863,128.82.

Total cost of construction: \$13,289,823.27.

Revenues: \$1,143,708.84.

Net amount to be repaid as construction June 30, 1923: \$12,146,114.43.

Construction cost repaid to June 30, 1923: Amount, \$76,491; per cent, 0.6.

Construction charges due but uncollected: Amount \$9.

Construction cost per acre: Highest, \$90; lowest, \$90; average, \$90.¹

Operation and maintenance: Amount due June 30, 1923, \$389,078.40; uncollected June 30, 1923, none.

Average annual charge per acre: \$2.02; 1922, \$2.38.

8. RECOMMENDATIONS

The questions raised regarding this project are:

(1) The proportion of construction cost assessed by the United States in order to fulfill its treaty obligations with Mexico.

¹ Contract with Elephant Butte and El Paso irrigation districts.

(2) The credit claimed by water users for lands used for the construction of drainage ditches.

The committee recommends:

(1) That no further appropriation by the United States is required to cover the expenditure made to fulfill treaty obligations for the reason that the original appropriation of \$1,000,000 has been found to be ample.

(2) That the lands taken for drain ditches be treated in accordance with Resolution No. 48.

(3) The plan of repayment provided by Resolution No. 23.

(4) That lands be classified as provided by Resolution No. 13.

(5) The operation and maintenance of the storage work and diversion dams should remain under the control and management of the bureau, which should complete the drainage systems.

(6) Each irrigation district should take over the operation and management of the distributing systems within their respective districts in accordance with Resolution No. 19.

(7) The bureau should continue investigations for dam sites with a view to future power development.

WILLISTON PROJECT

1. LOCATION

State: North Dakota.

County: Williams.

Project headquarters: Williston.

Railroad: Great Northern.

National highway: Theodore Roosevelt International Highway.

2. HISTORY

Authorized: January 23, 1906.

Construction began: 1906.

Water available: 1908.

First public notice: Buford Trenton division, April 8, 1908; Williston division, April 27, 1908.

Changes in original plans: Pumping station No. 4. Drainage.

Buford Trenton division abandoned. Changes in power plant plans.

3. WATER SUPPLY

Sources: Missouri River (pumping).

Available storage, 1922: None.

Water diverted, 1922: 1,942 acre-feet.

Water delivered to land, 1922: 1,352 acre-feet.

Water delivered per acre, 1922: 0.85 acre-foot.

4. LANDS

Acres for which bureau was prepared to supply water, 1922: 7,653.

Acres irrigated, 1922: 1,583.

Acres cropped, 1922: 1,571.

Ultimate irrigable acres (estimated): 10,753.

Public land entered to June 30, 1923: 254 acres.

Public land vacant June 30, 1923: 139 acres.

Lands under water-right contracts June 30, 1923: Public, none; private, 7,653 acres; total, 7,653 acres.

Acres damaged by seepage, 1923: Not reported.

Acres protected by drains, 1923: Not reported.

Acres furnished partial water supply under Wargen Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, dairy cows and hogs, corn, potatoes.
 Average crop returns per acre, 1913-1922: \$30.02 (6 years).
 Average crop returns per acre, 1922: \$33.24.
 Total crop value, 1922: \$52,230 (irrigated lands only).
 Size of farm unit: Public, 80; private, 160 acres.
 Character of soil: From sandy loam to clay gumbo.
 Average yield per acre, three principal crops: Alfalfa, 1.8 tons; wheat, 15.1 bushels; potatoes, 124.8 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 3.2; hogs, 4.7; poultry, 33.2.
 Elevation: 1,900 feet.
 Annual rainfall: 13 inches.
 Length of growing season: 124 days.
 Temperature: Maximum, 99°; minimum, -37°.
 Principal markets: St. Paul, Minneapolis, Duluth, and Chicago. Local markets important.

6. SETTLEMENT

Population, 1922: Towns, 4,500; farms, 220.
 Total number of farms, 1922: 105. Number of irrigated farms, 1922: 73; operated by owners, 99 per cent; operated by tenants, 1 per cent.
 Roads: Good system of roads reach all parts of project.
 Number of public schools, 1922: 6.
 Number of churches, 1922: 7.
 Number of banks, 1922: 2.
 Amount of deposits: \$1,700,000.
 Nationality of settlers: No report.
 Settlers with previous farming experience: No report.
 Settlers with previous irrigation experience: No report.
 Technical aid to settlers: None.

7. FINANCES (WILLISTON DIVISION ONLY)

Original construction cost: \$470,798.69.
 Supplemental construction: None.
 Operation and maintenance before public notice and miscellaneous: None.
 Total cost of construction: \$470,798.69.
 Revenues: \$10,691.51.
 Net amount to be repaid as construction June 30, 1923: None.
 Construction cost repaid to June 30, 1923: None.
 Construction charges due but uncollected: None.
 Construction cost per acre: Highest, \$38; lowest, \$38; average, \$38.
 Operation and maintenance: Amount due June 30, 1923, \$71,920.30; uncollected June 30, 1923—amount, \$45,242.55; per cent, 62.9.
 Average annual charge per acre: \$33.74; 1922, \$18.39.

8. RECOMMENDATIONS.

The history and prospects of this project do not justify its further operation by the Bureau of Reclamation. The committee recommends:

The Williston project be appraised and sold and the losses incurred charged to the reclamation fund.

UMATILLA PROJECT

1. LOCATION

State: Oregon.
 Counties: Umatilla and Morrow.
 Project headquarters: Hermiston.
 Railroads: Oregon-Washington Railroad & Navigation Co.; Spokane, Portland & Seattle Railroad.
 National highway: Theodore Roosevelt International Highway.

2. HISTORY

Authorized: December 4, 1905.
 Construction began: 1906.
 Water available: March 8, 1908.
 First public notice: December 27, 1907.
 Changes in original plans: Concrete lining of canals. Canals E and F abandoned and replaced by G pipe line. Irrigable area decreased. Extension of distribution system to vested right lands near Umatilla and Irrigon. Drainage.

3. WATER SUPPLY

Source: Umatilla River.
 Available storage, 1922: 50,000 acre-feet.
 Water diverted, 1922: 129,187 acre-feet.
 Water delivered to land, 1922: 59,313 acre-feet.
 Water delivered per acre, 1922: 4.47 acre-feet.

4. LANDS

Acreege for which bureau was prepared to supply water, 1922: 24,592.
 Acreege irrigated, 1922: 13,273.
 Acreege cropped, 1922: 10,188.
 Ultimate irrigable acreege (estimated): 28,300.
 Public land entered to June 30, 1923: 5,413 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 5,413 acres; private, 18,840 acres; total, 24,253 acres.
 Acreege damaged by seepage, 1923: 400.
 Acreege protected by drains, 1923: 2,000.
 Acreege furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, fruits, berries, vegetables, honey, and dairy products.
 Average crop returns per acre, 1913-1922: \$43.06.
 Average crop returns per acre, 1922: \$39.24.
 Total crop value, 1922: \$486,258.
 Size of farm unit: Public, 40; private, 160 acres.
 Character of soil: Sandy loam.
 Average yield per acre, three principal crops: Alfalfa, 3.7 tons; apples, 1,070 pounds; corn, 29.1 bushels.
 Livestock per 40-acre farm, 1922: Dairy cows, 4.8; hogs, 5.8; poultry, 54.3.
 Elevation: 470 feet.
 Annual rainfall: 7.94 inches.
 Length of growing season: 199 days.
 Temperature: Maximum, 105°; minimum, -7°; average, 52°.
 Principal markets: Portland, Oreg.; Spokane and Seattle, Wash., and eastern points.

6. SETTLEMENT

Population, 1922: Towns, 1,280; farms, 1,613.
 Total number of farms, 1922: 1,000.
 Number of irrigated farms, 1922: 558; operated by owners, 78 per cent; operated by tenants, 22 per cent.
 Roads: Columbia highway runs through project with good connecting roads.
 Number of public schools, 1922: 6.
 Number of churches, 1922: 9.
 Number of banks, 1922: 1; amount of deposits, \$300,000.
 Nationality of settlers: 90 per cent American-born.
 Settlers with previous farming experience: 60 per cent.
 Settlers with previous irrigation experience: No report.
 Technical aid to settlers: Experiment station. County agricultural agent and home demonstration agent.

7. FINANCES

Original construction cost: \$2,377,485.09.
 Supplemental construction: \$327,020.23.
 Operation and maintenance before public notice, and miscellaneous: \$190,853.69.
 Total cost of construction: \$2,895,159.01.
 Revenues: \$21,131.17.
 Net amount to be repaid as construction June 30, 1923: \$2,874,027.84.
 Construction cost repaid to June 30, 1923: Amount, \$356,599.38; per cent, 12.4.
 Construction charges due but uncollected: Amount, \$50,033.13; per cent, 12.3.
 Construction cost per acre: Highest, \$92; lowest, \$60; average, \$70; supplemental, highest, (17,000 acres), \$52.80; lowest, (11,500 acres), \$8; average, \$35.
 Operation and maintenance: Amount due June 30, 1923, \$279,861.19; uncollected June 30, 1923—amount, \$31,660.78; per cent, 11.3.
 Average annual charge per acre: \$5.65; 1922, \$2.69.

8. RECOMMENDATIONS

The Committee recommends:

1. That the construction cost of each division be spread equally over the entire area for which works have been constructed.
2. That the lands be classified as under Resolution No. 13.
3. That a type of agriculture and system of irrigation practice suitable for this project be devised and put into operation. (Resolutions Nos. 27 and 28.)
4. That the water users, through their irrigation districts, take over the full control of the operation and maintenance of the project. (Resolution No. 19.)
5. That the proposed plan of repayment, Resolution No. 23, be applied to such lands as are not relieved from payment under Resolutions Nos. 7 and 8.

KLAMATH PROJECT

1. LOCATION

States: Oregon and California.
 Counties: Klamath, Oreg.; Siskiyou, Modoc, Calif.
 Project headquarters: Klamath Falls, Oreg.
 Railroads: California Northeastern; Oregon, California & Eastern.
 National highways: Park to Park Highway.

2. HISTORY

Authorized: May 15, 1905.
 Construction began: 1906.
 Water available: May 16, 1907.
 First public notice: November 18, 1908.
 Changes in original plans: Exclusion of Lower Klamath Lake marsh lands; lateral construction not originally contemplated; drainage.

3. WATER SUPPLY

Sources: Upper Klamath Lake, Lost River, Clear Lake.
 Available storage, 1922: 726,000 acre-feet.
 Water diverted, 1922: 119,830 acre-feet.
 Water delivered to land, 1922: 49,862 acre-feet.
 Water delivered per acre, 1922: 1.11 acre-feet.

4. LANDS

Acres for which bureau was prepared to supply water, 1922: 51,000.
 Acres irrigated, 1922: 44,929 (includes 8,929 acres Van Brimmer land and miscellaneous pumping division).
 Acres cropped, 1922: 32,950.

Ultimate irrigable acreage (estimated): 169,397.
 Public land entered to June 30, 1923: 5,917 acres.
 Public land vacant June 30, 1923: None.
 Lands under water-right contracts June 30, 1923: Public, 5,909 acres; private, 39,354 acres; total, 45,263 acres.
 Acreage damaged by seepage, 1923: 2,000.
 Acreage protected by drains, 1923: 28,700.
 Acreage furnished partial water supply under Warren Act and special contracts: 10,000 (not including exposed Tule Lake bed, temporarily released).

5. AGRICULTURE

Principal products: Alfalfa, hay, grain, vegetables, stock, poultry, and dairy products.
 Average crop returns per acre, 1913-1922: \$19.68.
 Average crop returns per acre, 1922: \$16.30.
 Total crop value, 1922: \$537,140.
 Size of farm unit: 160 acres.
 Character of soil: Disintegrated basalt, volcanic ash, and diatomaceous earth, being largely classified as Yakima sandy loam.
 Average yield per acre, three principal crops: Alfalfa, 2.6 tons; wheat, 16.1 bushels; oats, 29.6 bushels.
 Livestock per 40-acre farm, 1922: Cows (beef and dairy), 3.2; hogs, 2.1; poultry, 26.6.
 Elevation: 4,100 feet.
 Annual rainfall: 12.7 inches.
 Length of growing season: 146 days.
 Temperature: Maximum, 97°; minimum, -4°; average, 46.5°.
 Principal markets: Portland, Oreg.; Sacramento and San Francisco, Calif.

6. SETTLEMENT

Population, 1922: Towns, 6,200; farms, 2,200.
 Total number of farms, 1922: 570.
 Number of irrigated farms, 1922: 542; operated by owners, 79 per cent; operated by tenants, 21 per cent.
 Roads: Project well provided with roads.
 Number of public schools, 1922: 22.
 Number of churches, 1922: 10.
 Number of banks, 1922: 5; amount of deposits, \$3,500,000.
 Nationality of settlers: No report.
 Settlers with previous farming experience: No report.
 Settlers with previous irrigation experience: No report.
 Technical aid to settlers: County agricultural agent.

7. FINANCES

Original construction cost: \$3,539,751.26.
 Supplemental construction: \$533,267.84.
 Operation and maintenance before public notice and miscellaneous: \$97,861.39.
 Total cost of construction: \$4,170,880.49.
 Revenues: \$192,704.76.
 Net amount to be repaid as construction June 30, 1923: \$3,978,175.73.
 Construction cost repaid to June 30, 1923: Amount, \$537,270.01; per cent, 13.5.
 Construction charges due but uncollected: Amount, \$30,541.57; per cent, 5.4.
 Construction cost per acre: Highest, \$90; lowest, \$30; average, \$35; supplemental, \$12.50 (covering 40,858 acres).
 Operation and maintenance: Amount due June 30, 1923, \$492,906.92; uncollected June 30, 1923, amount \$51,415.86; per cent, 10.4.
 Average annual charge per acre: \$1.14; 1922, \$0.95.

8. RECOMMENDATIONS

The claim of the settlers on the Tule Lake division of the Klamath project, that there should be a reduction in the charge of \$90 per acre as established by public notice of September 29, 1922, but subsequently withdrawn, is well founded.

There is available much information bearing on this subject, but we are of the opinion that a satisfactory recommendation concerning an equitable acre charge can be determined only after a detailed survey of Tule Lake lands has been made.

We recommend, therefore,

(1) That a survey of the Tule Lake Division of the Klamath project, in accordance with Resolution No. 13, be authorized.

(2) That upon the completion of this survey a board of review be appointed to formulate conclusions upon the findings of this survey and upon the large amount of information already in the possession of the Bureau of Reclamation.

(3) That this board of review consider the reduction of the present acre cost by adjusting the main items set up by the water users and the engineers who have examined the estimates, namely:

(a) The determination of the full acreage of Tule Lake lands that may ultimately be irrigated and which should share in the division construction costs.

(b) The allocation of the cost of the main canal in accordance with Resolution No. 6.

(c) The allocation of the cost of the diversion canal from Lost River to Klamath River, based on the benefits of this canal to the project as a whole.

(d) An equitable allocation of the costs of the Clear Lake and Gerber reservoirs.

(4) That the drainage estimates be not included in the acre charge, but as needed, appear as supplementary construction.

(5) That all project costs incurred for lower Klamath Lake lands, or other lands, later eliminated, shall be deducted from the construction costs on all project lands, which have been fixed or may be fixed, since such eliminations occurred. Such deducted amounts shall be held in the suspense account.

BELLE FOURCHE PROJECT

1. LOCATION

State: South Dakota.
 Counties: Butte, Mead.
 Project headquarters: Newell.
 Railroads: Chicago & North Western; Chicago, Burlington & Quincy; Chicago, Milwaukee & St. Paul.
 National highways: Black and Yellow.

2. HISTORY

Authorized: May 10, 1904.
 Construction began: 1905.
 Water available: April 14, 1908.
 First public notice: June 21, 1907.
 Changes in original plans: Inclusion of sublateral system; elimination of 9-mile unit, 7,500 acres to cost \$250,000; drainage.

3. WATER SUPPLY

Sources: Belle Fourche River.
 Available storage, 1922: 203,000 acre-feet.
 Water diverted, 1922: 115,629 acre-feet.
 Water delivered to land, 1922: 28,421 acre-feet.
 Water delivered per acre, 1922: 1.09 acre-feet.

4. LANDS

Acreege for which bureau was prepared to supply water, 1922: 82,190.
 Acreege irrigated, 1922: 31,150.
 Acreege cropped, 1922: 56,928.
 Ultimate irrigable acreege (estimated): 96,431.

Public land entered to June 30, 1923: 37,732 acres.
 Public land vacant June 30, 1923: 117 acres.
 Lands under water right contracts June 30, 1923: Public, 37,196 acres; private, 39,462 acres; total, 76,658 acres.
 Acreage damaged by seepage 1923: 4,133.
 Acreage protected by drains 1923: None.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Grain, corn, alfalfa, potatoes, garden truck, and sugar beets.
 Average crop returns per acre, 1913-1922: \$16.23.
 Average crop returns per acre, 1922: \$10.28.
 Total crop value, 1922: \$585,770.
 Size of farm unit: Public, 80 acres; private, 160 acres.
 Character of soil: North side of Belle Fourche River, principally heavy clay soil; south side, sandy loam.
 Average yield per acre, three principal crops: Alfalfa, 2 tons; wheat, 12.7 bushels; oats, 26.9 bushels.
 Livestock per 40-acre farm; 1922: Dairy cows, 2.1; hogs, 7; poultry, 18.3.
 Elevation: 2,800 feet.
 Annual rainfall: 14.55 inches.
 Length of growing season: 141 days.
 Temperature: Maximum, 103°; minimum, -38°; average, 47°.
 Principal markets: Omaha, Neb.; Chicago, Ill.; and mining towns in the Black Hills.

6. SETTLEMENT

Population, 1922: Towns, 2,386; farms, 2,700.
 Total number of farms: 1922, 1,292.
 Number of irrigated farms, 1922: 1,035; operated by owners, 89 per cent; operated by tenants, 11 per cent.
 Roads: 315 miles of roads, which are good in dry weather and bad in wet, due to gumbo.
 Number of public schools, 1922: 24.
 Number of churches, 1922: 9.
 Number of banks, 1922: 9; amount of deposits, \$2,606,200.
 Nationality of settlers: American, 64 per cent; Scandinavian, 12.4 per cent; Finn, 11.9 per cent.
 Settlers with previous farming experience, 56.9 per cent.
 Settlers with previous irrigation experience, 1.8 per cent.
 Technical aid to settlers: United States experimental station, county agricultural agent, and agriculturist, office of demonstration on reclamation projects.

7. FINANCES

Original construction cost: \$3,531,454.53.
 Supplemental construction: \$34,669.88.
 Operation and maintenance before public notice and miscellaneous: \$20,392.10.
 Total cost of construction: \$3,586,516.51.
 Revenues: \$19,079.38.
 Net amount to be repaid as construction June 30, 1923: \$3,567,437.13.
 Construction cost repaid to June 30, 1923: Amount, \$477,891.54; per cent, 13.4
 Construction charges due but uncollected: Amount \$271,312.06; per cent, 36.2.
 Construction cost per acre: Highest, \$45; lowest, \$30; average, \$33; supplemental \$0.50 (covering 69,338 acres).
 Operation and maintenance: Amount due June 30, 1923, \$870,863.27; uncollected June 30, 1923; amount, \$344,920.58; per cent, 39.7.
 Average annual charge per acre: \$1.77; 1922, \$1.85.

8. RECOMMENDATIONS

The combined expenses of providing water on this project, which included construction cost, operation and maintenance and payments on project construction costs of necessary drainage, have been greater than the value of water in irrigation, which has resulted in accumu-

lated arrears. These have been adjusted under a contract entered into between the district and the United States.

It is believed that under the plan of repayment recommended by the committee settlers can meet their payments, but there will be a large deficit until the unoccupied lands are settled and brought under cultivation.

The committee recommends:

1. Classification and equitable valuation of lands in accordance with Resolutions Nos. 13, 7, and 8.
2. The disposition of all adjusted unpaid charges in accordance with Resolution No. 24.
3. Adoption of the plan of repayment in accordance with Resolution No. 23.

STRAWBERRY VALLEY PROJECT

1. LOCATION

State: Utah.
 Counties: Utah, Wasatch
 Project headquarters: Provo.
 Railroads: Denver & Rio Grande, Union Pacific.
 National highways: Arrowhead Trail.

2. HISTORY

Authorized: December 15, 1905.
 Construction began: 1906.
 Water available: June 27, 1915.
 Changes in original plans: Capacity of storage reservoir changed. Power system development contract with old Strawberry Water Users' Associations canceled and project dealt with separately. Extension of canal and lateral system under the High Line division.

3. WATER SUPPLY

Sources: Strawberry and Spanish Fork Rivers and small streams.
 Available storage: 250,000 acre-feet.
 Water diverted, 1922: 79,500 acre-feet.
 Water delivered to land, 1922: 73,401 acre-feet.
 Water delivered per acre, 1922: 1.55 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 53,889.
 Acreage irrigated, 1922: 47,446 (includes High Line, Spanish Fork, and Springville-Mapleton divisions).
 Acreage cropped, 1922: 47,201 (includes 31,201 acres project lands).
 Ultimate irrigable acreage (estimated): 55,889.
 Public land entered to June 30, 1923: 1,953 acres.
 Public land vacant June 30, 1923: None.
 Lands under water right contracts June 30, 1923: Public, 1,953 acres; private, 30,048 acres; total, 32,001 acres.
 Acreage damaged by seepage, 1922: 8,500.
 Acreage protected by drains, 1922: 11,422.
 Acreage furnished partial water supply under Warren Act and special contracts: 1,000.

5. AGRICULTURE

Principal products: Alfalfa, hay, cereals, sugar beets, fruits, and vegetables.
 Average crop returns per acre, 1913-1922: \$50.67 (seven years).
 Average crop returns per acre, 1922: \$30.22 (\$29 on project lands).
 Total crop value, 1922: \$1,426,339 (\$904,839 on project lands).
 Size of farm unit: Public, 80; private, 160.
 Character of soil: Sandy loam, heavy clay, and varying mixture of both; black alluvium; loam; and gravel.
 Average yield per acre, three principal crops: Alfalfa, 2.9 tons; sugar beets, 10.9 tons; wheat, 25.3 bushels.

Livestock per 40-acre farm: Dairy cows, 8.5; hogs, 2.5; poultry, 30.5.
 Elevation: 4,600 feet.
 Annual rainfall: 15.07 inches.
 Length of growing season: 123 days.
 Temperature: Maximum, 100°; minimum, -11.5°; average, 50°.
 Principal markets: Salt Lake City, Utah, and adjacent towns and mining districts.

6. SETTLEMENT

Population, 1922: Towns, 16,000; farms, 7,000.
 Total number of farms, 1922: 3,200.
 Number of irrigated farms, 1922: 2,741; operated by owners, 84 per cent; operated by tenants, 16 per cent.
 Roads: Good.
 Number of public schools, 1922: 23.
 Number of churches, 1922: 25.
 Amount of deposits in banks: \$1,900,000.
 Nationality of settlers: 95 per cent American.
 Settlers with previous farming experience: 93 per cent.
 Settlers with previous irrigation experience: 90 per cent.
 Technical aid to settlers: County agricultural agent and home demonstrator.

7. FINANCES

Original construction cost: \$3,491,237.58.
 Operation and maintenance before public notice and miscellaneous: \$12,511.90.
 Total cost of construction: \$3,503,749.48.
 Net amount to be repaid as construction, June 30, 1923: \$3,466,968.
 Construction cost repaid to June 30, 1923: Amount, \$396,396.76; per cent, 11.4.
 Construction charges due but uncollected: Amount, \$79,948.71; per cent, 16.8.
 Construction cost per acre (High Line division only): Highest, \$100; lowest, \$80; average, \$82.
 Operation and maintenance: Amount due June 30, 1923, \$277,137.19.
 Uncollected, June 30, 1923: Amount, \$27,796.83; per cent, 10.

8. RECOMMENDATIONS

The management and operation of the Strawberry Valley project should be taken over at once by the water users. Nearly half of the lands of the project receive a part of their full water right from the project works and the remaining part from private irrigation companies which operate canals from Spanish Fork River. The water rights of these private irrigation companies are among the oldest in the United States, dating back to the first years of the Utah settlement. It is practically impossible to mingle the control of the rights of the private canals and the Government project. A contract with the United States similar to the contract with the Salt River project would enable the Strawberry Valley water users to assume control of the project and to operate it satisfactorily. At the time of making transfer of the management and operation the accrued and future receipts from grazing lands and power plants should be disposed of as directed by Resolution No. 20.

There is a surplus of available water above the present needs of the project. The contract with the water users should include all the stored water.

The repayment requirements of the project should be proportioned to the productive capacity of the project lands under the proposed repayment plan (Resolution No. 23).

OKANOGAN PROJECT

1. LOCATION

State: Washington.
County: Okanogan.
Project headquarters: Okanogan.
Railroads: Great Northern (branch line).
National highways: Okanogan Highway.

2. HISTORY

Authorized: December 2, 1905.
Water available: June, 1908.
First public notice: November 12, 1908.
Changes in original plans: Canal location changed. Location of Conconully Dam changed. Dam built by hydraulic method. Change in the design of dirt flumes from the borrow pits to the Conconully Dam. Other changes in borrow pits. Cippoletti weir installation. Concrete lining of canals. Extension of distribution system. Improvement and enlargement of Salmon Lake Reservoir.

3. WATER SUPPLY

Source: Salmon Creek.
Available storage, 1922: 24,900 acre-feet.
Water diverted, 1922: 21,318 acre-feet.
Water delivered to land, 1922: 15,295 acre-feet.
Water delivered per acre, 1922: 2.75 acre-feet.

4. LANDS

Acreege for which bureau was prepared to supply water, 1922: 7,676.
Acreege irrigated, 1922: 5,570.
Acreege cropped, 1922: 4,834.
Ultimate irrigable acreege (estimated): 7,676.
Public land entered to June 30, 1923: 116 acres.
Public land vacant June 30, 1923: none.
Lands under water-right contracts June 30, 1923: Public, 116 acres; private, 8,550 acres; total, 8,666 acres.

5. AGRICULTURE

Principal products: Fruit, hay, grain, and vegetables.
Average crop returns per acre, 1913-1922: \$159.20.
Average crop returns per acre, 1922: \$332.45.
Total crop value, 1922: \$1,607,140.
Size of farm unit: 40 acres.
Character of soil: Volcanic ash and gravel on upper benches and sand and gravel on lowlands along Okanogan River.
Average yield per acre, three principal crops: Alfalfa, 2.3 tons; apples, 5,766 pounds; potatoes, 114.9 bushels.
Livestock per 40-acre farm, 1922: Dairy cows, 2.5; hogs, 1.8; poultry, 52.3.
Elevation: 1,000 feet.
Annual rainfall: 11.55 inches.
Length of growing season: 132 days.
Temperature: Maximum, 108°; minimum, -10°; average, 48°.
Principal markets: States east.

6. SETTLEMENT

Population, 1922: Towns, 2,300; farms, 1,363.
Total number of farms, 1922: 447.
Number of irrigated farms, 1922: 445; operated by owners, 87 per cent; operated by tenants, 13 per cent.
Roads: Good system of roads.
Number of public schools, 1922: 6.
Number of churches, 1922: 8.
Number of banks, 1922: 5; amount of deposits, \$956,000.
Nationality of settlers: American, 75 per cent; Scandinavian, 10 per cent.
Settlers with previous farming experience: 74 per cent.
Settlers with previous irrigation experience: 14 per cent.
Technical aid to settlers: County agricultural agent.

7. FINANCES

Original construction cost: \$841,536.61.
 Supplemental construction: \$597,676.87.
 Operation and maintenance before public notice, and miscellaneous: \$14,483.15.
 Total cost of construction: \$1,453,696.63.
 Revenues: \$59,956.22.
 Net amount to be repaid as construction June 30, 1923: \$1,393,740.41.
 Construction cost repaid to June 30, 1923: Amount, \$54,281.38; per cent, 3.9.
 Construction charges due but uncollected: Amount, \$1,913.35; per cent, 3.4.
 Construction cost per acre: Highest, \$95; lowest, \$65; average, \$94; supplemental, \$140 (covering 6,188 acres).
 Operation and maintenance: Amount due June 30, 1923: \$220,967.53.
 Uncollected June 30, 1923: Amount, \$3,718.59; per cent, 1.7.
 Average annual charge per acre: \$4.13; 1922, \$9.52.

8. RECOMMENDATIONS

The committee recommends:

1. That the project cost, as of January 10, 1919, be spread equally over the entire area for which works had then been constructed.
2. That a competent survey be made (Resolution No. 13), and that upon the findings of this survey the lands susceptible of profitable cultivation shall be relieved of payment of any part of project costs allocated to lands, including those heretofore excluded, that shall be determined to be unsuited for profitable cultivation.
3. That the cost of the power plants built in canals to furnish power for pumping be charged to the project only if it is shown that power can be furnished as originally planned.
4. That the cost of the Salmon Lake and Conconully Reservoirs be deducted from the construction costs charged to the water users, and that water from these reservoirs be sold hereafter to the water users on a rental basis.
5. That a study be made of possible sources of irrigation water for the lands of the project.

YAKIMA PROJECT

1. LOCATION

State: Washington.
 Counties: Kittitas, Yakima, Benton.
 Project headquarters: Yakima.
 Railroads: Northern Pacific; Chicago, Milwaukee & St. Paul; Union Pacific system; Yakima Valley Transportation Co.
 National highways: Sunset Trail.

2. HISTORY

Authorized: December 12, 1905.
 Construction began: 1906.
 Water available: 1907.
 First public notice: Sunnyside, November 18, 1908; Tieton, November 7, 1910.

Changes in original plans: Tieton division—Irrigable area increased. Location of Tieton Canal headworks changed. Canyon division canal slopes flattened. Canyon division main canal lined. Main canal, Canyon division, built by force account. Government constructed sublaterals. Sunnyside division—Minor changes in Sunnyside Canal. Pipe line to supply Prosser lands. Power developed by drops in lateral system used for pumping. Changes in Bumping Lake, Kachess, Keechelus, Clear Creek, and Tieton Dams.

3. WATER SUPPLY

Sources: Yakima River and tributaries.

Available storage 1922: 415,850 acre-feet.

Water diverted 1922: Sunnyside, 421,950; Tieton, 93,754 acre-feet.

Water delivered to land, 1922: Sunnyside, 301,838; Tieton, 71,105 acre-feet.

Water delivered per acre, 1922: Sunnyside, 3.18; Tieton, 2.48 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water 1922: Sunnyside, 101,339; Tieton, 32,000.

Acreage irrigated 1922: Sunnyside, 95,000; Tieton, 28,700.

Acreage cropped 1922: 107,161.

Ultimate irrigable acreage (estimated); 339,987.

Public land entered to June 30, 1923: 7,358 acres.

Lands under water right contracts June 30, 1923: Public, 3,471 acres; private, 60,044 acres; total, 63,515 acres.

Acreage damaged by seepage, 1923: Sunnyside, 10,000; Tieton, 200.

Acreage protected by drains 1923: Sunnyside, 50,357; Tieton, 2,400.

Acreage furnished partial water supply under Warren Act and special contracts: 151,170.

5. AGRICULTURE

Principal products: Alfalfa, apples, pears, peaches, cherries, wheat, corn, potatoes, sugar beets, hops, stock and dairy products.

Average crop returns per acre 1913-1922: Sunnyside, \$91.35; Tieton, \$81.66.

Average crop returns per acre 1922: Sunnyside, \$78.13; Tieton, \$95.80.

Total crop value, 1922: \$3,838,750.

Size of farm unit: Public, 80; private, 160 acres.

Character of soil: Sunnyside, sandy loam or volcanic ash; Tieton, volcanic ash and decomposed basalt.

Average yield per acre, three principal crops: Sunnyside—Alfalfa, 4.5 tons; apples 7,405 pounds; wheat, 27.8 bushels. Tieton—Alfalfa, 3.2 tons; apples 5,626 pounds; wheat, 25.0 bushels.

Livestock per 40-acre farm, 1922: Dairy cows, 3.6; hogs, 4.6; poultry, 85.4.

Elevation: Sunnyside, 700; Tieton, 1,700 feet.

Annual rainfall: Sunnyside, 6.5; Tieton, 8.12 inches.

Length of growing season: Sunnyside, 154; Tieton, 127 days.

Temperature: Maximum, Sunnyside, 104°; Tieton, 98°; minimum, Sunnyside, -2; Tieton, -1; average, Sunnyside, 50.8; Tieton, 48.7.

Principal markets: Cities of Northwest, British Columbia, and Alaska; fruit market, entire United States.

6. SETTLEMENT

Population, 1922: Towns, Sunnyside, 7,250; Tieton, 23,000; farms, Sunnyside 12,332; Tieton, 3,542.

Total number of farms, 1922: Sunnyside, 3,138; Tieton, 1,480.

Number of irrigated farms, 1922: Sunnyside, 3,138; Tieton, 1,300. Operated by owners: Sunnyside, 76; Tieton, 74 per cent. Operated by tenants: Sunnyside, 24; Tieton, 26 per cent.

Roads: Sunnyside has 385 and Tieton 78 miles of improved roads.

Number of public schools, 1922: Sunnyside, 41; Tieton, 10.

Number of churches, 1922: Sunnyside, 30; Tieton, 4.

Number of banks, 1922: Sunnyside, 12; amount of deposits, Sunnyside, \$3,000,000. Tieton, no report.

Nationality of settlers: Americans, 78 per cent; foreign, 19 per cent.

Settlers with previous farming experience: Sunnyside, 75 per cent; Tieton, 70 per cent.

Settlers with previous irrigation experience: Sunnyside, 60 per cent; Tieton, 50 per cent.

Technical aid to settlers: State experiment station, county agricultural agent, entomologist, drainage engineer, club agent, and home demonstration agent.

7. FINANCES

Original construction cost: \$12,352,446.10.

Supplemental construction: \$113,010.39.

Operation and maintenance before public notice and miscellaneous: \$92,244.17.

Total cost of construction: \$12,557,700.66.

Revenues: \$318,461.09.

Net amount to be repaid as construction June 30, 1923: \$12,239,239.57.

Construction cost repaid to June 30, 1923: Amount, \$3,168,183.58; per cent, 26.

Construction charges due but uncollected: Amount, \$180,853.17; per cent, 5.3.

Construction cost per acre: Highest, Sunnyside, \$75; Tieton, \$110; lowest, Sunnyside, \$52; Tieton, \$93; average, Sunnyside, \$52; Tieton, \$96; supplemental, Tieton, \$11.60 (covering 32,000 acres).

Operation and maintenance: Amount due June 30, 1923: \$2,204,765.88.

Uncollected June 30, 1923: Amount, \$117,916.24; per cent, 5.3. Average annual charge per acre: Sunnyside, \$1.38; Tieton, \$2.38; 1922, Sunnyside, \$1.55; Tieton, \$2.94.

8. RECOMMENDATIONS

The record indicates that the difficulties confronting the water users of the Yakima project are chiefly those due to adverse marketing conditions and freight rates, high taxes, and a large interest-bearing indebtedness. The favorable agricultural nature of the project and the high quality and successful experience of the water users justify the belief that, under the following recommendations and all others having general application, this project will retain its position of leadership among the projects.

The committee recommends:

1. That the operation and maintenance of the Yakima project be taken over at once by the water users under a contract in accordance with resolution No. 19.

2. That the proposed plan of repayment apply to such divisions of the Yakima project as may elect to accept them. (Resolution No. 23.)

RIVERTON PROJECT

1. LOCATION

State: Wyoming.

County: Fremont.

Project headquarters: Riverton.

Railroads: Chicago & North Western.

National highways: Park to Park Highway.

2. HISTORY

Construction began: January 19, 1920.

Water available: None.

First public notice: None.

Changes in original plans: None.

3. WATER SUPPLY

Sources: Wind River.

Available storage 1922: None.

Water diverted 1922: None.

Water delivered to land, 1922: None.

Water delivered per acre, 1922: None.

4. LANDS

Ultimate irrigable acreage (estimated): 100,000 acres

5. AGRICULTURE

Size of farm unit: Not announced.

Character of soil: Sandy loam to heavy clay.

Elevation: 5,200 feet.

Annual rainfall: 8 inches.

Temperature: Maximum, 94°; minimum, -27°; average, 42.4°.

Principal markets: Omaha, Denver, and local.

6. SETTLEMENT

Population 1922: Towns, 2,500; farms, none.
 Number of public schools, 1922: 2.
 Number of churches, 1922: 7.
 Number of banks, 1922: 5; amount of deposits, \$1,000,000.

7. FINANCES

Original construction cost: \$1,079,928.12.
 Supplemental construction: None.
 Operation and maintenance before public notice, and miscellaneous: \$14,995.46.
 Total cost of construction: \$1,064,932.66.
 Revenues: \$4,704.57.
 Net amount to be repaid as construction June 30, 1923: \$1,060,228.09.

8. RECOMMENDATIONS

This project was authorized in 1917. The estimated cost is \$3,000,000, of which about \$1,000,000 has been expended. The acreage is estimated to be 100,000.

The committee recommends that in the future development of this project the Bureau of Reclamation apply to the principles contained in the resolutions of this committee applying to the construction of new projects.

SHOSHONE PROJECT

1. LOCATION

States: Wyoming and Montana.
 Counties: Park and Big Horn, Wyo.; Carbon, Mont.
 Project headquarters: Powell, Wyo.
 Railroads: Chicago, Burlington & Quincy.
 National highways: Park to Park Highway.

2. HISTORY

Authorized: February 10, 1904.
 Construction began: 1904.
 Water available: June 1, 1908.
 First public notice: Garland division, November 25, 1907; Frannie division, August 31, 1917.
 Changes in original plans: Two diversions instead of one on north side of river.
 Changes in Willwood division diversion plans. Drainage.

3. WATER SUPPLY

Source: Shoshone River.
 Available storage, 1922: 459,380 acre-feet.
 Water diverted, 1922: 192,851 acre-feet.
 Water delivered to land, 1922: 99,710 acre-feet.
 Water delivered per acre, 1922: 2.33 acre-feet.

4. LANDS

Acreage for which bureau was prepared to supply water, 1922: 71,223.
 Acreage irrigated, 1922: 42,870.
 Acreage cropped, 1922: 41,907.
 Ultimate irrigable acreage (estimated): 139,000.
 Public land entered to June 30, 1923: 63,265 acres.
 Public land vacant June 30, 1923: 1,816 acres.
 Lands under water right contracts June 30, 1923: Public, 64,056 acres; private, 1,950 acres; total, 66,006 acres.
 Acreage damaged by seepage, 1923: Garland 4,300; Frannie 3,500.
 Acreage protected by drains, 1923: Garland 25,000; Frannie 6,000.
 Acreage furnished partial water supply under Warren Act and special contracts: None.

5. AGRICULTURE

Principal products: Alfalfa, grain, potatoes, sugar beets, cattle, hogs, and dairy products.

Average crop returns per acre, 1913-1922: Garland \$25.81; Frannie \$17.23 (five years).

Average crop returns per acre, 1922: Garland \$20.50; Frannie \$12.96.

Total crop value 1922: \$788,125.

Size of farm unit: Public, 80; private, 160 acres.

Character of soil: Light sandy to heavy clay.

Average yield per acre, three principal crops: Garland division—alfalfa, 2.2 tons; potatoes, 144.6 bushels; wheat, 19 bushels. Frannie division—alfalfa, 1.8 tons; potatoes, 73 bushels; wheat 11.6 bushels.

Livestock per 40-acre farm, 1922: Dairy cows, 1.3; hogs, 1.7; poultry, 34.4.

Elevation: 4,500 feet.

Annual rainfall: 5.6 inches.

Length of growing season: 122 days.

Temperature: Maximum, 98.3°; minimum, -20.9°; average, 43°.

Principal markets: Omaha, Kansas City, Chicago, Denver, and Billings, Mont.

6. SETTLEMENT

Population, 1922: Towns, 1,585, farms, 2,444.

Total number of farms, 1922: 1,083.

Number of irrigated farms 1922; 914, operated by owners, 76 per cent; operated by tenants, 24 per cent.

Roads: Good.

Number of public schools, 1922: 7.

Number of churches, 1922: 8.

Number of banks, 1922: 4; amount of deposits: \$441,000.

Nationality of settlers: Garland division, 98 per cent American; Frannie division, 90 per cent American.

Settlers with previous farming experience, Garland division, 61 per cent; Frannie division, 60 per cent.

Settlers with previous irrigation experience, Garland division, 12 per cent; Frannie division, 24 per cent.

Technical aid to settlers: County agricultural agent and an agriculturist from the office of demonstrations on reclamation projects.

7. FINANCES

Original construction cost: \$7,287,831.10.

Supplemental construction: \$1,073,782.92.

Operation and maintenance before public notice and miscellaneous: \$1,151.57.

Total cost of construction: \$8,362,765.59.

Revenues: \$71,752.42.

Net amount to be repaid as construction June 30, 1923: \$8,291,013.17.

Construction cost repaid to June 30, 1923: \$611,416.72; per cent, 7.4.

Construction charges due but uncollected: \$190,786.64; per cent, 23.7.

Construction cost per acre: Garland division, highest, \$59; lowest, \$45; average, \$52. Frannie division, highest, \$100; lowest, \$66; average, \$80. Supplemental, Garland division, highest, \$19.50 (37,362 acres); lowest, \$12.50 (3,265 acres); average \$19. Frannie division, average \$30 (24,589 acres).

Operation and maintenance: Amount due June 30, 1923: \$608,112.93.

Uncollected June 30, 1923: \$188,403.42; per cent, 31.

Average annual charge per acre: \$1.44: 1922, \$1.40.

8. RECOMMENDATIONS

This is one of the projects in which the construction costs were greater than the value of water in irrigation. The three divisions vary greatly in agricultural value. The major portion of the lands of the Garland division have an agricultural value which justifies a proportionate share of the project costs. The lands on the Frannie division are of such low agricultural value as to make it impossible for them to pay the cost of operation and maintenance of the irrigation

works much less to return the construction costs. The prospect of repayment of project costs by the Willwood division now under development are not promising.

The committee recommends:

GARLAND DIVISION

1. The management of the divisions to be taken over by the water users. Resolution No. 19.
2. Classification and equitable valuation of the lands under Resolutions Nos. 13, 7, and 8.
3. Adoption of the new plan of repayment under Resolution No. 23.
4. Disposition of all unpaid charges under Resolution No. 24.
5. Segregation of operation and maintenance charges among the divisions of the project in such a manner as to make each division liable only for its own operation and maintenance costs.
6. Power profits should be credited to the power construction account until final adjustment of costs is made upon the several divisions.
7. Income from grazing lands and town sites under Resolution No. 20.

FRANNIE DIVISION

The committee believes that the Frannie division should be abandoned in whole or in part, but under such conditions as will be just to the settlers; hence it is recommended:

1. That the Bureau of Reclamation immediately make an examination of the division and make detailed recommendations to the Secretary of the Interior providing for such whole or partial abandonment.
2. That, pending such recommendations, the construction costs allocated to the division and all charges for construction and operation and maintenance against the settlers be held in suspense, without interest or penalty, that water be supplied to settlers now actually irrigating their lands at a rental to be agreed upon, and that no additional lands be irrigated.
3. That in the event the division is not wholly abandoned, the recommendation of the Bureau of Reclamation for the operation of lands not abandoned shall be in harmony with the resolutions of this committee regarding classification of lands, repayments, and such others as may be applicable.

PROPOSED LEGISLATION

A BILL Authorizing appropriations from the reclamation fund to provide for the investigation and construction of certain Federal irrigation works

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled: That the following sums are authorized to be appropriated out of the special fund in the Treasury of the United States created by act of June 17, 1902 (Thirty-second Statutes, page 388), and therein designated "the reclamation fund," to be available immediately subject to the applicable provisions of the reclamation law.

North Platte irrigation project, Nebraska-Wyoming: For continued investigations, commencement of construction of the Guernsey Reservoir, and incidental operations, \$800,000.

Spanish Springs irrigation project, Nevada: For continued investigations, commencement of construction, and incidental operations, \$800,000.

Owyhee irrigation project, Oregon: For continued investigations, commencement of construction and incidental operations, \$1,250,000.

Vale irrigation project (formerly called Warm Springs), Oregon: For continued investigations and for first payment toward purchase of an interest in the Warm Springs Reservoir, \$250,000.

Salt Lake Basin irrigation project, Utah: For continued investigations, commencement of construction, and incidental operations, \$1,500,000.

Yakima irrigation project, Washington: For continued investigations, commencement of construction of the Kittitas division, and incidental operations, \$1,500,000.

Sec. 2. That no part of any sum provided for herein shall be expended for construction on account of any division of any project until an appropriate repayment contract, in form approved by the Secretary of the Interior, shall have been properly executed by a district or districts organized under State law, embracing the lands irrigable under such division, and the execution thereof shall have been confirmed by decree of a court of competent jurisdiction, which contract, among other things, shall contain an appraisal approved by the Secretary of the Interior, showing the present actual bona fide value of all such irrigable lands fixed without reference to the proposed Government development, and shall provide that until the Government construction charges against such lands shall have been fully paid, upon any and every sale of the land or any interest therein, 50 per centum of all moneys, credits, and property received therefor above the value thereof, as shown by said appraisal, shall belong to the United States to be credited in reduction of the construction charge against the land so sold, and the Secretary of the Interior may convert into money through legal process, if necessary, any such credits or property so belonging to the United States; and all public lands irrigable under such division shall be entered subject to the conditions of this proviso which shall be applied thereto: *Provided further*, That no part of any sum provided for herein shall be expended for construction on account of any division of any project until all areas of land irrigable under such division and owned by any individual in excess of one hundred and sixty irrigable acres, shall have been conveyed in fee to the United States free of encumbrance to again become a part of the public domain, under a contract between the United States and the individual owner providing that the value as shown by said appraisal of the land so conveyed to the United States shall be credited in reduction of the construction charge thereafter to be assessed against the land retained by such owner; and lands so conveyed to the United States shall be subject to disposition under the reclamation law when so ordered by the Secretary of the Interior: *And provided further*, That no part of any sum provided for herein shall be expended for construction on account of any division of any project until an appropriate contract in form approved by the Secretary of the Interior shall have been properly executed by all holders of Federal land grants of more than one hundred and sixty acres irrigable under such division, which shall provide for the sale of such lands to actual bona fide settlers at not more than the value thereof as shown by said appraisal: *And provided further*, That the provisions of this section shall not apply to lands to be served with water from the Guernsey Reservoir of the North Platte irrigation project, to lands to be served with water under the Warren Act of February 21, 1911 (Thirty-sixth Statutes, page 925), nor to Indian lands in any project.

A BILL To provide safeguards for future Federal irrigation development, and an equitable adjustment of existing accounts on Federal irrigation 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 when used in this act—

(a) The word "Secretary" means the Secretary of the Interior.

(b) The words "reclamation law" mean the act of June 17, 1902 (Thirty-second Statutes, page 388) and all acts amendatory thereof or supplementary thereto.

(c) The words "reclamation fund" mean the fund provided by the reclamation law.

(d) The word "project" means a Federal irrigation project authorized by the reclamation law.

(e) The words "division of a project" mean a substantial irrigable area of a project designated as a division by order of the Secretary.

Sec. 2. That hereafter no new project, or new division of a project, shall be approved for construction until information in detail shall have been secured concerning its feasibility, its adaptability for actual settlement and farm homes, and the probable return of the cost thereof to the United States. To this end, it is directed that before approval by the Secretary of any such project or division, he shall secure a report in detail concerning the water supply, engineering features,

cost of construction, land prices, and probable acre cost of development. The Secretary shall also secure, through the Secretary of Agriculture, a report in detail relative to the climate, soil, kind of crops for which the proposed development is adapted, and probable production; also, through the Secretary of Commerce, a report in detail with respect to transportation facilities, markets, and other economic factors upon or affecting the proposed project or division.

Sec. 3. That hereafter no moneys shall be expended for construction on account of any new project or any new division of a project until an appropriate repayment contract, in form approved by the Secretary, shall have been properly executed by a district or districts organized under State law, embracing the lands irrigable thereunder, and the execution thereof shall have been confirmed by decree of a court of competent jurisdiction, which contract, among other things, shall contain an appraisal approved by the Secretary, showing the actual bona fide value of all such irrigable lands fixed without reference to the proposed Government development, and shall provide that until the Government construction charges against such lands shall have been fully paid, upon any and every sale of the land or any interest therein, 50 per centum of all moneys, credits, and property received therefor above the value thereof as shown by said appraisal, shall belong to the United States to be credited in reduction of the construction charge against the lands so sold, and the Secretary may convert into money any such credits or property so belonging to the United States; and all public lands irrigable under any such project or division shall be entered subject to the conditions of this proviso which shall be applied thereto: *Provided further*, That hereafter no moneys shall be expended for construction on account of any such project or division until all areas of land irrigable thereunder and owned by any individual in excess of one hundred and sixty irrigable acres, shall have been conveyed in fee to the United States free of encumbrance to again become apart of the public domain, under a contract between the United States and the individual owner providing that the value as shown by said appraisal of the land so conveyed to the United States shall be credited in reduction of the construction charge thereafter to be assessed against the land retained by such owner; and lands so conveyed to the United States shall be subject to disposition under the reclamation law when so ordered by the Secretary: *And provided further*, That hereafter no moneys shall be expended for construction on account of any such project or division until an appropriate contract in form approved by the Secretary shall have been properly executed by all holders of Federal land grants of more than one hundred and sixty acres irrigable thereunder, which shall provide for the sale of such lands to actual bona fide settlers at not more than the value thereof as shown by said appraisal: *And provided further*, That the provisions of this section shall not apply to Indian lands or to lands to be served with water under the Warren Act of February 21, 1911 (Thirty-sixth Statutes, page 925).

Sec. 4. That the Secretary is hereby authorized, under regulations to be promulgated by him, to require of each applicant for entry to public lands on a project, such qualifications as to industry, experience, character and capital, as in his opinion are necessary to give reasonable assurance of success by the prospective settler. Any person not having the qualifications so prescribed by the Secretary shall not be entitled to make such an entry or an application therefor.

Sec. 5. That hereafter the irrigable lands of each new project and new division of a project shall be classified by the Secretary with respect to their power, under a proper agricultural program, to support a family and pay water charges, and the Secretary is authorized to fix different construction charges against different classes of land under the same project for the purpose of equitably apportioning the total construction cost so that all lands may as far as practicable bear the burden of such cost according to their productive value. Reclassification surveys may be made by the Secretary periodically as experience may suggest, for the purpose of determining any changes that may accompany a continued cultivation and irrigation of the lands.

Sec. 6. That hereafter the Secretary shall as to each irrigable acre of land in a project, issue two public notices relating to construction charges. The first public notice shall be issued when the land is ready for settlement and will announce the construction charge per irrigable acre. The second public notice shall be issued when in the opinion of the Secretary the agricultural development of the project shall have advanced sufficiently to warrant the commencement of payment of installments of such construction charge. The second public notice shall fix the date when payments will begin on the construction charge announced by the first public notice, which date shall be not less than five years from the date of the first public notice.

Sec. 7. That hereafter all project construction charges shall be made payable in annual installments based on the productive power of the land as provided in this section. The installment of the construction charge per irrigable acre payable each year shall be 5 per centum of the average gross annual acre income for the ten calendar years first preceding, or for all years of record if fewer than ten years are available, of the area in cultivation in the division of the project in which the land is located, as found by the Secretary annually. The decision of the Secretary as to the amount of any such installment shall be conclusive. These annual payments shall continue until the total construction charge is fully paid. The Secretary is authorized upon request, to amend any existing contract for a project water right so that it will provide for payment of the construction charge thereunder in accordance with the provisions of this section.

Sec. 8. That the penalty of 1 per centum per month against delinquent accounts, provided in section 3 and section 6 of the act of August 1, 1914 (Thirty-eighth Statutes, page 686) is hereby reduced to one-half of 1 per centum per month, as to all installments hereafter coming due. The Secretary is authorized to amend all existing contracts accordingly.

Sec. 9. That whenever the water users take over the care, operation, and maintenance of a project, the total accumulated net profits derived from the operation of project power plants, leasing of project grazing and farm lands, and the sale or use of town sites, shall be credited to the construction cost of the project, and thereafter the net profits from such sources may be used by the water users to be credited, first, on account of project construction costs; second, on account of project operation and maintenance cost; and third, as the water users may direct. No distribution to individual water users shall be made out of any such profits before all obligations to the Government shall have been fully paid.

Sec. 10. That all profits which may be derived from the sale or rental of surplus water under the Warren Act of February 21, 1911 (Thirty-sixth Statutes, page 925), shall be credited to the project or division of the project to which the construction cost has been charged. Contractors for the use of water under said Warren Act shall participate in the assets of the project with the contractors for the use of water within the project in proportion to the amounts paid for the water right. The Secretary is authorized upon request to amend any existing contract made under said Warren Act so that it will provide for payment of the construction charge thereunder in accordance with the provisions of section 7 of this act.

Sec. 11. That the Secretary is hereby authorized to undertake a comprehensive and detailed survey of the physical and economic features of each existing project, and to classify the irrigable lands thereunder in accordance with the provisions of section 5 of this act.

Sec. 12. That when a classification of lands under this act shows in the opinion of the Secretary that any such land is unsuited for immediate cultivation and unable to support a family and pay water charges at the present time the Secretary may suspend the payment of such charges in whole or in part until such time as the land in his opinion is found suitable for cultivation and able to support a family and pay water charges.

Sec. 13. That when it shall have been definitely determined by the Secretary that any project land classed as irrigable and subject to the payment of water charges, is in fact unsuitable for cultivation by irrigation and can not by cultivation produce a return sufficient to support a family and pay water charges, such land may be eliminated from the project as nonirrigable, and the amount of the charges assessed against the same shall then be definitely charged off as a loss to the reclamation fund.

Sec. 14. That the Secretary is hereby authorized, after making a proper survey of all existing projects and a classification of lands as provided in this act, to make, in each case where it is ascertainable from such survey and classification that the present water charges per acre are more than the land can bear, such fair and equitable adjustment of construction charges as in his opinion will fix a charge per acre which the land can reasonably bear. Any difference between the construction charge as adjusted and the original charge shall be charged off as a loss to the reclamation fund.

Sec. 15. That in any adjustment of water charges as provided in this act, all due and unpaid charges, both on account of construction and on account of operation and maintenance, including interest and penalties, may, in the discretion of the Secretary, be added in each case to the total obligation of the water user, and the new total thus established shall then be the construction charge against the land in question.

Sec. 16. That every entryman on a project farm unit not yet patented, which unit has been classified by the Secretary as being insufficient to support a family

and pay water charges, shall have the right upon request to exchange his entry for another farm unit of unentered public land on the same or another project, in which event all installments of construction charges theretofore paid on account of the relinquished farm unit shall be credited on account of the new farm unit taken in exchange: *Provided*, That where two entrymen apply for the same farm unit under the exchange provision of this section, only one of whom is an ex-service man, as defined by the joint resolution of January 21, 1922 (Forty-second Statutes, page 358), the ex-service man shall have a preference in making such exchange.

Sec. 17. That the Secretary is hereby authorized to employ trained farm and economic advisers who will give farming and business advice to enable water users on the projects to increase their farm incomes and organize for cooperation in business and social affairs.

Sec. 18. That all contracts providing for new projects and new divisions of projects shall require that all operation and maintenance charges shall be payable in advance. In each case where the care, operation, and maintenance of a project, or division of a project, are transferred to the water users, the contract shall require the payment of operation and maintenance charges in advance. That whenever an adjustment of water charges is made under this act the adjustment contract shall provide that hereafter all operation and maintenance charges shall be payable in advance.

Sec. 19. That the cost and expense hereafter of the main office at Washington, District of Columbia, of the Bureau of Reclamation in the Department of the Interior, and the cost and expense of general investigations heretofore and hereafter authorized by the Secretary shall be charged to the general reclamation fund and shall not be charged as a part of the construction or operation and maintenance cost payable by the water users under the projects.

Sec. 20. That where, in the opinion of the Secretary, a right of way or easement of any kind over public land is required in connection with a project, the Secretary may reserve the same to the United States by filing in the General Land Office and in the appropriate local land office copies of an instrument giving a description of the right of way or easement and notice that the same is reserved to the United States for Federal irrigation purposes under this act, in which event entry for such land and the patent issued therefor shall be subject to the right of way or easement so described in such instrument; and reference to each such instrument shall be made in the appropriate tract books and also in the patent.

Sec. 21. That where real property or any interest therein heretofore has been or hereafter shall be donated and conveyed to the United States for use in connection with a project, and the Secretary decides not to utilize the donation, he is authorized without charge to reconvey such property or any part thereof to the donating grantor, or to the heirs, successors, or assigns of such grantor.

Sec. 22. That there is hereby authorized to be appropriated from the General Treasury, the sum of \$100,000 annually for five years for investigations to be made by the Secretary through the Bureau of Reclamation to obtain necessary information to determine how arid, swamp, and cut-over timber lands may best be developed in the future to meet the growing agricultural needs of the Nation.

Sec. 23. That the Secretary is hereby authorized, under regulations to be promulgated by him, to make short-time loans from the reclamation fund to entrymen upon projects, not to exceed \$800 at any one time to any person, for the purchase of necessary livestock and equipment, and provision shall be made for the repayment of such loans in amortized installments during a period of not to exceed five years with interest on deferred payments at 5 per centum per annum, computed from the date of the contract: *Provided*, That no such loan shall in any case exceed 60 per centum of the cost of the livestock and equipment purchased. Such loans shall be secured by chattel mortgage upon such livestock and equipment.

Respectfully submitted.

THOMAS E. CAMPBELL,
JAMES R. GARFIELD,
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ELWOOD MEAD,

Committee of Special Advisers on Reclamation.

EXHIBIT No. 1

TABLE No. 1.—Analysis of reclamation projects

State	Project	(1) Years water delivered calculated from year irrigation began, although works not completed	(2) Original estimated cost. ¹	(3) Net construction cost to June 30, 1923 ¹	(4) Original estimated irrigable acreage	(5) Acreage bureau prepared to supply water 1922 ²	(6) Acreage actually irrigated 1923 ²	(7) Amount paid by water users on construction to June 30, 1923 ²	(8) Difference between net construction cost (col. 3) and amount paid on construction (col. 7), representing amount unpaid on construction ⁴	(9) Original estimated cost per acre based on columns 2 and 4
Arizona.....	Salt River.....	17	\$5,650,000.00	\$10,548,118.28	200,000	121,370	123,330	\$9,656,308.46	\$28.00	
Arizona-California.....	Yuma.....	17	2,701,198.00	9,026,546.52	76,968	63,200	53,970	1,093,062.01	7,933,494.51	35.10
California.....	Orland.....	14	685,088.00	1,091,795.87	17,000	20,870	15,120	240,614.68	851,181.29	40.29
Colorado.....	Grand Valley.....	9	4,565,000.00	4,017,921.98	53,000	30,000	12,370	(⁵)	4,017,921.98	86.00
Do.....	Uncompahgre.....	16	2,500,000.00	6,715,074.41	100,000	97,410	64,730	102,706.34	6,122,368.07	26.00
Idaho.....	Boise.....	18	9,867,800.00	12,731,409.73	371,700	143,000	112,000	1,408,314.08	11,323,095.65	28.55
Do.....	King Hill.....	8	1,000,000.00	1,881,891.45	15,000	13,650	6,440	(⁵)	1,881,891.45	68.66
Do.....	Minidoka.....	17	2,538,656.00	8,064,663.26	121,000	121,560	105,590	2,866,208.24	5,198,455.02	20.98
Kansas.....	Garden City ¹¹	(¹¹)	258,000.00	385,651.07	8,600	(¹¹)	(¹¹)	51,176.11	334,474.96	30.00
Montana.....	Huntley.....	16	900,000.00	1,474,468.81	35,000	32,000	19,620	361,064.23	1,113,352.58	25.71
Do.....	Milk River.....	13	7,428,464.00	6,762,083.26	251,908	96,500	18,170	1,114.00	6,760,969.26	23.48
Do.....	Sun River.....	15	7,372,400.00	4,245,842.94	356,000	42,470	20,530	170,178.73	4,075,664.21	28.80
Montana-North Dakota.....	Lower Yellowstone.....	14	2,059,218.00	3,110,449.23	96,000	40,200	15,600	41,232.70	3,069,116.52	30.90
Nebraska-Wyoming.....	North Platte.....	16	3,600,000.00	13,672,160.32	100,000	162,240	111,250	1,742,767.88	11,929,392.74	25.00
Nevada.....	Newlands.....	18	4,383,997.00	6,988,475.92	370,000	73,750	44,960	622,100.51	6,466,375.41	14.55
New Mexico.....	Carlsbad.....	17	600,000.00	1,393,994.79	20,000	25,000	24,060	391,577.34	1,002,417.45	30.00
Do.....	Hondo ¹¹	(¹¹)	275,000.00	371,867.17	10,000	(¹¹)	(¹¹)	(¹¹)	371,867.17	27.50
New Mexico-Texas.....	Rio Grande.....	16	7,200,000.00	12,146,114.43	175,000	116,000	89,590	76,491.00	12,069,623.43	30.00
North Dakota.....	Williston.....	16	235,460.00	460,107.18	8,795	7,650	1,590	8,250.63	451,856.55	23.75
Do.....	Buford-Trenton ¹¹	(¹¹)	134,500.00	221,864.60	4,500	(¹¹)	(¹¹)	(¹¹)	221,864.60	29.88
Oregon.....	Umatilla.....	16	1,086,000.00	2,683,399.89	20,140	24,590	13,270	373,919.76	2,309,480.13	63.90
Oregon-California.....	Klamath.....	17	4,394,311.00	3,974,463.70	236,401	61,000	39,000	637,692.72	3,436,770.98	18.99
South Dakota.....	Belle Fourche.....	16	2,335,000.00	3,547,048.08	79,000	82,190	31,150	478,279.90	3,068,768.18	29.55
Utah.....	Strawberry Valley ¹¹	9	722,000.00	3,466,988.00	60,000	53,890	30,820	396,582.88	3,070,405.12	45.37
Washington.....	Okanogan.....	16	432,800.00	1,302,181.65	8,650	8,000	5,427.70	54,427.70	1,247,753.95	50.00
Do.....	Yakima.....	17	6,545,808.00	12,181,831.67	181,769	133,340	123,700	3,171,576.12	8,990,255.55	34.00
Wyoming.....	Riverton ¹¹	(¹¹)	6,777,025.00	1,090,226.00	100,000	(¹¹)	(¹¹)	(¹¹)	1,090,226.00	67.77
Do.....	Shoshone.....	16	4,310,238.00	8,290,865.42	110,000	71,220	42,730	611,608.50	7,679,256.92	39.18
Total.....	.....	.....	93,436,941.00	141,787,008.74	8,066,427	1,692,700	1,202,130	15,592,842.48	128,194,166.26	30.57

- 1 Approximately at time construction approved by Secretary of Interior; supplemental construction not included in these estimates.
- 2 These costs include supplemental construction and amounts expended under Warren Act and special contracts on 11 projects (estimated total, \$12,922,455).
- 3 Represents amount to be repaid by water users (including operation and maintenance during construction; excluding arrearages in operation and maintenance heretofore transferred to construction).
- 4 Extension act, 1914, provided 20 years additional time for payment of unpaid amounts.
- 5 Water sold under Warren Act and special contracts not included in columns 5 and 6.
- 6 Includes advance payments: Construction, \$366,334.27.
- 7 Salt River: Original estimate not found. Estimate used secured from "Table of approved projects, with estimated costs," submitted to House Committee on Irrigation of Arid Lands, Apr. 16 to 30, 1906.
- 8 Salt River: Acreage includes lands taken in by the Salt River Valley Water Users' Association on which the association spent additional money for construction work.
- 9 Yuma: This is original estimate of Yuma project and does not include Yuma Mesa auxiliary now under construction: \$300,000 was added to the above estimate at a later meeting of board of engineers.
- 10 Orland: Original estimate, \$650,000. Revised estimate of September, 1910, \$685,085.
- 11 Grand Valley, King Hill, and Milk River projects not under public notice; water sold on rental basis.
- 12 Original estimates on these projects include operation and maintenance in following sums: Boise \$1,868,600; Sun River, \$1,080,000; Lower Yellowstone, \$330,000; North Platte, \$500,000; Okanogan, \$53,000; Yakima, \$650,914; Shoshone, \$275,000; total, \$4,899,114.
- 13 Boise: Only half of project started on this estimate.
- 14 Garden City, Hondo, and Buford-Trenton projects abandoned.
- 15 Huntley: Estimate of board of engineers, Feb. 26, 1906, \$499,178; estimate given in table (\$900,000) is amount specified in authority of Secretary of the Interior for construction, Apr. 18, 1905.
- 16 Milk River: This estimate made June 8, 1912, includes St. Marys storage and Dodson unit, construction of which started prior to this date.
- 17 Rio Grande: This estimate secured from "Table of approved projects with estimated costs," submitted to House Committee on Irrigation of Arid Lands, Apr. 16 to 30, 1906.
- 18 Rio Grande: Cost includes \$1,000,000 covered by special appropriation not to be repaid by water users.
- 19 Strawberry Valley: Water sold on acre-foot basis, not on acreage basis.
- 20 Strawberry Valley: Estimate submitted June, 1910.
- 21 Yakima: Total of original estimates on Sunnyside, Tieton, and Wapato units.
- 22 Includes \$2,515,875.62 for Rimrock Dam, which will irrigate additional acreage.
- 23 Riverton: Under construction; no lands irrigated.
- 24 Average.

TABLE No. 1.—Analysis of reclamation projects—Continued

State	Project	(10)	(11)	(12)		(13)	(14)	(15)	(16)	(17)	
		Actual cost per acre to June 30, 1923, based on acreage bureau prepared to supply 1922 (col. 5) **	Actual cost per acre to June 30, 1923, based on acreage actually irrigated (col. 6) **	Aggregate charge per acre to settlers now being made under public notice	Original	Supplemental	Total operation and maintenance cost to June 30, 1923.†	Total operation and maintenance receipts to June 30, 1923.†	Amount unpaid on operation and maintenance, June 30, 1923, being difference between cost (col. 13) and receipts (col. 14) †	Delinquent charges, rentals of irrigation water, June 30, 1923 ††	Total amount unpaid by water users, being totals of columns 8, 15, and 16
Arizona.....	Salt River.....	\$49.50	\$51.90	\$60.00		(13)	(14)	(15)			\$9,656,303.46
Arizona-California.....	Yuma.....	142.80	167.45	55.00		\$1,667,960.99	\$956,921.08	\$711,039.91	\$4,852.06		8,649,386.48
				75.00							
California.....	Orland.....	52.80	72.20	44.00	\$11.00	218,610.67	200,351.55	18,259.12	32,904.83		869,440.41
Colorado.....	Grand Valley.....	133.90	324.80	(17)		(15)	(15)	(15)	(15)		4,050,828.81
Do.....	Uncompahgre.....	68.90	103.60	70.00		81,724.16	1,543.60	80,180.56	36,351.96		6,728,900.59
Idaho.....	Boise.....	89.00	113.70	26.80		1,631,887.35	1,424,251.14	207,636.21	13,127.47		11,543,859.33
Do.....	King Hill.....	137.75	292.15	77.44							
Do.....	Minidoka.....	66.30	78.20	30.00	12.00	(15)	(15)	(15)	2,861.36		1,894,252.81
				66.50		1,381,916.18	1,198,418.06	183,498.12	267.60		5,372,220.74
Kansas.....	Garden City ††	(11)	(11)	(11)		(11)	(11)	(11)			334,474.96
Montana.....	Huntley.....	46.10	75.50	30.00	15.00	850,502.46	321,806.29	528,696.17	207.92		1,642,256.67
Do.....	Milk River.....	101.70	372.20	(17)		(15)	(15)	(15)	23,470.81		6,784,440.06
Do.....	Sun River.....	100.00	206.80	30.00		201,770.14	124,686.46	77,083.68	26,892.89		4,179,640.78
				36.00							
Montana-North Dakota.....	Lower Yellowstone.....	77.35	200.00	45.00	18.50	744,420.61	62,361.87	682,058.74	1,996.50		3,752,871.76
Nebraska-Wyoming.....	North Platte.....	84.30	122.90	55.00	16.00	2,032,953.08	1,347,895.73	685,057.35	584.11		12,615,034.20
Nevada.....	Newlands.....	94.75	155.45	62.00	(18)	1,046,236.05	708,990.14	337,245.91	19.50		6,803,640.82
New Mexico.....	Carlsbad.....	55.75	57.90	45.00		483,724.56	405,595.17	78,129.39			1,060,546.84
Do.....	Hondo ††	(11)	(11)	(11)		(11)	(11)	(11)	35.49		371,902.66
New Mexico-Texas.....	Rio Grande.....	104.70	135.60	90.00		548,366.12	394,742.40	161,623.72	84,028.18		12,265,275.33
North Dakota.....	Williston.....	60.15	290.00	38.00		357,244.00	28,596.51	328,647.49			790,504.04
Do.....	Buford-Trenton †	(11)	(11)	(11)		74,771.07	2,317.41	72,453.66			294,318.35
Oregon.....	Umatilla.....	109.10	202.20	70.00	(19)	534,116.72	251,651.58	282,465.17			2,591,943.30
				92.00	(19)						
Oregon-California.....	Klamath.....	77.90	110.40	30.00	(19)	562,268.18	439,773.12	142,495.06	476.80		3,570,741.84
				94.00	(19)						
South Dakota.....	Belle Fourche.....	43.15	113.85	30.00		972,057.67	529,317.96	442,739.71	150.00		3,811,654.84
				40.00							
Utah.....	Strawberry Valley ††	64.30	112.50	80.00		352,254.65	243,775.56	108,479.09			8,178,864.21
Washington.....	Okanogan.....	162.80	233.80	95.00	(19)	379,212.10	223,082.61	156,129.59	1,643.97		1,406,507.51

Do.....	Yakima.....	91.20	98.80	{ 52.00 93.00	-----	2,200,887.18	2,098,687.09	207,200.09	614.83	9,198,171.47
Wyoming.....	Riverton ¹⁴	(¹⁵)	(¹⁶)	{ 80.00 61.00 52.00 95.00	{ 19.50 80.00	(¹⁷)	(¹⁸)	(¹⁹)	(²⁰)	1,060,228.09
Do.....	Shoshone.....	116.40	192.80			616,847.91	418,978.89	197,869.02	252.15	7,876,678.09
Total.....		²¹ 83.76	²² 117.94			²³ 17,069,231.85	²⁴ 11,570,744.09	²⁵ 5,688,487.76	180,137.28	132,062,788.25

¹ These costs include supplemental construction and amounts expended under Warren Act and special contracts on 11 projects (estimated total, \$12,922,450).

² Water sold under Warren Act and special contracts not included in columns 5 and 6.

³ Includes arrearages on operation and maintenance transferred; excludes operation and maintenance during construction in column 8.

⁴ Does not include water rentals and sales of water during construction period, which are contained in net figure, column 8.

⁵ This amount includes \$1,069,864.81, representing costs from Jan. 1 to June 30, 1923, for which no assessments have been made against the water users, leaving a net arrearage of \$4,628,623.45 on operation and maintenance.

⁶ Water rentals assessed are included in column 8.

⁷ Salt River: Acreage includes lands taken in by the Salt River Valley Water Users' Association on which the association spent additional money for construction work.

⁸ Salt River project operated by Salt River Valley Water Users' Association.

⁹ Grand Valley, King Hill, and Milk River projects not under public notice; water sold on rental basis.

¹⁰ Rental basis.

¹¹ District contract.

¹² Garden City, Hondo, and Buford-Trenton projects abandoned.

¹³ ¹⁴ and district contract.

¹⁵ Williston: Operation and maintenance loss prior to Apr. 1, 1919, \$178,667.20; Buford-Trenton, abandoned, operation and maintenance loss, \$71,149.89.

¹⁶ Strawberry Valley: Water sold on acre-foot basis, not on acreage basis.

¹⁷ Riverton: under construction; no lands irrigated.

¹⁸ Average.

¹⁹ Includes advance payments; operation and maintenance, \$19,251.80.

TABLE No. 2.—Showing operation and maintenance cost per acre on Federal irrigation projects

State	Project	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Arizona	Salt River					1.64	1.75	1.36	2.22						
Arizona-California	Yuma	6.64	9.37	8.81	10.20	3.55	3.42	4.05	5.00	3.68	4.12	5.22	6.89	6.33	5.00
California	Orland		2.07	2.55	3.11	2.02	2.61	2.17	2.72	2.47	2.11	2.19	2.36	2.66	2.33
Colorado	Grand Valley									11.18	9.08	5.92	5.04	5.28	3.96
Do	Uncompahgre	1.21	2.48	2.24	2.55	3.32	2.10	2.16	1.83	3.11	3.35	2.16	2.42	2.40	1.46
Idaho	Minidoka	1.31	2.13	1.45	1.42										
Do	Minidoka—Gravity					1.05	1.84	1.58	1.80	1.76					
Do	Minidoka—South side pumping					1.96	2.04	1.77	1.75	2.22	2.18	2.63	2.77	2.50	
Idaho-Oregon	Boise	1.92	1.70	1.37	1.43	1.50	1.44	1.33	2.17	2.10	2.67	1.99	2.32	2.19	1.58
Montana	Huntley	7.72	4.51	8.65	2.34	1.92	1.41	1.28	1.37	1.69	1.87	2.77	3.09	3.20	2.10
Do	Milk River			3.51	3.03	2.88	2.00	1.32	1.71	1.39	1.14	2.48	3.96	6.28	3.64
Do	Sun River—Fort Shaw			.90	1.43	1.91	1.66	2.35	2.88	2.02	2.14	1.97	3.34	1.93	1.82
Do	Sun River—Greenfields											3.13	3.62	3.63	2.03
Montana-North Dakota	Lower Yellowstone	16.10	5.79	4.16	25.34	4.78	4.24	1.98	4.43	2.06	3.56	3.10	4.90	2.75	2.10
Nebraska-Wyoming	North Platte—Interstate	5.47	3.36	2.50	1.55	1.46	1.41	1.50	1.56	1.67	2.44	2.55	3.48	2.61	1.71
Do	North Platte—Fort Laramie										3.48	3.88	6.04	3.32	2.79
Nevada	Newlands	1.34	1.42	1.33	1.24	1.11	1.06	1.24	1.28	1.67	2.17	1.89	2.37	2.33	2.53
New Mexico	Carlsbad	1.59	1.25	1.19	1.50	1.04	1.67	2.12	1.54	1.73	2.08	2.86	2.59	1.98	2.36
New Mexico-Texas	Rio Grande						1.03	1.44	.93	1.26	1.90	3.44	3.08	2.73	2.38
North Dakota	Williston	28.03	22.53	9.83	153.72	16.86	32.96					18.10	17.87	19.15	18.39
Oregon	Umatilla			9.05	8.90	6.55	5.16	4.69	3.60	5.74	6.87	4.60	3.53	2.45	2.69
Oregon-California	Klamath	7.9	1.80	.84	.59	1.13	1.47	1.43	1.00	1.41	1.61	1.90	1.47	1.48	.95
South Dakota	Belle Fourche	1.41	2.50	2.15	2.12	1.70	1.44	1.12	1.19	1.51	1.49	1.34	2.63	2.38	1.85
Washington	Okanogan	2.13	2.31	2.71	1.87	1.26	1.36	1.47	1.88	2.19	4.04	4.74	12.61	7.77	9.52
Do	Yakima—Sunnyside	1.05	1.50	1.35	1.38	1.30	1.13	1.13	1.09	1.37	1.67	1.48	1.80	1.52	1.55
Do	Yakima—Tieton			2.39	2.64	1.23	2.01	1.62	1.68	1.94	2.63	2.06	3.26	3.19	2.94
Wyoming-Montana	Shoshone	1.79	1.26	1.27	1.43	1.52	1.08	.89	.94	1.13	1.67	1.00	2.35	1.87	1.40
	Average of project operation and maintenance costs.	5.23	4.55	3.16	11.49	2.83	3.34	1.82	2.42	2.42	2.77	3.55	4.26	3.82	3.33
	Average of project operation and maintenance costs, Williston excluded.	3.60	3.42	2.81	4.00	2.16	2.00	1.82	2.42	2.42	2.77	2.92	3.77	3.16	2.64

TABLE No. 3.—Showing construction repayment in percentage of gross crop value Federal irrigation projects under public notice

State	Project	Fiscal year 1916	Fiscal year 1917	Fiscal year 1918	Fiscal year 1919	Fiscal year 1920	Fiscal year 1921	Fiscal year 1922	Fiscal year 1923	Average
Arizona	Salt River			1.49	1.12	0.65	0	.007	1.78	0.876
Arizona-California	Yuma	6.28	1.83	1.16	1.36	3.33	3.29	3.80	4.55	3.20
California	Orland		4.30	3.93	2.95	1.86	3.78	9.08	11.66	4.08
Colorado	Uncompahgre							.036	2.75	1.39
Idaho	Minidoka	2.21	3.67	1.88	2.65	2.34	2.90	5.42	5.79	3.35
Idaho-Oregon	Boise			2.40	2.93	2.66	2.72	4.11	5.94	3.44
Montana	Huntley			1.16	1.98	1.48	3.49	2.62	3.88	2.44
Do	Sun River	5.55	4.26	3.03	1.09	2.95	2.87	2.05	1.35	2.83
Montana-North Dakota	Lower Yellowstone	0.32	.0036	1.27	.0014	.003	.023	0	0	.203
Nebraska-Wyoming	North Platte	9.04	5.88	2.87	4.80	4.04	5.17	4.60	4.40	5.17
Nevada	Newlands	4.48	5.12	1.20	3.55	2.40	2.91	3.54	2.38	3.70
New Mexico	Carlsbad	10.30	4.31	3.46	2.50	2.15	2.24	6.25	4.69	4.45
New Mexico-Texas	Rio Grande								1.71	1.71
North Dakota	Williston					.64	.014	0	0	.163
Oregon	Umatilla	7.6	13.08	6.52	6.56	5.40	3.87	3.08	10.60	7.09
Oregon-California	Klamath	3.51	2.05	4.68	3.64	4.11	2.74	9.68	11.43	5.22
South Dakota	Belle Fourche	7.06	8.44	3.66	4.60	3.01	5.94	7.99	2.55	5.43
Utah	Strawberry Valley		2.08	2.72	2.33	2.09	3.68	5.31	5.12	3.76
Washington	Okanogan	8.21	0.18	1.06	.045	.11	.17	.33	.82	.72
Do	Yakima-Sunnyside	1.67	1.06	1.06	1.16	.77	1.28	2.47	2.21	1.46
Do	Yakima-Tieton	5.52	5.01	3.67	3.47	2.59	3.33	4.45	5.48	4.22
Wyoming	Riverton									
Wyoming-Montana	Shoshone	6.07	5.69	4.75	3.77	4.57	4.31	5.79	5.56	4.84
Average		5.14	3.93	2.69	2.62	2.40	2.96	3.7	4.82	

Total crop values from Bureau of Reclamation reports.
Construction repayments from Bureau of Reclamation, Accounting, January, 1924.

TABLE No. 4.—Showing operation and maintenance collection in percentage of gross crop value—Federal irrigation projects under public notice

[Total crop values from Bureau of Reclamation reports; operation and maintenance collections from Bureau of Reclamation—Accounting—January, 1924]

State	Project	Fiscal year 1916	Fiscal year 1917	Fiscal year 1918	Fiscal year 1919	Fiscal year 1920	Fiscal year 1921	Fiscal year 1922	Fiscal year 1923	Average
Arizona-California	Yuma	1.92	1.24	0.70	0.97	2.43	5.81	8.58	9.05	3.84
California	Orland			4.85	3.83	3.84	7.89	8.36	6.57	4.98
Idaho	Minidoka	3.41	2.77	1.95	2.55	2.00	1.94	5.23	2.52	2.80
Idaho-Oregon	Boise				2.22	2.79	3.47	4.13	3.45	2.68
Montana	Huntley	3.89	4.40	3.83	4.08	4.25	6.39	5.05	6.53	4.80
Do	Sun River	7.46	6.39	5.22	6.28	5.40	4.48	3.50	1.75	5.06
Montana-North Dakota	Lower Yellowstone	.053	.0072	.02	.00011			3.13	5.10	1.04
Nebraska-Wyoming	North Platte	3.89	5.77	3.17	5.46	5.64	3.24	4.01	2.89	4.20
Nevada	Newlands	5.92	5.50	3.32	4.07	4.86	6.01	7.65	6.89	5.53
New Mexico	Carlsbad	6.94	5.06	5.65	2.73	2.15	2.22	4.96	5.08	4.35
New Mexico-Texas	Rio Grande							8.74	3.82	6.28
North Dakota	Williston					9.29	2.30	10.76	2.62	6.24
Oregon	Umatilla	10.48	11.73	6.51	6.50	6.35	3.96	9.26	4.90	7.46
Oregon-California	Klamath	7.32	5.56	3.49	4.75	4.16	3.78	17.98	8.91	6.99
South Dakota	Belle Fourche	6.4	7.86	5.33	6.89	4.55	6.64	10.07	6.62	6.92
Utah	Strawberry Valley		1.10	1.41	1.43	1.44	2.25	4.11	3.99	2.25
Washington	Okanogan	.32	.25	1.58	1.25	1.25	11.33	2.55	2.73	2.53
Do	Sunnyside	2.42	1.86	1.12	1.67	1.14	1.22	2.21	1.91	1.69
Do	Tieton	3.83	3.32	2.61	2.27	1.63	1.86	3.24	3.17	2.74
Wyoming-Montana	Shoshone	4.98	4.66	2.80	3.27	3.50	4.76	7.29	2.97	4.25
Average		4.55	3.70	2.96	3.29	3.51	4.16	6.64	4.25	

TABLE NO. 5.—Showing status of lands and unsold water on Federal irrigation projects, June 30, 1923 (exclusive of Warren Act contracts)

State	Projects	Unentered public lands ¹	Other lands needing irrigation ²	Lands not contracted ³	Duty of water ⁴	Unsold water ⁵
		Acres	Acres	Acres	Acres	Acres-feet
Arizona-California	Yuma	34,137	8,663	10,332	2.88	29,756
Colorado	Grand Valley	12,713	3,887	45,000	3.58	161,100
Do	Uncompahgre	2,037				
Idaho	King Hill	77	3,098			
Do	Minidoka	107,289	7,711			
Idaho-Oregon	Boise	5,560	64,970	8,687	3.44	89,883
Montana	Huntley	2,570				
Do	Milk River	16,832	40,969	96,500	.63	60,795
Do	Sun River	38,026	78,360	29,547	1.48	43,730
Montana-North Dakota	Lower Yellowstone	2,412	16,917			
Nebraska-Wyoming	North Platte	17,454	57,240	53,436	2.08	111,147
Nevada	Newlands	29,598	55,655	24,969	2.98	74,408
New Mexico-Texas	Rio Grande	800	33,200	31,000	3.13	97,030
North Dakota	Williston	139	2,961			
Oregon	Umatilla	2,376	1,332			
Oregon-California	Klamath	20,776	97,621			
South Dakota	Belle Fourche	12,125	2,116	5,532	1.09	6,030
Utah	Strawberry Valley		1,500	6,443	1.41	6,060
Washington	Yakima	13,688	294,299	8,683	3.24	28,133
Wyoming	Riverton	69,000				
Wyoming-Montana	Shoshone	62,389	5,388	5,217	2.48	12,938
Total		449,798	775,887	325,346		661,010

¹ Twenty-second Annual Report, pp. 161-163.² Ultimate irrigable area minus "Unentered public lands" and "Acreage for which bureau was prepared to supply water, season of 1922," equals "Other lands needing irrigation."³ "Acreage for which bureau was prepared to supply water, season of 1922," not under water-right contracts.⁴ 1919-1923 (5-year) average.⁵ Column 3 multiplied by column 4 equals "Unsold water."

TABLE NO. 6.—Showing acre-feet per acre of land irrigated, delivered to farm, on Federal irrigation projects

[Data from Bureau of Reclamation annual reports]

State	Project	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Arizona	Salt River	4.2	3.6	3.53	3.94	2.97	2.62	2.66	3.58	2.67				2.90	2.64
Arizona-California	Yuma	4.85	3.10	3.43	4.6	4.36	3.69	3.34	3.2	3.7	3.3	2.9	2.94	2.69	2.59
California	Orland		3.4	3.9	3.97	3.0	4.08	3.40	4.07	3.5	1.91	2.95	1.49	3.01	3.34
Colorado	Grand Valley								2.42	3.54	3.69	3.81	3.07	3.67	3.74
Do	Uncompangre	4.5	3.25	3.44	4.81	3.98	3.66	3.56	3.08	3.96	3.30	3.42	3.70	3.52	3.52
Idaho	King Hill												4.69	3.08	3.57
Do	Minidoka		7.3	5.9	4.3	5.0	4.3	3.9	3.7	3.1	3.7	3.3	3.6	2.13	2.33
Idaho-Oregon	Boise	2.39	1.67	1.79	1.93	2.38	2.62	2.81	3.56	3.07	3.75	3.34	3.00	3.67	3.48
Montana	Huntley	2.0	2.08	1.88	1.5	1.63	1.43	.97	1.13	1.11	1.06	1.64	1.21	1.42	.96
Do	Milk River			1.28	.82	.92	.80	.69	.67	1.01	.68	.84	.58	.54	.51
Do	Sun River		2.3	1.65	1.71	1.5	1.73	1.1	1.22	1.36	1.48	1.9	1.47	1.39	1.17
Montana-North Dakota	Lower Yellowstone	.72	1.44	1.41	1.19	1.34	1.59	1.42	1.25	1.77	1.11	1.23	.87	1.28	1.17
Nebraska-Wyoming	North Platte—Interstate	3.17	3.93	4.26	2.25	2.49	2.92	1.38	3.17	2.13	2.31	2.27	1.99	2.14	2.55
Do	North Platte—Fort Laramie										*1.04	2.69	1.97	1.85	2.15
Do	North Platte—Northport												1.27	1.75	3.02
Nevada	Newlands	5.01	4.65	4.46	2.50	2.26	3.28	2.94	3.32	3.05	2.99	3.02	2.85	2.87	3.15
New Mexico	Carlsbad	2.3	2.4	2.2	2.9	2.30	2.44	2.14	2.43	2.33	2.43	2.4	2.42	2.49	2.36
New Mexico-Texas	Rio Grande	3.6	4.4	6.0	5.40	4.94	5.68	5.90	6.73	5.0	3.37	2.5	2.95	2.65	2.28
North Dakota	Williston		1.54	1.69	1.22	.86	1.31	1.70							.85
Do	Burd-Trenton	1.46	1.45	1.27								1.08	.97	.78	
Oregon	Umatilla	3.0	10.2	9.7	8.2	8.45	7.10	5.57	5.83	6.10	5.61	5.10	4.21	4.37	4.47
Oregon-California	Klamath	1.3	.88	1.23	1.13	1.17	1.05	1.13	1.02	.97	1.36	1.32	1.11	1.11	1.11
South Dakota	Belle Fourche	1.66	1.95	1.64	1.10	1.44	1.45	.37	.81	1.21	.99	1.46	.61	1.3	1.09
Utah	Strawberry Valley									1.84	1.42	1.33	1.27	1.50	1.55
Washington	Okanogan	2.5	2.46	1.27	1.24	1.57	2.59	2.38	2.60	2.49	.99	1.70	.96	2.96	2.75
Do	Yakima—Sunnyside	3.48	3.29	3.08	3.06	3.10	3.31	3.04	2.53	3.16	3.43	3.27	3.04	3.28	3.18
Do	Yakima—Tieton		1.73	1.91	2.27	2.27	2.09	1.83	2.15	2.26	2.43	2.62	2.47	2.50	2.48
Wyoming-Montana	Shoshone		2.05	2.20	1.66	2.08	2.38	2.12	2.34	2.10	2.29	2.31	2.50	2.47	2.33

* At lateral headgates.

Calendar years except Salt River, on which project 1921 and 1922 are irrigation years.

TABLE No. 7.—Showing acreage of water-logged lands on Federal irrigation projects

[Data from Bureau of Reclamation Annual Reports. Acreage given is amount reported at end of each fiscal year]

State	Project	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
Arizona	Salt River									8,400						
Arizona-California	Yuma				3,000		1,200	2,000	2,000	8,000	8,500	6,000	2,800	2,600		
Colorado	Grand Valley									275	250	80,225	80,400	81,400	80,800	29,000
Do	Uncompahgre									16,000	15,000	16,000	16,000	16,000	16,000	16,300
Idaho	Minidoka	945	1,056	3,446	3,722	5,568	3,200			1,600	543	543	590	590	590	1,000
Idaho-Oregon	Boise					160		11,000	18,750	18,750	25,750	6,650	3,400	7,160	7,180	6,050
Montana	Huntley		80	420		1,000	1,000	1,500	2,000	1,704	1,539	1,500	1,400	1,800	1,200	1,300
Do	Milk River										800	1,500	1,500	1,485	1,620	2,500
Do	Sun River					1,400	2,000	2,300	2,300	2,250	2,200	2,250	2,246	2,655	3,285	3,771
Montana-North Dakota	Lower Yellowstone				897			1,300	1,300	1,300	1,300	1,500		1,600	1,600	1,800
Nebraska-Wyoming	North Platte							5,000	2,900	3,000	3,500	3,250	3,800	360	2,810	3,490
Nevada	Newlands							8,700	10,000	11,000	11,500	12,000	12,100	12,100	14,260	10,200
New Mexico	Carlsbad					270		2,800	3,000	3,061	555	5,000	5,500	5,500		5,800
New Mexico-Texas	Rio Grande							20,000	40,000	55,000	118,000	80,700	55,000	46,000	30,000	17,000
Oregon	Umatilla									200	200	200	300	300	300	400
Oregon-California	Klamath							5,800	5,800	6,200	7,000	6,200	2,000	2,000	2,000	2,000
South Dakota	Belle Fourche					1,270	1,500	2,500	3,000	3,250	2,668	2,800	3,140	3,670	3,921	4,138
Utah	Strawberry Valley														8,500	8,500
Washington	Yakima										10,100	10,100	10,100	10,200	10,200	10,200
Wyoming-Montana	Shoshone			574	2,014	1,973	1,200	1,050	1,000	5,000	1,500	1,450	7,610	6,400	7,500	7,800
Total							189,000	79,950	108,468	142,208	241,580	188,060	188,256	183,580	140,506	181,444

1 Gravity only.

2 Estimated.

TABLE NO. 8.—Showing drainage accomplished on Federal irrigation projects

State	Project	Fiscal year 1914			1915			1916			1917			1918		
		Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains
		Open	Closed		Open	Closed		Open	Closed		Open	Closed		Open	Closed	
Arizona-California	Yuma	Miles	Miles		Miles	Miles		Miles	Miles		Miles	Miles		Miles	Miles	
Colorado	Grand Valley				11.5	4.0	9,250	11.5	4.0	5,000	14.5	4.0	12,000	21.7	4.0	16,000
Idaho	King Hill							.7		50	.7		50		.8	725
Do	Minidoka				108.5		38,700	108.0		43,933	108.0		30,000	109.0		30,000
Idaho-Oregon	Boise				57.0	.5	24,000	96.6	.8	38,500	131.9	.8	83,500	131.9	.8	83,500
Montana	Huntley				6.0	28.5	12,000	11.57	38.02	17,000	15.77	43.29	20,000	16.0	47.0	20,000
Montana-North Dakota	Lower Yellowstone				5.6		1,600	5.6		1,600	4.5	-1.1	1,600	4.5	1.1	1,600
Nebraska-Wyoming	North Platte				6.0	8.6	3,200	17.5	9.7	4,000	20.4	14.0	5,000	25.6	13.2	5,300
Nevada	Newlands				178.0	3.8			3.79			3.99	11,000	14.23	3.99	15,000
New Mexico	Carlsbad				1.0	3.0	1,070	2.3	3.8	870	9.0	3.9	2,769	13.15	3.74	5,058
New Mexico-Texas	Rio Grande							1.8		1,000	11.5		5,100	44.5		20,500
Oregon	Umatilla							10.0		2,000	10.0		2,000	10.0		2,000
Oregon-California	Klamath				32.0		10,000	49.0		17,000	67.7	5.7	17,000	89.1	8.2	18,800
Washington	Yakima															40,000
Wyoming-Montana	Shoshone				7.9	39.0	11,500	10.32	55.05	15,500	11.57	67.9	14,000	13.7	75.6	22,000
Total		363.5	37.4	144,000	413.5	87.4	109,320	823.89	115.16	166,453	416.04	144.68	204,019	497.68	158.43	281,083

State	Project	1919			1920			1921			1922			1923		
		Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains	Drains		Acreage protected by drains
		Open	Closed		Open	Closed		Open	Closed		Open	Closed		Open	Closed	
Arizona-California	Yuma	Miles 27.0	Miles 4.0	28,000	Miles 32.5	Miles 4.0	30,000	Miles 35.5	Miles 4.0	33,000	Miles 44.5	Miles 4.0	37,000	Miles 43.5	Miles 4.0	38,000
Colorado	Grand Valley	20.0	1.6	5,160	24.4	1.6	5,900	25.2	1.6	11,100	59.5	1.0	13,000	65.07	1.0	14,260
	Uncompaggre												9,200		94.0	9,200
Idaho	King Hill	3		800	3		600	3		600	3		600	3		800
Do	Minidoka	109.0		30,000	109.0		30,000	109.0		30,000	109.0		30,000	109.0		30,000
Idaho-Oregon	Boise	149.5	4	88,000	168.1	5	90,000	178.83	5	94,900	181.64	50	96,400	184.98	5	98,400
Montana	Huntley	16.0	48.0	20,000	16.0	49.0	20,500	16.0	50.5	21,000	16.78	50.5	21,500	16.78	50.5	21,500
Do	Milk River										1.8		100	2.0		100
Do	Sun River													5.1		1,840
Montana-North Dakota	Lower Yellowstone	4.5	1.1	1,600	4.5	1.1	1,600	4.5	1.0	1,600	4.5	1.1	1,600	4.5	1.1	1,600
Nebraska-Wyoming	North Platte	38.7	14.2	6,780	62.41	14.06	6,800	90.82	14.18	5,440	105.7	14.18	5,840	135.41	14.6	7,100
Nevada	Newlands	14.32	3.99	15,300	16.56	3.99	15,940	16.56	3.99	15,940	62.56	3.99	23,000	137.51	3.99	27,857
New Mexico	Carlsbad	11.14	3.65	5,500	11.14	3.65	5,031	11.14	3.65	5,031	11.14	3.65	5,031	11.14	3.65	5,031
New Mexico-Texas	Rio Grande	125.7		57,000	179.20		76,000	211.5		86,200	244.5		102,500	282.6		123,000
Oregon	Umatilla	10.0		2,000	10.0		2,000	10.0		2,000	10.0		2,000	10.0		2,000
Oregon-California	Klamath	83.9	8.0	23,400	83.9	8.0	23,300	93.7	8.0	23,686	100.1	8.0	23,686	103.0	8.0	23,700
Utah	Strawberry Valley										18.9	71.5	11,422	18.9	71.5	11,422
Washington	Yakima	73.0	51.0	43,850	77.59	59.0	46,779	82.86	79.56	50,468	89.65	87.77	52,425	90.35	97.87	52,757
Wyoming-Montana	Shoshone	18.0	82.0	24,000	20.67	88.14	25,000	44.45	92.20	30,980	67.51	92.56	34,600	112.53	95.81	31,000
Total		701.06	217.94	850,680	890.67	283.04	385,450	963.96	25,588	418,945	1,128.13	432.75	476,904	1,337.2	446.02	534,767

¹ Practically all of these are shallow drains which carry surface waste, but not deep enough to protect lands from seepage. Impossible to estimate area protected.
² Estimated.

Data from Bureau of Reclamation Annual Reports.
 Results shown are totals at end of each fiscal year.

TABLE No. 9.—Showing climatological data for Federal reclamation projects

Project	State	Average elevation	Rainfall			Degrees of temperature		Average annual wind movement	Average hourly wind velocity ¹	Average number of clear days ¹	Average number of partly cloudy days ¹	Average number of cloudy days ¹	Average number of days with precipitation .01 inch or more ¹	Percentage of sunshine ¹	Average length of growing season
			Maximum	Minimum	Average	Maximum	Minimum								
		Feet	Inches	Inches	Inches			Miles	Miles					Days	
Salt River.....	Arizona.....	1,200	19.7	8.8	8.0	117	16	84,928	4.0	237	89	39	37	84	289
Yuma.....	do.....	110	11.4	.6	8.4	120	22	84,440	6.2	293	56	16	15	88	285
Orland.....	California.....	250	28.6	7.6	18.4	120	24	60,267	6.9	221	78	66	66	70	264
Grand Valley.....	Colorado.....	4,700	11.6	3.6	8.4	104	-19	44,122	5.0	165	120	80	64	70	183
Uncompahgre.....	do.....	5,600	18.6	5.9	9.9	100	-27	52,948	6.0	165	120	80	64	70	146
Boise.....	Idaho.....	2,600	25.8	7.9	12.7	107	-28	87,180	4.2	189	101	126	90	65	177
King Hill.....	do.....	2,700	12.4	3.9	7.6	113	-5	87,180	4.2	189	101	126	69	65	186
Mindoka.....	do.....	4,225	19.7	8.6	11.2	104	-17	87,180	4.2	189	101	126	61	65	138
Huntley.....	Montana.....	3,000	18.6	10.9	14.4	119	-49	85,480	6.3	157	135	70	63	66	182
Milk River.....	do.....	2,200	20.2	9.4	12.6	113	-53	82,898	6.5	180	139	87	61	55	113
Sun River.....	do.....	3,700	16.1	4.2	10.6	112	-49	84,591	6.2	113	129	123	67	68	180
Lower Yellowstone.....	Montana-North Dakota.....	1,900	22.0	8.6	14.4	107	-49	82,930	6.5	120	138	107	91	66	124
North Platte.....	Nebraska-Wyoming.....	4,100	33.5	9.8	15.5	106	-45	93,222	10.6	132	156	77	72	65	182
Newlands.....	Nevada.....	4,000	8.1	2.5	4.8	103	-16	59,637	6.8	200	101	64	32	72	136
Carlsbad.....	New Mexico.....	3,100	22.4	4.0	14.1	112	-7	53,632	6.1	180	131	64	42	78	213
Rio Grande.....	New Mexico-Texas.....	3,600	21.8	2.2	9.1	105	-5	93,393	10.6	215	116	34	51	80	246
Williston.....	North Dakota.....	1,900	22.0	8.6	14.4	107	-49	82,930	6.5	120	138	107	91	66	124
Umatilla.....	Oregon.....	470	11.7	4.6	8.3	115	-28	75,904	8.6	188	120	107	67	58	169
Klamath.....	Oregon-California.....	4,100	19.6	8.3	13.5	105	-24	26,396	8.0	114	130	121	45	71	146
Belle Fourche.....	South Dakota.....	2,800	29.4	11.9	22.2	105	-30	80,706	6.2	136	126	101	66	60	141
Strawberry Valley.....	Utah.....	4,600	21.8	8.7	14.1	110	-28	45,267	6.2	138	118	69	66	62	128
Okanogan.....	Washington.....	1,000	19.5	12.0	16.6	98	-25	53,119	6.1	94	118	158	80	51	132
Yakima.....	do.....	700	8.7	3.0	6.8	108	-23	52,749	6.0	138	120	107	64	66	154
Sunnyside.....	do.....	1,700	13.8	3.9	8.4	109	-26	52,749	6.0	138	120	107	61	66	127
Tieton.....	do.....	1,700	13.8	3.9	8.4	109	-26	52,749	6.0	138	120	107	61	66	127
Shoshone.....	Wyoming.....	4,500	9.2	1.7	5.6	101	-32	56,153	6.4	135	114	116	44	60	123

¹ Information taken from weather station on the project or station nearest to the project.

NOTE.—Data furnished by U. S. Weather Bureau. Averages based on 5 to 40 year records.

TABLE No. 10.—Showing average crop value per acre for each year the project has been operated beginning with 1912, and the average value per acre for the whole period

Project	State	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Average
Salt River	Arizona	\$30.00	\$28.17	\$23.80	\$21.31	\$48.65	\$72.60	\$68.70	\$126.27	\$96.00	\$59.87	\$67.20	\$61.14
Yuma	Arizona-California	45.00	36.48	31.43	34.81	60.75	105.40	113.32	134.00	61.09	40.09	49.70	63.82
Orland	California	26.70	34.07	26.99	31.81	48.83	56.57	58.73	71.90	49.80	43.82	47.92	45.15
Grand Valley	Colorado					35.03	44.00	64.87	64.12	48.80	31.85	30.68	45.68
Uncompahgre	do	32.35	32.77	26.30	25.76	40.32	57.99	57.62	56.76	53.30	41.10	25.14	40.85
King Hill	Idaho						47.46		27.18	55.39	47.90	22.20	39.39
Minidoka	do		(17.15)	(16.79)	(22.40)	(34.41)	(55.36)	(52.63)	(59.95)	(41.05)	(33.84)	(30.25)	(36.38)
Gravity	do		16.08	16.91	23.13	34.78	57.58	58.70	58.95	35.00	28.58	27.18	35.19
South Side pumping	do		18.51	16.65	21.60	34.00	52.55	51.20	61.32	49.00	40.81	34.43	38.00
Boise	Idaho-Oregon	18.06	16.32	17.80	21.87	32.07	49.44	56.80	63.12	46.20	40.68	36.80	36.10
Huntley	Montana	27.10	29.35	26.63	29.41	26.32	30.16	39.00	49.14	37.10	23.59	29.33	31.22
Milk River	do												
Irrigated		14.34	9.76	16.00	13.18	15.25	19.13	17.17	24.63	14.90	8.05	11.14	14.89
Dry			5.99	7.86	10.00	13.92	5.42	6.93	5.37	8.05	11.40	9.70	8.47
Sun River	Montana								(33.28)	(17.95)	(13.76)	(16.36)	(20.34)
Fort Shaw	do	12.32	15.15	16.25	17.29	18.52	29.43	31.39	42.07	21.62	13.49	15.38	21.17
Greenfields	do								8.20	14.08	13.96	16.82	13.26
Lower Yellowstone	Montana-North Dakota												
Irrigated		11.40	13.71	17.20	16.18	20.70	29.35	31.86	(?)	30.60	15.28	21.63	20.70
Dry			7.18	10.64	10.30	18.07	10.36	11.39	(?)	15.85	8.23	11.88	11.64
North Platte	Nebraska-Wyoming								(32.77)	(41.64)	(25.66)	(18.99)	(32.94)
Fort Laramie		11.03	14.40	14.95	18.55	21.85	41.92	36.85	45.71	47.10	37.94	21.02	37.89
N. P. O. & C. Co.								12.71	22.91	30.00	15.43	15.65	19.32
Newlands	Nevada	12.83	12.92	11.23	15.39	20.70	37.00	34.26	35.13	40.80	130.41	117.64	31.65
Carlsbad	New Mexico	17.87	21.10	22.15	21.70	28.70	39.66	60.74	106.04	47.75	42.53	53.41	41.98
Rio Grande	New Mexico-Texas	30.74	25.40	42.51	34.22	46.81	56.60	53.00	53.00	59.60	32.12	53.06	47.27
Williston	North Dakota	15.72	23.06	34.87	(?)	(?)	(?)	(?)	29.53	31.70	27.70	33.24	27.97
Umatilla	Oregon	24.00	27.72	29.41	29.04	35.84	56.15	58.75	74.83	50.00	29.62	39.24	41.38
Klamath	Oregon-California	16.16	15.22	14.22	13.85	17.37	25.73	28.92	26.30	25.65	13.20	16.30	19.35
Belle Fourche	South Dakota	11.09	10.91	12.56	10.72	11.88	23.50	24.86	84.89	13.90	9.82	10.28	15.88
Strawberry Valley	Utah					62.70	50.37	55.18	67.50	66.50	82.50	30.00	50.67
Okanogan	Washington	36.60	31.69	32.83	32.60	62.64	97.66	141.85	167.23	67.70	385.38	332.45	148.05
Yakima	do	(31.79)	(55.14)	(31.00)	(46.82)	(67.67)	(109.44)	(101.02)	(163.72)	(111.13)	(101.62)	(82.46)	(86.45)
Sunnyside	do	69.50	61.00	58.02	50.03	73.04	121.87	102.86	167.07	105.50	96.65	73.13	89.36
Tieton	do	28.00	33.60	29.60	37.00	62.50	72.80	97.38	154.10	127.40	116.40	95.80	78.78
Shoshone	Wyoming-Montana							(39.43)	(46.00)	(24.10)	(16.24)	(11.80)	(22.61)
Garland	do	10.07	14.44	15.00	16.51	20.94	33.63	41.69	49.98	37.00	18.50	20.54	24.88
Frankie	do							24.47	26.10	14.50	8.15	12.96	17.23

Advance crop reports.

¹ Failure

² Project not operated.

NOTE.—Data taken from the annual crop reports of the United States Reclamation Service.

FEDERAL RECLAMATION BY IRRIGATION

TABLE No. 11.—Showing averages of yearly yields and values of principal crops on Federal irrigation projects, 1919 to 1922.

[Averages given are for period of 8 to 11 years unless otherwise noted]

[Data from Bureau of Reclamation Crop Reports, December 10, 1923]

State	Project	Alfalfa			Wheat			Potatoes			Corn		
		Average yield per acre	Value per unit of yield	Value per acre	Average yield per acre	Value per unit of yield	Value per acre	Average yield per acre	Value per unit of yield	Value per acre	Average yield per acre	Value per unit of yield	Value per acre
		<i>Tons</i>			<i>Bushels</i>			<i>Bushels</i>			<i>Bushels</i>		
Arizona	Salt River	3.8	\$12.23	\$48.73	25.6	\$1.48	\$39.39	70.7	\$1.36	\$94.99	28.7	\$1.25	\$37.80
Arizona-California	Yuma	2.9	12.00	34.10	18.9	1.48	28.08				25.7	.76	19.62
California	Orland	4.3	12.38	48.95	19.5	1.67	31.89	60.0	1.75	145.00	25.3	.88	21.72
Colorado	Grand Valley	2.9	13.22	39.02	16.9	1.51	25.20	94.8	.91	82.24	22.1	1.39	31.03
	Uncompahgre	2.8	8.56	24.64	25.9	1.22	31.60	176.1	.59	109.51	32.4	.99	31.80
Idaho	Boise	4.1	8.33	34.49	25.0	1.20	30.40	174.1	.75	133.20	34.6	.96	34.86
	King Hill	3.9	11.44	44.40	16.0	1.61	25.81	101.1	1.29	117.19	23.0	1.55	35.13
	Minidoka:												
	Gravity division	3.4	8.67	30.64	25.0	1.10	28.26	171.4	.57	98.89	37.0	.97	27.66
	South side pumping division	3.0	8.77	26.31	23.2	1.11	26.26	184.2	.83	102.64	16.5	.99	16.86
Montana	Huntley	2.6	9.36	28.66	18.4	1.35	24.41	110.5	.82	90.14	17.9	.94	17.68
	Milk River:												
	Irrigated	2.1	11.90	24.30	13.5	1.32	15.69	137.1	1.22	149.13	28.7	1.00	29.77
	Dry	1.2	11.00	11.78	9.2	1.30	10.52	95.5	1.09	100.81	16.1	.90	13.64
	Sun River:												
	Fort Shaw division												
	Irrigated	1.9	11.14	20.82	16.9	1.25	20.48	141.2	.77	106.43	19.4	1.20	21.44
	Dry	1.5	11.00	15.15	14.7	1.54	21.90	134.2	1.88	103.83			
	Greenfields division ¹¹	1.4	13.00	13.57	12.2	1.38	13.43	92.4	1.85	67.12	37.3	1.00	37.26
Montana-North Dakota	Lower Yellowstone:												
	Irrigated	2.2	10.64	23.07	16.6	1.36	21.60	132.8	.78	104.56	30.0	1.00	28.83
	Dry	1.3	9.64	12.16	11.5	1.25	12.88	103.6	.72	78.98	19.7	1.70	12.99
Nebraska-Wyoming	North Platte:												
	Interstate division	2.0	8.60	16.53	15.6	1.18	18.24	148.3	.57	87.28	18.0	.82	14.83
	Fort Laramie division	1.7	10.50	17.32	12.6	1.24	15.99	108.6	1.06	68.06	31.2	1.58	18.57
	Northport division	1.9	8.00	15.32	12.7	.75	9.55	57.	.40	22.73	22.1	.50	11.05
	N. P. C. & C. Co.	1.9	10.10	18.68	12.6	1.38	17.48	136.0	.62	86.30	18.3	1.69	15.02
Nevada	Newlands	3.2	10.36	35.02	20.2	1.83	36.41	140.0	.88	128.22	22.9	1.20	27.49
New Mexico	Carlsbad	2.2	13.99	31.81	18.7	1.49	28.71				19.2	1.09	20.73
New Mexico-Texas	Rio Grande	3.0	16.97	47.89	24.2	1.45	35.18	38.8	1.17	44.74	21.8	1.14	24.47

North Dakota.....	Williston:													
	Williston division—													
	Irrigated.....	¹⁰ 1.8	¹⁰ 15.80	¹⁰ 25.80	¹⁰ 15.1	¹⁰ 1.33	¹⁰ 17.29	¹⁰ 124.8	¹⁰ .94	¹⁰ 97.93	¹⁰ 34.7	¹⁰ .76	¹⁰ 25.70	
	Dry.....	¹⁴ 1.3	¹⁴ 12.50	¹⁴ 18.50	¹⁴ 18.6	¹⁴ .85	¹⁴ 11.97	¹⁴ 87.9	¹⁴ .63	¹⁴ 53.84	¹⁴ 19.7	¹⁴ .50	¹⁴ 9.84	
	Buford-Trenton													
	division—Dry.	¹⁴ 1.2	¹⁴ 11.50	¹⁴ 18.01	¹⁴ 18.9	¹⁴ .72	¹⁴ 13.90	¹⁴ 160.0	¹⁴ .80	¹⁴ 48.00	¹⁴ 10.0	¹⁴ .55	¹⁴ 3.50	
Oregon.....	Umatilla:	3.7	11.20	40.85	20.7	1.56	28.02	94.9	1.07	92.91	29.1	1.16	33.63	
Oregon-California.....	Klamath:													
	Irrigated.....	2.6	10.91	28.78	16.1	1.29	19.57	94.2	.93	90.87				
	Dry.....	2.1	7.50	15.87	14.1	.82	11.62	78.2	.65	47.97				
South Dakota.....	Belle Fourche.....	2.0	8.23	16.50	12.7	1.25	14.90	98.4	.90	86.40	19.3	.91	17.60	
Utah.....	Strawberry Valley.....	¹⁰ 2.9	15.29	43.93	25.3	1.48	36.73	121.6	.74	87.68	24.7	.94	22.17	
Washington.....	Okanogan.....	2.3	15.05	31.05	11.8	1.57	16.31	114.9	1.03	124.10	27.4	1.06	29.22	
	Yakima:													
	Sunnyside division.....	4.5	12.98	57.49	27.8	1.50	39.98	241.3	.65	153.77	48.0	.92	43.79	
	Tieton division.....	3.2	12.08	38.75	25.0	1.34	32.83	150.0	.62	95.77	37.8	.93	35.63	
Wyoming.....	Shoshone:													
	Garland division.....	2.2	9.95	22.20	19.0	1.20	23.23	144.6	.63	93.04	21.5	1.04	23.99	
	Frannie division.....	⁶ 1.8	⁶ 12.00	⁶ 21.76	⁶ 11.6	⁶ 1.47	⁶ 16.96	⁶ 73.0	⁶ .67	⁶ 38.93	⁶ 14.2	⁶ .95	⁶ 13.62	

¹ 1917 only.
² 54 pounds to 1 bushel 1912.
³ 110 pounds to 1 sack, 1918.
⁴ Also dry 12.3 \$1.92-\$23.59 (1917).
⁵ 1918-1922 exclusive of Chinook Division.
⁶ 5-year average.
⁷ 3-year average.
⁸ 4-year average.
⁹ 1922 only.
¹⁰ 7-year average.
¹¹ 1922 only.
¹² All 5-year averages 1918-1922 except apples.
¹³ 6-year average.
¹⁴ 2-year average.
¹⁵ 1914 only.
¹⁶ 1912 only.
¹⁷ 1913 only.
¹⁸ Averages do not include 1919, when 5,500 acres were nearly a total failure.
¹⁹ 1922 includes Big Coulee division.

NOTE.—Average yield per acre multiplied by value per unit of yield does not equal value per acre because duplicated area enters into the first and last items as a factor. The value per acre is obtained by dividing the total crop value by the total cropped area.

South Dakota.....	Belle Fourche.....				8.9	6.40	58.00			
Utah.....	Strawberry Valley.....				10.9	8.57	91.70	3,810	.034	95.01
Washington.....	Okanogan.....				4.0	15.00	60.00	6,768	.034	213.88
	Yakima:									
	Sunnyside division.....				8.4	9.00	82.82	7,405	.028	179.42
	Tieton division.....				10.8	8.63	94.68	6,628	.027	157.40
Wyoming.....	Shoshone:									
	Garland division.....				9.7	7.78	76.14	933	.037	33.33
	Frandee division.....				5.9	8.87	49.56			

¹ 1917 only.

² 1918-1922 exclusive of Chinook Division.

³ 5-year average.

⁴ 3-year average.

⁵ 4-year average.

⁶ Long staple, average 1913-1917 and 1920. Not including seed 650 pound average 1917 and 1920. For years 1918-19 and 1921-1923 reports combine lint and seed and do not specify long or short staple, 960 pounds average yield. Average short staple yield 1914-1916 350 pounds.

⁷ Long staple. Short staple price 1914-1916 was \$0.11. Lint and seed, long or short staple not specified 1918-19 and 1921-1923 was \$0.135.

⁸ Average returns per acre 1913-1923, lint and seed.

⁹ Short staple lint. Average for long staple lint 1917-1921 was 198 pounds. Average for Durango lint (1917) was 469 pounds.

¹⁰ Short staple. Average price for long staple lint was \$0.57 (1917-1921) and Durango lint (1917) \$0.31.

¹¹ Average returns per acre lint and seed. Long staple, \$121.37; short staple, \$74.60; and Durango (1917), \$145.46, not including seed.

¹² Includes beet tops, average price 1918-1922, \$4.24.

¹³ 1921 only.

¹⁴ 1916 only.

¹⁵ \$75.98 including beet tops 1921 \$3.00 and 1922 \$3.50.

¹⁶ Includes \$1.00 per ton for beet tops 1919 and 1920.

¹⁷ 1916-1922 includes beet tops.

¹⁸ Does not include cottonseed 488 \$0.017-\$0.08.

¹⁹ Does not include cottonseed 742 \$0.014-\$10.76, 4-year average.

²⁰ 1919 only.

²¹ 48 pounds to 1 bushel 1917 and 1920.

²² Averages do not include 1919, when 5,500 acres were nearly a total failure.

²³ 1922 includes Big Coulee division.

NOTE.—Average yield per acre multiplied by value per unit of yield does not equal value per acre because duplicated area enters into the first and last items as a factor. The value per acre is obtained by dividing the total crop value by the total cropped area.

TABLE No. 13.—Showing the total number of irrigated farms, the number of farms operated by tenants, and the per cent of farms operated by tenants on Federal irrigation projects

State	Project	1912			1913			1914			1915			1916			1917		
		Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants
Arizona.....	Salt River.....	2,954	955	32	2,680	735	27	2,000	1,000	33	2,600	900	25	2,004	671	22	4,284	1,714	40
Arizona-California.....	Yuma.....	470			616	120	19	1,698	1,129	18	737	1,249	134	1,790	1,297	138	900	1,355	139
California.....	Orland.....	211	18	9	246	20	8		22	8	351	31	9	384	42	11	531	48	9
Colorado.....	Grand Valley.....													76	26	34	202	105	52
Do.....	Uncompagre.....	1,245			1,244	505	38	1,470	650	37	1,107	492	44	1,320	607	46	1,402	693	42
Idaho.....	King Hill.....																125	15	12
Do.....	Minidoka.....	1,606	200	12	1,708	212	12	1,741	216	12	1,713	311	18	1,780	408	23	2,195	470	21
Idaho-Oregon.....	Hulse.....	1,223	173	14	1,575	225	14	1,771	250	14	1,908	550	29	2,450	860	35	2,780	880	31
Montana.....	Bonley.....	1,505	130	9	1,524	15	1	535	103	19	530	147	28	550	150	27	553	185	33
Do.....	Milk River.....				41	9	22	60	18	30	48	19	39	64	27	42	112	25	31
Do.....	Sun River.....	176	30	17	179	38	21	181	57	31	200	74	37	158	55	35	176	56	32
Montana-North Dakota.....	Lower Yellowstone.....				1,212	121	10	94			260	62	24	260	62	24	1,247	152	12
Nebraska-Wyoming.....	North Platte.....	777	202	26	908	305	33	950	475	50	1,095	413	38	1,189	408	39	1,274	464	36
Nevada.....	Newlands.....	497	135	7	494	55	11	404	55	11	540	60	11	584	70	12	600	75	12
New Mexico.....	Carlsbad.....	345	200	58	362	138	38	362	122	34	390	110	28	455	83	18	535	243	45
New Mexico-Texas.....	Rio Grande.....				1,784	695	39	1,800	700	39	1,700	700	41	1,638	493	30	1,700	530	31
North Dakota.....	Williston.....	16	8	50	54	22	41	26	8	31	44	10	23	10				10	
Oregon.....	Umatilla.....	295	50	17	311	99	32	320	100	31	1,306	158	12	364	148	40	411	109	26
Oregon-California.....	Klamath.....	406	40	10	325	66	20	333	83	25	352	105	30	409	122	30	527	191	36
South Dakota.....	Belle Fourche.....	611	206	34	637	181	28	659	217	33	717	256	35	802	249	31	813	260	32
Utah.....	Strawberry Valley.....																		
Washington.....	Okanogan.....	432	4	9	441	2	5	450	2	4	440	6	1	456	5	1	475	10	2
Do.....	Yakima-Sunyside.....	2,441			2,450	1,536	22	2,448	536	22	2,450	540	22	2,553	655	12	2,740	798	29
Do.....	Yakima-Tieton.....	575			1,740	130	149	1,900	1,414	146	1,905	1,483	148	1,100	1,500	145	1,190	464	39
Wyoming-Montana.....	Shoshone.....	360			396	47	12	424	65	15	469	97	21	577	119	21	621	154	24
Total.....		18,444	2,151		18,030	4,415		18,991	5,122		19,943	5,672		20,945	6,127		24,393	7,764	
Average percentage of tenants for all projects reporting.....		21			24			27			28			29			32		

¹ Data from plan of inquiry, project reports.

State	Project	1918			1919			1920			1921			1922		
		Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants	Total irrigated farms	Tenants	Per cent of tenants
Arizona	Salt River							4,200			5,000			5,000		
Arizona-California	Yuma	1,185	1,485	141	1,225	1,502	141	1,230	1,519	142	1,211	1,388	132	1,216	1,454	137
California	Orland	593	44	7	602	53	9	644	52	8	693	74	6	693	125	18
Colorado	Grand Valley	317	131	41	324	123	38	376	125	33	402	138	34	387	170	44
Do.	Uncompangre	1,514	585	37	1,528	514	34	1,588	511	32	1,639	698	43	1,624	690	42
Idaho	King Hill	125	15	12	125	15	12	125	15	12	160	19	12	175	44	25
Do.	Minidoka	2,208	652	29	2,353	476	20	2,420	657	27	2,454	407	19	2,451	583	24
Idaho-Oregon	Boise	3,080	970	32	3,207	692	21	3,290	843	26	3,300	890	26	3,559	693	19
Montana	Huntley	561	202	36	549	234	43	603	283	47	578	201	35	590	283	34
Do.	Milk River	184	44	24	247	61	25	250	22	9	178	44	25	209	79	38
Do.	Sun River	187	69	37	201	50	25	354	90	25	347	97	28	393	118	30
Montana-North Dakota	Lower Yellowstone	370	75	20	405	85	21	375	94	25	370	117	32	370	114	31
Nabraska-Wyoming	North Platte	1,274	500	39	1,310	450	34	1,300	590	39	1,530	715	47	1,710	727	42
Nevada	Newlands	648	80	12	604	75	11	742	65	9	788	80	10	778	97	12
New Mexico	Carlsbad	458	227	50	565	267	47	363	267	74	426	140	33	333	149	45
New Mexico-Texas	Rio Grande	2,287	910	39	2,793	737	27	3,021	353	12	3,222	564	18	3,534	590	16
North Dakota	Williston		11			24		94	19	20	76	12	16	73	9	1
Oregon	Umatilla	469	120	26	500	150	30	528	78	15	545	102	19	558	123	22
Oregon-California	Klamath	530	190	36	540	190	35	542	190	35	542	112	21	542	112	21
South Dakota	Belle Fourche	906	316	35	1,000	332	33	1,024	332	32	1,035	342	33	1,035	342	33
Utah	Strawberry Valley							2,700	500	18	2,740	400	15	2,741	450	16
Washington	Okanogan	401	23	6	407	40	11	400	50	12	439	51	12	445	57	13
Do.	Yakima-Sunnyside	2,780	797	29	2,810	801	28	2,905	638	22	3,005	743	24	3,138	768	24
Do.	Yakima-Tieton	1,280	400	31	1,253	350	28	1,340	292	22	1,300	290	22	1,300	335	26
Wyoming-Montana	Shoshone	750	134	18	803	184	23	910	215	24	935	289	31	914	218	24
Total		22,077	7,020		23,349	6,351		31,274	6,605		32,982	7,220		33,708	6,969	
Average percentage of tenants for all projects reporting			32			27		24			26			24		

1 Data from plan of inquiry, project reports.
 2 Data from project operation and maintenance reports.

TABLE NO. 14.—Statement of costs per acre

State	Project	Lowest rate under public notice	Highest rate under public notice	Acre costs under present contracts, including items to be paid as supplemental construction	Remarks
Arizona.....	Salt River.....			\$60.00	Payments made under contract.
Arizona-California.....	Yuma.....	\$65.00	\$90.00	75.00	
California.....	Orland.....	44.00	44.00	55.00	
Colorado.....	Grand Valley.....				No public notice issued.
Do.....	Uncompahgre.....	70.00	70.00	70.000	
Idaho.....	King Hill.....	112.00	112.00	112.00	Based on irrigable acreage, 16,823.
Do.....	Minidoka—Gravity.....	22.00	52.00	42.00	
Do.....	Minidoka—South Side.....	56.50	74.75	58.60	
Idaho-Oregon.....	Boise.....	77.44	92.93	77.44	Additional drainage paid as operation and maintenance, possibly \$8 total per acre.
Montana.....	Huntley.....	30.00	66.00	45.00-60.00	
Do.....	Milk River.....				No public notice issued.
Do.....	Sun River (Fort Shaw division).....	30.00	60.00	30.00-38.00	
Montana-North Dakota.....	Lower Yellowstone.....	42.50	45.00	63.00	
Nebraska-Wyoming.....	North Platte—Interstate.....	35.00	74.26	71.00	
Nevada.....	Newlands.....	22.00	150.00	60.00	
New Mexico.....	Carlsbad.....	31.00	81.00	45.00	
New Mexico-Texas.....	Rio Grande.....	90.00	90.00	90.00	
North Dakota.....	Williston.....	38.00	38.00	38.00	
Oregon.....	Umatilla.....	14.00	101.20	110.00	
Oregon-California.....	Klamath.....	30.00	90.00	88.00-90.00	
South Dakota.....	Belle Fourche.....	30.00	48.00	50.00	
Utah.....	Strawberry Valley.....	80.00	118.80	80.00	
Washington.....	Okanogan.....	64.00	96.00	230.00	
Do.....	Yakima—Sunnyside.....	52.00	75.00	52.00	
Do.....	Yakima—Tieton.....	93.00	110.00	104.00	
Wyoming.....	Riverton.....				No public notice issued.
Wyoming-Montana.....	Shoshone—Garland.....	45.00	95.00	81.50	
Do.....	Shoshone—Frankie.....	66.00	100.00	98.00-130.00	