Minutes of the Meetings of the
American Irrigation Association, 1926 and 1928

Mr. James C. Marr
Associate Irrigation Engineer
Box 835
Boise, Idaho

1929
Minutes of the Meeting of the
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
held at
Asilomar, Pacific Grove, Calif.
June 28, 1938

The meeting was called to order by Chairman R. L. Parshall at 2:10 p.m.

The following were present:

S. H. McCrory, Chief, Bureau of Agricultural Engineering
Washington, D. C.

A. T. Mitchelson, Acting Chief, Division of Irrigation,
Berkeley, Calif.

R. L. Parshall, Senior Irrigation Engineer, Division of
Irrigation, Fort Collins, Colo.

S. P. Lyle, Senior Agricultural Engineer, Bureau of Agricultural
Engineering, Washington, D. C.

G. E. P. Smith, Irrigation Engineer, University of Arizona,
Tucson, Ariz.

Frank Adams, Irrigation Economist, University of California,
Berkeley, Calif.

N. E. Edlesen, Associate Irrigation Engineer, University of
California, Davis, Calif.

F. J. Veihmeyer, Irrigation Engineer, University of California,
Davis, Calif.

M. R. Huberty, Associate Irrigation Engineer, University of
California, Riverside, Calif.

Karl Harris, Associate Irrigation Engineer, Division of
Irrigation, Phoenix, Arizona.

Harry F. Blaney, Irrigation Engineer, Division of Irrigation,
Los Angeles, Calif.

David Clerk, Quebec, Canada
Mark H. Kulp, Irrigation Engineer, University of Idaho, Moscow, Idaho.

Joseph Gross, Consulting Engineer, Sacramento, Calif.

E. E. Brackett, Prof. of Agricultural Engineering, University of Nebraska, Lincoln, Nebr.

W. L. Powers, Soil Scientist, Oregon State College, Corvallis, Oreg.


H. F. McColly, Prof. of Agricultural Engineering, North Dakota State College, Fargo, N. Dak.

C. A. Taylor, Associate Irrigation Engineer, Division of Irrigation, Pomona, Calif.

H. B. Roe, Prof. of Agricultural Engineering, University of Minnesota, St. Paul, Minn.

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G. E. P. Smith displayed a specimen of tamarisk wood showing a very beautiful grain and suggested that the wood should be valuable for the production of novelties. He had found that tamarisk fence posts were short-lived when untreated but are very easily impregnated with cold creosote. Since the trees grow very rapidly on alkali land it appears that they may become a valuable farm wood lot product.

Dr. Smith then presented a discussion on the Physiography of Arizona Valley. This discussion was based on a paper on the same subject published in Pan American Geologist Vol. 69, pp. 321-327 (June 1938). He pointed out the great similarity of the different valleys, showed the three different base levels to which the valleys
have been graded or eroded during their geologic history, and suggested that these might well be correlated with the advances of the Continental Ice Sheet in Pleistocene times.

Frank Adams told of the work in which he is engaged. This work consists of an attempt to answer the question as to what return the administration of the Central Valley Project can expect from the sale of water during the first 10 years of its operation. He referred to the somewhat similar work reported on in Bulletins 34 and 43 of the California Department of Public Works. It is proposed to study separately each of the 26 areas where landowners are expected to apply for water from the project.

Land Classifications of the area have heretofore been made by Harding and Strahorn, and by the Storie Index method. The new study will include other factors in addition to the land alone and the final result will be a rating on a scale of 0 to 160 by steps of 10. Mr. Adams felt that it was still possible that the rating of the highest quality lands was relatively low in spite of extending the scale from 100 to 160.

Mr. Smith asked if county and irrigation district assessments were based on the same valuations. Adams replied that there is no necessary relationship between the two.

W. L. Powers described the methods used in classifying some 3,000,000 acres of land for irrigation and drainage purposes in Oregon. A percentage scale was used in this work.

Mr. Parshall suggested that the representatives of the different States describe the irrigation and drainage research in their States.

Mr. Kulp described vegetation surveys being made of the alkali
lands in the Fayette Valley of Idaho by the Soil Conservation Service for the purpose of determining their value for settlement by farm families from the drought area.

A study of the maintenance of drainage systems had shown that drainage wells were not pumped unless the water was needed for irrigation.

Concrete and asphaltic canal linings have not proved satisfactory. One system is trying out bentonite, (sometimes referred to as Volclay). The canal is excavated to a depth of 7 or 8 inches outside of the finished section, 1 or 2 inch layer of a mixture of 10 percent of Volclay and soil are applied and a 6-inch top cover of local soil placed.

J. B. Brown described an oil treatment used by one of the moving picture companies on an artificial lake at a cost of 3 to 5 cents per square foot. This seems to be giving satisfactory service.

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H. F. McColly said that a number of years ago he started teaching a course in reclamation at North Dakota Agricultural College which included some work in irrigation. At that time the authorities insisted that he drop the work in irrigation since it would be of no value in North Dakota. This attitude has been entirely reversed in recent years. No irrigation research is being done in this State at the present time but tentative plans call for such studies. There are many possibilities
for both the ordinary and flood irrigation projects in the State. There are about 350,000 acres of river bottom lands subject to irrigation chiefly by pumping. Flood irrigation projects will raise the total to perhaps a million acres.

W. L. Powers described the studies of uniformity of irrigation by sprinklers which he has been carrying on for the last two years. Rotary sprinklers are used spaced 60 feet on the line and with lateral 65 feet apart. Pressure at the end of the line is held at 35 pounds per square inch. He reported that 20,000 acres are irrigated in the Willamette Valley, two-thirds in Ladino clover by the border method and about 2,500 acres by sprinklers.

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There followed a general discussion of the cost of pumping and the economic limit of lift. Both Smith and Brown agreed that this limit was approximately 80 feet. It was pointed out that this limit depended on so many factors that no single value could be used under all conditions.

It was moved by Smith, seconded by Veihmeyer that the organization be kept intact and that it be left to the president and secretary to keep in touch with possibilities and to call the next meeting when an opportunity offered. Motion passed.
Election of officers was held with the result that M. R. Lewis was named for president, Mark R. Kulp, secretary.

R. L. Parshall, Chairman

M. R. Lewis, Secretary
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P.S. Randall, Chairman
M.R. Lewis, Sec'y
June 24, 1986

A. This meeting was an informal gathering of the members of the Association held in connection with the Annual Convention of the American Society of Agricultural Engineers at the Stanley Hotel.

The meeting was called to order by Chairman R.E. Parshall at 2:00 P.M. and briefly outlined the historical background of this Association and the scope of the field of investigation which concerns this group. Special reference being made to the problem of water supply and the present outlook.

Mr. Parshall.
Western Irrigation and Drainage Research Association.

Estes Park, Colorado,

June 24, 1936.

The first meeting of this association was held at the University of California in Berkeley on September 3 and 4, 1925. Previous to that time, Director C. P. Gillette of the Colorado Experiment Station was made chairman of a committee of the Association of Land Grant Colleges. This committee was to obtain information relative to projects for the inter-mountain states in irrigation and reclamation which would be suitable for study and investigation on Purnell or other Federal funds. In order to contact scientific workers having knowledge of possible new and important projects which could be recommended for study at the various experiment stations throughout the West, a meeting was called at Berkeley. At the conclusion of this conference, it appeared very desirable, because of the scope of the work, to meet every two years at some central point where the various problems and lines of investigational work conducted at the western experiment stations could be discussed.

The basic factors for developing desirable projects were outlined in the 1925 meeting. The keynote of the meeting was the "Economic Use of Water in Irrigation", however, the subjects of Land Valuation and Land Utilization were later considered.
were rather completely discussed.

At this time, it may be of interest to enumerate the topics of these outlines:

"Factors Underlying the Economic Use of Water in Irrigation.

1. Soil and irrigation relationships.

   1. Water holding capacity of soils as influenced by
      (a) Texture, structure, and other soil properties
      (b) Depth to ground water.

   2. Analysis of forces affecting soil moisture movement
      (a) Driving forces
      (b) Resisting forces.

   3. Conditions governing the application of irrigation water.
      (a) Soil and water properties
      (b) Topography and preparation of land
      (c) Rate, duration, and frequency of water delivery
      (d) Crops grown
      (e) Depth to ground water
      (f) Storage of water in the soil
      (g) Cost of land, water, and labor.

2. Plant and Irrigation Relationships

   1. The moisture relations of plants
      (a) With reference to growth
      (b) With reference to disturbance of normal functioning.
2. The moisture requirements of plants
   (a) For maximum yield
   (b) Economic
   (c) For practical field requirements.

3. The quantity of water required per acre for economic irrigation.

Suggested Subjects for Research in Land Valuation and Land Utilization.

Physical Factors.

Effect on Land Value of - Soils, topography and drainage,

Climatic Conditions and Health Conditions:

Economic Considerations

Effect on Land Value of -

Location, markets, marketing institutions, and transportation.
Cost of agricultural development - Project of immediate importance
Scientific agricultural methods
Economic cycles - Project of immediate importance
Earning power and cost of production
Ability and experience of individual farmer
Irrigation practice
Carrying charge on undeveloped lands
Agricultural business institutions
Sources of capital for land purchase and available capital
Agricultural credit facilities
Speculation
Capitalization of estimated future returns.
National financial conditions
Contingencies and risk, with particular reference to security values
Cost of reclamation construction - Project of immediate importance
Incomplete construction of drainage or irrigation works
Character and quality of irrigation and drainage works
Water supply and irrigation requirement
Annual cost of irrigation, reclamation, and drainage service
   Not including interest on capital invested.
Water rights
Management of irrigation and drainage projects
Organized colonization methods
Rate of land settlement
Immigration and increase in population.
Land titles
Type of farm enterprise.
Size of unit.
Existing indebtedness of community and individual
Land ownership
Taxes - tax rate, present and prospective

Social
Effect on Land Value of -
Racial types, religious creeds and social class
Recreation facilities

Political
Effect on Land Value of -
	Political factions and policies."

The following men were present at this first conference:
Messrs. Adams, Beckett, Blaney, Brown, Davis, Fortier, Gaines,
Harding, Hutchins, Hoff, Israelsen, Lewis, McLaughlin, Parshall,
Powers, Pyle, Scobey, Showers, Stout, Weeks, Weir, West and
Winsor.

The second meeting of this research group was held at
Berkeley on December 28, 29 and 30, 1927. There is not time
to review the full scope of this meeting, however, I shall read
the letter of transmittal to the Directors of Experiment
Stations of the Western Division of the Association of Land
Grant Colleges, which constitutes the first page of the
report covering this meeting: I quote:

"Gentlemen:

There is herewith transmitted a report of the Second
Conference of Irrigation Workers in the Western States, held
at Berkeley, California, December 28, 29, 30, 1927, addressed
through the respective Directors to the Irrigation Sections of the
Experiment Stations."
Six states and one federal agency were regularly represented at the Conference, Arizona, California, Colorado, Montana, Oregon, Utah and U.S.D.A. Division of Agricultural Engineering, Irrigation Investigations.

A permanent organization of Workers in Irrigation and Drainage Research in the Western States was effected with Mr. W. W. McLaughlin as Chairman and Dr. O. W. Israelsen as Secretary for the next two years.

The conference was conducted as a round table discussion, the subjects being confined to the following topics: (1) Duty of Water, (2) Drainage, and (3) What information on Irrigation and Drainage is available for use of Extension workers?

The conference adjourned with the firm conviction that an exchange of ideas, a comparison of experimental technique at regular intervals, is extremely valuable and should be encouraged.

Respectfully,

R. L. Parshall, Chairman

G. D. Clyde, Secretary.

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Concerning the general attitude of those present at the meeting in 1925, I wish to quote the report of the committee on permanent organization at the second conference of irrigation and drainage research, and investigational work. I quote:

"Your Committee is of the opinion that conferences
such as the one held in September, 1925, and the present conference of December, 1927, are of great value to those attending them, and therefore to the institutions represented by the delegates. These conferences afford opportunity for contact of individual workers in the same line of investigation, and an exchange of information and opinions and of technique used in research work that will ultimately bring about a measure of coordination that will be for the betterment and ultimate value of work undertaken. These meetings also afford an opportunity for focusing upon difficult problems the attention of investigators from various parts of the West, and in many instances suggestions are made which permit a more ready solution of problems under study.

"It is believed that these meetings will be of value to the Association of Land Grant Colleges by putting before it in definite form the irrigation and drainage problems upon which the different institutions are working and the methods adopted in this work; they should also be a ready means of ascertaining the important problems upon which work has not been or is not now being done."

"Your Committee therefore recommends:

(1) That a conference of workers in irrigation and drainage investigations and research be held biennially.

(2) That membership in this conference include those engaged in irrigation and drainage investigations and research in land grant colleges or other educational institutions of the eleven western states, and in the Division of Agricultural Engineering of the U. S. Department of Agriculture."
That a member of the State Relations Service of the U. S. Department of Agriculture be accorded honorary membership and extended an invitation to participate in our conferences.

That the Committee on Irrigation and Drainage Research of the Association of Land Grant Colleges be continued in order that the conference may have a central body to which it can report and from which it may receive suggestion and direction.

That a president and secretary be elected at the close of each meeting of the conference, these officers to be responsible for the program and for the conduct of the next conference."

Respectfully submitted,

W. W. McLaughlin
G.H.P. Smith ""

A motion was made to adopt this report. Seconded and carried.


The third conference of the group was held at Logan, Utah, June 18, 19 and 20, 1929, with Mr. W. W. McLaughlin as president and H. E. Murdock as Secretary. The official name, "Western Irrigation and Drainage Research Association", was adopted. Complete and comprehensive reports containing the minutes of the meetings and the papers of the worker of each representative were published for the second conference and this session.
Mr. Beckett states in the conclusion of his paper on "Coordination of Experimental Work in Plants and Irrigation Relationships"; I quote:

"In the coordination of the work of this group, the most satisfactory results are to be obtained through discussion of the various and sometimes unusual problems which develop in the course of the routine work and through a frank discussion and criticism of methods and results obtained at the various stations."

At the Lggan meeting the following preamble and recommendations were adopted:

"Preamble

"To assure the complete agricultural development of the United States; to provide homes and food for our increasing population; to further the accessibility and utilization of the vast timber, mining and grazing resources of the arid region; to assure the permanence of profitable agriculture under irrigation; to assist in the coordination and strengthening of research work in irrigation and drainage, the Western Irrigation and Drainage Research Association recommends as follows:

Recommendations

1. That each of the Division coordinators ascertain at an early date the total amount of Adams and Purnell Funds which will be used during 1929-30 in each of the eleven western States to support research concerning "The Factors Underlying the Economic Use of Water in Irrigation" and report such findings to the President of the Association."
2. That about July 1930 each coordinator obtain similar information for the fiscal year 1930-31, and that reports of these findings be made to the Association in its 1931 meeting.

3. That the division of Irrigation and Drainage Research into five major groups as divided and adopted in 1925, be approved and continued.

4. That the division coordinators of each of the five major divisions continue to constitute a coordinating committee for the Association.

5. That the coordinating committee be encouraged to give special attention to the feasibility of "Cooperation in irrigation and drainage research — between the experiment stations of the several states" as proposed in recommendation No. 8 of the 1925 conference.

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The fourth biennial conference of the Western Irrigation and Drainage Research Association was held at Tucson, Arizona, July 16, 17 and 18, 1931. Those present and representing the State Experiment Stations and U. S. Department of Agriculture were Messrs. Smith, Schwalen,
Steenberger, Beckett, Hedrickson, Murdock, Lewis, Israelsen, Wright, and Blaney. About 20 guests attended the sessions of the conference. Prof. Smith of the University of Arizona was president and was Secretary at this meeting. Prof. Smith mentioned at this meeting, I quote:

"I know that all members of the Association will agree with me that the discussions of research problems, the exchange of ideas, and comparison of methods and technique have been extremely stimulating and helpful and that these biennial meetings should be supported by the workers themselves and encouraged by administrators.

Our main handicap is the great distances to be covered by representatives of the various experiment stations in reaching a common point. Oregon, Montana and Arizona are far apart. As the place of meeting is moved about, however, all workers in our field should be able to attend some of the meetings, in fact, each experiment station should have a representative at most of the meetings, if not all.

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Resulting from this conference a very good report containing the papers and discussions was prepared.

You are now aware that for the period 1925 to 1931, four biennial conferences have been held. I have attended all of these meetings except the last one held at Tucson. At this last conference, the group selected me as chairman and Prof. Lewis of Oregon as secretary, and with the assurance that the work of this organization would go forward and that the next regular meeting would be held in 1933.

About this time financial distress overtook practically all the State Experiment Stations, and in many cases to weather the trying times, the budgets were reduced to absolute necessities which resulted in reductions of salary and strict orders prohibiting out-of-state travel. The meeting was directed to the attention of the representatives of the various stations, and replies indicated that it was practically impossible to expect an attendance which would warrant a meeting.

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imposed—such as time devoted to this activity, long distances to be travelled by representatives to attend, and the expense involved in attending the meetings. In the past, some men have personally assumed the expense rather than be denied the opportunity of being present. Personally,

Personally, I am heartily in accord with the purpose of the association, and I trust that the representatives of the experiment stations may continue with the work of this organization effectively and without interruption.

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those of 1934. In northern Wyoming, the ranges are drying up and forcing the movement of herds out of the area, and other cases may be cited where shortage of water supply at this time is acute.

I am inclined to believe that the drought period still prevails, and this extended condition forces upon us the subject which was discussed at the first meeting of this organization at Berkeley in 1925, namely, "The Economic Use of Water in Irrigation". This subject is as important now as when it was proposed for serious consideration by this group in 1925. These dry years should call to mind the necessity of more active work in this important field, and I am again proposing that this association give further consideration and thought to this essential problem.

F. S. Parshall, Chairman,
M. R. Lewis, Sec'y.
Minutes of the Meeting of the
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
held at
Estes Park, Colorado
June 24, 1936

This meeting was an informal gathering of the members of the
Association held in connection with the Annual Convention of the
American Society of Agricultural Engineers at the Stanley Hotel.

The meeting was called to order by Chairman R. L. Parshall at
2:00 p.m., who outlined the historical background of this Association
and the scope of the field of investigation which concerns this group.
Special reference being made to the problem of water supply and the
present outlook.

A general discussion of the aims of the association followed
and it was informally agreed that an effort should be made to arrange
a meeting at the time of the next meeting of the American Society of
Agricultural Engineers on the Pacific Coast.

The following were present:
S. H. McCrory, Chief, Bureau of Agricultural Engineering, Washington, D.C.
Geo. R. Boyd, Assistant Chief, Bureau of Agricultural Engineering,
Washington, D.C.
W. W. McLaughlin, Chief, Division of Irrigation, Bureau of Agricultural
Engineering, Washington, D.C.
G. E. F. Smith, Irrigation Engineer, University of Arizona, Tucson, Arizona
Frank Adams, Irrigation Economist, University of California,
Berkeley, California.
Harry F. Blaney, Irrigation Engineer, Bureau of Agricultural Engineering,
Los Angeles, California.
Mark R. Kulp, Irrigation Engineer, University of Idaho, Moscow, Idaho.

Carl Rohwer, Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colorado.

M. L. Winsor, Irrigation Engineer, Bureau of Agricultural Engineering, Salt Lake City, Utah.

Dean George D. Clyde, Irrigation Engineer, Utah Agricultural College, Logan, Utah.

W. E. Code, Associate Irrigation Engineer, Colorado Agricultural Experiment Station, Fort Collins, Colorado.

O. W. Israelsen, Irrigation Engineer, Utah Agricultural College, Logan, Utah.

W. W. Weir, Drainage Engineer, University of California, Berkeley, Calif.

M. R. Lewis, Irrigation Engineer, Bureau of Agricultural Engineering, Oregon State College, Corvallis, Oregon (Secretary)

R. L. Parshall, Senior Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colorado (Chairman)

R. L. Parshall, Chairman

M. R. Lewis, Secretary
Meeting called to order by R. L. Parshall,

Introduction

Parshall: Have the past efforts of this group been worthwhile and of sufficient importance to continue this organization? Probably we can make only recommendations and after the consideration of the Directors of the Experiment Stations we may decide later what can be done. Do we wish to carry on this organization or not?

Mr. Lewis: The work we tried to do has been worthwhile but during the past five years the American Institute of Farmers and the Los Angeles Section of the Society of Civil Engineers have done much work in this same field. However, we have little contact in Oregon with these activities in the past five years and I vote for the continuance of this association.

Clyde: I feel somewhat as Lewis does. We are getting into so many organizations that the work is overlapping, however, the existence of the organization is warranted. The expense involved and the distance to be covered from various points in the eleven states is a drawback, but the organization might go ahead if the stations can support it.

McCory: I am not very familiar with what has been going on, but I believe that the organization is worthwhile. If the organization is continued, I can pledge our hearty support, probably not financially but permission will be granted for our people to attend.
McLaughlin: I am very much in favor of the work as it gives an intimate contact with details and with methods used in research work and of the problems of different parts of the country. No other organization has done this as most other organizations deal with general problems. The station workers and others in research will get much out of it that they won't get elsewhere.

Adams: The need for the organization is just as strong now as when organized. The value has come from criticizing and discussing problems, methods of approach and objectives. We should find a way to continue the enterprise and should meet every two years. It is hard to get the acquiescence of the Dean. There are always some of our staff wanting to go to more meetings than are allowed. I am sure of our cooperation and we should get together to discuss our problems.

Parshall: In 1925 we were to have a 2-day session but ran over into the third day. We are a small group but we can easily spend two or three days discussing problems of common interest to us.

G.E.P. Smith: For some 25 years I have worked alone, but after having the opportunity of convening at meetings with the association and with my research colleagues, the idea has grown upon me very much like a man who has electricity in his home. Previously it was a luxury but now it has become a necessity. None of us can do full work unless we match wits with others and get the broader view that we get from these association meetings. Dr. Gillette called the first two meetings; perhaps because he was vitally interested in the work and I believe we
should continue our meetings but we should not make too hard a job of it by tying ourselves down. Let the president and coordinating committee of five select the time and place of meeting. If, after correspondence with the members, we cannot meet next year; plan a 1-, 2- or 3-day meeting at Santa Cruz.

The Western Association of State Engineers overlapped our field somewhat or invaded our field. They held rather extensive programs in which we were very much interested, and they have lapsed from grace and have become a political appendage of the Western Resources Association. We cannot depend upon any other organization to meet our needs, and I am strongly in favor of carrying on this meeting.

Israelsen: I do feel that this organization should be continued and our personal contacts cannot be overstressed. We have things to do that we should make the organization function continuously instead of two or three days. In research we have so much to learn and progress is too slow. I think the organization will expedite our work and can best solve our problems by group action.

Kulp: This is the first meeting I have had the opportunity and privilege of attending and I have read the reports and wish that I could have attended the meetings myself. The chance of meeting at Santa Cruz will keep it alive for two more years. I should like to meet with workers from the adjacent states on the same basis as we meet here.
Weir: The thing that I like about this organization is the informality of the whole meeting. We have excellent papers from other organizations but we do not have the chance of discussing them as we do here. The drainage and irrigation work at California as two separate divisions may make it difficult, however, the division of soils is small and we each belong to a number of organizations and I am wondering if it will be possible to attend. We will try to have some one either from the irrigation or soils division.

Williams: I am not connected with any Experiment Station or college but am sitting in as a visitor. I can see, however, that workers getting together and discussing problems of irrigation can derive a great benefit.

Boyd: One of our ideals in research work from a Federal standpoint has been a closer coordination between the state and federal agencies. The problems should be limited to regions and states. We have talked in Washington about the possibility of working out a research project by breaking it down into these various research aspects. The project would be regional in character and one which the states could not handle either from financial or other reasons, and then by a cooperative agreement among the states and the work apportioned among them so that when the project could be finished at the same time. A number of things, however, would have to be taken into consideration. A group of this kind working together may be able to work out some plan, duplication is avoided and subject matter and time are correlated.

Rohwer: I thought I was just a visitor and after what has been said I could not make the picture any clearer.
Adams: We will not accomplish as much meeting with another body as Mr. McLaughlin also mentioned.

McLaughlin: The most profitable meeting was at Logan. We were there for a special purpose and we accomplished something. Probably we should meet previous to the meeting of the A.S.A.E.

Rohwer: We should have a separate meeting in order to make any headway.

McLaughlin: I move that we continue our association and be subject to call of the secretary and president and the meeting to be not later than two years from now.

Seconded by Weir.

Discussion: Smith: Is it convenient to have the 5 on the coordinating committee to function in the interim?

Adams: We should take action or review the coordinating committee again.

Motion carried.

Parshall: McLaughlin and Adams suggest that we appoint a new coordinating committee or review the old one (See Fourth Report for committee and divisions).

Smith: I think that the president and secretary should be in close contact with these men.

Adams: I move that a committee of three be appointed to study the grouping and relationships in order to set up a coordinating committee and report back to this group before we leave Estes Park.
Weir: Since soil conservation is interested in this work we perhaps should consider whether they would want to participate or not.

Motion seconded by Kulp.

McLaughlin: I think the matter needs some study, more than we could give it this afternoon.

Smith: I believe we should give it more consideration.

Adams: I make an amendment to the motion, that is, that the committee report to the President and Secretary.

Motion carried as amended.

Parshall: I shall appoint the committee before we adjourn. What about new officers for this organization.

McLaughlin: I make a motion that we retain the officers.

Adams: I second the motion.

Motion carried.

Parshall: Do you think it is possible for this group to have a meeting later in the week either here or at Fort Collins?

After discussion it was agreed that a meeting would be held at 1:30 P.M. Thursday afternoon.

Topics suggested for discussion by the various members for the Thursday afternoon meeting were:

Grand Lake Project
Rio Grande Investigation
Snow Cover in Utah and Early Floods
Soil Conservation.

A motion for adjournment was made and seconded. Carried.
R. L. Parshall, Chairman

M. R. Lewis, Secretary
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This meeting was an informal gathering of the members of the Association held in connection with the Annual Convention of the American Society of Agricultural Engineers at the Stanley Hotel.

The meeting was called to order by Chairman R. L. Parshall at 2:00 p.m., who outlined the historical background of this Association and the scope of the field of investigation which concerns this group. Special reference being made to the problem of water supply and the present outlook.

The first meeting of this association was held at the University of California in Berkeley on September 3 and 4, 1925. Previous to that time, Director C. F. Gillette of the Colorado Experiment Station was made chairman of a committee of the Association of Land Grant Colleges. This committee was to obtain information relative to projects for the inter-mountain states in irrigation and reclamation which would be suitable for study and investigation on Furnell or other Federal funds. In order to contact scientific workers having knowledge of possible new and important projects which could be recommended for study at the various experiment stations throughout the West, a meeting was called at Berkeley. At the conclusion of this conference, it appeared very desirable, because of the scope of the work, to meet every two years at some central point where the various problems and lines of investigational work conducted at the western experiment stations could be discussed.
The basic factors for developing desirable projects were outlined in the 1925 meeting. The keynote of the meeting was the "Economic Use of Water in Irrigation", however, the subjects of Land Valuation and Land Utilization were rather completely discussed.

"At this time, it may be of interest to enumerate the topics of these outlines:

"Factors Underlying the Economic Use of Water in Irrigation".

1. Soil and irrigation relationships.

1. Water holding capacity of soils as influenced by
   (a) Texture, structure, and other soil properties
   (b) Depth to ground water.

2. Analysis of forces affecting soil moisture movement
   (a) Driving forces
   (b) Resisting forces.

3. Conditions governing the application of irrigation water.
   (a) Soil and water properties
   (b) Topography and preparation of land
   (c) Rate, duration, and frequency of water delivery
   (d) Crops grown
   (e) Depth to ground water
   (f) Storage of water in the soil
   (g) Cost of land, water, and labor.

2. Plant and Irrigation Relationships

1. The moisture relations of plants
   (a) With reference to growth
   (b) With reference to disturbance of normal functioning.
2. The moisture requirements of plants
   (a) For maximum yield
   (b) Economic
   (c) For practical field requirements.

3. The quantity of water required per acre for economic irrigation.

"Suggested Subjects for Research in Land Valuation and Land Utilization."

Physical Factors.

"Effect on Land Value of - Soils, topography and drainage,

Climatic Conditions and Health Conditions:
Economic Considerations

"Effect on Land Value of -

Location, markets, marketing institutions, and transportation.
Cost of agricultural development - Project of immediate importance
Scientific agricultural methods
Economic cycles - Project of immediate importance
Earning power and cost of production
Ability and experience of individual farmer
Irrigation practice
Carrying charge on undeveloped lands
Agricultural credit facilities
Agricultural business institutions
Sources of capital for land purchase and available capital
Speculation
Capitalization of estimated future returns.
National financial conditions
Contingencies and risk, with particular reference to security values
Cost of reclamation construction - Project of immediate importance
Incomplete construction of drainage or irrigation works
Character and quality of irrigation and drainage works
Water supply and irrigation requirement
Annual cost of irrigation, reclamation, and drainage service not including interest on capital invested.

Water rights
Management of irrigation and drainage projects
Organized colonization methods
Rate of land settlement
Immigration and increase in population
Land titles
Type of farm enterprise
Size of unit
Existing indebtedness of community and individual
Land ownership
Taxes - tax rate, present and prospective

Social
"Effect on Land Value of -
Racial types, religious creeds and social class
Recreation facilities

Political
"Effect on Land Value of -
Political factions and policies."

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The following men were present at this first conference:
Messrs. Adams, Beckett, Blaney, Brown, Davis, Fortier, Gaines, Harding,
Hutching, Hoff, Israelisen, Lewis, McLaughlin, Parshall, Powers, Pyle,
Scobey, Showers, Stout, Weeks, Weir, West and Winsor.

"The second meeting of this research group was held at Berkeley on December 28, 29 and 30, 1927. There is not time to review the full scope of this meeting, however, I shall read the letter of transmittal to the Directors of Experiment Stations of the Western Division of the Association of Land Grant Colleges, which constitutes the first page of the report covering this meeting: I quote:

"Gentlemen:

There is herewith transmitted a report of the Second Conference of Irrigation Workers in the Western States, held at Berkeley, California, December 28, 29, 30, 1927, addressed through the respective Directors to the Irrigation Sections of the Experiment Stations.

Six states and one federal agency were regularly represented at the Conference, Arizona, California, Colorado, Montana, Oregon, Utah and U.S.D.A. Division of Agricultural Engineering, Irrigation Investigations."
A permanent organization of Workers in Irrigation and Drainage Research in the Western States was effected with Mr. W. W. McLaughlin as Chairman and Dr. O. W. Israelsen as Secretary for the next two years.

The conference was conducted as a round table discussion, the subjects being confined to the following topics: (1) Duty of Water, (2) Drainage, and (3) What information on Irrigation and Drainage is available for use of Extension workers?

The conference adjourned with the firm conviction that an exchange of ideas, a comparison of experimental technique at regular intervals, is extremely valuable and should be encouraged.

Respectfully,

R. L. Parshall, Chairman
G. D. Clyde, Secretary."

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"Concerning the general attitude of those present at the meeting in 1925, I wish to quote the report of the committee on permanent organization at the second conference of irrigation and drainage research, and investigational work. I quote:

"Your Committee is of the opinion that conferences such as the one held in September, 1925, and the present conference of December, 1927, are of great value to those attending them, and therefore to the institutions represented by the delegates. These conferences afford opportunity for contact of individual workers in the same line of investigation, and an exchange of information and opinions and of technique used in research work that will ultimately bring about a measure of coordination that will be for the betterment and ultimate value of work undertaken. These"
meetings also afford an opportunity for focusing upon difficult problems the attention of investigators from various parts of the West, and in many instances suggestions are made which permit a more ready solution of problems under study."

"It is believed that these meetings will be of value to the Association of Land Grant Colleges by putting before it in definite form the irrigation and drainage problems upon which the different institutions are working and the methods adopted in this work; they should also be a ready means of ascertaining the important problems upon which work has not been or is not now being done."

"Your Committee therefore recommends:

(1) That a conference of workers in irrigation and drainage investigations and research be held biennially.

(2) That membership in this conference include those engaged in irrigation and drainage investigations and research in land grant colleges or other educational institutions of the eleven western states, and in the Division of Agricultural Engineering of the U. S. Department of Agriculture.

(3) That a member of the State Relations Service of the U. S. Department of Agriculture be accorded honorary membership and extended an invitation to participate in our conferences.

(4) That the Committee on Irrigation and Drainage Research of the Association of Land Grant Colleges be continued in order that the conference may have a central body to which it can report and from which it may receive suggestions and direction.

(5) That a president and secretary be elected at the close of each meeting of the conference, these officers to be responsible for the
program and for the conduct of the next conference."

Respectfully submitted,

W. W. McLaughlin
G. E. P. Smith

A motion was made to adopt this report. Seconded and carried.

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The third conference of the group was held at Logan, Utah, June 18, 19, and 20, 1929, with Mr. W. W. McLaughlin as president and H. E. Murdock as Secretary. The official name, "Western Irrigation and Drainage Research Association", was adopted. Complete and comprehensive reports containing the minutes of the meetings and the papers of the worker of each representative were published for the second conference and this session.

Mr. Beckett states in the conclusion of his paper on "Coordination of Experimental Work in Plants and Irrigation Relationships": I quote:

"In the coordination of the work of this group, the most satisfactory results are to be obtained through discussion of the various and sometimes unusual problems which develop in the course of the routine work and through a frank discussion and criticism of methods and results obtained at the various stations."

At the Logan meeting the following preamble and recommendations were adopted:
"Preamble

"To assure the complete agricultural development of the United States; to provide homes and food for our increasing population; to further the accessibility and utilization of the vast timber, mining and grazing resources of the arid region; to assure the permanence of profitable agriculture under irrigation; to assist in the coordination and strengthening of research work in irrigation and drainage, the Western Irrigation and Drainage Research Association recommends as follows:

Recommendations

1. That each of the Division coordinators ascertain at an early date the total amount of Adams and Furnell Funds which will be used during 1929-30 in each of the eleven western States to support research concerning "The Factors Underlying the Economic Use of Water in Irrigation" and report such findings to the President of the Association.

2. That about July 1930 each coordinator obtain similar information for the fiscal year 1930-31, and that reports of these findings be made to the Association in its 1931 meeting.

3. That the division of Irrigation and Drainage Research into five major groups as divided and adopted in 1925, be approved and continued.

4. That the division coordinators of each of the five major divisions continue to constitute a coordinating committee for the Association.

5. That the coordinating committee be encouraged to give special attention to the feasibility of "Cooperation in irrigation and drainage research --- between the experiment stations of the several states" as proposed in recommendation No. 8 of the 1925 conference.
6. That particular attention be given by the officers of the Association and also by each Division coordinator to furthering recommendation No. 10 of the 1925 conference, namely: "That due to the very important place irrigation has in maintaining profitable and permanent agriculture in the West, every experiment station of the western States be urged to conduct research of a basic character and of regional significance on one or more of the topics outlined by this conference."

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R. L. Parshall, Chairman

M. R. Lewis, Secretary.
The committee herewith recommends:

1. That the outline of research prepared by the association be continued in force without change.

2. That the secretary of the association write the members of the present coordinating committee to determine if they are willing to accept appointment for the next two years.

3. That the officers of the association be authorized to appoint new members to coordinating committee if it is found that present members cannot continue to act.

Signed

George P. Clyde

Frank Adams

W. R. Lewis
Meeting called to order by R. L. Parshall.

Introduction

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grown upon me very much like a man who has electricity in his home. Previously it was a luxury but now it has become a necessity. None of us can do full work unless we match wits with others and get the broader view that we get from these association meetings. Dr. Gillette called the first two meetings; perhaps because he was vitally interested in the work and I believe we should continue our meetings but we should not make too hard a job of it by tying ourselves down. Let the president and coordinating committee of five select the time and place of meeting. If, after correspondence with the members, we cannot meet next year; plan a 1-, 2- or 3-day meeting at Santa Cruz.

The Western Association of State Engineers overlapped our field somewhat or invaded our field. They held rather extensive programs in which we were very much interested, and they have lapsed from grace and have become a political appendage of the Western Resources Association. We cannot depend upon any other organization to meet our needs, and I am strongly in favor of carrying on this meeting.

Israelsen: I do feel that this organization should be continued and our personal contacts cannot be overstressed. We have things to do that we should make the organization function continuously instead of two or three days. In research we have so much to learn and progress is too slow. I think the organization will expedite our work and can best solve our problems by group action.

Kulp: This is the first meeting I have had the opportunity and privilege of attending and I have read the reports and wish
that I could have attended the meetings myself. The chance of
meeting at Santa Cruz will keep it alive for two more years.
I should like to meet with workers from the adjacent states on the same basis as we meet here.

Weir: The thing that I like about this organization is the
informality of the whole meeting. We have excellent papers
from other organizations but we do not have the chance of
discussing them as we do here. The drainage and irrigation
work at California is two separate divisions may make it
difficult, however, the division of soils is small and we each
belong to a number of organizations and I am wondering if it will
be possible to attend. We will try to have some one either from
the irrigation or soils division.

Williams: I am not connected with any Experiment Station
or college but am sitting in as a visitor. I can see, however,
that workers getting together and discussing problems of irrigation
can derive a great benefit.

Boyd: One of our ideals in research work from a
federal standpoint has been a closer coordination between the
state and federal agencies. The problems should be limited to
regions and states. We have talked in Washington
about the possibility of working out a research project by
breaking it down into these various research aspects. The project
would be regional in character and one which the states could not
handle either from financial or other reason, and then by a
cooperative agreement among the states and the work apportioned among them so that when the project could be finished at the same time. A number of things, however, would have to be taken into consideration. A group of this kind working together may be able to work out some plan, duplication is avoided and subject matter and time are correlated.

Rohwer: I thought I was just a visitor and after what has been said I could not make the picture any clearer.

Adams: We will not accomplish as much meeting with another body as Mr. McLaughlin also mentioned.

McLaughlin: The most profitable meeting was at Logan; We were there for a special purpose and we accomplished something. Probably we should meet previous to the meeting of the A.S.A.E.

Rohwer: We should have a separate meeting in order to make any headway.

McLaughlin: I move that we continue our association and be subject to call of the secretary and president and the meeting to be not later than two years from now.

Seconded by Weir

Discussion: Smith: Is it convenient to have the 5 on the coordinating committee to function in the interim? Adams: We should take action or review the coordinating committee again.

Motion carried.

Parshall: McLaughlin and Adams suggest that we appoint a new coordinating committee or review the old one (See Fourth Report for committee and divisions)
Smith: I think that the president and secretary should be in close contact with these men.

Adams: I move that a committee of three be appointed to study the grouping and relationships in order to set up a coordinating committee and report back to this group before we leave Estes Park.

Weir: Since soil conservation is interested in this work we perhaps should consider whether they would want to participate or not.

Motion seconded by Kulp.

McLaughlin: I think the matter needs some study, more than we could give it this afternoon.

Smith: I believe we should give it more consideration.

Adams: I make an amendment to the motion, that is, that the committee report to the President and Secretary.

Motion carried as amended.

Parshall: I shall appoint the committee before we adjourn. What about new officers for this organization.

McLaughlin: I make a motion that we retain the officers.

Adams: I second the motion.

Motion carried.

Parshall: Do you think it is possible for this group to have a meeting later in the week? Either here or at Fort Collins:

Thursday, 1:30 P.M.

After discussion it was agreed that a meeting would be held at 1:30 P.M. Thursday afternoon.
Topics suggested for discussion by the various members for the Thursday afternoon meeting were:

Grand Lake Project
Rio Grande Investigation
Snow Cover in Utah and Early Floods
Soil Conservation.

A motion for adjournment was made and seconded. Carried.
Water Supply Available for Transmountain Diversion.

A study has been made of the water resources of the Colorado and Green and tributaries to determine the annual supply available to the Granby Reservoir. This investigation includes the supplies derived from the Colorado River into the reservoir, the diversion of Willow Creek into that stream, and surface drainage to the reservoir.

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Note: The handwritten notes on the right side of the page are not legible.
Sublimation - dry 20%?

How shall we put to the directors of the Stateline the importance of this case?

Wood Duck

Windsor - Bird refuges

Clyde - Snow surveying
Forecasting + flood flow

Smith - Control of high temperatures of soils
Examine our soil temp records
Present at this meeting:

1. S. H. McCrery, Chief, Bureau of Agricultural Engineering, Washington, D.C.


3. W. W. McLaughlin, Chief, Division of Irrigation, Bureau of Agricultural Engineering, Berkeley, Calif.


5. Frank Adams, Irrigation Economist, University of California, Berkeley, Calif.

6. Harry Blomery, Irrigation Engineer, Bureau of Agricultural Engineering, Los Angeles, Calif.

Mark R. Kulp, Irrigation Engineer, University of Idaho, Moscow, Idaho.
Carl Robins, Irrigation Engineer, Bu. of Agricultural Engineering, Fort Collins, Colo.

M. E. Winsor, Irrigation Engineer, Bu. of Agricultural Engineering, Salt Lake City, Utah.

Dean George D. Clyde, Irrigation Engineer, Utah Agricultural College, Logan, Utah.

W. E. Cole, Associate Irrigation Engineer, Colo. Agri. Exp. Station, Fort Collins.

O. W. Ossewell, Irrigation Engineer, Utah Agricultural College, Logan, Utah.

M. R. Lewis, Irrigation Engineer, Bu. of Agri. Engineering, Oregon State College, Corvallis, Oregon (Secretary).

W.W. Weir, Drainage Engineer, University of California
September 22, 1938.

Mr. R. L. Parshall,
c/o U. S. Forest Service,
Durango, Colorado.

Dear Mr. Parshall:

As you suggested to Mr. Reedy when you were in the office last Monday, I am enclosing a list of precipitation stations being operated by the Bureau of Reclamation. This list is sent for your information and in the hope that you may have an opportunity to visit some of these stations on your trip. The stations are arranged in order downstream along the Colorado River and its tributaries.

Very truly yours,

E. B. Debler
Hydraulic Engineer.

Encl.
# LIST OF PRECIPITATION STATIONS
OPERATED BY BUREAU OF RECLAMATION

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Observer</th>
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<tbody>
<tr>
<td>C-1</td>
<td>Grand Lake, at Ranger Station north of town</td>
<td>Ranger Fred D. Mclaren, Mrs. Dorothy H. Thompson</td>
</tr>
<tr>
<td>C-2</td>
<td>Hot Sulphur Springs, at Thompson ranch, 1 mile east of town</td>
<td>Mrs. Elizabeth T. Bush, Harvey Markle</td>
</tr>
<tr>
<td>C-4</td>
<td>State Bridge</td>
<td>Mrs. Victoria R. Peabody (in County Clerk's office)</td>
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<tr>
<td>C-21</td>
<td>Glen Mar Ranch (near Parshall)</td>
<td>Fred G. Rehklau</td>
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<tr>
<td>C-22</td>
<td>Breckenridge</td>
<td>Lee Elliott</td>
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<tr>
<td>C-24</td>
<td>Tennessee Pass</td>
<td>Mrs. Beth C. Byers, John E. Henry</td>
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<tr>
<td>C-25</td>
<td>Redcliffe</td>
<td>Hjalmer T. Anderson</td>
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<td>C-27</td>
<td>Eagle</td>
<td>George L. Brown</td>
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<tr>
<td>C-28</td>
<td>W. Portal Independence Pass tunnel</td>
<td>J. W. Simmons</td>
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<tr>
<td>C-30-1</td>
<td>Maroon Lake Ranch, near Aspen</td>
<td>Bryan P. O’Fallon</td>
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<tr>
<td>C-32</td>
<td>Marble</td>
<td>J. Roy Hicks</td>
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<tr>
<td>C-33</td>
<td>Simmons Ranch, west of DeBeque</td>
<td>W. E. Buckley</td>
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<tr>
<td>C-35</td>
<td>Taylor Park Dam</td>
<td>J. R. Liska</td>
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<td>C-42</td>
<td>Sargents, at Hicks' ranch, west of town</td>
<td>W. R. Clay</td>
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<td>C-43</td>
<td>Marshall Pass</td>
<td>Mrs. Louise H. Pyle</td>
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<td>C-47</td>
<td>Lake City</td>
<td>Lem Lindsey</td>
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<tr>
<td>C-53</td>
<td>Ouray (at power plant)</td>
<td>Mrs. Margaret L. Mann</td>
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<tr>
<td>C-61</td>
<td>Dolores</td>
<td>Frank R. Clark</td>
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<td>C-64</td>
<td>Placerville</td>
<td>George Evenson</td>
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<td>G-19</td>
<td>Yampa, at town water intake</td>
<td>Archie B. Toner</td>
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<tr>
<td>G-24</td>
<td>Hamilton</td>
<td>Miss Esther M. Mallett</td>
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<td>G-25</td>
<td>Pyramid, at Clark's ranch near Willow Creek</td>
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<td>G-40-2</td>
<td>Marvine Lodge, near Buford</td>
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<tr>
<td>S-12</td>
<td>Palisade Lake, at Toner's ranch, near Bridge Ranger station northwest of Pagosa Springs</td>
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<td>S-31</td>
<td>Mancos</td>
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November 8, 1938.

Mr. Ralph L. Parshall,
Senior Irrigation Engineer,
Colorado State College,
Fort Collins, Colorado.

Dear Mr. Parshall:

It has been brought to my attention that in a recent bulletin published by the Colorado State College Experiment Station, it is stated that "one inch of rainfall is equal to three inches of irrigation."

If it is possible for you to recognize this particular bulletin without too much trouble, will you kindly send me two copies.

Very truly yours,

E. B. Debler,
Hydraulic Engineer.
Mr. R. L. Parshall,  
Colorado Agricultural Experiment Station,  
Fort Collins, Colorado.

Dear Mr. Parshall:  

Enclosed is copy of Mr. Lewis' letter of August 17, in reply to mine of August 6, regarding mimeographing the minutes of the two meetings of the Western Irrigation and Drainage Research Association. You will note Mr. Lewis' suggestions as to headings and outline, particularly the suggestion in the next to the last paragraph of this letter. If you will, therefore, submit to this office a draft of the form in which you wish these minutes to appear we will proceed to mimeograph the 75 copies requested.

Very truly yours,  
Division of Irrigation  

By  
A. T. Mitchelson,  
Acting Chief.
Corvallis, Oregon,
August 17, 1938.

Mr. A. T. Mitchelson,
Acting Chief,
Division of Irrigation,
Post Office Box 180,
Berkeley, California.

Dear Mr. Mitchelson:

I have your letter of August 6 enclosing copy of Mr. Parshall's letter of July 29 and minutes of the two meetings of the Western Irrigation and Drainage Research Association.

In the main, I am inclined to agree with you as to the minutes of the meeting held at Estes Park in 1936. However, I would suggest that a single page of minutes of that meeting be made up and included with the minutes of the meeting held at Pacific Grove this year.

I would suggest that the minutes for the Estes Park meeting consist simply of a heading, the first two paragraphs of the minutes as prepared by Mr. Parshall, and that a third paragraph be added somewhat along the following lines.

"A general discussion of the aims of the association followed and it was informally agreed that an effort should be made to arrange a meeting at the time of the next meeting of the American Society of Agricultural Engineers on the Pacific Coast."

Since the rest of the minutes as prepared by Mr. Parshall consist in the main of quotations from earlier reports and summaries of work done at earlier meetings, I am inclined to agree with you that it would not be desirable to mimeograph the whole thing.

I am in accord with Mr. Parshall's suggestion that it would be better to have 75 copies rather than 50 made.

Yours very truly,

M. R. Lewis,
Irrigation Engineer
Corvallis, Ore.,
Jan. 16, 1939

Mr. R. L. Parshall,
Senior Irrigation Engineer,
Agricultural Experiment Station,
Fort Collins, Colo.

Dear Mr. Parshall:

I am enclosing herewith a copy of the list of men to whom I sent copies of the minutes of the last two meetings of the Western Irrigation and Research Association.

I have about twenty-five copies left and shall be glad to send copies to anyone whom I may have missed.

I am sending copies of this list to Kulp and Mitchelson.

Yours very truly,

M. R. Lewis,
Irrigation Engineer.
Corvallis, Oregon
January 10, 1939

Dear Sir:

I am enclosing herewith copies of the minutes of the meetings of the Western Irrigation and Drainage Research Association held at Estes Park, Colorado, on June 24, 1936, and at Asilomar, Pacific Grove, California, on June 28, 1938.

You will note that both meetings were somewhat informal and that at both the question of the necessity for continuing the organization was raised. Both times the consensus of opinion was that the group should continue to function.

It is hoped that a more formal meeting with a definite program can be arranged for some time in 1940. Any suggestions will be gratefully received.

Yours very truly,

M. R. Lewis
Senior Agricultural Engineer
Minutes of the Meeting of the
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION

held at
Estes Park, Colorado

June 24, 1936

This meeting was an informal gathering of the members of the Association held in connection with the Annual Convention of the American Society of Agricultural Engineers at the Stanley Hotel.

The meeting was called to order at 2 p.m. by Chairman R. L. Parshall, who outlined the historical background of the Association and the scope of the field of investigation which concerns this group, general reference being made to the broad problem of water supply with special attention to the present outlook for water.

A general discussion of the aims of the Association followed and it was informally agreed that an effort should be made to arrange the next meeting at the time of the meeting of the American Society of Agricultural Engineers on the Pacific Coast.

The following were present:

R. L. Parshall, Senior Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colo. (President)
M. R. Lewis, Irrigation Engineer, Bureau of Agricultural Engineering and Oregon State College, Corvallis, Ore. (Secretary)

Frank Adams, Irrigation Economist, University of California, Berkeley, Calif.
Harry F. Blaney, Irrigation Engineer, Bureau of Agricultural Engineering, Los Angeles, Calif.
Geo. R. Boyd, Assistant Chief, Bureau of Agricultural Engineering, Washington, D. C.
C. D. Clyde, Dean, School of Engineering, Utah Agricultural College, Logan, Utah.
W. E. Code, Associate Irrigation Engineer, Colorado Agricultural Experiment Station, Fort Collins, Colo.
O. W. Israelsen, Irrigation Engineer, Utah Agricultural College, Logan, Utah.
Mark R. Kulp, Irrigation Engineer, University of Idaho, Moscow, Idaho.
S. H. McCrory, Chief, Bureau of Agricultural Engineering, Washington, D. C.
W. W. McLaughlin, Chief, Division of Irrigation, Bureau of Agricultural Engineering, Berkeley, Calif.
Carl Rohwer, Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colo.
G. E. F. Smith, Irrigation Engineer, University of Arizona, Tucson, Ariz.
W. W. Weir, Drainage Engineer, University of California, Berkeley, Calif.
L. M. Winsor, Irrigation Engineer, Bureau of Agricultural Engineering, Salt Lake City, Utah.

Discussion

MR. PARSHALL: Have the past efforts of this group been worth while and of sufficient importance to warrant the continuance of this organization? Probably we can only make recommendations; after their consideration by the Directors of the Experiment Stations we may decide what can be done. Do we wish to carry on this organization or not?

MR. LEWIS: The work we tried to do has been worth while, but during the past 5 years the Institute of Irrigation Agriculture and the Los Angeles Section of the American Society of Civil Engineers have done much work in this same field. However, we have had little contact in Oregon with these activities during that time and I vote for the continuance of this Association.

PROF. CLYDE: I feel somewhat as Mr. Lewis does. We are getting into so many activities that the work is overlapping; however, the existence of the organization is warranted. The expense involved and the distance to be traveled from various points in the 11 States is a drawback, but the organization might go ahead if the stations can support it.

MR. McOHORY: I am not very familiar with what has been going on, but I believe that the organization is worthwhile. If the organization is continued, I can pledge our hearty support, probably not financially, but permission will be granted for our people to attend its meetings.

MR. McLAUGHLIN: I am very much in favor of the work as it gives an intimate contact with details and with methods used in research work and the problems of different parts of the country. No other organization has done this, as most other organizations deal with general problems. The station workers and others in research will get much out of it that they won't get elsewhere.

PROF. ADAMS: The need for the organization is just as strong now as when it was started. The value has come from criticizing and discussing problems, methods of approach and objectives. We should find a way to continue the enterprise and should meet every two years.
It is hard to get the acquiescence of our Dean. There are always some of our staff wanting to go to more meetings than are allowed. However, I am sure of our cooperation, and feel that we should get together periodically to discuss our problems.

MR. PARSHALL: In 1925 we were to have a 2-day session but ran over into the third day. We are a small group but we can easily spend 2 or 3 days discussing problems of common interest to us.

DR. G. E. F. SMITH: For some 25 years I have worked alone, but after having the opportunity of convening at meetings of the Association and with my research colleagues, the idea has grown upon me. It is all very much like the experience of a man who has electricity in his home. Previously it was a luxury but now it has become a necessity. None of us can do full work unless we match wits with others and acquire the broader view that we get from these Association meetings. Dr. Gillette called the first two meetings, perhaps because he was vitally interested in the work, and I believe we should continue them, but we should not make too hard a job of it by tying ourselves down. Let the President and Coordinating Committee of Five select the time and place of each meeting. If, after correspondence with the members, we cannot meet next year, plan a 1-, 2- or 3-day meeting at Santa Cruz.

The Western Association of State Engineers overlapped our field somewhat or invaded it. At first they held rather extensive programs in which we were very much interested, but now we cannot depend upon any other organization to meet our needs, and I am strongly in favor of carrying this one along.

DR. ISRAELSEN: I do feel that this organization should be continued. The value of our personal contacts cannot be overstressed. We have so many things to do that we should make the organization function continuously instead of for only 2 or 3 days at a time. In research we have so much to learn and progress is so slow. I think the organization will expedite our work, and that we can best solve our problems by group action.

PROF. KULP: This is the first meeting I have had the opportunity and privilege of attending but I have read the reports of the other meetings and wish that I could have attended them myself. The chance of meeting at Santa Cruz will keep the organization alive for two more years. I should like to meet with workers from the adjacent States on the same basis as the one upon which we meet here.

PROF. \text{wIR}: The thing I like about this organization is the informality of its meetings. We have excellent papers from other organizations but we do not have the chance of discussing them as we do here. The fact that the drainage and irrigation work are handled at the University of California as two separate divisions may make it difficult for both to be represented in future meetings; however, the
division of soils is small and each member of its staff belongs to a number of organizations. I am wondering whether it will be possible for representatives of each to attend. However, we will try to have some one either from the irrigation or soils division present at future meetings.

MR. WILLIAMS: I am not connected with any experiment station or college but am sitting in as a visitor. I can see, however, that workers getting together and discussing problems of irrigation can derive a great benefit from such exchanges of thought.

MR. BOYD: One of our aims in research work, from a Federal standpoint, has been a closer coordination between State and Federal agencies. We have talked in Washington about the possibility of working out a research project by breaking it down into its various research aspects. The project might be regional in character, and one which individual States, either from financial or other reasons, can not handle; but by a cooperative agreement among the States the work could be apportioned among them and its different parts finished at the same time. A number of things, however, would have to be taken into consideration in such planning. A group of this kind working together may be able to work out some plan whereby duplication is avoided, and subject matter and time are correlated.

MR. ROHRWER: I thought I was just a visitor. After what has been said I could not make the picture any clearer.

PROF. ADAMS: We will not accomplish as much meeting with another body, as Mr. McLaughlin also mentioned.

MR. McLAUGHLIN: The most profitable meeting was at Logan. We were there for a special purpose and we accomplished something. Probably we should meet previous to the meeting of the A.S.A.E.

MR. ROHRWER: We should have a separate meeting in order to make any headway.

MR. McLAUGHLIN: I move that we continue our association and be subject to call of the President and Secretary for a meeting to be held not later than 2 years from now.

Seconded by Prof. Weir.

Discussion: DR. SMITH: Is it convenient to have the 5 members on the Coordinating Committee functioning in the interim?

PROF. ADAMS: We should take action or review the Coordinating Committee again.

Motion carried.

MR. PARSHALL: Mr. McLaughlin and Prof. Adams suggest that we appoint a new Coordinating Committee or review the old one (See Fourth Report for committees and divisions).
DR. SMITH: I think that the President and Secretary should be in close contact with these men.

PROF. ADAMS: I move that a Committee of three be appointed to study our grouping and relationships in order to set up a Coordinating Committee and report back to this group before we leave Estes Park.

PROF. WILK: Since Soil Conservation is interested in this work, we perhaps should consider whether they would want to participate or not.

Motion seconded by Prof. Kulp.

MR. McLAUGHLIN: I think the matter needs some study - more than we could give it this afternoon.

DR. SMITH: I believe we should give it more consideration.

PROF. ADAMS: I make an amendment to the motion; that is, that the Committee report to the President and Secretary.

Motion carried as amended.

MR. PARRISH: I shall appoint the Committee before we adjourn. What about new officers for this organization?

MR. McLAUGHLIN: I make a motion that we retain the officers.

PROF. ADAMS: I second the motion.

Motion carried.

MR. PARRISH: Do you think it is possible for this group to have a meeting later in the week either here or at Fort Collins?

After discussion it was agreed that a meeting would be held at 1:30 p.m., Thursday afternoon.

Topics suggested for discussion by the various members for the Thursday afternoon meeting were:

- Grand Lake Project
- Rio Grande Investigation
- Snow Cover in Utah and Early Floods
- Soil Conservation.

A motion for adjournment was made and seconded. Carried.

M. R. Lewis, Secretary.
Minutes of the Meeting of the

WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION

held at

Asilomar, Pacific Grove, Calif.

June 28, 1938

The meeting was called to order by Chairman R. L. Parshall

at 2:10 p.m. The following were present:

R. L. Parshall, Senior Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colo. (President)

M. R. Lewis, Irrigation Engineer, Bureau of Agricultural Engineering and Oregon State College, Corvallis, Oreg. (Secretary)

Frank Adams, Irrigation Economist, University of California, Berkeley, Calif.

Harry F. Blaney, Irrigation Engineer, Bureau of Agricultural Engineering, Los Angeles, Calif.

E. E. Brackett, Prof. of Agricultural Engineering, University of Nebraska, Lincoln, Nebr.

J. B. Brown, Irrigation Specialist, University of California, Berkeley, Calif.

David Clerk, Chief Engineer, Drainage Section, Dept. Agr., Quebec, Canada.

N. E. Edlefsen, Associate Irrigation Engineer, University of California, Davis, Calif.


Joseph Gross, Consulting Engineer, Sacramento, Calif.

Karl Harris, Associate Irrigation Engineer, Bureau of Agricultural Engineering, Phoenix, Ariz.

M. R. Huberty, Associate Irrigation Engineer, University of California, Riverside, Calif.

Mark R. Kulp, Irrigation Engineer, University of Idaho, Moscow, Idaho.

S. P. Lyle, Senior Agricultural Engineer, Bureau of Agricultural Engineering, Washington, D. C.

H. F. McCollly, Prof. of Agricultural Engineering, North Dakota State College, Fargo, N. Dak.

S. H. McCrory, Chief, Bureau of Agricultural Engineering, Washington, D. C.

A. T. Mitchellson, Acting Chief, Division of Irrigation, Bureau of Agricultural Engineering, Berkeley, Calif.

W. L. Powers, Soil Scientist, Oregon State College, Corvallis, Oreg.
H. B. Roe, Prof. of Agricultural Engineering, University of Minnesota, St. Paul, Minn.
C. E. P. Smith, Irrigation Engineer, University of Arizona, Tucson, Ariz.
C. A. Taylor, Associate Irrigation Engineer, Bureau of Agricultural Engineering, Pomona, Calif.
F. J. Veihmeyer, Irrigation Engineer, University of California, Davis, Calif.

Dr. C. E. P. Smith was called upon to present a discussion on the Physiography of Arizona Valley, based on a paper on the same subject published in Pan American Geologist Vol. 69, pp. 321-327 (June 1938). Before doing so, Dr. Smith displayed a specimen of tamarisk wood showing a beautiful grain and suggested that the wood should be valuable for the production of novelties. He had found that tamarisk fence posts were short-lived when untreated but are very easily impregnated with creosote. Since the trees grow very rapidly on alkali land it appears that they may become a valuable farm wood-lot product.

Dr. Smith then proceeded with his discussion on the Physiography of Arizona Valley. He pointed out the great similarity of the different valleys, in that both have three different base levels to which they have been graded during their geologic history, and suggested that these might well be correlated with the advance of the Continental Ice Sheet in Pleistocene times.

Prof. Frank Adams told of the work in which he is engaged, which consists of an attempt to answer the question as to what return the administration of the Central Valley Project can expect from the sale of water during the first 10 years of its operation. He referred to the somewhat similar work reported on in Bulletins 34 and 43 of the California Department of Public Works. It is proposed to study separately each of the 26 general areas where landowners are expected to apply for water from the project.

Land classifications of the whole area have heretofore been made by Harding and Strahorn, and the Storl Index soil ratings have been applied to it. The new study will include other factors in addition to the soil and the final result of the work will be a rating on a scale of 0 to 160 by steps of 10. Prof. Adams felt that it was still possible that the rating of the highest quality lands was relatively low in spite of extending the usual scale from 100 to 160.

Dr. Smith asked if county and irrigation District assessments were based on the same valuations. Adams replied that there is no necessary relationship between the two.

Dr. W. L. Powers described the methods used in classifying some 3,000,000 acres of land in Oregon for irrigation and drainage purposes. A percentage scale was used in this work.
Mr. Parshall suggested that the representatives of the different States describe the irrigation and drainage research in progress in their States.

Prof. Kulp described vegetation surveys being made of the alkali lands in the Payette Valley of Idaho by the Soil Conservation Service for the purpose of determining their value for settlement by farm families from the drought areas. A study of the maintenance of drainage systems had shown that drainage wells were not pumped unless the water was needed for irrigation. Concrete and asphaltic canal linings have not proved satisfactory. One system is trying out bentonite. The canal is excavated 7 or 8 inches beyond the contours of what is to be the finished section. One or 2 inches of a mixture of 10 percent "Volclay" with soil is then applied, followed by a 6-inch cover of local soil.

Prof. J. B. Brown described an oil treatment used by one of the moving picture companies on the sides and bottom of an artificial lake. The cost was 3 to 5 cents per square foot. This seems to be giving satisfactory service.

Prof. E. B. Brackett discussed irrigation from the Platte River gravels, describing briefly the new projects in central Nebraska which include the Tri-county and Southerland units on the Platte River and the Loop River project. He described the pumping of water from a surface stream on the agricultural experiment station apple orchard located some 50 miles east of Lincoln. This orchard had depleted the soil and subsoil moisture to a great depth and was in serious need of supplemental water.

Prof. H. F. McColly said that a number of years ago he started teaching a course in reclamation at North Dakota Agricultural College which included some work in irrigation. At that time the authorities insisted that he drop the work in irrigation since it would be of no value in North Dakota. This attitude has been entirely reversed in recent years. No irrigation research is being done in that State at the present time but tentative plans call for such studies. There are about 350,000 acres of river bottom lands which could be irrigated, chiefly by pumping. Flood irrigation projects will raise the total to, perhaps, a million acres.

Dr. W. L. Powers described the studies of uniformity of irrigation by sprinklers which he has been carrying on for the last 2 years. Rotary sprinklers are used, spaced 60 feet on the line and with laterals 65 feet apart. Pressure at the end of the line is held at 35 pounds per square inch. He reported that 20,000 acres are irrigated in the Willamette Valley. Two-thirds of this total is Ladino clover irrigated by the border method and about 2,500 acres by sprinklers.

He discussed the use of strawberry clover on alkali soil and reported the great influence of temperature on the toxic limits.
This clover will germinate at Klamath Falls in soil with a Ph of 9.5 and at Vale when Ph is 9.0. Maturity Ph values at these locations may be 10.0 and 9.5, respectively.

There followed a general discussion of the cost of pumping and the economic limit of lift. Both Dr. Smith and Prof. Brown agreed that this limit is approximately 80 feet. It was pointed out that this limit depends on so many factors that no single value can be used under all conditions.

It was moved by Dr. Smith, seconded by Dr. Veihmeyer, that the organization be kept intact and that it be left to the President and Secretary to keep in touch with possibilities and to call the next meeting when an opportunity offered. Motion passed.

Election of officers was held with the result that M. R. Lewis was named for President, and Mark R. Kulp for Secretary.

M. R. Lewis, Secretary.
Prof. Frank Adams, Irrigation Economist, University of California, Berkeley, California.

Mr. Robert B. Allyn, Junior Irrigation Engineer, Bureau of Agricultural Engineering, P.O. Box 1149, Medford, Oregon

Mr. Harry F. Blaney, Irrigation Engineer, Bureau of Agricultural Engineering, 447 Pacific Electric Bldg., Los Angeles, California

Mr. Dean W. Bloodgood, Asso. Irrigation Engineer, Bureau of Agricultural Engineering, Pomona, California

Prof. E. E. Brackett, Dept. of Agricultural Engineering, University of Nebraska, Lincoln, Nebraska

Dr. P. S. Burgess, Director, Agricultural Experiment Station, University of Arizona, Tucson, Arizona

Prof. J. E. Christiansen, Asst. Irrigation Engineer, University of California, Davis, California

Dr. J. E. Church, Meteorologist, University of Nevada, Reno, Nevada

Mr. David Clerk, Chief Engineer, Drainage Section, Department of Agriculture, Quebec, Canada

Prof. Geo. D. Clyde, Dean, School of Engineering, Utah State College, Logan, Utah

Prof. W. E. Code, Associate Irrigation Engineer, Colorado State College, Fort Collins, Colo.

Prof. Albert S. Curry, Irrigation Investigations, New Mexico College of Agriculture, State College, New Mexico

Director S. B. Doten, Agricultural Experiment Station, University of Nevada, Reno, Nevada

Prof. N. E. Edlefsen, Asso. Irrigation Engineer, University of California, Davis, California
Mr. Paul E. Ewing, Irrigation Economist, Bureau of Agricultural Engineering, P.O. Box 180, Berkeley, California

Mr. A. Lincoln Fellows, Irrigation Engineer, 1663 Broadway, Denver, Colo.

Dr. Fabian Garcia, Director, Agricultural Experiment Station, New Mexico College of Agriculture, State College, New Mexico

Prof. George Hardman, Dept. of Irrigation, University of Nevada, Reno, Nevada

Mr. Karl Harris, Associate Irrigation Engineer, Bureau of Agricultural Engineering, Room 24 Post Office Bldg., Phoenix, Arizona

Director J. A. Hill, Agricultural Experiment Station, University of Wyoming, Laramie, Wyoming

Mr. M. R. Huberty, Assoc. Irrigation Engineer, University of California, Riverside California

Mr. Wells A. Hutchins, Irrigation Economist, Bureau of Agricultural Engineering, P.O. Box 180, Berkeley, California

Dr. C. B. Hutchison, Director, Agricultural Experiment Station, University of California, Berkeley, California

Director E. J. Iddings, Agricultural Experiment Station, University of Idaho, Moscow, Idaho.

Dr. O. W. Israelsen, Irrigation Engineer, Utah State College, Logan, Utah

Mr. L. T. Jessup, Drainage Engineer, Bureau of Agricultural Engineering, 310 Federal Bldg., Yakima, Washington

Director E. C. Johnson, Agricultural Experiment Station, Washington State College, Pullman, Washington

Prof. Mark R. Kulp, Dept. of Agricultural Engineering, University of Idaho, Moscow, Idaho

Mr. M. R. Lewis, Senior Agricultural Engineer, Bureau of Agricultural Engineering, Corvallis, Oregon

Prof. H. F. McCollum, Dept. of Agricultural Engineering, North Dakota State College, Fargo, North Dakota
Director Clyde McKee, Agricultural Experiment Station, Montana State College, Bozeman, Montana

Mr. W. W. McLaughlin, Consulting Engineer, Soil Conservation Service, P.O. Box 180, Berkeley, California

Mr. J. C. Marr, Assoc. Irrigation Engineer, Bureau of Agricultural Engineering, P.O. Box 835, Boise, Idaho

Mr. A. T. Mitchelson, Acting Chief, Division of Irrigation, Bureau of Agricultural Engineering, P.O. Box 180, Berkeley, Calif.

Mr. Dean C. Muckel, Asst. Irrigation Engineer, Bureau of Agricultural Engineering, P.O. Box 484, Pomona, California

Mr. Harry G. Nickle, Asst. Irrigation Engineer, Bureau of Agricultural Engineering, Irrigation Branch Experiment Station, Prosser, Washington

Mr. R. L. Parshall, Senior Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colorado

Prof. R. L. Patty, Dept. of Agricultural Engineering, South Dakota State College, Brookings, S. D.

Dr. W. L. Powers, Soil Scientist, Oregon State College, Corvallis, Oregon

Mr. John C. Reese, Junior Irrigation Engineer, Bureau of Agricultural Engineering, Room 4, Post Office Bldg., Pomona, Calif.

Prof. H. B. Roe, Dept. of Agricultural Engineering, University of Minnesota, University Farm, St. Paul, Minnesota.

Mr. Carl Rohwer, Irrigation Engineer, Bureau of Agricultural Engineering, Fort Collins, Colorado

Dr. E. P. Sandsten, Director, Agricultural Experiment Station, Colorado State College, Fort Collins, Colorado

Director Wm. A. Schoenfeld, Agricultural Experiment Station, Oregon State College, Corvallis, Oregon

Mr. Fred C. Scoobey, Senior Irrigation Engineer, Bureau of Agricultural Engineering, P.O. Box 180, Berkeley, California
Dr. G. E. P. Smith, Irrigation Engineer, University of Arizona, Tucson, Arizona

Mr. C. A. Taylor, Associate Irrigation Engineer, Bureau of Agricultural Engineering, Pomona, California

Dr. F. J. Veilmeyer, Irrigation Engineer, University of California, Davis, California

Prof. W. W. Weir, Drainage Engineer, University of California, Berkeley, California

Mr. R. A. Work, Associate Irrigation Engineer, Bureau of Agricultural Engineering, P.O. Box 1149, Medford, Oregon

Mr. A. A. Young, Assoc. Irrigation Engineer, Bureau of Agricultural Engineering, Room 202, Post Office Bldg., Pomona, Calif.

Director, Agricultural Experiment Station, Utah State College, Logan, Utah
Fort Collins, Colorado
January 29, 1939

Professor M. R. Lewis
Irrigation Engineer
Oregon State College
Corvallis, Oregon

Dear Professor Lewis:

I have your letter of January 16 enclosing copies of the minutes of the two meetings of the Western Irrigation Research Association, Estes Park, 1936 and Asilomar, 1938.

I will check over the list which you have mailed this report and it may be that I will be able to send on other copies to persons not listed which would be interested in our association.

Thanking you, I am,

Yours very truly,

R. L. Parshall
Senior Irrigation Engineer
Bureau of Agricultural Engineering
U.S.D.A.
TO MEMBERS WESTERN IRRIGATION AND DRAINAGE ASSOCIATION:

I take pleasure in submitting copy of minutes together with appendix of our third bi-annual meeting held at Logan, Utah, June 18, 19, and 20, 1929.

Mr. Murdock and I trust that the minutes – of necessity somewhat sketchy – will be sufficient to refresh the memory of those that were present so they may recall vividly the many interesting and instructive points discussed at Logan, and to those not in attendance, will give some idea of the work attempted at the gathering.

If any serious errors are discovered please notify either the Secretary or myself.

Sincerely,

Western Irrigation and Drainage Association

W. W. McLaughlin, President.
Report of
Biennial Convention
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
Held at
Logan, Utah
June 18, 19, and 20,
1929.
Report of
Biennial Convention
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
Held at
Logan, Utah
June 18, 19, and 20, 1929.
MEMBERS OF "WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION."

Gentlemen:

You will recall that in 1925 Director C. P. Gillette, Chairman, Committee on Irrigation and Reclamation Projects, Western Division of Land Grant Colleges, called a conference of irrigation workers of Experiment Stations of the Western States. This conference was held at Berkeley, California, September 3, 4 and 5, and there were represented five States - Colorado, Utah, Idaho, Oregon and California - and the Division of Agricultural Engineering of the U. S. Department of Agriculture.

This conference sought in the main to accomplish two purposes: "To restate and to group in logical relation the subjects of irrigation research and to instill the spirit of cooperation among the individual workers." The Conference adjourned with a feeling that substantial progress along both of these lines had been made.

A second conference was held at Berkeley, California, December 28, 29, and 30, 1927. This conference was also called at the suggestion of Director Gillette. There were represented six States - Arizona, California, Colorado, Montana, Oregon and Utah - and the Division of Agricultural Engineering of the U. S. Department of Agriculture. A permanent organization of workers in irrigation and drainage research

-1-
in the Western States was effected, to meet every two years. The subjects discussed at the second conference were:

1. Duty of water
2. Drainage
3. What information on irrigation and drainage is available for use of extension workers?

"This conference adjourned with the firm conviction that an exchange of ideas, and a comparison of experimental technique at regular intervals is extremely valuable and should be encouraged."

The third conference, a summary of which is embraced in this report, was held at Logan, Utah, on June 18, 19 and 20. There were represented nine States – Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah and Washington – and the Division of Agricultural Engineering of the U. S. Department of Agriculture. Thus our meetings have showed a steady increase in the number of States represented, and evidenced increased interest in such meetings.

There was selected at the conference a permanent name for the organization, which appears at the top of page 1.

The notes of the meeting as given in the body of this report, are brief statements of discussions and remarks as taken down by the Secretary. They will of necessity be of prime value to those present and taking part in the meeting. The second part of the report, or the Appendix, will be of value to both those who attended the meeting and those not present. The Appendix contains brief statements of work now in progress by the several State institutions represented at the meeting.
It is proposed for future meetings that very definite programs be worked up in advance as was done for the present 1929 meeting. The perfecting of a coordinated program allows the leader of each major subject as well as others of the group to bring to the meetings the latest information and to present such questions as may be troublesome in their investigations.

Respectfully,

W. W. McLaughlin  President
H. E. Murdock  Secretary
Report of
Biennial Convention
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
Held at
Logan, Utah
June 18, 19, and 20
1929.

The conference was called to order at 9:30 a.m. on June 18, by Mr. W. W. McLaughlin of Berkeley, California. Adjourned at 5 p.m. June 20, after adopting the following Preamble and Recommendations:

PREAMBLE

To assure the complete agricultural development of the United States; to provide homes and food for our increasing population; to further the accessibility and utilization of the vast timber, mining and grazing resources of the arid region; to assure the permanence of profitable agriculture under irrigation; to assist in the coordination and strengthening of research work in irrigation and drainage, the Western Irrigation and Drainage Research Association recommends as follows:

RECOMMENDATIONS

1. That each of the Division coordinators ascertain at an early date the total amount of Adams and Purnell Funds which will be used during 1929-30 in each of the eleven western States to support research concerning "The Factors Underlying the Economic Use of Water in Irrigation" and report such findings to the President of the Association.
2. That about July 1930 each coordinator obtain similar information for the fiscal year 1930-31, and that reports of these findings be made to the Association in its 1931 meeting.

3. That the division of Irrigation and Drainage Research into five major groups as divided and adopted in 1925, be approved and continued.

4. That the division coordinators of each of the five major divisions continue to constitute a coordinating committee for the Association.

5. That the coordinating committee be encouraged to give special attention to the feasibility of "Cooperation in irrigation and drainage research --- between the experiment stations of the several states" as proposed in recommendation No. 8 of the 1925 conference.

6. That particular attention be given by the officers of the Association and also by each Division coordinator to furthering recommendation No. 10 of the 1925 conference, namely: "That due to the very important place irrigation has in maintaining profitable and permanent agriculture in the West, every experiment station of the western States be urged to conduct research of a basic character and of regional significance on one or more of the topics outlined by this conference."
MINUTES

Forenoon Session, June 18, 1929.

Present


Mr. W. W. McLaughlin called the meeting to order. The matter of electing a new secretary came up as Dr. Israelsen wished to be relieved on account of his hearing. Mr. Murdock of Montana was nominated by Mr. Beckett and seconded by Mr. Clyde. Mr. McLaughlin then called for a vote and Mr. Murdock was unanimously elected. He officiated during this conference and will act as secretary for the coming two years.

Dr. Israelsen brought up selecting a new name for this group. He had already done some work on this and was then ready to report in writing on the blackboard.

Mr. McLaughlin gave a history of the group which follows: "Four years ago the Association of Land Grant Colleges and Experiment Stations appointed a committee to report irrigation and drainage research work of which committee Director Gillette of Colorado was made chairman. He was instrumental in bringing about the first meeting which was held at Berkeley in 1925 for the purpose of securing information for this committee. This conference had as its purpose the finding out of what was being done in irrigation and drainage research. Those workers assembled at this meeting felt an exchange of ideas on research problems and
methods was a good thing and therefore proposed to continue the group meetings. It was felt that a meeting every two years was more desirable than annual meetings. These thoughts were put as motions and adopted."

The conference was then ready to make a choice of a name for the group and the following three names were suggested:

1. Western Irrigation and Drainage Research Workers.
2. Irrigation Workers of the Western Agricultural Experiment Stations.
3. Western Irrigation and Drainage Research Conference.

As a result of the questionnaire on names, the first received five votes, the second none, and the third, two votes. Moved and seconded to adopt the first. Discussion brought out "Western Irrigation and Drainage Research Association."

Mr. McLaughlin then suggested that each man present at this conference should tell of the general work carried on at his station and that at least four out of the five committee chairmen should report. The chairmen and the subject assigned them were as follow:

I. Soils and Irrigation Relationships - C. E. P. Smith.
II. Plant and Irrigation Relationships - S. H. Beckett.
IV. Drainage and Reclamation of Waterlogged, Alkali, and Overflowed Lands - M. R. Lewis.
V. Institutional Irrigation and Drainage Relationships - Wells A. Hutchins.
Professor Smith being called East unexpectedly it was suggested that a substitute chairman be appointed on Soil and Water Relationships committee. In view of the nearness of the meeting date and the overlapping of the field of this committee and the committee on Plant and Irrigation Relationships, it was thought best to let the report of the latter committee answer for the reports of both committees.

The committee reports follow:
COORDINATION OF EXPERIMENTAL WORK

IN PLANT AND IRRIGATION RELATIONSHIPS

by

S. R. Beckett

At the first conference of the Irrigation and Drainage Investigators of the Experiment Stations of the Western States and the Office of Irrigation Investigations of the Federal Division of Agricultural Engineering, an outline was adopted, classifying irrigation and drainage research under a general heading of "Factors underlying the economic use of water in irrigation". This classification called for a proposed division of experimental work under five general headings, the second of which was as follows:

II. Plant and Irrigation Relationships.

1. The moisture relations of plants

   (a) With reference to growth

   (b) With reference to disturbance of normal functioning

2. The moisture requirements of plants

   (a) For maximum yield

   (b) Economic

   (c) For practical field requirements

3. The quantity of water required per acre for economic irrigation.

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At this meeting, a recommendation was made that the experiment stations rewrite their irrigation and drainage projects in accordance with the regrouping as adopted.

In notifying the writer of his appointment as chairman of the Committee on Plant and Irrigation Relationships, the secretary urged that careful thought be given to the possibility of coordinating research carried on by irrigation and drainage workers in the matter of plant and irrigation relationships with a view to making definite and specific recommendations concerning the problem.

In attempting to fulfill this request, a letter was written to the head of the Irrigation or Agricultural Engineering Department of each of the eleven western States and to the Acting Chief of Irrigation Investigations of the Federal Division of Agricultural Engineering, asking for the following information:

1. A brief description of their projects, which might be classed under plant and irrigation relationships.

2. If an attempt had been made to rewrite or adjust their projects to conform with the recommendations made at the 1925 meeting.

3. In view of the wide differences in climatic and soil conditions under which the various stations are working, is it practicable or possible to adjust the projects to fit the outline.

4. Suggested changes in the adopted outline covering plant and irrigation relationships.
Of the eleven western States to which this inquiry was directed, replies were received from seven. In all stations except one, experimental work was being carried on, the nature of which placed it under the general heading of plant and irrigation relationships. These projects included work with tanks and field plots, dealing principally with the effects of time and depths of irrigation on the quantity and quality of crops produced. The crops under investigation included small grains, forage crops, sugar beets, beans, potatoes, truck crops, cotton, grapes, and deciduous and citrus fruits. Although but little information was obtained concerning the methods used, it is assumed that the results obtained are such, that a direct comparison between them may be made. In addition to the above, two stations report investigations dealing with the relation of irrigation and soil fertility to crop yields and one station reports projects dealing with the fundamental principle underlying the use of water by plants. Since the adoption of the outline at the 1925 meeting, three stations report old projects to have been rewritten or adjusted and their new projects written to conform with the outline. At the remaining four stations, no attempt has been made to rewrite old projects, although three of them report the outline to have been followed in planning new projects.

With but one exception, the general impression was that such differences as soil and climatic factors found at the various stations would not be a serious handicap in adjusting their projects to the
outline. However, one station pointed out that where cooperative federal funds were used and where the project had to be approved by federal authorities, some difficulty might be encountered in getting them to approve the project as submitted.

But one suggestion was received concerning the outline as adopted. In this, it was stated that in the opinion of the writer the outline was too general and should be amplified and expanded so that new projects would more readily fit one or more of the subheadings.

In view of the limited information obtained, the writer is of the following opinion:

1. In general, although the recommendations concerning the rewriting of projects was not followed, the investigations now being carried on by the several stations apparently seemed to pretty well fit into the adopted outline covering plant and irrigation relationships.

2. Due to the variability of conditions under which the projects are carried out, the individual ideas of the investigator and the fact that the project must be written to fit conditions surrounding it, it is not possible, and probably not desirable, that projects should be written to exactly conform with a predetermined outline, especially since it is generally recognized that the best experimental results have been obtained through following the leads which have been developed from the routine work of the original problem.
3. Probably the greatest coordination in experimental work such as this should be obtained through a better standardization of methods. This applies especially to a standardization of the methods used in a determination of the use of water by plants grown in containers and involves such questions as desirable sizes of tanks, methods of filling and weighing, regulation of moisture content, etc. In the use of field plots, the size of the plot, the number of replication necessary, methods of water measurement, soil sampling, etc., might be discussed to advantage.

4. In the coordination of the work of this group, the most satisfactory results are to be obtained through discussion of the various and sometimes unusual problems which develop in the course of the routine work and through a frank discussion and criticism of methods and results obtained at the various stations.

Davis, California
June 15, 1929.
NOTES CONCERNING THE EXPERIMENTAL WORK IN COLORADO

IRRIGATION WATER SUPPLY AND ITS PHYSICAL CONTROL

by

R. L. Farshall

As chairman of the committee concerning recommendations relative to Section III of the 1925 conference project outline, namely, Irrigation Water Supply and its Physical Control, I can report nothing of a constructive nature. In expressing my own opinion, I believe that project outlines of the various experiment stations dealing with the same general study or investigation can not be similar in all details. One of the fundamental considerations underlying the 1925 conference project outline was the quite general application of the scope of investigation as applicable to all the western irrigated States. However, it was recognized that not all our problems could be studied advantageously in all States, and, therefore, for some projects the work could be better accomplished in one State than in another because of the local conditions and limitations to the study.

The correlation of projects according to the outline set up at the Berkeley conference in 1925 has not been fully developed at the Colorado Station. Since the first conference only one major project has been initiated, namely a study of Pumping for Irrigation and Drainage in Colorado. This study is rather broad in its scope and touches upon all the subheadings of the 1925 conference outline.
Section III, Item 3, Pumping for Irrigation. In this investigation, attention is being given to: Equipment and power, pumping from surface sources, pumping from ground water, economic limits of pumping lift, and, further, a comparative study of the costs of pumped and gravity-flow irrigation water.

At the present time there are three general projects actively pursued in Irrigation Investigations at the Colorado Experiment Station: Studies in Evaporation, Measurement of Water, and Pumping for Irrigation and Drainage. The studies in Evaporation Losses from Free Water Surfaces have been virtually completed and a report prepared by Mr. Carl Rohwer. During the past three years, studies have been conducted on Evaporation Losses from Moist Soils, where the water table has been carried at depths of 1, 6 and 12 inches.

(See April Proceedings, Am. Soc. Civil Engineers.)

Beginning this season, this soil evaporation equipment has been revised, where all tanks were filled with the same soil. For the 6-inch water table, five tanks are included in this series. One is without plant growth, two with bluegrass sod, and two with a sod of a mixture of wire grass and a sedge grass of the genus Carex. For the 12-inch water table there is a similar plan, while for the 18-inch series six tanks are included of which two are without plant growth, two with blue grass and two with wire grass and sedge. In the whole series, two tanks are maintained to determine the loss from a free water surface as a matter of making comparisons on the relative rates.
of evaporation and transpiration losses. The Mariotte tube regulation apparatus is being used to maintain a constant water level.

The studies in connection with the Water Measurement project are confined to the investigation of the law of flow through large sized improved Venturi flumes. At the present time there are under investigation flumes having 10-, 12-, 20-, and 40-foot throats, this largest flume having a maximum capacity of 2,000 second-feet. The rate of discharge through these large structures is based upon the experimental data derived from the laboratory work on small sized structures, and also the development of the law of flow through successively increasing sizes. Last March a bulletin was issued on the Improved Venturi Flume. Reports seem to indicate that this type of measuring device is gaining favor in the irrigated West, as well as many foreign countries.

In order to perfect a measuring device which is accurate and dependable in meeting conditions where small loss of head is available for measurement, and, further, to successfully meet conditions of sand and silt deposit, a device has been developed known as the Adjustable Tube Meter. It consists, in its present design, of a converging and diverging section with an intermediate throat section having a level floor and vertical side walls. The top side of this throat is defined by a horizontal plate attached to the lower edge of a vertical gate. The size of opening of the throat is regulated by an ordinary screw
lifting device. This meter is equipped with an indicating mechanism of such a type that by the simple multiplication of two indicated values the rate of discharge can be determined, these accessories eliminating the necessity of measuring depths, reference to tables, charts or curves, as is the usual practice for submerged orifices. It is expected that when this meter is fully developed, it will be able to meet conditions now beyond any of the practical devices in use where flat grades and silt deposits are contending factors.

The study on Pumping for Irrigation and Drainage consists of the study of typical pump set-ups throughout various irrigated areas in Colorado, with occasional tests for efficiencies and the cost of pumping. Particular attention is being given this season to ascertaining the relative costs of pumped water for irrigation as against ditch or gravity flow. A number of farms in Weld County are equipped with the improved Venturi flume as a means of measuring the water delivered, both from ditches and pumps, and daily records are being kept as to the use of this water on the farm.
DRAINAGE AND RECLAMATION OF WATER-LOGGED,

ALKALI, AND OVERFLOWED LANDS

by

M. H. Lewis

Due to a series of misadventures the Committee on Research on the Drainage and Reclamation of Alkali, Water-logged and Overflow Land consisting of the writer did not get going at all. As a result the present report expresses only the writer's personal viewpoint.

The most important factor in this field at this time is the increasing use of deep wells and pumps. There seems to be a field for study here as to the best methods. How deep and how large should wells be? What are the limitations of field and machine perforations in controlling sand?

The use of wells gives new point to the old question, "How far down should the water table be in an alkali area?" Most drainage engineers have heretofore been agreed that the answer was "as deep as possible"; even if they did argue violently as to how deep was possible (economically feasible). With deep wells, apparently, much greater depths are possible. More definite information should be available as to the minimum depths which will give security from alkali concentration. There is a possible connection here with Dr. Israelson's equilibrium curve. Does a water table at a moderate depth make possible a higher duty of water? If so, the minimum depth perhaps, should also be the usual depth.

The study of the reclamation after drainage of alkali lands by chemical means does not seem to be leading to very hopeful results in
the case of black lakali lands. Possibly feasible results may be secured by such cropping methods as rice growing or wild pastures, or by extremely frequent irrigation. In some areas the use of ground water carrying large amounts of calcium and magnesium has been very successful. Here again the depth of the water table is a factor of prime importance.

In the case of overflowed tidal lands there seems to be a lack of information as to the required size of tide gates. Where ocean tides alone are concerned, a mathematical analysis of the problem seems possible. Where the flood flow of streams is added to the tidal fluctuation the problem becomes impossible of strict mathematical solution, but still something better than an outright guess should be possible.

These are problems in the drainage of irrigated and overflow lands for which solutions are urgently needed. Undoubtedly, others know of other equally important questions.
INSTITUTIONAL IRRIGATION AND DRAINAGE RELATIONSHIPS

by

Wells A. Hutchins

The purpose of this report is to state in very general terms what has been and is being done under the various subdivisions of institutional irrigation and drainage relationships, and to emphasize the necessity for further research work in certain fields.

1. Irrigation and drainage laws, regulations, and customs.

Irrigation district laws.— The district laws of the several States are frequently reproduced and to some extent analyzed in reports of State engineers. Comments are usually confined to sections concerning which changes are suggested, mainly those sections covering State supervision over district activities.

In connection with a project under way at the present time, the Division of Agricultural Engineering will publish, in mimeographed form, a comparative summary of the irrigation district laws of the 17 Western States in force in 1929.

A project for future consideration involves the effect of State laws upon failure of irrigation projects. In other words, to what extent have irrigation failures been due to defective State laws, and what changes will remove this source of failure?

Water titles.— Several projects have been carried on in the past concerning water-right laws and their administration; and
much has appeared in various publications on water titles. In the past few years this question has come to the fore in discussions of interstate water problems.

The doctrine of prior appropriation is followed exclusively in eight Western States, and concurrently with the riparian doctrine in the other nine. In this latter group, recent court decisions have tended to modify and narrow the riparian doctrine in Washington and Oregon and to confine its application to ordinary stream flow and underflow in Texas; and while recent cases in California have definitely strengthened the riparian rule in that State, a constitutional amendment passed by the voters last fall endeavors to limit that rule to reasonable and beneficial uses. In other words, the trend of the times appears to be toward the appropriation doctrine.

In view of this, it is interesting to note that a prominent water law authority, whose leanings it must be admitted have been toward the riparian doctrine, in a report to the California Joint Legislative Committee upon Water Resources, squarely challenges the success of the appropriation laws in the West, declaring that attempts to divide water in kind, owing to "the hydraulic impossibility of dividing the hydraulic head," have only left "a long trail of relitigation." Many will not agree that the appropriation doctrine has been a failure. That it is not perfect in all States, however, is apparent. Therefore it is suggested that the actual operation
of appropriation statutes and administrative procedure in all of the States be carefully studied to determine their soundness after a half-century of experience under State administration of priorities.

Another closely related project is a study of the operation of laws governing underground waters. Several States now require permits to divert underground waters. It will be advisable to follow the operation of such statutes, particularly in view of the close relationship existing between the surface flow and underflow of streams.

2. Conservation of irrigation water through the merging and extension of irrigation works or enterprises having a common source of supply.

So far as known, there are no active projects under this head. A project, now temporarily suspended, was carried on for some years in Utah by the experiment station and the Division of Agricultural Engineering. Based upon the results obtained in promoting such reorganizations among mutual companies in Utah, and upon a reconnaissance of irrigation project mergers in other States, a report was prepared but not published. It will be desirable to bring this work down to date when the opportunity offers.

Aside from such comprehensive study of the technique of irrigation enterprise consolidations, the most valuable work in this field will consist of intensive studies in selected localities - for example, the Cache la Poudre, Colorado - which would appear to benefit from consolidation of enterprises having a common source of water supply. These studies will necessarily involve much extension work, as well
as the securing of new data and uncovering of new principles.


Studies of the more important types of irrigation enterprise have been conducted for some years, partly by the Division of Agricultural Engineering on its own responsibility and partly under cooperative arrangements between the Division and the States of California and Utah. Publications have been or will be issued on irrigation districts, mutual irrigation companies, and commercial irrigation companies. An exceedingly comprehensive report now in press covers the irrigation-district situation in California. Work has also been done in connection with drainage enterprises, principally relating to assessments of drainage benefits and damages. Probably the most valuable work along these lines in the immediate future will consist in revising as often as necessary the statistical information on hand, and in keeping in close touch with the effect of economic changes upon the usefulness and development of the several types of organization.

There is a valuable and only partly covered field for research in the subject of irrigation management. Most work done to date has dealt with water delivery and canal maintenance, which are only two phases of management, although very important phases. Studies on this
subject should begin with policies of the directorate, and should follow these policies through to their ultimate effect upon the water users and upon the credit and creditors of the enterprise.

4. Quantitative analysis of factors determining the feasibility of irrigation and drainage projects.

There is probably no subject in the field of reclamation economics on which there is greater need for research by workers with broad economic training and vision. Engineering feasibility has been so well worked out that few enterprises at present can be said to fail primarily from engineering troubles, provided the work has been honestly done. It is the economic and social factors which, often influenced by political considerations, have so much to do with the success or failure of an enterprise. It is only in recent years that these factors have been given really serious consideration by those responsible for initiating reclamation enterprises.

Economic studies since the War have been made by the Division of Agricultural Engineering, in cooperation with State agencies and in certain cases with the Bureau of Reclamation, in connection with proposed new enterprises and with financial reorganizations of defaulting enterprises. The Bureau of Reclamation itself has also cooperated with the States in making economic studies. This is a distinct advance over those earlier policies which laid most stress upon engineering feasibility and which in addition seldom went beyond examinations of soils. Nevertheless there remains much to be done in the matter of analyzing these feasibility
factors from a broad standpoint.

The irrigation resources in many parts of the West are clearly overdeveloped; yet there are proposed, in addition to a large number of smaller undertakings, such projects as Columbia Basin, Boulder Canyon, and California's Statewide plan. These programs comprise not only irrigation development, but flood control, power, and other industrial developments. The interests involved are tremendous. To what extent are the State and Federal governments justified in financing or subsidizing such work?

There is much honest difference of opinion on the question of State aid to irrigation. Recent experiences of Oregon in advancing interest on district bonds, and of Washington in buying bonds outright, to help new development, have been far from encouraging. Most of the Oregon districts on which interest was advanced by the State are in arrears on their repayments to the State, and several face reorganiza-
tions in which the State has legislative authority to forgive its claim altogether. A report on the venture of the State of Washington reads: "But what does the record disclose? Not only losses of State investments running into millions but actually negative results so far as real reclamation is concerned. Not a single new project has been established on a firm footing." On the other hand, Wyoming has loaned $296,000 to six irrigation districts since 1923, and the State Engineer writes that all have kept up their payments of principal and interest to date. Taking the question by and large, in view of accumulated
experiences, the conclusion seems justified that at least part of any
future large-scale reclamation financing by State and National govern-
ments must be regarded as subsidy. The extent of such financing, and
its proper timing, must necessarily depend upon proper analysis of all
interrelated factors of feasibility. Assuredly the trained efforts of
research workers are needed here; and it is encouraging to report that
at least two State experiment stations are actively engaged upon the
general problem.

5. Irrigation and drainage costs.

Much work has been done by the several State experiment stations
and by the United States Department of Agriculture on the subject of
farm costs in irrigated regions. Some of these projects have been
primarily farm-management studies that have included the cost of water
simply as one of the farm operation costs; others have laid more emphasis
upon the irrigation feature by considering the character of water right,
type enterprise supplying the water, amount of water provided per acre,
and method of delivery. Still other work has been directed toward
ascertaining all elements of the cost of water to irrigators on groups
of enterprises and under individual pumping plants.

Cost of water information is of far greater importance in
reclamation economics than in farm management. In the latter field,
that is, the water charge is only one item of expense, and is an item
on which the efficient irrigation farmer may or may not be able to
truly economize. But it goes to the root of feasible reclamation.

The annual operation and maintenance charge is not relatively important. Surveys made several years ago showed this charge to average 5 per cent of the total farm expenditures in 17 communities scattered throughout the West; and another study in Great Salt Lake Valley showed 6.4 per cent. The real concern lies in ascertaining and coordinating with other farm costs the permissible and requisite capital irrigation charge which the irrigation farmer is called upon to bear. In other words, what is the handicap of water cost, considered not only as between various sections of the West, but in relation to the non-irrigation farmer of the East?

Drainage costs have been given less attention in the past few years than formerly. That we may yet have something to learn as to feasible drainage charges, however, is indicated by certain pending drainage district reorganizations. At least one proposed study of drainage costs has been allowed to slumber because of the apparent lack of demand for such information at the present time.

6. The settlement of irrigated lands.

An abundance of material is available for the research student of land settlement and rural credits in the West. California and Washington have financed State land settlement enterprises, under irrigation conditions. The Bureau of Reclamation in recent years has
devoted much attention to the problem of securing properly qualified settlers for Federal reclamation projects. Private enterprises for which active land settlement campaigns have been conducted are numerous.

An integral part of the whole colonization problem is the problem of financing settlers. The Federal system of rural credits, valuable as it has been to operating farmers, is not designed to finance the development of raw land. South Dakota issued bonds in order to lend the proceeds to farmers at a rate of interest only sufficiently greater than the bond-interest rate to cover the overhead; but according to a recently published statement has "a special tax levy of $1,000,000 annually to check a growing deficit" resulting from its $47,000,000 venture into the field of rural credits.

Those responsible for the settlement of irrigation enterprises are coming more and more to realize that in the making of a successful settler "anyone" will not do. On certain projects there are definite standards which prospective settlers must satisfy. Rigid requirements, however, are still entirely too ideal to be general under present adverse conditions surrounding the settlement of irrigated lands.

It is generally known that heavy losses in the aggregate have been sustained by individual settlers on irrigation projects; just what the loss amounts to can not even be approximated. The turnover has been so heavy that the statement is sometimes heard that it is the third settler on a given tract who makes good after profiting by the mistakes and losses of his two predecessors. Washington and California
went into their respective land-settlement ventures on the basis of eliminating all exploitation, and of giving the original settler the financial help necessary, with every inducement to make good; yet Washington has closed out its deal at a heavy loss, with the published conclusion of the adjustment board that "the whole land settlement scheme is uneconomic, un-American, socialistic, paternalistic, and contrary to the best interests of the settlers and State;" while California has undertaken to liquidate its investment in one of its two projects.

Now what is wrong with our settlement policies? The difficulty of securing new settlers at the present time is undoubtedly closely associated with the general agricultural economic situation; but the problem of securing and financing settlers who could stay and make good on irrigated farmsteads existed long before the post-war depression. Settlement and rural credits experience in the East and Middle West will merit careful study. On the whole, in view of the existing agricultural surplus, it is difficult to see any immediate need for extensive new irrigation development. From many local standpoints, however, settlers are badly needed on enterprises facing adjustment of their bonded indebtedness as well as on numerous sound projects. Furthermore, when the need for new development again arises, there will probably be a repetition of the great economic waste involved in failures of individual settlers unless in the meantime competent research shall have solved the settlement problem.
Forenoon Session, June 18, 1929. Cont'd.

Mr. Beckett was called upon to give a report on the work done in California. He outlined the work done by Dr. Veihmeyer; mentioned the Bulletin by Professor Adams on Irrigation Districts in California; and the new project which Mr. Christiansen had taken charge of. (See Appendix, page 1.)

Mr. Murdock gave a brief report on the work done in Montana. He stated that due to weather conditions during the summer they had been able to do but very little accurate work on plant and irrigation relationship. He also stated that Mr. Monson was working on a project concerning the economics of irrigation, and is making a study of the "marginal acre-foot of water." (See Appendix, page 10.)

Mr. McLaughlin stated that the difficulty with irrigation and duty of water studies in Montana is that heavy precipitations occur in June and during the rest of the summer, and that they have had as much as 5 inches of rainfall in June.

Mr. Lewis gave a brief report on the work done in Oregon. He stated: I have recently moved from Idaho to Oregon and am finding problems there quite different. We are making a general study of irrigation and drainage problems in Baker Valley, which resembles Cache Valley, having an elevation of 3,400 feet, a comparatively short growing season and climate more severe than its elevation warrants. Quite a bit of stock raising and dairying is done. In the eastern part of the valley, there is a portion which is extremely alkaline, but conditions appear favorable for drainage by pumping.

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Mr. Lewis further stated that he had made a rough topographic map last summer and got all of the well logs he could, also tried to get financial backing for a demonstration well. He reported that Dr. Powers was working on the reclamation of water-logged and alkali land at Vale, and was making a study of underground water supply in the Willamette Valley. (See Appendix, page 12.)

Mr. Schwaalen of Arizona reported as follows: Until two years ago, our research was confined to irrigation studies. We are now carrying on duty of water studies with the Agronomy Department on cotton, having six different irrigation treatments on one-tenth-acre plots in order to determine whether irrigation really does affect the quality of cotton. Professor Smith is working on a citrus irrigation study which indicates that plots more frequently irrigated have shown best growth. We are using border irrigation and flash irrigation methods. We are also conducting duty of water experiments on lettuce, in cooperation with the Horticulture Department. The system of irrigation is to run water in furrows and keep it running for 24 hours. (See Appendix, page 16.)

Dr. Israelsen submitted a report on work done in Utah. (See Appendix, page 20.)

Mr. McLaughlin gave a report on soil moisture investigations. (See Appendix, page 22. Supplemental report on work of U. S. Division of Agricultural Engineering)

The meeting adjourned for the noon hour to meet again at 2:00 p.m.
Afternoon Session, June 12, 1929.

Present:


The meeting was called to order by Mr. McLaughlin.

Mr. Clyde gave a report on his mountain hydrology studies. He outlined methods used; gave a history of snow measurements and development of methods for measuring; explained methods of determining winter precipitation and correlating it with run-off. (See Appendix, page 27.)

A discussion of Mr. Clyde's paper followed, in which Messrs. Beckett, Lewis and Clyde participated. This discussion touched upon "Watershed characteristics" affecting run-off, the effects of forests on run-off, correlation between precipitation in valleys and on mountains.

Mr. McLaughlin suggested at this time to take up the regular program, and that Mr. Beckett's report would be discussed.

Mr. Beckett reported: In 1925, we went into Southern California in cooperation with the Division of Agricultural Engineering of the United States Department of Agriculture to determine what the economic duty of water would be in that area. The first season we started with one-fourth acre plots with a liberal number of soil samples taken at two and three week intervals in an attempt to find out the shape of the soil moisture curve between irrigations. We got entire loss for 6 feet of
soil on 30-day basis. We are therefore able to draw reasonably consistent transpiration curve.

A discussion on soil moisture followed:

Beckett: Have definite chart to 6 feet depth (explaining curve on the board). If there was much movement through the soil, we would be able to detect it by frequent sampling.

Lewis: There is still a possibility that some moisture is going down all the time. In normal irrigation there is a downward loss.

McLaughlin: Position of water table had no effect on this proposition. I agree with Dr. Israelson that moisture can go through and not leave a trace. Moisture can not go through the soil and not leave a trace if the soil is nearly dry.

Schwalen: If you have a bare field and take soil moisture, the total moisture in the first 6 feet will almost make a straight line.

Murdock: How far below the 6-foot level will you find this dry condition?

Beckett: Depends on the method of irrigation and cost of irrigation water.

McLaughlin: Our results show no movement of moisture when the percentage is near the wilting point, although equilibrium has not been reached.

Beckett: (Explained with a chart on the board some transpiration curves for cotton, walnut trees and citrus and said that these curves would correlate with evaporation curve.) Knowing the water holding capacity of the soil you can determine the total seasonal water requirement from our work. We have even tried to correlate the size of the tree with the monthly

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losses of soil moisture. This brings up the old question of the efficiency or irrigation. About 70 per cent is the highest efficiency we found. From that we get remarkably consistent figures of total seasonal requirement. The rate of water extraction is in direct proportion to the percentage of mass of soil moistened. In the spring all of this is up to the same moisture content. When the soil in here (referring to chart) reaches the wilting point no increase in the rate of water extraction occurs. Our work merely indicates these facts to be true, whether they are or not.

Parshall: Wouldn’t that limit the growth of the plant?

Beckett: Take this area (illustrated by chart drawn on board) and irrigate it consistently throughout the season, by June it reaches the wilting point. Irrigating in the same zone gives dry and wet areas.

McLaughlin: Why select one tree? Why don’t you take the whole orchard?

Beckett: (Placing another chart on board). That is the way the holes are located around four trees. Now you say we could take this single tree and compare losses. We found that we got the most consistent results by taking these four trees.

Lewis: What about the plant side of that?

Beckett: Nothing. We are trying to answer the question, “What is the reasonable water requirement.” (Discussing Veihmeyer’s work).

McLaughlin: We have been studying the type of oven to use in making moisture determinations. Also have been studying sampling tools. Taylor asked for a truck and an air hammer, with which he said he could do more work in one hour than he could in five hours with the hand outfit.
Beckett: Who in this gathering are doing soil sampling?

At this time a question came up if sampling before and after irrigation mean anything.

McLaughlin: With frequent sampling we find that on a certain day the soil reached the wilting point. By adding one-half more moisture would keep above wilting point. Sampling before and after does not tell the whole story.

Parshall: Seems to me like it would be a fine thing if a mechanical apparatus could be worked out to sample almost automatically.

Lewis: How do you determine the cross-section of the wilted zone?

Beckett: Go down into soil.

Mr. Parshall was called on to report.

Parshall: The work in Colorado is more in the hydraulics of irrigation. In regard to the section assigned to me I have taken Mr. Beckett’s viewpoint. We have been giving much attention to evaporation from free water surface, and soil moisture losses by evaporation. Work done last year on studying soil moisture evaporation is the third season of the study. From sands we find for one inch water table the evaporation is the same as for a free water surface. From black alkali soil we found 80 per cent amount of evaporation from free water surface. We found that in fine sand the rate of evaporation is the same as from free water table. The scheme for maintaining constant water level in evaporation tanks was developed by Mr. Rohwer and Major Stout and passed on to us.

Beckett: What variation do you get in individual tanks under similar conditions?
Parshall: We had four soils that were nearly the same. Those carried for one year. I might tell of the work we are doing this season on this experiment. We have reset some of the tanks. We had a 1", 6", and 12" water table before and now we have 6", 12" and 18" below the surface. We are using sandy loam soil. (Illustrated tanks on the board) We took a sedge grass out in circles of sod of equal area. In the 18" tank we had sedge sod. Now trying to get sod to find out relative transpiration of these two sods. (See report, page 12).

Winnor: What is the relative height of the sedge?

Parshall: Sixteen inches.

Winnor: Is it tule? That is a common plant in our marshes. Your experiment dovetails with our work.

Parshall: There is not a great deal of difference in blue grass and sedge. We will have to assume that no evaporation loss since it is covered with sod. At any rate it is relatively small. Charge to transpiration loss direct. We are carrying two fallow tanks. Fallow losing 2" per week. Blue grass shows 2".

Clyde: What about the contact between sod and soil?

Parshall: Sprinkling to make contact.

Winnor: I would rather see you eliminate the 6" and 12" in order to have condition as on our swamp areas. Bulrush and tule will grow best with water at surface.

Parshall: Won't get real growth on these. Heretofore have attempted to protect pot with covers. Now we have decided to let 'er rain.

Winnor: Could you add another six tanks?
Parshall: They cost about $50 apiece. $15 to install one tank.

McLaughlin: (Talking of tanks used at San Bernardino.) Tanks placed by forcing into soil with jacks.

Magness: What are they made of?

McLaughlin: Galvanized iron, 16 gauge.

Winsor: (Told of Bear River Bay Bird Refuge work.) We are trying to determine how much country we can flood. The limiting factor is the water supply. We are making swamp lands instead of draining them. Trying to check up on evaporation loss. We want a closer check on losses. The work is in the beginning.

At this time there was some discussion about adjourning and it was decided to hold conference till 6 o'clock. Five minute recess.

Mr. Parshall: (Reported on study made on the evaporation on free water surface, which is being conducted by Mr. Rohwer.) Became interested in this project in 1914. Have since that time made an extended series of studies of evaporation from free water surfaces. Attempted to measure loss by weighing. Inaccuracies overshadowed losses and results were of little value. We then got a tank 3 feet square and 10 inches deep. We placed the pan in a room where the air was still. We worked out a scheme of measuring loss by means of an apparatus which determined changes in water level. So sensitive was the apparatus that we were not permitted to go near the tank because of vibration on concrete. We took observations by means of transit. We could sit there at telescope and see hair keep creeping up scale. Took observations every hour for 30 hours. Were able to pick out relation of vapor pressures. We found that the rate of evaporation was at a maximum.
at between 5 and 7 o'clock in the morning. Our work was conducted both
in the laboratory under controlled conditions and also outside in small
tanks. We verify the theory of evaporation of John Dalton, the pioneer
evaporation worker of 1803. The wind factor was determined by building
a wind tunnel having at one end a one-fourth H.P. electric motor with
four bladed fan mounted directly on shaft. At the end of the tube we
placed an evaporation pan. Measured rate of wind and took observations.
Same as under still air conditions. Fits very well with actual observed
values from laboratory.

There was established in Denver in 1916, a field laboratory in which
a great variety of tanks was installed. Developed curve showing rate of
evaporation and size of tank. Later at Fort Collins we were permitted to
spend $3500 in putting copper lining in large concrete tank, which resembled
a large wash bowl. Carried on observations for three years in copper lined
tank, which was 85 feet in diameter. We find there is a little difference
between rate of evaporation in an 85-foot tank and in a 12-foot tank, which
proves that Sleight's curve is correct. It is of interest to know the rate
of evaporation from a small land pan as compared with the actual loss from
a reservoir.

Observations were made on evaporation from ice. Very difficult to
get suitable conditions. Data check in very consistently with Dalton's
theory. Observations were made at Imperial, California, at 68 feet below
sea level, Nebraska at 1150 feet, Logan at 4778 feet, Fort Collins at 5,000
feet, Lake Tahoe 6255 feet, Vistor, Colorado at 10,069 feet and at summit
of Pikes Peak at 14,129 feet. On high elevations assumed that evaporation
greater. We set up a tank in the laboratory and put on .2 or an inch of transformer oil to eliminate evaporation and took readings to find out the effect of changes in temperature on the tank, water, etc. The effect is less than 5 per cent.

If any of you have had occasion to look over J. R. Freeman's report you will remember that he said that evaporation is greater in winter on the Great Lakes than in the summer. We found that when water is warm, and air cold, the maximum evaporation occurs. John Freeman seems to have made a correct assumption.

At this time Dr. E. C. Peterson, President of the Utah Agricultural College, came into the meeting and was introduced by the chairman to each member of the group. President Peterson said he came in as a listener and to personally extend to those present the facilities of the institution. He also expressed his hearty approval of such group meetings and the contacts they afforded.

The meeting adjourned until 9:15 the next day.

Morning Session, June 19, 1929.

Present:

W. W. McLaughlin and W. A. Hutchins, California; (U.S.D.A.)
S. H. Beckett, California; George Hardman, Nevada; H. Beresford, E. H. Neel,
H. P. Magnuson, Idaho; H. W. Schwalen, Arizona; M. R. Lewis, Oregon;
R. L. Parshall, Colorado; C. W. Israelsen and G. E. Clyde, Utah.

Mr. McLaughlin called the meeting to order. He asked Mr. Hutchins to discuss the institutional side of irrigation problems.

Mr. Hutchins gave a report (See report by Wells A. Hutchins, page 18).
The reference to statutes requiring permits to divert underground water caused considerable discussion, in which Messrs. McLaughlin, Clyde, Parshall, Hutchins, Lewis, Beckett, and Schwalen participated. Mr. Beckett emphasized the practical difficulties in supervising appropriation of underground waters. Parshall brought out the effect on other appropriators of operation of one's own pump.

Beckett: We haven't been able to settle the water rights question in 20 or 30 years of litigation - can we ever do anything about anything so undefined as underground flow?

Hutchins: The difficulties are great, but some brake must be applied on unrestrained pumping. If there had been some organized plan of granting permits 50 years ago the present critical situation in over-pumped areas in California could have been avoided. If California had followed the advice of William Ham Hall much surface water litigation would have been saved. The underground water damage is already done in parts of California, and other States should benefit from California's experience.

Lewis: Isn't it feasible to say that in Santa Clara Valley when the water table gets down to the economic limit we must stop further development by pumping?

Schwalen: You can't determine in a pumping district just where to stop granting permits.

Hutchins: You could require consideration by the State engineer before the permit is granted. When the water table in a defined area is permanently lowered to a point at which existing appropriators are being seriously interfered with, then - no more pumping plants in that area. The legal and physical
difficulties are very great, but that is no reason why the problem
should not be tackled. As it is now, every man who puts in a pumping
plant is at the mercy of every one who follows him. He has no
protection whatever.

Clyde: You can determine the annual recharge and permit with-
drawal on this basis.

McLaughlin: If other states don't start on the problem pretty
soon, they will be in the same predicament as California. After tonight's
talk by Director William Peterson, the problem may not seem so formidable.

The question of having a definite plan of land settlement is an
important one. For instance the Grant's Pass district will, I think,
pay dollar for dollar on their debt. The land was originally owned
chiefly by a large company. Have maintained a land settlement organ-
ization in Chicago to send out settlers. I think they will pull out
because they have a well defined land settlement policy. Optimistic
estimates on feasibility of districts bring about the proposition of
the third settler making good on the land. Six hundred thousand farmers
left the farm last year, yet modern machinery and methods made it
possible to keep up production. It is doubtful if any defaulting
Oregon project outside of Grant's Pass will pay dollar for dollar.
Agricultural Experiment Stations and U. S. Department of Agriculture
do definitely contribute to the solution of feasibility problem.
Hutchins: None but the California station has attacked the problem as a research problem. Arizona, Oregon, and Utah have all done work designed to settle difficulties on specific enterprises, but so far as I know no State except California has actually made analytical studies of the fundamentals of the feasibility problem. Most of the work done so far has been more in the nature of extension work.

McLaughlin: The Bureau of Reclamation has called in State agencies in many States to make a feasibility study of definite proposed projects. The first study conducted by the Department of Agriculture for Reclamation Service was on the Baker project. Montana called in the farmers to discuss the problem. It was done under the leadership of the Extension Service. Latest information indicates that they are getting along better than under no set up.

Clyde: There is no doubt but what Station can do much to determine feasibility of proposed projects.

McLaughlin: We outline a plan for districts in trouble, to follow. We set down in figures what we think the land can produce and then the expense which is to be expected. We have tried to be reasonable in estimates and yields.

Clyde: Do requests come from the bondholder or user?

McLaughlin: Both.

Beckett: To what extent is the Utah Station used in determining feasibility of projects?

Clyde: They don't ask for information until they get into trouble.
Hutchins: The general liability feature of State irrigation district laws has not been a cause of failure of districts, but has aggravated the case after default started. Has been a contributing rather than original cause of failure. Laws could be changed in reference to receivership.

Clyde: If hadn't had general liability couldn't have formed the Cache County Water Conservation District. Bondholders would never come in unless there was blanket liability. Districts in Utah have all been organized with narrow margin.

McLaughlin: Our policy is not to go into a district if there is opposition from an interested party. Will not accept invitation by landholders without permission of bondholders. In Oregon they have a very active reclamation commission. They are taking the initiative.

At this time there was a discussion on moisture equivalent by Messrs. McLaughlin, Beckett, Lewis and Murdock, which brought out the work done by Dr. Weihmeyer again; the use of mechanical analysis; and the conclusion was reached that it was an important study, and should keep on determining moisture equivalents. The next 30 minutes was turned over to Mr. Lewis.

Mr. Lewis suggested some fields of study. Stated that there is a very great possibility in further emphasis on drainage of irrigated lands by the use of pumps, and that a project on the amount of drawdown at casing in wells had been taken charge of by Mr. King in Oregon. He has found that very little difference in drop here between casing and screen, not more than 1/16 inch and another where the opening is 5/16 of an inch. Mr. Lewis outlined the problem of flood control along the rivers in his section (See report on work done in Oregon, page 16).
McLaughlin: Lewis' problem on flood gates is really a civil engineering problem.

The members accepted an invitation extended by Mrs. Winsor and Mrs. Israelson to a luncheon at the Winsor home.

Meeting adjourned.

Afternoon Session, June 19, 1929. Mr. R. L. Parshall presiding.

Present: The members of the forenoon session.

Professor Magnuson gave a brief report on work in Idaho.

Magnuson: The project in Idaho is a cooperative one between several departments and the Division of Agricultural Engineering of the U. S. Department of Agriculture. We have a tract of 25 acres and are trying out nearly all of the methods. We have an open drain on the tract. (Illustrating on board). We found that there was a water table of from 3 to 3 feet and a water table above impervious layers of from 0 to 20 inches. As a result of our studies we decided that we could probably get the water through highly impervious layer if we lowered the water table enough. We have blasted subsoil and find that troublesome layers run together. Two plots were ponded for periods of 20 months and a record of water put on kept. The first year we put 2 acre-feet of water through, and the second year, we were able to push through 7 acre-feet of water. Two crops are being used, Zawadke's grass and strawberry clover. They grow quite well. We are concerned with the tolerance of plant for alkali and not necessarily the tolerance of soil for alkali. (See Appendix, page 31. Also report by E. H. Neal, page 39.)

Parshall: Is there any discussion?
Beckett: How about the quality of water?

Macnuson: Very good water.

Lewis: What is the series of methods you are using?

Macnuson: Have had success with this procedure - made plots on one-half acre covered with manure in fall and sowed with sweet clover on top and get almost a full stand over extremely heavy concentration of alkali.

Mr. Parshall asked Mr. Hardman to report on work done in Nevada.

Hardman: At the present time most of the experiment station funds in Nevada are devoted to livestock problems. Comparatively small portion of our funds devoted to irrigation and soils. We have one project on alkali. The soil is heavy in lime. We have taken as high as 30 per cent out by leaching. We have a problem of soil building.

Parshall: It was the intention of Mr. McLaughlin to bring out methods and standards along with the other discussions. If anyone has any specific problem that they want information on, now is the time to get it.

Murdock: We are starting a new project on economics of irrigation. Are making a study of the marginal acre-foot of water. Many farmers are dry farming on irrigable lands. The problem is to study beneficial effect of the acre-foot of water under these conditions and determine if the farmer will be justified in expanding money to get the water. We are going to proceed by questionnaire method.

At this time there was some discussion on farmers keeping record.
Parschall: It is about time we select our next meeting place and elect the new officers. I feel that the duties of chairman would be better handled by definite assignments and early appointment.

It was decided not to modify the outline of irrigation research prepared in 1925.

A motion was made by Mr. Hutchins that the question as to whether the committee chairman be elected or appointed be settled before the new president is chosen. Seconded and carried.

It was decided to call the committee leaders coordinators instead of chairmen. Moved and seconded that the group elect the chairman of the standing committees including:

I. Soils and Irrigation Relationships
II. Plant and Irrigation Relationships
III. Irrigation Water Supply and its Physical Control
IV. Drainage and Reclamation of Water-logged, Alzali and Overflow Lands
V. Institutional Irrigation and Drainage Relationships.

Moved, seconded and carried that the existing chairman of committees be appointed for ensuing two years as division coordinators including the following:

1. O. W. Israelson, Utah (G. E. P. Smith reserved for chairman of group)
2. S. H. Beckett, California
3. R. L. Parschall, Colorado
4. M. R. Lewis, Oregon
5. W. A. Hutchins, California.

Committee on Experimental Methods and Standards consists of three representatives from Western experiment stations and one from the U. S. Department of Agriculture. Moved, seconded and carried that this committee be appointed by new chairman.
Nominations were opened for chairman. Dr. G. E. P. Smith of Arizona was nominated, seconded, and unanimously chosen as chairman.

Mr. Beckett said that he would like to see Dr. Israelson on Committee I.

Mr. Schwalen moved that Dr. Smith be relieved of the chairmanship of Committee I and that Dr. Israelson be substituted. Seconded and carried.

Moved, seconded and carried that the name of committee chairman be changed to division coordinator.

Mr. Murdoch was elected as secretary.

Moved, seconded and carried that the acting chairman make the appointments.


The question came up where the next conference would be held.

Mr. Parshall stated that Director Gillette extends an invitation to come to Colorado, Mr. Beckett California, Mr. Beraford Idaho, Mr. Schwalen Arizona - either Tucson or Phoenix. Only obstacle increased cost.

Mr. Parshall also spoke of expense and wanted to shift meeting around to different stations.

Moved and seconded that selection of time and place for next meeting be left until it is determined if meeting can be held at or near the same time of newly organized association of State Engineers or Western Association for Advancement of Science, the final selection to be made by ballot of the several states. Carried.

Vote of thanks to the local representatives and institutions for the excellent entertainment.
Business concluded.

Friday was spent in a field trip through the Cache Valley, visiting drainage and irrigation projects including the experimental work being conducted in the floor of the Valley by the Utah Experiment Station in cooperation with the Division of Agricultural Engineering of the United States Department of Agriculture.

At the invitation of the Utah delegation, the group met in the evening at a banquet. Professor Wm. Peterson, Geologist and Director of Extension, gave a very interesting discussion of ground waters and the best methods of determining their quantity. He dwelt at some length upon his research work on underground hydrology.
APPENDIX

Report of
Biennial Convention
WESTERN IRRIGATION AND DRAINAGE RESEARCH ASSOCIATION
Held at
Logan, Utah
June 18, 19, and 20, 1929.
OUTLINE OF INVESTIGATIONAL WORK OF THE
DIVISION OF IRRIGATION INVESTIGATIONS AND PRACTICE,
COLLEGE OF AGRICULTURE, UNIVERSITY OF CALIFORNIA

by

S. H. Beckett

Since the adoption of the outline classifying Irrigation and
Drainage Research as presented at the first conference of the Western
Irrigation and Drainage Research Association held at Berkeley in 1925,
the experimental projects of this Division were revised to conform, as
nearly as possible, to the adopted outline. Since that time, new pro-
jects have been so written that each of them comes under one of the
several subheadings in the outline.

Following is a brief description of the active Irrigation
Investigations projects of the California station, the methods used,
the project leaders, and a brief statement of some of the more important
results obtained.

SOIL AND IRRIGATION RELATIONSHIPS.

Project No. 745 A. Principles of soil moisture in relation to
irrigation. Veihmeyer. A general study of basic principles under-
lying the movement of water through soils and their water-holding
capacities in relation to depth of irrigation. A study of the moisture
equivalent method has been made and suggestions for standardization of
procedure have been published. In addition to this, a special speed-
control device, adapted to the moisture-equivalent machine, has been
devised. An instantaneous reading atmometer and temperature coefficients
for its use have been worked out.
In connection with the studies of the ratio of wilting coefficient to moisture equivalent, different depths of water have been measured on 8' x 8' plots in the predominate soil types and, by means of intensive sampling at 24-hour intervals after irrigation, the effect of depth of application on soil-moisture content is being studied.

PLANT AND IRRIGATION RELATIONSHIPS.

Project No. 653 A. Moisture requirements of deciduous orchards. Veihmeyer (cooperating with the Division of Pomology). In this project, studies are being made on the relation of time and depth of irrigation and the resulting soil-moisture content to the quality of canning peaches, the work being carried on at the two principal canning peach sections of the Sacramento Valley (Yuba City and Modesto). As a result of this work conclusions have been drawn that as long as the principal portion of the soil mass occupied by the root system of the trees is above wilting point no effect is shown on the equality of the canned fruit. The results of these studies are now being prepared for publication. Phenomena relating to the wilting of plants, the question of drought resistance, and the relation of soil moisture to root development are being studied.

Project No. 633 B. Irrigation studies with Delchi Muir peach orchard. Veihmeyer (cooperating with the Division of Pomology). This project was concluded at the end of the 1929 irrigation season and consists of 6 years' work on the relation of irrigation to the growth
of trees, the yields and quality of the fruit, especial attention being paid to the effect of the varying irrigation practices on the quality of the dried fruit. A manuscript covering the results of this work has been prepared.

Project No. 632 C. Orchard irrigation studies at Davis. Veithmeyer (cooperating with the Division of Pomology). This includes work on all of the irrigation orchards at Davis, comprising a mature prune orchard of 3.5 acres on which 5 year records have been secured; plantings in field 7, including 9 acres of French prunes, 7 acres of Phillip Cling peaches and 5 acres of Concord walnuts. These trees were planted in 1923, and measurements of growth have been obtained from individual trees in order to determine the variability in different portions of the orchards before starting differential treatment.

Project 630 A. Rice investigations in the Sacramento Valley. Dunahue. In 1922, studies were begun at Cortina in the Sacramento Valley of weed control by means of continuous submergence following seeding. This work is being continued together with the rice fertilizer tests and pot studies at Biggs on the effect of different depths of submergence on the rice weeds, this work being in its third season. Tank studies are also being conducted at Biggs to determine the various proportions of water applied to rice fields that are used in transpiration, lost by evaporation, and lost by percolation. This work is in its fourth year.
Project No. 747. Duty of water investigations in the Sacramento Valley. Adams and Huberty (cooperating with the Division of Agricultural Engineering, U. S. Department of Agriculture, and the Division of Engineering and Irrigation, California State Department of Public Works). Within the past 5 years, about 25 fields have been under observation, during a period of from one to three years each, these fields being quite uniformly scattered between Winters and Red Bluff in the Sacramento Valley and near Penryn in the Sierra foothill section. These studies deal primarily with consumptive use of water by orchards, vineyards, and field crops. Small tracts of about one acre each were selected from representative fields and by means of intensive soil sampling, a continuous record was obtained of the existing soil-moisture content throughout the season. Standard practices of the locality as to the time and depth of irrigation were followed in applying water to the plots. The results of these 5 years' observations are now being prepared for publication. In this publication, conclusions are drawn concerning the irrigation needs of small grains, corn and grain sorghums, rice, deciduous orchards, and vineyards.

Project No. 799. Economic field duty of water in southern California. Beckett (cooperating with the Division of Agricultural Engineering, U. S. Department of Agriculture, and the Division of Engineering and Irrigation, California State Department of Public Works). In 1929, this work was transferred from San Diego County in southern California to the citrus area of Orange County. The methods
used are substantially the same as those reported at the 1927 conference. A sized plot, consisting in the area cornered by four trees, has been uniformly used during the past two years of these investigations. Each set of soil samples taken at two-week intervals consists of samples taken at one-foot depths from 17 permanently located points within the plots. The results of this intensive sampling is used as a basis for determining the time and frequency of irrigation and the economic and seasonal water requirement for citrus groves in southern California. The results of the first two years' work carried on in San Diego County is now ready for publication.

Project No. 816. Investigations of the irrigation of cotton in California. Dunahoe (cooperating with the Bureau of Plant Industry, U. S. Department of Agriculture). This work is being conducted at the U. S. Cotton Experiment Station at Shafter, California. Variable irrigation treatments to field plots and intensive soil sampling are used as a basis for determining the consumptive use of water by the crop and the total seasonal economic requirements. The effect of this variable irrigation treatment upon the flowering, shedding, quality of the fiber, and yields is also being observed. The variable irrigation treatments, as carried on in the plots, is being duplicated in large tanks in which the soil mass occupied by one plant is equivalent to that occupied by one plant in the field. A close correlation between the use of water from the tanks and from the field plots is being obtained. This work is in its third season, with no results of the investigations having been published to date.
In addition to the above, plot variability under uniform treatment is being observed at the University Farm in three blocks, each containing one-sixth acre, which have been under uniform cropping for six years in an attempt to obtain plot variability before starting differential irrigation treatment. The inconsistent results obtained necessitates a continuation of the observations.

Also, controlled tank experiments on the relation of yield of alfalfa to soil moisture content are being conducted. These experiments are designed to secure data on the growth of alfalfa as related to soil-moisture conditions to be used in interpreting results of studies on the consumptive use of water by alfalfa. Previous work by this Division (Hilgardia, Volume 2, No. 6) has shown that deciduous fruit trees can use water from the soil with equal facility even though the soil-moisture content may vary between the maximum field capacity to about the wilting coefficient. Consequently, tests are being made with alfalfa plants. Some tanks are being irrigated when the soil-moisture percentage is reduced to a little above the wilting coefficient, others when reduced to approximately one-third between moisture equivalent and wilting coefficient, others when reduced to approximately two-thirds between moisture equivalent and wilting coefficient.
IRRIGATION WATER SUPPLY AND ITS PHYSICAL CONTROL.

Project No. 779. Pumping for irrigation in California. Adams and Givan. This includes studies of adaptability of different types of pumps to various pumping conditions, well construction, and the investigation of the various phases of underground water supply. Work started in 1925, discontinued in 1926, and taken up again in 1929.

Project No. 860. Improvement of farm irrigation structures. Beckett and Christiansen. This project was started in 1929, and includes a field study of the various types of structures and their adaptability as used in the delivery and control of irrigation water. Special attention is being given to obtaining practical information concerning the construction and use of structures used in developing the farm water supply. Later, it is intended that this work shall include the design and installation of concrete pipe systems on the farm.

IRRIGATION AND DRAINAGE RELATIONSHIPS.

Project No. 854. Community irrigation movements in California. Adams. This study, completed in the spring of 1930, includes a historical, statistical, and economic study of the California Irrigation Districts. The information was obtained in cooperation with the State Department of Public Works and publication of the results by the California State Department of Public Works is now in press.
RECENT PUBLICATIONS.

Circular 312, Principles governing the choice, operation and care of small irrigation pumping plants, by C. N. Johnston. 1928.

Bulletin 450, Irrigation investigations with field crops at Davis, and at Delhi, California, by S. H. Beckett and M. R. Huberty. 1928.


Soil Science, Vol. 25, No. 6, A simple speed controller, especially adapted to the moisture-equivalent centrifuge, by F. J. Veihmeyer and C. V. Givan. 1928.


Proc. Placer County Fruit Growers' Seventh Annual Convention, Auburn, California, October 25, 26, 1927, p. 7-20, Some relations of soil moisture to growth and quality of canning peaches, by A. H. Hendrickson and F. J. Veihmeyer.


Hilgardia, Vol. IV, No. 4, Soil moisture and root development, by J. P. Conrad and F. J. Veihmeyer.

Davis, California
July 16, 1929.
IRRIGATION INVESTIGATIONS IN MONTANA

DUTY OF WATER

by

H. E. Murdock

An 80-acre farm had been used for irrigation experiments and demonstrations at Valier in north central Montana. This is in what might be called marginal area as dry land farming in this district usually gives good returns. Under these conditions, irri-
tation farming does not receive so much attention as it does in a humid area where farming depends entirely on irrigation. The last two years there was so much rainfall on the irrigated plots of the farm that no duty of water data could be obtained. It was impossible to control the variable factor so as to get data showing variation of yields with depth of water applied. As a result the experiments were discontinued and the farm turned entirely into a demonstration farm.

IRRIGATION VERSUS DRYLAND FARMING

This is a new project on which Mr. Monson is at present working. Visits are made to the irrigation farmers and a questionnaire filled in giving data on costs of producing crops on irrigated and on non-irrigated land where both kinds are produced. Other information is also called for on the questionnaire.

SEEPAGE FROM CANALS

This is a project started twenty years ago. Data were collected at that time in many sections of irrigation ditches and canals, but no
bulletin had been written giving the results. After the lapse of 16 or 18 years, the work was revived and seepage measurements taken on the same stretches of ditches and canals for comparison with the former results. It is planned to start in at the head of a canal system and follow it through to the end and check up on all sections.

GENERAL INVESTIGATIONS

The department is frequently called upon to do work other than that outlined in specific problems in both irrigation and drainage. To take care of this kind of work, we have general projects in both irrigation and drainage.
IRRIGATION AND DRAINAGE RESEARCH IN OREGON

by

M. R. Lewis

The program of irrigation and drainage investigation in Oregon for the past two years has included extensive rather than intensive studies in the Grand Ronde, Willamette, Baker and Coquille valleys as well as the continuation of the duty of water and rotation studies at Corvallis and the alkali reclamation work at Vale. The determination of the economic status of the irrigation districts of the State is also a very important line of work.

GRAND RONDE VALLEY

During the summer of 1927, Mr. T. C. Adams, working under a cooperative agreement between the Oregon State College and the Division of Agricultural Engineering, made a study of the drainage problem in the southern part of the Grand Ronde Valley. Mr. Adams made a survey of the area to determine which portions were in need of drainage as indicated by the vegetation and by the alkaline reaction, if any, of the soil. He also made a reconnaissance of the possible outlets for deep gravity drains from certain areas and of the geological conditions causing the present topography and their relation to the drainage problem.
Last summer and this, Mr. A. M. Piper of the United States Geological Survey, working in cooperation with the Experiment Station, has been making a study of the geology of the Willamette Valley with a view to determining in what areas and to what extent ground water may be available for pumping for irrigation. This valley is, of course, by far the most important agricultural area in the State. However, in spite of a normal annual rainfall of about 44 inches at Corvallis, crop production is seriously handicapped by the summer and early fall drought.

A decided interest in underground water is evident in all parts of the State and the people of various other localities are urging that similar work be undertaken in their areas.

BAKER VALLEY

The writer, continuing the cooperative work done by Mr. Adams, has spent the major part of the past year making a general study of the irrigation and drainage problems in the Baker Valley. At its inception this work contemplated the reclamation of a comparatively small area of lands rapidly being abandoned on account of alkali. Since the water supply for these lands was very deficient and the drainage and irrigation problems were, as usual, so inextricably related, a general study of the problem for the whole valley was proposed and approved by the County Chamber of Commerce which is assisting financially in a small way.

The study as outlined includes a rough topographic map of the valley, a water table study extending over a year and a half, a
vegetation and an alkali survey, a geological reconnaissance, limited surface water supply studies and the drilling and pumping of test wells. One well is now, July 12, 1929, under contract and much interest has been aroused in the proposed plan of pumping for drainage and supplemental irrigation.

COQUILLE VALLEY

In the Coquille Valley the extremely high rainfall, 100 inches at 1000 feet elevation and above, and the topography are such as to create what seems to be an insoluble flood control problem. Complete relief from floods which occur perhaps once in four years appears, on preliminary study, to be economically infeasible. For the extreme floods there seems no possible solution.

DUTY OF WATER

Irrigation trials aiming at an answer to the question of the most economic use of water per unit of crop production, as reported by Dr. Powers two years ago, are being continued.

ALKALI RECLAMATION

The alkali tracts at Vale are still being operated with some enlargement in the number of treatments used. On the basis of cost as compared to results obtained, repeated irrigation on pasture plots is the best treatment yet found. On the cultivated plots the checks are still barren. Sulphur seems to be the most effected chemical treatment used.
FEASIBILITY STUDIES

Last but by no means least in importance, have been the investigations made by the Oregon Experiment Station, the Division of Agricultural Engineering, U. S. Department of Agriculture, and the Oregon State Engineer's Office in the effort to find a fair basis for the reorganization of the finances of a number of irrigation districts which have defaulted on bond, interest, or principal. The soil of the projects, the results obtained by the farmers on the project during the past several years, and the physical properties of the districts including the water supply were carefully inventoried. On the basis of these studies recommendations were made as to a proper basis of settlement between the bondholders and the settlers. It is believed that much good will come of this work.
BRIEF REPORT OF THE PROJECT WORK
IN IRRIGATION BEING CARRIED ON IN ARIZONA

by

H. C. Schwalen

The Agricultural Engineering Department is carrying on the same
two projects in Duty of Water as reported by Professor Smith two years
ago. Both of these are cooperative projects with the Horticultural
Department, and come under the heading of Soils, and Plant and
Irrigation Relationships.

The citrus irrigation work was started with a new grove on the
Yuma Mesa and the work has necessarily been of a preliminary nature.
Professor Smith has gone into detailed study of the measurement of
soil moisture in the particular type of soil on the Yuma Mesa and its
water holding capacity. He has also found that irrigations even in
the middle of summer have had the effect of reducing the temperature
in the root zone about 3 per cent and he thinks this may be of great
importance as the temperature of the soil in the summer is very close
to the critical temperature for the growth of citrus. So far the
plots having the more frequent irrigation treatment have shown the
most rapid growth, although none of the plots have been allowed to
suffer from lack of water. Professor Smith now has ready for publica-
tion a report on the results of the preliminary work he has carried
on at Yuma and we hope it may be ready for distribution at an
early date.
The lettuce irrigation work is carried on at the Mesa Station in a clay loam soil of fairly uniform texture with a water holding capacity of about 18-19 per cent and a wilting point of approximately 11 per cent. The plots are 0.12 acres in area, as nearly level as possible, and are run in duplicate; the water is measured to each plot through 90° V-notch weirs. The furrows are 44 inches apart with two rows of lettuce on each bed. The time of irrigation is determined by the moisture content of the plots for which purpose soil samples were taken in the lettuce rows at the upper, center and lower end of each plot.

As nearly as possible the following treatments were given:

1. Soil to be kept by frequent irrigations up near the field water holding capacity during entire period of growth.

2. Soil to be kept near field water holding capacity up to bunching stage and then allowed to dry out.

3. Soil to be allowed to drop to about 14 per cent moisture before irrigation throughout the season.

4. Soil to be allowed to approach wilting point before irrigation up to the bunching stage and then frequent irrigations are applied to keep it near the field water holding capacity.

5. Soil allowed to approach wilting point before irrigation throughout the entire season.
At harvest the following data were secured:

1. Total number and weight of heads harvested.
2. Total number and weight of marketable heads.
3. Compactness figures on 100 heads of each plot.
4. Total number bursted heads.
5. Total number slime heads.
6. Per cent of plants not heading.

Under the classification of Irrigation Water Supply and its
Physical control we have a project on the study of the movement of,
the effect of pumping, and the recharge to the ground water is
being carried on below Tucson on the Pima Farms Company project where
we have in one group about 30 pumping plants supplying water to
about 9,000 acres of land. At present we are hoping to finish up
the field work on this project if we have a rainy summer with
resultant heavy floods so we may be able to determine how much
recharge may be expected from this source. The series of drouth
years has prevented us from securing this necessary data to complete
the project.

The project on pumping machinery has been inactive for the past
two years and except for calls from the various county agents will
also remain dormant for the next few years.
In addition to the work of the Agricultural Engineering Department, projects are being carried on by the Agronomy and Horticultural Department which would come under the classification of Plant and Irrigation Relationships.

The Agronomy Department on one-tenth acre plot is carrying on work on the effect of irrigation at the different stages of growth on cotton with particular reference to the length and quality of lint. They are taking soil moisture samples before and after irrigation but have only one series where the time of irrigation is governed by the percentage of moisture in the soil.

The Horticulture Department has for several years been carrying on an experiment to determine the effect of time of irrigation upon the size, quality and crop yield of Thompson Seedless grapes. Soil moisture samples have been taken before and after irrigation but not with a view of determining the time of irrigation by the moisture content of the soil.
RESEARCH PROJECTS

Utah State Agricultural College, Logan.
Agricultural Experiment Station

by

O. W. Israelson

Project No. 15. Title: Pumping for Irrigation.

Investigator: L. M. Winsor.

Purpose: To determine the condition under which small pumping plants may be used to provide water for irrigation.

Progress: Detailed examinations have been made of the installation and operation of irrigation pumping plants through the West, in cooperation with the United States Department of Agriculture, Division of Agricultural Engineering. A report has been prepared for publication. A special report on "Development of Ground Water for Irrigation in Utah" has also been prepared for publication by the Utah Agricultural Experiment Station.

Project No. 17. Title: A Study of Some Factor which Influence the Reclamation of Water-logged and Alkali Lands.


Purpose: To study the extent to which, and the conditions under which, the basic laws of the sciences of hydraulic engineering, physics, and chemistry may be applied to the reclamation of water-logged and alkali lands.

Method: To determine the feasibility of reducing influence of upward pressure gradient on surface soil by drainage with artesian...
wells, to consider water pressures in the gravels underlying the more impervious soils, to conduct conductivity studies of soils involved and to carry on soil-productivity studies.

Progress: (1) The Experiment Station has obtained a 20-year lease on a 30-acre tract of water-logged land overlying an artesian basin.

(2) Nine wells of from two to four-inch diameter have been drilled on the experimental farm, the average depth being about 55 feet.

(3) Fifteen \( \frac{1}{2} \)-inch pressure wells have been installed throughout the water-logged area. Marked reductions in pressures, as measured by the \( \frac{1}{2} \)-inch wells have been noted as a result of opening the nine large wells and permitting water to flow from them. The large wells are capped to prevent flow of water except during periods of observations.
ACTIVITIES OF THE DIVISION OF AGRICULTURAL ENGINEERING

U. S. DEPARTMENT OF AGRICULTURE

by

W. W. McLaughlin

Purpose and development. — The Division of Agricultural Engineering of the Bureau of Public Roads is devoted to research and investigational work in all lines of agricultural engineering, including reclamation.

The Division has evolved from a small organization created for irrigation inquiry in the early nineties, which was made permanent a few years later and placed in the Office of Experiment Stations; augmented subsequently by association of a drainage office; combined in 1914 with other agricultural engineering offices and placed in the Office of Public Roads and Rural Engineering; and was developed into its present organization during and immediately following the war, with headquarters in Washington, D. C., and western headquarters under an Associate Chief, concerned primarily with irrigation and drainage studies, at Berkeley, California. These successive steps have been taken to meet public demands for information first on irrigation, then drainage, and finally other phases of agricultural engineering.

The work of the Division has always been affiliated with the Department of Agriculture. We have always pursued a policy of cooperation with State agricultural colleges or other State agencies in the West having to do with irrigation and drainage.
It has been a further policy of the Division to assist in the coordination of irrigation and drainage investigations, and it has been the endeavor to avoid duplication, and in no instance have we tried to take the place of a State institution.

Most of our funds are spent in work in cooperation with State agencies, and we have at one time or another conducted cooperative work in all of the Western States. Our funds are supplemented for cooperative work, in those States where we have cooperation, with from a minimum in one State of $2000 to a maximum in another State of $21,000 annually.

We are now conducting research investigations on the following project:

**Utilization of Water**

- Duty of Water
- Loss of Water by Evaporation
- Pumping for Irrigation and for the Drainage of Irrigated Lands

**Irrigation Conduits and Structures**

- Design and Invention of Irrigation Apparatus
- Silt and Gravel in Streams and Reservoirs
- Lining as Applied to Irrigation Canals and Ditches
- Cleaning and Maintenance of Irrigation Canals and Ditches used in Western Reclamation
- Flow of Water in Irrigation Ditches, Pipes, and Other Irrigation Conduits

**Customs, Regulations and Laws Relating to Irrigation**

- Financial Rehabilitation of Irrigation Enterprises
- Irrigation District Operation and Finance.
Reclamation, Drainage and Management of Alkali Lands

Reclamation and Management of Alkali Lands
Relative Elevation of Water Table and the Plane of Saturation in Fine Textured Soils
Flood Control and Drainage

In addition to this it is hoped that very shortly we will extend our activities to include other branches of agricultural engineering such as farm machinery and equipment, work in soil erosion, investigations of farm building design and construction, etc.

To give an idea of the extent and variety of our work, there follows a list of bulletins prepared by our Division and published by the Government or by State institutions during the past two years; also a list of manuscripts submitted for publication during the same period, which are as yet not printed but are in process of printing; and a list of reports submitted to the Berkeley office during that time.

**PUBLICATIONS OF U. S. GOVERNMENT**

Orchard Irrigation (Revision)

The Border Method of Irrigation. (Revision). F.B. 1243.


Irrigation Requirements of the Arid and Semiarid Lands of the Missouri and Arkansas River Basins. Tech. Bul. 36.


Irrigation of Small Grain. (Revision). F.B. 1556.

Practical Information for Beginners in Irrigation. (Revision). F.B. 864.
PUBLICATIONS OF U. S. GOVERNMENT (Cont'd.)

Pumping from Wells for Irrigation. (Revision). F.B. 1404.
Mutual Irrigation Companies. Tech. Bul. 82.

PUBLICATIONS BY STATE INSTITUTIONS COVERING COOPERATIVE INVESTIGATIONS

Mutual Irrigation Companies in Utah. Utah A.E.S. Bul. 199.
The Improved Venturi Flume. Colorado A.E.S. Bul. 336.
Irrigation in Colorado. Colorado A.E.S. Bul. (unnumbered)

MANUSCRIPTS TO BE PUBLISHED

Economic Limits of the Cost of Water for Irrigation.
Irrigation Requirements of the Arid and Semiarid Lands of the Southwest.
The Flow of Water in Riveted Steel and Analogous Pipes.
Irrigation and Drainage Studies in Baker Valley, Oregon.
Irrigation Requirements of the Arid and Semiarid Lands of the Columbia River Basin.
Evaporation from Free Water Surfaces.
The Discharge of Drains Serving Irrigated Lands.
Seepage of Water from Channels.
MANUSCRIPTS TO BE PUBLISHED (Cont'd.)

Irrigation of Alfalfa. (Revision).


Commercial Irrigation Companies.

REPORTS SUBMITTED

Agricultural and Economic Phases of following projects:

Water Users Municipal Irrigation District, Arizona.

Vamoy Irrigation District.

Warm Springs Irrigation District.

Grants Pass Irrigation District.

Eagle Point Irrigation District.

Deschutes (Tumalo Project).

Summer Lake Irrigation District.

Silver Lake Irrigation District.

Crock County Improvement District No. 1 (Lone Pine Dist.).

Ochoco Irrigation District.

Reclamation of Alkali Lands, Idaho.


Silting and Life of Southwestern Reservoirs. R. G. Hemphill.

(Published in Transactions A.S.C.E.).

Adjustable Tube Measuring Device.

Drainage of Land Overlying Artesian Wells.

Duty of Water in the Sacramento-San Joaquin Delta, Nov., 1928.

Control of Gravel in Irrigation Channels.
RELATIONSHIP OF STREAM DISCHARGE TO PRECIPITATION WITH SPECIAL REFERENCE TO FORECASTING THE SUPPLY OF WATER FOR IRRIGATION FROM SEASONAL SURVEYS OF SNOW COVER ON MOUNTAIN WATERSHEDS

by

G. E. Clyde

The objects are: (1) To determine the basic principles underlying the relationship between the precipitation on a drainage area and the resulting runoff from the drainage area, and (2) to establish for each area the precipitation-runoff relations so that upon the basis of measurement of precipitation the stream discharge can be forecast.

The general purpose has been to develop and extend the science of mountain hydrology, particularly in the arid regions of the United States, so as to form a basis for forecasting the amount of water available for irrigation, power, and municipal purposes in advance of its utilization.

There are now six years of record available on the Logan River area. This data is inadequate to indicate the relationship between precipitation and runoff. However, it is pointing out some significant conditions. A long time record of snow cover and runoff together with the other meteorological and physical factors will be necessary before the problem can be completely solved, but it is thought that two more years of record will enable certain fundamental relationships to be established.

Due to inaccessibility of the high watersheds in the winter satisfactory records from people cooperating with the Station have
been hard to get. The water users, however, are beginning to realize
the value of the seasonal data on their watersheds and I think they
will assume the responsibility of continuing the collection of data
for predicting their water supply after the proper methods have been
worked out.

The collection of data has been continued on the Logan watershed,
and through the cooperation of water commissioners and other interested
parties, on the other principal watersheds of the State.

Daily hydrographs, isographs, and thermographs, have been kept
up to date and studied to determine:

1. The effect of summer precipitation on runoff
2. The effect of temperature on time of runoff and the total runoff
3. The runoff characteristics of different streams.

Due to weather conditions no evaporation experiments were
conducted this spring. High level precipitation stations were maintained
throughout the past summer. The records continue to indicate little
or no correlation between valley and mountain stations. The measure-
ment of accumulated snow on the mountains shows little correlation with
the total precipitation in the valleys.

Up to 1928-29 there was an apparent direct relationship on the
Logan watershed between the snow cover and the April-September,
inclusive, runoff. The data collected in 1928-29 indicate very strongly
that the temperature and early spring precipitation plays an important
role in the total amount of runoff and its distribution.
The snow cover surveys for 1924-28, inclusive, showed very little snow below 6,000 feet at the time the surveys were made. The 1929 measurements show a heavy cover below 6,000 feet and indications are that this low snow must be considered in making a forecast of stream flow. More data will no doubt bring out this relationship. The relationship between snow cover and runoff indicated in the last annual report must be discarded and a new one developed which gives weight to the factors affecting the runoff other than snow cover.

The forecast of water supply for Logan River this year is based on water content of the snow cover weighted according to areas between each 1,000 foot contour and compared with the snow cover and runoff since 1924. On this basis the Logan River should discharge (April-September, inclusive) a total of 165,000 to 175,000 acre-feet with a minimum September flow of 190 to 200 c.f.s. The Blacksmith Fork River adjoining the Logan River on the south, should discharge about 20 per cent more water than in 1928.

The detailed study of snow cover-runoff relations made on the Gooseberry watershed in the spring of 1928 have indicated the following:

1. The rate of melting is a function of the temperature and is not materially affected by the density of the snow cover.
2. The density of the snow increases until the water starts leaving the snow when it begins to decrease in density.
3. The path the water takes from the snow to the streams is largely determined by the temperature and rates of melting. If the rate of melting is rapid much of the water goes over the surface of the ground. If the rate is slow most of the water goes into the ground appearing later through springs and seeps.

4. The net yield of a snow cover to mountain feeder ditches is dependent on the location of the feeder ditch, its cross-section, and grade.

5. There is no material contribution from side hill slopes to feeder ditches.

6. Feeder ditches located at 9000 feet or above in Central Utah collected from 16 to 56 per cent of the water in the snow cover above the ditch. The highest yielders were those which intercepted the greatest number of natural drainage channels.
RECLAMATION OF ALKALI LANDS IN IDAHO

Cooperative
University of Idaho and Bureau of Public
Roads, U. S. D. A.

by

H. P. Magnuson

A project comprising 50 acres of very badly alkalized land has been conducted cooperatively for some three years to study the alkali reclamation employing a large variety of methods in the hope of reclaiming the land, or establishing certain characteristics of that land which make its drainage not feasible. A very thorough report of this work is prepared each year. The work to date is briefly summarized and discussed in the following report:

SUMMARY OF RESULTS

Though, as during 1926 and 1927 progress has been made in the past year on the Helms experimental tract near Caldwell, Idaho, results so far obtained fail to furnish conclusive proof that impermeable black soils can be reclaimed economically.

Though the best soil, which is fairly well represented on the Helms tract, has yielded rapidly to soil improvement and cropping, the remaining area has been slow to respond to treatments.

Failure on the one hand and fair success on the other is explained by the wide variation in soils. Originally the best soil was fairly

31.
porous, the pH was closely 9.0, and the surface foot contained from 100 to 200 PPM normal carbonate, from 150 to 300 PPM sulphates, and a negligible quantity of chlorides. The worst soil was deflocculated to a degree that made it practically impervious, had a pH of 10.0 or more, and contained in the surface foot from 700 to 4800 PPM normal carbonate, from 600 to 4000 PPM sulphate, and usually a moderate amount of chlorides.

According to chemical analyses, which check closely with other data, the best soil has been materially reduced in sulphate and normal carbonate content throughout the soil column. With the impervious, black alkali soil type, however, a reduction in normal carbonate is quite frequently offset by an increase in the chlorides and sulphates, which indicate deficient drainage and presages only temporary improvement.

Due either to the impervious condition of the soil, or to inadequate drainage, or both, the groundwater has stood high in the impervious black alkali areas throughout the irrigation season. So extreme is this condition in some spots that the water table remains within 2 feet of the ground surface during most of the irrigation season.

Efforts made to drain these spots by the use of shallow ditches, return flow wells, subsoiling and blasting and by lowering the water level in the deep open drain, which serves the tract, have failed to improve conditions materially.

There remains the possibility of draining these soils by radically lowering the general water table. From developments which
which have occurred elsewhere in connection with similar experiments it appears that a lowering of the general groundwater level to a depth of 8 or 10 feet may increase percolation sufficiently to make some of the treatments now employed feasible.

The general water table can be lowered to any extent that may be required by piping from wells. A plan is now being perfected which will probably result in this procedure being used for draining the Helms tract.

Of the treatments used on the Helms tract, benefit has been derived from the following: application of gypsum, sulphur, and sulphuric acid; manure mixed with the soil to a shallow depth, or applied as a surface covering; sand used as a backfill for tree planting; the planting and care of crops; shade for reducing evaporation and soil crusting, and irrigation.

On the other hand, no apparent benefit has resulted from: application of straw, subsoiling to a depth of from 1 to 1½ feet, and thorough blasting to a depth of 4 or 5 feet.

Chemical treatments with gypsum, sulphur, and sulphuric acid have improved the soil, but it appears doubtful if results justify either the time consumed or the cost of the chemicals. Compared with untreated, or check plots in the same series and having the same type of soil, the chemically treated soil is more friable, has a lower pH, shows a greater reduction in salt content, and produced a better crop. The soil defects in most instances, however, have been only
partially corrected. The most pronounced effects from the use of chemicals has taken place in Series "F" where they are applied during the period July, 1926 to March, 1927 and in the following amounts: gypsum 17.2 and 34.4 tons per acre, sulphur 3.2 and 6.4 tons per acre, black sulphur 3.9 tons per acre, sulphuric acid 11.4 and 15.2 tons per acre, and calcium chloride 6.3 tons per acre. At least two seasons have passed with practically no crop returns and the original investment for chemicals is conservatively placed 10 to 20 times the present value of the land. Though yielding these discouraging results these experiments support the theory underlying the use of certain chemicals for reclaiming alkali land. Furthermore adverse soil drainage obtains in Series "F" and in the unproductive spots in Series A and if it could be remedied by more efficient drainage a more hopeful view of the utility of chemicals for reclaiming impervious, black alkali soils could be taken.

Manure appears to serve best as a buffer against the action of alkali and as a preventative for soil crusting. Its use in preparing a seed bed by mixing it with the soil to a shallow depth, or by applying it as a surface covering has resulted in better seed germination as well as healthier and thicker stands of young plants. Whether due to the further action of manure through the culture of aerobic soil bacteria and the production of carbon dioxide, or to soil improvement brought about by growing plants, areas so treated have continued to produce more crop than adjoining check plots.
Growing crops on alkali land are being considered from three different angles, i.e. their effect on the soil, their alkali resistant nature, and their commercial value. Among the grasses and legumes grown on the Helms tract no one crop has been found to produce maximum benefits. The planting of several crops together for pasture or hay has been recognized as a good plan to follow.

Soil improvement may be brought about by growing crops through the medium of carbon dioxide which is given off by the plant roots, through physical and fertilizing effect of root penetration and decay, and by consumption of alkali in plant growth. Observations indicate that white blossom sweet clover is particularly adapted to this work. Regardless of treatment with chemicals, or organic materials, this crop, after being once successfully started, improves from year to year and gradually crowds out unproductive spots. A correlation of crop improvement and reduction of alkali content in the soil has been observed.

Tolerance for alkali is, of course, a very necessary requirement in any crop to be grown on alkali land and all of those planted on the Helms tract more or less possess this quality. The one crop which is outstanding in this respect is Zawadke's Alkali Grass. It has been found to thrive in the worst black alkali soils on the Helms tract, and according to laboratory tests ranks among the most alkali resistant plants. This crop was planted on Plot 7, Series B in February, 1928, and has become seeded naturally in many other places on the tract. Aside from being exceedingly tolerant of alkali it has considerable value as a pasture grass. A similar claim is made for Strawberry clover, but this crop has not been introduced on the Helms tract.
The alkali resistant qualities of some of the crops produced on the Helms tract as shown by pH determinations made in the field with a Morgan soil testing set are as follows: Zawadke’s Alkali Grass 9.6+, White Blossom sweet Clover 9.0, Meadow Fescue 8.8, Alfalfa 8.4 to 8.6, and Tall Meadow Oat Grass 8.2. These limits of endurance are somewhat higher when the surface of the ground is shaded, or when manure is applied to the soil. It is probable that the pH values are actually higher as shown by laboratory tests.

Commercial values of alkali land grown crops are important from an economic standpoint. It is usually the case that feasible reclamation depends on production of something of value which will offset at least a portion of the expense during the period required for reclamation, otherwise the ultimate cost may exceed the value of the improvement. It has been the aim in growing hay on Series "A" and "F" and pasture on Series "I" to make the poorest soils produce something by planting extremely alkali resistant crops. Grasses and legumes which are more sensitive to alkali but which have greater value have been planted that soils of the better character may yield a maximum return. Sweet clover and alfalfa were planted for hay, while a mixture of white clover, bluegrass, and sweet clover was used for planting pastures. It is almost certain that valuable results from pasture could be procured by also planting Zawadke’s alkali grass, or strawberry clover. During 1928 hay, a probably one-half the value of first class alfalfa, was harvested from Series "A", the average yield for the various plots being from 1.45 to 2.03 tons per acre. The pasture carried an average of one head of stock per acre from 125 days during the 1928 season.
Shade afforded either by natural vegetation or by artificial means has been found beneficial in starting crops on the poorer soils. This phenomenon is undoubtedly due to a lower toxic effect of the alkali. It has been suggested in previous reports that success met in producing fair pasture by seeding sweet clover and bluegrass on uncleared land may be due, at least in part, to shade produced by natural vegetation. This view was corroborated during 1928 by growing white clover and bluegrass on black alkali soil shaded with burlap.

Undoubtedly irrigation has played an important and necessary part in the process of growing crops, and in the chemical reactions and removal of alkali otherwise made possible through the application of chemicals. As an individual agent, working alone, it has caused improvement very slowly in relatively impervious soils, and more rapidly under permeable soil conditions. Harmful results have been produced in instances where more water has been applied than could be taken care of by underdrainage, and in cases where poor surface drainage and impervious soil caused more or less continuous standing water.

The nearest approach to economic reclamation on the Helms tract has been reached by seeding uncleared, raw alkali land to sweet clover, white clover and bluegrass followed by copious irrigation. Within two years fair pasture has been produced and the cost has been small. Furthermore, it appears probable that an even better showing might have been made had Zawadko's alkali grass and strawberry clover been included with the crops planted. The attractive features of this method of handling
alkali land, and those which may make the plan feasible, are a low first cost followed by a minimum amount of necessary attention and labor, and productivity during the process of reclamation which at least partly offsets expenses. The extent to which the plan may prove economical depends on the necessary outlay in preparing such land for irrigation. Forest and shade tree experimental plantings have so far yielded the following results:

Of the hardwoods planted in the best soils 82+ per cent lived, while of the conifers planted in the same soil only 14+ per cent lived.

Of the hardwoods planted on the worst soils and backfilled with coarse sand 77- per cent lived, while of the conifers planted in the same manner and in the same soil 24- per cent lived. Though the number of live trees in this planting compares favorably with the planting in the best soils, the condition of growth is not so good.

Of the hardwoods planted in the worst soils and backfilled with the natural soil 13- per cent lived, while of the conifers planted in the same way and in the same soil none lived.

Of the hardwoods planted, Chinese Elm, Russian Olive, Silver Poplar, and Weeping Willow made the best showing.
PROGRESS REPORT UPON
IRRIGATION AND DRAINAGE PROJECTS AS OF July 1, 1929

by

E. H. Neal

The Irrigation and Drainage projects of the Agricultural Engineering Department, Idaho Agricultural Experiment Station, are classified under the general project "Factors Underlying the Economic Use of Water in Irrigation" as proposed at the first Conference of Irrigation Workers of the Western Agricultural Experiment Stations held at Berkeley, California, September 3 to 8, 1925, inclusive.

An investigation is being made under Section 3. Conditions governing the application of irrigation water, of Division I, Soil and Irrigation Relationships, upon the quality of percolating waters from irrigated lands. This investigation is in cooperation with the Department of Agricultural Chemistry. It is hoped that information may be obtained with regard to the effect upon the soil and upon present and future crop production of the wasteful methods of irrigation practised in sections of this State. A number of samples of irrigation and drainage waters have been collected for chemical examination. Plans are being perfected to collect percolating waters from soil in situ.

Studies are being made upon the time of irrigation for sugar beets, potatoes and beans. This work is in its first year with beans, second year with potatoes, and third year with sugar beets. The project is classified under Section 2, The Moisture Requirements of Plants.
under Division II, Plant and Irrigation Relationships.

Under Division IV, Drainage and Reclamation of Water-logged, Alkali, and Overflow Lands, Section 2, Reclamation after Drainage and extensive project has been carried on for several years. This project is in cooperation with the Division of Agricultural Engineering, United States Department of Agriculture and the Department of Agricultural Chemistry. Field work has been carried on upon a 40 acre tract of greasewood and saltgrass land, heavily charged with alkali salts. This land had not been previously cultivated. Various chemical and physical treatments have been tried with little success, possibly due to the presence of a perched water table over a large portion of the tract. This condition persists though a deep drain is excavated along one side of the tract. A deep well drainage pump has recently been installed in an effort to obtain effective drainage.

A study of the cost and effectiveness of Pumping for Drainage has recently been initiated. Five deep well pumps have been installed for drainage purposes during the past year in the Boise Valley. The results obtained with these plants are now being studied.