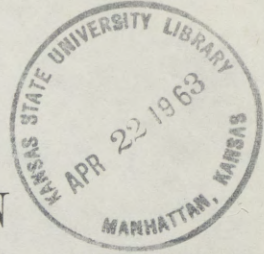


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# WATER RESOURCES RESEARCH ACT

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## HEARINGS BEFORE THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE

EIGHTY-EIGHTH CONGRESS  
FIRST SESSION

ON

### S. 2

A BILL TO ESTABLISH WATER RESOURCES RESEARCH CENTERS AT LAND-GRANT COLLEGES AND STATE UNIVERSITIES TO STIMULATE WATER RESEARCH AT OTHER COLLEGES, UNIVERSITIES AND CENTERS OF COMPETENCE, AND TO PROMOTE A MORE ADEQUATE NATIONAL PROGRAM OF WATER RESEARCH.

FEBRUARY 19 AND 20, 1963

Printed for the use of the Committee on Interior and Insular Affairs



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# WATER RESOURCES RESEARCH ACT

TUESDAY, FEBRUARY 19, 1963

U.S. SENATE,  
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,  
*Washington D.C.*

The subcommittee met, pursuant to notice, at 10 a.m., in room 3110, New Senate Office Building, Senator Clinton P. Anderson presiding. Present: Senators Anderson, Moss, Hayden, Burdick, McGovern, Nelson, Allott, Miller, Dominick and Jordan of Idaho.

Also present: Benton J. Stong, professional staff member, and Jerry T. Verkler, staff director.

Senator ANDERSON. The committee will be in order.

The chairman, who may be supplanted by Senator Jackson shortly, is glad to welcome to the committee its newest member, the distinguished senior Senator from Arizona, Mr. Hayden.

It seems a little strange that after he has served more than 50 years in Congress we finally get on the committee one who has helped us by his work all these years. We are very happy to have him as a most distinguished member.

The hearing today is on S. 2 to bring about the establishment of water resources research institutes, or centers, at land-grant colleges and State universities and other educational institutions, and to make use of centers of competence wherever they exist to promote a more adequate national program of water resources research.

Let me just pause to say I have had an inquiry from one of the land-grant colleges as to whether I really meant land-grant colleges or meant State universities. The land-grant institutions use both "college" and "State university" in their names. The only thing I could explain was that we meant land-grant institutions. We don't attempt to exclude other institutions but I feel this is something that very well could center in the land-grant institutions of the country.

I have been joined in the introduction of the bill by Senator Jackson, the new chairman of this committee and a member of the Select Committee on National Water Resources; Senator Kuchel, the ranking minority member of this committee who served as vice-chairman of the Select Committee on National Water resources; by the majority leader, Senator Mansfield, author of the Senate resolution which set up the select committee in the 86th Congress; by Senators Engle, Hart, McGee and Moss who were members of the select committee, and by Senators McGovern, Gruening, Burdick, Metcalf, Morse, Carlson, Yarborough, Long of Missouri, Bayh, Hruska, Bartlett, McIntyre and Brewster.

In its report on national water resources in January, 1961, the Senate select committee on that subject recommended an expanded, coordinated, scientific Federal research program in the water field.

S. 2 is one part of such a program, designed to make available to agencies responsible for meeting the Nation's water needs highly trained personnel now in related disciplines in the colleges and universities of the Nation, and at the same time to help them train much-needed new personnel in hydrosociences.

When the select committee report was filed, President Kennedy advised Congress that, pursuant to the select committee recommendations, he had asked the National Academy of Sciences to—

study and report on the present state of research underlying the conservation, development, and use of natural resources.

That report was recently made public in the form of a summary statement, supported by seven specialized studies. The Academy report on water resources will be included in the files on the bill before us today.

I pause to say that anybody who wants to take a very good look at a very fine document, I recommend to them this document. Also, I noticed this morning in the Washington Post a very good story on the report of the Council for Science and Technology on water research work and I think it is a fine thing that these reports are coming along.

Significantly, the first conclusion reached by Dr. Abel Wollman, chairman of the Academy's water resources study group, was that the greatest shortage in the water field is experts, and its greatest need, is a—

new generation of well-rounded water scientists ready and able to approach the Nation's multidisciplinary water resources problems in a unified manner as "hydrosociences."

The report added :

Since the primary restraint on the speed with which research may go forward lies in the limited number of competent investigators, immediate support must be provided for university education and in-service training. These, in turn, await the creation of laboratories, offices, and classroom facilities.

This very primary need is, of course, one reason that S. 2 proposes aid to colleges and universities in establishing water resources research centers. Federal research will thereby provide facilities, stimulus, and projects around which a program can be built for training the needed new generation of well-rounded hydrosocientsists while conducting useful research work.

President Kennedy also directed the Federal Council for Science and Technology to—

review ongoing Federal research in the field of natural resources and to determine ways to strengthen the total Government research effort relating to natural resources.

Pursuant to that instruction, the Federal Council last weekend submitted to the President, and the President yesterday transmitted to Congress, the report of its Task Force on Coordinated Water Resources Research by the Federal Government. In forwarding the task force report to the President, Dr. Jerome B. Wiesner, the President's Science Adviser, who is also director of the Office of Science and Technology and Chairman of the Federal Council for Science and Technology, wrote the President :

The Federal Council concurs in the task force report with minor reservations indicated in the text. It recommends your approval of the attached document,

and also recommends that it be transmitted to Congress for its use in considering both the administration's water resources research program for fiscal year 1964 and the need for new legislation.

Since the report has been submitted as a guide for Congress and particularly for the Interior and the Appropriations Committees and will be in considerable demand by hydroscintists, colleges, and universities across the Nation, it is my hope that it can be printed as a committee print or a Senate document. Meantime, for the use of this committee during the present hearing, we yesterday obtained enough mimeographed copies to put at the place of each of the Senators here today.

Under the circumstances, I shall cite for inclusion in the record of these hearings only one or two brief passages which bear directly on the place of S. 2 in such a coordinated Federal water research program.

First, I would like to congratulate the task force on the report, and not entirely because it supports every argument I have made for S. 2. I was particularly pleased to find the task group was aware of the need by water consumers, including farmers, towns, counties, and States, for the scientific assistance in the water field which might be made available to them through the staffs and through an extension service type of program operated by the universities in each State where the water research centers are located.

The task force report also presents, in a fashion which can be readily understood by those of us who do not have doctors' degrees, a splendid analysis of water research categories and needs, sums appropriated to the various Federal agencies in each of the categories of water research in 1963, and sums requested for 1964.

It is an excellent job, and I congratulate those who produced it.

The task force report, endorsed by the Federal Council and forwarded to us, says:

It is the view of the task group that the Department of the Interior and the Corps of Engineers should be given explicit authority and necessary funds to make grants and contracts with educational institutions for the support of research related to their broad mission responsibilities in the field of water resources. The Department of Health, Education, and Welfare already has a strong extramural program in water. The Departments of Commerce and Agriculture should have adequate funds and should be encouraged to use their authorities for making extramural research grants. The planning and administration of the extramural grant programs of the several departments should be coordinated through the proposed Coordinating Committee on Water Resources Research of the Federal Council for Science and Technology.

The explicit conclusions and recommendations of the task group in regard to legislative needs reiterate the contents of the paragraph I have read and declare it desirable to develop additional centers of water resources research in many universities and to strengthen existing centers and programs. They recommend support for the universities in the precise forms provided in S. 2, including in part, a—

small formula amount to one or more designated research institutions in each State to establish or strengthen the capacity for water resources research, and (2) in part on a matching fund basis, giving consideration to the research potential.

These two types of support are provided in section 100 of S. 2.

The report endorses giving one agency administrative responsibility for the basic formula grant and the matching funds. It qualifies the recommendation, as does S. 2, with the proviso that grants should be

made after consultation with other agencies having substantive interests in the field of water resources.

Without objection, the text of the task force conclusions and recommendations on legislation will be placed in the record.

(The material referred to follows:)

#### CONCLUSIONS AND RECOMMENDATIONS

New legislation is needed to strengthen substantially the contributions that the universities can make to research and graduate education in water resources.

(a) All agencies concerned with water resources should be able to contract with and make grants to any university, whether or not it is the location of a water research center, in support of agency missions.

(b) It is desirable to develop additional centers of water resources research in many universities and to strengthen existing centers and programs.

(c) In order to accomplish the objectives of (b), some Federal support to each such center on a continuing basis will be necessary in addition to the support provided under (a). The way in which these additional funds would be used should be left to the university itself.

(d) Support to centers should be (1) in part on the basis of a relatively small formula amount to one or more designated research institutions in each State to establish or strengthen the capacity for water resources research,<sup>1</sup> and (2) in part on a matching fund basis, giving consideration to the research potential.

(e) New legislation should give to one agency the administrative responsibilities for carrying out (d) (1), without in any way superseding authorities presently vested in the several agencies.

(f) Similar authority is needed for (d) (2). The administrative responsibility should be vested in one agency which should seek appropriations for this purpose, but the grants should be made in consultation with the other agencies having substantive interests in the field of water resources, which should participate in the drawing up of rules and regulations and criteria for evaluation. Such consultation and coordination as is necessary could be accomplished through the proposed Coordinating Committee on Water Resources Research.

(g) All agencies concerned with water resources should be able to make arrangements with educational institutions to permit Government scientists and engineers to teach and engage in water resources research at educational institutions.

Senator ANDERSON. These conclusions and recommendations can only be interpreted as an endorsement of S. 2.

As a matter of fact, Dr. Jerome Wiesner has written in his comment on the bill, after noting that it includes several very constructive suggestions which he made in regard to the original version, S. 3579 of the 87th Congress:

Based on our studies of the Federal programs and activities in water resources research, I am confident that S. 2 can contribute significantly to the strengthening of the capabilities of the colleges and universities to undertake broadly based research and analysis in the many disciplines bearing on water resources.

Dr. Wiesner will be here to testify at 10 a.m. tomorrow. He could not appear today because of a conflict with a very important meeting called by Vice President Johnson. Dr. Wiesner is anxious that S. 2 set high standards of quality for the research to be undertaken under it. I believe that we can assure him, based on the criteria in the bill to qualify for basic support, and for matching funds or grants, and based on the magnificent record of the land-grant institutions in the field of agricultural research, that the bill assures the high quality of research he very properly seeks.

<sup>1</sup> The Federal Council for Science and Technology qualified its acceptance of this recommendation, agreeing that at least one water resources research or analysis center could be established with Federal grants on a permissive basis in each State, under explicit qualification standards.

Without objection, I shall put in the record at this point the text of S. 2, the reports received from the Department of the Interior, the Office of Science and Technology, the Bureau of the Budget, the General Accounting Office, the Federal Power Commission and other agencies.

(S. 2 and the documents referred to follow :)

[S. 2, 88th Cong., 1st sess.]

A BILL To establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities and centers of competence, and to promote a more adequate national program of water research

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That it is the policy and purpose of the Congress to assure the Nation at all times an abundance of water, both as to quantities and quality, necessary to meet the requirements of its expanding population, and, to help achieve this objective, to stimulate, sponsor, and provide for the conduct of research, investigations, and experiments in the field of water and related resources as they affect water, supplementing present programs, and to encourage the training of scientists in fields related to water by assistance to colleges and universities in the development of water resources research programs.

#### TITLE I—STATE WATER RESOURCES RESEARCH INSTITUTES OR CENTERS

SEC. 100. (a) There is authorized to be appropriated, for the fiscal year 1964 and subsequent years, for distribution to a college or university in each State and Puerto Rico, established in accordance with an Act approved July 2, 1862 (12 Stat. 503), entitled "An Act donating public lands to the several States and territories which may provide colleges for the benefit of agriculture and the mechanic arts," or such other institutions of higher education as any State shall determine, a sum adequate to provide \$75,000 to each State in the first year, to be increased by \$12,500 each succeeding fiscal year for two years and to continue at \$100,000 thereafter, for the purpose of establishing a collegewide or university-wide water resources research institute, center, or equivalent agency. It shall be the duty of each such institute or center to plan and conduct and/or arrange for a component or components of its college or university to conduct competent researches, investigations, or experiments, of either a basic or practical nature, or both, in relation to water resources, including but not limited to aspects of the hydrological cycle, supply and demand for water, conservation and best use of available supplies, methods of increasing such supplies, economic, legal, social, engineering, recreation, biological, geographic, ecological, and other aspects of water problems, as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Puerto Rico, to water research projects being conducted by agencies of the Federal Government, and to those related to agriculture being conducted by the agricultural experiment stations, and also having regard to avoidance of any undue displacement of scientists and engineers elsewhere engaged in water resources research.

(b) There is further authorized to be appropriated to the Secretary of the Interior in the fiscal year 1964 the sum of \$1,000,000, increasing by \$1,000,000 each year for four years to \$5,000,000 in fiscal year 1968 and thereafter, which the Secretary of the Interior may use to match, on a dollar for dollar basis, funds made available to State water resources research institutes or centers by the States or other non-Federal sources, to meet the necessary expenses of water resources research projects which could not otherwise be undertaken, including the expense of planning and coordinating regional water resources research projects by two or more State water research agencies.

SEC. 101. Sums available to the States under the terms of section 100(a) of this Act shall be paid to the designated institution or institutions in each State in equal quarterly payments beginning on the first day of July of each fiscal year upon vouchers approved by the Secretary of the Interior. Each such agency authorized to receive funds shall have an officer appointed by its governing authority who shall receive and account for all funds paid to the State under the provisions of this Act and shall make an annual report to the Secretary of the Interior, on or before the first day of September of each year, on work accomplished and the status of projects underway together with a detailed statement

of the amount received under any of the provisions of this Act during the preceding fiscal year, and of its disbursement, on schedules prescribed by the Secretary of the Interior. If any of the moneys received by the authorized receiving officer of any State water resources research agency under the provisions of this Act shall by any action or contingency be found by the Secretary of the Interior to have them improperly diminished, lost, or misapplied, it shall be replaced by the State concerned and until so replaced no subsequent appropriation shall be allotted or paid to such States. Pending a meeting of the legislature of any State, the Secretary of the Interior shall pay sums appropriated pursuant to section 100 of this Act to a qualified institution designated by the Governor of such State.

Sec. 102. Moneys appropriated pursuant to this Act shall also be available, in addition to meeting expenses for research and investigations conducted under authority of this Act, for printing and disseminating the results of such research, retirement of employees subject to the applicable provisions of the Act approved March 4, 1940 (54 Stat. 39), administrative planning and direction, and for the purchase and rental of land and the construction, acquisition, alteration, or repair of buildings necessary for conducting research. The State water resources research agencies are authorized to plan and conduct any research authorized under this Act in cooperation with each other and such other agencies and individuals as may contribute to the solution of the water problems involved, and moneys appropriated pursuant to this Act shall be available for paying the necessary expenses of planning, coordinating, and conducting such cooperative research. Two or more States may cooperate in the designation of a single interstate or regional research institute or center.

Sec. 103. Bulletins, reports, periodicals, reprints of articles, and other publications necessary for the dissemination of results of the researches and experiments, including lists of publications available for distribution by the institutions, shall be transmitted in the mails of the United States under penalty indicia: *Provided, however,* That each publication shall bear such indicia as are prescribed by the Postmaster General and shall be mailed under such regulations as the Postmaster General may from time to time prescribe. Such publications may be mailed from the principal place of business of the institute or center, or from an established subunit of such agency.

Sec. 104. The Secretary of the Interior is hereby charged with the responsibility for the proper administration of this Act, and, after full consultation with other Federal agencies, is authorized and directed to prescribe such rules and regulations as may be necessary to carry out its provisions, including requirement of a showing that agencies designated to receive funds have, or may reasonably be expected to have, the capability of doing effective work. It shall be the duty of the Secretary to furnish such advice and assistance as will best promote the purposes of this Act, including participation in coordination of research initiated under this Act by the State water resources research agencies, from time to time, to indicate such lines of inquiry as to him seem most important, and to encourage and assist in the establishment and maintenance of cooperation by and between the several State water resources research agencies and between the State agencies and the United States Department of the Interior and other Federal establishments.

On or before the 1st day of July in each year after the passage of this Act, the Secretary of the Interior shall ascertain as to each State whether it is entitled to receive its share of the annual appropriations for water resources research under section 100(a) of this Act and the amount which thereupon each is entitled, respectively, to receive.

The Secretary of the Interior shall make an annual report to the Congress of the receipts and expenditures and work of the water resources research agencies in all States under the provisions of this Act and also whether any portion of the appropriation available for allotment to any State has been withheld and if so the reasons therefor.

Sec. 105. Nothing in this Act shall be construed to impair or modify the legal relation existing between any of the colleges or universities under whose direction State water resources research institutes or centers are established and the government of the States in which they are respectively located: *Provided,* That in any State which designates more than one such college or university to have a water resources research center the appropriations made pursuant to section 100(a) of this Act for such State shall be divided between such institutions as the legislature of such State shall direct: *Provided further,* That in any instance where two or more States designate a single interstate or regional institute or

center, the funds of each of the States under section 100(a) may, upon the direction of the States, be paid to the designated agency.

## TITLE II—ADDITIONAL WATER RESOURCES RESEARCH PROGRAMS

Sec. 200. There is authorized to be appropriated to the Secretary of the Interior \$5,000,000 in fiscal year 1964, increasing \$1,000,000, annually for five years, and continuing at \$10,000,000 annually thereafter from which he may make grants, contracts, matching, or other arrangements with educational institutions, private foundations, or other institutions; with private firms and individuals; and with local, State, or Federal Government agencies, to undertake research into any aspects of water problems related to the mission of the Department of the Interior, which may be deemed desirable and are not otherwise being studied.

## TITLE III—MISCELLANEOUS PROVISIONS

Sec. 300. The Secretary of the Interior shall arrange for the regular advice and cooperation of all agencies of the Federal Government concerned with water problems, of State and local governments and of private institutions and individuals, to assure that the programs authorized in this Act will supplement and not duplicate established water research programs, to stimulate research in otherwise neglected areas, and to contribute to a comprehensive, nationwide program of water and related resources research. He shall make generally available information and reports on projects completed, in progress, or planned under the provisions of this Act, in addition to any direct dissemination of information by the research agencies themselves. Each Federal agency doing water resources research or investigations shall advise the Secretary of the Interior at least once annually of work underway or scheduled by it. The Secretary of the Interior shall classify and maintain for general use a catalog of water resources research and investigation projects in progress or scheduled by Federal agencies, and by such non-Federal agencies of government, colleges, universities, private institutions, firms and individuals as may make voluntarily available information to him: *Provided*, That upon the establishment of a central or general system of cataloging current and projected scientific research in all fields encompassing the cataloging function herein authorized, the President may transfer this function as he determines to be desirable.

Sec. 301. Nothing in the foregoing section nor in this Act is intended nor shall be construed as giving its Secretary or the Department of the Interior any authority or surveillance over water resources research conducted by any other agency of the Federal Government, nor shall it be construed as repealing, superseding, or diminishing existing authorities or responsibilities of any agency of the Federal Government to plan and conduct, contract for, or assist in research in its areas of responsibility and concern with water resources.

Sec. 302. The Secretary of the Interior is authorized to establish in the Department of the Interior a Water Resources Service for the purpose of administering programs authorized in this Act.

Sec. 303. Not to exceed 4 per centum of any funds appropriated pursuant to the provisions of this Act may be used for the purpose of administration. The Secretary of the Interior is authorized to employ a director of the Water Resources Service at civil service grade 18 and, if necessary to obtain personnel competent to administer a program involving scientific knowledge and highly trained staffs, he may employ not to exceed five employees above civil service grade 15 in addition to the number otherwise authorized by law.

Sec. 304. Contracts or other arrangements for water resources research work authorized under this Act may be undertaken without regard to the provisions of section 3684 of the Revised Statutes (31 U.S.C. 529) when in the judgment of the Secretary of the Interior such payments are necessary to facilitate such research.

Sec. 305. Within not more than a year following the fifth year of operation of this Act, the Secretary of the Interior shall prepare and submit to the President for transmittal to the Senate and House of Representatives a comprehensive report on progress and accomplishments under the Act, together with his recommendations on revisions of the Act, and with the independent recommendations of the governing authorities of the State colleges and universities on desirable revisions. This section is not intended to preclude any interim recommendations deemed desirable.

SEC. 306. This Act may be known as the "Water Resources Research Act."

DEPARTMENT OF THE INTERIOR,  
OFFICE OF THE SECRETARY,  
Washington, D.C., February 18, 1963.

Hon. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR ANDERSON: This responds to your request for the views of this Department on S. 2, a bill to establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research.

We strongly recommend the enactment of this legislation.

Our views on this subject were set forth at some length in our report of January 3, 1963, on S. 3579, a similar bill introduced in the 87th Congress. We refer you to that report for a more detailed elaboration on the reasons why we feel the enactment of the proposed legislation will make a major contribution toward promoting basic and applied research and investigations of a multi-disciplinary character in those areas not now adequately covered under existing programs, augmenting the critically inadequate numbers of experts broadly experienced in the sciences related to water resources, assisting in the assembly and coordination of information on existing and needed research areas, and stimulating non-Federal competent and participation in the solution of water resources problems. We note that a number of changes which were recommended in S. 3579 have been incorporated in S. 2, and we believe that the amendments strengthen and improve the legislation.

It is axiomatic that the availability of adequate supplies of good quality water affects all of man's pursuits. Yet our current use of water is more than 300 billion gallons per day and projections indicate that within two decades the demand may double and will continue to rise in the years that follow. These competing demands for water for its many purposes will render even more critical the need for wise decisions as to its allocation and use. The correctness of these choices in turn will depend, in large measure, on the availability and quality of our knowledge about water in its many aspects. S. 2 will promote the acquisition of this knowledge by supplementing existing Federal and State activities in the field of water research and investigation.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the administration's program.

Sincerely yours,

STEWART L. UDALL,  
*Secretary of the Interior.*

DEPARTMENT OF THE INTERIOR,  
OFFICE OF THE SECRETARY,  
Washington, D.C., January 3, 1963.

Hon. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR ANDERSON: This responds to your request for the views of this Department on S. 3579, a bill to establish water resources research institutes at land-grant colleges and State universities and to promote a more adequate national program of water research.

We strongly recommend enactment of this legislation, and suggest certain technical amendments for the consideration of the committee.

The purpose of the bill is well stated in its title. Title I of S. 3579 authorizes the Secretary of the Interior to provide financial assistance to States and Puerto Rico in the amount of \$75,000 a year increasing to \$100,000 after 1966 for the purpose of establishing a collegewide or universitywide water resources research institute at a land-grant college or other equivalent university within the State. Each institute would have the responsibility to plan and conduct a broad program of basic or applied research relating to water resources, taking into consideration the needs of the respective State, water research projects being con-

ducted by Federal agencies, and agricultural research projects being conducted by agricultural research stations. In addition, title I authorizes appropriations to the Secretary of the Interior in the amount of \$1 million the first year, increasing to \$5 million annually the fifth year and thereafter, for grants to the institutes for the necessary expenses of water resources research projects. At least 50 percent of the cost of projects would be financed from funds furnished by the States or other sources.

Title II of the legislation authorizes the Secretary of the Interior to establish a Water Resources Service to administer programs authorized in the act; to encourage Federal cooperation in water problems research; to foster and develop a balanced, nationwide program of water and related resources research and action; to maintain for general use a catalog of water resources research investigation projects by Federal agencies and by non-Federal agencies on a voluntary basis; and generally to make available information on the research work conducted under the authority of the act. In addition, section 201 of title II authorizes the appropriation to the Secretary of the Interior of \$5 million the first year, increasing \$1 million annually for 5 years, for water problems research grants to schools, private foundations, other firms and individuals, and local, State, and Federal agencies, including the State water resources research institutes.

Enactment of the proposed legislation would make a major contribution toward the solution of four problems relating to the Nation's water policy: (1) It would promote the carrying out of urgently needed research work in all areas relating to water resources, particularly with respect to integrating and relating the economic, legal, social, engineering, recreation, biological, geographic, ecological, and other aspects of water problems; (2) it would provide a greatly needed opportunity for the training of scientific personnel for water matters; (3) it would provide a mechanism to assist in the coordination of Federal research efforts and the collation of information on water problems; and (4) it would strengthen non-Federal participation in planning and carrying out water resources conservation and development programs.

Central to the significance of the legislation is the establishment of the water resources research institutes at State universities or land-grant colleges. In this connection, the report of the Senate Select Committee on National Water Resources, in urging the substantial increase and expansion of water resources research activities, stated:

"Note should be made of one problem that shows up when expansion of research programs is considered; namely, the limited availability of competent research scientists. In recent years, fields such as electronics, aeronautics, astronautics, and nuclear energy have been glamorized and supported financially to the point where they are attracting many of the Nation's best research brains. Research in water has received much less public attention. The committee hopes that strengthening of water research programs as discussed herein would help to increase interest in this field. In the near future, additional steps may be necessary to see that our colleges and universities expand their training facilities, and get increasing numbers of competent people to select this field in order that additional research can be carried out" (S. Rept. No. 29, 87th Cong., 1st sess., p. 62).

The key importance of utilizing institutions of higher education for both enlarging our knowledge through research and training scientists and engineers is attested by a distinguished series of authorities. Notable among them is the President's Science Advisory Committee's 1960 Report of the Panel on Basic Research and Graduate Education under the chairmanship of Dr. Glenn T. Seaborg, then chancellor of the University of California at Berkeley and now Chairman of the Atomic Energy Commission.

The Panel stated:

"The central proposition of this report is that science and the making of scientists go best together. This means that when it can be managed, basic research should be done in, or at least in association with, universities. Exceptions to this rule are numerous, of course. Some problems, by their nature, require attack in ways that are not suited to university life; and the work of the geological survey, for example, can hardly be divided among the universities, yet it requires science of high quality, and basic research is essential to the whole undertaking; the same thing is true of many other enterprises of government and industry. Yet we hold to the view that in the absence of special considerations the university is the best place for basic research, and we note that separate installa-

tions which do the best work are, as a rule, those which have a close and effective connection with academic centers; the geological survey, in its intimate relation to academic geology, is an excellent case in point."

Prof. Abel Wolman, Chairman of the Water Resources Study of the National Academy of Sciences-National Research Council found that:

"The most critical shortage in the field of water resources by far is the very real shortage of broadly trained people capable of planning and executing effective research programs. At present, we have no institutional structure in the United States to take care of multidisciplinary research in water. The whole hydrosciences field is now pathetically limited for the tasks involved. To strengthen it will require immediate provision of a program to enlist and train new people in a great many of the disciplines relating to water resources. The ultimate objective should be the development of a new structure and a new generation of well-rounded water scientists ready and able to approach the Nation's multidisciplinary water-resources problems in a unified manner as 'hydrosciences'."

The Committee on Natural Resources of the National Academy of Sciences-National Research Council came to the conclusion that:

"In adapting their research programs and activities to the requirements of the problems outlined in this report, governmental and nongovernmental agencies and institutions should take full advantage of the resources of the universities, contracting out especially those studies for which the universities are uniquely equipped. It should be remembered that an important byproduct of the university research is the training that accompanies it, and the Committee reemphasizes the need for training research workers to deal effectively with the problems relating to natural resources. These problems require closer cooperation between natural and social scientists."

Thus, enactment of S. 3579 would have the two beneficial results of enlisting the scientific and engineering competence of university research in water resources problem-solving, and also of augmenting the critically inadequate numbers of scientists and engineers trained in the sciences related to water resources.

The proposed legislation would build on and utilize the established facilities of the State colleges and universities, thereby taking advantage of a system of educational institutions that for over a century has demonstrated its effectiveness in disseminating and advancing knowledge widely throughout the Nation. Concurrently, the proposed legislation also would enable State universities to strengthen their participation in the sciences of natural resources management. These are persuasive reasons for establishment of broadly based water resources research centers at State universities. At the same time, the long-established activities and concern with agricultural water problems of the Agricultural Experiment Stations should be maintained and developed.

Confidence in the success of this arrangement is enhanced by the State universities' recognition of and readiness to accept the obligations and the opportunities of participation in water resources research activities. At its November 13, 1962, annual meeting, the Association of State Universities and Land-Grant Colleges, composed of 64 such institutions in the 50 States, endorsed and supported the principles that are embodied in S. 3579.

This confirms the desirability of provisions of the bill which leave the decision to establish water resources research centers to the universities themselves as they may be authorized by their State legislatures. Implicit in the bill, furthermore, is an obligation to provide a substantial amount of non-Federal financing for any State water resources research institute. This assures that such centers will be established in response to valid needs recognized by the States in which they are located.

The broad concept of the nature of water resources research explicit in the proposed legislation is of key importance. As defined in S. 3579, such research comprehends the horizon of physical and social sciences and engineering. From our own experience in the Interior Department, we are well aware that the disciplines of economics as well as hydrology, of ecology as well as geology, of law as well as physics are essential elements in developing the knowledge required for dealing with complex water resources problems. It is especially because interdisciplinary research is essential for water resource problems that universities can develop the needed approaches. At universities, the faculties of engineering, agriculture, natural sciences, economic and social sciences, and law can jointly attack the many-faceted research problems.

For like reasons, it is desirable that, in addition to the land-grant colleges and State universities, other universities and research institutions, many of

which have already exhibited a high degree of competence in water resources research, also be aided in water resources research. Title II of S. 3579 adequately meets this objective and makes it possible to enlist competence wherever it exists. The provisions of title II, in fact, make possible assistance in the development of high levels of competence where that is the objective of particular institutions. It should be noted with respect to title I of the bill, that its provisions are applicable to State universities and comparable institutions as well as to land-grant colleges.

Current review of ongoing and projected water resources research of the Federal agencies indicates that assistance to university research such as is contemplated by S. 3579 may be of interest to other Federal agencies as well as to the Department of the Interior. It would be the purpose of this Department to consult closely with other Federal agencies to the end that full consideration will be given to their views and recommendations relative to university research proposals. Thus, until their needs are otherwise provided, university research that other Federal agencies indicate they expect to be of value in the discharge of their assigned responsibilities would be supported to the same extent as proposals related to the missions of this Department. It should be recognized also that enactment of S. 3579 would not in any way preclude or limit assistance to university research, including research by the institutes, by other Federal agencies under whatever authorities they now have or may secure subsequently.

Another important benefit that will accrue from the authorization for assistance to water resources research at State universities, is the encouragement of centers in each State where State and local officials and others concerned in State, local, and regional water resource problems can secure research assistance and information especially pertinent to their particular problem. This will be a major factor in strengthening non-Federal participation in planning and carrying out water resources conservation and development work.

In regard to the detailed provisions of the bill, there are several amendments and comments we suggest to the committee for consideration. First, we feel it would be desirable to make some minor changes in section 100 to afford the States greater flexibility in determining the organizational form and location of the proposed water resources research institutes. Along this line, we suggest that the term "center" be substituted for the more confining word "institute," and that the centers be described as those which are "multidisciplinary in character" rather than "universitywide or collegewide," as this will permit drawing on the contributions of more than one institution in appropriate cases. We also suggest that the bill be so drafted as to permit the State to participate in a regional center serving more than one State if it so desired.

We suggest that the provisions of section 106 for reports and recommendations by the Secretary of the Interior on progress and accomplishments should be made applicable to title II as well as to title I. To this end, we recommend amendment of section 106 on page 8, line 7, by striking the words "title I" and inserting in lieu thereof "this act." Because such amendment would make the provisions of that section generally applicable to the act, it would be appropriate to move the present section 106 to become a new section 303, and to renumber the remaining section accordingly.

The Senate Select Committee on National Water Resources pointed out that improved coordination of Federal water research programs is probably of equal importance with increasing Federal efforts in the most promising fields of research. Some of the provisions of sections 200 and 202 of S. 3579 deal with this urgent but difficult problem by assigning certain responsibilities to the Secretary of the Interior. We, of course, stand ready to make whatever contribution we can. It must be recognized, however, that successful coordination cannot be accomplished through the efforts of one department alone, but can be brought about only through the wholehearted cooperation of all affected Federal agencies acting under the central direction of the President and his office and working through productive Government-wide coordinating machinery.

In considering what might be the appropriate role of this Department under the act in the field of coordination, the distinction between staff and executive functions should be kept in mind. The most important aspect of overall Federal coordination is the determination of the character and content of the research programs and allocation among the Federal agencies of responsibility for performance of the several component parts. This is the executive direction of the program and it is the responsibility of the President; in discharge of this responsibility the President is assisted by the Director, Office of Science and Technology, as provided in Reorganization Plan No. 2 of 1962.

There is wide agreement that certain additional staff services are required for effective coordination. These include: (a) the compilation and dissemination of information about the findings and conclusions of research—a function which has been seriously neglected, as emphasized in recent hearings before the Senate Committee on Government Operations; (b) the current cataloging of ongoing research so that there is readily available knowledge of what is being investigated by whom; and (c) the analysis of research activities in relation to research needs by a full-time professional staff of the highest caliber—that is, ascertaining what are the significant problems whose solution require research. These three elements of coordination, although related to the President's executive direction of the program, are different in character, inasmuch as they are staff rather than executive functions.

Provisions of S. 3579 would authorize organizational arrangements and funding for the three above-described staff activities. They are essential for effective progress of water resources research and there is wide agreement on the need for their performance. The December 21, 1962, letter from Dr. Jerome B. Wiesner, Director, OST, to Senator Anderson states that: "Mechanisms now exist in the Executive Office of the President for assuring necessary coordination of the type contemplated in section 200, which would place coordination responsibilities in a Water Resources Service of the Department of the Interior." Dr. Wiesner's letter describes the measures being considered to accomplish these purposes. The committee may, therefore, wish to amend section 200 in the light of that advice and of the effectuation of Reorganization Plan No. 2 of 1962. Our main concern is to see that these staffing functions are adequately provided for, and we feel that satisfactory staffing assignments can be worked out after consultation among the parties concerned.

An additional item that warrants attention is assurance that the authorizing legislation permits continuance of support of research activities beyond the single 12-month period of an annual appropriation. Most worthwhile research needs to extend over several years so as to afford adequate opportunity to pursue promising leads. Serious research often will not be undertaken by qualified scientists and engineers unless there is reasonable expectation of multiyear support. It is equally true that universities cannot be expected to provide laboratories or other facilities except on the basis of a continuing program. In order to dispel any uncertainty on this score, we recommend that title II be amended by inserting on page 9, line 2, after the word "years," the following: "and to continue at the rate of \$10 million annually thereafter."

The provisions in the act authorizing Federal financial assistance to private research projects raise the question of protecting the public interest in any patents which might be developed as a result of such research. Three recently enacted statutes authorizing the Department to contract for research in the fields of coal, saline water, and helium require that patents and other results of Government-financed research be available to the general public royalty free. A similar provision would appear to be appropriate for inclusion in the bill.

While the Virgin Islands, Guam, and American Samoa are not eligible for assistance under title I, we hope that in years to come the fledgling institutions of higher learning in these territories will develop to the point where they would be qualified to assume the responsibility for establishing water resources research institutes, and the necessary legislative amendments can be made at that time. Meanwhile, we note that appropriate entities in the territories would be eligible to receive research project assistance under section 201.

Enclosed is our 5-year estimate of personnel and other costs as required by the act of July 25, 1956 (5 U.S.C. 642a). In preparing these estimates, we have anticipated that the centralized administrative staff, although high in caliber, would be quite small in numbers. It also is our intention to rely heavily on an extensive series of highly competent consultants for guidance in selection of research proposals for assistance. This would bring to the Government the best guidance in the various scientific and engineering fields available outside of the Federal Government. In general, there is reason for confidence that the expenses of program administration can be held within the limitations of the bill, although we recognize that expenses such as those that fall in the cataloging and dissemination functions might in time develop to the point where the 4-percent limitation contained in section 300 might have to be increased.

In conclusion, in addition to enthusiastically urging enactment of S. 3579, we want also to concur fully in the view that it would be complementary to continued and enlarged research by Federal scientists employed in the several

departments. Valuable as will be the advances in water resources knowledge that flow from the program contemplated by S. 3579, such "extra-mural" research in universities can in no sense substitute for the ongoing research of the agencies, including contract research that is an integral part of agency programs. Along with strengthening research at universities, we should concurrently strengthen "in-house" research of the Federal agencies. Certainly there are plenty of problems for both groups.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the administration's program.

Sincerely yours,

STEWART L. UDALL,  
*Secretary of the Interior.*

S. 3579, A BILL TO ESTABLISH WATER RESOURCES RESEARCH INSTITUTES AT LAND-GRANT COLLEGES AND STATE UNIVERSITIES AND TO PROMOTE A MORE ADEQUATE NATIONAL PROGRAM OF WATER RESEARCH

*Estimated additional man-years of civilian employment and expenditures for the first 5 years of proposed new program*

	19cy	19cy+1	19cy+2	19cy+3	19cy+4
Estimated additional man-years of civilian employment:					
Supervisory and professional.....	4.5	7	9	11	12
Clerical.....	8.0	13	18	22	25
Consultants (w.a.e.).....	12.0	13	14	15	16
Total, estimated additional man-years of civilian employment.....	14.5	23	31	38	43
Estimated additional expenditures:					
Personal services.....	\$165,000	\$265,000	\$355,000	\$425,000	\$475,000
All other.....	6,700,000	10,500,000	14,000,000	16,400,000	18,500,000
Total, estimated additional expenditures.....	6,865,000	10,765,000	14,355,000	16,825,000	18,975,000

<sup>1</sup> 1 man-year equivalent to 300 man-days.

EXECUTIVE OFFICE OF THE PRESIDENT,  
OFFICE OF SCIENCE AND TECHNOLOGY,  
*Washington, D.C., January 1, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR: I am pleased to respond to your request for my comments on S. 2 aimed at promoting a more adequate national program of water research.

In my letter to you of December 21, 1962, I commented extensively on its predecessors, S. 3579 introduced in the 87th Congress. A copy of that letter is attached since it states my views concerning the objectives and general character of the legislation needed to accomplish the purposes of that bill which are similar to those of S. 2. I am pleased to note that the revisions incorporated in the latter bill reflects favorable consideration of many of the points raised in my letter.

Based on our studies of the Federal programs and activities in water resources research, I am confident that S. 2 can contribute significantly to the strengthening of the capabilities of the colleges and universities to undertake broadly based research and analysis in the many disciplines bearing on water resources. I wish to reiterate, however, that the Government should adhere to high standards of quality in the administration of the program envisaged in S. 2. It would seem desirable to have specific language in the bill to this effect in order to make it clear to both the Government and the universities that this is the intent of the Congress.

Sincerely yours,

JEROME B. WIESNER.

EXECUTIVE OFFICE OF THE PRESIDENT,  
OFFICE OF SCIENCE AND TECHNOLOGY,  
Washington, D.C., December 21, 1962.

Hon. CLINTON P. ANDERSON,  
Chairman, Committee on Interior and Insular Affairs,  
U.S. Senate, Washington, D.C.

DEAR SENATOR: This is in response to your request for my views on the water resources research bill (S. 3579) of the Senate Committee on Interior and Insular Affairs. I appreciate the opportunity to comment on the scientific and technical aspects of the bill.

Legislation along the general lines of the bill could serve a useful purpose in providing additional authority and funds for a concerted approach to the problems in the field of water resources research. To carry out the additional research in water resources needed to assure an abundance of water of adequate quality requires augmentation of research in the universities to more effectively utilize their research potential, to bring to bear the several interrelated disciplines bearing on water resources, and to train the new scientists and engineers sorely needed for research and teaching in this field.

Some half dozen Federal departments and agencies have major responsibilities in water resources requiring research. They support research in their own laboratories and in the universities in accordance with their missions. The extent of such support is quite modest in relation to the needs for better understanding of the problems involved. Shortages of highly trained manpower would particularly limit the expansion of creative research in this field even if more funds were made available. There are many different kinds of research needed in water resources ranging from basic scientific research, on the one hand, to applications engineering and economic analyses on the other. There is a special need for research and analysis that draws on the combined talents of scientists, engineers, social scientists, economists, lawyers, and others. There is also a need at local levels for technical analyses and studies to apply the findings of research. The research problems may be national or highly local in character.

As I perceive the broad objective of legislation along the lines of the bill, it should be aimed at supplementing existing agency arrangements for support of water resources research by fostering university planned and initiated research and investigation that draws on the diverse scientific, technical, and other skills throughout the schools and departments of the university or college; that is directed at State, regional, or National water resources problems; and that is not shaped by the mission of a particular Federal agency providing financial support. Federal support of a program of this nature would need to be administered in the broad national interest and in the interests of all the Federal agencies having missions in water resources.

I would hope that the flavor of the foregoing remarks could better be reflected in your bill so that there would be no misunderstanding as to its objective to supplement existing forms of support in certain important respects. On the other hand, by strengthening and expanding universitywide and college-wide capabilities for water resources research, additional research potential would be made available to all of the interested Federal agencies.

#### WATER RESOURCES RESEARCH INSTITUTES

Title I of the bill recognizes the need for financial incentives to encourage special organizational arrangements for the creation of universitywide research centers, whereby workers in several disciplines can be brought together in a common approach to problems of water resources research. There is provision for "seed money" to assure sustained research at such centers on problems deemed important by the universities and States. The sharing feature of the bill is desirable to provide tangible expression of both State and university interests.

While supporting these measures, I would like to offer several suggestions with respect to title I:

(a) I question whether the organizational unit for carrying out water resources research at the universities should be specified in legislation as water resources research "institutes," since the bill's objective is to create within the designated institution an organizational framework for advancing universitywide research in water resources. In some instances an institute for water resources research might fit into the organizational pattern of the educational

institution. In other cases, it may be preferable to strengthen the competence where it resides in the university, and to bring it into focus on water resources problems through other types of organizational arrangements than research institutes. In any case, it would seem undesirable to require a particular form of university organization for research in water resources as a condition for Federal support. Considering the uniqueness of each university in terms of its organization and research capabilities, the form of organization should be determined by the institution.

(b) In view of the limited availability of technical manpower to support university centers for water resources research, and the regional nature of many water resources problems, it would seem highly desirable in section 100(a) to authorize and encourage States to join together in support of a single research center where their common interests would be better served.

(c) Although section 100 would cover arrangements "substantially equivalent" to land-grant institutions, it is important to adhere to the principle that water resources research centers be located at the most qualified institution, whether public or private.

(d) The provisions of title I would need to be administered so as to avoid sudden and excessive pressures to establish more water resources research centers than can be staffed with qualified scientists and engineers. The on-going water research effort should be protected from disruptive dislocation of the meager number of scientists and engineers working in this field from one institution to another, particularly from Government laboratories where much of our scientific competence in this field now resides. Thus, consideration should be given to revision of section 104 of title I to make it clear that the responsible agency would have discretion to deny a grant to an institution where the purposes of the grant under section 100(a) would not be achieved. The agency should also clearly have discretion to approve or disapprove proposals for matching grants for research support under section 100(b), to be exercised in accordance with criteria developed in consultation with the other Federal agencies engaged in water resources research. There should be ample authority to insist on high standards of quality in judging research capabilities deserving of Federal assistance.

(e) Although the administrative responsibility for implementation of the act will need to be placed in a single agency, all agencies having missions in water resources should have the right to participate concerning policies, criteria for evaluation, rules, and regulations. This is required because a substantial amount of research on various phases of water resources at the universities is being supported by a number of Federal agencies through a variety of arrangements; and this support should be continued and strengthened. The act will need to be administered with careful consideration of the interests of all Government agencies in view of the shortage of scientists and engineers in the water resources field and the many research needs of the Government. Section 104 should recognize the interests of other agencies in the assignment of responsibility for coordinating and guiding research under title I and for assisting cooperation between the institutes and the Federal Government.

#### EXTRAMURAL RESEARCH GRANTS

In order to satisfy the research needs in water resources and facilitate the training of new scientists, there needs to be augmentation of present types of support of research and education at the universities in fields relating to water resources. Such research should be supported by all of the Federal agencies engaged in water resources research, and they should all have ample authority for this purpose. At the present time, the Department of the Interior does not have sufficiently broad authority to make research grants and contracts with educational institutions. In this regard, section 201 of the bill is desirable. Since the other agencies have coordinate responsibilities and interests, the language of section 201 needs to be restricted to provide the Department of the Interior with a significant extramural research program for the purpose of serving its own mission responsibilities in water resources.

#### COORDINATION

Mechanisms now exist in the Executive Office of the President for assuring necessary coordination of the type contemplated in section 200, which would place coordination responsibilities in Water Resources Service of the Depart-

of the Interior. With the passage of Reorganization Plan No. 2 in the last session of Congress, the Office of Science and Technology has been given responsibilities for assisting the President in the coordination of Federal science programs. Working closely with the Federal Council for Science and Technology, The OST can provide the focal point for encouraging and bringing about such coordination. Serious consideration is being given to the establishment of a coordinating committee on water resources research under the Federal Council and to the creation of a high caliber analytical staff for support of the work of the Federal Council in developing a coordinated water resources research program.

The inventory of current efforts in water resources research contemplated in section 202 is needed. However, legislation is not required for this purpose; nor would it be desirable to make this a statutory responsibility of a given department or agency. This is a matter for consideration by the Federal Council for Science and Technology in the context of the overall management of scientific and technical information within the Government.

The Committee on Interior and Insular Affairs has made an outstanding contribution to public understanding of the serious nature of the water resources problem, and it has shown a way for meeting this problem through research and education. The committee's work has been of great value to the executive branch in developing a coordinated research program.

We are grateful to you and your committee for your leadership and for the thorough and understanding manner in which you have approached this complex subject.

Sincerely yours,

JEROME B. WIESNER.

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#### FEDERAL POWER COMMISSION REPORT ON S. 2, 88TH CONGRESS

A bill to establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities and centers of competence, and to promote a more adequate national program of water research.

This bill, if enacted, would be known as the Water Resources Research Act. Title I of the bill would authorize the establishment of a state water resources research institute or center at a land-grant college or university or other institution of higher education in each state for the purpose of conducting research in relation to water resources. In addition, the Secretary of the Interior would be authorized to match funds made available to such institutes or centers by the states or other sources to meet the expenses of specific water resources research projects. The proposed water resources institutes would be patterned after the agricultural experiment stations currently located at land-grant institutions.

Title II of the bill would authorize annual appropriations over a 5-year period to the Secretary of the Interior from which fund he would be empowered to make grants, contracts, matching, or other arrangements for research into water problems by educational institutions, private foundations, and other institutions, private firms or individuals; and with local, State, and Federal Government agencies.

The administration of the various research programs authorized by the proposed enactment would be under a Water Resources Service to be set up by the Department of the Interior.

The bill makes specific mention of certain types of research which would be conducted, including the hydrological cycle, supply and demand for water, conservation and best use of available supplies, methods of increasing such supplies, economic, legal, social, engineering, recreation, biological, and other aspects of water problems.

The bill specifically states that the research programs authorized thereby are designed to supplement present programs and are not intended to supplant the work of various other public and private agencies engaged in water resources research. Section 301 expressly provides that the proposed legislation shall not be construed as giving the Secretary of the Interior "any authority or surveillance over water resources research conducted by any other agency of the Federal Government, nor shall it be construed as repealing, superseding, or diminishing existing authorities or responsibilities of any agency of the Federal Government to plan and conduct, contract for, or assist in research in its areas of responsibility and concern with water resources." In this connection, it also

should be noted that the Secretary, in prescribing appropriate rules and regulations for administering the act, would be required to do so only "after full consultation with other Federal agencies."

It appears, therefore, to be the intent of this legislation that the work of the research institutes or centers and any other research programs which may be initiated under this proposal be closely related to and carried out coordinately in cooperation with the work of existing Federal agencies such as the Corps of Engineers, the Bureau of Reclamation, the Weather Bureau, Geological Survey, Public Health Services, Bureau of Outdoor Recreation, and the Office of Saline Water.

Pursuant to the provisions of the Federal Power Act, the Commission issues licenses to citizens, corporations, States, and municipalities authorizing the construction, operation, and maintenance of waterpower projects on lands of the United States and on streams over which the Congress has jurisdiction. Closely related to the licensing activities are the Commission's responsibilities under the Flood Control and River and Harbor Acts to advise and make recommendations to the Federal constructing agencies on power matters. In both activities the Commission makes basinwide investigations and studies of the possible multiple-purpose uses of rivers and their tributaries. Thus, the Commission has an important interest in all phases of water resource development and in research related thereto. Any effective measures designed to further research in this field would be of value to the Commission.

The Commission therefore supports the purposes and objectives of this bill.

FEDERAL POWER COMMISSION,  
(Signed) JOSEPH C. SWIDLER, *Chairman*.

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EXECUTIVE OFFICE OF THE PRESIDENT,  
BUREAU OF THE BUDGET,  
*Washington, D.C., February 15, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in reply to your letter of January 24, 1963, requesting the comments of this office with respect to S. 2, to establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities and centers of competence, and to promote a more adequate national program of water research.

Under title I of the bill, funds would be authorized for distribution by the Secretary of the Interior to land-grant or other State designated institutions for the purpose of establishing water resources research institutes. Additional funds would also be authorized which the Secretary could use to match funds made available to the institutes by the States or by other sources.

Title II of the bill would authorize additional appropriations to the Secretary of the Interior from which he could make grants, contracts, or other arrangements with Government or private agencies and institutions. Title III contains certain miscellaneous provisions related to the administration of programs under the bill, including authority for the Secretary of the Interior to establish in the Department a Water Resources Research Service.

We recently provided views on a predecessor bill, S. 3579, to your committee and also informally suggested alternative language on certain provisions of that bill to committee staff. It is noted that a number of our comments on S. 3579, as well as those of other agencies, were taken into account in the drafting of S. 2. Consequently, we are now commenting on only two aspects of the bill which pose difficulties.

There is no explicit statement in the bill that the Secretary of the Interior is to approve plans for and review research being conducted under title I to assure its adequacy and conformance with the broad objectives of the bill. Section 101 contemplates that the Secretary is to be concerned with fiscal controls to assure that funds are not misapplied. Section 104 provides that the Secretary is to prescribe rules and regulations to carry out provisions of the bill and is to furnish assistance to research institutions. Because these actions do not provide adequate authority to the Secretary of the Interior in administering the program, we believe he should be authorized to set standards for research and to monitor adherence thereto. To that end, we would suggest that language such as the following be inserted at the end of section 100 of the bill: "The Secretary

shall approve proposals for and maintain a review of all research under this section to assure high standards of quality." In the interests of promoting strong research programs we would expect the Secretary of the Interior to encourage cooperative arrangements among State water research agencies, as envisioned under section 102, whenever appropriate. We recommend specific language to this effect be included in the bill.

Finally, we believe that provisions of title III with respect to establishment of a Water Resources Service within the Department of the Interior are unnecessary and undesirable. The Secretary of the Interior now has adequate reorganization authority to take future action if and when he so decides. Furthermore, in view of the general authorization provided in the Postal Service and Federal Employees Salary Act of 1962, special personnel provisions should not be required to staff new constituents of the Department.

Strengthening of university water research activities would constitute a major step toward meeting goals set forth by the President in the water resources area. The Bureau of the Budget advises that enactment of legislation along these lines would be in accord with the President's program.

Sincerely yours,

(Signed) Phillip S. Hughes,  
PHILLIP S. HUGHES,

*Assistant Director for Legislative Reference.*

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,  
*Washington, February 18, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,  
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This letter is in response to your request of January 24, 1963, for a report on S. 2, the proposed "Water Resources Research Act."

We are wholly in sympathy with the bill's basic objective to promote a more adequate national program of water research. However, for the reasons summarized below, we question the need for title I of the bill, and we are not wholly in accord with the provisions of title III.

The provisions of title II of the bill—authorizing appropriations to the Department of the Interior to be used for grants, contracts, or matching or other arrangements for conducting research into aspects of water problems related to its mission (not defined in the bill)—are desirable and in accord with existing accepted methods for productive Federal research participation. They provide for the widest possible participation by scientists in research on water resources matters, permit all institutions, public and private, and all disciplines to participate, and can be administered to supply stable support for programs in universities and yet obtain flexibility in research approach. And they would give to the Secretary of the Interior research and research-support authority comparable to that which is vested in this Department under the Water Pollution Control Act in order to promote good-quality water adequate for all legitimate uses.

If title II is enacted and similar authorization is provided, as it should be, for all other Federal water resources agencies that now lack such authority, there is, in our opinion, little, if any, need for the proposed title I programs under which grants would be made by the Secretary of the Interior for the establishment and support of a water resources institute or center at a land-grant college or other State-designated educational institution in each State (including Puerto Rico). However, if title I is retained, some modifications are indicated. In the first place, the complete spectrum of water resources aspects specified as subjects for desirable research and investigations to be conducted by the proposed water research agencies is necessarily of basic interest to all Federal water resources agencies. We would therefore suggest participation by other Federal departments in the formulation of the rules and regulations necessary to carry out these provisions, with the Secretary of the Interior promulgating them. Secondly, we recommend deletion of the provision of section 104 that would require the Secretary of the Interior to encourage and assist in the establishment and maintenance of cooperation between the State research agencies and Federal establishments. We have encountered no difficulties in this regard in the administration of our research programs and,

from the standpoint of this Department, do not perceive any need for an intermediary agent as proposed.

Finally, if the provision for a central water research and investigations catalog is retained in the bill (instead of leaving this matter to administrative discretion), we recommend that the function of establishing and maintaining such a coordinating device, on the basis of reports from Federal and other agencies and organizations, be vested in the Office of Science and Technology—which already has responsibilities for review and coordination of major Federal activities in scientific research—instead of deferring its transfer, as provided in the bill, to the time when, if ever, a central catalog is established for all scientific research.

If the bill is modified as above suggested, we would have no objection to its enactment.

The Bureau of the Budget advises that, while there is no objection to the submission of this report, the enactment of legislation along the lines of S. 2 would be in accord with the program of the President.

Sincerely,

ANTHONY J. CELEBREZZE, *Secretary.*

DEPARTMENT OF THE ARMY,  
*Washington, D.C.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,  
U.S. Senate.*

DEAR MR. CHAIRMAN: Reference is made to your request to the Secretary of Defense for views of the Department of Defense with respect to S. 2, 88th Congress, a bill "to establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities and centers of competence, and to promote a more adequate national program of water research." The Department of the Army has been assigned responsibility for expressing the views of the Department of Defense on this bill.

Title I of the bill would authorize appropriation of \$75,000 annually, increasing to \$100,000 in the third year, to each of the States to help finance a collegewide or universitywide water resources research institute or center. There would be authorized appropriation of an additional \$1 million, increasing to \$5 million in the fifth year, which the Secretary of the Interior would be authorized to use to match State or other non-Federal funds for specific water research projects at these institutes or centers.

Title II of the bill would authorize to be appropriated to the Secretary of the Interior \$5 million, increasing to \$10 million in the fifth year and annually thereafter, from which he would make grants or enter into contracts or make matching or other arrangements with educational institutions, private entities, or governmental agencies for research into water problems related to the Interior Department mission.

Title III would authorize the Secretary of the Interior to establish in the Department of the Interior a water resources service for the purpose of administering programs authorized in the bill. Section 301 states that nothing in the bill is intended nor shall be construed as giving the Secretary of the Interior any authority or surveillance over water resources research conducted by any other agency of the Federal Government.

The Department of the Army believes that an expansion of State research in the water field, supplementing and complementing the water research of the Federal agencies, would be desirable. Moreover, it is believed that an increase in the grants which the Federal Government now makes to the States to encourage research would be justified by the benefits which would accrue to the Nation as a whole. Hence, the basic objective of S. 2 has the full support of the Department of the Army, on behalf of the Department of Defense.

The attention of the committee is invited to the fact that the National Science Foundation has broad authority for making grants for basic research. In addition, as you are aware, the Office of Experiment Stations in the Department of Agriculture already has organizational facilities through which Federal grants-in-aid of research are being made annually to land-grant institutions. Other important grants to the States for water research are made by the Public Health Service in the Department of Health, Education, and Welfare. In view of the

existence of such agencies, we question the need for establishment of still another agency to administer such programs. Accordingly, the Department believes that they could most appropriately be administered by the National Science Foundation.

The attention of the committee is invited to the fact that the Federal Council for Science and Technology's Task Group on Water Resources Research, on which all of the water resources agencies were represented, has made a careful study of the need for legislation to strengthen the field of water resources research through providing authority for multidisciplinary program grants, extramural research grants, and education and training. Prior to completing its consideration of this bill, it is suggested that the committee should have the benefit of the report of the task group. This Department understands that the report will include a recommendation that a water resources committee be established under the Federal Council for Science and Technology; that committee would be assigned the responsibility for coordinating the planning and programming of Federal in-house and extramural programs of water resources research.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that the enactment of legislation along the lines of S. 2 would be in accord with the program of the President.

Sincerely yours,

(Signed) CYRUS R. VANCE,  
*Secretary of the Army.*

DEPARTMENT OF AGRICULTURE,  
*Washington, D.C., February 19, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate.*

DEAR MR. CHAIRMAN: Thank you for your letter of January 24, 1963, giving us the opportunity to report on Senate bill 2. The bill is entitled "To establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research."

We support the purposes of S. 2, as it would stimulate water resources research in colleges and universities, thereby strengthening the overall research in this significant field and at the same time helping train new scientists and engineers that are much needed for research and teaching in this field.

Title I of S. 2 authorizes an appropriation of \$75,000, increasing to \$100,000 in the third year, to each of the States to help finance a collegewide or university-wide water resources research institute, center, or equivalent agency. It further authorizes an appropriation of an additional \$1 million, increasing to \$5 million in the fifth year, which the Secretary of the Interior may use to match State or other non-Federal source funds for specific water resource projects.

Title II of S. 2 authorizes an appropriation of \$5 million, increasing to \$10 million in the fifth year, which the Secretary of the Interior may use for grants, contracts, matching or other arrangements with educational institutions, private foundations, or other institutions; private firms and individuals; local, State, and Federal Government agencies to undertake research into any aspects of water problems related to the mission of the Department of the Interior which may be deemed desirable and would not otherwise be studied.

Title III contains certain miscellaneous provisions related to the administration of programs under the bill.

The magnitude of public and private programs to make efficient and effective use of the Nation's soil and water resources is well known.

The U.S. Senate, through its exhaustive "Report of the Select Committee on National Water Resources," has made the public increasingly aware of the Nation's water problems—problems which make it incumbent upon the research agencies to make new advancements in their solutions.

The Department of Agriculture is concerned that the proposed bill covers only a part of the total coordinated program of scientific research on water as requested by the Senate Select Committee on National Water Resources.

The Department of Agriculture has outlined a comprehensive program of basic and applied research on the production, development, management, and use of water on crop, forest, and rangeland watersheds. In its proposed program the Department would direct its studies toward obtaining a better understand-

ing of the basic relationships between the quantity, quality, and management of water and the development and use of other resources of crop, forest, and rangelands. Research is now and in the future would be aimed at economic and institutional problems of water use, improving water yields from our forested watersheds and rangelands, increasing efficiency in the agricultural use of water, and protection of our soil resources from uncontrolled water. Such a program would be substantially as outlined in committee print No. 28, Senate Select Committee on National Water Resources entitled "Water Resources Research Needs."

Agriculture's tremendous responsibility in the effective use of water is evident when we consider some of the data on water use and management. The average annual precipitation for the conterminous United States is 4.75 billion acre-feet. The first impact of this primary water supply is on the surface of the land. The nature of vegetative cover, slope, soil characteristics, cropping patterns, and conservation practices exert the first determination whether precipitation becomes surface runoff, deep percolation, or soil moisture for evapotranspiration. The lion's share of this total water supply—3.38 billion acre-feet—presently is used by evapotranspiration from vegetative lands. The remaining 1.37 billion acre-feet constitute the massed water supply available to the Nation. Irrigation agriculture is dependent on this supply and accounts for 90 percent of the water that is consumptively used.

How land in farms and forest, and rangeland not in farms, are managed has a tremendous impact on the potential yield and use of water. In fact, water, soil, and vegetation are so closely related that they cannot be managed separately. Thus, it has been logical and necessary for the U.S. Department of Agriculture to develop programs of soil and water research and watershed management over the past 50 or 60 years. The close association in the U.S. Department of Agriculture between research and action in land and water use is of great importance. Each serves the other. Action programs in the U.S. Department of Agriculture dealing with more than three-fourths of the land area in the United States are principal users and often the first to use research results. They provide practical tests for research and point the way to new investigations. Also, research is often directed to specific management problems.

This partnership of research and management in the U.S. Department of Agriculture has produced an understanding of the close association of soil, water, and vegetation resources. The long background of experience and interest has established in the Department a capability acquired through a long tradition of scientific research. This has enabled it to make the major contribution to progress in the entire field of soil and water conservation research. The Department of Agriculture's long history of effective cooperative and coordinated work with the program of the land-grant colleges as established under the Morrill Act of 1862, including cooperative work carried out under the Hatch Act of 1887, further establishes its position of leadership in conducting the type of effort proposed in title I of the bill. The proposed administrative arrangements in title I would unavoidably complicate this relationship and generate new problems of research coordination at the State level.

We construe the language of section 100(a) to render eligible the State agricultural experiment stations as qualified for designation, at the option of the land-grant college, as a water resources research institute, center, or equivalent agency.

Title II of the bill we wholeheartedly support, but recommend that it be broadened to include the Secretary of Agriculture and the mission of the Department of Agriculture so that the established technical competence in each of the Departments will strengthen the total needed effort in water resources research. The Department of Agriculture currently has very limited authority for research grants other than the Hatch Act as amended.

This Department is seriously concerned about some of the provisions contained in title III of the bill. We question whether it is the most effective form of organization to authorize one of the departments participating in water research to exercise a coordinating role in relation to the activities of other departments. We suggest that this coordinating role might more properly be exercised by the Executive Office of the President. These comments apply particularly to section 300.

The Bureau of the Budget advises that enactment of legislation along the lines of S. 2 would be in accord with the program of the President.

Sincerely yours,

ORVILLE L. FREEMAN, *Secretary.*

THE SECRETARY OF COMMERCE,  
Washington, D.C., February 19, 1963.

Hon. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,*  
*U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This letter is in reply to your request for the views of this Department with respect to S. 2, a bill to establish water resources research centers at land-grant colleges, and State universities, to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research.

The bill would authorize grants of \$75,000 annually (to be increased eventually to \$100,000 annually) to land-grant or other institutions designated in each State for the financing of water-research institutes therein. The bill would also authorize appropriations of \$1 million for fiscal year 1964, and greater amounts in succeeding years for grants to be matched by the States and used to finance water resources research projects at such institutes. Finally, the bill would authorize appropriations of \$5 million for fiscal year 1964, which would increase annually by \$1 million for 5 years to be used for any aspects of water research related to the mission of the Department of the Interior.

The Department of Commerce believes that increased emphasis should be placed on water resources and related research, and we are, therefore, in favor of the objectives of S. 2.

We feel that the establishment of 50 or more separate research institutes might result in duplication of effort and consequently in some inefficiency. Although there may be a need for a geographically dispersed program in some research fields such as agriculture, the needs of water resources research programs are quite different. Therefore, the same degree of dispersal for water research is not necessarily justified by the satisfactory experience under agricultural research programs. This objection might be met by establishing only a limited number of water-research institutes by States cooperatively on a regional basis.

The Bureau of the Budget advises that enactment of legislation along the lines of S. 2 would be in accord with the program of the President.

Sincerely yours,

C. D. MARTIN, Jr.  
*Acting Secretary of Commerce.*

Senator ANDERSON. I introduced a first draft of this water research bill last July for the purpose of having it studied, getting reports and preparing a revised version.

There were many very constructive and helpful suggestions made to us. Most of them were incorporated in the bill and it was reintroduced on January 14 and became S. 2 of the 88th Congress, which is before us today.

We have a distinguished list of witnesses, including a panel of five outstanding State University educators and equally distinguished scholars and experts in the water research field from other institutions of higher education and private life. There are also our faithful following of organizational representatives, whom we see rather regularly. They render this committee a real service the year around by bringing the viewpoints, the ideas and the positions of their constituencies on many matters. They are always welcome and appreciated.

Since some of you will leave before the close of the hearings, I want to thank all witnesses now for their part in this hearing. I believe we are dealing with a measure that can make a significant contribution to the continued growth and well-being of our country. I deeply appreciate, and I am sure other committee members join me, the time that each of you has taken to study S. 2, to prepare comments, and to assist in its consideration.

Senator ANDERSON. Senator Bible, did you want to comment on the bill?

Senator BIBLE. Mr. Chairman, I would like to endorse this bill and congratulate you on formulating it and sponsoring it.

We have the desert research center at the University of Nevada. As the committee print on water research projects shows, it is doing research work on reduction of evaporation, increasing streamflow and forage production through the eradication of undesirable plants, water quality, weather modification, underground water, drainage, integrated ground and surface water management, and other problems of an arid area.

Unfortunately, we do not even have a supply of saline or brackish water to offer us hope in the Great Basin, except in the Salt Lake area, and we don't want to empty the lake. Success of the saline water work, which I heartily support, will not improve our situation much, if any at all.

Our great hope for water to sustain growth and economic development lies in careful management of every drop we have, and in weather modification—more rain and snowfall. That appears to be several years away.

In looking over the projects of the University of Nevada, I am impressed that the university officials are having to more or less stitch together a program, project by project, as they go along. They use Hatch agricultural research funds, National Science Foundation grants and in one instance they have two State agencies and six Federal agencies cooperating in a project.

It seems to me that the section 100(a) funds provided in the bill—a regular, basic allowance for the maintenance of a water resources research institute or center—provide a very important assurance of a continuing, minimum program, which will make it possible for the university to attract more of its faculty people to work on water problems. There will no longer be the threat that the program will phase out as projects are completed. I am sure that both the 100(a) and 100(b) funds will make possible research which will pay manifold dividends, not just to Nevada, but the Nation. What we learn about phreatophytes and other useless plants, or weather modification, or conservation of water by improved irrigation practices, will be of use in other States, and in other nations around the world.

We are eyeball-to-eyeball with water shortage in Nevada. It is not difficult for us to see not just the practicality, but the urgency, of the program Senator Anderson has proposed. Perhaps some of the humid States will not have such a feeling of urgency for another decade, or even two or three decades. But I suggest that it will be their good fortune that this program was started well before they are hard pressed by their water problems, as we are in Nevada.

I am impressed that the provisions of the bill agree, almost item by item, with the needs and recommendations subsequently made by the Water Resources Task Group of the Federal Council for Science and Technology. It provides for the development of additional centers of water research, for aid on both the continuing and project basis recommended by the Council, for local autonomy and for unified Federal administration.

This program will both get needed research done and train the increasing number of experts we need in the water field in the years just ahead.

Thank you, Mr. Chairman, for the opportunity to make this statement. This is a fine bill which we should enact without delay.

Senator ANDERSON. Thank you, Senator Bible.

Since I mentioned the new Member from Arizona and expressed my joy in seeing him here, I see Senator McGovern of South Dakota is also here for the first time. George, we welcome you and are very happy to have you take your place on this Committee.

Senator MCGOVERN. Thank you very much.

Senator ANDERSON. The Committee has letters and statements on S. 2 from Senators Hart, Morse, Engle, and Fong—all supporting the bill—which will go in the record at this point.

(The statements referred to follow:)

U.S. SENATE,  
Washington, D.C., February 19, 1963.

HON. CLINTON P. ANDERSON,  
*Interior and Insular Affairs Committee,*  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR: S. 2, which I was privileged to cosponsor with you will, I believe, be a very important milestone in the Nation's effort to tackle the water problem.

We in Michigan used to think that this was something for the West to worry about, that we had an inexhaustible supply of fresh water. We are learning, better every day, that this is not so.

In this respect, the work of the Senate Select Committee on National Water Resources served us well. I remember particularly the hearing in Detroit, where Dean Fontanna told us: "One of the remarkable things about the Great Lakes is the tremendous lack of knowledge of the waters of the Great Lakes. It is a matter of fact that the amount of research into the various aspects of the waters of the Great Lakes has been very, very minimal. It has been attacked spasmodically by State agencies, and by Federal agencies and by the Canadian Government, but only spasmodically and on a very, very small scale."

Certainly I share your conviction, embodied in S. 2, that our State resources for research must be fully and effectively utilized. I am proud that Michigan State University has already established a water resource institute, and that the University of Michigan's competence has received additional national recognition with the location of the new Public Health Service Water Pollution Laboratory at Ann Arbor. Others of our institutions are also contributing to our knowledge and ability in this field.

This program will be welcome in Michigan, and I wish to add my word of support for early passage of the legislation.

Sincerely,

PHILIP A. HART.

U.S. SENATE,  
COMMITTEE ON FOREIGN RELATIONS,  
February 18, 1963.

HON. CLINTON P. ANDERSON  
*United States Senate, Washington, D.C.*

DEAR CLINT: I note that on February 19 and 20 your subcommittee will be hearing witnesses on S. 2.

This is a measure which has my full support. It is my hope that the subcommittee, the full committee and the Senate will take early and favorable action upon it.

With best personal regards.

Sincerely,

WAYNE MORSE.

U.S. SENATE,  
COMMITTEE ON COMMERCE,  
February 25, 1963.

Hon. HENRY M. JACKSON,  
*Chairman, Senate Interior and Insular Affairs Committee,*  
*U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: I should like to endorse the testimony in support of S. 2 that was presented by Dr. Daniel G. Aldrich and Dr. Omer J. Kelley, of California, at the committee hearings on February 18 and 19. Thank you for your consideration of their interest in water research work.

As a cosponsor of S. 2, I am pleased to note the favorable reports on it submitted by the Department of the Interior, the Budget Bureau, the Federal Power Commission, and the President's Office of Science and Technology.

With kindest regards,  
Sincerely yours,

CLAIR ENGLE, *U.S. Senator.*

STATEMENT OF HON. HIRAM L. FONG, A U.S. SENATOR FROM THE STATE OF HAWAII

I appreciate this opportunity to submit this statement in support of S. 2, the water resources research bill. As a cosponsor of the measure, I heartily endorse the objectives of the bill and the approach proposed for dealing with this all-important subject of research into water resources.

There is every reason to be concerned over the growing problem of water shortages in the United States. The enormous increase in population, the rising per capita consumption of water, the increasing pollution, the shortage of transmission and distribution facilities—all contribute to a major problem for our Nation.

S. 2 is designed to establish water resources research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research. By these means, I believe we can go far toward achieving the objective of assuring the Nation at all times an abundance of water, both as to quantities and quality.

Speaking for the people of the State of Hawaii, I wish to express the great importance we place upon water research in coping with our present problems and the future growth of our island economy.

We, too, have had our problems of water shortages. While we share the general problem with some other sections of the country, the causes of our trouble are unique. It will require local research to overcome them.

In 1959 the Senate Select Committee on National Water Resources, chaired by the late Senator Robert S. Kerr, agreed that separate and specific attention should be given to the water problems of Hawaii and Alaska because in many respects the water problems of the two newest States are far different from those of the contiguous States of the United States. Moreover, the committee noted that the two States have not had the benefit of longstanding water resources programs which have been carried out in the older States.

At the committee's request, the Secretary of the Interior prepared and submitted a report covering the water resources of Hawaii. The Department's report pointed out that the Hawaiian Islands receive an abundant rainfall but that because of mountainous terrain precipitation is distributed unequally and because of seasonal variations in precipitation there are several areas with recurring water shortages.

However, the report pointed out that the water problems of the islands can be solved if the economic problems relating to the development of the water resources can be solved, as the water resources are there and can be made available if we are willing to pay the relatively high costs involved.

The Department of the Interior identified the major water problem in all of the islands of Hawaii as one of adequate supply for expansion of man's activities. "As the population of the islands is increasing rapidly—it more than doubled between 1930 and 1959—the demand for water is also increasing rapidly," the Department's report noted. "Much of the increase in demand on Oahu arises from the greater per capita demands as well as the greater number of people.

There are sizable tracts of land on each of the islands that could be agriculturally productive if adequate water could be found for them. Many problems arise because of the lack of complete knowledge about ground water."

The report then described the problems facing each of the islands, pointing out the areas of water shortages. In recent years we in the State of Hawaii have become acutely conscious of the water shortages that have developed in certain locations, requiring the costly hauling of water by trucks (and even by ship tankers from another island) in order to provide water for domestic uses as well as for agricultural and commercial purposes.

During the latter part of 1962 and into this year, drought problems in some sections became so prolonged and acute that they were declared disaster areas and emergency assistance by way of surplus grains had to be provided by the Federal Government to prevent cattle herds from being wiped out.

Some research needs in water conservation in Hawaii have been identified by such agencies as the Soil Conservation Service of the U.S. Department of Agriculture. A considerable volume of printed materials on water supply and use in Hawaii has been compiled over the years. Although appreciable information exists there are some serious gaps. Research can give some answers in minimum time for a number of problems. Long-range research also would be in order so that more detailed information can be obtained and analyzed. It is evident that a great deal more research in many phases of water resources is needed in Hawaii.

In response to the request last year of Senator Clinton Anderson, then chairman of this committee and now the prime sponsor of S. 2, the University of Hawaii furnished data on its research projects, underway or scheduled, that bear on the possibilities of increasing usable water supplies or making more efficient use of present supplies.

The University of Hawaii, as a land-grant university, wholeheartedly endorses the objectives of S. 2. Dr. Thomas Hamilton, the president of the University of Hawaii, states that the economic growth of Hawaii requires continual modification and expansion of water development. The problems of locating, analyzing, and conserving water supplies arise continually. According to Dr. Hamilton, water research needs are pressing and Hawaii's unique problems make local research essential. I am including the full text of a wire I received February 20 from Dr. Hamilton on this subject.

Both the short- and long-range needs of the State of Hawaii require the expansion of water resources research of the kind envisioned in S. 2. The future growth of Hawaii—her increasing population, expansion of agriculture, and the need for more jobs and income—is dependent to a large extent on our ability to develop, conserve, and utilize our water resources. We need the best research in order to accomplish these goals.

I urge that the members of this committee approve S. 2. The people of Hawaii will be grateful to you for your approval of this important measure.

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HONOLULU, February 19, 1963.

Senator HIRAM FONG,  
U.S. Senator From Hawaii,  
Washington, D.C.:

Economic growth of Hawaii requires continual modification and expansion of water development problems of locating, analyzing, and conserving water supplies arise continually. Water research needs are pressing. Unique problems make local research essential.

THOMAS HAMILTON,  
University of Hawaii.

Senator ANDERSON. The first witness this morning is the Secretary of the Interior, Stewart Udall, accompanied by an able aid well known to the committee since he served on the staff for several years, Eugene D. Eaton.

Mr. Secretary, we are very happy to have you here and will be very happy to hear from you.

STATEMENT OF HON. STEWART L. UDALL, SECRETARY OF THE  
INTERIOR, ACCOMPANIED BY EUGENE D. EATON

Secretary UDALL. Thank you, Senator. It is a real pleasure to appear before you and I, too, would like to felicitate the committee on the new members you have. Senator Hayden's decision to come on Interior, I think, should be good news for you since he knows all the legislation and appropriations of the last 50 years, and I am sure you will find him a very valuable addition to the committee.

Senator ANDERSON. I can only say, Mr. Secretary, like you, I served in the House of Representatives and on a sort of Interior Committee. Many times things were taken out of our bills on the House floor by the large city delegations that caused distress to all of us. We would get together around the crying towel and cry a little bit, and then we would say, "well, Senator Hayden will put it back in." He almost always did. So we are very glad to have him here this morning.

Secretary UDALL. I think if I may add to that, Mr. Chairman, the Senator has put more things back in for conservation and has done more things to build the country than anyone in the history of the country.

As all of us know, the process of getting things started is two steps, one, the legislative, the matter of declaring legislative policy which is the step we are at now, and the second is the process of getting the money.

I think this is one of the most significant pieces of legislation that I will have an opportunity to testify on this year. The truth of the matter is that since the really fine landmark study of our water problems in this country conducted by the select committee under the chairmanship of the late Senator Robert Kerr, from Oklahoma, was completed about 2 years ago, that, in my opinion at least, we haven't really undertaken the task of fully implementing that report. I think the river basin planning legislation that the President has submitted is one step.

This proposed legislation (S. 2) is another equally significant step. And I am very hopeful, Mr. Chairman, that due to the interest that has been aroused across the whole country by the bill that you have sponsored and by the wonderful opportunity this offers to tackle problems that will always be with us and that are getting more difficult and more grave as we go along, that we can do an adequate job.

An account appeared in the press this morning of a report that was prepared by a committee under Dr. Wiesner—I understand Dr. Wiesner is going to appear—and headed by Dr. Roger Ravelle, my own science adviser. I think this report should be part of the file, part of the record on this hearing, because it shows the growing need all over this country for an understanding and a knowledge of our water problems and because there is no resource more basic for human needs, for industrial use, for all uses than this key resource.

This committee has given distinguished leadership, Mr. Chairman, in many aspects of water resources problems and notably so in providing for the studies of the Select Committee on National Water Resources. As a result of those studies, we have informed under-

standing of the facts of water resources problems and the lines of action that are needed.

The bill being considered by you today is an important step forward in solving water problems. It will implement a key recommendation of the Select Committee on Water Resources.

The grave facts of our water situation are acutely evident. In major areas of the Nation water supply deficiencies threaten economic growth and living conditions. This is a threat right now in much of the West, it is only one or two decades away in some of the Middle Western States, as the report of the scientists pointed out this morning, and for many localities even in the humid areas both water quality and water quantity problems are increasingly serious.

The select committee provided clear recommendations for remedial action. Its factual studies demonstrate that the yearly rainfall that maintains streamflow and lake levels, on the average, is more than enough to meet all requirements for population and economic growth well into the next century.

But those studies show that there are complex and difficult problems of water resource development and conservation, to even out the annual and seasonal variations in runoff, to equate geographic differences in the location of water occurrence and water use, and to choose among competing water uses for municipal, agricultural, and industrial developments. Among the most difficult problems are how to provide for the growing water requirements of recreation and wildlife, how to deal with the water-borne wastes from the chemical, paper, mineral, and other industries and still save the healthful and beautiful waterways with which this Nation is endowed.

One of the principal recommendations of the select committee is to increase water resources research effort. A considerable number of outstanding scientific and engineering authorities have expressed the view—a view which I share—that action to strengthen water resources research is among the most important and productive actions that can be taken at this time.

This is true because the impact of water shortage on economic development, human welfare, and national security can be so drastic, and water requirements are growing greatly and expanding in relation to the fixed amount of the water supply. For this reason we must rapidly increase our knowledge of how to conserve water resources and increase our ability to use them fully and wisely. This bill, S. 2, the proposed Water Resources Research Act, is a major advance toward that objective. And I should like to say a very creative step toward that objective.

This administration vigorously supports the water research work of the Federal agencies. Eight major Federal agencies are engaged in this, and their staffs include some of the most highly competent scientists and engineers in their professions. In 1963 funds for water resources research are 40 percent more than the preceding year, and this shows that members of the Appropriations Committee, for example, are deeply conscious of this problem. The President's budget for fiscal year 1964 provides a further increase.

In my own Department of the Interior, water research is carried on by the Office of Saline Water, the Geological Survey, the most pioneering organization in the field, the Bureau of Mines, the Fish and Wild-

life Service, the Bureau of Reclamation, and others as well. Our program has grown from a 1962 level of \$17.5 million—this is research money—to \$35 million requested in the 1964 budget.

But encouraging as is the research progress of the Federal agencies, it alone cannot be expected to meet our needs in time. We need to expand water research so as to be able to match water uses with the supply available, and the timetable makes this urgent. By 1980 water supply will limit further growth and development in major portions of the Nation.

Let me remind you that expenditures on water facilities in the United States are now more than \$10 billion per year, but we know that this will have to be multiplied very substantially to meet rising water requirements. In the multibillion dollar water expenditures, research is only three-fourths of 1 percent of the total.

No progressive industry or country can remain healthy with such inadequate attention to research. The Federal Government, the States, and local governments need vigorous research programs to maintain the efficiency of their operations in the water resources field. Doubling or tripling of water research is certainly necessary.

Now, how should we go about doing this?

For one thing, research by Federal agencies must be greatly strengthened because it is the principal source of competence in water problems that are national in scope. Additionally, a great number of recognized experts in the water field advise that there are other urgent needs for enlarged and expanded water research. But they also point out that the shortage of competent research scientists and engineers now is a major limitation on our ability to get the knowledge needed.

A clear-cut answer to this is to enlist the research resources of the universities. They are an important reservoir of technical competence that has been only partially utilized.

If I may say, Mr. Chairman, one of the things that has impressed me most as a new administrator of the past 2 years, one of the things I hadn't realized previously, is the extent to which the success of our country in conservation, in the use of our resources, in the field of energy, and the military field, too, really rest on our success in scientific research of all kinds.

Senator ANDERSON. Mr. Secretary, since you sort of interrupted yourself in your address there, do you mind if I ask you if sometime you would give us a comment on whether you think three-fourths of 1 percent is a fair amount to put into research? Or do you deal with that later on in your statement?

Secretary UDALL. Well, the point I would make is that if you take any industrial concern—I don't care whether it is in the field of minerals, field of manufacturing, processing, whatever it is—that the amount spent for basic research will normally run anywhere from 3 to 5 to 6 percent or more. And so this amount actually is very low, dangerously low.

Senator ANDERSON. It is extremely low.

Secretary UDALL. That is correct.

Senator ANDERSON. I know we set up a Research Administration one time in the Department of Agriculture, set up a Research Act, made a study of what all the progressive industrial companies were doing, and we found that a great many of them were spending many,

many times in excess of what you mention here. I wouldn't want the impression to go out that you thought three-fourths of 1 percent was a large figure.

Secretary UDALL. No.

Senator ANDERSON. You think it is a small figure?

Secretary UDALL. It is a very small figure. One of the great success stories of this country, and this is, in fact, so successful that we are overproducing, is in the field of agriculture. This is known all over the world: that American agriculture is one of the wonders of the world. But this, in my opinion—and I am not an agricultural expert, but my scientists tell me that this is the case—if you are going to single out any one factor for our success in this field, it is research, the fact that we have had this agricultural extension program, the research stations and the universities. And this is what the chairman has really proposed in this bill and what the administration supports—to use this pattern of activity that has been so successful in the field of basic agricultural research and take it over into the water field.

The bill to accomplish this implements the recommendations of the Select Committee on National Water Resources, the report of the National Academy of Sciences-National Research Council, the findings of the Federal Council on Science and Technology and many distinguished scientists and engineers including the President's Science Adviser, Dr. Jerome B. Wiesner. Its principles are endorsed by the Association of State Universities & Land-Grant Colleges, by a number of professional societies, and by associations in the reclamation and soil and water conservation fields.

Legislation to assist water resources research at universities will have two beneficial results. It will enlist the scientific and engineering competence of university research in water resources problem solving, and it will also result in augmenting the critically inadequate numbers of scientists and engineers trained in the sciences related to water resources.

The proposed legislation would build on and utilize the established facilities of the State colleges and universities, thereby taking advantage of a system of educational institutions that for over a century has demonstrated its effectiveness in advancing and disseminating knowledge widely throughout the Nation. Concurrently, the proposed legislation would enable State universities to strengthen their participation in the sciences of natural resources management. These are persuasive reasons for establishment of broadly based water resources research centers at State universities.

The universities' readiness to accept the obligations and opportunities of participation in water research activities has been stated by the Association of State Universities & Land-Grant Colleges.

I see, Mr. Chairman, that you have a distinguished list of witnesses representing that organization.

Because a number of university representatives are scheduled to testify, I defer to them as spokesmen for the academic world. I want to say, however, that from the point of view of the Department of the Interior, we greatly welcome and look forward to full involvement of universities in this critically important field of water resources research.

Another special benefit that will result from water resources research centers at State universities will be their increased ability to provide informed professional assistance to State and local officials and others concerned in State, local, and regional water-resources problems.

As water resources activities move ahead, State and local governments and nongovernmental interests will take an increasingly active part in them. That participation needs expert professional assistance that is informed on local conditions and local problems. The water resources research centers at the State universities can provide that needed professional assistance.

It is our opinion, if I may say so, Mr. Chairman, that there is no region, there is no State that does not have its own peculiar problems, and we think this type of research center activity will prove, just as the agriculture research program has proved, a very wise step.

The bill being considered by the committee, S. 2, provides that, in addition to the land-grant colleges and State universities, other universities and research institutions may also be aided in water resources research. In other words, the total program is not limited merely to the land-grant schools.

Title II of the bill makes it possible to enlist research competence wherever it exists—at any university or college, and also at nonacademic research institutions.

These provisions will encourage and strengthen competence at a number of locations throughout the United States. High caliber professional activity in water resource matters should exist widely throughout the United States so that it is readily accessible to people everywhere as they may need it.

The bill recognizes that in order to avoid unproductive duplication of research, assistance to universities will have to take account of the investigations being carried on or programed by the various Federal and non-Federal agencies.

Provision for this is made in section 300. The information on research activities thus assembled will, of course, be extremely useful to many people in the water resource field. For that reason, the bill wisely provides that such information shall be available for general use.

In this connection, I want to mention the overall coordination of research in the executive branch. Recognizing that Federal research has now grown to the \$15 billion per year level, overall, President Kennedy established the Office of Science and Technology to give the needed scientific leadership.

The Department of the Interior looks to the Director of Science and Technology as the representative of the President for overall coordination of water resources research and we believe that information developed by the Interior Department will be useful to him in that capacity.

I am fully in accord with the provisions of section 301 that clarify Interior Department relationships in water resources research. This section makes abundantly clear that the purpose of the legislation is to increase the amount of water resources research and not in any degree to take over or to curtail the activities of any agency, Federal or non-

Federal. My principal comment is that so much water research is urgently needed that there is much more than enough for everyone to do.

Now, just a word or two on our preliminary views on the mechanics of the program. First, it seems to me important to bear in mind that the purpose of the program is to enlist the research abilities of the universities to broaden national competence in water resources research.

In order to tap the abilities and to enlist the interest of the university people, they should have a lot of initiative in proposing what research projects they undertake.

Such projects would be sent forward by the universities as proposals for Federal assistance. Of course, in many cases, research proposals will come about because State or local officials or others request the university people for information or advice which will show that there is need for research on the subject.

Through the continuing leadership of the President's Office of Science and Technology, there would be interdepartmental coordination so as to avoid duplication or other unproductive expenditures of money or technical manpower.

As a basis for decision on whether to award a grant or contract, I expect to rely to a considerable extent on consultants who should be the best men in each of the scientific and engineering fields involved. These technical experts would be qualified to advise on the technical merit of research proposals.

Furthermore, the program would need to be considered both as to its overall technical adequacy and also as to the broad public interest. For this purpose there would be need for advice that would evaluate and recommend on the overall progress and direction of the program. It seems to me that this kind of consultation is essential for the Secretary of the Interior, and in addition, I believe that it should be helpful to the universities as well.

This is in accord with section 104 of the bill under which the Secretary of the Interior would have responsibilities to advise with the universities relative to their water research activities. I am confident that this function can be mutually beneficial both to the universities and to the Government, and that it will establish a helpful relationship.

Naturally, there is concern about what is done with Federal funds that may be granted to non-Federal organizations. I feel that this bill, S. 2, provides for fiscal responsibility and accountability so that reasonably simple procedures will give the needed protection in this regard.

As a final word, Mr. Chairman, permit me to commend you and this committee for the important service you are performing to the whole field of water resources. This bill, the proposed Water Resources Research Act, is in my opinion a bold step forward.

Thank you for the opportunity to present my views. I am very happy to be with you this morning.

Senator ANDERSON. Thank you, Mr. Secretary. At this point, without objection the full written text of your statement will appear in the printed record of this hearing.

(The statement is as follows:)

## STATEMENT OF STEWART L. UDALL, SECRETARY OF THE INTERIOR

Mr. Chairman, planning, foresight, and research are the essence of sound action where our water resources are concerned.

This committee has given distinguished leadership in many aspects of water resources problems and notably so in providing for the studies of the Select Committee on National Water Resources. As a result of those studies, we have an informed understanding of the facts about water resources problems and the lines of action that are needed.

The bill being considered by you today is an important step forward in solving water problems. It will implement a key recommendation of the Select Committee on National Water Resources.

The grave facts of our water situation are acutely evident. In major areas of the Nation water supply deficiencies threaten economic growth and living conditions. This is a threat right now in much of the West, it is only one or two decades away in some of the Middle Western States, and for many localities even in the humid areas both water quality and water quantity problems are increasingly serious.

The select committee provided clear recommendations for remedial action. Its factual studies demonstrate that the yearly rainfall that maintains streamflow and lake levels, on the average, is more than enough to meet all requirements for population and economic growth well into the next century.

But those studies show that there are complex and difficult problems of water resource development and conservation to even out the annual and seasonal variations in runoff, to equate geographic differences in the location of water occurrence and water use, and to choose among competing water uses for municipal, agricultural, and industrial developments. Among the most difficult problems are how to provide for the growing water requirements of recreation and wildlife, how to deal with the waterborne wastes from the chemical, paper, mineral, and other industries and still save the healthful and beautiful waterways with which this Nation is endowed.

## A SELECT COMMITTEE RECOMMENDATION

One of the principal recommendations of the select committee is to increase water resources research effort. A considerable number of outstanding scientific and engineering authorities have expressed the view—a view which I share—that action to strengthen water resources research is among the most important and productive actions that can be taken at this time.

This is true because the impact of water shortage on economic development, human welfare, and national security can be so drastic, and water requirements are growing greatly and rapidly in relation to the fixed amount of the water supply. For this reason we must rapidly increase our knowledge of how to conserve water resources and increase our ability to use them fully and wisely. This bill, S. 2, the proposed Water Resources Research Act, is a major advance toward that objective.

This administration vigorously supports the water research work of the Federal agencies. Eight major Federal agencies are engaged in this, and their staffs include some of the most highly competent scientists and engineers in their professions. In 1963 funds for water resources research are 40 percent more than the preceding year, and the President's budget for fiscal year 1964 provides a further increase.

In my own Department of the Interior water research is carried on by the Office of Saline Water, the Geological Survey, the Bureau of Mines, the Fish and Wildlife Service, the Bureau of Reclamation, and others as well. Our program has grown from a 1962 level of \$17½ to \$35 million requested in the 1964 budget.

But encouraging as is the research progress of the Federal agencies it alone cannot be expected to meet our needs in time. We need to expand water research so as to be able to match water uses with the supply available, and the timetable makes this urgent. By 1980 water supply will limit further growth and development in major portions of the Nation.

## WATER PROJECTS RUN \$10 BILLION A YEAR

Let me remind you that expenditures on water facilities in the United States are now more than \$10 billion per year but we know that this will have to be multiplied very substantially to meet rising water requirements. In the mul-

tibillion-dollar water expenditures, research is only three fourths of 1 percent of the total.

No progressive industry can remain healthy with such inadequate attention to research. The Federal Government, the States, and local governments need vigorous research programs to maintain the efficiency of their operations in the water resources field. Doubling or tripling of water research is certainly necessary.

Now, how should we go about doing this?

For one thing, research by Federal agencies must be greatly strengthened because it is the principal source of competence in water problems that are national in scope. Additionally a great number of recognized experts in the water field advise that there are other urgent needs for enlarged and expanded water research. But they also point out that the shortage of competent research scientists and engineers now is a major limitation on our ability to get the knowledge needed.

A clear-cut answer to this is to enlist the research resources of the universities. They are an important reservoir of technical competence that has been only partially utilized.

The bill to accomplish this implements the recommendations of the Select Committee on National Water Resources, the report of the National Academy of Sciences-National Research Council, the findings of the Federal Council on Science and Technology and many distinguished scientists and engineers including the President's science adviser, Dr. Jerome B. Wiesner. Its principles are endorsed by the Association of State Universities and Land-Grant Colleges, by a number of professional societies, and by associations in the reclamation and soil and water conservation fields.

#### TWO BENEFITS

Legislation to assist water resources research at universities will have two beneficial results. It will enlist the scientific and engineering competence of university research in water resources problem-solving, and it will also result in augmenting the critically inadequate numbers of scientists and engineers trained in the sciences related to water resources.

The proposed legislation would build on and utilize the established facilities of the State colleges and universities, thereby taking advantage of a system of educational institutions that for over a century has demonstrated its effectiveness in advancing and disseminating knowledge widely throughout the Nation. Concurrently, the proposed legislation would enable State universities to strengthen their participation in the sciences of natural resources management. These are persuasive reasons for establishment of broadly based water resources research centers at State universities.

The universities' readiness to accept the obligations and opportunities of participation in water research activities has been stated by the Association of State Universities and Land-Grant Colleges. Because a number of university representatives are scheduled to testify, I defer to them as spokesmen for the academic world. I want to say, however, that from the point of view of the Department of the Interior, we greatly welcome and look forward to full involvement of universities in this critically important field of water resources research.

Another special benefit that will result from water resources research centers at State universities will be their increased ability to provide informed professional assistance to State and local officials and others concerned in State, local, and regional water resources problems.

As water resources activities move ahead, State and local governments and nongovernmental interests will take an increasingly active part in them. That participation needs expert professional assistance that is informed on local conditions and local problems. The water resources research centers at the State universities can provide that needed professional assistance.

#### CENTER OF COMPETENCE ENLISTED

The bill being considered by the committee (S. 2) provides that, in addition to the land-grant colleges and State universities, other universities and research institutions may also be aided in water resources research. Title II of the bill makes it possible to enlist research competence wherever it exists—at any university or college, and also at nonacademic research institutions.

These provisions will encourage and strengthen competence at a number of locations throughout the United States. High-caliber professional activity in

water resource matters should exist widely throughout the United States so that it is readily accessible to people everywhere as they may need it.

The bill recognizes that in order to avoid unproductive duplication of research, assistance to universities will have to take account of the investigations being carried on or programed by the various Federal and non-Federal agencies. Provision for this is made in section 300. The information on research activities thus assembled will, of course, be extremely useful to many people in the water resources field. For that reason, the bill wisely provides that such information shall be available for general use.

In this connection, I want to mention the overall coordination of research in the executive branch. Recognizing that Federal research has now grown to the \$15-billion-per-year level, President Kennedy established the Office of Science and Technology to give the needed scientific leadership.

The Department of the Interior looks to the Director of the Office of Science and Technology as the representative of the President for overall coordination of water resources research and we believe that information developed by the Interior Department will be useful to him in that capacity.

I am fully in accord with the provisions of section 301 that clarify Interior Department relationships in water resources research. This section makes abundantly clear that the purpose of the legislation is to increase the amount of water resources research and not in any degree to take over or to curtail the activities of any agency, Federal or non-Federal. My principal comment is that so much water research is urgently needed that there is much more than enough for every one to do.

#### UNIVERSITY RESPONSIBILITY

Now just a word or two on our preliminary views on the mechanics of the program. First, it seems to me important to bear in mind that the purpose of the program is to enlist the research abilities of the universities to broaden national competence in water resources research.

In order to tap the abilities and to enlist the interest of the university people, they should have a lot of initiative in proposing what research projects they undertake. Such projects would be sent forward by the universities as proposals for Federal assistance. Of course, in many cases, research proposals will come about because State or local officials or others request the university people for information or advice which will show that there is need for research on the subject.

Through the continuing leadership of the President's Office of Science and Technology, there would be interdepartmental coordination so as to avoid duplication or other unproductive expenditures of money or technical manpower.

As a basis for decision on whether to award a grant or contract, I expect to rely to a considerable extent on consultants who should be the best men in each of the scientific and engineering fields involved. These technical experts would be qualified to advise on the technical merit of research proposals.

Furthermore, the program would need to be considered both as to its overall technical adequacy and also as to the broad public interest. For this purpose there would be need for advice that would evaluate and recommend on the overall progress and direction of the program. It seems to me that this kind of consultation is essential for the Secretary of the Interior, and in addition I believe that it should be helpful to the universities as well.

This is in accord with section 104 of the bill under which the Secretary of the Interior would have responsibilities to advise with the universities relative to their water research activities. I am confident that this function can be mutually beneficial both to the universities and to the Government, and that it will establish a helpful relationship.

Naturally, there is concern about what is done with Federal funds that may be granted to non-Federal organizations. I feel that this bill (S. 2) provides for fiscal responsibility and accountability so that reasonably simple procedures will give the needed protection in this regard.

As a final word, Mr. Chairman, permit me to commend you and this committee for the important service you are performing to the whole field of water resources. This bill, the proposed Water Resources Research Act, is a great step forward.

Thank you for the opportunity to present my views. If you or others of the committee have questions, I will gladly try to answer them.

Senator ANDERSON. Mr. Secretary, you have a paragraph, three or four paragraphs from the end, where you say the Secretary of the

Interior would have responsibility to advise with the universities relative to their water research activities. When I was Secretary of Agriculture, we tried to set up an agriculturature research act, the Department of Agriculture sent questionnaires out to find out what every university in the country was doing in the way of agricultural research and we would find out, for example, that one university right next door to another university was engaged on the same problem. They didn't know they were doing research in the same field.

We had an example of a study on the question of dyeing irrigated cottons and putting colors into rainbelt cotton. Two institutions were making parallel studies and neither knew the other was doing it. By getting a chance to list all the things that the Department is doing everywhere, we found it was possible to increase the efficiency of research work by reducing unnecessary paralleling and duplicating.

Don't you feel this is a further advantage to this bill, that you will get a chance to know what is under way so, if projects are proposed on one subject you can pursue one aspect in one area and a different phase of the same subject somewhere else, but not necessarily the same thing?

Secretary UDALL. I think this is a very good point, Mr. Chairman, that this is one of the advantages that does not now exist. We think that through a relatively simply procedure, this type of coordination, is not only practical, but would be highly useful to everyone concerned.

Senator ANDERSON. Fine.

Before we go further with questions, another newcomer has just come in, Senator Gaylord Nelson, of Wisconsin. We welcome you. Your State under your administration made great strides in conservation. Other States might well follow its example.

I also want to say that you testified before this committee many times and were an excellent witness. We are very happy to have you on the committee.

We will start with questions.

Senator Moss?

Senator Moss. I really have no questions, Mr. Chairman. I wish to commend the Secretary for his interest in and leadership in this field. Coming from the arid State of Utah, we know the value of research and we need this sort of impetus to promote research on water, learn how to use it better, and preserve it better and develop it better.

Thank you very much.

Senator ANDERSON. Senator Hayden?

Senator HAYDEN. I have no particular comments to make except I doubt if there is any State in the Union that needs water more than Arizona. We are very rapidly exhausting our underground water supply. A very serious situation is being developed there.

Senator ANDERSON. The State of Arizona is mining its water resources very rapidly. I remarked in a short talk last week in Albuquerque that if Arizona finally won all the things it wants to win in the California-Arizona water suit, it will only be able to offset part of its present deficit, and that is pretty rough.

Secretary UDALL. Mr. Chairman, if I may say so, and there is no point in not speaking one's mind on this subject, it has always been

my regret that Arizona, as far as underground water is concerned, did not follow the New Mexico pattern but decided to mine it, not as a renewable resource, but rather as something which would just be taken out like ore and after it is taken out we are through. And I think a lot of us have had cause to regret that this is what has taken place.

Senator ANDERSON. I think there are many hopeful signs and there may be opportunities to find new ways of developing water supplies. I know that you, Mr. Secretary, will be interested in the possibility of the use of nuclear energies to develop supplies, and of making better use of our water. I know the able chairman of the Appropriations Committee has the same feeling. I do believe we will be able to clear some of these things up. We are very glad that Senator Hayden made the remark he did.

Senator McGovern?

Senator MCGOVERN. Mr. Chairman, I would just like to raise a couple of points that were brought up in the discussion I had this morning with a man from my State who is very much interested in this bill and who supports the general outline of the bill. I will be interested in the Secretary's comments on the point.

He raised the question first of all about the need for the training of experts in this field. He said that, important as research is, at least in our State the great need is for competent people, and he felt that possibly this might have an even great priority than basic research.

Secretary UDALL. This is a very good point and this is one of the things that I learned from Dr. Wiesner and my own science adviser, that any scientific program can be no better than the people that you have developed. Of course, they come out of the universities, and the competence of the professional people in the universities in turn has a very direct relationship to the number of graduates and students. We think this is one of the real advantages of this legislation, because some of our State universities have very few people at the present time working in this field. This proposed legislation would give those universities an opportunity to set up a research center and to develop competent people and to begin to produce the type of people with the ability and scientific skill that we will need in this field.

So it has this other beneficial effect, too, that you point out.

Senator MCGOVERN. The second point he raised about it is the danger that this approach might lead to a certain amount of fragmentation in our water-resource programs. Do you have any comment on that?

Secretary UDALL. Well, I don't consider that is a real hazard. In something like water which is a universal problem, and looking to a national program with each State setting up an institute at its land-grant college, I do not believe that this is fragmentation. Of course, this is something to be concerned about, and this is the reason that we need coordination. But I think the agricultural research programs have proved the wisdom of activating the States, of having programs at the various State levels. So, as far as I am concerned, I think this is a very good pattern and a sound pattern and I think if we coordinate it properly, as Senator Anderson just discussed a moment ago, the bad effect of fragmentation would not occur.

Senator MCGOVERN. Thank you very much.

Senator ANDERSON. Senator Jordan?

Senator JORDAN of Idaho. Mr. Secretary, of course in my State of Idaho we always have a tremendous interest in water resource development. We either have too little or on occasion we have too much, as we have had already this year in some parts of my State. I might say there is a great interest in my State in the proposal set forth in this bill. I would have a question for you with respect to the coordinating aspect that was mentioned. I am sure that it would be of great benefit to all people engaged in water research work if they had access to the work of other people also so engaged in order to avoid duplication in their effort and to achieve the utmost success in all lines.

I assume that your coordinator would first start out by taking inventory of all the research projects now going on? Would you comment on that?

Secretary UDALL. I think this would be an objective certainly, to pull together what you would call an inventory of what work is being undertaken so that there is one place that is fully informed on what the existing programs are. The bill provides that we keep a catalog of water research projects underway for everyone to use.

Senator JORDAN of Idaho. And there would be a very tremendous reciprocity of information between the several agencies of the Federal Government and the universities and the State resource agencies—

Secretary UDALL. That would be highly essential I would think, yes.

Senator ANDERSON. Might I just say I mentioned this agriculture research work a while ago because I was tremendously interested in it and I think the Department did an exceptionally fine job after I left it. We tried to find out what was going on. We found out that rain belt cotton takes dye a little bit differently, apparently, than irrigated cotton, or seems to, and some States were trying to make some study of the way in which irrigated cotton took dye and how it might be handled.

The State right next door to it was also conducting the same research and didn't know that the other State was already doing it. All the Department did was call attention to the fact that one State was doing it, and the other State was doing it. We asked if they wanted to get together and compare results, make their research money go further. The Department didn't interfere with a program in a single State. It merely pointed out that one State was doing it, the other State was doing it, too, and they then went on to see if they could work out an arrangement so their studies would supplement each other, using the medium of the Department to do it.

I don't think it is the intention of the Secretary of the Interior that he would sit down and divide up the pie and say, you do this in this State and something else in some other State, but I do think the process of keeping information can be extremely useful to all concerned, and if all States know what other States are doing, they can make their own research money go further than if they didn't know that, and hence duplicate a lot of work.

Secretary UDALL. Mr. Chairman, I would like to point out the way you have designed the bill we think is particularly good in this respect because there will be an initial grant to each of the land-grant universities to set up the program at a research center, get their program going, their personnel. Then there is also a fund set up which will be available in addition to that initial grant, and the universities

could submit proposals to us for additional research. We will analyze them and, of course, we will know, then, at a central location what is being proposed, and we naturally will coordinate the awarding of these contracts and grants for each particular proposal.

Senator ANDERSON. Senator Nelson?

Senator NELSON. I didn't hear all of your testimony but as to the allocation of \$100,000 a year to one college in each State, will they have to propose projects or will this just be pure research on their own?

Secretary UDALL. No. The initial grant to each of the land-grant colleges is for them to set up what you would call an institute or center. Some of them already have one but this is available to be sure that each of the land-grant colleges has a water-research institute established.

Then the next amount of money that would be available over and beyond that initial grant, would be money available to those centers to apply to additional research. A further sum could be allocated to these centers or other universities that would also be free to apply. As far as this last type of money is concerned it could be used for grants for particular research projects.

Senator NELSON. \$100,000 is a free grant?

Secretary UDALL. That is right.

Senator NELSON. With which they may do anything they please with it, in research?

Secretary UDALL. That is right, so long as they set up a water-research program.

Senator NELSON. They do not have to submit projects, proposals for study, to the Secretary.

Secretary UDALL. No, however, each such center would have to set up its research program.

Senator NELSON. Then as I read it, after that starting out at \$5 million a year and rising to \$10 million a year, the Secretary has the funds available for special projects?

Secretary UDALL. That is correct.

Senator NELSON. And will your office initiate projects as well as receive proposals from universities?

Secretary UDALL. The Interior Department will have responsibility for making suggestions to universities for research subjects. In addition, Dr. Wiesner and the other scientific people that I have talked to, feel that one thing that we have demonstrated in research in this country, in general, is that the best program is to have a strong, "in-house" program in the Federal Government. That is, the Federal agencies should have a strong program. Such "in-house" research programs are now underway and in existence within the Government agencies. They complement each other, that you have in a sense a rivalry, a competition, a production of a greater degree of effort and of greater excellence by this pattern rather than if you did it all either way.

Senator NELSON. But you will have \$10 million a year.

Secretary UDALL. That is right, for research under section 200 of this bill.

Senator NELSON. All I am saying is do you have the authority to initiate a proposal for research to be done by a university out of your own agency?

Secretary UDALL. Oh, yes, and I fully anticipate, for example, with programs that we have in my own Department, fish and wildlife and water fowl and reclamation, and so forth, we may have a water research problem that we may feel a State university could help on. Possibly because of work it has been doing, the university is better equipped than we are to undertake it, and maybe this problem has wide ramifications. So we would ask the State university if they are interested in a grant or contract to do this particular research job, and so on. It would work both ways.

Senator NELSON. Is water pollution within the purview of the studies that you propose to make?

Secretary UDALL. Well, we are certainly concerned with water quality. There are also many water pollution problems related especially to fish and wildlife and to commercial fisheries. It is often very difficult for me to draw the line distinguishing a pollution problem and some of the other water quality problems.

Senator NELSON. Is there any conflict between the—I just read this very quickly—authority to make grants in areas that aren't already being investigated by other agencies or departments. Am I correct in reading that some place here. What I am getting at is, it seems to me that there isn't any question but what a major, if not the major destroyer of fresh water assets in this country, is still pollutants, with sewage I think probably being second, and that it is having dramatically serious consequences, and now as a consequence in just an isolated case of detergents, the word "nonsoluble" ones, whatever the right word is, now polluting the underground resources all over the country.

I notice that West Germany passed legislation barring the nonsoluble detergents from the market, I think a few years from now. But in our own State, which, along with Minnesota and Michigan, I should guess has more fresh water assets than any other State in the Nation, our own State, in somewhere around 60 counties we already find nonsoluble detergents in the underground water supply.

Now, it seems to me this is a crucial area in which we have to move very rapidly, maybe with legislation. I suggested in our State, to bar their use which would be very difficult to pass, but it seems to me it is a really critical problem. I was wondering whether you would have authority in that \$10 million annual appropriation to specifically move into this field yourself in addition to whatever work is being done by the Public Health Service and other areas.

Secretary UDALL. Well, the answer is yes, Senator, the Interior Department is deeply concerned with certain aspects of pollution. But the Department of Health, Education, and Welfare has the principal program in the pollution field.

Senator ANDERSON. I would hope it might be a qualified yes because certainly Health, Education, and Welfare has responsibility in this field, and if they thought this was a means to take over the study of water pollution, their report on this bill would be a little bit adverse, and I would want it to be. We have trouble enough with trying to conserve water without trying to decide whether Dash or All are better than Stream to keep it from bubbling up a little bit.

Therefore, the answer would be a qualified yes, wouldn't it? You do not contend with HEW, do you, Mr. Secretary?

Secretary UDALL. I have learned in my work with Dr. Wiesner—and I think setting up this Office of Science and Technology was a very wise step the President took—that some of these problems of overlap that we have had we can resolve very, very readily. There is a twilight area between water pollution and water quality and it is a rather—it is hard even for some of the scientists to differentiate. I have tried to pin them down, to get them to draw a line between what I would call a water quality problem and a pollution problem, where the line begins. There are, I think, certain types of pollution, industrial waste, for example. This is an area where there is a major problem, even in these areas that think they have a water surplus, yet I think one of the great forms of waste in this country today is the waste of water through industrial pollution particularly. It is just as bad as they way that we wasted our forests 75 years ago. We just consider that water is so abundant that we will waste it, and so we pollute it. And I think we are going to need all the efforts that we can make on the pollution front as well as all the efforts we can make in basic water research, too, and sometimes these inevitably do overlap, but this isn't a bad thing necessarily. The Interior Department approaches these problems principally in our studies of water quality and aquatic biology.

Senator NELSON. Mr. Chairman, the reason I raised the question, it is obvious from the bill—I don't have an opinion one way or the other—it is obvious from the bill that the 50 various State universities may engage in any kind of pure research they please relative to water, I would gather, under this bill. Therefore, some university decides to do research in the field of water pollution and in all States the problems differ.

We have one, for example, involving pollution of effluents from papermills. Well, the University of Wisconsin, which has done a lot of waterwork, may proceed in this field. You have \$10 million a year and you may like what they are doing here. This is industrial pollution. No one is raising questions whether or not you have authority, then.

Certainly then the universities under the grants here would have authority, I would gather, to do whatever research they please in any way affecting the quality of water, source of water, use of water.

Does your supplementary appropriation of \$10 million give you the policy authority to then say we would like to have you expand your program here at this university on industrial pollutants in some particular way?

Secretary UDALL. Senator, I think I can clarify the point this way, that this is a water research program we are talking about. It is not a program that is an attack on the methods particularly of curing industrial pollution, for example. There is a very aggressive program in the Department of Health, Education, and Welfare which they are administering. They are doing some very good work in some parts of the country. And I think this distinction is somewhat clearer if you keep in mind that this is research. Of course, some of this research is related to water quality and it will have considerable significance on the attack on pollution problems, yet research under this bill is not, as such, a program that is directed toward methods of solving the pollution problem itself. These take treatment works and,

you know, the sort of thing that many of the States now are engaging in.

Senator ANDERSON. I only want to say, Mr. Secretary, that one of the things that interests me is the fact that sometimes institutions close to each other do not know what one institution is doing or the other institution is doing. In my own State the school that used to be called New Mexico College of Agriculture and Mechanic Arts, now known as the New Mexico State University—I am sorry they dropped the word "Agriculture" from it—New Mexico State University would probably administer this act and they are very much interested in water research, particularly phreatophytes. And the school that used to be called the New Mexico School of Mining, but I believe is now called New Mexico Tech—they shift these names around very freely—is headed by Dr. Workman, who is one of the pioneers in study of cloud seeding in order to increase water supply, and other phases of weather modification.

I think it is important that the State schools, State universities which administer the programs, know that Dr. Workman is working on cloud seeding. I don't think they would start a program of study of cloud seeding because that is a sort of specialized field that General Electric and some of its people and some others have already worked in, and not everybody has experience in it. They know that there is an intent elsewhere to study the increase in water by use of cloud seeding and atmosphere physics.

Many times they didn't know it, although it was only a short distance away. It is useful for the general coordinating agency to know what is going on in the various State schools.

Are there additional questions?

Thank you very much, Mr. Secretary. We appreciate your being here.

Senator ANDERSON. Mr. Byerly is here from the Department of Agriculture. We are glad to hear from him.

**STATEMENT OF T. C. BYERLY, ADMINISTRATOR, COOPERATIVE STATE EXPERIMENT STATION SERVICE, DEPARTMENT OF AGRICULTURE; ACCOMPANIED BY HARRY A. STEELE, ECONOMIC RESEARCH SERVICE**

Mr. BYERLY. Mr. Chairman, I am T. C. Byerly, Administrator of the Cooperative State Experiment Station Service and I am accompanied by my colleague, Harry Steele of the Economic Research Service.

We support the purposes of S. 2. In our opinion its emulation in many respects of the Hatch Act of 1887 is a sound approach to the needed increase in Federal support for research on problems related to water resources in the land-grant colleges and universities and other designated research institutions. Federal grants expended in the State agricultural experiment stations under the provisions of the Hatch Act have been highly productive in terms of significant research results without restriction of the proper freedom of research workers in those stations to conduct their research according to sound scientific precepts. The Hatch Act assures the existence in each State of a research center competent in agricultural research, jointly sup-

ported by Federal and non-Federal funds and responsive to both local and national needs.

The State agricultural experiment stations conduct water resource research oriented to the needs of agriculture and rural communities in the broadest sense. Research in most of the areas designated in title I, section 100(a) is in progress at one or more of these stations. The total amount of such research is inadequate. S. 2 provides additional authority to increase it.

The problem of coordinating research authorized under title I, section 100(a) within the recipient institutions will be complex and varied. Water resources research in the agricultural experiment stations must be coordinated with all other water resources research in the parent institutions if the most effective use of all resources is to be achieved.

In some instances the college or university may elect to designate the agricultural experiment station as its water resources research center. Some of the stations now administer projects in several colleges, or divisions, or departments; at Michigan State University, for example. About 20 other institutions now have water research institutes; Oregon State University and Cornell University are examples. Each has met the problem of coordinating water research administered in the State agricultural experiment station and that located in other units of the university in its own way.

Senator ANDERSON. Did you indicate how many of these States are being handled this way?

Mr. BYERLY. With respect to water research institutes? I can examine for the record. I cannot now tell you exactly how many there are. There are other than the two I noted. Michigan State I mentioned as an example of experiment station doing work in several divisions. It does not as far as I know have a water resource research institute.

Senator ANDERSON. I was going to say nobody has a higher respect for the head of that institution than I do. I borrowed his brains every time I could when I was in the Department of Agriculture. He is a strong supporter of this bill.

Without objection, we will include in the record a letter I received from him on the bill last year.

(The letter referred to follows:)

MICHIGAN STATE UNIVERSITY,  
East Lansing, Mich., July 20, 1962.

HON. CLINTON P. ANDERSON,  
U.S. Senate, Washington, D.C.

DEAR SENATOR ANDERSON: This note acknowledges your letter of July 2 asking for our response to the draft bill which proposes the establishment of water resources research institutes at all land-grant colleges and State universities.

We see considerable merit in your proposal and endorse the general program which it seeks to realize. Through its proposed implementation, the draft bill takes cognizance of the fact that the use of water constitutes one of the most complex and pressing problems confronting almost every State in the country. The bill further recognizes that because of the complexities involved, and interdisciplinary approach is mandatory, that both basic and applied research are required, and that there is need to collect and disseminate important information pertaining to this whole problem. At the same time, the draft bill does not exclude the possibilities of supplemental funds not covered by the bill.

Your comments concerning the material submitted by our people in the institute of water research are appreciated. I am sure they would be happy to share with

others how Michigan State University is organizing itself to administer effectively its institute of water research. As indicated, we endorse the concept and general ideas expressed in the draft bill.

Sincerely,

JOHN A HANNAH, *President.*

Mr. BYERLY. I have known John Hannah for more than 30 years and I share your admiration for him.

Senator ANDERSON. We are happy to hear you say that. He is a very remarkable public servant.

Mr. BYERLY. He is indeed.

Senator ANDERSON. And I am sure he feels this job is not being adequately handled in all of the States. In how many of them do you think—have you any idea in how many States it is being adequately handled?

Mr. BYERLY. Water resource research?

Senator ANDERSON. Yes.

Mr. BYERLY. I don't think it is being adequately supported in any of them. Does that answer your question?

Senator ANDERSON. Yes.

Mr. BYERLY. Agriculture's tremendous responsibility in the effective use of water is evident when we consider some of the data on water use and management. The average annual precipitation for the conterminous United States is 4.75 billion acre-feet. The first impact of this primary water supply is on the surface of the land. The nature of vegetable cover, slope, soil characteristics, cropping patterns, and conservation practices exerts the first determination whether precipitation becomes surface runoff, deep percolation, or soil moisture for evapotranspiration. The lion's share of this total water supply—3.38 billion acre-feet—presently is used by evapotranspiration from watershed lands. The remaining 1.37 billion acre-feet constitute the massed water supply available to the Nation. Irrigation agriculture is dependent on this supply and accounts for 90 percent of the water than is consumptively used. The efficiency of agriculture's water use—watershed and irrigation—is therefore very important to other uses.

Water research in the U.S. Department of Agriculture and the State experiment stations is concentrated on problems related to water and land management for plant growth and economic and institutional problems of water development and management. The Agricultural Research Service conducts a broad program of research in Department laboratories, in cooperation with other Federal agencies and in cooperation with State agricultural experiment stations on precipitation, evaporation, transpiration, water movement in soils, soil-water-plant relationships, watershed protection, erosion and sedimentation, upstream flood abatement, irrigation, drainage, and agricultural use of water of impaired quality. Agriculture conducts some research on phreatophyte control. It has been estimated that phreatophytes in the 17 Western States use more water than is withdrawn for public use in the whole United States of America. The Forest Service research emphasizes watershed protection, water yield, erosion and sedimentation, and upstream flood abatement. The Economic Research Service conducts research on the role of water in regional and national growth, on the economics of water development and management, watersheds, and water values, and on the economic

analysis of water institutions. The State agricultural experiment stations use Federal-grant funds appropriated under the Hatch Act, together with State and other non-Federal funds and grant funds from other Federal agencies, to support a broad program of water resource research. Areas of emphasis include water movement in the soil, soil-water-plant relationships, water yield, irrigation and drainage, and the economics of water management and development. Some research on recreational use of water is underway.

The U.S. Department of Agriculture and the State agricultural experiment stations have planned comprehensive programs of basic and applied research on the management and use of water on crop, forest, and rangeland watersheds. Public Law 87-788, the Cooperative Forestry Research Act, provides additional authority for appropriations of grant funds to designated State research institutions for forestry research, including water resource research. The U.S. Department of Agriculture has built 10 new soil and water research laboratories, 4 water hydrology installations, and 5 forest laboratories at field locations at a total cost of \$10.3 million during the period 1958-62. Funds for three new or expanded soil and water laboratories at a cost of \$920,000 and three forest laboratories at a cost of \$825,000 are included in 1963 appropriations. Additional research is urgently needed to facilitate optimal patterns of alternate and multiple use of water for agricultural, industrial, domestic, and recreational use. Basic research on water movement into and through soils and into and through plants is needed to make agricultural use of water more efficient.

We have noted the language of section 100(a), which stipulates that research conducted under authority of S. 2 shall have due regard to research being conducted by agencies of the Federal Government and that being conducted by agricultural experiment stations. As emphasized by the Senate Select Committee, it is highly desirable that a Government-wide scientific water research program be developed. This means that in addition to grants to State universities, in-house water resource research oriented to the missions of the Federal agencies and the water resource research of the agricultural experiment stations must receive full and adequate consideration in planning future water research budgets. The Department of Agriculture is concerned that the proposed bill covers only a part of the total coordinated program of scientific research on water as requested by the Senate Select Committee on National Water Resources.

We strongly support title II, section 200. Similar authority to make grants for mission-oriented research is needed by the U.S. Department of Agriculture. Current project grant authority is limited to the provisions of Public Law 85-934, which provides such authority only for basic research. No funds have been made available for grants under this authority in the U.S. Department of Agriculture, and the authority of the Hatch Act of 1955 which provides authority for grants for regional research projects recommended by a committee of nine persons elected by the experiment station directors and to a limited authority in the Forest Service under the Whitten Act. Such funds under the regional research portion of the Hatch Act are limited to 25 percent of the fund appropriated under the Hatch Act. The U.S. Department of Agriculture needs additional authority, especially for mission-oriented project research grants.

We recognize the need for cooperation, coordination, and communication, the purposes of title III, section 300. We question whether it is the most effective form of organization to authorize one of the departments participating in water research to exercise a coordinating role in relation to the activities of other departments. We suggest that this coordinating role might more properly be exercised by the Executive Office of the President. Information storage and retrieval with respect to current research can be expedited by the Science Information Exchange.

Senator ANDERSON. Could I ask you just where in the bill you find this authorization for the Department of the Interior to exercise a coordinating role over the activities of the other departments? Would you read the language?

Mr. BYERLY. Mr. Chairman, in reading the language of section 300, it seems to me that it does in fact provide that.

Senator ANDERSON. Just read the language, if you will, please, sir.  
Mr. BYERLY (reading):

He shall make generally available information and reports on projects completed, in progress, or planned under the provisions of this Act, in addition to any direct dissemination of information by the research agencies themselves. Each Federal agency doing water resources research or investigations shall advise the Secretary of the Interior at least once annually of work underway or scheduled by it. The Secretary of the Interior shall classify and maintain for general use a catalog of water resources research and investigation projects—

And then—

Senator ANDERSON. Is that your idea of coordination?

Mr. BYERLY. No. There is one other portion.

Senator ANDERSON. I mean just cover this one. Is this your idea of coordination?

Mr. BYERLY. Sir, this is not my idea of total coordination.

Senator ANDERSON. Is it any kind of coordination at all?

Mr. BYERLY. I beg your pardon?

Senator ANDERSON. Is it any kind of coordination at all? Are you familiar with the Agricultural Act of 1946?

Mr. BYERLY. Yes, sir.

Senator ANDERSON. Does that provide complete coordination? Does it attempt to catalog research facilities? Do you remember anything about the adoption of it? Were you there at the time?

Mr. BYERLY. I was present at the time, yes, sir, but not close to it.

Senator ANDERSON. Do you remember how many yards and yards and yards of material we got ready as to what was going on in other departments?

Mr. BYERLY. Yes, sir.

Senator ANDERSON. Did we attempt to coordinate the programs in any of those other departments?

Mr. BYERLY. No, sir.

Senator ANDERSON. Well, then, the collection of information is not coordination, is it?

Mr. BYERLY. The collection of information itself is one of the steps of coordination; yes, sir. Communication and information is a step in coordination and an essential step in coordination.

Senator ANDERSON. Do you think that the Agricultural Act of 1946, the collection of this information, was an attempt to coordinate, was a first step in coordination?

Mr. BYERLY. I am a little confused, Mr. Chairman, as to whether you refer to coordination within the Department of Agriculture and coordination of the work of the Department of Agriculture and the State experiment stations or coordination among the executive agencies.

Senator ANDERSON. I am only reading what happens to be in the letter that Mr. Freeman sent from the Department and he said:

We question whether it is the most effective type of organization to authorize one of the departments participating in water research to exercise a coordinating role in relation to the activities of other departments.

Now, that says exercise a coordinating role. That is what I want to talk about, whether it is a first step or some other.

Mr. BYERLY (reading):

to assure that the programs authorized in this Act will supplement and not duplicate established water research programs, to stimulate research in otherwise neglected areas, and to contribute to a comprehensive, nationwide program of water and related resources research.

Sir, in my opinion that conveys authority for coordination.

Senator ALLOTT. Where are you reading from?

Mr. BYERLY. Section 300, sir, beginning at line 25, the last statement.

Senator ALLOTT. Starting at line 25.

Mr. BYERLY. Yes, sir.

Senator ALLOTT. All right.

Senator ANDERSON. I thought that started off:

The Secretary of Interior shall arrange for the regular advice and cooperation of all agencies in the Federal Government—

For this purpose, not for itself.

Mr. BYERLY. Yes, sir. He shall arrange for it, and to me, sir, that is a coordinating role which should better be vested in the Office of the President.

Senator ANDERSON. Your objection, then, is to where it is located.

Mr. BYERLY. Oh, yes. Not at all that it ought to be done. I am very much in favor of coordination being done.

Senator ANDERSON. This was put in so the Secretary of the Interior could get information on what other agencies were doing so he could judge his program accordingly. He would not be interested in the slightest in other things they are doing. I don't think there is any intention to do this in this bill.

All I can say is that I hope we learn by experience. I hope that I did, at least, and I think one of most interesting experiences that I had in the Department of Agriculture was in collection of the material in connection with the passage of the Agriculture Research Act.

I thought it was a somewhat important step. I thought it was a useful step. It didn't have its value because of what the Department thereupon did to the State schools but by virtue of what it found out was going on, so it might make suggestions to do things they should look at.

I don't know what happened after I left the Department. I only know what happened up to the time I left and that since that time I have never had a letter from one school in the country saying that particular research act was used to crowd down on them programs that they didn't want and deprive them of programs that they did want.

If you have information to the contrary, I wish you would send it to me.

Mr. BYERLY. Sir, I hope there is no information to the contrary. We take pride in the fact that the latitude to the State experiment stations to conduct their programs of research is very broad indeed and we do try through evaluation and through communication to provide information so there will not be unnecessary duplication on those programs.

Senator ANDERSON. Senator Allott?

Senator ALLOTT. Mr. Chairman, since this question has been raised, I think we should try to lay it at rest either here or later. I would like to point out to the witness, referring to the section you just referred to, let's read it carefully:

The Secretary of the Interior shall arrange for the regular advice and co-operation of all agencies of the Federal Government concerned with water problems, of State and local governments and of private institutions and individuals, to assure that the programs authorized in this Act will—

“Authorized in this Act.”

Senator ANDERSON. “This Act.”

Senator ALLOTT (reading):

will supplement and not duplicate established water research programs.

Now, I must confess that perhaps we should pay attention to making this clearer, if possible, but it seems to me that the way this is read, while one interpretation could be made like the witness has, I certainly would not put that interpretation on it, particularly since it says that the programs authorized in this act will supplement, and it doesn't go beyond that phase. I don't think it authorizes him to go into programs of other agencies.

Senator ANDERSON. Let me say to my friend from Colorado, who is a very good lawyer and useful member of this committee, that he has found on occasion, too, it is well to protect these points as we go along. I want to assure the witness that the exact thought that Senator Allott had was in our mind, that this covers programs authorized by this legislation, doesn't interfere in any way with any other programs you now have. If you started to put the Department of the Interior to controlling agricultural research, as it now exists, I am sure the witness knows who the strongest opponent would be because I don't believe in that at all. But I do say things authorized in this legislation ought to supplement and ought not to contravene and ought not to reflect in any way on the regular programs now going on in these other departments.

That is the reason I answered as I did a moment ago about water pollution. I think HEW is working in that field and I would hate to see the money in this program used to sort of dip into the water pollution program because I believe that belongs where it is.

If there is some special study that might be made that would have some bearing on that and HEW said, we would like to know what is happening in a certain part of the world, fine. But I am glad Senator Allott brought this out because we are only trying to deal with programs authorized in this act and I hope the legislative history would be sufficiently clear on that point, and I appreciate the Senator from Colorado making it, I think, clear. We don't intend to interfere in any way with programs already existing.

Mr. BYERLY. I thank the Chairman and the Senator from Colorado for the statement, sir.

Senator ANDERSON. Senator Moss?

Senator MOSS. I do not have any questions. I am interested in the discussion here on the point. I agree we should clarify it fully so that there won't be any doubt remaining about superseding any of the research activities that are now being carried on.

Senator ANDERSON. Senator Jordan?

Senator JORDAN. No questions.

Senator ANDERSON. Senator McGovern?

Senator MCGOVERN. Mr. Chairman, with regard to the point that has been under discussion, it seems to me that if there is any doubt about it, it would be cleared up in section 301. I think the only practical danger stemming from the point that the witness has made is that the existing authority of some department might be diminished by this act. But it is spelled out very clearly in section 301:

Nothing in the foregoing section nor in this Act is intended nor shall be construed as giving its Secretary or the Department of the Interior any authority or surveillance over water resources research conducted by any other agency of the Federal Government.

It seems to me this language is very clear.

I have no further questions.

Senator ANDERSON. No further questions. Thank you very much. Again I want to assure you that I appreciate all the fine research going on through the Department of Agriculture. A very fine piece of work was done by the Department in drafting the Agricultural Research Act of 1946, and by longtime employees who know what they were doing when they got it all together.

Senator ANDERSON. I have just received a statement from Senator Bartlett supporting S. 2. Senator Bartlett had hoped to be here. We will put his communication, including a letter from the president of the University of Alaska, in the record.

(The letter referred to follows:)

U.S. SENATE,  
February 20, 1963.

Senator CLINTON P. ANDERSON,  
*Chairman, Senate Interior and Insular Affairs Committee.*

DEAR MR. CHAIRMAN: I am pleased to be a cosponsor of S. 2, a bill to assist the establishment of water resource research centers at State universities; to promote a more adequate national program of water research; and to provide for the training of research personnel.

This bill is important to my State of Alaska and to all the States. I congratulate you and your committee, Mr. Chairman, for giving this measure the priority consideration it so clearly deserves.

The bill before the committee is a modest proposal concerning a major problem. The problem, of course, is how efficiently to utilize our water resources and how best to provide for their proper conservation. The proposal is not a solution to this problem—nor is it intended to be. When solutions are found however, they will be found by personnel trained under the provisions of S. 2, utilizing techniques and equipment developed in S. 2 laboratories.

The research centers which this bill provides for are modeled after the wholly successful program of State agriculture extension services. Funds—not more than \$100,000 per year—would be provided to the several States for use in the establishment of a State water center. This bill also provides for specific grants-in-aid for particular research projects. It is the hope of the sponsors of this legislation that it will encourage and develop the training of scientists and personnel equipped to work in the area of water research.

I am hopeful, Mr. Chairman, that the committee will make very clear that S. 2 will not conflict with—but will rather complement—research programs al-

ready undertaken by the Federal Government in water use and conservation. It should also be made clear that it does not interfere with studies now under way, with Federal, State, and local participation, into the economic needs and development of river basins.

For example, under the terms of the Federal Water Pollution Control Act, seven water pollution laboratories are to be constructed at sites across the country. Alaska is fortunate to have been selected as one of the sites and the fiscal 1964 budget now before the Congress includes funds for the construction of this laboratory. It is clear, I believe, that should the University of Alaska undertake to set up a water resource research center using S. 2 funds there would be ample opportunity for coordination and cooperation between the two facilities.

The Alaska congressional delegation has been working closely with the executive branch in an effort to establish a joint Federal-State planning commission to attempt a coherent projection of the economic development of Alaskan resources. Such a study would, of course, include water use and would have ample reason to work closely with, and to profit from, a State water research center.

The University of Alaska is greatly interested in S. 2. Enclosed you will find expression of this interest, a letter from the president of the university, William R. Wood. I would appreciate your making it a part of the committee record on the bill.

Sincerely yours,

E. L. BARTLETT.

UNIVERSITY OF ALASKA,  
*College, Alaska, February 12, 1963.*

HON. E. L. BARTLETT,  
*U.S. Senate,  
Senate Office Building, Washington, D.C.*

DEAR SENATOR BARTLETT: I have read with much interest the copy of S. 2, "A bill to establish water resources research centers at land-grant colleges and State universities," which as a cosponsor you sent to my office. The bill has been reviewed in detail by a number of our faculty, including Dr. Kenneth Rae, director of the institute of marine science, Dean Earl Beistline of the College of Earth Science and Mineral Industry, and Dr. C. T. Elvey, vice president for research and advanced study. All of us are keenly interested in the intent of S. 2 and are in strong support of its several provisions. We believe that a program such as the one proposed would complement the work that is in prospect in water-pollution studies by the U.S. Public Health Service, and could become an important part of the total Arctic research program which we are attempting to develop.

I am enclosing a copy of a letter from Dr. Elvey to Senator Anderson concerning the interest of the University of Alaska in water resources research. These, I am certain, you will find of interest.

Sincerely yours,

WILLIAM R. WOOD, *President.*

Senator ANDERSON. Mr. Sam Thompson, director of the Mississippi Water Board, for the Interstate Conference on Water Problems of the Council of State Governments. Mr. Thompson is a longtime friend of many of us here.

**STATEMENT OF SAM THOMPSON, DIRECTOR OF THE MISSISSIPPI WATER BOARD, FOR THE INTERSTATE CONFERENCE ON WATER PROBLEMS OF THE COUNCIL ON STATE GOVERNMENTS; ACCOMPANIED BY DR. MITCHELL WENDELL, COUNCIL OF STATE GOVERNMENTS**

Mr. THOMPSON. Thank you, Senator. I have with me Dr. Mitchell Wendell, staff member of the Council of State Governments, who worked with the policy committee in developing our policy position in this statement.

My name is Sam Thompson and I am appearing on behalf of the Interstate Conference on Water Problems. This Interstate Con-

ference on Water Problems is a national organization of State officials concerned with all phases of water resources planning development, use, and administration. Consequently, the conference is vitally interested in the improvement of water research programs and in legislation designed for this purpose. We appear in support of the objectives of S. 2 and wish to offer the following observations on the problem to which it is addressed, and on certain of the bill's provisions.

With ever-increasing demands on our water supplies, the need to have complete information concerning our water resources and the most efficient means of using them grows. For the Nation as a whole, it seems unlikely that we will have an actual shortage of water in the predictable future. However, a usable abundance depends on proper distribution of the available supplies of water, upon optimum management of the supply, and upon constant improvement of techniques for using and reusing water. We have learned a great deal about hydrology and other water resources matters, but in important respects our information and know-how are still inadequate.

Essential to any program of water resources research is basic data collection. No program can be any better than the raw material it has to work with. Basic data collection has been carried on by the U.S. Geological Survey and the States on a cooperative basis, with matching funds and close cooperation of Federal and State personnel. It is our understanding that the research authorized by S. 2 would be in addition to, and not in substitution for or replacement of, the cooperative basic data collection program. Continuation and expansion of the existing program is of the first importance, and it would not be wise to sacrifice or impair it in order to devote funds and personnel to some other type of effort. On the other hand, provision for broadened water research programs, while safeguarding the continued development of the existing cooperative Federal-State program would be very worth while.

The idea of State or regional institutes connected with colleges or universities is a good one. Despite the fact that much of the results of research will be applicable throughout the country, many of the physical aspects of the contemplated research must be undertaken in the geographic areas concerned. Also regional variations in water resources problems can be better reflected by State or regional institutes than they could be by a single consolidated facility, however excellent. We are especially glad to note that the bill expressly recognizes that either land-grant colleges or other institutions of higher learning could be the appropriate location for research activities of the types contemplated, and that each State is given an opportunity to decide where its institute would be lodged.

In this connection, however, the bill could give greater recognition and prominence to existing public and nonprofit water research agencies. Some of them are attached to State or private universities. Others exist as non-university-connected departments, boards or commissions of State government. While the facilities of a college or university are highly useful for research activities and will strongly impel States to locate the institutes provided by this proposed legislation on university campuses, the objective of the bill is to promote water resources research in whatever way is most efficient. Conse-

quently, we would suggest that the committee consider modifying the opening language of section 100(a) so as to permit the operation of institutes in States under any suitable administrative pattern, particularly where a nucleus of competence or a material volume of research data are already available. Several conforming changes would have to be made in the title and other parts of the bill if this were done. Emphasis could still be placed on colleges and universities by mentioning them specifically as among the suitable locations for the research work.

Also, we wish to commend the sponsor and supporters of the bill for making express provision for States to establish joint facilities on a regional basis. In particular instances a State may find it most suitable to have a research facility whose territorial service area is coincident with the boundaries of the State; in other circumstances, larger service areas—perhaps a river basin or group of river basins—will be more economic or convenient. Encouraging States to engage in cooperative undertakings, wherever appropriate, without penalizing them financially for doing so is a constructive approach.

The problem of effective use of research funds and personnel has another aspect. The language of the statute should provide means for avoiding duplication of research activities, both as among institutes in the several States and among institutes and other Federal and non-Federal research agencies. In addition to the notice already taken of this problem in the bill, we suggest that the statute might provide for a committee of officials from States participating in the program with which the Secretary could confer in order to shape the various parts of the research activities carried on pursuant to this legislation in ways that would make them complementary, rather than duplicative, but without imposing restrictions on initiative to devise and execute research.

At its December 1962 meeting, the Interstate Conference on Water Problems adopted a resolution dealing with water resources research. It is as follows:

RESOLUTION ADOPTED BY THE INTERSTATE CONFERENCE ON WATER PROBLEMS OF THE COUNCIL OF STATE GOVERNMENTS REGARDING WATER RESOURCES RESEARCH

Whereas the constantly increasing demand upon the Nation's water resources necessitates an immediate and pronounced acceleration of water resources research; and

Whereas the States have a responsibility to aid in the solution of problems requiring research; and

Whereas there was introduced in the 87th Congress legislation which could be helpful in promoting such research and in assisting the States in discharging their responsibilities: Now, therefore, be it

*Resolved by the Interstate Conference on Water Problems meeting in Chicago, December 5, 1962, That the States are urged to increase their support of coordinated programs of water resources research; and be it further*

*Resolved, That the Congress is urged to give favorable consideration to legislation providing for distribution of sums for research in furtherance of programs developed by a qualified college or university in each State and Puerto Rico, or such other substantially equivalent arrangement as the State may determine, such distribution to be made only after consultation with the Governor or appropriate State agency as the Governor may direct and for programs of coordinated research or for programs which are compatible with coordinated research programs.*

Mr. THOMPSON. If the Interstate Conference on Water Problems can be of any assistance to the committee in the further development of this legislation we will be happy to cooperate with you.

We wish to thank you, Mr. Chairman, and the members of your committee, for the opportunity to express our views on this important legislation.

Senator ANDERSON. Thank you, Mr. Thompson, for a very fine statement.

I want to call your attention to the fact that the bill does permit arrangements with the educational institutions, private foundations, with private firms and individuals. So the Secretary could make as broad as possible use of the funds given to him.

Senator MOSS.

Senator MOSS. No questions, Mr. Chairman.

Senator ANDERSON. Senator Burdick.

Senator BURDICK. No questions.

Senator ANDERSON. Senator Church.

Senator CHURCH. No questions.

Senator ANDERSON. Thank you very much for your testimony, Mr. Thompson. It has been extremely interesting and helpful.

Mr. Kimball, I am happy to see you here.

#### STATEMENT OF THOMAS L. KIMBALL, EXECUTIVE DIRECTOR, NATIONAL WILDLIFE FEDERATION

Mr. KIMBALL. I am Thomas L. Kimball, executive director of the National Wildlife Federation. I appreciate this invitation and opportunity of commenting briefly upon S. 2, to establish water resources research centers at land-grant colleges and State universities to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research.

By way of identification, the National Wildlife Federation is a private organization which utilizes educational means to attain conservation objectives in the public interest. Among the 51 independent affiliates of the National Wildlife Federation are conservation organizations located in all States and the District of Columbia. An estimated 2 million persons are included among those who make up these affiliates and otherwise support programs of the National Wildlife Federation.

Conservation groups long have recognized the need for additional research on water resources and were pleased that the Senate Select Committee on National Water Resources, after exhaustive study, saw fit to recommend such a program. We believe S. 2 would implement this program and the National Wildlife Federation is in accord with its principles.

Persons concerned with natural resources are aware of the many valuable contributions made to agriculture by research conducted at experiment stations. Many observers, in fact, attribute this Nation's leadership in agricultural production at least in major part to studies and investigations of these institutions.

Senator ANDERSON. Let me interrupt you to observe that it is not only the experiment station, it is the work of the extension services that carry the work of the experiment stations into the home.

Mr. KIMBALL. That is right. I think that emphasis needs to be applied, it is the application of that research.

Senator ANDERSON. The experiment station is useful, but it is made useful by carrying the information all the way through from the Department in Washington to the State land-grant colleges, through the extension services and right into the home of the farmer. I think that has been the great glory of that whole experimental work.

Mr. KIMBALL. We are confident that a program for water research along the same general lines also will pay rich dividends, directly in more efficient management of the resource and, indirectly, in training of persons with professional competence in the field. Land-grant institutions offer unique opportunities for a combination of education and research.

In view of the importance of water resources to almost all facets of life, the program proposed in S. 2 appears modest and reasonable.

The National Wildlife Federation believes in the multiple use of water for domestic purposes, for agriculture, for industry, for essential power generation, navigation, wildlife, and recreation. Our principal interest, of course, is in public outdoor recreational opportunities and we urge the committee to make it clear in both its report and in the approved version of the bill that water research shall be authorized and directed in these areas as well as for other purposes. The public has a real and demonstrated interest in water-related recreations such as fishing, hunting, boating, swimming, et cetera, which can benefit from research. And, as a general rule, these recreations do not constitute uses which consume or damage the water for other beneficial purposes.

To illustrate one of our areas of concern, Mr. Chairman, I might point out that the National Wildlife Federation believes many large impoundments could offer additional public recreational opportunities if the production of game fish is increased. Much remains to be researched and investigated, however, on the management of these large bodies of water. While the management of farm ponds and small lakes has been the subject of much study, considerably less is known on what needs to be done on large impoundments to maintain fishing success at a high level. Production may vary widely within soil types, water qualities, pollution, and a host of other factors. Solution of such problems, when correlated with proper water resource planning, would be proper objectives of research centers.

In conclusion, Mr. Chairman, we hope early favorable consideration is given to this proposal.

Thank you for the opportunity of appearing.

Senator ANDERSON. Thank you very much.

Do you happen to know which State of the Union has the largest number of pleasure boats per capita?

Mr. KIMBALL. I believe it is Arizona.

Senator ANDERSON. I believe it is, too, at least I hope it is, because I said so in a speech a few days ago.

What I am trying to say is that in the early days, certainly only a few years ago when we were concerned with conduits and dams and the Salt River irrigation project, we weren't concerned with the recreation values, and now we find that the recreation values are extremely important. I hope the San Carlos Apaches in Arizona have learned that the land along the streams in Arizona is far more valuable for use for recreation than for any other purpose, and they can rent it to

people from Phoenix and take revenues from it. I am glad you stated it in this hearing today.

Any questions?

(No response.)

Senator ANDERSON. Thank you very much for coming.

Mr. Spencer Smith?

I am glad to see you here, Mr. Smith.

**STATEMENT OF SPENCER M. SMITH, EXECUTIVE DIRECTOR,  
CITIZENS COMMITTEE ON NATURAL RESOURCES**

Mr. SMITH. Thank you very much, Mr. Chairman.

I am Mr. Smith, executive director of the Citizens Committee on Natural Resources, which is a national conservation organization. We have on the board of directors some of the outstanding conservationists in the Nation. Our chairman is Dr. R. M. Gibbons.

We want to commend you, Mr. Chairman, and the many people who have fostered the study of water conditions and are responsible for the introduction of this legislation.

One of the things that we were somewhat concerned about when it first went out was whether, since it involved land-grant colleges, this was going to be strongly oriented to agriculture only. We are very pleased with the broad gage that this legislation has.

We want to call special attention to the message that the chairman of this committee gave to the Senate on January 14 in which he points out:

The principle of multidisciplinary or collegewide agencies—  
which will be involved in this study—  
has received general endorsement.

We want to emphasize at this time that in many instances in the past, at least as far as the administration was concerned, water was thought of primarily in connection with agriculture or engineering, and we are pleased with this bill that takes the broad look that it does.

I want to quote again, if I may, from your statement of January 14, which I think highlights our particular interest in this bill:

Engineers, hydrologists, and physical scientists will not be required for all of the projects undertaken, nor for all of the tasks of training needed personnel which are involved. Water problems are social as well as physical. There is a great deal we need to know about the economic value of water in alternative uses, about the suitability and adequacy of our divergent systems of riparian and appropriation rights in water law, about the efficiency and effectiveness of the social and political institutions which administer water, the social and economic objectives of water resources development, the economic effects of interbasin transfers, the potentialities of flood plain zoning, methods of evaluating the use of water for recreation and scenic preservation \* \* \*.

One of the gentlemen who called our office was originally concerned as to whether such things as wildlife, recreation, and scenic values were going to be properly considered with such research. And when we pointed out that Senator Anderson was the author of the bill he said:

I feel a little better about it, because I know his sincere interest in wilderness preservation and recreation and others, and I know that this is adequately provided for.

So I think we have a great deal of trust simply in the authorship of the bill.

I might mention also that this bill does have three significant programs for water research. The one that has received the most attention, and rightly so, is Federal assistance to the land-grant colleges. It has been my understanding—and I have served on the faculties of land-grant colleges—administrators of these colleges have been anxious to broaden the scope wherever possible, and they are constantly pressing for this. In some cases I would be less than candid if I did not say that there was some restraint placed on them by the governing institutions or governing bodies. But I do feel that the emphasis has been—certainly within the last two decades—land-grant colleges haven't tried to think of these things as parochial problems but broad social problems. And we are very pleased to see that they are starting or will start if this bill is enacted, a program of water research to provide us with a really excellent corps of people trained in water management.

I was especially interested in the comments by Senator McGovern, because time and time again when money is available for certain kinds of water research it is pointed out that technical people are not available. And this takes a long look and gets us a pretty good study of problems that come in the future by people in many different disciplines who have a water consciousness and have the professional capacity to deal with some of these problems.

I want to call attention especially—and maybe I misread the bill—I was pleased at the colloquy between the Senator and the representatives of the Department of Agriculture, because I had looked upon this catalog of information as one of the fine parts of the bill. And I know the Senator is aware of our constant hounding everybody for information on this, and trying to find some centrally located place that brings these things together. As I interpreted the bill, it is primarily for guidance of the Secretary of the Interior, and not necessarily to coordinate or to say to another Federal agency that it could or couldn't do this, but to say that these programs—I have now information that these programs are going on in a few weeks, and I will be guided by them in the way I administer other additional water resources funds provided for in the bill, or the matching grant, \$5 million, and I would presume that the Secretary would not intentionally duplicate something that is being carried in another Federal agency.

Senator ANDERSON. I want to thank you for that observation, because that is the purpose of the bill. I do feel that the Department of Agriculture was well within its rights in trying to get some legislative history which would show that to be the purpose. As for myself, I don't think anybody needs to question how I feel about it, because I have the kindest feelings toward the Department of Agriculture and its staff and the wonderful work it does. There is no intent on my part to cut the existing programs there. But at the same time, we are having a dam built out in New Mexico on the Rio Grande that could have a recreation value if 50,000 acre-feet is provided for a permanent pool, and maybe the operation loss per year will be 5,000 acre-feet. I think that 5,000 acre-feet could better be used there than for agricultural purposes around Albuquerque and

the Central Rio Grande Valley. It will bring a greater economic return. I introduced a bill to provide the needed water in which the city of Albuquerque, which is growing rapidly, seems to be very much interested. The city is taking steps to release some of the water assigned for the city's use for this purpose of filling the dam for recreational purposes. A study made at the University of New Mexico just recently indicates that while the agricultural value of that water is high, the recreation value is many times higher. We don't intend to disturb the agricultural possibilities. We have got plenty of those. But we do need this recreation resource lying close to our city line.

Mr. SMITH. I think this is one of the things that we can get excited by in this bill. In many instances this will place many of the values that the Senator knows that we are concerned about up for consideration and research. I noticed just recently a report, a water planning and research report that came out of the State of Texas. None of the values that we have been mentioning here today were involved in this report. And while it is not our purpose to exclude other very important values, it certainly is our purpose to hope that the things that we are concerned about here are included. This is one of the reasons for our interest in this bill.

Mr. Chairman, at this time I would like very much—it may be impertinent, but I don't mean it to be—but in all the discussions I have had in my college about S. 2, one of the basic documents we have used for reference is your speech to the Senate of January 14. I would like to recommend that this be placed in the record at this time, because it provides an excellent source for our review, and it may serve the same purpose for the people reading committee reports.

Senator ANDERSON. I am a little prejudiced, I will admit; so, without objection, that will be done.

(The excerpt from the Congressional Record referred to follows:)

[From the Congressional Record, Jan. 14, 1963]

#### ESTABLISHMENT OF WATER RESOURCE CENTERS AT CERTAIN COLLEGES

Mr. ANDERSON. Mr. President, I send to the desk for appropriate reference a bill to establish water resources research institutes or centers at land-grant colleges and universities, to stimulate water resources research at other institutions of higher education, and to promote a more adequate national program in this field.

I request unanimous consent that the bill lie on the desk for 3 days to permit any Senators who wish to do so to join in coauthorship of the measure.

The first draft of this bill was introduced in the 87th Congress on July 27 of last year. I then announced that it was introduced for the purpose of study, to stimulate discussion, obtain the views of the agencies in the executive branch of the Government, and to become a vehicle for the preparation of a revised bill for presentation to this Congress.

The response to the study bill has been a stimulating experience.

Comments and suggestions have come from every corner of the country, and they have been almost invariably constructive. Many have been incorporated in the revision. Without any exception, the basic plan in the bill to stimulate water resources research in colleges and universities, where it will help to produce much-needed, highly trained personnel in the water field, has been warmly endorsed and supported.

The principle of multidisciplinary or collegewide agencies has received general endorsement.

The sums proposed to be authorized for the research programs have not been criticized. We have been advised that they are modest in comparison to expertly estimated needs for college and university located research on water problems, but not so modest that they will not permit substantially adequate begin-

nings of a program which is expected to stimulate and attract matching funds from other sources.

#### THE WATER RESOURCES SITUATION

Before dealing in greater detail with this water resources research bill, we should review briefly where we stand as this session of Congress opens in relation to water resources to meet the Nation's growing needs.

In January 1961, under the leadership of the greatly missed Senator from Oklahoma, Robert S. Kerr, the Senate Select Committee on National Water Resources warned us in its final report that we will have abundant water supplies in the years ahead only if we conserve them and manage them wisely.

Full development of all available supplies is going to be necessary to meet the needs in 1980 of five major river basins, or areas: the South Pacific area in California, the Great Basin in Nevada, the Rio Grande-Pecos, the Lower Colorado, and the upper Missouri River Basins.

Another three great water areas will be at the limit of their supplies, with full development, by the year 2000. This group includes the western Great Lakes area composed of Michigan, northern Indiana, most of Illinois, and eastern fractions of Wisconsin and Minnesota. It also includes the western gulf area in Texas, and the upper Arkansas-Red River Basins involving major parts of Colorado, Kansas, and Oklahoma, and smaller sections of northeastern New Mexico and northern Texas.

Briefly, by the year 2000 the western half of this Nation excepting the upper Mississippi, the immediate Mississippi River drainage area, the lower Missouri and the Columbia River Basin will have come to the end of presently available water resources. The rest of the Nation will be struggling with conserving, purifying, recycling, and transporting water to points of need with investments in water facilities running well over 10 or 15 billion 1961 dollars per year.

Some of us are right now at the bottom of the barrel. The San Juan-Chama project in New Mexico will develop our last major available water supply unless and until we can purify brackish waters. In Arizona, 60 percent of water needs are being met from ground water sources which are being pumped out far faster than they are replenished. Southern California is now importing water, planning to import more from the northern end of the State, and hoping the Supreme Court will permit it to have more from the Colorado River Basin despite an adverse report of the Court's master in the case.

Totally, America has an abundance of water to meet her needs for centuries to come if the water and population are managed right. It will require enormous investments, at best, to manage properly. We are right now eyeball-to-eyeball with shortages, and in many areas we cannot afford enough time to blink. We must invest in water development and research or stagnate.

#### SELECT COMMITTEE RECOMMENDATIONS

The Select Committee on National Water Resources, on which I had the honor to serve with Senators Kerr, Murray of Montana, Chavez, Ellender, Magnuson, Jackson, Engle, Hart, McGee, Moss, Kuchel, who was vice chairman, Young of North Dakota, Schoeppel, Case of South Dakota, Martin of Iowa, and Scott of Pennsylvania, made five recommendations. These included:

First, development of comprehensive water development and management plans for every major river basin in the United States by 1970.

Second, a 10-year program of financial aid to States to help them become active participants in the big planning job.

Third, a greatly expanded and comprehensive Federal program of scientific research on water, probing ways both to increase our supplies and to increase the efficiency of our use of available supplies.

Fourth, preparation of a biennial Federal assessment of the water demand-supply situation in each of the water resource regions of the United States so we will know where we stand, starting this year.

Fifth, Federal-State cooperation in a program to encourage efficiency in water development and use.

President Kennedy took the initial steps to implement these recommendations during his first month in office. In February 1961, in his resources message, he advised that he had asked the National Academy of Sciences to give him a report on the situation in respect to scientific research on all natural resources. He had also asked the Council on Science and Technology to provide an interim report on water research.

## THE WATER PLANNING ACT

In July of the same year—1961—he sent to Congress a draft of a Water Resources Planning Act to provide the machinery for development of major river basin plans by 1970, and to provide the recommended aid to the States for participation in planning work.

Despite a great divergence of views about who should do our river basin planning, and a feeling in many quarters that agency and departmental competitions in the water field make the achievement of the task of coordinated planning in a reasonable period of years absolutely impossible. I have a great deal more than bare hope that the 88th Congress of the United States will solve this puzzle and get such planning underway on the basis of President Kennedy's bill.

The Interior and Insular Affairs Committee sat jointly with the Public Works Committee in hearings on the President's planning and State aid proposal in 1961. There was opposition to it from those who insist that State water rights are paramount to Federal rights—or should be. The situation did look hopeless, but the Interior Committee has persisted in an effort to reach agreement with the States on a mechanism for planning which will avoid the State-Federal rights issue. I appealed to Gov. Nelson Rockefeller, of New York, at one point in this effort to help end the impasse between Federal and States rights advocates which has existed since President Teddy Roosevelt's Inland Waterways Commission recommended comprehensive Federal planning in 1908.

A series of conferences between representatives of the Interstate Commission on Water Problems of the Council of State Governments and of our committee has ensued. Modifications of President Kennedy's proposal for basin planning commissions have been developed which I have reason to hope will find broader acceptance than any previous draft. There should consequently soon be before this Congress a revision of S. 2246 of the 87th Congress, intended to implement recommendations Nos. 1 and 2 of the Select Committee on National Water Resources and the President's proposal to get planning started.

We are not going to drop the effort to achieve orderly water resources planning. Wise management of the water resources of our planet is fully as important as exploring space. Both are going to be top priority concerns of mine in this Congress.

## IMPLEMENTING THE RESEARCH RECOMMENDATION

The bill I have just introduced, the water resources research bill, is intended to contribute to the implementation of the select committee's third recommendation—a comprehensive Federal water research program.

So there will be no continuing misunderstanding of the bill, as is reflected in one departmental report on S. 3579, it should be clearly understood that the measure does not propose a total Federal water research effort and no such claim is made for it.

The bill proposes Federal financial assistance to land-grant colleges and universities or other competent higher educational institutions in each State, as the State determines, to establish a universitywide water resources research institute or center, in the general pattern of the Hatch Act of 1887 which authorized the agricultural experiment stations. Each State center will be entitled to \$100,000 annually on a continuing basis, plus matching funds for specific research or experimental projects. The Secretary of the Interior is also authorized to make grants, matching agreements and contracts with other colleges and universities, States and other governmental agencies, private foundations and other institutions, firms and individuals, to conduct water research projects within the scope of the Department of the Interior's mission in the water field. Appropriation of \$5 million in the first fiscal year, increasing to \$10 million over the next 5 years, would be authorized.

The program does not meet the need for expansion of direct Federal research work on important water problems like pollution control, weather modification and saline water conversion, nor the need for the departments of the Federal Government, other than Interior, to use the colleges and universities on research projects in their fields of responsibility. Just as the agricultural experiment stations supplement Federal agricultural research at Beltsville and many other direct Federal agricultural laboratories and research centers, the water research program proposed in this bill would supplement present programs of Federal agencies, not supplant them.

When I introduced the original draft of the bill, I said:

"The proposal is not a solution to all water resources research problems. It will make a great contribution both to the assurance of adequate water supplies and the advancement of our scientific knowledge but there will be a continuing necessity for special Federal water research programs such as the present saline water and pollution control work. There will be need for intensified fundamental scientific research into the nature of this element, and into every aspect of the hydrologic cycle, not only in the colleges and universities, but wherever competent scientists can be enlisted and supported in the work.

"This bill proposes what I believe will become a very important part of the sort of national water research program called for by the Senate Select Committee on National Water Resources in its 1961 report, but only one part of it."

#### STATEMENTS IN SUPPORT

Mr. ANDERSON. Mr. President, in my original remarks, I included statements from a number of eminent educators and scientists in regard to some of its major features.

They include the findings of a symposium of engineers that water research involves many fields of knowledge—mathematics, physics, chemistry, geology, meteorology, statistics, bacteriology, biology, geography, soil, science, agriculture, forest management, law, economics, public administration, political science, medicine and sociology. This listing supported the finding that water research must be interdisciplinary, with highly trained men available from a broad array of fields.

Dr. Joseph L. Fisher of Resources for the Future, and Dr. John C. Geyer of the Department of Sanitary Engineering and Water Resources at Johns Hopkins University are quoted on the need for more scientists—social as well as physical scientists—working in the water field. Together with Dr. Carl E. Kindsvater of the University of Georgia, they support the urgency and great value of combining research and education to bring about the training of much-needed scientists specializing in water problems.

The original endorsements of the basic objectives of this water resources research proposal could now be extensively supplemented from the reports of the executive agencies on S. 3579, from the findings of educational and scientific bodies who have independently made recommendations paralleling S. 3579 since its introduction, and from communications about the proposal from people with knowledge of our critical water situation.

I shall cite some of these supporting statements which are pertinent to features of the bill which have been, and will doubtless be debated further, during its consideration.

It has been suggested that regional, rather than State, water research centers would be adequate and that in some instances other than land-grant institutions should be designated as the home of the State water research agency.

The original bill provided that funds for a center should go to a land-grant college or university, or "such substantially equivalent arrangement as the State shall determine." That has been changed in the current draft to specify a land-grant institution or "other institution of higher education as the State shall determine." This is intended to make clearer that the State may designate whatever college or university it considers best to conduct interdisciplinary water research work. The new draft is further amended to authorize, but not require, two or more States to join in a single interstate or regional water research agency if they desire to do so.

#### MANPOWER REPORT

There should be such discretion in the bill, but I am prepared to defend, with the backing of some outstanding authorities, the wisdom of staying close to the pattern of the Hatch Act of 1887—the Agricultural Experiment Station Act—which authorized the establishment of experiment stations at the land-grant school in each State.

Report No. 1 of the President's Science Advisory Commission on "Meeting Manpower Needs in Science and Technology," declares:

"Additional first-rate educational opportunities should be located in such manner as to serve all geographic areas more effectively. Centers of excellence serving more regions and States would stimulate and spread economic progress because, as recent experience has shown, industry tends to concentrate around

leading institutions of science and technology. In addition to enlarging present programs, special arrangements will be required to assist areas of the country which now possess inadequate foundations for an effective graduate education program."

The President's Committee also found:

"Nowhere are the benefits of scientific research more dramatically revealed than in food production. Fifty years ago in this country an agricultural worker produced food for only 3 or 4 others in contrast to his capability to feed 27 individuals today.

"This accomplishment can be directly attributed to research that has been systematically supported by the Federal Government, the States, and private sources, in programs that have historically and effectively linked education and research. As a consequence, universities have been eminently able to meet changing needs."

#### WATER RESEARCH IN AGRICULTURAL PATTERN

The universities to which this comment alludes, are, of course, the land-grant institutions proposed to be activated in the water field by the bill I have introduced. The program of systematic Federal, State, and private support effectively linking education and research to which our great success in the food field is attributed is the exact pattern which would be established in the water resources field by the measure I have presented, for the language of the Water Resources Research Act is the language of the Hatch Act which started the agricultural experiment station system.

In the field of water research, the proposed act would spread centers of competence to serve the needs of the States on the same pattern which the President's Committee found the most outstanding example there is of the benefits of scientific research.

The Committee on Natural Resources of the National Academy of Sciences—National Research Council, in its study of the status of natural resources research for the President, has come to the conclusion that—

"In adapting their research programs and activities to the requirements of the problems outlined in this report, governmental and nongovernmental agencies and institutions should take full advantage of the resources of the universities, contracting out especially those studies for which the universities are uniquely equipped. It should be remembered that an important byproduct of the university research is the training that accompanies it, and the committee reemphasizes the need for training research workers to deal effectively with the problems relating to natural resources. These problems require closer cooperation between natural and social scientists."

#### WOULD ENLIST LAND GRANT SCHOOLS

The National Science Foundation group concluded that the Federal Government should "enlist the potentials of land-grant institutions" and that—

"These institutions should be encouraged to extend their interest to cover the total span of natural resources, particularly as they relate to the future well-being of the areas they serve. For example, these institutions in the coastal States could develop fisheries experiment stations similar to the agricultural experiment stations which have so successfully aided the development of agriculture in the United States.

"The faculties of these universities should be called upon to serve as advisers and assistants to local and State agencies with responsibilities for resource development, planning, and management."

It is appropriate to repeat at this point that one of the facts which stimulated the original concept of S. 3579 was the Interior Committee's finding, during a committee survey of current water research and study activities, that the States, in their efforts to meet pressing water problems, are already calling on land-grant college and university faculty members for help and advice.

As the cooperative Federal-State water resources planning work recommended by the Senate select committee, and by the President, gets underway—and there is going to be water planning because of the pressure of requirements whether Congress provides an orderly method or it has to be a patchwork job—State and local officials throughout the Nation are going to have increased need for such advice and assistance.

The conclusions of the National Academy study and of the President's Science Advisory Committee that we need more centers of competence, and that they

should be available to aid State and local needs, are sound and strongly support the soundness of assistance to each State to provide itself with the services of a water resources research center.

There are a great many water problems that are of interstate, regional, national, and even worldwide in character, such as saline water conversion and pollution. The soap companies sell detergents everywhere. The chemistry and the physical characteristics of the element itself are the same in New York and California, regardless of which is the bigger State. They are the same on all of the continents of the world, and much of the knowledge we gain through water research will have value in our international relationships.

#### PROBLEMS VARY WITH ENVIRONMENT

But water problems also vary with every difference in the environment in which the water occurs. Environment varies with the nature of human habitation and use in the area in which it occurs, with climate, with topography, elevation, vegetative cover, or lack of it, geology and scores of other factors.

There is fully as much variation in problems, and therefore justification and need for water resources research centers by States as there was and is for the agricultural experiment stations which have had such phenomenal success.

Another point of considerable discussion concerning this water research proposal has been the scarcity of hydroscintists. Fear has been expressed that the new State centers will enlist and draw scarce manpower away from useful water research work now in progress.

There are not going to be 50 research centers set up suddenly a week after this measure passes Congress and is signed. There must first be appropriations. The States must designate colleges and universities to establish centers, or institutes. The institutions designated will have to develop plans for competent and useful research having regard, under the terms of this revised bill, to the avoidance of any undue displacement of scientists and engineers elsewhere engaged in water resources research.

Development of the centers will come over a period of several years. It may not require 25 or 30 years, as in the case of agricultural experiment stations, but it would not all happen in 1 year. Department of Interior estimates, in its report on S. 3579, indicate that the programs will still be somewhat below maximum authorizations in the bill after 5 years.

Engineers hydrologists, and physical scientists will not be required for all of the projects undertaken, nor for all of the tasks of training needed personnel which are involved. Water problems are social as well as physical. There is a great deal we need to know about the economic value of water in alternative use, about the suitability and adequacy of our divergent systems of riparian and appropriation rights in water law, about the efficiency and effectiveness of the social and political institutions which administer water, the social and economic objectives of water resources development, the economic effects of interbasin transfers, the potentialities of flood plain zoning, methods of evaluating the use of water for recreation and scenic preservation, and a great many other matters outside the field of physical sciences. Many questions outside hydrology and engineering will arise in the process of planning river basins for optimum use, as we are committed to do.

#### MANPOWER POOL AVAILABLE

We are assured that there are a great many highly trained members of the faculties of colleges and universities, trained in both the social and scientific disciplines involved in water problems who, although not classified as hydroscintists, can be enlisted to specialize on work related to water and to conduct water related research, and direct and train students in such work. A great deal of effective and competent work can be accomplished in the period in which additional pure hydroscintists are being trained, which will also contribute to their training.

The University of New Mexico has just published a very valuable study of the comparative economic values of water in alternative uses directed by Dr. Nathaniel Wollman, an economist.

The study indicates that water from our San Juan-Chama project used for recreation will add four to five times as much to the State's gross product as water used in agriculture. Water used by industry will increase gross

State product 12 to 15 times more than use in recreation. A new mix of water uses is clearly in order.

Traditional social and economic concepts about water have been shaken not only in New Mexico, but in all water-short areas by the study. Things we have suspected have been factually demonstrated. A great deal of research, restudy, and replanning of water developments will need to be done to assure optimum use. There is need for research into our institutional arrangements for the transfer of water between uses. Standards and criteria for the justification of water projects must be reviewed. Repayment arrangements and pricing schedules will need restudy.

In its summary report on "Natural Resources Research" which was issued January 9, the National Science Foundation-National Research Council says in regard to water:

"Systems research directed toward simultaneous evaluation of combinations of alternative uses, operating procedures, and physical structures would greatly benefit all agencies having responsibility for regional and water basin developments. This research must utilize social as well as physical data and thus will require programs of supporting research in the social sciences as well as the physical sciences and engineering."

Any argument that we do not have adequate trained personnel to attack water problems competently and fruitfully in a very considerably expanded research program is necessarily based on a narrower concept of the nature of problems which need to be studied than the reality.

#### EXECUTIVE AGENCIES SUPPORT THE IDEA

Mr. President, the reports of the executive agencies have almost unanimously endorsed the basic objectives of S. 3579. Nearly all have made suggestions for amendments. Many of them have been incorporated in the draft I have just introduced. A few have not. All will be considered, of course, in committee hearings and executive sessions on the measure.

The major departmental reports have reached the committee since the new year so there has not been time to consider all suggestions for revision as carefully as will be done with more time.

The reports, and nongovernmental endorsements of the basic program proposed in S. 3579, are convincing that the measure deserves the attention and study of the Congress.

The Department of the Interior has "strongly recommended enactment of this legislation."

The Secretary of the Army has raised several questions in regard to S. 3579, which have been clarified in the new measure, but reports:

"The Department of the Army believes that an expansion of State research in the water field, supplementing and complementing the water research of the Federal agencies, would be desirable. Moreover, it is believed that an increase in the grants which the Federal Government now makes to the States to encourage research would be justified by the benefits which would accrue to the Nation as a whole. Hence the basic objective of S. 3579 has the full support of the Department of the Army, on behalf of the Department of Defense."

The Federal Power Commission asked that the measure be amended to assure that "other interested Federal agencies," as well as departments involved in water programs, are advised and consulted. After explaining the Commission's interest in hydroelectric power development and multiple-purpose planning of river basins, Chairman Joseph C. Swidler states:

"The Commission favors enactment of legislation that would accomplish the objectives of this bill."

The Tennessee Valley Authority, while raising the question of using regional instead of State research centers, reports: "We strongly subscribe to the bill's objective of encouraging research relating to the conservation, development and more effective use of our water resources. We believe that the proposal to make greater use of our colleges and universities in such a program is sound, not only as a means of acquiring needed technical assistance for research but also as a means of increasing the general interest of the colleges and universities in our water resources. We believe also that the problems in this field are so broad in scope and of such national importance that the Federal Government should provide direction and financial assistance in the efforts to solve them."

## DR WIESNER'S COMMENT

In his report on S. 3579, Dr. Jerome Wiesner, the President's science adviser and Director of the Office of Science and Technology, prefaces his specific suggestions with this comment:

"Legislation along the general lines of the bill could serve a useful purpose in providing additional authority and funds for a concerted approach to the problems in the field of water resources research. To carry out the additional research in water resources needed to assure an abundance of water of adequate quality requires augmentation of research in the universities to more effectively utilize their research potential, to bring to bear the several interrelated disciplines bearing on water resources, and to train the new scientists and engineers sorely needed for research and teaching in this field.

"Some half dozen Federal departments and agencies have major responsibilities in water resources requiring research. They support research in their own laboratories and in the universities in accordance with their missions. The extent of such support is quite modest in relation to the needs for better understanding of the problems involved. Shortages of highly trained manpower would particularly limit the expansion of creative research in this field even if more funds were made available. There are many different kinds of research needed in water resources ranging from basic scientific research on the one hand, to applications engineering and economic analyses on the other. There is a special need for research and analysis that draws on the combined talents of scientists, engineers, social scientists, economists, lawyers and others. There is also a need at local levels for technical analyses and studies to apply the findings of research. The research problems may be national or highly local in character.

"As I perceive the broad objective of legislation along the lines of the bill, it should be aimed at supplementing existing agency arrangements for support of water resources research by fostering university-planned and initiated research and investigation that draws on the diverse scientific, technical and other skills throughout the schools and departments of the university or college; that is directed at State, regional or national water resources problems; and that is not shaped by the mission of a particular Federal agency providing financial support. Federal support of a program of this nature would need to be administered in the broad national interest and in the interests of all the Federal agencies having missions in water resources.

"I would hope that the flavor of the foregoing remarks could better be reflected in your bill so that there would be no misunderstanding as to its objective to supplement existing forms of support in certain important respects. On the other hand, by strengthening and expanding university- and college-wide capabilities for water resources research, additional research potential would be made available to all of the interesting Federal agencies."

The report of the Bureau of the Budget identifies that agency with Dr. Wiesner's report and specific suggestions made in subsequent portions of his letter.

Much of the suggested flavor, as well as most of the specific modifications, which Dr. Wiesner recommended, will be found in the new draft of the proposed legislation.

## COORDINATION NOT IN S. 2

A point of concern emphasized by the Budget Bureau concerned coordination. Language in S. 3579 which directed the Secretary of the Interior to encourage a coordinated Federal water research program has been deleted. The word "encourage" was disregarded and the clause aroused the fears of some departments that Interior might be getting some surveillance over them. No such authority was intended. It is disclaimed in the new draft in a proviso so extensive and explicit it should end all fears.

The Executive Office of the President is working toward coordination of water resources research through the Office of Science and Technology. The Water Resources Planning Act, previously discussed, will provide coordination in the water planning field through the proposed Federal Water Resources Council, composed of the Secretaries of the Interior, Agriculture, Army, and Health, Education, and Welfare. Coordination of both planning and research is needed and can wisely be provided in the manners intended. It is neither attempted nor intended in this Water Resources Research Act.

Because administration of the proposed research program as a supplement to present work will require that the Department of the Interior know of re-

search projects in progress and planned throughout the Government, provision is made for the Department to be advised of research projects underway and planned by all of the Departments. Since it will have this information at hand if the measure is enacted, it is further directed to make up a file, or catalog, of all the Federal projects for public as well as departmental use.

This is a bookkeeping function—not coordination. It is needed. It took our committee months to gather together data on water resources projects underway within the Federal Government last year. It is already out of date. The bill I have proposed provides for the Department of the Interior to maintain a catalog of projects on an interim basis and authorizes the President to transfer it as he determines wise upon the establishment of a central catalog on scientific research, or an overall program for keeping such information available.

It has been gratifying that a number of major groups concerned with our water resources have endorsed S. 3579 directly, or in terms of its objectives.

The Association of State Universities and Land-Grant Colleges adopted two resolutions in respect to S. 3579, one originating in its committee on water resources. The second was offered by its engineering division.

Mr. President, I ask unanimous consent to include in my remarks at this point the two resolutions approved by the association at its convention here November 12 and 13.

The VICE PRESIDENT. Without objection, it is so ordered.

The resolutions are as follows:

“REPORT FROM THE COMMITTEE ON WATER RESOURCES OF THE ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

“The water resources committee also considered the proposed legislation known as the Anderson bill, S. 3579. The committee endorses S. 3579, as recognizing problems of extreme national concern. For many years, the land-grant institutions through their research and education capabilities have been working on these problems. However, the Anderson bill provides the mechanism for them to take a concerted national action through—

“(a) Providing for the establishment of university wide water resource research institutes or the equivalent.

“(b) Providing continuing financial support for research on the water resources problem.

“The water resources committee believes that the Anderson bill is to be commended particularly for its forward-looking proposals in five areas:

“(1) It identifies the need for basic research and a focus of multidiscipline capabilities on the water resources problem.

“(2) It recognizes the need for local and regional centers of interest and activity on water resources problems.

“(3) It provides a mechanism for increasing the supply of highly educated manpower capable of dealing with water resources problems.

“(4) It provides for a realistic combination of funds for continuing research programs with funds for grants and contracts on a short-term, special-project basis.

“(5) It creates a channel that does not now exist through which a Federal Government agency and the educational institutions of America can mutually advance the national interests in a key resources area.

“The water resources committee suggests that, if practical, the language of the bill should be amended to give consideration to the following suggestions:

“(a) That matching of Federal funds by the States under section 100(b) be on a dollar-for-dollar basis.

“(b) That for clarity, section 106 be placed under title III.

“(c) That provision for continuation of title II funds beyond 1969 be included.

“(d) That the Service should use consultants and advisory boards to the fullest extent practical in identifying the research problems of most importance to be financed by title II funds.

“Approved, water resources committee, November 11, 1962.

“W. E. MORGAN,  
“Chairman.

“Approved by the Senate of the Association of State Universities and Land-Grant Colleges, November 13, 1962.”

"RESOLUTION FROM THE ENGINEERING DIVISION, ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

"The Engineering Division of the Association of State Universities and Land-Grant Colleges heartily endorses S. 3579, the Anderson bill, and supports its enactment. The bill is commended for its proposals to establish State water resources research institutes, to provide funds for both continuing research programs and project research, and to establish a Water Resources Service in the Department of the Interior. The division believes that engineering research and education have much to offer to this proposed coordinated effort to focus the strength of educational institutions on the water resource problem. The member schools of engineering of the division look forward to participating in the proposed university-wide efforts. The division believes that passage of the Anderson bill will open up a much-needed channel for cross-fertilization between programs of the Department of the Interior and those of educational institutions. Copies of this resolution are to be sent to Senator Anderson, the Department of the Interior and the Office of Science and Technology.

"Approved, engineering division, November 12, 1962.

"J. D. RYDER,  
"Secretary.

"Approved by the Senate of the Association of State Universities and Land-Grant Colleges, November 14, 1962."

Mr. ANDERSON. Mr. President, I ask unanimous consent also to include at this point in my remarks a resolution adopted by the Interstate Conference on Water Problems of the Council of State Governments at its annual meeting in Chicago on December 5, 1962.

The VICE PRESIDENT. Without objection, it is so ordered.  
The resolution is as follows:

"RESOLUTION ADOPTED BY THE INTERSTATE CONFERENCE ON WATER PROBLEMS OF THE COUNCIL OF STATE GOVERNMENTS REGARDING WATER RESOURCES RESEARCH

"Whereas the constantly increasing demand upon the Nation's water resources necessitates an immediate and pronounced acceleration of water resources research; and

"Whereas the States have a responsibility to aid in the solution of problems requiring research; and

"Whereas there was introduced in the 87th Congress legislation which could be helpful in promoting such research and in assisting the States in discharging their responsibilities: Now, therefore, be it

*Resolved by the Interstate Conference on Water Problems meeting in Chicago, December 5, 1962,* That the States are urged to increase their support of coordinated programs of water resources research; and be it further

*Resolved,* That the Congress is urged to give favorable consideration to legislation providing for distribution of sums for research in furtherance of programs developed by a qualified college or university in each State and Puerto Rico, or such other substantially equivalent arrangement as the State may determine, such distribution to be made only after consultation with the Governor or appropriate State agency as the Governor may direct and for programs of coordinated research or for programs which are compatible with coordinated research programs.

"Adopted, Chicago, Ill., December 5, 1962."

Mr. ANDERSON. Mr. President, I have today received a letter from the American Society of Civil Engineers saying that the "society believes that enactment of legislation along the general lines of this bill (S. 3579) would advance its aims in the field of water related research."

Mr. President, I ask unanimous consent to include the society's letter, signed by Mr. William H. Wisely, in the Record.

The VICE PRESIDENT. Without objection, it is so ordered.

The letter is as follows:

AMERICAN SOCIETY OF CIVIL ENGINEERS,  
January 10, 1963.

HON. CLINTON P. ANDERSON,  
Chairman, Committee on Interior and Insular Affairs,  
U.S. Senate, Washington, D.C.

DEAR SENATOR ANDERSON: The American Society of Civil Engineers has a continuing interest in all aspects of national water policy. On the basis of its study

of all aspects of water problems, the society is convinced of the need for an increase in research in civil engineering fields related to water resources.

It is the thoughtfully considered viewpoint of this society that support should be given to the general principle of Federal-State participation in such research. Furthermore, it is essential that provision be made for better coordination of research and educational approaches to the development of water resources.

In recent months, note has been taken of the prospect of establishment of water resource institutes at each land-grant college, through the enactment of S. 3579 of the 87th Congress. The society believes that enactment of legislation along the general lines of this bill would advance its aims in the field of water-related research.

It is hoped that there will be an appropriate time and place for full discussion of future policies for water resources research. At such time, well-qualified and informed officers and members of this society would welcome the opportunity to elaborate upon this brief statement.

Cordially,

WILLIAM H. WISELY,  
*Executive Secretary.*

Mr. ANDERSON. Mr. President, I ask unanimous consent that a resolution adopted by the Policy and Coordinating Committee on Water Resources of the University of Idaho may be printed in the Record.

The VICE PRESIDENT. Without objection, it is so ordered.

The resolution is as follows:

“RESOLUTION ON S. 3579 BY THE POLICY AND COORDINATING COMMITTEE ON WATER RESOURCES OF THE UNIVERSITY OF IDAHO

“Whereas Senate bill 3579 which is better known as the Water Resources Research Act submitted by Senator Anderson, of New Mexico, is now before the Congress; and

“Whereas this bill is designed to establish a water resources research institute at the various State universities to promote a more adequate national program of water research and to train competent personnel in fields related to water resources; and

“Whereas the University of Idaho through its policy and coordinating committee on water resources is dedicated to assisting in formulation of coordinated research and planning for the development of the water resources of the State of Idaho and is interested in a coordinated water resources policy and program for the Nation; and

“Whereas the University of Idaho recognizes that the manner in which we utilize and develop water resources will influence our health, security, economy and well-being for all time, and as such, support from this act would help to meet the needs of the University of Idaho and the Nation as a whole; and

“Whereas it is the considered judgment of the policy and coordinating committee on water resources and its advisory committee, as listed below, that the bill is in the best interest of the University of Idaho, the State of Idaho, and the Nation that the proposed legislation be enacted: Now, therefore, be it

“Resolved, That the congressional delegates from the State of Idaho and the Governor of the State of Idaho use their good offices to lend their support and endeavor to obtain the adoption of the Water Resources Research Act, Senate bill 3579.”

Senator ANDERSON. I would like to call attention also to the speech made on the Senate floor by the able Senator from Nebraska, Mr. Hruska. It is a very, very fine statement. If there is no objection I would like to include that very fine statement in the record at this point. Senator Hruska may still come and testify, but this is as good testimony as a man could give. It is a very fine statement by him.

(The matter referred to is as follows:)

ESTABLISHMENT OF WATER RESOURCES RESEARCH CENTERS

Mr. HRUSKA. Mr. President, the senior Senator from New Mexico [Mr. Anderson] introduced earlier in this session S. 2, a bill to establish water resources research institutes or centers at land-grant colleges and universities, to stim-

ulate water resources research at other institutions of higher education, and to promote a more adequate national program in this field.

The Senator from Nebraska gladly responded to the invitation to cosponsor this bill. It is a desirable and urgently needed measure. It should be accorded early hearings and prompt enactment. I shall do what I can to support and advance it.

#### PROVISIONS OF BILL IN GENERAL

S. 2 proposes Federal financial assistance to land-grant colleges and universities or other competent institutions of higher education in each State, as the State determines, to establish a universitywide water resources research institute or center, in the general pattern of the Hatch Act of 1887 which authorized the agricultural experiment stations. Each State center will be entitled to as much as \$100,000 annually on a continuing basis, plus matching funds for specific research or experimental projects. The Secretary of the Interior is also authorized to make grants, matching agreements and contracts with other colleges and universities. States and other governmental agencies, private foundations and other institutions, firms and individuals, to conduct water research projects within the scope of the Department of Interior's mission in the water field. An appropriation of \$5 million in the first fiscal year, increasing to \$10 million over the next 5 years, would be authorized.

The purpose of the bill is to implement recommendation No. 3 of the Senate Select Committee on National Water Resources. Specifically this select committee recommended that a coordinated research program on water be undertaken to include both research into ways to increase available supplies and ways to increase efficiency in the use of water required to produce manufactured goods and crops. In greater detail, the committee recommended that existing programs be strengthened by taking the following action—page 18 select committee's Report No. 29, 87th Congress, 1st session:

“(a) Expanding the programs of basic research dealing with atmospheric physics, solar activity, hydrology of groundwater movement and recharge, the physical chemistry and molecular structure of water, photosynthesis, climatic cycles, and other natural phenomena associated with water in all its forms. Such research is essential to a major breakthrough in such fields as short- and long-range weather forecasting, weather modifications, efficient management of underground reservoirs, evaporation reduction, desalinization, and pollution abatement, as well as to major improvements in works for the storage and control of water.

“(b) Providing for a more balanced and better constructed program of applied research for increasing water supplies through desalinization, weather modification, and evaporation and evapotranspiration reduction.

“(c) Providing for an expanded program of applied research for water conservation. Special emphasis should be given to research on improved waste treatment methods, on ways of increasing efficiency in the agricultural use of water, on fish and wildlife needs, and on methods of system planning for the optimum development of water resources of river basins.

“(d) Evaluating completed projects with a view to determining modifications to enable them more effectively to meet changing needs, to provide better guidelines for future projects, and to better determine their effect on the local, regional, and national economy.”

The committee made four other recommendations. They will be discussed later.

#### NEED FOR ACTION

The future water needs of the Nation were thoroughly inquired into, studied, and reported by the Senate Select Committee on National Water Resources organized in 1959. Extensive hearings were held. A report was made to the Senate in January 1961—Report No. 29, 87th Congress, 1st session.

The findings of the committee show how rapidly America is approaching the point at which shortages of available water supplies will constitute a significant barrier to our economic and social progress. It identified major portions of the United States, equal to more than one-fourth of the land area of the mainland States except Alaska, which by 1980 will have very little water to meet the requirements of expanding industry and a growing population. The committee further found that by the year 2000 this condition of water scarcity would extend to an area comprising virtually one-half of the land

area of the 48 contiguous States. Maintenance of water quality will be a critical problem everywhere in the United States. Indications of this appear in our newspapers almost daily.

The demands on the Nation's water resources have increased tremendously in recent years. The present 300 billion gallons of daily withdrawal will double by 1980. These demands will triple by the year 2000. These computations are based on medium projections of population increase and on assumptions which include such factors as, first, that there will be continued growth of the Nation's economy at the same rate as in the past; second, that adequate water supplies will be made available under the present general pricing policies; third, that there will be relatively little change in presently known technical methods of water use; and fourth, that with the exception of increase application of techniques for improving the efficiency of irrigation, present methods of using water will continue.

In the course of the testimony on "Supply of and Demand for Water in the United States as Estimated for 1980 and 2000"—see page 123 of report—there is found an outlined and summary of three potential programs for meeting water demands. Each is designed for meeting demands under different assumptions, but all are for assumed medium levels of population and economic growth; a maximum storage-minimum treatment program; a minimum storage-maximum treatment program; and a minimum cost program which would provide for meeting needs at the least cost.

Capital costs of these three programs range from \$54.2 to \$74.3 billion by 1980. The range by the year 2000 is from \$99.6 to \$118.3 billion.

The report then makes this very challenging statement:

"Regardless of which of the programs is adopted, five regions, the upper Missouri, upper Rio Grande and Pecos, Colorado, Great Basin and South Pacific, will be short of water under the assumptions made, and will require maximum regulation by 1980."

Mr. President, this brings the problem very close to home for all people of my State because "upper Missouri River region" contains the entire State of Nebraska, among other neighboring States. In fact, Nebraska is the only State which lies entirely within the boundaries of the Missouri River Basin.

In other words, the States in the five water regions referred to will be required to develop fully all available water resources by 1980 or earlier if the projected increase in population is experienced and economic activity is to be achieved.

The year 1980 is only 17 years away.

The foregoing information is just an indication of the startling statistics and other disclosures contained in the select committee series of 32 committee prints issuing its studies. They cause thoughtful individuals to pause; to wonder at the benefactions of nature which has so generously provided for our wants until now; and to consider seriously the methods we must adopt and means we must provide in order to conserve, develop, and wisely use water upon which all human endeavor so heavily depends.

Later in my remarks, I shall discuss the Nebraska situation in greater particular.

#### WHAT CAN BE DONE

The select committee made five principal recommendations, each of which is supported by voluminous material. Briefly stated, these recommendations are:

First. The Federal Government, in cooperation with the States, should prepare and keep up to date plans for comprehensive water development and management for all major river basins of the United States.

Second. The Federal Government should stimulate more active participation by the States in planning and undertaking water development and management activities by setting up a 10-year program of grants to the States for water resources planning.

Third. The Federal Government should undertake a coordinated scientific research program on water.

Fourth. The Federal Government should prepare biennially an assessment of the water supply demand outlook for each of the water resources regions of the United States.

Fifth. The Federal Government in cooperation with the States should take steps to encourage efficiency in water development and use.

The recommendations are based on the committee's belief that future water demands can be met best by a proper combination of the following efforts: (a) construction program; (b) scientific research; (c) development of known tech-

nical methods; and (d) strengthening of government policies affecting water development and use. However, the Select Committee Report wisely observes:

"Such a combination of efforts cannot be achieved overnight, and will require the combined efforts of the legislative and executive branches of the Federal Government, as well as a continuation and strengthening of work in these fields by State and local governments and private enterprise."

#### FEDERAL LEGISLATION TO ACHIEVE RECOMMENDATIONS

However desirable and well considered any recommendation may be, a proposal to implement it legislatively must also be politically acceptable.

This became very clear two summers ago when the Senate Interior and Insular Affairs Committee sat with the Senate Public Works Committee in hearings on S. 2246, the President's water resources planning bill. This measure was designed to implement the select committee's recommendations 1 and 2 by providing machinery for development of major river basin plans by 1970 and to provide the recommended aid to the States for participation in planning work.

It encountered stern resistance from those who vigorously contend that State water rights are paramount to Federal rights in that field; that they have been for a long time as a matter of national policy; and that they should remain so. This position has been asserted often in the past 50 years since there was first boldly proposed a comprehensive Federal planning program. The concept of national planning was directly opposed to the position maintained for a century and a half and more that the citizens of the individual States have had the powers and responsibilities for the control, use, and development of the water resources within their State boundaries in accordance with local needs and conditions. At any rate, the result of this fundamental, sharp, and irreconcilable conflict of philosophies with regard to the President's bill in the 87th Congress was a complete stalemate.

Since that time, determined effort has been made to agree upon and develop a common ground which opponents on this point can occupy. Senator Anderson optimistically noted that some progress has been made, and that the President's proposal to implement legislatively the select committee's recommendations 1 and 2 is being so modified as to prompt him to hope that there will be broader acceptance of the modified 1963 version than there was of the 1961 bill.

Parenthetically, the Senator from Nebraska joins in the hope that sufficiently common ground can be found. I am in full agreement with the statement that there will be water planning the Nation over, because of the growing pressures for water. Planning of some kind will be undertaken whether Congress provides an orderly method or not. It behooves every interested person to exert utmost good faith and diligence to the end that a workable and acceptable method be found as expeditiously as possible.

However, not any price can be paid for such a result. As important as the objectives of the 1963 administration bill for recommendations 1 and 2 are, the fact remains that they are not the sole considerations. The convictions held by so many that citizens of individual States have recognized powers and responsibilities as to control, use, and development of water are deeply held as being vital to continued survival of social and economic progress over the Nation. This is especially true in the semiarid States. The idea of surrendering long-held State preferences in this field leaves them very cold indeed. They will not compromise unduly; nor will they capitulate easily. And they should not.

#### PHILOSOPHIC BASIS OF S. 2

One direct result of the State-Federal conflict over water supremacy encountered in the last Congress is that S. 2 resorts to the time honored and very successful Hatch Act concept. This approach avoids the bitter struggle and probably hopeless strife as to paramount water rights.

The Hatch Act, originally enacted in 1887—a revision and codification was enacted in 1955—created an agricultural experiment station system at the land-grant colleges and States universities. The pattern of State-Federal cooperation established some 75 years ago has been very successful.

Under the Hatch Act splendid teaching and scientific talent has been made available for the study and teaching of basic scientific endeavors, as well as coping with practical problems of agriculture. Education and research have been combined. Highly trained personnel serve State and individual needs for new and useful information. How well this concept has worked is widely known.

American agricultural production and experimentation are the wonders and envies of the world.

Because of its general acceptance, the Hatch Act concept was applied in the drafting of S. 2.

Senator Anderson frankly and proudly states that S. 2 is "an effort to copy and expand the agricultural experiment station system and the pattern on which it was built." In his remarks on introducing S. 2, he pointed out that the bill proposes Federal financial assistance to land-grant colleges and universities or other competent higher educational institutions in each State, as the State determines, to establish a university-wide water resources research institute or center in the general pattern of the act authorizing the agricultural experiment station. He specifically pointed out—page 186, Congressional Record for January 14, 1963:

"The program does not meet the need for expansion of direct Federal research work on important water problems like pollution control, weather modification and saline water conversion, nor the need for the Departments of the Federal Government, other than Interior, to use the colleges and universities on research projects in their fields of responsibility. Just as the agricultural experiment stations supplement Federal agricultural research at Beltsville and many other direct Federal agricultural laboratories and research centers, the water research program proposed in this bill would supplement present programs of Federal agencies, not supplant them."

The Senator from Nebraska fully concurs with these declarations.

#### COST OF PROGRAM

Cost of the program will be of deep concern and great interest to all, and properly so.

Question 1. Can we at this juncture of high taxes and Government spending and the highest Federal Government deficits afford to embark on a research program which authorizes expenditure of approximately \$50 million in the next 5 years for this limited water development program?

Question 2. Can the Nation afford a program which the select committee estimates at a gross of some \$54 billion to the year 1980 for storage, waste collection, and treatment over all levels of Government?

These sums are astronomical. Perhaps they can be scaled down. But if we extended the period by 10 years to 1990 and would reduce the expenditures by \$10 billion, they still sound pretty much out in the realm of the stars.

In an effort to answer these questions, let us reconsider the report of the select committee:

"Regardless of which of the (three potential) programs is adopted, five regions, the Upper Missouri, Upper Rio Grande and Pecos, Colorado, Great Basin, and South Pacific, will be short of water under the assumptions made, and will require maximum regulation by 1980 (p. 124)."

Mr. President, this is the answer to questions 1 and 2. In the light of the quotation from the report, we can readily paraphrase both of the questions as follows: "Can the economy of the United States continue to grow and prosper—or even to exist—with inadequate supplies of water for our population, our agriculture, and our industry?"

To ask the question is to answer it.

#### NEEDS WILL BE SUPPLIED

In one way or another, these water needs will be supplied. They must be. As an intelligent, energetic people with some eye to the future, we should go about it sensibly—not haphazardly or tardily. S. 2 is a sound first step. Solidly worked out in concept and in operational methods, the bill will be successful if we give it a chance. It will implement recommendation 3 of the select committee report relating to research.

Mr. President, as for recommendations 1 and 2, the Senator from Nebraska would rather await the introduction of a bill stating in precise and specific language what will be undertaken before making comment. It is my earnest hope that the measure in process of preparation will be sufficiently possessed of "broader acceptance" than the 1961 version. If it does not, it will be opposed. It should be.

Meantime, the task at hand as to S. 2 is one upon which we will find wide agreement. We should proceed in advancing it with such dispatch as we can command.

## NEBRASKA'S INTEREST

My home State has been conscious of and highly concerned with water from the time it entered the Union. As a reclamation State, this is understandable.

Our longtime, keen interest, and participation in the Pick-Sloan plan typifies the interest expressed in water resources. All of the State's eastern boundary and a part of its northern line are formed by the Missouri River.

It is with gratification that we witness the substantial completion of the main-stem system of reservoir projects. After years of study, planning, and construction, the vision of farsighted men is materializing in the 90-percent completion of reservoir construction. Eighty percent of ultimate water storage is now available, and 60 percent of the ultimate power capacity is now on the line. Over and above these advantages we have the very vital assurance of water for navigation, industrial, and domestic purposes, fish and wildlife, and recreation.

In this connection we are aware of two factors: First, all of these attainments were pursuant to a plan conceived and authorized by law nearly 20 years ago. Many changes have occurred since then in technology and objectives. Second, the main-stem development is only a part of the development of water resources. There remain the vast demands of geographical and population areas away from the Missouri River main stem for available supplies of water. Likewise, short-term as well as long-term needs must be provided for and planned.

Many water storage and supply structures and works have been completed within our State. Others are under construction, while still others are in the planning or study stages.

We have reached, and maybe gone well into the stage where specific water problems claim immediate attention. In approaching them it would be extremely helpful to have the advantage of scientific studies made by our university addressed to our specific needs, in addition to the general value such analysis would have.

This is particularly apparent when we consider the legislation pending before the current session of the Nebraska State Legislature.

## ADVANTAGES TO NEBRASKA

The advantages in having these studies prepared can also be seen by considering the following general propositions:

First, there are several irrigation projects either under construction or in planning in the Lower Loup Valley. It is important to know their ultimate effect upon the streamflow in lower river reaches after these projects are completed.

Second, the effect these and other projects will have on domestic water supplies and their priority under the constitution.

Third, comprehensive studies should be conducted on the subject of the supply of underground water in Nebraska.

We are disposed to think that it is an inexhaustible supply and earnestly hope it will always prove to be. But if future studies will show some indication in years ahead of depletion, it is essential to have technical advice on what system of appropriation to apply to prevent overpumping and what system of priorities to apply with reference to the various 24,000 wells now in existence. In this connection it would be important to know whether these priorities should be on a statewide basis or on a river valley basis and where the boundaries of such valleys are if that will be the area unit.

Hand in hand with this will be discovery and early adoption on a wide basis of more efficient uses and storage practices of this precious natural resource.

All of these and many other subjects of inquiry will fall within the purview of recommendation No. 3 of the report on national water resources, as implemented by S. 2.

All of these subjects will be embraced within the activities of the basic research, studying ways to increase available supplies and methods to increase the efficiency in the use of water required to produce manufactured goods and crops.

Hence, it is readily seen that for the State of Nebraska, in common with all of the reclamation States, and indeed all the States without regard to their geographic location, S. 2 is of highest importance.

It is to be hoped that all of these approaches will be thoroughly canvassed so that the best possible legislation for the purpose at hand can be achieved by this bill.

Senator ANDERSON. May I read from this Agricultural Research Act of 1946.

It says:

The Secretary of Agriculture, in accordance with such regulations as he deems necessary, and when in his judgment the work will be carried out more effectively, more rapidly, or at less cost than if performed by the Department of Agriculture, may enter into contracts with such public or private organization or individuals as he may find qualified to carry on work under this section without regard to the provisions of section 1, title 41.

In other words, we recognize that there is research work that might be best done by a private organization. We found that the Du Pont Co.—I don't want to give them any free publicity—had a very wonderful compilation of agricultural research programs that they knew about in the country, and we thought it might be useful maybe to use their private facilities. And then at the tail end of this section:

Such research shall in addition to research provide for under other law, but both activities shall be coordinated so far as practical, and shall be conducted by such agencies of the Department of Agriculture as the Secretary of Agriculture may designate or establish.

It is designed to be in addition to the regular things now going on.

Personally, I am happy that the Department of Agriculture has brought this point out, because it now will be in the record sufficiently clear, I think, so there can be no question about the administration.

Are there questions?

Thank you very much for coming.

Mr. SMITH. Without being facetious, it has been said that one of the appealing features is that if we allow our State colleges stations to have this program we will soon have enough water surpluses to match our grain supplies in storage.

Senator ANDERSON. We are going to have to work hard, because I noticed in a grain publication I was reading last week that they thought they were going to be able to develop a hybrid variety of wheat, similar to hybrid corn, which could give regular production running 150 bushels to the acre. When I left the Department of Agriculture I think the average production was 17.9 bushels per acre. Down in New Mexico I got 50 bushels per acre on one irrigated plot, and thought that was extremely fine. Imagine what would happen to the wheat situation in America if you produced that much wheat per acre—150 bushels! Then men would certainly be able to spare an acre for recreation, and maybe even a little for wilderness.

Mr. Penfold.

#### STATEMENT OF JOSEPH PENFOLD, IZAAK WALTON LEAGUE OF THE U.S.A.

Mr. PENFOLD. Thank you, Mr. Chairman.

I am Joseph Penfold, director of the Izaak Walton League.

After starting this morning I had a phone call from Mr. Philip A. Douglas, executive secretary of the Sport Fishing Institute, who could not be here today, and he asked that I express for him the wholehearted support of his organization for this legislation.

The Izaak Walton League of American appreciates the privilege of appearing in behalf of Senate bill No. 2. The league has had a longtime concern with this subject, not only because the complex problems of water supply and its allocation are of paramount importance to fish and wildlife, but also because all the things we do, and everyone

else does, working, recreating or whatever, in the last analysis depends upon water, in ample supply, and of usable quality.

This legislation has a broad purpose: To stimulate, sponsor and provide for research, investigations and experiments in the field of water and related resources as they affect water, supplementing present programs and to encourage the training of scientists in the field by assistance to colleges and universities in the development of water resources research programs. The purpose beyond this is to assure an abundance of water both in quantity and quality that will be necessary to meet all of our increasing requirements. These purposes are strongly endorsed by the Izaak Walton League. It would seem to us that the water resources research recommendation of the Senate select committee, in the long run will prove to be the most important of its recommendations.

Mr. Chairman, we can claim no special competence in determining the ways and means where by maximum results may accrue from Federal research dollars. Nonetheless, the proposal to encourage the land-grant colleges, or other university specified by each State, to establish a water resources research institute on a permanent basis would appear an essential first step. Clearly our fundamental problems in water resources will not be solved until the public itself is understanding of them and prepared to act responsibly in the decisions and choices which the public alone can make. The nationwide character of the research base which title I of the legislation would establish will prove most important, we believe.

To digress a moment, Mr. Chairman, I am delighted that Professor Morgan, of Colorado State University, is here to testify in support of this legislation. Having had two sons and two daughters-in-law graduate from his university, I have a very strong bias for the competence of that university to follow through very quickly on this program with his approval.

Senator ANDERSON. You are entitled to have that prejudice.

Mr. PENFOLD. Thank you.

An equally important element of this proposal is that the water resources institute be universitywide, that it cut across all the disciplines, not only the physical sciences but the social sciences as well. To make an analogy, it may well be that our engineers can place a spaceship on the farthest planet, and bring it back, long before they have found how to provide an environment for the astronauts that will permit them to make the trip. Similarly, the engineers can undoubtedly find far more efficient ways to intercept, conserve, store, channel, and distribute water supplies, without contributing anything meaningful to man's environment. They might indeed detract from it.

The authors of this legislation, we are sure, had the broader concept in mind in specifying the universitywide base. Certainly, Senator Anderson when introducing the bill gave important emphasis to it. In this connection Mr. Chairman, we note in those same remarks that—

The program does not meet the need for expansion of direct Federal research work on important water problems like pollution control, weather modification and saline water conversion \* \* \*

And down that same paragraph—

the water research program proposed in this bill would supplement present programs of Federal agencies, not supplant them.

We mention this because waters which are now too polluted to use, once cleaned up, may very well offer our greatest opportunity to expand total usable water supplies. This should be a particularly productive area of research for each State institute, because the problem ties directly to the industries and agriculture of the particular State as well as to all the other water needs of the people of that State.

In conclusion, Mr. Chairman, we would like to emphasize another point which Senator Anderson made very well in introducing the bill. He said that as a result of a University of New Mexico water economics study that "traditional social and economic concepts about water have been shaken not only in New Mexico, but in all water-short areas." I am sure this is true. I am sure we will be shaken still more, as research brings us a whole new body of facts which will enable us to understand more clearly and precisely what our real needs are and what we must do to meet them.

It seems to us that the Federal-State approach, with universities the core of the effort, as provided in S. 2, makes the best kind of sense.

We appreciate this privilege to offer our comments.

Senator ANDERSON. Thank you.

Are there any questions?

(No response.)

Senator ANDERSON. William E. Welsh, secretary-manager of the National Reclamation Association, is our next witness.

Mr. Welsh.

#### STATEMENT OF WILLIAM E. WELSH, SECRETARY-MANAGER, NATIONAL RECLAMATION ASSOCIATION

Mr. WELSH. The purpose of this bill by Senator Anderson and others is to establish water resources research centers at land-grant colleges and State universities to stimulate water research at other colleges, universities, and centers of competence and to promote a more adequate national program of water research.

Our association has long been actively interested in this type of research. We have had a special committee working with the problem of soil and water research for more than a decade. We believe that a great deal has been accomplished through the efforts of our National Reclamation Association committee. The first report of our special committee, through the assistance and cooperation of Senator Carl Hayden, Arizona, was published in January 1952 as Senate Document 98. This document was given widespread distribution throughout the entire country. Another very worthy document was Senate Document 59, published in September 1959, also through the efforts of Senator Hayden. Our National Reclamation Association committee purchased a large number of these documents and had them given nationwide distribution.

In June 1961, the National Reclamation Association joined with the National Association of Soil Conservation Districts in sponsoring a national water research symposium. This symposium was held March 28-30 of that year in Washington, D.C. Speakers at this symposium included men of known ability who had given a great deal of time and attention to the problems of water research. This symposium assisted materially in bringing to the attention of Mem-

bers of the Congress, as well as people over the Nation as a whole generally, the necessity of accelerating our water research program.

The National Water Research Symposium program, including the full text of the many excellent addresses delivered, was published as Senate Document 35 in June 1961.

As further evidence of the interest of our members in the important subject of water resources research, I refer you to Resolution 18 adopted at the 31st annual meeting of our association which was held in Portland, Oreg., last October. This resolution is entitled "Basic Water Research." A copy of this resolution is attached to my statement and I request that it be inserted in the record along with my statement.

(The resolution is as follows:)

RESOLUTION 18—BASIC WATER RESEARCH

Whereas the constantly increasing demand upon the Nation's water resources, together with the impairment of water quality incident to many uses, necessitates an immediate and pronounced acceleration of basic research toward securing the preservation and improvement of water quality for necessary successive uses; and

Whereas there is urgent and immediate need for such research activity and for avoidance of duplication of effort and diffusion of responsibility: Now, therefore, be it

*Resolved*, That the National Reclamation Association urges (1) the adoption of high priority of adequate financing and activity in the field of basic soil and water research, including adequate funds for expenditure by existing Federal agencies, the State universities, and the land-grant colleges to establish and carry through an effective, fully coordinated, basic soil and water research program; (2) the request for and immediate appropriation of adequate funds to implement the findings of Senate Document No. 59, 86th Congress, 1st session.

Mr. WELSH. In many areas of the West and particularly in the Southwest, the possibility of water shortage looms on the horizon as a serious threat to the continued future growth and development of that area. Research, such as proposed by S. 2, will be a very important and vital factor—in fact, a very necessary factor—if we are to meet the water requirements of the rapidly increasing population of the West and particularly the Southwest.

We strongly endorse S. 2 and express our appreciation to Senator Anderson and the other Members of the Senate who have joined him in sponsoring this important legislation.

We appreciate the opportunity of presenting this statement on behalf of the entire membership of the National Reclamation Association.

Senator ANDERSON. Senator Gale McGee, of Wyoming, wants to make a statement on the bill. We are delighted to have Senator McGee, who was a member of the Senate Select Committee on Water Resources.

STATEMENT OF HON. GALE MCGEE, A U.S. SENATOR FROM THE STATE OF WYOMING

Senator MCGEE. Mr. Chairman, as a cosponsor of S. 2, a bill to establish water resources research centers at land-grant colleges and State universities, and to promote a more adequate national program of water research, I am very happy to support this bill and urge the committee to report it to the Senate for early consideration.

I feel it was a great privilege to serve on the Senate Select Committee on National Water Problems because of the focus which was placed upon this most precious of our natural resources. The reports which we on the committee prepared have served as a guideline for future action, including the preparation and introduction of this bill.

On October 8, 1959, the committee conducted a hearing in Laramie, Wyo., at my invitation to develop a record on Wyoming's water resources. During the course of that hearing it was pretty well developed that Wyoming has sufficient water resources if they are properly utilized. The concept of using the trained personnel of the land-grant colleges to do water research is a wise one indeed. At the University of Wyoming we have a well-trained staff of people who fully understand the problems peculiar to Wyoming and by utilizing their services considerable amounts of money can be saved. Undoubtedly, this is true throughout the other Western States.

By starting the program at a scale of \$75,000 for each State to be scaled upward after a period of 3 years to an amount of \$100,000 is also a wise course to follow in my judgment. These amounts will afford the technicians an opportunity to develop workable plans and follow a course of action which will be most beneficial to the State and Nation.

I am also pleased with the provision which requires the funds allocated under this act must be used for new projects, and cannot be used to relieve the States or their subdivisions of financial responsibilities which they may now have.

In the final instance, there are sufficient safeguards in the bill to prevent Federal domination of the research work, but the results of the studies will be available for all interested agencies to gain the benefits derived therefrom.

I enthusiastically support this proposal and hope it may be enacted into law.

Senator ANDERSON. I have a letter and resolution from the Texas Water Conservation Association endorsing S. 2, and without objection it will be included in the record.

(The letter and resolution are as follows:)

TEXAS WATER CONSERVATION ASSOCIATION,  
*Austin Tex., February 18, 1963.*

Senator CLINTON P. ANDERSON,  
*Senate Office Building, Washington, D.C.*

MY DEAR SENATOR: At its 18th annual meeting held in San Angelo, Tex., October 7-8, 1962, the Texas Water Conservation Association unanimously adopted resolution endorsing your bill, S. 3579, 87th Congress, 2d session, a bill to establish water resources research institutes at land-grant colleges and State universities, and to promote a more adequate national program of water research.

I understand your bill, S. 2, 88th Congress, 1st session, is the same as S. 3579, and, therefore, we want to be recorded as endorsing it.

Enclosed is copy of Resolution 5—Water Resources Research Institutes. Please place this in the record of the hearings on S. 2.

Most respectfully submitted.

J. E. STURROCK,  
*General Manager.*

#### RESOLUTION 5—WATER RESOURCES RESEARCH INSTITUTES

Whereas there is a general feeling among the water conservation leaders throughout the Nation that there is an urgent need for more research in the field of water resources if this country is to meet its long-range water supply needs; and

Whereas Senator Clinton P. Anderson, of New Mexico, has introduced in the U.S. Senate S. 3579, a bill to establish water resources research institutes at land-grant colleges and State universities, and to promote a more adequate national program of water research; and

Whereas the bill provides that "It shall be the duty of each such institute to plan and conduct original researches, investigations, or experiments, of either a basic or practical nature, or both, in relation to water resources, including but not limited to aspects of the hydrological cycle, supply and demand for water; conservation and best use of available supplies; methods of increasing such supplies; economic, legal, social, engineering, recreation, biological, geographic, ecological, and other aspects of water problems, as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Puerto Rico, to water research projects being conducted by agencies of the Federal Government, and to those related to agriculture being conducted by the agricultural experiment stations"; and

Whereas Senator Anderson said on July 27, 1962, the day he introduced the bill, that it was being introduced at that time for the purpose of making it available to all Members of Congress, to the executive agencies and others interested, so they may give us the benefit of their suggestions and criticisms before next January 1; and

Whereas reprints of the Congressional Record of July 27, 1962, containing Senator Anderson's remarks and copy of S. 3579 have been distributed at this convention: Now, therefore, be it

*Resolved*, That the Texas Water Conservation Association in convention assembled in San Angelo, Tex., this the 8th day of October 1962, does hereby endorse said bill, S. 3579; and be it further

*Resolved*, That a copy of this resolution be forwarded to Senator Clinton P. Anderson and to all members of the Texas delegation in Congress.

Unanimously adopted by the Texas Water Conservation Association at its 18th annual meeting in San Angelo, Tex., October 7-8, 1962.

Senator ANDERSON. This concludes the morning session, and we will resume at 2 o'clock with President Morgan of Colorado State as our first witness.

(Whereupon, at 11:40 a.m., the morning session was concluded to resume at 2 p.m. of the same day.)

#### AFTERNOON SESSION

Senator ANDERSON. This afternoon we are going to hear from a panel of State university and land-grant college representatives, who are entitled to speak with great authority. Their institutions have behind them an unrivalled record of accomplishment, and I have chosen that adjective with some care.

Report No. 1 of the President's Science Advisory Committee, entitled "Meeting Manpower Needs in Science and Technology," has this to say about their record:

Nowhere are the benefits of scientific research more dramatically revealed than in food production. Fifty years ago in this country an agricultural worker produced food for only 3 or 4 others in contrast to his capability to feed 27 individuals today.

This accomplishment can be directly attributed to research that has been systematically supported by the Federal Government, the States and private sources, in programs that have historically and effectively linked education and research. As a consequence, universities have been eminently able to meet changing needs.

They have done such an outstanding job that they were also recognized in the recent reports on natural resources of the National Academy of Sciences-National Research Council.

In its summary report on "Natural Resources," the Academy said:

In adapting their research programs and activities to the requirements of the problems outlined in this report, governmental and nongovernmental agencies

and institutions, should take full advantage of the resources of the universities. \* \* \* It should be remembered that an important by-product of university research is the training that accompanies it, and the committee reemphasizes the need for training research workers to deal effectively with the problems relating to natural resources. These problems require closer cooperation between natural and social sciences.

At that point, the summary report cites a supporting paper, where it says:

One of the more promising channels for this research is in the system of land-grant universities and regional agricultural institutions. Acceptance by them of enlarged responsibilities in the field of natural resources would be a reasonable extension of their present rapidly shifting activities.

I could not agree with the Academy more than I do when it recommends that the land-grant institutions be asked to accept wider responsibilities in the resources field.

It is consequently very gratifying that the National Association of State Universities and Land Grant Colleges has approved S. 2, and that five members of its water resources committee are here today to discuss it with us, headed by Dr. W. E. Morgan, president of Colorado State University and chairman of the association's committee.

He is accompanied by the dean of engineering at Utah State University, Dr. D. F. Peterson; the chancellor of Irvine campus, University of California, Dr. Daniel G. Aldrich; the president of the University of Maryland, Dr. Wilston H. Elkins; and the president of the University of Florida, Dr. J. Wayne Reitz.

I just pause to say, and I want this in the record, we in New Mexico were very happy when Dr. Elkins left Texas Western and went to Maryland because his football teams had a bad habit of beating the University of New Mexico with regularity. We welcomed his transfer.

Dr. Morgan, we would be glad to have your group come to the table together and discuss S. 2 with us in whatever manner you desire. It is a privilege for this committee to have such a distinguished panel of witnesses.

Do come forward now. We are happy to have you.

While they are coming up, let me put a letter in the record.

We have a letter endorsing S. 2 from the chairman of the Kansas Association of Soil and Water Conservation Districts, Mr. Tom Bemis, of the U-Bar Ranch at Plainville, Kans., whom I invited to appear today. He was unable to be here and wrote his views instead.

I might suggest that the Kansas association consider him for a place on their legislative committee, for I observe that he sent copies of his fine letter to the Senators from Kansas, his Congressman, and the Governor.

(The letter referred to follows:)

KANSAS ASSOCIATION OF SOIL AND  
WATER CONSERVATION DISTRICTS,  
Plainville, Kans., February 15, 1963.

In re Senate bill 2, water resources research.

Senator CLINTON P. ANDERSON,

*Chairman, Committee on Interior and Insular Affairs, U.S. Senate, Washington, D.C.*

DEAR SENATOR ANDERSON: I have read Senate bill 2, as well as the Congressional Record wherein reference is made to the establishment of a water resources research program as outlined by recommendations of the select Senate committee thereon.

My particular interest in this concept of a water resources research program relates primarily to my interest in the future development of soil and water conservation districts.

It is well known that of recent years soil conservation districts have been adding the word "water" to their titles. There is a definite reason for this inclusion. The reason being that soil conservation and water conservation are renewable natural resources that must be coordinately considered in any land-use conservation program.

Since 1937 every State in the United States has enacted soil conservation legislation, and there are now in existence some 2,900 local conservation districts. They include 92 percent of the Nation's privately owned lands and 96 percent of the farms and ranches; representing three-fourths of the Nation's land area. Thus, most of our fresh water originates on privately owned farm, ranch, and forest land. How farmers, ranchers, and woodland owners deal with that vast land surface determines in large measure the quality and quantity of water that will be available for cities and industry as well as agriculture.

As fresh water supplies become more critical in the near future the responsibility of soil and water conservation districts to actively participate in a known water conservation program will be paramount. Furthermore, there will be a direct concern by the State and Federal Government to insure this responsibility. And, as soil and water conservation districts are responsive to the technical knowledge and technical assistance provided to them by the Federal Government they will be receptive to new obligations beholding to their position of being legal subdivisions of State government.

Therefore, it should be clearly appreciated that any Federal-State cooperation in a program to encourage efficiency in water resources conservation development, and use, will be a vital aid to the execution of the broadening conservation concept being charged to soil and water conservation districts as found in the articles of the USDA Secretary's memorandum No. 1488.

As a water resources research program Senate bill 2 should help establish the necessary Federal-State cooperative means to probe techniques both to increase our fresh water supplies and to increase the efficiency of providing these supplies as needed. From this knowledge, conservation districts could then extend themselves as a readymade medium to help execute these policies on private lands.

It is hoped that Congress will look favorably on senate bill 2, as you have proposed along with other Senators which does include our Kansas Senator, Frank Carlson.

Cordially yours,

TOM BEMIS,  
KACD Research Committee Chairman,  
Past KACD Director.

STATEMENT OF W. E. MORGAN, PRESIDENT OF COLORADO STATE UNIVERSITY, FOR THE NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES; ACCOMPANIED BY DR. D. F. PETERSON, DEAN, COLLEGE OF ENGINEERING, UTAH STATE UNIVERSITY; DR. J. WAYNE REITZ, PRESIDENT, UNIVERSITY OF FLORIDA; DR. WILSON H. ELKINS, PRESIDENT, UNIVERSITY OF MARYLAND; AND CHANCELLOR DANIEL G. ALDRICH, UNIVERSITY OF CALIFORNIA, IRVINE CAMPUS, BERKELEY

Senator ANDERSON. Dr. Morgan, I want you to run your show now under whatever rules you determine on and take full charge of this presentation on behalf of these fine schools.

Mr. MORGAN. Thank you, sir.

Senator Anderson, members of the committee, I should like first, sir, to respond to your very generous comments concerning the institutions that we collectively represent. This makes us feel very good and very eager to testify in behalf of this important piece of legislation.

My name is William E. Morgan. I am president of Colorado State University, which is the land-grant institution in the State of Colorado. My appearance here is in the capacity of chairman of the Water Resources Committee of the Association of State Universities and Land-Grant Colleges.

I may say that I am going to file a statement that has all this in it if it will help assist you in any of your secretarial chores.

I wish to thank the committee on behalf of the 74 universities and colleges comprising the membership of the association for this opportunity to speak in their behalf in favor of S. 2, the Water Resources Research Act.

The association I represent endorses, by virtual unanimous vote of its membership, the purposes and objectives of this bill. If your committee desires, a representative from each of these institutions would appear before you in support of the association's stand. In lieu of that, our association, by agreement with your committee staff, is represented here today by personnel from five of the member institutions.

I would like to identify them. You have already indicated their names. I will identify them in the order in which I will ask them to respond in our presentation.

The first is the dean of the College of Engineering of Utah State University, Dr. D. F. Peterson, who is on my right. Dr. Peterson's topic will deal with science and engineering aspects of the research job that confronts the Nation in fields related to water.

Then we have the president of the University of Maryland, who is on the left at the end of the table, Wilson H. Elkins, who will touch on the subject of national requirements for trained manpower and what this bill might do to further the development of that critical resource.

Then we have the president of the University of Florida, Dr. J. Wayne Reitz, who is prepared to comment on water as an economic resource and who also will comment on the funding proposals in the bill.

And then we have the chancellor of the Irvine campus of the University of California who currently is holding down the additional assignment of statewide university dean of agriculture, Dr. Daniel G. Aldrich, Jr. Dr. Aldrich will comment on some of the Federal-State relationships involved and, in discussing some of the bill's potentials, will draw on his experience in a State which has already put forth much effort on research related to water.

And finally I should like to close our discussions with some comments on water as a public resource.

We are especially grateful to the committee for permitting us to deal with the subject in such extended fashion; and now I should like to open our testimony with a background statement on developments that bring us here today as representatives of the Association of State Universities and Land-Grant Colleges.

Every activity of man, every facet of industry, leaves its influence on the water resource. Water, like sunshine and air, is fundamental to life itself, and the right of the individual to enjoy unpolluted water necessary for the essentials of life and health is today more than just a license. Water is a major concern of civilized society. "The story of water is the story of man." As every informed person knows, the demands upon the water resource are rapidly multiplying, and, in an

area embracing nearly one-third of the United States, 1980 demands will exceed the supply.

The rather sudden national awareness of an impending water shortage has naturally led us to talk more and more about water research. Research is today the base for our general welfare. We have found research to be the key to the most productive agriculture of all time; to greatly improved health; to a viable, productive, modern industry; to national security; to an extension of our environment beyond the earth's atmosphere, and to many other desirable objectives. Thus, it is only proper that we should turn to research for assistance in stretching our limited water resources to the limit.

Mr. Chairman, the prepared statement left with your committee goes on to recite initially in inventory fashion some of the monumental works that have been assembled on this subject. I would like to call your attention first to the "Yearbook of Agriculture" published in the year 1955. This book is a compilation of 91 topics related to water, most of them treating the agricultural aspects but not limited to that. Every topic in this book makes reference to the results of research.

And then in 1961 there was held here in Washington a National Water Research Symposium. It was sponsored by the National Reclamation Association and National Association of Soil Conservation Districts. This symposium reported at length on research needs. As a matter of fact, 235 pages in that report dealt with that subject. It was printed as Senate Document No. 35 in the 87th Congress.

And then there is the monumental work of the Senate Select Committee on Water Resources of the 86th Congress. The findings of that committee appear in some 32 papers.

Senator ANDERSON. May I just say that not only the committee worked well and hard on it but I see in the back of the room Ted Schad, who was our professional staff man, and who worked extremely hard and did a very fine job in the preparation of this. It just proves that Senators can turn out good reports if they have a good staff.

Mr. MORGAN. We agree with that, sir. This reference was used many times in the testimony this morning. Again, our group would like to pay our respects to the monumental efforts put forth by that committee and the results that it has brought forth, all of which are printed in the 32 papers of the proceedings.

I would say that those 32 papers should be required reading for anyone who is concerned with the water resources in these United States. The summary of those proceedings lists five recommendations. The third of those recommendations deals with a coordinated program of water research. It concludes that a great deal more such research is needed and it pinpoints some of the deficiencies in detail.

Then in May of 1962 there was published a compilation at the chairman's own request of reports of research from Federal agencies, from State colleges, from other institutions having to do with the subject of water research. This bulletin, the committee print, has in it a table indicating some of the State activities on this subject and appears in my formal statement.

Now, one of the very significant aspects from reading all this material is the revelation of the extent to which the States themselves are active in this area. Attention to this was called in December of 1962

by Mr. Ackerman of the Carnegie Institution of Washington in these words:

The problem of the States is not as to whether there is research for them to undertake but as to what they choose among all there is to do.

Mr. Ackerman's fine statement didn't even mention the purported chain reaction possibilities of coupling research with programs of education. That, of course, is a principal feature, as we see it, of the Anderson bill before us.

And finally, just released yesterday, is this report to the President on the water resource research from the Federal Council for Science and Technology. I find during a hurried scanning of this report this morning after it became available, numerous references to the fact that there is a joint product when an educational institution undertakes research. You not only obtain answers to basic questions. You not only apply some of those answers to the solution of current problems for the moment, local, regional, national problems, problems that are crying for solution, but you get almost as an extra dividend the development of scientific manpower, kind of a multiplication of the supply of the scientific community for the future, if you please.

Senator ANDERSON. Can I interrupt you just a second? I introduced this morning new members of the committee. We are very happy to have Senator Dominick from Colorado. We welcome him and express our appreciation to him for coming with us and serving on the committee.

This paper that you referred to, this last one sent to the President by the Scientific Advisory Committee, we have some copies of it.

We have been asked to have this reprinted either as a Senate document or committee print. If you don't care to express your opinion on it now, we would be very happy to have you do it later. I don't care to waste money printing, but it seems to me this is an important document to have printed and I would like to have your opinion some time, and your associates, as to either having it printed as a Senate document or a committee print, a print of this committee. It struck me that there was a lot of important information in it and we ought to have it in some permanent form and distribute it to institutions, and if you desire extra copies, you can have it in your own work for your institutions.

I would be glad to have your comments as to whether it would be well to have this printed.

Mr. MORGAN. Yes, sir. Senator, I should like to consult with my colleagues before giving you their views but I would like to state mine now. Bulletins like this committee print that summarize the results of your inquiry a year ago, the summary of your select committee, are most useful documents as a ready reference work on your desk or in the bookcase nearby to people on campuses—here I speak with firsthand knowledge—to people in industry, and I am sure to the research establishments in the private sector. I would hope that you see fit to publish this in bound form. Its usefulness is greatly enhanced by having it in bound, published form.

As a second-best choice, of course, the mimeographed bulletin that we received this morning is good, but the printed copies fit your desk, they fit the top left-hand drawer, if that is where you keep the important reference works. I hope you are able to effect quite a dis-

tribution of them, too, so that the usefulness of the publication is thereby increased.

Senator ANDERSON. Thank you very much. If it is published as a committee print or Senate document, it will be published in the same size as that summary you just held up there; yes, that size, and therefore will be more useful.

There was some question about that second document there, the answers to the inquiries, as to whether that document had any real significance after we started to work on the legislation itself. I think we had more mail after we sent this out than we did on almost any document we sent out because a great many people wrote back and said, "I would like to present my point of view." That is what we wanted—points of view. It worked out very, very well indeed.

As you know, the replies in there were carefully prepared and we valued the publication a great deal. It has worked out to be a truly useful publication. I am glad to have your comments on it. So many times we print these things and wonder who if anybody is ever going to read them, but I am encouraged by what you say here today.

Mr. MORGAN. I could submit as exhibit A a dogeared copy that has had a lot of use; so much so, in fact, that one of the sheets near the end is torn, and if additional copies are available, I would like to put in a bid for one.

Senator ANDERSON. Thank you, Doctor. That is the type of evidence we need. I think we can find you another copy.

Mr. MORGAN. Finally, from my own opening statement, I would like to comment on why we think it is important that research effort be undertaken at the State level as well as at the Federal level. May I read the last two pages of this statement.

The position of the State in the check and balance action which ought to be characteristic of the total development of the water resource is highly important. The State must speak for the individual and the community. It must be concerned with the fine-grained synthetic problems of matching resources, people, and economic objectives, enterprise by enterprise and community by community.

In contrast to Federal agencies, which are often dedicated to single functions or missions in a sort of vertical array, the State has the responsibility to provide a positive environment whereby economic elements, of which water is an important one, may be melded at the grassroots level in a horizontal sense, somehow consistent with the overall economic and social aims of the statewide community and the coordinate objectives and policies of the Federal Government.

This is not to overlook or minimize the great responsibility of the Federal Government in water resources, but to point out the importance of the role that the State should play. That the Senate select committee was conscious of the balancing role of the States, as well as of the Federal responsibility, is quite evident from its reports. In its summary report the committee listed eight areas in which action was needed to meet national goals. Area No. 3 was improvement of State and local planning and decisionmaking. Pointing out that most water problems will continue to be local or regional, the committee stated that:

<sup>f</sup> Broadly speaking, national problems are the sum of large numbers of regional and local problems.

The committee noted that—

State and local agencies still play a minor role in many water resource decisions \* \* \* the State and local agencies are in the position of having to approve or disapprove plans without having made comprehensive background studies which are needed before a major decision in the water resource field can be made.

The committee suggested Federal assistance to States for a limited period in order that they might develop capability for comprehensive long-range plans for optimum development of water resources within the State. It is doubtful whether such plans could be effectively made without research on problems that are specific and often unique to them. Certainly assisting the States to establish water resource research centers is consistent with this particular recommendation of the committee and within the Federal responsibility as visualized by them.

A third reason for establishing the State centers as visualized by S. 2 is the broad linkage which this establishes with education. It is in this way that the educational effort might become exponential; that is, like a chain reaction, students associating with research and researchers are more apt to become researchers themselves. Graduate students can contribute to research; research employment may make graduate study attractive. From the point of view of practice, students educated in a research environment will be more knowledgeable and their judgments will be better than otherwise. Regardless of the amount and quality of research information available, it can have no impact upon the water resource except through the myriad elemental decisions made daily by a great many people working within the structure of all the people involved in this decisionmaking process. It is important that the knowledge and wisdom of these decisionmakers at every level be as great as possible. I would expect that the impact of establishing the proposed centers at universities, in terms of improved operational decisionmaking, might well be as great as the research knowledge itself.

Now, sir, I would like to ask Mr. Peterson—

Senator ANDERSON. Before you go on, since you come from Colorado, I thought I would find out if Senaor Allott had any questions he wanted to ask at this time.

Mr. ALLOTT. Thank you, Mr. Chairman. I am very happy to have here Dr. Morgan, whom I have known for many years and whose zealously and ability for a school, which I always regarded as a competitor when I was in school and which I now regard with the best of any schools in the State, is very commendable. Dr. Morgan has been here before this committee and other committees many times and has been a great help to all of us.

I also wanted at this time particularly to welcome my own new colleague, Senator Dominick, to the committee. This is one of the few instances I believe in which two Senators from the same State, from the same party, serve on a committee, and I am very happy to have him here, particularly because of his great legal ability and his knowledge of water, land, and resource matters.

Doctor. I have one question I would like to ask you because I think your conclusion is a little different from mine.

I am very seriously concerned about the next to the last paragraph of the bill, section 304, which in effect is a waiver of section 3684. I

wonder if you would state your views on this matter and the necessity for it.

Mr. MORGAN. As I understand the meaning of that section, it permits the Secretary, in arranging for research work to be done by one of the centers or other persons, to waive the provisions that require work to be performed before the funds are advanced. Is that correct, sir?

Senator ALLOTT. That is correct. Section 3648 of the Revised Statutes—the bill says 3684. My memorandum says 3648, whichever it is—it provides—

no advance of public money shall be made in any case unless authorized by the appropriation concerned or other law and in all cases of contracts for the performance of any service or delivery of any articles of any description for the use of the United States, payment shall not exceed the value of the service rendered or of the articles delivered previously to such payment.

Now, this proposed bill would waive that. Now, I would like to have your comments on it because this particular section does bother me.

Mr. MORGAN. Senator Allott, for an educational institution, and more particularly a public institution, which is the category in which all of our land-grant institutions fall, the ability to obtain what the commercial world would call operating capital for the performance of the type of services contemplated here, which is a continuing on-going research function where a professional person is employed, probably on a permanent tenured basis, and to fund cost of the research—this cost consisting of salaries that occur currently, bills that must be paid monthly—without advance payment is for most educational institutions an impossible thing and for the remaining institutions a most difficult thing.

We are public institutions. There are certain limitations in financing inherent in a public institution. The access to commercial lending, for example, is very limited to us. And we are not quite in the category, let us say, of the private enterprise research laboratory that, with a contract in hand, goes to a commercial banker and assigns the proceeds of the contract to obtain operating funds and, in the normal commercial sense, goes on with his business.

Senator ALLOTT. Well, now, Mr. Morgan, the thing to which this refers, which is water research programs, refers also to programs with educational institutions, private foundations or other institutions, private firms and individuals, and with local, State, or Federal governmental agencies. Do you know—I believe, generally that neither the National Science Foundation nor the NIH has a waiver of this provision except in one or two small instances. Am I wrong in that?

Mr. MORGAN. I am under the impression that there is substantial advance funding from those agencies.

Can you help me out on this?

Senator ANDERSON. This is a very important question, Doctor.

Will the Senator from Colorado permit me?

Senator ALLOTT. Yes.

Senator ANDERSON. Is there anywhere you can spend money before the legislature appropriates it? You have to wait for legislative action, do you not, before you start spending money?

Mr. MORGAN. That is right, sir. The only legal way we may do it.

Senator ANDERSON. Well, the legal way is the way we want you to work. We don't want to send you to the penitentiary after the nice things Senator Allott said about you.

This isn't like a banking piece of paper that you can take to the bank and borrow on. If one has a contract, that is a good prime commercial paper and you can take it to the bank and borrow on it. Can you do that?

Mr. MORGAN. Generally our institutions may not.

Senator ANDERSON. I remember one time I went down to see at the Oklahoma State University Henry Bennett. He was borrowing money right and left but what the State of Oklahoma and what he could do and what he worked out doesn't always apply to every State and this is merely an effort to make it possible for you to fund your project. Senator Allott might have put his finger on the fact that it might be made too wide for other than public institutions to get advances, but this is about the only way a State institution could operate under this bill. We wouldn't want the question of funds to bog them down. I may be that private institutions, Senator Allott, could go ahead and get their money. Maybe we ought to eliminate them from the bill, I wouldn't want to say for sure about them at this time but I know these State institutions, for them it is extremely difficult without advances. We are trying to open the door for them and make it possible for them to do research for us. They say yes, we will take on a research project but you have got to fund it for us; we can't fund it in advance under our legislative action. We don't want to wait for the legislature of Colorado to meet and provide advance funds. This is something they would let us do if we waited. We will have to take your appropriation on the same basis as if we had the money appropriated already by the legislature, so it will support the work as it progresses.

Isn't that what you understand the language to be?

Mr. MORGAN. Yes, sir. This is generally the case. I interpret the language here to be permissive.

Senator ANDERSON. Yes. It is permissive.

Mr. MORGAN. It may be undertaken without regard to the provisions of the section involved on a basis of discretionary authority. The exercise of discretion by the contracting authority which would be the Secretary of the Interior in this bill.

Senator ANDERSON. I would be interested in the point that Senator Allott has made. We ought to check this and find out what other agencies do and try to limit it as much as we can, but it would be pretty hard for the land-grant colleges to do it, would it not?

Mr. MORGAN. That is right. The Hatch Act funds are provided in advance. Semiannually now. They used to be annually. This provided institutions operating funds, operating capital, if you please, to carry on going operations.

The business management of a complex university with a very complex pattern of obligations that fall due at unsuspected and uneven times is a real art, and no university administrator I know operates very long without a very skillful business manager.

Senator ANDERSON. Senator Allott, I defer to you. I took too much time.

Senator ALLOTT. That is perfectly all right, Mr. Chairman. I just remarked that when we were considering what is now S. 20 last

year, a similar program, the committee took out this provision because it didn't have—the words used were “pending a more conclusive showing of an actual need for it.”

I asked Mr. Morgan this question because he is aware of my reservations about it and I think it ought to be laid out here so that when the committee considers the bill, we can decide whether we want to limit more, or leave it, or take it out.

Senator ANDERSON. I agree.

Senator MOSS, do you have any questions?

Senator MOSS. I have no questions, Mr. Chairman.

Senator ANDERSON. Senator Dominick?

Senator DOMINICK. Mr. Chairman, I just have a few questions. First of all I would like to express my gratitude to you for the warm welcome to the committee and my pleasure to be on it with you.

Senator ANDERSON. The reason is I heard of your good work in the House and thought it fortunate to get hold of you.

Senator DOMINICK. Thank you. I also want to say it is a pleasure to be on the committee and work with you and Senator Allott and Senator Moss and all the other Senators who do such a fine job here.

I also want to join with Senator Allott in welcoming Dr. Morgan here. Dr. Morgan's college used to be in my congressional district. It still is now that I am statewide. I am delighted to have a chance to be of assistance.

I have some few questions which go to the substance of the bill as a whole. You in the CSU at the present minute are conducting a number of water research programs, are you not, Doctor?

Mr. MORGAN. Yes, sir.

Senator DOMINICK. Including underground water research programs?

Mr. MORGAN. Yes.

Senator DOMINICK. Are you finding that you are having any difficulty in getting funds to continue this type of program?

Mr. MORGAN. The problem of adequate funds for research into the myriad number of problems associated with a resource that is as all pervading as water is a continuing problem that we have on our campus and on other campuses, too, where significant effort is being put forth in water problem research.

If I may answer your question this way, we are confident on our campus that we could put to immediate and instantly productive use any additional funds that came to us for support of research on water problems. We have a standby capability in this area, developed in part from a long history of effort going back into the last century, that has uncovered as many problems as it went along as it solved, or to which it found answer. And thus we are eager to explore the bypaths that show up in a piece of research that is already funded and which must be completed by pursuing the original question to its end.

Senator DOMINICK. Do you know how many institutions in Colorado are now engaged in water research programs?

Mr. MORGAN. I could not answer this categorically. If one interpreted the question broadly, it is probable that every institution in the State is doing research on any significant scale at all is inquiring into some of the problems that are related to this resource.

For example, I happen to be personally acquainted with a friend down at Colorado College, a private liberal arts college. He is engaged in a very interesting inquiry into some of the biological aspects of our Colorado ecology, and I am sure that his results will be helpful to other researchers in their application to specific problems related to water in our State.

I offer this as just a kind of an extreme example of how the universal nature of these scientific problems is so interrelated that, if you pull one thread in one location, you almost invariably affect the fabric at some distant spot down in the weaving.

Senator DOMINICK. Thank you, Mr. Chairman.

Senator ANDERSON. Senator McGovern?

Senator MCGOVERN. Mr. Chairman, I would like to ask President Morgan a question here relating to the funds that are provided in Section 100. It refers to a figure that builds up to \$100,000 for the purpose of establishing a collegewide or universitywide water resources research institute. Could that money be used to fund research projects in an institution such as yours?

Mr. MORGAN. It would not be. We would contemplate its use immediately.

Senator MCGOVERN. For research purposes?

Mr. MORGAN. People who were employed to conduct the research in hand or whose assignments inside the institution were shifted over to this fund because their effort was then put forth on the project to be funded by this? Is this your question, sir?

Senator MCGOVERN. Would it be used to pay salaries of research people?

Mr. MORGAN. It would be used to pay salaries. It would be used to pay the normal expenses of conducting a research center. Senator, we have a member of our panel who is going to speak specifically to this point. May we defer that, sir?

Senator MCGOVERN. All right.

Senator ANDERSON. Are there other questions?

Thank you very much, Dr. Morgan.

(The full prepared text of Mr. Morgan is as follows:)

PREPARED STATEMENT OF WILLIAM E. MORGAN, PRESIDENT, COLORADO STATE UNIVERSITY, AND CHAIRMAN, WATER RESOURCES COMMITTEE, ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

My name is William E. Morgan. I am president of Colorado State University which is the land-grant institution in the State of Colorado. My appearance here is in the capacity of chairman of the Water Resources Committee of the Association of State Universities and Land-Grant Colleges. I wish to thank the committee on behalf of the 72 universities and colleges comprising the membership of the Association for this opportunity to speak in their behalf in favor of S. 2, the Water Resources Research Act.

The association I represent endorses, by virtual unanimous vote of its membership, the purposes and objectives of this bill. If your committee desired, a representative from each of these institutions would appear before you in support of the association's stand. In lieu of that, our association, by agreement with your committee staff, is represented here today by personnel from five of the member institutions. I should like to introduce these gentlemen and indicate the portion of the association's testimony which each is prepared to present.

First we have the Dean of the College of Engineering, Utah State University, Dr. D. F. Peterson, whose topic is science and engineering aspects of the research job that confronts the Nation in fields related to water.

Next we have the President of the University of Maryland, Wilson H. Elkins, who will touch on the subject of national requirements for trained manpower and what this bill might do to further the development of that critical resource.

Then there is the president of the University of Florida, Dr. J. Wayne Reitz, who is prepared to comment on water as an economic resource and who also will discuss the funding proposals in the bill.

Next we have the chancellor of the Irvine campus of the University of California, who currently is holding down the additional assignment of statewide university dean of agriculture, Dr. Daniel G. Aldrich, Jr., who is to comment on some of the Federal-State relationships involved and who, in discussing some of the bill's potentials, will draw on his experience in a State that has already put forth much effort on research related to water.

Finally, I should like to conclude with a statement on water as a public resource.

We are especially grateful to the committee for permitting us to deal with the subject in such extended fashion, and now I should like to open our testimony with a background statement on developments that bring us here today as representatives of the Association of State Universities and Land-Grant Colleges.

Every activity of man, every facet of industry, leaves its influence on the water resource. Water, like sunshine and air, is fundamental to life itself, and the right of the individual to enjoy unpolluted water necessary for the essentials of life and health is today more than just a license. Water is a major concern of civilized society. "The story of water is the story of man."<sup>1</sup> As every informed person knows, the demands upon the water resource are rapidly multiplying and in an area embracing nearly one-third of the United States, 1980 demands will exceed the supply.<sup>2</sup>

The rather sudden national awareness of an impending water shortage has naturally led us to talk more and more about water research. Research is today a base for our general welfare. We have found research to be the key to the most productive agriculture of all time; to greatly improved health; to a viable, productive, modern industry; to national security; to an extension of our environment beyond the earth's atmosphere, and to many other desirable objectives. Thus, it is only proper that we should turn to research for assistance in stretching our limited water resources to the limit.

#### RECENT COMPILATIONS OF WATER RESEARCH NEEDS

An early publication which recognized the desirability of research on water was the U.S. Department of Agriculture Yearbook for 1955 entitled "Water." This publication included discussions of 91 topics relating to the use of water. These are primarily of interest to agriculture, but, in many cases, are of wide general interest also. I do not think this publication was designed to be simply a research report, yet the discussion of every topic includes major reference to the results of research.

In 1961 the National Reclamation Association and the National Association of Soil Conservation Districts held a national water research symposium in Washington, D.C. Scientists, engineers, and public officials of national stature in the field of water resource development and use reported research needs. These reports were later published as Senate Document 35, 87th Congress, 1st session, and fill 235 pages.

The extensive study of the Senate Select Committee on Water Resources, 86th Congress, brought a new and realistic perspective to the water resource picture but stressed the importance of research. The impacts of the various water needs were weighed against the supplies and local and regional differences were considered in detail. The reports of this study did much to "clear the air" and they quite clearly show the critical areas, not only geographically, but in terms of technology and public policy as well. While the urgency varies, the need for action is evident in all regions and for all kinds of uses, but it is clear that intelligent planning, cooperative action, continuing assessment of problems, and positive steps or incentives to encourage efficient use, backed up by research, can greatly extend our capability to match demands with supplies. Much of the report, which consists of 32 separate papers, is concerned with research. Indeed, the report itself is the result of research. Print No. 28 written by the Department of Agriculture is entitled "Water Resources Research Needs" and discusses a great many specific areas of research. Ten other prints, Nos. 21 to 27 and 29 to 31, are primarily reports of research accomplished, of future research needs in specific areas, and of the possibilities for application of

<sup>1</sup> Bernard Frank in "Water," U.S. Department of Agriculture Yearbook, 1955.

<sup>2</sup> "A Better Gage of the Water Outlook," annual report, Resources for the Future, Inc., Washington, D.C., 1960, pp. 14-24.

research results in these areas. These reports thus quite comprehensively cover the research picture and should be "required reading" for those concerned with water research programs. It would be quite unlikely that I would add anything new to this vast cataloging of research needs. Hopefully perhaps some emphasis might be given to certain aspects of research, especially in relation to the concept of State research institutes as visualized by S. 2.

The summary report of the select committee<sup>3</sup> emphasizes research. On the basis of the results of the study, five recommendations were made. Recommendation No. 3 requested a coordinated program of water research, and in discussing this recommendation, the committee stated its belief "that a great deal more research and demonstration is needed on almost all phases of water resources." Deficiencies in present research programs were discussed in some detail. In part II E, section 4, the committee delineated and discussed 17 specific research areas.

In May 1962, Senator Clinton P. Anderson, chairman of the Committee on Interior and Insular Affairs of the U.S. Senate, asked for reports on water resources research from the Federal departments, land-grant colleges and State universities, other public, educational and private institutions, and individuals in each of the 17 categories of research suggested by the Senate select committee. The results of these inquiries are summarized and appear in a committee print<sup>4</sup> of the 87th Congress, 2d session. The contributions of the land-grant and State universities and other institutions illustrate the broad base on which important water research is already founded as well as emphasize the fact that many educational institutions are already contributing significantly to the effort in water resources research. Table 1 summarizes these contributions.

TABLE 1.—*Land-grant universities, agricultural experiment stations, and other institutions engaged in water resources research*

Categories	Number of institutions		
	Land-grant universities	State agricultural experiment stations	Other institutions <sup>1</sup>
(a) Evaporation reduction.....	19		3
(b) Phreatophytes.....	14		2
(c) Evapotranspiration reduction.....	24	19	7
(d) Reduction of wasteful irrigation practices.....	21	9	5
(e) Waste treatment and control.....	31		14
(f) Waste water salvage.....	8	3	5
(g) Industrial water conservation.....	10		8
(h) Desalting.....	11	1	6
(i) Weather modification.....	17		2
(j) Hydrometeorologic forecasting.....	17	25	8
(k) Application of nuclear products.....	9	2	6
(l) Groundwater use and control.....	27	16	7
(m) Economic incentives.....	2		
(n) Alternative water use.....	8		1
(o) System planning.....	9		5
(p) Economic effects of existing projects.....	19		5
(q) Engineering problems.....	15		10

<sup>1</sup> This column includes State universities other than land-grant, private universities and foundations, institutes and corporations. While all land-grant universities and State experiment stations were doubtless canvassed, conceivable there could have been omissions in the canvas covering other institutions. It is likely, also, that some research efforts of agricultural experiment stations were not distinguished from the associated land-grant universities.

#### INTEREST OF STATES IN WATER RESEARCH

It would appear that the need for increased water research and the broad areas in which this need occurs are quite well established. The question is, What shall be done first and who shall do what? In a paper given at Chicago in 1962,<sup>5</sup>

<sup>3</sup> Report of the Select Committee on National Water Resources pursuant to S. Res. 48, 86th Cong., together with supplemental and individual views, committee print, 87th Cong., 1st sess., S. Rept. 29, Jan. 30, 1961.

<sup>4</sup> "Water Resources Research." Memorandum of the chairman to the Committee on Interior and Insular Affairs, U.S. Senate, September 1962.

<sup>5</sup> "Water Research Needs." Edward A. Ackerman, Carnegie Institution of Washington. Address before Interstate Conference on Water Problems, Chicago, Ill. Dec. 4, 1962.

Edward A. Ackerman said: "The problem of the States is not as to whether there is research for them to undertake but as to what they choose among all there is to do." Ackerman suggested that the States should consider those research needs that are particularly suited to attention and initiative on the part of State governments. He pointed out the great differences between the social and natural environments that exist in the various States and suggested that the determination of what research needs are "starts with politics and policy." Ackerman asked:

"What are reasonable objectives for the development of the State in the future? Is it minimizing employment [sic]? Or income? Is it creation of an economic base to attract a greater number of residents? Or is a determined effort needed to preserve action to prevent deterioration of resources and amenities? Even in these few questions a distinction can be seen between the proper objectives of Alaska, California, West Virginia, or South Dakota."

Ackerman did not suggest any other restrictions on the type or subject matter of the research to be done by the State, nor did he discuss the possibility for coupling the research with programs of education, as is anticipated by Senate bill 2 in providing for establishment of research centers at universities. In a university context, part of the research done should be basic.

Linking research and education adds vast new dimensions to the potential of the proposed effort. One of the overwhelming reasons for a university connection relates to the development of manpower, both in terms of numbers and in quality of their education. This manpower subject will be discussed in detail by one of my colleagues so I will restrict my remarks on it to some limited comments later on and return to the question of why State water resource centers are needed. Why should part of the water research effort be undertaken at State levels rather than exclusively by Federal agencies?

One important reason already suggested stems from the large differences that exist among the States. These differences involve not only great variations in the nature of the resource itself and the degree to which the resource has been developed, but also in the detail of the economic and social structure. These differences are reflected in the political and policy aims of the various States.

The differences in the resource and the degree and nature of its development were pointed out by the reports of the Senate Select Committee on Water Resources, especially by prints Nos. 6 and 32. As an example, many Western States, limited in their water resources to begin with, have placed great pressure on the resources because of the steady demand for irrigation. The availability of dilution water for pollution control and for cooling, already low, bears a further reduction because of the high consumptive use of irrigation. On the other hand, water transportation is not a significant factor in most Western States. The significance of water in recreation is primarily in maintaining the attractiveness of the vast areas of unoccupied watersheds. The consumptive use of the water resource is approaching a practical saturation limit so that new uses essential to economic development must occur in most instances at the sacrifice of some present use. In contrast, a typical Eastern State might have a primary interest in maintaining river navigation. Waste dilution demands and pollution become the significant factors dominating allocation of streamflow rather than consumptive use for irrigation. Irrigation is limited and sporadic, depending on season. Recreational use of unoccupied land is quite limited and direct utilization of water for fishing, boating, etc., is relatively more important in the recreational picture.

The differences between even adjoining States are apt to be greater than one might think. Utah's development is mostly based on the short, snow-fed streams of the Wasatch front discharging onto the desert floor. This has resulted in the development of rather small, generally independent irrigation units. Idaho's streams are larger; occurrence of groundwater in fractured lava is common. Differences in climate, elevation, and soil have generated significant differences in problems of agricultural use of water. In Wyoming there are many scattered irrigation developments, often associated with ranching and fairly large irrigation projects principally on the North Platte and its major tributaries. One could continue to recite these resource differences in detail.

The differences in the economic-social detail as among States may even be greater than the resource differences. The particular lines which future economic development may take are highly unique State by State. These are greatly influenced by the nature of natural resources, other than water, such as minerals, fuel, and timber (including their accessibility, and their quality in relation to competitive sources, etc.); by transportation; by the nature of the population

resource (such as degree of urbanization, geographical distribution, and nature of occupational capabilities and social background); by educational activities; by the administrative and legal structure; by taxation practices; by the availability of markets; by recreational resources; by strategic resources; by Federal interest in public lands, and by many other factors. These differences lead to unique and different policies and objectives.

The position of the State in the check and balance action which ought to be characteristic of the total development of the water resource is highly important. The State must speak for the individual and the community. It must be concerned with the fine-grained synthetic problems of matching resources, people, and economic objectives enterprise by enterprise and community by community. In contrast to Federal agencies in the field, which are often dedicated to single functions or missions in a sort of vertical array, the State has the responsibility to provide a positive environment whereby economic elements, of which water is an important one, may be melded at the grassroots level in a horizontal sense, somehow consistent with the overall economic and social aims of the statewide community and the coordinate objectives and policies of the Federal Government. This is not to overlook or minimize the great responsibility of the Federal Government in water resources, but to point out the importance of the role that the State should play. That the Senate select committee was conscious of the balancing role of the States, as well as of the Federal responsibility, is quite evident from its reports. In its summary report<sup>6</sup> the committee listed eight areas in which action was needed to meet national goals. Area No. 3 was improvement of State and local planning and decision-making. Pointing out that most water problems will continue to be local or regional, the committee stated that, "Broadly speaking, national problems are the sum of large numbers of regional and local problems." The committee noted that "State and local agencies still play a minor role in many water resource decisions \* \* \* the State and local agencies are in the position of having to approve or disapprove plans without having made comprehensive background studies which are needed before a major decision in the water resource field can be made."

The committee suggested Federal assistance to States for a limited period in order that they might develop capability for comprehensive long-range plans for optimum development of water resources within the State. It is doubtful if such plans could be effectively made without research on problems that are specific and often unique to them. Certainly assisting the States to establish water resource research centers is consistent with this particular recommendation of the committee and within the Federal responsibility as visualized by them.

A third reason for establishing the State centers as visualized by S. 2 is the broad linkage which this establishes with education. It is in this way that the educational effort might become exponential; that is, like a chain reaction, students associating with research and researchers are more apt to become researchers themselves. Graduate students can contribute to research; research employment may make graduate study attractive. From the point of view of practice, students educated in a research environment will be more knowledgeable, their judgments will be better than otherwise. Regardless of the amount and quality of research information available, this can have no impact upon the water resource except through the myriad elemental decisions made daily by a great many people. It is important that the knowledge and wisdom of these decisionmakers at every level be as great as possible. I would expect that the impact of establishing the proposed centers at universities, in terms of improved operational decisionmaking, might well be as great as the research knowledge itself.

Senator ANDERSON. Let us run through the next four presentations without question, and then come back all at one time.

I only wanted to break in at this point because we had two Colorado Senators here who may leave to go to the floor, and I thought it was fine to give them a chance to ask you questions.

Mr. MORGAN. Yes, sir. Well, I will say as a matter of personal interest that I am happy to know that there are two Colorado Senators, including my former Congressman, now on this committee.

May I ask Dean Peterson to comment on the scientific phase.

<sup>6</sup> Ibid., p. 3.

Senator ANDERSON. Dean Peterson, we are very happy to hear from you.

**STATEMENT OF DR. D. F. PETERSON, DEAN, COLLEGE OF  
ENGINEERING, UTAH STATE UNIVERSITY**

Mr. PETERSON. Thank you, Senator Anderson. I am very happy to be here today.

The task that has been assigned to me is to talk about the scientific and engineering research needs. Dr. Morgan has already indicated the great volume of material that has been written that has outlined these needs in considerable detail. I am not quite sure how I can compete with this tremendous library of needs that have already been compiled. What I propose to do, therefore, is to mention a few of the items which are particularly attractive; and, in doing this, I will depart somewhat from the prepared text that I proposed to file with the committee.

I hope I can do this without sounding too much like a professor. I am only one step removed from the classroom, whereas my colleagues here are at least two steps removed.

One shortcoming of water resources research is that there isn't enough basic scientific knowledge so that the engineering research and the technological research can always be efficient. Engineering research shouldn't have to stumble up blind alleys of trial and error because there aren't guideposts of sound scientific research to help out.

I would like to mention two or three examples of basic scientific research which would subtend large areas of engineering research capability, that is, areas on which engineering could be founded.

One of these is the matter of evaporation control. The lakes and rivers of the United States evaporate a tremendous amount of water.

We have made some efforts to control this evaporation. These efforts have been largely in terms of field trials, learning how to apply monomolecular films, and so forth. We need to attack the basic physical chemistry of this film to understand exactly how the molecules go through it, what are the energy relations, and so forth. If we would do this systematically, I am sure that the process of doing the engineering and placing this scientific possibility into action would be greatly shortened.

Much has been said about desalinization. The promise of producing inexpensive water under present systems is not very good. However, theoretically the promise that we might get this down to quite a reasonable cost is good. So we need to do this basic research to find a way to utilize this wherever possible.

In atmospheric physics and weather modification, about 12 years ago the work of Langmuir and his associates at GE brought forth a great rash of cloud seeding and weather modification experiments. Most of these had little scientific basis or hope of success. Nevertheless, there were some careful evaluations made. Dr. Workman, of New Mexico Mining & Technology, did an outstanding example of this kind of scientific investigation. We need to continue this work on a little different tack. The entire atmosphere needs to be studied, development of storm systems, for instance, and the development of individual rain cells over arid land, which promises to be an area of fruitful research.

I might mention that the existence of man and his civilization as we know it has already begun to modify rather seriously the lower atmosphere. I would mention the smog in California, if it would not hurt Chancellor Aldrich's feelings. The possibility of modifying the upper atmosphere is even greater. Because they are very dense, a few tons of exhaust gases could lead to considerable modification in the upper atmosphere.

There is also the matter of macrometeorology which is the interaction between the lower atmosphere and the earth.

Another basic process is the matter of plant transpiration. This may be a sort of "way out" proposal, but at the present time a plant transpires as much as 500 pounds of water to produce one pound of dry material. It may be possible to develop methods which would reduce this ratio of water transpiration to production of usable dry material. Breeding techniques might produce plants which were more efficient in their use of water. This has already been done in the case of grain sorghums which are used in the western Great Plains. These are drought resistant and have low water requirements.

As for the matter of water-soil system: Nearly all water which falls on the earth passes into the soil, moves through the soil, either out through the plant or into the rivers or the ground water reservoirs. Agriculture has done a great deal of work in this field and especially in relation to plant growth. We need to extend this generally. I am sure that we will begin to want to use the soil mantle, or at least to study the use of a soil mantle, in relation to the disposal of wastes.

I am not going to discuss morphology and stream development. My remarks will be contained in the record. I would, however, like to say something about hydrology. Hydrology has been defined as the science that treats of the waters of the earth, their occurrence, circulation, and distribution, their chemical and physical properties, and their reactions with their environment, including their relation to living things. The domain of hydrology embraces the full life history on the earth.

Now, the reason I would like to say something about this is that hydrology is a basic science. It is, however, a derived science. It is synthesized from a number of physical sciences. It is the servant of all water resources development and planning. However, hydrology as it exists today has been gerrybuilt as needed to further our immediate objectives of civil engineering, forestry, and so forth, and researchers in this science usually switch hats from their basic disciplines to work in this field. This approach is neither efficient nor very specific. The treatment cannot help but be superficial instead of fundamental. The deficiencies in hydrology have been recognized by many reports, including those of the Senate Select Committee on Water Resources, and the Ad Hoc Panel on Hydrology.

In 1962 under a project sponsored and financed by the University of California Water Resources Center, a conference was called of representatives of 20 universities, together with observers from the Federal agencies with programs and interests in hydrology. This led to the formation of the university's council on hydrology. The first two objectives of this council were (1) to represent the university community in activities aimed at encouraging the growth of education and research in hydrology, and (2) to provide and disseminate

information considered necessary for an adequate representation of the status of hydrological education research.

As of January 17, 1963, the following universities were members of this council: University of Arizona, University of California at Berkeley, University of California at Los Angeles, California Institute of Technology, University of Chicago, Colorado State University, Cornell, Georgia Institute of Technology, University of Illinois, University of Idaho, University of Iowa, Johns Hopkins, Massachusetts Institute of Technology, Michigan State University, Southern California, Stanford, University of Texas, Utah State University, Washington State University, University of Washington, and University of Wisconsin.

These universities have determined to proceed in building an interdisciplinary science and capability in hydrology. The formation of the proposed water resources centers would certainly further the progress of this endeavor.

Now, with regard to engineering research, these range from very simple tasks such as a gate to close and open the entry of an irrigation lateral to a very, very complex system of river development such as we see on the Colorado River. This latter may involve water supply, storage, hydroelectric power, flood control, irrigation, and drainage.

At least one report has been made on engineering research needs that relate to water resources. This resulted from a panel study on basic research in civil engineering fields as related to water resources held at Fort Collins, Colo., in June 1961 under the sponsorship of the American Society of Civil Engineers, the U.S. Bureau of Reclamation, and Colorado State University. Sixty-five engineers of considerable eminence participated in these panels. They delineated seven areas of research. The whole report is of interest but I will quote only two conclusions which are most relevant.

Conclusion 3 says:

Research in the field of water resources is not being supported adequately and it is clear that the current level of research activity must be increased severalfold if it is to keep pace with the projected requirements.

Conclusion 4 said:

Expenditures for research in the field of water resources should be increased from the present level of less than two-tenths of 1 percent of funds spent on related constructions to a figure of about 1½ percent of construction funds.

I will mention a few samples of engineering areas which will illustrate the need for engineering research.

Engineering structures and devices: Almost every change that man imposes on a water resource is by the use of some kind of an engineering structure or device. I suppose the major portion of the money by far which is invested in water research development goes to design and build these devices and structures. I think there is a continuing opportunity to improve the efficiency and reduce the cost of these devices. I might say that in general the cost of such devices is too great—is so great that it prohibits the development of some of our minor marginal water resources.

Another topic is the matter of information sensing, telemetering, processing and interpretation. Compared to systems that we are using in astronautics, when we can go to Venus 53 million miles away and collect hydrometeorological data, techniques we use in this field are

primitive and generally expensive. We need to measure better such streamflow characteristics as discharge, sediment transport, pollution, quality and temperature, and to make these readily available to researchers. We need more modern techniques which can increase these efforts so that they will be adequate to the task.

Another area is hydraulics. Hydraulics is the study of the flow of water, and this is the basic analytical tool which every engineer uses in developing his structures. Irrigation and drainage draw on most aspects of engineering and the agricultural sciences. These are synthesized into a system which is part socioeconomic in nature. The industrialization of the West will probably not decrease the economic attractiveness of irrigation but it will compete for the same water resources. The needs for research in irrigation and drainage are too broad to outline in detail. The importance of the physical and biological sciences will continue but increased emphasis will be given to economic and institutional aspects of irrigation.

I personally am convinced that irrigation agriculture is extremely sensitive to the socioeconomic environment. I think it is important to note that, by chance or otherwise, the friendly or neutral undeveloped nations of south Asia and the Mideast, north Africa, Latin America, lie in climatic zones and possess natural resources such that irrigated agriculture must usually be a very dominant element in their development.

Waste disposal and pollution control has already been mentioned. This is the overwhelming problem that imposes the ceiling limitations on our water resources development. It seems, therefore, that it would be urgent to investigate every possibility, no matter how farfetched it appears, which could possibly mitigate the effects of the load which waste disposal places on our streams.

Areas of investigation which might be considered include improved treatment processes, accelerated regeneration of stream oxygen, systems of waste transport and disposal which do not require water or use of streams, more objective limits on pollution standards, and continued reduction of industrial pollution by alternate systems and improved methods.

Systems engineering. Systems engineering is a technique for analyzing and developing complex systems which give you optimum objectives or which meet the objectives in an optimum manner. Systems engineering has been developed in many areas of engineering such as astrophysics and aeronautical engineering, but has had little application to water resource development.

Water-demand management is another important area. We usually think of finding a water supply in order to meet a specific demand rather than adapting demand to the supply. If we could match our demand to existing supplies a little better, then we would have more efficient utilization of the resource. To do this, we would need to find incentives which would get people to comply with this type of an approach. So we need research not only to see how much of this is possible but also to develop the incentive systems that might make it possible.

Ground water resource represents one of our greatest potentials for increasing our water supply. There are a great many things about ground water management that might be improved. For example,

ground water has the capability of being free from evaporation in the atmosphere generally. Ground water resources can be seriously damaged and wasted if they are improperly exploited. Research could lead to the most sensible public policies on ground water conservation.

I hope these limited remarks may serve as illustrative examples of the job that is before us. I think that it will be apparent that these examples and many others will be accelerated by the program proposed by Senate bill 2. I think water research problems will have to be attacked item by item, location by location. They must be closely linked to community and individual objectives and State research efforts will greatly assist the States in discharging their responsibilities in planning development.

Senator Anderson, I believe this covers in a general way a sort of index of research that might be basically helpful to the job that we are trying to do. I thank you for the opportunity to be here.

Senator ANDERSON. Thank you, Dr. Peterson. You have made a very fine statement and I appreciate it very much.

(The full prepared text of Mr. Peterson is as follows:)

STATEMENT OF DR. D. F. PETERSON, DEAN OF ENGINEERING,  
UTAH STATE UNIVERSITY

President Morgan has mentioned the compilations of research needs that have already been made. It would be inappropriate to do anything more than cite these compilations and perhaps place some emphasis on certain urgent research considerations. In doing this I will divide the subject into two topics, basic scientific research and engineering research.

BASIC SCIENTIFIC RESEARCH

Perhaps one shortcoming of water resource research is that there is not enough basic scientific research being conducted so that engineering and technological research can be efficient. Engineering research should not have to stumble in endless blind alleys because the guideposts of basic scientific knowledge are lacking. I would like to mention a few examples of basic research endeavor that appear particularly attractive to me, especially in the context of a university related research facility. The subjects are not in any order of priority.

*Evaporation control*

A very large share of our basic water supply is lost to the atmosphere by evaporation from lakes and streams. Efforts to control this loss by use of monomolecular films have been largely limited to field trials, systems of application, and evaluation of such suppressants applied to bodies of water. More basic effort should be devoted to the physical chemistry of the film system and its relation to the water body and the atmosphere. There is doubtless much that could influence the molecular nature of the film; fundamental understanding of the film and its air and water interfaces could doubtless accelerate the progress of engineering research.

*Desalinization*

A great deal of effort has already gone into desalinization research. Present systems do not show promise of producing inexpensive water; however, the costs of the theoretical energy requirements are of the order of one-tenth or less of minimum anticipated costs using present known systems. Basic research which could lead to new systems would appear promising.

*Atmospheric physics and weather modification*

Laboratory demonstrations by Langmuir and other in the late 1940's of the effectiveness of artificial nucleation in condensing water vapor from super-saturated air led to vast expenditures for cloud seeding. Some carefully controlled field experiments yielded information of value, however, much of the cloud-seeding effort was made with little scientific basis for success and with no hope for evaluation. Nevertheless, much has been learned, new re-

search tools have been developed, and great new vistas for basic study of atmospheric physics have been opened.<sup>1</sup> Besides the physical chemistry of the air-water vapor system continuing studies of the atmosphere itself will undoubtedly yield information of great value. There is no doubt that nucleation under certain conditions will induce precipitation; however, the need for sublimation nuclei under natural conditions is still somewhat obscure. Modification of the atmosphere is certainly a possibility, but, as Workman implies, this might perhaps best be studied from the point of view of energetics. There have been major changes in climate in the recent geological past. Modern man has already modified at least the lower atmosphere locally and, it appears that the extreme upper atmosphere, where densities are extremely low, might quite easily be modified significantly with relatively small releases of rocket exhaust. Besides the gross atmosphere, future studies should include storm systems as well as basic physics. Formation of convective thunderstorms associated with diurnal heating, especially in arid regions, would seem to be a fruitful topic for continued study and considerable progress along these lines has already been made in the Southwest. Micrometeorology, that is the detailed physics of the lower atmospheric boundary, has great significance relative to evaporation, transpiration from plants and sublimation and melting of snow and ice. Much more detail is needed.

#### *Transfer processes*

This refers to the mechanism by which a physical quantity, mass, energy, or momentum, is transferred from a source. While all transfer processes are not mathematically identical, there is general mathematical resemblance among them. Transfer processes occur widely in the hydrologic cycle and include such phenomena as evaporation of water into the atmosphere, scouring and transport of sediment, viscous drag between a stream and its boundaries, and heating of the atmosphere by thermal conduction from the earth's surface. Increased general basic research in this field will multiply the analytical tools of the scientist or engineer in many aspects of water research.

#### *Stochastic models*

To the scientist all events must be weighed in terms of their probability. Techniques for describing complex relations between hydrologic events could result in reliable but extremely complex mathematical descriptions. Information theory has made great progress in applying new mathematical techniques to communications. These techniques should be extended to hydrologic and hydraulic problems. Improved stochastic models could define much more accurately hydrologic and climatologic events of wide public interest. The dry farmer could know the odds for adequate rain rather exactly; the design flood might be determined much more accurately by the spillway designer, etc.

#### *Plant transpiration*

A tremendous amount of water passes into the atmosphere through the plant's respiratory system. For every pound of dry material produced by plant growth the amount of water which must be transpired is of the order of 500 pounds. Perhaps it is farfetched to suggest that practical methods which would reduce transpiration might ever be developed, it may nevertheless be worthwhile to study the basic transpiration process in greater detail. Plant breeding techniques could be utilized also to improve the drought resistance and lower the water requirements of certain crop varieties. This has already been done for specialized varieties of grain sorghums used in the western Great Plains.

#### *Water-soil systems*

Nearly all the water which falls on the earth's surface enters the pores of the soil mantle during some part of the hydrologic cycle. Thus, the interaction between water, entrapped gases, and the soil is of great significance. In this connection, I use the term "soil" to include all of the unconsolidated fragments of the earth's mantle, rather than restricting it to the portion in which plants grow. Agriculturists have long been concerned with the dynamics of soil-water systems under the forces generated by surface tension, gravity, thermal and chemical gradients, and osmotic pressure, and with the chemical transfers between the soil, water and plant. Much basic knowledge has already been contributed by them. This work, extended to the general soil mantle, is far from complete however, but its impact transcends most of engineering and hydrology. Some

<sup>1</sup> For example, see Workman, E. J., "The Problem of Weather Modification," Science, vol. 138, No. 3538, Oct. 19, 1962.

practical questions in which detailed basic information is needed relate to the disposal of pollutants in the soil, entry of surface waters, ground water development, and water movement in relation to the production of streamflow by watersheds.

#### *Morphology and stream development*

Study of stream formation in relation to surface morphology could yield results of extremely useful engineering significance. Man never really harnesses a river; more properly he lives with it because the modifications he makes are usually of petty geologic significance. Even though geological processes are long, man's lifespan is not too short to encounter some of these when he deals with a river. Siltation, periodic flooding and erosion are part of these processes and we may well have to live with some of them. Sometimes I think our judgment is rather poor in the way in which we try to modify and interrupt some of these processes. On high watersheds, study of stream morphology could perhaps lead to methods of estimating streamflow hydrology.

#### *Hydrology*

Hydrology has been defined as "the science that treats of the waters of the earth, their occurrence, circulation, and distribution, their chemical and physical properties, and their reactions with their environment, including their relation to living things. The domain of hydrology embraces the full life history of water on the earth."<sup>2</sup>

Hydrology is interdisciplinary, deriving from many basic sciences such as physics, chemistry, and geology and is of great interest to such disciplines as agronomy, biology, civil engineering, forestry, geography, irrigation, and meteorology. Hydrology, such as it exists today, has been somewhat "jerry built" as needed to further the rather immediate objectives of civil engineers, agronomists, foresters, etc., and usually members of these disciplines have "switched hats," sometimes temporarily, to study hydrology as it relates to their own specific problems. This approach is neither efficient nor very scientific. It means that the treatment will emphasize the superficial rather than the fundamental; indeed, it is hard to see how anything very fundamental could come from this approach. The deficiencies in hydrology have been recognized in recent years by several reports, including those of the Senate Select Committee on Water Resources and the Ad Hoc Panel on Hydrology. The latter report stated:

"The water development and management problems of the last few years have created a need for scientific hydrology that exceeds the capacity of the relatively few individuals who have come into the field from bordering disciplines. The time has come to encourage colleges and universities to make a conscious effort to develop scientists trained to work on hydrologic problems from a broad base in the fundamental sciences."

In August 1962, under a project sponsored and financed by the University of California Water Resources Center, a conference was called of representatives of 20 universities and observers from the Federal agencies with programs and interests in hydrology. This led to formation of the Universities Council on Hydrology (UCOH). The first two objectives of this council are as follows:

(1) To represent the university community in activities aimed at encouraging the growth of education and research in hydrology. It is intended that all academic disciplines within the university which are concerned with hydrology be represented.

(2) To provide and disseminate information considered necessary for an adequate representation of the status of hydrologic education and research.

As of January 17, 1963, the following universities were members of UCOH:

University of Arizona	Johns Hopkins University
University of California, Berkeley	Massachusetts Institute of Technology
University of California, Los Angeles	Michigan State University
California Institute of Technology	University of Southern California
University of Chicago	Stanford University
Colorado State University	University of Texas
Cornell University	Utah State University
Georgia Institute of Technology	Washington State University
University of Illinois	University of Washington
University of Idaho	University of Wisconsin
University of Iowa	

<sup>2</sup>"Scientific Hydrology." Ad Hoc Panel on Hydrology of the Federal Council for Science and Technology, Washington, D.C., 1962.

Hydrology is the servant of all disciplines concerned with water resources. Increased basic research is essential and the universities, with the encouragement of Federal agency representatives, have determined to build a program founded on both education and research. The formation of Water Resource Centers as proposed by S. 2 would most certainly further the progress of hydrology as visualized by the Universities Council.

#### ENGINEERING AND APPLIED RESEARCH

Engineering tasks in water resources may range from the development of a very simple device, such as a gate to open and close the entry of an irrigation lateral to a vast river development system involving water supply, storage, hydroelectric power, flood control, and irrigation and drainage. At least one report has been made recently on engineering research needs that relate to water resources. This resulted from a panel study on "Basic Research in Civil Engineering Fields as Related to Water Resources," held at Fort Collins, Colo., in June 1961 under the sponsorship of the American Society of Civil Engineers, the U.S. Bureau of Reclamation, and Colorado State University.<sup>3</sup> Sixty-five engineers, most of considerable eminence, participated in these panels, which included (1) static and dynamic behavior of soils, (2) static and dynamic behavior of rock, (3) static and dynamic behavior of concrete, (4) fluvial hydraulics, (5) hydraulics of water conveyance, (6) flow in porous media, and (7) conservation and utilization of water. Engineering research on the last four topics listed would be accelerated by establishment of the proposed Water Resources Research Centers. While the entire report of the panel is of interest, I will quote only the two conclusions most relevant:

\* \* \* \* \*

"3. Research in the field of water resources is not being supported adequately and it is clear that the current level of research activity must be increased severalfold if it is to keep pace with the projected requirements.

"4. Expenditures for research in the field of water resources should be increased from the present level of less than 0.2 percent of the funds spent on related constructions to a figure of about 1½ percent of construction funds."

\* \* \* \* \*

As with basic research, anything resembling a complete summary of engineering research needs is impossible herein. A few selected topics of general significance, with my comments are presented:

#### *Engineering structures and devices*

Almost every change imposed by man on the water resource involves some kind of engineering structure or device. I suppose by far the major portion of the money invested in water resources development is for construction of devices or structures. I think that there is opportunity both for the reduction of the cost of such structures and for improvement in their efficiency through research. In general, engineering devices are too expensive to fully utilize our minor water resources. Since most engineering structures are individually designed, better methods of arriving at functional criteria, improved analysis and design techniques, better materials and improved methods of construction could broaden the scope of what we can afford to do in water resource conservation and development.

#### *Information sensing, telemetering, processing, and interpretation*

Compared to systems used in astronautics, for example, the sensing, telemetering and processing of hydrometeorological information is crude and expensive. Measurements of streamflow characteristics such as discharge, sediment transport, pollution quality and temperature, are few in comparison to need. It is almost impossible to make a valid measurement of sediment transport, for example. Meteorological items such as temperature, humidity, wind movement, evaporation, snow cover, and precipitation, are likewise limited. We need to apply modern techniques to increase our efforts in this field so that adequate information for scientific research, for engineering design, and for systems operation, can be collected and interpreted. Digital computers could make possible the use of mathematical models for predicting the effect of natural events and the results of operational decisions in relation to hydrological and meteorological

<sup>3</sup> "Symposium on Basic Research in Civil Engineering Fields as Related to Water Resources." Colorado State University, Fort Collins, Colo., June 12-15, 1961.

systems. Analogs likewise could be developed. These techniques have not been exploited extensively in the water resource field.

### *Hydraulics*

Much still needs to be accomplished in hydraulics research. Hydraulics is the basic analytical tool in the development of all engineering devices for handling the flow of water. Better hydraulics means better water engineering. Open channel flow, especially in alluvial materials, needs continued investigation, and is one example of a great many areas of needed research in hydraulics.

### *Irrigation and drainage*

Irrigation and drainage draws on most aspects of engineering and the agricultural sciences. These are synthesized into a system which is in large part socioeconomic in nature. It is unlikely that industrialization in the West will decrease the economic attractiveness of irrigation, although it will doubtless compete for the same water resources. The needs for research in irrigation and drainage are too broad to outline in detail. While the importance of the physical and biological sciences in relation to irrigation problems will continue, increased emphasis will need to be given to economic and institutional aspects of irrigation. I personally am convinced that irrigation agriculture is extremely sensitive to its socioeconomic environment.<sup>4</sup> I think it may be important to note that, by chance or otherwise, the friendly or neutral underdeveloped nations of South Asia, the Mideast, North Africa, and Latin America lie in climatic zones and possess natural resources such that irrigated agriculture must usually be a very dominant element in their development.

### *Waste disposal and pollution control*

According to estimates made by Wollman<sup>5</sup> in the Eastern United States, approximately 90 percent of projected flows are required to dilute the projected levels of waste discharge. In five regions of the country projected losses alone (without allowances for waste dilution) will exceed the maximum sustained flow capable of being developed in 1980. Thus, waste disposal plays a very dominant role in our water resources picture. It would seem urgent that every possibility, no matter how farfetched it appears, should be explored to mitigate the effects of the load which waste disposal places on our streams. Areas of investigation which might be considered include:

- (1) Improved treatment processes.
- (2) Accelerated regeneration of stream oxygen.
- (3) Systems of waste transport and disposal which do not require water or use of streams.
- (4) More objective limits on pollution standards.
- (5) Continued reduction of industrial pollution by alternate systems and improved methods.

Some rather "far out" ideas come to mind. For example, if pipeline materials could be developed to which organic wastes would not stick, a system of transporting them by air and disposal by dessication or burning might be developed. For an area which may soon face economic strangulation for want of a water supply, such "high risk" research may not be entirely ridiculous.

### *Systems engineering*

This technique is a process for developing the optimum "system" for particular objectives. The difficulty of analysis of a system increases exponentially with the number of system components which interact. Applications of the techniques of "operations research" to the design of water resource developments could lead to systems which approach optimum use. Systems may have economic and social objectives as well as engineering ones and many likewise include natural elements and people as well as engineering devices.

<sup>4</sup>In a summary article entitled "Agriculture and Urban Life in Early Southwestern Iran," *Science*, April 1962, vol. 136, No. 3511, Robert M. Adams, associate professor of anthropology, University of Chicago, after reviewing 7,000 years of agricultural pre-history and history of cultures which were highly dependent on water utilization, and at times quite materially successful, cautiously concludes: "But if valid general insights ever can be sought in the history of so small an area, two may be suggested here. The first is that at least the immediate opportunities and impediments to the enhancing of man's economic well-being seem to have lain more often in his social institutions than in the presence or absence of particular items of material equipment." I suspect that times and places may not have changed the implications of Professor Adams' statement, especially where irrigation is an important factor.

<sup>5</sup>Committee Print 32, "Water Resource Activities in the United States," Senate Select Committee on National Water Resources, 1960.

*Water demand management*

As mentioned by Ackerman<sup>6</sup> we usually think in terms of finding a water supply in order to meet specific demands rather than adapting demands to the supply. Improved matching of demands to supplies could lead to reduced investment in water supply works and greater efficiency of utilization to meet our economic objectives. Research is needed to determine the most fortuitous arrangement of demand on a water supply, as well as on incentives which would induce industrial and other users to plan their developments in accordance with such an arrangement.

*Ground-water development and management*

While some of the statements made herein apply to ground water, research on this resource needs special attention. Improved methods for evaluating ground-water supplies and optimizing systems for development are needed, as are well techniques for utilizing marginal aquifers and better methods of well construction. Artificial recharge needs to be further exploited. Properly planned and operated ground-water development is one of our most promising means of conserving water supplies. Water may be stored underground without subjecting it to evaporation loss and control so that levels are below the reach of roots of uneconomic water-loving plants could save tremendous amounts now transpired in swamps and marshes. Systems analysis might be used to develop plans for such optimum management.

Ground-water resources can be seriously damaged and wasted by improper exploitation; many ground-water basins may be subjected to drafts far in excess of recharge with consequent rapid exhaustion. Research which could lead to the most sensible public policies on ground-water conservation is badly needed.

## CONCLUSIONS

I hope that these limited examples of needed research may illustrate the job that is before us. I think that it should be apparent that these examples will be benefited by accelerated research by the States on those problems which are of most significance to them. I believe many of the problems of applied research will have to be attacked item by item, location by location. Water resource development must be closely linked to community and even individual objectives and I believe that State research efforts will greatly assist the States in discharging their responsibilities in planning and development. I believe that duplication can be avoided by the coordination envisioned in the proposed bill, although researchers would avoid this, in any case. There is little professional prestige in duplicating someone else's work.

Bringing the universities into the picture has many advantages besides the production of increased manpower. Universities since World War II have generally demonstrated their capability in administration of research. The interdisciplinary resources of the university should accelerate the progress of basic and interdisciplinary research. In the university, research and teaching work together not only to develop the body of new knowledge; but with the same effort, to spawn the manpower capability which can reduce that new knowledge to common practice.

Senator ANDERSON. Go ahead, Dr. Morgan.

Mr. MORGAN. Senator Anderson, one of our party has to leave at 4 o'clock for a flight to Florida and I am going to put him on out of the order indicated to you earlier.

The president of the University of Florida, J. Wayne Reitz. He will discuss the funding portions of the bill.

**STATEMENT OF DR. J. WAYNE REITZ, PRESIDENT, UNIVERSITY OF FLORIDA**

Mr. REITZ. Senator Anderson and members of the committee, I wish I were going to Florida, but I am going to Arizona instead, but I am going to get back to Florida tomorrow afternoon.

<sup>6</sup> "Water Research Needs," Edward A. Ackerman, Carnegie Institution of Washington. Address before Interstate Conference on Water Problems, Chicago, Ill., Dec. 4, 1962.

I appreciate very much this opportunity to be here with you today. Earlier, Dr. Morgan said that I would speak somewhat on water as an economic resource, as well as the funding provisions of the bill. Because I think the tremendous impact that water has upon our daily lives and the industry, recreation, agriculture and metropolitan areas of this country is obvious to all of us, I am not going to comment on that aspect but rather limit my remarks to a brief summary of views with respect to the funding and fiscal aspects of Senate bill 2.

Senator ANDERSON. Excuse me. Off the record.

(Discussion off the record.)

Senator ANDERSON. On the record.

Mr. REITZ. At the outset I should like to express my appreciation to you, Senator Anderson, and to your colleagues for what I consider to be a carefully evaluated procedure in establishing the funding provisions of this bill. It recognizes, it seems to me, very clearly the needs, the problems, and the desired rate of progress in a water research program.

The first part of the bill, title I, in section 100(a), starts right off by providing specific allocations to the individual States at the rate of \$75,000 the first year and then, of course, to increase by \$12,500 for each of the next 2 years to reach an annual level of \$100,000. This to me is a very important aspect because it satisfies a number of requirements.

In the first place, it will make it possible for any State to immediately, without having to wait for a legislative session, to expand or, in some instances, to perhaps embark upon water resources research. It also very clearly recognizes the variety and complexity of problems that we find among the various States and regions in this country. And further I think it clearly recognizes that widely dispersed programs not only would facilitate research on local as well as regional and national problems, but it will also hasten the training of personnel not only for water management but for the additional needs in water research. And so you have recognized in this initial allocation of funds a very important principle of wide distribution in order to take care of the existing trained resources in water research in this country.

In your opening statement this afternoon, Mr. Chairman, you alluded to the magnificent developments that have taken place in American agriculture as a result of the establishment of the land-grant colleges, and I often stop to think that, if we had not had the insight back in 1862 and particularly in 1887 when the Hatch Act was passed, providing for agricultural research in each of the States, to extend these enterprises to each of the States rather than, as is sometimes done, to concentrate them in a few areas, we probably would not even approach the magnitude of the accomplishments that have been made in the field of agriculture.

And so I commend you highly on this basic philosophical concept.

Then, too, you recognize that within the framework of these land-grant institutions, there is a core of people in the sciences, in agriculture, in engineering, who can bring about an interdisciplinary approach to the solution of problems. These institutions today have broad programs in the social sciences, and many have law schools. For example, in my own State, one of our real problems is developing a better legal framework within which we can govern and administer

certain water programs, and I am sure that this must be the case in certain other States.

Then, if I may refer briefly to title I, section 100(b), here again you have made provision in this bill which permits expanding this research program on an orderly basis in modest annual increments and this, of course, will encourage every State as it sees fit to expand its program through additional allocations and also it will certainly encourage a State to match these funds because this is on a matching basis.

Furthermore, I believe it is highly desirable under section 100(b) that two or more States can join together in developing a program because this recognizes that many problems with respect to water management and water use extend beyond State lines.

Then finally I would like to comment on the realistic approach you have made with respect to the use of these funds. Here again you have provided a real flexibility, very desired flexibility, and it represents a very practical viewpoint in that in these funds which would be allocated to the various States may be used for salaries or expenses, whatever is necessary to promote and foster research in water use and resources.

I believe it is also quite fitting that there is provision whereby these funds may be used for capital outlay, because there will be some States that in order to take advantage of this program, will have to build or alter certain physical facilities. These may be relatively modest, but where this is necessary, I think that some of the initial allocation of these funds for this purpose is highly desirable.

There will be, of course, other States where this may not be so necessary and the full amount can immediately be put into salaries and operating expenses.

If I might just mention title II, section 200, that provides \$5 million, with an increment of \$1 million each year thereafter, for agency contracting, it seems to me that this gives the Secretary of the Interior the desired flexibility in choosing any particular institution, agency, or private firm to do research on water problems which would be within the mission of the Department of Interior.

This, certainly, from a national level—the Federal Government's point of view—provides, it seems to me, the necessary flexibility and the desired flexibility at the same time as section I recognizes so clearly the need to disperse these funds and make use of the talents that do exist in our land-grant institutions.

So, in summary, may I just say that the funding pattern of this bill seems to me to be very clearly conceived.

Furthermore, I believe that, as a starting program over a 5-year period, I would have to say that it is adequate and well timed.

Again, I commend you for the insight you have shown in getting the proper geographic distribution of these funds. And again I emphasize that this program will not only result in findings which will be of great value to the country, but it will also provide an opportunity for training additional people as a byproduct of research. And at the end of 5 years, when the Secretary of the Interior is requested under the terms of the bill to evaluate the program, if this has all been put into effect, as I hope it will be, I have no doubt but that the results will be most encouraging and fruitful for the benefit of this country.

If there are any questions which you would like to ask, I should be most happy to entertain them. I think, though, that with the short time I have used, I will not have to slip away. And I apologize for the fact that I slipped in ahead of President Elkins.

Senator ANDERSON. Thank you very much for that statement.

I am glad you mentioned the fact that we leave a great deal of opportunity for action on the part of these land-grant schools, they can use the funds for salaries, or if they have to use them for facilities, they can do so. That is based on the fact that we have tremendous respect for these land-grant colleges and the way they handle their obligations, and therefore we can give them a great deal of leeway.

There are some people in the water research field that claim they can't find schools to do their research. Will not the basic funds provided for State research centers in section 100(a) help to get schools interested in water research?

Mr. REITZ. I feel very strongly so, Senator Anderson. As a matter of fact, when it is said that we can't get universities to do certain projects in water research, that may presuppose that someone is saying that this may be the specific project on which they put a priority. But if we make these funds and resources available to the land-grant institutions, there is enough talent and imagination to make it possible for these institutions, following the historical pattern, to develop programs in research that will be appropriate to the peculiar and particular problems that are of the greatest importance to the people in the particular areas they serve. I think when we do this, we won't need to worry too much about what the final end product will be from the national point of view.

Senator ANDERSON. I believe that the University of Arizona is probably the only one in the country that has a school of hydrology. I referred to that in an address down at the New Mexico State University, our land-grant college, not very long ago. And someone said, "Well, I didn't even know Arizona had one."

That is right next door to us, and evidently word doesn't get around too fast.

So I am very much encouraged by the remarks you have made today. I think we are making some headway.

While I am on the subject of Arizona's pioneering in hydrology, I would like to attempt to adjust an oversight in our committee print on "Water Resources Research" of September 1962.

The University of Arizona submitted to the committee a bound list of ongoing research projects at the university in May 1962. Unfortunately, the document included extraneous matter and was filed with exhibits which had been included by some other universities, including several research reports, school catalogs and brochures. It was not submitted to Mr. Theodore Schad for his analysis of research in various fields underway in the country, and it did not appear in the body of the committee print.

Without objection, I shall make the report of the University of Arizona as of January 1963, an appendix to this hearing.

The report is very interesting beyond the information contained in the project descriptions, statements of progress and similar data. It shows that water related research is being done in the university's departments of agricultural chemistry and soils, economics, engineer-

ing, agronomy, anthropology, atmospheric physics, chemical engineering, civil engineering, geochronology, geology, hydrology, horticulture, tree ring research, water utilization, and watershed management.

It is a demonstration of the multidisciplinary character of water research which reaches beyond the single field of hydrology. It shows the possibilities of enlisting a good many competent scientists in related fields to work on water problems through S. 2 programs.

Oklahoma State University has requested amending their report on water research in a letter advising that their earlier report, which appeared in the September 1962 committee print, was incomplete.

Without objection, we will include the Oklahoma State material as exhibit 2.

Dr. Elkins?

#### STATEMENT OF DR. WILSON H. ELKINS, PRESIDENT, UNIVERSITY OF MARYLAND

MR. ELKINS. Senator Anderson and members of the committee, I thought, when I left your part of the country, perhaps there wouldn't be any water problem when I came to Maryland. But I found that there was still a water problem, and there continues to be, and will continue to be.

However, in response to your earlier remark about football at El Paso, I have to admit that my fortunes in football in Maryland have not been such that any of our opponents are eager for me to leave.

I am pleased to have this opportunity to support enthusiastically Senate bill 2, because I believe that it will accomplish within a reasonable period of time some of the things that have been accomplished in the area of agriculture and agricultural research.

There seems to be, I am sure, a unanimous and strong feeling on the part of all who have spoken today, and also from the extensive studies that have been made in this field, that there is a great need for a tremendous amount of research to be done which has not been done in the past. In order to do this research, we need to find more manpower than we have had in the past. We need this manpower to do research management, and also, I hope, for some teaching in this area. And with the increasing population of the country and the vast uses of water at the present time, the demand is going to increase very rapidly.

We have a relatively small number of people trained specifically in water resources. We have a much larger number—many of whom, I think, have not been identified—who have competence in some aspect of this broad field.

There are a number of agencies at the national level, and there is an expanding number of agencies at the State level and at the local level, who are interested in this important subject. But when they get into the matter themselves, a lack of basic information and a lack of personnel is a serious deterrent to any real progress.

One of the main questions in connection with manpower is that of where do we get the personnel to do the research at the present time. And I think that this manpower is available, as has been indicated previously, in our land-grant colleges and universities. Water research is a subject which requires an interdisciplinary approach.

And there are many individuals within various disciplines in the land-grant colleges who have some competence to do research in this field. By bringing them together in a center such as has been provided in this bill, I think that we will provide a much larger group of people that can do substantial and worthwhile research.

When the Hatch Act was passed in 1887 providing for the agricultural experiment stations, there weren't people available to do the work in just specifically the area of agriculture. They had to draw upon the sciences and other fields to find people to do this kind of work. But in time they got a large number of people involved in it, and they also provided a number of people as they went along with the research program and with the teaching program in the land-grant colleges and State universities.

In order to attract these people and to focus attention upon the importance of water resources, we are going to have to generate some interest, we are going to have to induce people to come into this field and to work particularly in the field. And in order to do this, practically all—I suppose all—of the States will need additional financial support. In my own institution, there are a number of people engaged in some aspect of water-resources conservation and other areas of water research. But we do not have a sufficient amount of money to point this up and to get the kind of information that is really needed to have a substantial impact upon this problem.

In addition, as has been indicated, as we go into the research field in considerably more depth, I think that we will train a number of young graduate students who will be attracted to the field. I am hopeful that in this way—and I think we have reason to believe in this way—there will be added to the number of personnel a rather large group of people who are not now attracted to the field of water resources because there hasn't been sufficient attention focused upon the field. But if you find a professor in a particular area who is competent, he is going to have graduate students who will work with him. And these graduate students, in time, of course will be competent to do the work themselves and will add to the manpower that is needed.

On the problem of Federal support, while I think most of the States are spending money in this field in some way or another at the present time, the public universities are hard pressed to do everything that needs to be done, particularly at the national level. As you well know, and everyone knows, we are faced today with an increasing number—a rapidly increasing number—of students, so that it is difficult for the States to appropriate a sufficient amount of money to take care of the number of undergraduates. It is going to be even more difficult for the States to do so in the next decade. Unless we can get financial support, as we have gotten financial support, as you know, in the area of defense, to do research work, the universities and colleges are simply not going to have the finances to take care of the needed water resources research. I know from observation and from talking with people in some of the institutions that have established centers that, although they are making progress and find that the field is promising, they simply do not have sufficient funds to carry out their research to the extent that they would like to carry it on and to accomplish the results that are desired.

By having it in all of the land-grant colleges or State universities, or in every State, you are going to be able to take advantage of the talent that you find all over the country. I think this is much more advantageous and much more productive in the long run than having it in a few centers where you would not attract nearly so many people who are already in the colleges and who, of course, would have to move if they did this work. It is going to bring together the faculties, or some of the faculties, from the various disciplines; and, in time, and in the not too distant future, in my opinion, you are going to find a very substantial product coming from the centers that may be established in these various areas. You are going to find that the number of people who are interested in it will increase and that we will train as we go along with this program a great many new people also.

Thank you very much, Senator.

(The prepared statement of Mr. Elkins is as follows:)

STATEMENT OF DR. WILSON H. ELKINS, PRESIDENT, UNIVERSITY OF MARYLAND  
NATIONAL MANPOWER DEVELOPMENT

*Manpower in the water resource field*

There seem to be no truly accurate estimates of the present number of people trained in the water resources field or of the numbers of such people that may be required in the future. In 1960, approximately 800 scientists reported an hydrologic specialty to the National Register of Scientific and Technical Personnel, and an additional 2,500 reported some professional competence in one of the hydrologic categories. It is important to note that 65 percent of those reporting hydrology as their major field of competence are employed by the Federal Government while only 6 percent are associated with educational institutions.

In spite of the absence of more specific estimates of individuals now engaged in some aspect of water resources and of those needed in the future, it is evident from many sources, for example the Summary Report of the Select Committee on National Water Resources that the demand for qualified individuals presently exceeds the supply and that additional manpower in substantial quantities will be required for inventory, research, development, planning, management, regulation, and conservation of this resource. Manpower will be required for research, planning and control at all echelons of government. In addition, many private industries will need the services of water resource specialists.

Agencies in need of water resource specialists may include the following:

National level:

U.S. Department of the Interior:

Bureau of Reclamation.

Geological Survey.

Water Resource Research Service.

U.S. Department of Agriculture:

Agricultural Research Service.

Cooperative State Experiment Station Service.

Federal Extension Service.

Soil Conservation Service.

Forest Service.

Department of Defense:

Corps of Engineers, U.S. Army.

Civil Engineers Corps, U.S. Navy.

Department of Commerce: Small Business Bureau.

Health, Education, and Welfare.

AID and Peace Corps, consultants and technicians.

Executive department: Scientific advisers.

National Science Foundation.

## State level:

Executive department.  
 Planning department.  
 Economic development commission.  
 Roads commission.  
 Geological survey.  
 Water pollution control department.  
 Forests and parks department.  
 Game and inland fish department.  
 Health department.  
 Agricultural extension service.  
 Agricultural experiment station.  
 State board of agriculture.  
 State soil conservation committee.

## Local level:

Planning and zoning commissions.  
 County health department.  
 County roads.  
 Water and sanitary commissions.

In the State of Maryland, the Governor has recently appointed a commission to study the conservation, coordination, and planning for the development of natural resources. The State planning department has contracted for research related to water resource problems, supply, utilization, and future potentialities. The State economic development commission, the pollution control commission, State health department, State department of geology, mines, and water resources, and other State agencies are involved in some phase of water resources. The lack of much more basic information and education is a serious deterrent to progress.

*Teaching of water resource science*

The inventory, development, management and conservation of water resources requires applications of the biological, physical, earth and social sciences. If one asks the question: "Where are teachers who discuss water resource conservation?" it may be answered: "Everywhere, even in the elementary schools." If, however, we ask where water resource science is being taught in sufficient depth or concentration to provide informed manpower and leadership for the future, it would be necessary to say, "Only in a very limited number of institutions of higher education."

"Scientific Hydrology," published in June 1962 by the Federal Council for Science and Technology, presents specific data relative to the teaching of hydrology and to the entire water resources problem. One of the pertinent facts to be noted is the statement that only 4 percent of the 881 hydrologists reporting to the National Register of Scientific and Technical Personnel indicated teaching as their work activity. To quote the report: "It is this tiny fraction upon whom we are dependent for training additional hydrologists to meet the tremendous growth and development in the field of water resources." This report indicates that while 73 of 128 engineering institutions provided a basic undergraduate course in hydrology, and 42 offered a basic graduate level course, only 29 institutions offered one or more courses in special phases of hydrology beyond the basic course.

The need for research and advanced study in the field is indicated by the fact that only 5 percent of the hydrologists listed have a graduate degree. In contrast, 15 percent of the earth scientists and 35 percent of all scientists have the doctor's degree. Again to quote the report: "\* \* \* in an age of increasing knowledge and specialization, advanced study is absolutely essential if the science is to meet its responsibilities."

It is only fair to point out, however, that most hydrologists with bachelor's degrees have taken courses in fluid mechanics, hydraulics, soil mechanics, soil physics, geology, mathematics, and physics, thus providing a foundation upon which they can grow professionally. In the area of agricultural engineering, courses are offered which are directly related to soil and water resources. Curricula in the plant sciences include basic courses in soils, soil-moisture-plant relationships and conservation. In many subjects, including economics, geology, geography, meteorology, oceanography, civil engineering, and others, some undergraduate work is offered relating to water resources, but there is relatively little advanced study. There are a number of programs dealing with the broad area

of natural resources, such as that found in the Natural Resources Institute of the University of Maryland, but these programs do not provide the information nor the personnel to cope with the complex problems of water resources utilization.

The preceding comments may be summarized very briefly and succinctly. In our colleges and universities we have many who are involved in research or teaching of some aspect of water resources science. Yet, there are few institutions where the "whole cloth is put together" and the subject treated in the depth required to provide leaders of the future. The threads with which to weave the cloth exist in our land-grant colleges and State universities, but there remains the task of weaving the threads into the desired pattern. In order to do this there is need for Federal encouragement and support.

#### *The institute approach to meeting manpower and research needs*

As an example of the institute approach to meeting manpower and research needs, Cornell University has established a multidisciplinary water resources center. This program enables the doctoral or masters candidate to gain a comprehensive understanding of water resources at the same time he pursues the primary work in his major field. Fellowships and assistantships are offered to encourage interest. This joint educational enterprise in interdisciplinary instruction and research brings together faculty from the departments of agricultural economics, agricultural engineering, agronomy, conservation, economics, geology, hydraulics, regional planning, and sanitary engineering. The program, one of limited number in the country, is evidence of what can be accomplished in our land-grant institutions and State universities.

The need for knowledge and the need for trained manpower in the field of water resources today might well be compared with needs in the field of agriculture at the time of the passage of the Hatch Act in 1887 which provided for the establishment of the agricultural experiment stations. Men from the natural sciences were employed as professors of agriculture in order to meet the teaching and research needs of that day. The development of knowledge since that time has led to a high degree of specialization, to the training of adequate numbers of scientists and teachers, and to the production of an abundance of food supplies to meet our ever-increasing needs.

Establishment of a water resources institute in each State, as proposed in Senate bill 2, can provide the nucleus and the impetus for development of knowledge and trained manpower in the water resources field. The institute approach makes possible the bringing together of interested faculty from different disciplines to guide the development of graduate students and research in water resources. At the same time, this approach avoids the dangers of withdrawing scientists from fields in which they are currently needed. It also provides opportunity for these scientists to better understand the broad problems in the water resources area and opportunity to direct their research efforts toward the solution of these problems.

#### *Justification for Federal assistance*

Land-grant colleges, State universities, and private institutions have generally been unable to finance interdisciplinary sciences except for specific situations of limited scope. While future needs are recognized, the pressures to expand facilities to meet the basic demands for undergraduate education are placing an ever increasing burden on the States. In fact, these pressures are such that the probability of obtaining sufficient State funds to undertake and develop a substantial and meaningful effort in the interdisciplinary area of water resources is not promising.

With further reference to the Hatch Act of 1887, and the resulting agricultural experiment stations, a tradition has developed of interdepartmental research and cooperation related to farm problems. With this record of achievement as a precedent, it seems reasonable to assume that water resources research and manpower development could follow a somewhat similar route. Enactment of enabling legislation and appropriation of Federal funds as outlined in Senate bill 2 now under consideration would lay the foundation. As in the case of the agricultural experiment stations, the proposed institutes in each State, while permitting study of local problems, would produce knowledge from research of significance to the States and to the Nation as a whole.

The welfare of the individual, the economic growth of the Nation, and the security of all of the people will depend on how well we know and manage our

water resources. To do the job that is required, more education and research directed toward water resources are essential to the development of enough manpower and the accumulation of sufficient knowledge to assure the Nation of an abundance of water.

Senator ANDERSON. I am glad to hear what you said about increases in enrollment, and so forth. You know our State well enough so that you can appreciate this. I was having a discussion with a very prominent educator and trying to point out to him that the enrollment in all of our universities is going to increase. If they had, for example, the 16,000 students now, I pointed out that they were going to have about 35,000 by 1980.

He said, "You must be insane."

And I said, "You're the one that is insane; you aren't doing anything about it."

They are going to have them, and they ought to be making accommodations for them.

In addition to accommodating students, there is scholarly work to be done. But the States can't just reach out and do all these things, because they already have uses for more money than they can get.

So I am very glad to have your statement.

Dr. Aldrich?

#### STATEMENT OF DANIEL G. ALDRICH, CHANCELLOR, UNIVERSITY OF CALIFORNIA, IRVINE CAMPUS, BERKELEY

Mr. ALDRICH. Senator Anderson and members of the committee, it is my privilege to comment this afternoon about the water resources research that has been conducted by a State deeply concerned with water resources and development, and a State that, through its State land-grant institutions, has attempted to produce some of the research information so important to the development of a water resource program.

I will indicate that in addition to my responsibility as university dean of agriculture and chancellor of a new campus of the University of California, I also come here as a chairman of the coordinating board of the water resources center of the University of California. I have been asked by Mr. Morgan to comment on how we view the provisions of the Anderson bill insofar as development of water resources research in this country is concerned.

As a background for my comments, I think it is appropriate to draw attention to the fact that the arid States of this Nation have long been concerned about water resource development. Within a day of the time Brigham Young arrived in Salt Lake City in 1847, they were diverting the water from City Creek for agricultural purposes. Within 8 months of the time that California was admitted as a State to this Union, efforts were being made to modify the long existing common water law which established riparian rights and which even through court action permitted the wastage of water established on such basis. And as early as 1880 tremendous effort was being made by the State engineers of California to modify the law so as to permit maximum utilization of water resources development in that State.

These, of course, were pointed at the problems associated with agriculture. But I would note that as early as 1900 the city of Los Angeles was aware that the surface water provided by the Los Angeles River

and the underground water supplies of the South Coastal Basin were not sufficient to meet the domestic and industrial needs of that city, and set in motion the building of facilities to bring water 250 miles to that city.

Simultaneously the city of San Francisco, recognizing the inadequacies of the water supplies of that area, laid plans to bring water from the Hetch-Hetchy project in the Tuolumne River country some 140 miles to San Francisco.

By 1930, even though water was being transported 250 miles to Los Angeles from the Owens River Valley, Los Angeles recognized that still there were inadequate water supplies for the development of that area, and formed the Metropolitan Water District, which resulted in a project bringing Colorado River water 247 miles to that city.

I point out that during this period, starting in late 1900's, and as late as 1956, when California reviewed its entire water plans and set in motion a master plan for water research development, the price of delivery of water ranged from less than \$1 an acre-foot to projections as high as \$80 an acre-foot today.

Certainly the increase in cost of water and the monumental works that are necessary to transport water from one area of production to an area of use have set in motion problems which only research in the social sciences, the physical sciences, the biological sciences, in the political and in the legal aspects, will produce the information necessary to solve.

Traditionally, research on water relates primarily to the identification of supplies, their quality and the efficiency of application.

Today it is a far more sophisticated and complex requirement that faces not only our State but also the Nation. And disciplines which heretofore have never concerned themselves with water development or resource development—those other than engineering and agriculture—must now concern themselves with it if the problems are to be solved.

And so I move from this background commentary to a comment on the impact of the Anderson bill as we view it upon our State and a water resources research center already in motion, because it was apparent in 1956 to the State of California that the magnificent contributions of the agricultural experiment station to the agricultural uses of water, as well as the occasional contribution from our colleges of engineering about the impounding of water or the production of works for the transport of water, the pumping and distributing of it, were really inadequate for the job ahead. It was a piecemeal effort, it was a case of too little and too late.

As a consequence, Senator Collier in California introduced a bill which provided \$100,000 for the establishment within the University of California of a water resources research center. And this center today, as a consequence of providing the university in the State of California with a research arm that may coordinate existing researches within this institution and may stimulate researches in areas heretofore never explored, has actually set in motion an additional \$400,000 from the State of California, so that today in excess of a half million dollars of State funds are made available to the water resources center of the university for research.

But I would point out that this is an entirely inadequate amount. Because of the complexity and sophistication of research required in

water research development today, there is tremendous talent, not only in our land-grant institution, but in every land-grant institution in this country, that is going untapped because of the inadequacy of funds to stimulate these people—to encourage these people to devote their talents to water resource development.

So we look upon the provisions of the Anderson bill as providing the catalyst that will set in motion talent that is already at hand.

I would say without reservation that there exists within the land-grant institutions of this country today, every one of them, talent that is not yet exploited. In fact, no State as I view it has the money to exploit the brains presently on the staffs of our land-grant institutions.

And so in answer to the comment raised by Senator McGovern concerning the \$100,000 that might be provided to each State, I would simply say that, in many instances, that money would just go a little way toward providing the resources to enable this brainpower already assembled there to go into motion.

I would then comment upon the impact of this bill as we view it upon a State that has not yet set in motion such a research center, or which is presently contemplating a master plan for water resource development. Anything that we have said about California could be said about a State that hasn't even begun such development. For certainly, as I view the water problems, we find there support for the old adage, you never miss the water until the well runs dry. And I point out that even though we are very much involved in our own State, we are really 20 years too late, because the works that are being set in motion now in California require an intensity of information which 5 years more research might provide the answer to, but for which today decisions must be made.

As a consequence, I am grateful for the opportunity for States not yet concerned in developing their water resources to be stimulated by the moneys provided through this bill to set in motion prior planning, so that they will not be in the situation of too little too late.

I would also like to comment about the level at which the program set in motion by this bill is to be administered within the Department of Interior should be conducted. Water resource development is of national concern. It involves concern as to defense, health, commerce, agriculture. And certainly as we focus the attention of many agencies upon water development, we cannot submerge the administration or the coordination or the correlation of problems related to water research within some small agency, or some minor bureau. It must have the top level concern of certainly a Secretary or Under Secretary. This is too important a matter to be submerged.

I therefore would conclude with a commentary upon what I view to be the importance of the relationship, the cooperative relationship that must be set in motion between Federal agencies and the State agencies, as, for example, land-grant institutions.

The magnificent contribution of the agricultural experiment stations and their associated extension services to the advance of technology in American agriculture we understand and appreciate.

As a consequence of the relationship established between the agricultural experimental stations and the Federal Government, the U.S. Department of Agriculture, there has been the opportunity for exchange of information between those generating new information and

applying it at the State level, as well as among those who are generating it and applying it at the national level. It is a two-way street.

The exchange of information moves from the States to the national level, and similarly from a national level to those operating and applying information in the States.

I think the provision in Senate bill 2 that provides for the collection of information is an exceedingly important facet of it, if the States and the Nation are to do the job of water resource development which we believe must be done.

Thank you.

(The prepared statement of Mr. Aldrich is as follows:)

PREPARED STATEMENT OF D. G. ALDRICH, JR., UNIVERSITY DEAN OF AGRICULTURE,  
UNIVERSITY OF CALIFORNIA

I. WHAT A STATE THAT IS CONCERNED ABOUT ITS WATER RESOURCES HAS DONE IN  
PLANNING AND DEVELOPING THEM

Most of the States in the arid West have taken the initiative in the development of their water resources. The early pioneers were realists and fully appreciated the vital importance of the development of water supplies. Within a day after the arrival of Brigham Young in the Salt Lake Valley in 1847 water was diverted from City Creek for the purpose of irrigation. California took steps to plan for development of its water resources 8 months before its admission to the Union.

In all the arid States development of water resources was hamstrung by centuries of common law which had firmly established riparian rights, including the court approved right to waste water urgently needed elsewhere. In California as in other States, firm actions were taken to break with this crippling tradition. By 1880 the State engineer was engaged in an assessment of the water resources of the State of California and was pressing for carefully coordinated planning for their development. In 1887, the Wright Irrigation Districts Act broke the monopoly of riparian rights and, as amended, provided the impetus to the growth of locally developed irrigation enterprises.

Nor was the phenomenal growth of irrigated agriculture the sole force in water resources development. By 1900 the city of Los Angeles had outgrown the water supply provided by the combined above ground and subsurface flow of the Los Angeles River. In 1905 the voters approved a daring engineering proposal to build a 250-mile aqueduct to bring relief to a water rationed community. San Francisco, facing similar problems approved its Hetch-Hetchy aqueduct system to the Tuolumne River in Yosemite at about the same time. By 1930 the demand for water in southern California had outstripped even the most liberal estimates and, by means of a State enabling act, these communities were joined in a metropolitan water district, now serving cities from San Diego to Ventura.

Regional planning in California came to a head in 1930 with the first California water plan. A bond sale to finance the first phase of this project was authorized. Because of the depression years the bonds failed to sell and the project was constructed by the Federal Government as the Central Valley project.

Most recently, under an up-dated California water plan, the voters of the State authorized the Feathers River project carrying water to the productive but arid southern San Joaquin Valley and to the south coastal districts.

Although the pace of economic development in California has resulted in greater development than has occurred with her neighbors, a similar story can be told for the other States of the arid West.

California's research in water resources, like that of her neighbors, was first directed to the identification of supplies and needs. As the more readily available resources were exhausted it was necessary to turn to alternative more costly projects and to take steps to determine more accurately the duty of water and to provide for more efficient use. The colleges of the University of California, particularly engineering and agriculture, devoted considerable time and attention to these problems. Because of the impact of the Hatch Act the latter moved with exceptional efficiency toward the solution of those problems related to the use of water for agricultural purposes including the effects of water quality.

By 1955 it was apparent that for the guidance of water resources development in California, this piecemeal approach to water resources research in the university was both too little, too late and somewhat less than well coordinated. With a budget of \$100,000 from State funds provided by the Collier bill a coordinated research program was initiated by the University of California in 1956. This evolved in 1956 into the Water Resources Center. Responsibility for saline water conversion research conducted by the university's colleges of engineering since 1952 was assigned to the center in 1958.

The water resources center has been quite successful in stimulating appropriate research and suggesting the recasting of other studies. It has provided research funds with a minimum diversion of the attention of the research staff. It enjoys excellent cooperation with all departments of the university. The center conducts its research through these departments, providing a medium for interdisciplinary discussions. It complements rather than replaces the current research of the departments and has permitted undertaking important investigations which otherwise would not be feasible. In many cases the combined resources of the center have attracted extramural funds, increasing the total effectiveness.

The center has also served as a focal point for the dissemination of research results to and from other universities throughout the country and to the State department of water resources. It currently has a mailing list of 265 libraries, important individuals, and local, State and Federal agencies.

## II. WHAT EFFECT WOULD A FEDERAL SOURCE OF FUNDS FOR RESEARCH, SUCH AS THOSE PROVIDED IN THE ANDERSON BILL, HAVE ON SUCH A STATE?

There are some important ideas which have developed in the last few decades which have altered the nature of water resource research. Unappropriated water has become increasingly scarce, the quality poorer, and the cost of its development correspondingly more expensive. Water in the Turlock and Modesto Irrigation Districts of California has a cost less than a dollar per acre-foot. The Los Angeles Aqueduct delivered its first water at a cost of \$6.10 per acre-foot. Current cost of Colorado River water to the metropolitan water district, including current taxes, is about \$40 per acre-foot. The Feather River project will deliver water at a cost variously estimated from \$60 to \$80 per acre-foot. These developments have occurred at approximately 30-year intervals and each has come barely in time to alleviate a serious water shortage.

These steadily rising costs and progressively more monumental projects puts an even greater burden on research, both to reduce their cost to a minimum and to solve the geometrically increasing number of problems associated with more intensive development.

Furthermore, the nature of the research problems has changed materially. Emphasis in California is now on regional and interbasin aspects of water resources. Political and economic questions associated with long-distance transfers of water have been raised. A far greater number of alternative elements of the plans for regional development must be considered. These accentuate the cry for more and more accurate information in all aspects of water resources, physical, social, and economic.

No individual university today can be expected to finance all the research required by that State's water resources development. The research that it does conduct, however, will accrue to the benefit of other States and to the Federal agencies. If adequate attention is to be given to the important research problems which face all of the United States with a greater or lesser urgency, more work must be encouraged and a considerable degree of national coordination provided.

Federal financial assistance as provided in Senate bill 2 should serve as the catalyst for stimulating the additional research which is vitally needed. The water resources service should provide a focal point for nationwide coordination of all water resources research, supplementing the research program where necessary with contracts and grants.

One of the most important features of the financial support to the water resources institutes is the efficiency with which those funds can be directed to productive investigations. As a conservative estimate at least 20 percent of the research time of the university staff is used to prepare contract and grant proposals to a variety of sources of funds and to prepare interim progress reports to each source. The water resources institutes, if the experience of the

water resources center can be taken as a guide, will substantially reduce this encroachment on productive research without loss of financial control or necessary administrative supervision. Additionally the long unproductive timelag which now often exists between the formulation of good research proposals and their ultimate funding can be virtually eliminated. The most critical element in water resources research other than funds is qualified principal investigators. Their time must be used most effectively. Because the water resources institutes will be quite familiar with the capabilities of the research staff a minimum diversion from productive research will be required in order to assess fully the contributions to be expected, and their importance to the overall problems of water resources development. The result will be more effective utilization of research staff for research.

### III. WHAT EFFECT WOULD SUCH FUNDS HAVE ON A STATE WHICH HAS NOT BEGUN PLANNING AND DEVELOPMENT OF ITS RESOURCES?

Water problems have the habit of proving the truth of the adage, "You never miss the water till the well runs dry."

Those States which have only begun resources planning are often aware for the first time of the urgency of their problems. The need for research, historically, has not been apparent until the time when all the attention of the community must be directed to the solution of a critical problem.

Despite the success of the water resources center of the University of California, it is painfully evident that such a research unit should have been organized at least two decades ago. In order to meet demands for water in 1970, concrete must be poured today. Firm decisions have been required even though it was evident that 5 years' additional research could have made a material difference on costs, pricing, and financial feasibility.

States whose water resources planning has just begun may profit from this experience. The Anderson bill will provide the incentive for those States to move promptly on the research questions which must be resolved by the time the moment of final decision arrives. It also provides for improved coordination by which these States may make use of the research contributions already made which have applicability to their problems. Equally important to the United States is the welcome increment to water resources research provided by the staff of universities in these States toward the resolution of problems in other sections of the Nation.

### IV. DESCRIBE HOW THE HATCH ACT HAS BENEFITED AGRICULTURE IN EACH STATE WITHOUT PLACING LIMITATIONS BECAUSE OF FEDERAL ORIGINS OF FUNDS

Experience with the Hatch Act, which provides similar Federal support for agricultural research, demonstrates the effectiveness of the form of support proposed in Senate bill 2.

In most other instances, where there is a multiple source of funds for a research project, there has resulted considerable inefficiency. The request for funds itself has to be directed to many potential sources in order to obtain support from a few. Each request must be phrased differently in light of the specific objectives of the potential source. More often than not the response is several grants or contracts each small in amount. Often each contract will require a specific localized objective. This procedure results in a very substantial portion of the principal investigator's time spent in the quest for funds for his research and in diversionary studies of less general importance. Such is the normal situation for much of the research in departments of engineering across the Nation.

In contrast to this agricultural research departments, because of the Hatch Act, have been able to devote most of their research talent to the problems of research rather than in seeking support. Minor objectives of special groups can still be accomplished through grants and contracts but the Hatch Act has given these departments the ability to pursue an integrated program of research, well coordinated nationally, without limit or restriction because of source of funds other than that of basic policy and the mutually complementary objectives of State and Federal Government.

The combined financial resources of State and Federal Government have permitted a broader scope of research activity. Long-range projects, ordinarily infeasible with local or special interest financial support, have been undertaken.

Modern equipment has assured first-class research information in place of a crude experiment and an extrapolation.

The research staff members, under the Hatch Act, are quite unaffected by the particular combination of State and Federal support accorded his research. Other than being fully aware and appreciative of the sources of funds and the effectiveness of this combination, he is free to pursue his research in the objective manner which is a prerequisite for accurate and useful results.

Nor does it appear from the experience of the water resources center of the University of California that any problem will arise with both Anderson bill funds and Hatch Act funds provided to the same center or institute. Support by the center for water resources research in the agricultural departments of the university complements the support provided from State and Hatch Act funds. It has not diminished previous support from these sources nor has it detracted from other important programs in agricultural research.

There has resulted greatly increased coordination between the research of the agricultural departments and other departments of the various campuses of the university. There has also resulted a greater appreciation of the complex interrelationships which exist and a corresponding trend toward water resources research and agricultural research in this broader context.

V. COMMENT ON THE NEED FOR THIS PROGRAM TO BE ADMINISTERED AT SECRETARY OR UNDER SECRETARY LEVEL

To be fully effective, this program should be administered at the Under Secretary level. It is imperative that the research program should be broad. It is even more imperative that it be dynamic. This virtually precludes a routine assignment of its administration as a collateral responsibility of any one bureau or office.

The modern multiple use concept is vital to optimum development of water resources. At the same time, multiple use also implies multiple conflict of interest between many of these users to a greater or lesser extent.

Under these circumstances, it is obvious that no one of these multiple users should be given a research advantage over any other if long-range water planning is to serve equitably all the parties involved. For this reason alone administration at the Under Secretary level would appear to be a necessary condition for the ultimate success of this plan.

High-level attention is important from another point of view. The water resources research program must be dynamic and responsive to the needs of the Nation. It must reflect matters in many other areas of the national interest including virtually every other secretarial department and executive office. National defense, health, education, international relations, commerce, and agriculture, to mention a few, have inseparable interests in the water resources research program. To fractionate the research effort among these departments would destroy the very purpose of the act. To bury it deep in any one department would be equally destructive.

VI. COMMENT ON THE NEED FOR TOTAL PROGRAM DEVELOPMENT IN WATER RESOURCES TO BE A COOPERATIVE ONE BETWEEN STATES AND THE WATER RESEARCH SERVICE

Just as the need for cooperation and coordination at high levels of the Federal Government is essential to the success of the administration of this program, so the need for a truly cooperative relationship between the water research service and the States is vital to the execution of the program. This must be based on a mutual understanding of the strengths and modus operandi of each.

State and privately supported universities provide a unique assembly of research staff of highest competence for both fundamental and applied research. Long experience has demonstrated that this assembly makes its greatest contributions when it is governed only at the policy and objective level. More detailed instructions for the guidance of the work, allocation of funds to the specific studies and similar controls should be the responsibility of the director of the water resources institute and its governing body. These persons are in the best position to assess both the need for research in a given area, the capabilities and limitations of its research staff and facilities in that area, and the extent to which more detailed guidance will be necessary.

Responsibility for nationwide coordination must rest jointly on the water resources institute and the Federal Government. Where necessary research is required in an area not adequately covered by the water resources institute,

the water research service must be in a position to fill the gap through direct grants or contracts with any qualified research group willing to undertake the study. At the same time, care must be taken that indiscriminate contracting for the services of the same research staff required for the water resources institutes' programs does not work to the disadvantage of the national interests.

Nor is the policy and objective guidance a one-way street. The research staff and the administrative officers of the water resources institutes, through direct contact with those intimately concerned with specific problems and through their own independent status, are often in an excellent position to evaluate research needs and their priorities in an objective manner with first-hand information. The water resources institutes must be given an adequate voice in the development of a long-range water resources research program. This voice must be that of a cooperative partner if, through research, both State and National interests in the optimum development and preservation of our water resources are to become a reality.

Senator ANDERSON. I am deeply indebted to you personally for that very fine statement. I think it is excellent, and I am delighted to have it.

I am also happy that you state that the State which I understand now claims to be first in population, certainly one of the very first in riches, realizes the importance of doing this on a nationwide basis, giving other States not so fortunate as California an opportunity to participate and get their study and planning done in good time. You have done a fine thing in the research study you have made, and given a great stimulation to the rest of us.

Dr. Morgan, I want to state before we start questions that I appreciate very much the way the land-grant colleges have responded to this invitation to testify. They have come in with a concerted program and have taken various phases of this subject and presented it to us. I think it is very helpful. And you have built a very fine case in preparation for action by this committee. I thank you individually and on behalf of the committee for this presentation this afternoon.

Are there questions?

Senator Burdick?

Senator BURDICK. I would like to ask this of the gentleman from California. The question might be asked by someone, Why do we diffuse and spread our money throughout the several States rather than put our funds in one central agency of some kind to make an intensive study?

Mr. ALDRICH. I want to be clear about your question, sir. Why do we propose to spread it rather than concentrate it?

My immediate answer, sir, is that genius is where you find it. And I feel that there is no State in this Union or no region in this country that has a corner on brains. One can only look to the tremendous contribution that agriculture has made through a program in which each of the States has participated and to which each of the States in its own way has contributed—to the generation of those minds and those abilities that take their place in producing information, be it for agriculture or for water resources.

I feel that it is a great mistake to think about concentrating the talent in one location. First, there is no individual as far as I am concerned who can defend the statement that that is best. Further, I feel that providing the catalyst that sets in motion the creative ability of people gathered in the 50 States will enable us to get further ahead. I would simply use the example in my own institution. I know that

the contribution that the University of California has made to the State and to the Nation is much greater for having had a campus at Davis, a campus at Berkeley, a campus at Riverside, and a campus at Los Angeles, rather than if there had been a single campus at one location.

Senator BURDICK. I agree with you completely, but I wanted the record to show it.

Senator ANDERSON. Look at all the good football we would have missed.

Senator BURDICK. One more question.

Is there some apparatus that universities have between them to exchange information?

Mr. ALDRICH. Yes, there is. I would go back to the arrangement which we have in agriculture. As a consequence of regional projects, as a consequence of a national organization such as the Association of State Universities and Land-Grant Colleges, in which there is a division of agriculture, a division of engineering, and a graduate division, there is provided annually and periodically during each year opportunity for people with common concerns and responsibilities to get together to share information about what they are doing in their researches in order specifically to minimize unnecessary duplication of effort, to minimize the possibility of fishing in dry ponds, or moving down blind alleys. And certainly, as is noted in this bill, that there shall be collected together at one point all of the works that go on related to water resource development, I feel that with that mechanism one sets in motion the opportunity for exchanging information, coordinating and correlating research efforts, and minimizing the problem of unnecessary and uneconomical duplication.

Senator BURDICK. Thank you, Doctor. And I would like to thank all members of the panel for their contribution today.

Senator ANDERSON. Senator Dominick?

Senator DOMINICK. I would like to ask Mr. Aldrich a question, and maybe Dr. Peterson.

What is the principal area of research that you think should be concentrated on at the present time?

Mr. ALDRICH. Do you wish for me to respond to that, Senator Dominick, in terms of the national interest, or in terms of local interest?

Senator DOMINICK. What I am asking for is what you think is the most important single area in connection with water that should be concentrated on?

Mr. ALDRICH. Certainly we must devote every talent that we have to insure an adequacy of water supply. And there are many approaches to achieving an adequacy of supply, be it for agricultural use, industrial use, domestic use, or what have you. There is the modification of unsuitable waters, as for example, the desalinization of brackish waters, which may be accomplished at a lower cost than the desalinization of seawater. There is a tremendous effort being made to devise inexpensive energy sources to bring about this improvement of water quality, particularly where dissolved solids are the problem.

I would also point out that we are approaching this matter of providing an adequacy of supply by also moving into water reuse

in which are involved the problems of virus transmission, the problems of disease transmission, be they bacteria, fungi, or viruses of any nature. There is also the matter of toxicity, because of certain toxic elements being introduced into water in some place or another. We are very much involved in the development of techniques that will permit water reuse and therefore greater efficiency of water usage.

But then these comments relate specifically to techniques for insuring the adequacy of supplies. One of the great problems that we face today in this country is assuring that where the water exists in adequate supply it can be transported to the point of great usage. And so in my own State, for example—and I am quite sure that this occurs in other parts of the country, too—the problem that faces us is that two-thirds of the water falls on one-third of the State, and that two-thirds of the usage occurs in the one-third where the water does not fall.

And so a complex problem confronts us. It is one of political institutions, of social institutions, and the economic requirements that will permit us to get our water at one point and deliver it at another point and yet provide all citizens with an appropriate right to water, not causing one segment of the population to suffer economically in order to provide for the other.

So my answer obviously is a multiple answer. I cannot confine my comment to just one area, since they are all interrelated.

Senator DOMINICK. Thank you.

Senator ANDERSON. One final question as far as I am concerned, Dr. Morgan.

There has been some criticism that the bill doesn't provide adequate oversight and regulation of research in the States. Would it be a mistake to have excessive Federal supervision of the State programs, in your opinion? I just worry when I have somebody who says, well, let us regulate all the State programs. I think that might be exceedingly dangerous.

Mr. MORGAN. Certainly the States recognize that the people of the country through their Federal Government are entitled to be assured that funds made available by the Congress to States will be put to good use. But when we embark upon an objective such as the broad one outlined in the Anderson bill, the wisdom of Solomon is hardly enough, even if it could be concentrated in one place, to direct the really productive use of these funds. As Dr. Aldrich has said, genius is where you find it. Our bank account of professional competence in this country, our national stockpile of talent, talent capable of that unusual capacity to generate brandnew ideas, something that hasn't been thought of, which is the fountain spring of productive research—that talent is scattered all over.

And this bank account—I might use this analogy—is in deposits all over the country. A very great deal of it is deposited in the staffs of these colleges and universities who would, with the funding available under this bill, be able to trigger their talent, turn it loose, set it loose in finding through the generation of new ideas solutions, to some of the problems that confront us in this area.

Some of this inquiry would be very basic in nature. At the other extreme, some of the inquiry would be very practical in nature, that is to say, applied to the solution of observable problems. And to

imagine that creativity involved in this national fund of scientific talent and professional competence would flourish under conditions of distant control is to imagine something that just won't happen.

Senator ANDERSON. Dr. Aldrich seems to be anxious to say something on that.

Mr. ALDRICH. I would simply like to augment Dr. Morgan's comments about the role of an educational institution.

Really, even with the collection of scientists and minds that are found in these institutions, one must not for 1 minute minimize the importance of the stimulation that comes from some young man or young woman sitting before you and questioning what you as an experienced citizen claimed to be fact. There is no agency on earth that is subject to the rigors of examination, the testing of ideas, that our educational institutions are. And this bill which provides for the support of research on water resources in a land-grant college, in an educational institution, takes on its stature, as far as I am concerned, because it permits young minds to share in this experience of pushing back the frontiers of knowledge. This is the stimulation that comes only in an educational institution, and no master organization of senior scientists will ever accomplish it. They do not reproduce their kind. Only an educational institution has the capability of testing, being tested, and reproducing young people.

Senator ANDERSON. Dr. Morgan?

Mr. MORGAN. Mr. Chairman, the concluding statement that I will file with your committee discusses some of the public aspects of water quality and recreation and navigation and flood control, river system planning, economic growth, and so on.

(The concluding statement of Mr. Morgan follows:)

CONCLUDING STATEMENT PRESENTED BY WILLIAM E. MORGAN, PRESIDENT, COLORADO STATE UNIVERSITY, AND CHAIRMAN, WATER RESOURCES COMMITTEE, ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES

#### WATER AS A PUBLIC RESOURCE

##### *1. Why invest in research on a broad and diversified basis?*

Gentlemen, you have heard why we think this bill will open the door to eventual solution of many of the Nation's problems presently associated with water use and development. I shall not attempt to summarize these points. Rather, I would like to bring to your attention reasons which call for public support and investment in research on a broad and diversified basis. We are all aware of the manifold financial decisions facing the Congress as well as other levels of government. Yet, the expenditures contemplated under this bill must be classed with those which are directly an investment in the future productivity of our economy.

To what extent will such investment be made by the private sector, and to what extent is technological progress and the solving of serious problems of water allocation a public responsibility? A few activities will be carried on by private enterprise as has been noted previously, and State and local governments will attack some specialized problems. But the basic and fundamental solution calls for research effort that extends beyond the normal range of immediate interest or beyond the funding capabilities of these units.

The contribution urgently needed at the present time is a contribution of knowledge. When this is available, other agencies will have many tasks to perform. By providing this system for financing research, public support is not supplanting the efforts of others; rather, it enables others to expand their efforts and lessens the risk of failure as they undertake their own research. This way of doing things is the essence of our heritage of economic and political organization. The productivity increases which have ensued from the agricul-

tural experiment station system indicate the creative potential from this type of partnership organization and effort between central and local governments.

Water is a public resource. A phrase to the effect that the water in a State is the property of the people, or that water is owned by the people or the public, is not uncommon in State constitutions. Public rules have been defined which permit private rights to water use, but the very nature of the resource has resulted in a continued public interest.

## 2. *Water quality*

Let us look for a moment at one of the most vexing current problems which is destined to become more troublesome in the future, namely, the quality of our available water. These questions are important in all of our major river systems. In an earlier time, individual users, whether farm, industry, or municipality, gave scant attention to these problems. However, today's increased pressure on water use has greatly changed this situation. Urban wastes contaminate other urban uses. Irrigation return flow inhibits future agricultural use. The degradation of ground water imposes a limitation upon other users today as well as in the future. In many of these situations, intergovernmental relationships are very significant, including municipality, State, and international.

Two of the crucial questions at this point are technological and economic with the legal and organizational problems being closely associated. Since an individual user seldom suffers the effects of his own pollution but shifts them to the downstream users, public responsibility has been widely recognized by the establishment of minimum standards for effluent. The tendency has been to shift the incidence of the cost, at least in part, back upon the original user.

At this point we are brought face to face with the technical-economic issue. Does the user have available technical means to improve the quality of his effluent and not be forced to price himself out of the market? The public can make the rules and organize the enforcement of the criteria. We need research to provide the technology and to improve the rulemaking structure itself. The responsibility to see that the basic scientific information is available which farmer, industry, municipality, and Federal agency can adapt to their particular situations and interests is widespread and continuing in nature. The results that flow from research made possible by Senate bill 2 can be a major factor in organizing the orderly and economic disposal of wastes not only by stimulating research but by making readily available within each State a center from which scientific information can flow to farmers, industries, municipalities, and others who have need of it. All State universities are experienced not only in research but in the communication of scientific information to those who need it through extension education program both formal and informal, through seminars, workshops, publications, and so on.

## 3. *Recreation*

Quality limitations have been important to many fields of water use, both old and new. A use which is not new but which has been expanding rapidly is recreation. This is important from the high mountain trout streams, down to reservoirs and lakes, along the rivers to the ocean estuaries and seaside beaches. Need I do more than assert the common observation that water attracts people from the crowded metropolitan park to the wilderness area?

Quality is also important in this case—quality of recreational enjoyment. Our ability to judge and assess these characteristics is extremely crude to say the least. Some recreational activities enter into the commercial market, yet major factors with respect to water based recreation are not market oriented. The investment which provides them is often a public investment, and public rules and regulations control the activities on the water. The issues seem clear that the problems ensuing from the increased pressure of recreational use are public issues.

Let me just suggest some of the questions which are relevant. To what extent and in what fashion can part of the costs of public recreational investment be repaid by the users and still provide recreational opportunities on a wide enough basis to satisfy our criteria of democratic equity? This is not a simple problem and will need more concentrated research effort than is presently being devoted to it. What are the best criteria for deciding upon sites for recreational investment? To what extent are various recreational water uses competitive with each and with other uses? If the uses are mutually exclusive,

by what criteria can we allocate the water; or, if they are complimentary, how can we organize uses to yield an optimum benefit? These are just a few questions of a policy nature which urgently need answers based upon sound research.

And again, they are problems which confront State and local governments as well as the Federal Government. Indeed, the Outdoor Recreation Resources Review Commission describes the States and State and local areas as key in meeting recreational demands. Every State and many communities will be confronted with problems of best allocation and management of complimentary uses of specific waters to serve recreational needs.

#### *4. Recreation uses illustrate again the need for multidiscipline research*

You may wonder that I have not mentioned any of the technological problems within this area—problems associated with wildlife and watershed management in particular. My not delineating these does not mean that I do not recognize their importance—just the contrary. They are also fundamental, but to handle the issues noted above we would need prior or concurrent knowledge in natural science fields. It is this relationship between the social and natural sciences which I want to emphasize. The two fields are highly interdependent, and research needs in both fields are equally overlapping and intermingled. The organizational structure contemplated in this bill is designed to advance research efforts which will coordinate social and natural sciences as they attack our water problems. I call your attention specifically to the provision which establishes the research centers as an all university organization.

#### *5. Navigation*

No consideration of the public aspects of water can overlook one of the oldest public concerns, navigation on our major waterways. That we have such a long history in dealing with this facet does not mean all of the problems have been solved, as you are well aware. Important technical considerations concerning the maintenance and development of these channels is needed. And this function should be thoroughly integrated into the overall program of research into stream and channel management. Another essential ingredient is to relate through research this water use to other modes of transportation. Public accountability would demand no less. In this way we can expect these waterways to make their optimal contribution.

#### *6. Flood control*

Research into channel problems is not limited to navigation but relates to another of the long-recognized public responsibilities; namely, flood control. Specialized research has been going forward, but channel conditions are dynamic and present new problems as system development progresses. And as noted in previous instances, research in the area of the physical sciences should be coordinated with research into flood plain planning and development. We have examples of programs which are progressing, but the problems we face are larger and more diverse. Through a research program such as contemplated in this bill, the potential economies to be realized in flood control action programs of local, State, and Federal agencies are incalculable.

#### *7. River system planning*

Much of what has been said suggests the important idea that river system planning has been another major public responsibility. The basic research contemplated here will provide a firmer foundation for this planning—will provide better knowledge and techniques for this purpose. For example, many years ago the Congress provided for public planning for the use of hydroelectric sites. We still have the public responsibility to use the resources to make the best contribution to our economy.

As the navigation, we have a public trust to develop the technology along with the integration of hydropower development with that from other fuel sources. Our power system a half century from now either will benefit or suffer from what we do today. The research initiated today will alleviate today's problems, but another of its lasting dividends will be the contribution it makes to building our economy of tomorrow.

#### *8. Economic growth*

The importance of municipal and industrial development to our future economic growth hardly needs stating. This growth obviously is dependent upon a multitude of factors other than water supply.

Reasonably priced water in adequate quantity and quality will not insure the economic growth of a region, but without it many of today's thriving communities would have been bypassed. Others face a precarious future solely on the basis of their situation with respect to water supply. No one can guarantee that this bill will furnish the answer to their salvation, but no proposal offers more hope for proper guidance in the effort these communities will put forth to survive.

At the risk of being repetitious, I again point out that community water problems will vary with each community and that S. 2 admirably meets the need for a wide geographic spread of water science centers to serve such localized requirements for information and guidance.

*9. Legal, administrative, and organizational aspects of water management*

There are also legal and political uncertainties which are of major importance. Water law is at the same time both rigid and changing. These characteristics certainly are not without their value, but their force should act as a spur to let our best research knowledge help guide the direction of change.

Similarly, one of the most baffling tasks we face is that of organizing water management and development. Our political economy of water is complex; water is a production requisite universally employed by direct utilization; indirectly it touches every facet of our economy in exceedingly complicated financial and power relationships. The service to be rendered by public research into public organization should hardly have to be argued.

*10. Theoretical and practical; basic and applied*

Universal rules are hard to come by. Adaptation to solution of the problems of the moment is equally important. This bill will permit—will bring about—both a firmer understanding of the universal rules as well as application to particular situations. It provides the means, the organization and the incentive to tap the creative talents of the whole range of diversified brainpower available on university campuses and in the laboratories of America. It will stimulate both practical and basic research. It will provide the nucleus for training the experts—the hydrosociologists—who are already greatly needed and who will be needed in increasing numbers as water problems become increasingly critical to increasing numbers of towns, States, and regions as well as to the Nation itself.

Before all of us now in this room will have passed on, this bill, if enacted, will have taken its place along with the Morrill Act, the Hatch Act, and the Smith-Lever Act as another monumental contribution to the structure of basic legislation that promotes the common good in America.

Mr. MORGAN. I would like to just mention one of those as illustrative of the answer that I am trying to give you.

In this area of recreation, in which there obviously is a very great public interest, we get into the area of intangible values. As we bring into sharp focus research related to resource use in part for recreational purposes, we bring into play the natural scientist, the social scientist, we bring into play the legal and the organizational specialists in our society, all of these people working in team fashion on a given problem. This to me illustrates the wisdom of allowing great freedom to the researcher on the end of the pipeline, where the work is being done, to let his imagination run and let his curiosity be put to effective use. There just isn't the wisdom available on this earth to give intense direction and supervision to this kind of creative activity. You talk about the President's office on the university campus in the same terminology that you talk about the executive department of the Federal Government. These people need a lot of loose rein in which to roam.

Senator ANDERSON. I couldn't help recalling while Dr. Aldrich was speaking that I once was privileged to have a discussion with Dr. Ernest Lawrence. And he got down to the fact that both of us had come from South Dakota, which of course gave us a common background. And I pointed out at that time that more U.S. Senators had

been born in South Dakota than any other State in the Union, five of them as against three in the next State. We got to talking about genius being where you find it. There was a farm machinery supply house in a little town in South Dakota, and they kept the spare parts in boxes from 1 to 10 stacked from the floor to the ceiling. At the end of the year representatives of the harvester company would come around and count what was left in the boxes, and they would settle on that basis. They would take everything out of the boxes and count it and then put it all back in again. This young clerk thought that that was a wasteful process, a time-consuming process. So he invented a sectional bookcase and sectional filing cabinets to keep account of parts more readily. He did that in a little town in South Dakota that had no contacts with major business management at all. And Mr. Wernecke did very well with his invention.

Again I say that that is the way things come about. They don't all come out of the great centers of business, they don't all come out of the Federal Government. They don't all come from centers of excellence. Many of them come from students who have ideas and who clash with the professors. They come from widely scattered sources.

I am glad to have you answer. States should not be left free to make mistakes in spending this sum, \$100,000 a year, but they should not be hamstrung.

Do you have anything additional?

Mr. MORGAN. I would like to make one concluding statement. The colleges in the land-grant system feel that before we who are in this room today pass on, assuming that we live out our normal life expectancies, that before then, if this bill is enacted, it will take its place along with the Morrill Act and the Hatch Act and the Smith-Lever Act as a monumental contribution to the structure of basic legislation that promotes the common good in this country.

Senator ANDERSON. If it should, the land-grant colleges will have a great deal of credit for it.

Any questions?

(No response.)

Senator ANDERSON. Mr. Bailey, of Auburn University, is here. And we will ask him to come up. You folks may stay here as long as you wish, because I enjoy having this fine battery that we have had before us this afternoon.

#### **STATEMENT OF W. S. BAILEY, ASSOCIATE DEAN, GRADUATE SCHOOL, AND COORDINATOR OF RESEARCH, AUBURN UNIVERSITY**

Mr. BAILEY. I am W. S. Bailey, associate dean of the graduate school and coordinator of research, Auburn University, Alabama's land-grant college.

This opportunity to express our enthusiastic approval of and support for the water resources research act is sincerely appreciated.

I should like to speak to many of the important and strong features of the bill under consideration, but the effective presentation of President Morgan and the other representatives of our association makes this unnecessary, and the lack of time prohibits it. Therefore I will merely mention the activity currently underway in Alabama which indicates the importance which we attach to this problem in a State

with abundant water resources but with limited financial resources for the task at hand.

There is being prepared at the present time legislation to be introduced in the forthcoming special session of the State legislature providing for the establishment of a water resources research institute at Auburn University, and for an appropriation of \$100,000 for its support. We are hopeful that S. 2 will receive favorable action in the near future. And at the same time we are convinced of the importance and the need for our modest local program, and are working for its activation at the earliest possible date.

Thank you.

Senator ANDERSON. Thank you very much.

Dr. Morgan, before you go, I want to say this: You have a good organization scattered around the country. I just hope you will continue to keep interested in this bill. And if suggestions come to you as to ways in which it might be improved, I hope you will let us hear your suggestions and ideas. We don't intend to close our minds on this. We will use every opportunity to profit by your suggestions. And that goes for Auburn University and any other institution in these hearings.

We have a fine letter of endorsement of S. 2 from President Eric Walker of Pennsylvania State University. He is a member of the President's Science Advisory Committee which is studying availability of scientists. We will include it in the record at this point.

(The letter referred to follows:)

THE PENNSYLVANIA STATE UNIVERSITY,  
*University Park, Pa., February 20, 1963.*

Senator CLINTON P. ANDERSON,  
*New Senate Office Building,  
Washington, D.C.*

DEAR SENATOR ANDERSON: The Pennsylvania State University has followed with great interest the progress of S. 3579 introduced by you in the 87th Congress and S. 2 recently introduced by you in the 88th Congress.

The projection outlined by the report of the Senate select committee that by the year 2000—namely, that 90 percent of the surface water in the Northeast would be required for pollution abatement—is startling.

Scientists at the Pennsylvania State University for some time have been aware that the passage of detergents through sewage disposal plants without being completely destroyed is creating hazards in streams and other water supplies receiving effluents from such plants.

With only a limited volume of water being available to dilute the increasing volume of waste from an expanding population and industrial complex, and in order to stop and reverse the increasingly serious pollution of our water resources, more research is urgently needed on new methods of disposal on non-aqueous sites. At the Pennsylvania State University a large-scale interdisciplinary research program is now underway on the reconversion and conservation of sewage effluent. Approximately a quarter of a million dollars of university funds have been expended on this to date as our zoologists, foresters, bacteriologists, agronomists, sanitary engineers, and geologists are cooperating to find answers to the problems of waste waters. In addition, a land and water resources research institute has recently been established at Penn State to stimulate, expedite, and coordinate research programs dealing with these resources.

The Pennsylvania State University stands ready to support your efforts in behalf of this legislation and is prepared to implement the provisions of such a bill without delay. If we can be of any assistance in encouraging the passage of Senate bill S. 2 in the 88th Congress please do not hesitate to call upon us.

Sincerely yours,

ERIC A. WALKER, *President.*

Senator ANDERSON. Our meeting tomorrow will be at 10 o'clock. I won't be able to attend. Dr. Jerome Weisner, Director of the Office of Science and Technology, and Science Adviser to the President, will be the first witness. I invite any of you who wish to come back tomorrow. And if you get additional ideas during this hearing later, we would be glad to have them.

I thank all of you for being here.

(Whereupon, at 4:05 p.m., the hearings was in recess, to reconvene at 10 a.m., Wednesday, February 20, 1963.)

The following is a list of the names of the members of the Senate Subcommittee on Water Resources Research, as reported to the Senate on February 14, 1963. The members are: Senator ANDERSON, Chairman; Senator CARROLL, Vice Chairman; Senator BAKER, Ranking Member; Senator BENTON, Member; Senator BIRNBAUM, Member; Senator BROWN, Member; Senator BURKE, Member; Senator CANTWELL, Member; Senator COCHRAN, Member; Senator COWLES, Member; Senator DODD, Member; Senator EASTLAND, Member; Senator GARDNER, Member; Senator GRAY, Member; Senator HALE, Member; Senator HARRIS, Member; Senator HAYWARD, Member; Senator HEALEY, Member; Senator HOLLIFIELD, Member; Senator JAVORSKI, Member; Senator JOHNSON, Member; Senator KENNEDY, Member; Senator LEAHY, Member; Senator LONG, Member; Senator MANSFIELD, Member; Senator McCLINTOCK, Member; Senator McGRATH, Member; Senator MURPHY, Member; Senator MUSKIE, Member; Senator NIEMI, Member; Senator PASTOR, Member; Senator PERDUE, Member; Senator ROBERTS, Member; Senator ROSEN, Member; Senator SCHEMATA, Member; Senator SMITH, Member; Senator STANLEY, Member; Senator TOLSON, Member; Senator TROTT, Member; Senator TUNNEY, Member; Senator WADSWORTH, Member; Senator WALKER, Member; Senator WALLACE, Member; Senator WALTERS, Member; Senator WELLS, Member; Senator WHEELER, Member; Senator WISNIEWSKI, Member; Senator WOODRUFF, Member; Senator YARBER, Member; Senator YERGEN, Member; Senator ZORIN, Member.

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# WATER RESOURCES RESEARCH ACT

WEDNESDAY, FEBRUARY 20, 1963

U.S. SENATE,  
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,  
*Washington, D.C.*

The subcommittee met, pursuant to recess, at 10 a.m., in room 3110, New Senate Office Building, Senator Clinton P. Anderson presiding.

Present: Senators Anderson, Jackson, Moss, Burdick, McGovern, Nelson, Allott, and Jordan of Idaho.

Senator ANDERSON. The committee will come to order. Senator Hruska, of Nebraska, has a statement. We will hear from him now.

## STATEMENT OF HON. ROMAN L. HRUSKA, A U.S. SENATOR FROM THE STATE OF NEBRASKA

Senator HRUSKA. Mr. Chairman, I thank the committee for the opportunity to appear before you in support of S. 2 and to commend the chairman, Senator Anderson, for his leadership in authoring this important bill and in pressing for early hearing this session. The committee is to be commended for its support toward the goal of enactment.

Earlier this week, I spoke at some length on the floor of the Senate on behalf of this bill. I understand that my remarks there were made a part of the record of this hearing at the instance of the chairman, for which I thank him.

I would, however, Mr. Chairman, like to restate the major points I stressed yesterday.

First, the report of the Senate Select Committee on National Water Resources makes it abundantly clear that America is rapidly approaching the point at which water shortages in vast areas will constitute a significant barrier to our overall economic and social progress.

Second, the time for action is now. Some kind of start must be made and this bill is a significant step in the right direction.

Third, however publicized and thoroughly studied any recommendation may be, a proposal to implement it legislatively must conform to the standard of political acceptance. In this regard, we have "witnessed" within the past 2 years a stalemate between those who believe that State water rights are paramount to Federal rights and those who hold the opposite view. Necessarily a common ground of agreement must first exist.

Fourth, happily, there is contained in the bill before us an approach which avoids the bitter struggle and probably hopeless strife as to paramount water rights. I refer to the Hatch Act of 1887 which created the Nation's agricultural experiment stations. These stations

over the past 75 years have operated under Federal and State cooperation with eminent success.

Fifth, I wish to make it clear, Mr. Chairman, that the Senator from Nebraska prefers to await the precise language of proposed legislation to implement the first two recommendations of the select committee regarding the Federal role in water resource development before commenting thereon. But this reservation in no way applies to S. 2. It is a good bill and it should be passed.

Finally, Mr. Chairman, I wish to emphasize how essential water conservation is to my own State of Nebraska. We are proud of the accomplishments and determined to expand our efforts but we realize that much remains to be done.

The establishment of a water resources research center at the University of Nebraska would be of great benefit in helping to find both long-term and short-run solutions to our water problems as it would in other States throughout the Nation.

Mr. Chairman, this bill up to this point has drawn heavily upon the structure and record of the State experiment stations through the Department of Agriculture. As one deeply interested in its success, I express the hope that there will be frequent reference to the history and workings of the State experiment stations. Frequent consultation in that regard will be very helpful indeed.

While the subject bill is one that is full of promise and potential, there are many caution signals which present themselves for consideration at the very outset. No doubt, most of them have already been covered by the testimony of witnesses heard. Notably, they would pertain to duplication of research effort by other agencies or bodies both governmental and nongovernmental, the need for coordination of research effort to avoid duplication and recognizing gaps that need to be filled, the necessity to guard against disruptive competition for the relatively limited supply of scientists and engineers in this field, and the necessity for suitable and adequate library services. This latter would include provision for data and information on water resources research and investigation projects to serve as a source of information from which catalog and the library could be compiled and maintained.

In more recent times, it has been my good fortune, through my service on the Agriculture Appropriations Subcommittee, to have considered these aspects of the agricultural research effort through the State experiment stations and generally. Although I should hesitate to speak on the subject in view of this committee chairman's greater knowledge and ability in that field, I venture to do so in the hope that what remarks and suggestions I make might prove of some value in the planning of the Department of Interior for this water resources research center system.

The State experiment stations program has proved to be primarily one of service. Of course, there is responsibility in the Department for seeing that the funds are spent as intended by the Congress. However, there is the further responsibility of making available technical assistance which it is called upon to give. That assistance includes comprehensive reviews of Federal-grant research, regional research, and coordination of research effort among the States as well as between the States and Department.

We were told within the past year that records of some 12,000 Federal-grant and State-supported projects are maintained by the State

Experiment Stations Division. Research summaries which indicate the nature of the studies made and material on the projects supported are published biennially. It is through such means as these broad review and coordinating services that it is sought to avoid duplication of effort and planned to carry out a more effective Federal-State program and recognize gaps that need to be filled by taking suitable and timely steps.

It might be of interest, Mr. Chairman, to note that the library services in the Department of Agriculture, through the National Agricultural Library, currently carry an appropriation of a little over \$1 million. Constant effort is made to improve the general bibliography, to provide necessary specialized individual services to scientists by supplying material from the literature; and to select, acquire, and preserve suitable publications. All of these things and many more will be encountered and similar services contemplated by those called upon to implement the subject bill.

Of course, the Office of Science and Technology as reconstituted only 2 years ago will be of great help in this regard.

Even here, however, we see there is continuing effort to improve procedures. It was with gratification that we witnessed introduction by the Senator from Arkansas, Mr. McClellan, of a bill last week calling for the establishment of a Commission on Science and Technology. Its purpose is to strengthen Federal programs in the fields of science and technology and to avoid duplication and overlapping between Federal departments and agencies engaged in scientific and technological research. With the recollection that eight major Federal agencies are now engaged in water research work, all of us can be impressed by the utter necessity of laying especial emphasis upon these goals. The Hoover Commission approach proposed by the Senator from Arkansas will help immensely.

However numerous or apparently perplexing these details of organization might be, the fact remains that water resources research institute is solid in concept. It will be fruitful in great degree in the training and development of additional scientific personnel; in the wide dissemination of the results of its work in speedy effective fashion; and because of its decentralized functioning, it will be capable of producing results calculated to deal with peculiar characteristics of the water uses storage and distribution problems which might inhere in various localities and, therefore, can best be dealt with by intensive effort in such locality.

Again I say, the chairman of this committee and the committee itself are to be commended for the leadership they have shown in drafting this bill and pursuing its enactment into law.

Senator ANDERSON. I appreciate your kindness, Senator, your able statement and the very vigorous support you are giving this bill.

The committee is honored this morning by the appearance of Dr. Jerome B. Wiesner, Director of the Office of Science and Technology, and the President's scientific adviser, who has evidently given a great deal of thought to this situation, because he has written some very fine comments on it.

Dr. Wiesner, all of us are tremendously interested in this subject. And your appearance here today personally is a matter of gratifica-

tion to Senator Jackson and myself, and I am sure the other Senators as well.

We will be pleased to hear your comments.

**STATEMENT OF DR. JEROME B. WIESNER, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY, AND SCIENCE ADVISER TO THE PRESIDENT OF THE UNITED STATES**

Dr. WIESNER. Thank you, Senator Anderson.

I am pleased to appear before your committee to discuss S. 2, a bill to stimulate water research in colleges and universities, and to promote a more adequate national program of water research. First, let me emphasize my agreement with the assumptions underlying this bill: that the water resources problems facing the Nation are of such scope and complexity as to justify immediate steps to broaden and strengthen research on those problems; that there is need to encourage research on water resources problems of State and regional significance; that there is need to expand research and inquiry into the fundamental physical, biological, and social aspects of water resources; and that there is need to enlist and increase combined efforts of scientists, engineers, economists and other scholars for research and graduate education in the several disciplines underlying water resources.

The nature and importance of research in water resources has been amply detailed in the excellent reports by your committee and by recent comprehensive studies within the executive branch of the Government.

Although this country is blessed with an abundance of water in nature, variations in geographical distribution and the rapid expansion of our population and industry have combined to pose mounting problems of availability of water of adequate quality. Consequently, the development of water resources has become one of the largest single activities in the United States. Water resources development, encompassing all sectors of society, presently involves an expenditure of about \$10 billion every year, and the rate is rapidly increasing.

A small fraction of this annual investment devoted to research aimed at better understanding of the many complex ways water enters into man's environment could provide enormous economic benefits. Research needs range from basic research on the nature of water to research in the social sciences in relation to water management. Some of the problems are of national character; others are of State or regional interest. If we are to make adequate headway in anticipating and ameliorating water shortages—and by this I mean high-cost water, because you can always get water if you pay a high enough price—it is necessary to develop and mobilize the scientific and technical capabilities of our research institutions, Federal and State; public and private.

The importance of research in natural resources was underscored by the President in his messages to the Congress on natural resources in February 1961 and on conservation in February 1962. In the former message, he called on the National Academy of Sciences to undertake a broadly based study and evaluation of the present state

of research underlying the conservation, development, and use of natural resources.

The report of the National Academy of Sciences has been completed and is being followed up in the Federal Council for Science and Technology. It includes a study of water resources which emphasizes the need to increase research efforts on selected aspects of water resources and calls for urgent consideration of interdisciplinary training of personnel capable of planning and executing effective research programs in this field.

In the same message, the President directed his science adviser and the Federal Council for Science and Technology to review ongoing Federal research activities in the field of natural resources and to determine ways to strengthen the total Government research effort relating to natural resources.

The Federal Council has underway a broad study of research in natural resources being conducted and planned by Government departments and agencies. It established a Special Task Group on Coordinated Water Resources Research under the leadership of Dr. Roger Revelle, science adviser to the Secretary of the Interior. The task group was asked—

- (1) to formulate, in as broad terms as possible, the applied problems in water management and control which are part of the missions of different Federal departments and independent agencies, and which require research and development to enable them to carry out their responsibilities more effectively;

- (2) to prepare inventories of present research and development programs, including both basic and applied research, within each department and independent agency in terms of their relevance to these applied problems;

- (3) to develop the considerations that should determine policy and that will influence choices among policy alternatives regarding an expanded program including both intramural and extramural activities;

- (4) to compile, on the basis of planned fiscal year 1964 budgets, a proposed national program of water resources research and development for fiscal year 1964;

- (5) to identify points of agreement and disagreement between different departments and agencies concerning responsibilities for water resources research and development; and

- (6) to suggest policy framework of any new legislation and mechanisms for further interagency coordination.

The report of the task group was endorsed by the Federal Council with minor qualifications and on Monday of this week was transmitted by the President to the Speaker of the House and the President of the Senate for consideration in connection with the budget request for fiscal year 1964 and the need for new legislation.

The task group report for the first time presents a comprehensive inventory of ongoing research in water resources within the Federal Government and research planned for fiscal year 1964. The work of both the academy and the Federal Council on water resources research was taken into consideration in the administration's budget request for fiscal year 1964 which calls for significant expansion of research effort in this field. The report sets forth certain guidelines

for new legislation required to strengthen the Federal programs in water resources research to which I invite your attention in connection with the consideration of S. 2. These guidelines are amply backed up in the report by extensive discussion of the research, manpower, policy, and organizational needs for strengthening the water resources research capabilities of the Nation.

New legislation is needed to strengthen the contributions that universities can make to research and graduate education in water resources. In my view, such legislation should be consistent with the following principles:

(1) All Federal agencies concerned with water resources should have the authority and funds to contract with and make grants to any universities, whether or not they are the location of water research centers.

(2) It is desirable to develop additional centers of water resources research in many universities and to strengthen existing centers and programs. There is special need for research and analysis that draws on the combined talents of scientists, engineers, social scientists, economists, lawyers, and others. There is also a need at local levels for technical analyses and studies to apply the findings of research. The centers should draw on the diverse scientific, technical and other skills throughout the schools and departments of the university or college. The character of Federal support for such centers should avoid excessive orientation of research to the mission of the particular Federal agency providing financial support and should encourage research directed at State, regional, or national water resources problems. In order to meet this objective, some Federal support to each center is required on a continuing and university-planned basis and should complement the extramural research grants programs of the Federal agencies in support of their separate missions. S. 2 wisely recognizes that the form of organization of these research centers should be determined by the institution itself, since the objective should be to strengthen competence where it resides in the university and to bring it into focus on water resources problems through arrangements that fit the organizational pattern and development plans of the educational institution.

(3) Support to the water resources research centers should be in part on the basis of a relatively small formula amount to a designated research institution in the State to permit it to establish or strengthen its capacity for the conduct of water resources research, and in part on a matching-fund basis for support of research at the center, giving careful consideration to the potential of the institution to conduct research of high quality. The Federal Council for Science and Technology expressed the view that the establishment of water resources research or analysis centers in the States with Federal grants should be on a permissive basis, under explicit qualification of standards. I feel that legislation should emphasize the creation of such centers on a State or regional basis, depending on the availability of qualified personnel and the desirability of establishing centers on a regional basis, where cooperative effort among States would better utilize available scarce personnel and more effectively bring them to bear on problems of mutual interest. In other words, one shouldn't insist that centers be established on the basis

of States. Also, the administrator of the grants program should have clear authority to decide whether or not Federal funds should be used, on the basis of the capabilities or potential of the research or analysis center to do high quality work.

(4) Although new legislation should give to one agency the administrative responsibilities for carrying out the formula and grant programs, the legislation should in no way supersede authorities presently vested in other agencies to conduct extramural research in the colleges and universities. In the administration of matching grants for the conduct of research, the administrative agency seeking appropriations for this purpose should evaluate the proposals for grants in close consultation with the other agencies having substantive interest in the field of water resources. The other agencies should participate in the drawing up of rules and regulations and criteria for evaluation of research support.

I recognize the need, from the standpoint of prudent management, to designate a single executive agency such as the Department of the Interior for the administration of a national program of the type envisaged in S. 2, but I am also aware of the historical and legislative development of the interests and missions of other major Federal departments and agencies in water resources research. The bill recognizes the coordinate interests of other agencies and would not place the Department of the Interior in a controlling position. However, I would like to emphasize that, in carrying out the provisions of this act with respect to the support of universitywide water resources research centers, the Department of the Interior should, in effect, serve as an executive agent in furthering the interests of all of the agencies in their common objective of strengthening the water resources research capabilities of the Nation.

The continuing leadership for interagency coordination and for securing interagency agreement on the national water resources research program will be provided through the Office of Science and Technology and the Federal Council for Science and Technology. With the passage of Reorganization Plan No. 2 in the last session of the Congress—with which Senator Jackson is familiar—the Office of Science and Technology was given responsibilities for assisting the President in the coordination of Federal science programs. Working closely with the Federal Council for Science and Technology, my Office provides the focal point for encouraging and bringing about such coordination. A coordinating committee on water resources research is being established under the Federal Council for Science and Technology, and serious consideration is being given to the creation of a high caliber analytical staff for support of the work of the Council in developing a coordinated water resources research program. The Federal Council, with the assistance of a committee on water resources research, will make assignments of technical leadership responsibilities for given segments of the water research effort to particular agencies in order to develop a well-conceived water research program that conserves and strengthens the supply of qualified scientists and engineers, and that is sufficiently strong in depth to serve the broad scope of national needs and interests in water resources.

The effectiveness of interagency coordination of research in water resources and of the management and conduct of agency research

requires an adequate Government-wide scientific and technical information system to serve the needs of program administrators as well as working scientists and engineers. Although I am in sympathy with the objectives expressed in S. 2 to maintain a current catalog of water resources research and investigation projects in progress or scheduled by Federal agencies, I feel that it would not be wise to provide for this in legislation. Water resources research is but one of a number of important areas of research activity that require a current inventory of ongoing efforts, only one of a very large number. The Federal Council for Science and Technology has the matter of scientific and technical information, including this problem, under study, but has not yet determined the organizational arrangements that could best serve the purposes intended in S. 2. For example, the Science Information Exchange, supported on an interagency basis at the Smithsonian Institution, has responsibility for maintaining an inventory of current research in the physical and biological sciences. Possibly this activity should be broadened to embrace water resources research so that it can be properly related to other research efforts supported by the Government. In fact, I would suppose that much of the water research activity is supported there. I would much prefer to see the handling of this problem left to the discretion of the administration which, I can assure you, will work expeditiously to arrive at a solution that will meet the objectives of the bill.

In conclusion, I would like to emphasize the considerable importance of strengthening the in-house competence of Federal laboratories engaged in the conduct of water resources research. Although I recognize that the bill under consideration is directed at the support of research and related graduate training in educational institutions, we should keep in mind that in some areas of water resources research a major part of the scientific and technical competence in the field resides within the Federal research establishments. We must strive to upgrade the competence and level of effort in both the Government laboratories and the universities if we are to achieve the objectives of the bill to promote a more adequate national program of water research.

Senator JACKSON (presiding). Dr. Wiesner, I want to thank you for a very fine statement.

I was particularly interested in your comments regarding the coordination within the executive branch of the various agencies already engaged in this field. I take it that a coordinating committee is being established—has it been established?

Dr. WIESNER. We are in the process of establishing it. And, as I said, we are also in the process of doing one additional thing, and that is exploring how to put together a permanent information group, because one thing I believe the staff of this committee found in its studies and that we found in preparing this report which we forwarded to you was that it was extremely difficult to find in the Government Establishment and in the institutions that we support outside the Federal Establishment just precisely what is going on and what progress is being made and how it interrelates to the other activities of other agencies. And we believe that the most important single step in proving the integration of the research activities in

the Government is to provide ourselves with a considerably better quality and quantity of information regarding research.

Now, just exactly how we will do this we don't know, for the reason that we find this problem in several fields, not only in the water resources field. And I am still uncertain as to whether one should handle each of these independently, at least temporarily while we experiment, or whether we should do it on a broader base.

Senator JACKSON. There are certainly quite a number of agencies now involved in the water research program. If a good job is to be done in connection with the provisions of this bill, of course, we have to be carefully coordinated first at the Federal level in order that the right programs are undertaken in the various States through the assistance to colleges of higher learning; do you agree on that?

Dr. WIESNER. I think that the one thing which stood out in the minds of the panel is that there is a great shortage of people to do the research you are talking about, and that is why we feel that S. 2 is so important a step in strengthening the water research activities in this country. I think it is extremely important, though, that this does lead to a higher quality and larger output.

Senator JACKSON. So that we don't waste talent.

Dr. WIESNER. Yes. And that is why we feel that the agency which goes forward with this program should have a considerable amount of discretion and not be required by law to automatically place a center in the State—as I say, there may be areas in the country where it would be desirable to have the program handled on a regional basis, though on an educational basis it is probably true the more centers we are able to create the better off the country would be.

Senator JACKSON. Senator Allott.

Senator ALLOTT. I wonder, Dr. Wiesner, just how much will be done toward coordinating this. I think, generally speaking, probably that in this whole field the various Western universities, and what we used to call agricultural colleges but which have since graduated into something else, they have probably done more work in this area than the schools of the East, because the pressure has never been, up to the moment, on the Midwest or the Eastern States for this development.

Looking into the future, I am a little concerned that if this proposed bill should become a law, that almost every land-grant college and a lot of universities would be in here with all sorts of projects, some of which work has probably been accomplished and done by some of our schools in this country many, many years ago. Do you think this department of yours could keep this straightened out and stop this sort of worthless duplication.

Dr. WIESNER. Well, I wouldn't promise that we would be able to ferret out or even try to ferret out every piece of duplication at that low level, I think it would require me to have a bureaucracy that would be so long that neither you nor I would like it. I think you have to count on having a quality faculty to avoid that aspect of the problem. I think it is unlikely that any good research man is going to permit himself to repeat a piece of work that was done sometime ago, and that is why I think the emphasis has to be on quality. I think what we want to do is be sure that two agencies are not plowing over the same ground on a very large scale, unknown to us and unknown to themselves and unknown to you.

There may be areas where we will encourage duplication. I think I have said that before to the Congress. I don't think that research on all parallel or duplicate roads is bad. And I think we should sometimes encourage people to work on the same problem. And we find that good research workers will rarely follow the same direction. People don't like to copy, and they don't like to start with a method somebody else has used.

I do think we have to place a responsibility on the agencies that are sponsoring the research to also be concerned about both the quality and the duplication problem.

And then at our level we have to try to coordinate and avoid gross duplication without design, and try to avoid an even more important thing; that is, missing important aspects of the problem.

For example, in this field today, because we haven't quite decided whether it is water research, atmospheric sciences, or oceanographic, a very important part of the hydrological cycle, which is the interaction of the oceans and the atmosphere, is not being studied by anyone, and an omission of this sort—

Senator ALLOTT. You say it is not being studied?

Dr. WIESNER. Not in detail. There are efforts going on. But I think that the looks we have had at this problem have led us to believe that here is a part of the research cycle that needs a great deal of additional potential and coordination, not only among people worrying about hydrology, but here we need cooperation between the people interested in oceanography and the atmospheric sciences. They do talk to each other, but I think that is a part where the Federal Government ought to see that the things we are paying for in these various fields are really complementary rather than completely isolated.

Senator ALLOTT. I thought some of the research projects of the National Science Foundation now are pretty well into that field.

On page 8 of your statement, at the bottom of the page, you say:

However, I would like to emphasize that in carrying out the provisions of this act with respect to support of universitywide water resources research centers, the Department of the Interior should, in effect, serve as an executive agent furthering the interests of all of the agencies in their common objective to strengthen the water resources research capabilities of the Nation.

The chairman of this committee went into some detail yesterday about this same question. And the difficulty he posed is with other departments. I don't suppose you mean here that the Department of the Interior should go into this; do you?

Dr. WIESNER. No. What I do mean is that the Department of the Interior, in dealing with academic institutions, should take into account the interests and the problems of other departments. For example, if a department, another agency of the Government, already has a well-established, well-running, competent water resource activity going on, I hope that nothing would be done under the institutional form we are setting up here which would cause the Department of the Interior to go in and compete for manpower or compete for resources.

So I do think we should have a continuing evaluation by the inter-agency coordinating committee of the creation of these new centers, and there should be general agreement that they are desirable.

And I would think also, in going into special areas and deciding on the kind of research that is going to be done, it would be well if the emphasis took into account the problems of these other agencies. And in some agencies the problems may relate more to water for agriculture, and others, such as in the East, where we have an abundance of water, to pollution problems. And then the centers ought to take into account the problems of health.

On the other hand, I don't think we should preclude cooperative activities between the various departments of the Government to the extent that they want to pool their resources and deal through a single agency. We know in the Department of Defense on many basic research activities this has worked very well. The three services have offered to pool their research in the university and managed to provide a much better facility than when they were competing for manpower. But I think something has to be said in many instances for coordination.

Senator ALLOTT. I would like to ask one further question. How do you feel about the portion of the bill on page 10, the bottom of page 10, which waives the provisions of section 3684 of the revised statute.

Dr. WIESNER. I have not formed any judgment, sir, I have not examined that problem.

Senator ALLOTT. Thank you very much.

Dr. WIESNER. I did not intend to imply that I was opposed to this provision of the bill.

Senator ALLOTT. I took it that you didn't have any opinion at the present time.

Dr. WIESNER. Yes, that is what I was saying.

Senator ALLOTT. Thank you.

Senator MOSS (presiding). Thank you, Dr. Wiesner.

I think you should know that when this hearing commenced yesterday Chairman Anderson was very laudatory of the report you and your task force made on this subject. We considered it a great contribution, and we are using it very extensively here in this hearing. And so we are happy to have you here in person to testify today.

Your testimony has suggested some very good objectives and guides for the administration of the program proposed in the bill.

There may be some other questions.

Senator METCALF.

Senator METCALF. No questions.

Senator MOSS. Senator Nelson.

Senator NELSON. No questions.

Senator MOSS. Senator Jordan.

Senator JORDAN. Doctor, I think we have to agree that wherever people are we have a water problem, the use of water throughout the world has been before us since the time that civilization began. And I suspect that research in the use of water has been going on since research began.

I wonder—of course, I realize that there is no end to the amount of studies that can be directed toward a subject of such universal interest. But is there any part of this we ever get behind us? We seem to go deeper and deeper, and spread our research efforts, with more agencies doing it, and more people engaged in it, and I wonder if we can ever say that we have put any of it behind us and draw from

the pages of history or from the experimentation and research even of foreign nations and foreign people?

Dr. WIESNER. Do you want me to talk about research in general or research in the water field?

Senator JORDAN. In the water field.

Dr. WIESNER. The answer is probably the same.

Well, first of all, the need. Except for certain areas of our country where there has always been a serious water problem, and where water management has been a way of life, our country has not had any serious water problems. We now have areas of the country, of course, where the problem is growing. And therefore the problem is becoming one to which we are being forced to pay more and more attention.

But there are other things about our society which are also making this necessary. Only one of the problems of water research is the question of how to assure adequate supplies of water. This is certainly a very important—to some people the most important—problem.

But there are problems of how we deal with pollution, and how we can control quality so as to preserve wildlife, fish, and game. We have problems in the field of agriculture where the problem of use of water can greatly improve our agricultural activity. And I think all of these are problems which are growing in extent.

Also I would say the following thing is true, that working in this field in the past, a large part of the research—you call it research, but it has not been research, it has been engineering, and it has been directed toward a fundamental understanding of the problem. And as we come to the point where some of the problems are more critical, and we come to the point where scientific understanding of many basic phenomena of nature is better than it was, we are in a position to apply our general basic scientific knowledge to understand problems of the water field that we couldn't understand before.

We are in a better position to understand the fundamental properties of water, which surprisingly enough, are very poorly understood. It is one of the commonest substances we have, but we know very little about it.

We know very little about the chemistry of water purification. We have invented by trial and error the processes. But when we become concerned about the economics of water purification, for example, then it is very important that we understand better than we do at the moment the fundamental properties of water processes. And the research that we have begun is in that field.

I mentioned earlier the interaction, called the interface between the ocean and the atmosphere. We have very little knowledge about the phenomena that go on. This is not important today, and probably will not be important in 5 or 10 years from now. But we are concerned with a period 20, 30, 50, or 100 years from now when our water requirements will be greater. And one of the things that we at least want to think about the possibility of is rather large scale weather modification. And here an understanding of the phenomenon is important.

It is also important in the prediction field. I think we all feel that there would be a great economic advantage in being able to improve our predictions.

So the building up of fundamental information in this field, a field which is an outstanding one—as I said earlier, we are spending \$10 billion in the water field, the field expenditures in the basic field are under \$100 billion a year, so it is very small—

Senator JORDAN. Here is my point, if I may interrupt. I believe in research, and I believe it is very necessary to carry out research. But what I would like to see sometime is an application of the things we learn in research toward the cleaning up of some of these streams that are polluted all over the country. Where do we get an application of the result we achieve in research toward accomplishing some of our objectives?

Dr. WIESNER. I am sure that if we set out to do it we can find a great many examples of research done in the past where it has not been applied. But the country is going to make the decision to carry the burdens and the cost and the inconvenience of clearing out pollution, which is not so much a fundamental problem of understanding as it is a problem of economics and law. I think there are many places where we know what to do, but research doesn't always make it cheaper to do something, or at least make it so cheaper that we are going to do it. It may make it easier or less expensive. But I think the pollution problem is a separate problem in research activities. I think that continued research and development is going to make it easier. But I don't believe that anyone who sponsors or advocates that we spend money on research will claim that it is going to eliminate pollution problems without major efforts.

Senator MOSS. Senator McGOVERN.

Senator McGOVERN. I just have one question.

You made reference to the rather acute shortage of trained people who are capable of carrying on research of this kind. Is it true that there is a potential pool of research talent that could be activated by legislation of this kind?

Dr. WIESNER. The studies which we have done on scientific and technical manpower in the last year have indicated to us that there is a very substantial body of young men and women coming out of the high schools—some of them go to college and some do not—who have the innate ability and competence to do research in any scientific field, including this one.

So that we were rather pleased to see—as we began our investigation we were concerned about whether or not technical manpower problems which we foresee for the next decade were fundamental in the sense that we were running out of young people to train and educate, and we couldn't believe that there is really a shortage of youngsters. And we believe that as our society's character continues to change so that we want fewer and fewer unskilled people, therefore freeing more and more people to do intellectual work, it is not only desirable but important to put them to work in these areas if we want to keep our society advancing and growing in the way that it is now growing.

Senator MOSS. Senator NELSON.

Senator NELSON. Just briefly, you referred to \$10 billion a year being spent on water resources and development. What does that figure come from and what does that mean?

Dr. WIESNER. That word "development" there is probably misleading. This is in developing the facilities for supplying water, the water mains, the dams, the reservoirs, and distribution systems.

Senator NELSON. It does refer to that. Does it also apply to flood control projects, the acquisition of flood lands, everything affecting land?

Dr. WIESNER. Land acquisition is not included. I am not certain, but I think that this survey included in this all of the expenditures that are made for the improvement of our ability to manage water, flood control, navigational control.

Senator NELSON. It includes water plants for cities?

Dr. WIESNER. Yes. It is a very large sum of money.

Senator MOSS. Thank you very much, Mr. Wiesner. We certainly appreciate your testimony today, and the very fine report that has been prepared and made available to the committee.

Our next witness is Mr. Irving Fox, vice president of Resources of the Future.

We are happy to have you, Mr. Fox.

You may proceed.

#### STATEMENT OF IRVING K. FOX, VICE PRESIDENT, RESOURCES FOR THE FUTURE

Mr. Fox. I appreciate the invitation of the committee to appear today and offer my reactions and comments on S. 2, the water resources research bill. The interest of the committee in water resources research is particularly gratifying. There is a need for more knowledge relating to the use of water resources and I believe that the right type of research will yield large returns.

Senator ALLOTT. Mr. Fox, before you start your statement, will you tell me what Resources for the Future is.

Mr. Fox. I will be glad to. Resources for the Future is a research and education organization. It was established about 1952 by the Ford Foundation. All of the funds that support the work of Resources for the Future have been provided by the Ford Foundation. We have a staff of about 20-odd professional people who are engaged in studies in the field of natural resources generally, and we also provide grants to universities and colleges for studies in the field of natural resources, and some educational work. Our funds amount to about a million dollars a year, and roughly half of our research work is handled through grants to universities and colleges. Our work has been concentrated in what you might call the social sciences, economics, political science, law, and so on.

Senator ALLOTT. Where are your offices?

Mr. Fox. Our offices are here in Washington, in the same building as the Brookings Institute on Massachusetts Avenue.

Senator ALLOTT. Thank you.

Senator MOSS. Thank you very much, Mr. Fox. You may proceed.

Mr. Fox. At the outset I should emphasize that Resources for the Future as an organization does not take a position on legislation or public policy issues. Therefore, the views expressed are my own.

In my comments I propose to discuss what appear to me to be the basic features of S. 2 and then examine some of the major problems of administering a Federal program of the type visualized by the proposed bill. Inasmuch as the committee has excellent advice on the drafting of legislation, I do not propose to comment on the details of the proposal.

First, I will comment on the basic features of S. 2.

The general objective of the proposed legislation is to advance knowledge about the development and use of water resources at a more rapid rate so that in the years ahead the Nation will realize increasing benefits from these resources. This objective is to be achieved by engaging universities and other institutions in a larger and more effective role in water resources research. By providing support for centers at numerous locations, a wide geographic distribution of the research effort will take place. Furthermore, research bearing on all aspects of water development and use is encouraged instead of being directed to a specialized problem area which has often been the practice in the past.

I believe that the objective and basic features of the legislation are sound. It seems clear that a more rapid rate of scientific advance and institutional improvement will be needed to provide the benefits from water that a larger population will want and a more prosperous economy will require. In these circumstances, there is no question about the desirability of an expanded and more intensive research effort.

I will next comment on colleges and universities in water resources research.

Many universities and colleges already have underway substantial research programs relating to water. Some of these activities are being supported with Federal funds. S. 2 would enlarge the number of educational institutions engaged in research and permit an expansion of the work already underway.

There are, I believe, several reasons why it is desirable for universities and colleges to have more substantial programs of water resources research and for there to be a wide geographic distribution of the research effort.

First, when a substantial advance in a field of knowledge is wanted there is merit in having a number of quite independent institutions engaged in the effort, rather than intensifying and expanding the work of a few existing organizations. Within a single organization patterns of thought tend to harden. There occurs, I suppose, a measure of inbreeding of ideas and a narrowing of focus. When other institutions become involved, a more fertile environment is established which stimulates innovation and creativity. There becomes in effect a competition among ideas.

Second, a program of the type proposed in the bill will contribute to the strengthening of educational institutions. One of the most serious and important problems the Nation faces is that of equipping its universities to do the educational task which lies ahead. I recognize that S. 2 is not concerned directly with education. Also, I feel that the task of training people to do a more effective job of planning, developing, and operating water resources programs and engaging in research should be viewed as a separate problem and objective. Nevertheless, a research effort is the cornerstone of an effective educational program, particularly at the graduate level.

Third, my experience suggests that there are underutilized, competent research personnel, particularly at the smaller universities and colleges, whose talents could be applied effectively to water resources research. There is a tendency for funds from the Federal Government and foundations to go to the larger and better known universities.

Research personnel at the less well-known schools, in some fields in particular, even when fully competent, have difficulty in securing support.

In this connection the agricultural colleges merit special comment. In view of the tremendous advances that have been made in agricultural productivity, I believe that there are substantial numbers of research people at many of these institutions whose talents might well be diverted for short or long periods to water problems. The proposed legislation offers an opportunity to help diversify the programs of these institutions in accord with the needs of our highly urbanized and industrialized society.

Fourth, it is evident that research conducted at universities and colleges frequently offers a measure of freedom that is difficult to attain in Government agencies. This is particularly true of research in the social sciences or where a study has important policy implications. I am convinced that if some of the more complex economic and institutional issues relating to water use are to be attacked effectively, the work must be undertaken outside of the Government where research workers can be insulated from the influence of special interests, including a commitment—perhaps subconscious—to current Federal programs.

In citing these reasons for more effective participation by educational institutions in water resources research, I am not losing sight of the need for strengthening the programs of research actually conducted by Federal personnel. The so-called in-house research of the Federal agencies should not be neglected because it is, as I will explain more fully later, an essential corollary of a more effective program at educational institutions.

I would like to make a comment about the wide geographic distribution of the research effort.

The intention of establishing research centers at possibly as many as 51 locations does pose some difficult problems which I will comment on later. However, the needs of modern society, with a rapidly growing and large population, demand many centers of highly competent educational and research effort, not merely a few centers of excellence. In addition, the physical, social, and economic aspects of water supply and use vary a great deal by regions of the country. As in agriculture, research must be directed specifically to solving the problems of these separate regions. This can be done best by research institutions located within the regions which are sensitive to the problems of the areas in which they are located and which are available to serve the people and the enterprises of these areas.

I should like to comment on a broad program bearing on all aspects of water development and use.

There has been a tendency for Federal research programs to be narrowly focused. Operating agencies, such as the Corps of Engineers and the Bureau of Reclamation, have quite appropriately emphasized research bearing directly upon their individual operating responsibilities. The assignment of specific tasks to individual agencies has also fostered compartmentalization of research responsibilities. No organization of the Federal Government has had either the authority or the responsibility to look across the entire field of water resources and consider all kinds of research possibilities. This situation would be changed by S. 2, because the proposed Bureau would

be authorized to grant funds for a wide range of water resources research activities.

I am particularly pleased that the proposed legislation appears to offer the opportunity for more support for what I will call institutional and social science research. Here I refer to studies in the field of economics, public administration, political science and the law. Except for studies conducted by private institutions and some universities, this type of research has tended to be neglected as related to water resources. It is abundantly clear that because of limitations in our institutional arrangements—law, governmental organization, intergovernmental relations and the like—we are not deriving the benefits from our water resources that it should be possible to secure with existing levels of scientific and technological know-how. Recently this situation has been impressed upon us by practices followed in the Ruhr region of Germany for managing the water supplies of this highly industrialized area.

Last spring we sent a member of our staff, Dr. Allen Kneese, to the Ruhr to study water resources practices in that region. The report he brought back illuminates rather dramatically the point I have just made. This region has a population of approximately 8 million people crowded into an area about half the size of the Potomac River Basin. About 40 percent of the industrial capacity of West Germany is located in the region. Between 75 and 90 percent of total West German production of coal, coke, iron, and steel takes place there. The cities and industries of the area depend almost entirely upon the ground water and the surface flows of the relatively small streams of the area, although during extreme drought there has been resort to the use of the waters of the Rhine. The water supply on which the region depends is somewhat less than half of the supply available in the Potomac River Basin. It is, I believe, of the utmost significance that because of the unique arrangements that have evolved there, this large concentration of population and industry is capable of maintaining a high standard of living and economic productivity at relatively low cost for water and waste treatment, while maintaining the Ruhr River itself sufficiently clean to permit safe and pleasant recreational use. The Germans are not using a superior technology or a superior knowledge of hydrology. They have developed in this particular instance superior institutional arrangements for using the scientific know-how which is common to both countries.

Social science research is, of course, my special interest. I am convinced that the promise it holds is great and to neglect these studies could mean that the gains we make through our advanced understanding of physical and biological phenomena may be lost through our inability to utilize this knowledge effectively. It is for this reason that I am particularly pleased that the bill recognizes the need for support of work in the social sciences and law.

Now, I would like to comment briefly on three problems of administration.

The points that I have made so far clearly indicate that I am favorably disposed to the objective of S. 2 and the broad features of the approach contemplated to achieve that objective. To be realistic, one must recognize that a program of this nature poses some difficult administrative problems. Three of these are of major importance and I would like to comment on them briefly. They are:

First. The enlistment and development of sufficient competent personnel to conduct the research envisaged in the legislation;

Second. The retention on a continuing basis of the kind of staff required to administer a program of this nature most effectively; and

Third. The maintenance of an effective and dynamic program over time.

I want to comment on the first of these at the outset here.

Although I believe there are individuals capable of conducting research at many locations who are not being fully utilized, and that other people can be developed to undertake research of this nature within a few years, it is important to recognize that it will take time to get a program of this nature in full gear. In the interim it may be difficult to avoid considerable competition among institutions for the services of the relatively few more experienced and better known people. Such a result could be undesirable in terms of the objective of the proposed legislation.

I am glad to see that the legislation gives the administrator of the program discretion to determine when one of the proposed research centers is competent to begin work. Congress and the executive branch should expect the administrator to be tough-minded on this question because the best interests of the Nation, as well as the best interests of the universities, will not be served through the establishment of second-rate programs. This problem can be met in part by encouraging a degree of specialization at particular universities during the early stages of the program, based upon the special competence of the people a particular university now has. Following this approach, one university might specialize in ground water hydrology. Another might be able to initiate its program largely in the field of water law. A third might be concerned primarily with water quality technology, and others with engineering aspects of design. As time goes on it should be possible for schools with specialized programs to broaden them into other areas. We should not lose sight of the fact that in the long pull some of the largest payoff in water resources research will come through interdisciplinary—that is, different economics, engineering, law, all of these being combined in a total program of study—research programs.

In spite of efforts such as the foregoing, it would be provident to make haste slowly. I doubt that anyone can estimate accurately how long it will take to get competently manned centers functioning at all locations contemplated. We should be prepared to accept the possibility that it may take a number of years. Thus I feel that we should encourage a fairly gradual buildup of the program under both titles and insist, as the program progresses, that all recipients of funds be fully qualified to undertake the research contemplated.

Now, I would like to comment on the problem of administering the grant program.

The proposed Bureau has two heavy responsibilities. One of these is to determine whether the prospective new centers are capable of undertaking quality research, and the other is the task of awarding grants and contracts for research. The overriding objective is to develop and conduct a research program that promises the largest practicable payoff with available funds and manpower. Some may feel that it is not difficult to grant money, or that it may be assumed that at the salary levels contemplated for the top staff of the new

Bureau it will be easy to employ personnel capable of doing the job effectively. Or, alternatively, that the major burden can be shifted to special committees of outstanding individuals who will be convened temporarily to assist with the more difficult decisions. I believe that the task is more formidable than the foregoing views suggest.

Based upon my experience at Resources for the Future, I am convinced that it is extremely difficult to develop and operate a research fund-granting institution which functions with vigor, imagination, and creativity unless that institution is also engaged in substantive research in similar or related fields. To make the kind of decisions that need to be made requires people with research experience and competence and outstanding intellectual caliber. Such people are seldom attracted for long periods by either high salaries or the prestige of a position. They are attracted by an opportunity to devote at least a portion of their time to research.

Although consultants employed for short periods can help meet this problem, they do not promise an entirely satisfactory solution. There must be a highly competent permanent group in charge which can provide the imaginative leadership a program of this type requires; a group that merits the respect of research personnel at the Nation's universities. Furthermore, temporary consultants or advisory councils cannot have nor feel the sense of responsibility that a person does who must be accountable for the results over a period of time.

What we want is a scientifically oriented institution, that will attract and command harmonious working relationships with universities and colleges throughout the country. To achieve the respect of university research personnel, the Bureau must have on its staff individuals with good judgment in the research field and these people invariably are individuals who insist upon being engaged in research themselves. In other words, I feel that if we are to realize the full benefit of the opportunity afforded by the program envisaged in S. 2, the organization which administers the program should have substantive research responsibilities as well as fund-granting responsibilities.

I can well appreciate from my own experience in government that practical considerations may preclude such an arrangement at the present time. It may not be possible nor expedient now to resolve the question of how an intramural research program such as I have suggested would relate to the research activities of existing agencies. Possibly at the outset a group of able, dedicated research people can be recruited to administer the program envisaged in S. 2.

However, I doubt that such people will find a continuing incentive to stay with the program unless there is an intramural research effort. Accordingly, I feel that the Congress and the executive branch should be mindful of the need—if not now, within a few years—of combining the fund-granting program set forth in S. 2 with a Federal intramural research effort.

If this matter were seriously considered, I can appreciate that the Congress would be reluctant to assign an intramural research program to still another Federal agency when so many agencies are already engaged in some aspect of water resources research. Any effort to combine a program of the nature outlined in S. 2 with existing research programs poses difficult problems. In particular, agencies

with developmental and operating programs, such as the Corps of Engineers and the Bureau of Reclamation, may not be well suited to conducting a program of this kind, while at the same time they should engage in research to improve their own operations. On the other hand, the S. 2 grant program might appropriately be combined with existing programs of agencies that do not have strong developmental or operating responsibilities. Examples are the Geological Survey and the Public Health Service. Here the alternatives might be, and I will mention three possibilities: First, to assign the S. 2 program to one of these agencies; second, to consolidate two or more of these agencies and the S. 2 program within one of the existing agencies; or third, to consolidate two or more of these agencies and the S. 2 program in an entirely new bureau.

A move in this direction would not only strengthen the program contemplated in S. 2, but it could have a salutary influence on the total Federal water resources research effort. Many Federal agencies are and should continue to be engaged in various aspects of this research. Contrary to an often expressed view, the task of coordination—in the sense of avoiding duplication of activities and exchanging information—is not serious. What is serious is that no one has the responsibility for examining the full range of research possibilities in light of what research is under way and in view of the significance of existing or emerging water problems and then applying Federal funds to encourage research where the payoff promises to be greatest. An agency that has research responsibilities including both an intramural and a grant program, and which does not have operating and developmental responsibilities, could perform this function. Furthermore, this could be done without infringing upon the freedom of inquiry of research personnel or interfering with the authority of other Federal agencies to conduct research essential to the improved performance of their assigned operating and developmental responsibilities.

As a final point, I would like to comment on the maintenance of a vigorous and effective program over time. I think it is difficult for anyone to foresee all of the problems and all of the consequences of a new program of the type proposed. Accordingly, we should be prepared to make adjustments in the program after we have had some experience with it.

With this in mind, the committee might wish to consider writing into the bill arrangements for a periodic, independent appraisal of the program. The people whose activities are evaluated feel apprehensive about having such assessments made. But I am convinced that they are salutary.

One possibility for handling a periodic evaluation of this kind would be to assign responsibility to the Comptroller General. He could be authorized within, say a 5-year period and each 5 years thereafter to convene a panel of recognized experts in the field of water resources research who would make a careful review and assessment of the program, probably over a period of several months, and submit a report on their evaluation of the accomplishments of the program and their suggestions as to how it might be improved. When these reports are received by the Congress, consideration could be given to amending the legislation on which the original program was

based. If the adjustments could be made through executive action without new legislation, such possibilities could be considered by the President and the department head responsible for the program.

Mr. Chairman, I hope that the foregoing observations and suggestions will be of value to the committee.

Senator Moss. They are indeed very helpful. This is a thoughtful presentation that you have made. And we appreciate your coming here to give us your suggestions today.

This is a somewhat new area, and reaching out and trying to have so many areas of research going, and one of the problems that we worry about is this diffusion of effort over a large area. And you pointed to some of the trials that may be encountered in doing this. We are very happy to have you here today.

There may be some questions.

Senator Allott, do you have some questions.

Senator ALLOTT. No; I do not.

I would like to say, though, Dr. Fox, I appreciate your paper. I think you have made a very conscientious and sincere effort to be constructive and helpful, which I can't say is true of all of our witnesses.

You have raised in the case of the Bureau situation one question which we perhaps ought to recognize. We have available, not only in this country but almost throughout the world, a great amount of knowledge which will enable us to cure some of our ills if we would only utilize it. It isn't always the necessity for new knowledge so much as it is the intelligent application of the knowledge we have. It is a sad commentary, perhaps, that people get enthused with painted pictures, but are satisfied to live in a community where a cesspool runs down the middle of it that can hardly be tolerated.

But I do appreciate your comments.

Senator Moss. Thank you.

Senator Burdick, do you have any comment? I know you just came in.

Senator BURDICK. No questions.

Senator Moss. Senator Metcalf?

Senator METCALF. No questions.

Senator Moss. Senator Nelson, do you have any questions or comments?

Senator NELSON. Yes.

I have been concerned about an aspect of the bill which gives the Secretary of the Interior \$10 million a year for—ultimately \$10 million, I guess—for allocation to research projects, and specifically on the very point you were making. What proposals are there in the bill for an evaluation of the nature and seriousness of the problems and lining them up in some order of priority so that the Secretary will be allocating research funds out of this \$10 million to the most serious problems first?

Mr. Fox. Well, I would assume—as I interpret the legislation, the Secretary has authority to establish some priorities and determine which should come first. This means, I assume, that he will seek to assemble, if the bill is enacted, a staff of people who are competent to do this. I assume the staff is provided by the bill. I assume further that he will also assemble consultants to advise him on this matter,

advisory groups, and so on. And out of this I would anticipate that he would have authority to establish criteria for considering projects, areas of emphasis, and the kind of problems, you might say, that deserve first priority.

Senator NELSON. There is nothing that you can see, is there, in the bill that requires that to be done? In other words, I take it from reading the bill that if various universities around the country submitted proposals—which may all be fine—that took up the \$10 million, that without any policies at the Interior level, you might grant the \$10 million here and proceed with various research projects with no direction to it at all?

Mr. Fox. My impression is that the authority is permissive. It seems to me that it would be the logical thing to do. I do not believe that it is directed or required—it would be difficult to see a responsible administrator going about it in any other way.

Senator NELSON. I take it it is permissive because there isn't anything in the proposal as I can see—

Mr. Fox. You mean as to criteria?

Senator NELSON. As to establishing priorities by any criterion at all.

Mr. Fox. I hesitate to trust my memory, but as I remember it, there is authority for him to do it; but he is not directed to do it.

Senator NELSON. What I am getting at, how do you do that?

Mr. Fox. How do you do it? Well, you are relying, of course, in large part on your judgment of people, an assessment of what are the most serious problems on the one hand, the ones that you might say are plaguing it the most. And we have a fairly good basis, I believe, with the knowledge that may be assembled in recent years, of what our more serious difficulties are.

And second, there is the question as to the scientist's judgment as to what the promise is as to research in particular areas. And I assume that out of this one could develop a set of criteria, or if not one, a group assembled for this purpose.

Senator NELSON. Let me put the question another way. If the bill does not specifically propose that this shall be done, and some method for it, isn't there a distinct possibility that the research and the allocation of that \$10 million would be willy-nilly to applications that come from universities around the country?

Mr. Fox. Well, it is hard for me to judge on this question, sir. I would assume that the type of people that the Secretary would want to recruit for this job would be very much interested and want to do this sort of thing. I suppose there is always the chance that there would be considerable pressure to get moving to use the money that is available, and not be too much concerned about criteria and being tough minded about what these elements are. These are pressures that I think any research group has to contend with. And conceivably some change in language might make it easier for an administrator to withstand this kind of thing.

Senator MOSS. Senator McGovern.

Senator MCGOVERN. No questions.

Senator MOSS. Thank you very much, Mr. Fox. We certainly do appreciate your testimony today.

Our next witness is Dr. Arthur Maass, professor of government and chairman of the faculty committee of the Harvard water program.

Dr. Maass is a very distinguished authority on water resources. He served in the field of the Hoover Commission about a decade ago. And he is the leading author of a book on the design of water resources systems, a copy of which I have here which was brought over from the Library.

We appreciate your coming down here today to share with us your comments on the pending legislation, Dr. Maass.

**STATEMENT OF ARTHUR A. MAASS, PROFESSOR OF GOVERNMENT,  
AND CHAIRMAN, FACULTY COMMITTEE, HARVARD WATER  
PROGRAM**

Dr. MAASS. Thank you very much.

Title I of this bill promotes continuing research on water resources in the land-grant colleges. This in my view is an admirable objective for the very same reason that Senator Anderson gives in his statement introducing the bill which appears in the Congressional Record for the 14th of January, namely, the success of this particular pattern of research in the field of agriculture, the need for water resources experts who can be trained in association with widely dispersed research programs in the land-grant colleges; geographical variations in water problems, and the desirability of strengthening State and local agencies concerned with water development by having research facilities available to them for advice and assistance.

I should add to these that the proposal to match the research capacities and research facilities of the land-grant colleges and their associated experiment stations with the research needs in water resources is most fortuitous. As the importance of agriculture declines relatively in our economy, exciting research opportunities become fewer in agriculture in relation to those in other fields. Thus, unless the prospectives of the agriculture at institutions broaden to comprehend new challenges, it is unlikely that they will be able to retain their traditional high standards, and many of the young who have previously been attracted by these institutions will gravitate to other work.

To a certain extent a desirable broadening of prospectives is occurring now in the agricultural research institutions. Witness their growing interest in recreation, in rural redevelopment, in foreign agriculture. At the same time, research in water resources involving complex technological, economic, and governmental factors in the development and use of water for industrial and domestic and recreational and other uses in addition to agriculture should provide a significant stimulus, a new and important challenge for many groups of professionals interested broadly in national resources, and in public investments.

In short, title I of the Anderson bill would affect a happy marriage between institutions in search for research opportunities and research needs in search for institutions to support.

Title II, providing for research in centers of excellence other than the land-grant college, is a desirable and necessary complement to title I. Our experience since 1955 in the Harvard water program confirms, I believe, the several bases on which, according to Senator Anderson's remarks in the Record, justification for this title rests.

Most important, we have found that with an interesting and carefully formulated research objective, we have been able to attract and retain the attention of leading professors in several fields who without the stimulation of the Harvard water program would have done their research on other subjects.

I should point out that if this result is to be achieved, it is essential that funds be assured over the full period needed to carry out the research.

For the land-grant colleges this is provided in a sense by the annual grants of title I of the bill. For the private centers of excellence it will be necessary to authorize no year appropriations as is now customary in space, defense, atomic energy, and other fields of research supported by the Government, and to make use of such authority in budgets and appropriations.

If I understand section 304 of the bill correctly, and I may not, it authorizes advances out of appropriations. If I am wrong, however, the bill in my view should be amended to accomplish this purpose and in any case, I think the need for such funding should be entered in the record of your hearings today.

Finally, the water resources research bill does not and cannot attempt to rationalize the organizational structure of government agencies concerned with water resources development. Your committees and others in the Congress, the executive agencies, and all of us interested in water resources must be especially careful, it seems to me, not to encumber this limited-purpose bill with a responsibility for which it is not the proper vehicle. Equally we should not delay enactment of the bill until the organizational problem is solved, if it ever will be solved. The date for this none of us can foresee and we should get on now, it seems to me, with needed water resources research.

Senator Moss, that is the conclusion of any formal statement I have. I will be glad to answer any questions.

Senator Moss. Thank you very much, Mr. Maass. We know of the very excellent program that you have been carrying on with the Harvard water program. Therefore, we are most happy to have your comments on this legislation being considered by the committee.

Do you have any fears about the rather wide diffusion of research effort that would be made, assuming that we have 40 or even 50 of the centers set up?

Mr. MAASS. I would answer that in this way, Senator, and the answer is somewhat similar to the answer that Dr. Weisner gave to a similar question. Certainly in fields where we are making great research progress, I think, the health field, for example, through the grants administered by the National Institutes of Health, and the various research programs of the defense and space agencies, they are not terribly self-conscious about the problems of duplicating research. It may be that if two or three groups of experts work on the same problem, they will have different approaches and come up with different answers and be able to evaluate each other's work. I think to a certain extent the same is true of the vast research program in the Department of Agriculture and I just have a feeling that because the problem of organization in water resources has been such a sensitive one over a number of years because of the agencies involved, we

tend to be too sensitive about the dangers of duplication of research in this field, and I am not terribly concerned about it.

Second, I would point out that in many of these problems, although the basic research may be similar for all problems, there are significant regional variations in the adaptation of the basic research to particular problems and using the land-grant colleges may be the very best way to achieve an adaptation of these technique to the problems in different areas.

Senator MOSS. Problems of each of the areas.

Mr. MAASS. Yes, sir.

Senator MOSS. Thank you very much. I appreciate that.

Do you have any questions, Senator Burdick?

Senator BURDICK. I wasn't here at the early part of the hearing and maybe this question was gone into. But could you describe the apparatus that exists formally throughout the country between the various land-grant colleges and universities for the exchange of findings of information?

Mr. MAASS. Well, I am sure there are several. I don't know that I can answer your question as well as Dr. Byerly could, for example, but there are several means.

One, the Department of Agriculture itself has a very fine bibliographic service including a monthly publication by the Library of the Department of Agriculture of all bulletins and research findings of the different stations and universities and private institutions, too. This is a source that I know I have consulted many times and I am sure everyone who works in this field does.

It certainly is one means.

Second, of course, the manner in which the publications of these research institutions are subsidized in a sense by the grants made to the agricultural colleges and research stations and by the franking privilege which they have for mailing, helps to insure that this information is interchanged.

And finally, of course, each or many of these projects involve research in particular fields. The professions have their journals on research and as a result that research which relates to one field will be reported in the journal or the abstract of that particular field.

So I think there is a fairly wide interchange of information among research people interested in the same field. Specifically I probably should mention finally that Resources for the Future—Mr. Irving Fox testified immediately preceding me—puts out, for example, a monthly little bulletin which in some ways summarizes important research going on in various institutions in different source fields.

Senator BURDICK. Thank you.

Senator MOSS. Senator Metcalf?

Senator METCALF. Nothing.

Senator MOSS. Senator McGovern?

Senator MCGOVERN. Nothing.

Senator MOSS. Thank you very much, Dr. Maass. We do appreciate your appearance and testimony.

Senator MOSS. Dr. Omer Kelley, of the Stanford Research Institute, will be our next witness. We are pleased to have you with us, Dr. Kelley. You may proceed.

**STATEMENT OF OMER J. KELLEY, MANAGER, AGRICULTURAL  
RESEARCH CENTER, STANFORD RESEARCH INSTITUTE**

Mr. KELLEY. Thank you, Senator. It is a pleasure for me to be here today.

I might give you just a little background concerning myself and the Stanford Research Institute.

Senator Moss. We would appreciate it if you would do that, Dr. Kelley.

Mr. KELLEY. I am manager of the agriculture research center at the Stanford Research Institute in South Pasadena. The Stanford Research Institute is affiliated with Stanford University. It is a nonprofit, non-tax-supported, nonendowed research organization that does research for business and for Government.

We have around 2,200 people on the staff. Last year we did about \$34.5 million worth of research.

We have always been interested in water research and in resource research and I might quote from the institute's charter:

\* \* \* to promote and foster the application of science in \* \* \* the discovery and development of methods for the beneficial utilization of natural resources.

Previous to my affiliation with the Stanford Research Institute, I was with the U.S. Department of Agriculture for 19 years, during which time for the most part I was in charge of their soil and water research program in the 17 Western States. So having spent most of my life in water research in the western part of the country, I feel that I do have some knowledge of water problems as they exist in this part of the country.

Obviously the West is not alone with respect to water problems. The problems exist throughout the Nation and they are becoming more and more critical even in the more humid parts.

I don't feel there is any need for me to try to evaluate water problems in the country because they have been amply documented and your committee I think has been one of the foremost in calling these to the attention of the people and has done an excellent job on it.

Rather, I would like to talk a little bit about some of the opportunities in research. Being a research man myself, I naturally believe that any problem can be solved by research if enough effort is put to it. We have to recognize, of course, that one can over-research a problem. However, I don't think there is any imminent danger of this happening to the water problem.

To be sure, we have made progress on our water problems in the past and in relation to the amount of money that has been spent, I think we have made substantial progress. But in relation to the needs I think or progress has been slow.

The need for solving our problem seems to be increasing exponentially with time.

In many areas already the immediately available water supplies are completely allocated. In other areas the quality of the water has been reduced to the extent that it is questionable for human use and even for agricultural and industrial purposes.

While these situations are alarming, they need not be discouraging because science, too, has been progressing during this period of time.

Senate bill 2 would do much to add emphasis to the water research program. Your committee print of last September itemizes the various water problems and I believe that these are conclusive, and while there may be some research being done on most aspects. I feel that none of them are receiving the total amount of research they should and I am also sure there are some aspects that are not receiving any attention.

I would like just as an example to mention one area of water research, the water problem, where I think there is a tremendous opportunity. By this I don't want to imply that there aren't opportunities in all these areas. I believe there are. But I would like to mention one and this applies over most of the arid and semiarid parts of this country as well as the world.

If we take a look at the State of Arizona, for example, there are in excess of 80 million acre-feet of water that falls in that State every year. It is averaged out, of course. Some years will be higher and some years will be lower.

Now, if we make the most optimistic estimate that we can, there is less than 6 million acre-feet of this water that is beneficially used. In other words, it is used by beneficial crops or finds its way into streams or underground aquifers. So this, you see—a very small amount is used.

What happens to the rest of this? The rest is lost either by evaporation from the soil surface or by nonbeneficial plants and in the case of Arizona the bulk of it is lost by evaporation from the soil surface. Maybe we can't do much about that right now but certainly research can.

For instance, there is no question in my mind but that there are areas in the United States and also in the world where the land would be more valuable for the water you could get from it than for any other use, and it is conceivable that science could so treat these areas that you would get 100 percent runoff.

Now, you have problems. It is not too difficult right now with the knowledge we have to treat an area so that the water will all run off. But one does have other problems. You have problems of stabilizing the soil to prevent erosion. This is a serious problem, you have the problem to prevent weed growth if you do get some moisture there.

But I want to point this up. I think there are tremendous opportunities here and throughout this whole water field.

Now, solution to these problems isn't just going to happen. It is going to come about only by research and by the application of science and technology to the water problems.

I would like to comment on one other aspect of the bill. Having worked 19 years with the Federal Government in water research, I have some appreciation of the problems concerned with information on water research at the Federal level. As your committee found out when beginning studies were made on this, there was no single place, there had been no level where one could go and obtain an up-to-date statement of figures or information on all of the research activities of water in the Federal Government or the extent and amount of money and types of programs that were going on.

I think your bill, Senate bill 2, would do very much to alleviate this problem.

This is important not only to people like yourselves, your committee. It is also of equal importance to scientists throughout the country.

Now, in view of the testimony that has gone on earlier in relation to duplication and people being up-to-date on research, certainly data that is published is easy to stay up-to-date on and I think Dr. Maass and Dr. Weisner pointed this out amply, that top scientists do know what is going on pretty well from the standpoint of data that is about to be published and this sort of thing. But I think there are lots of investigations, in fact I know there are, in the Federal Government that go on that may never be published. They are done for a given agency or this or that, and it is this type of information that is a little bit difficult to get until it is published.

Eventually when it is published, it is not difficult.

I think this bill would be very helpful from this particular standpoint.

One other aspect I would like to comment on, and that is with respect to the finances. A modest amount of money is mentioned initially with respect to this bill. I don't think there is any question at all but that the human resources and the physical resources are now available to use immediately, efficiently and effectively the money that is available in the first years of this bill.

Now, by this I don't want to imply that we don't need more scientists. We do need more scientists and as time goes on we will probably need more facilities, but this bill tends to help to provide these things.

I might comment on one other aspect. In some ways I think we are very fortunate when we look at the water problem in that it is diverse. It involves the many disciplines of science as was mentioned here earlier. The socioeconomic, hydrologists, engineers, physicists, lawyers—it is a gamut of disciplines, so that this in itself makes it easy to get started on a program of magnitude that you are talking about.

I might divert here. I think this is all I care to say with respect to my text, but I might divert just to give you an example of one of the things I am talking about.

One problem we are working on now in the water field is being handled almost entirely by an organic chemist and one might say, well, what is an organic chemist doing in the water field? Well, an oil company came to us with the problem that they have in trying to get rid of water that is in their oil. They have an appreciable amount of water from a number of wells. These waters contain boron up to about 7 to 10 parts in a million and anything in excess of 2 parts to a million will kill most plants.

Where are they going to put the water? In the past they have been putting it into consumption and it was seeping into the underground supply and the State water board said they couldn't do this. They have got to get rid of this. How do you get the boron out of this?

The first thing is to develop a chelating material to tie the boron into the water so the plants can't get it. The plant would take up just as much boron as it would if the material wasn't in the water, but it doesn't break down and react. This gives the oil company a temporary lease on life here, but the problem still comes up, will this break down in soil? If it does, then maybe it is just as detrimental over time as if you don't have the chelating material in there.

Another chemist was sitting in on the discussion on this and he said there was no reason why you couldn't modify this chelating material so it would be insoluble in water and soluble in oil. So if this was mixed with the oil and water as it came out of the well, the boron would then go into the oil phase and not in the water.

I don't know if this will happen, but we are doing research on it by the organic chemist who one would think would never be working in the water problem.

The thing I am pointing out is that the water problem is of such diverse nature that any research will find some input into some phase of the water problem.

I thank you very much.

Senator Moss. Thank you very much, Dr. Kelley.

You did not fully read your text, so it will appear in full in the printed hearing record here as well as your comments which we appreciate very much.

Working as you do in the field of water research, we appreciate having your expert comment and are glad to note that you approve generally of the provisions of the bill and believe that it will be helpful in stimulating accelerated research in the water field whereas other witnesses have said, and I am sure you agree, although a lot of research is being done, we just don't seem to be holding our own.

We are falling behind because of the tremendous increase of demands on our water supply.

Do you have any questions, Senator Metcalf?

Senator METCALF. No questions.

Senator Moss. Thank you very much, sir.

(The full prepared text of Mr. Kelley follows:)

PREPARED STATEMENT OF OMER J. KELLEY, MANAGER, AGRICULTURAL RESEARCH CENTER, STANFORD RESEARCH INSTITUTE

I am Omer J. Kelley, manager of the agricultural research center of Stanford Research Institute, in South Pasadena, Calif. Stanford Research Institute, affiliated with Stanford University, is a nonendowed, nontax supported research organization which conducts research for businesses and the Government. We have a staff of slightly over 2,200 people and last year conducted some \$34.5 million of research. We have a wide variety of interests and are particularly concerned with our natural resources, of which water is a primary concern. To quote from the institute charter, " \* \* \* to promote and foster the application of science in \* \* \* the discovery and development of methods for the beneficial utilization of natural resources."

Previous to my association with Stanford Research Institute, I worked for 19 years with the U.S. Department of Agriculture during which time I was in charge of the soil and water research program for the 17 Western States. Having been born and reared in the Western part of the United States, and having worked most of my life in soil and water research in that area, I feel that I am well acquainted with many of the water problems of that part of the country.

Obviously, the West is not alone with respect to water problems today. Water problems exist throughout the United States. That these problems are of extreme importance and becoming more critical every day has been amply documented many times; your committee has been one of the foremost and most active groups in the United States to so recognize and document. I, therefore, feel that there is no need in attempting to list the many water problems to such a well-informed group as you. Rather, I should like to discuss the tremendous opportunities that exist for the solution of the water problems throughout this country, and some of the steps that need to be taken.

Being a research man, I naturally believe that all problems can be solved if enough time and effort (this means financial support) are devoted to proper research. Obviously, one can overresearch a problem, but there is certainly no

imminent danger of this happening to our water resource problems. To be sure, we have made progress in the past through research; in relation to the amount of money invested, this progress has been substantial. But in relation to the needs of the people and to opportunities that exist, the progress has been slow. The need for solution of many water problems seems to be increasing exponentially with time. In many areas today, all of the immediately available water supplies have already been allocated. In many cases the quality of the remaining water has become so poor that it has questionable use for human consumption and for agricultural and industrial purposes. While these situations are alarming they need not be discouraging because science has been progressing. The real need is to advance knowledge and to apply our newer sciences in the field of water resources.

Senate bill 2, which we are discussing here today, will do much to add needed emphasis to the water research program. The tremendous amount of background material compiled and made available in support of this bill outlines extensively and completely the opportunities for research accomplishment in relation to the water problem.

Your committee print published in September of last year itemized the various water problem areas. While I am sure these are inclusive and some research is being done on the various items listed, I am equally confident, and believe the committee will agree, that there is inadequate research on all the items listed. In many cases there are vitally important phases which as yet are not receiving research attention. While I do not want to go into each of the specific categories and discuss their research needs and potential, I would like to take just one item as an example and give some statements concerning potentials that exist through research.

In the State of Arizona, almost 82 million acre-feet of water fall every year on the average. By the most optimistic estimates it can be determined that not more than 5 or 6 million acre-feet of the water that falls in the State of Arizona is beneficially used or can be accounted for by streamflow and underground accretions. The remainder of this water is lost either through evaporation from the soil surface or through evapo-transportation from nonbeneficial crops. There is little doubt that, through proper research, a tremendous amount of this water and similar losses in other States can be salvaged. For instance, we know that there are ways of treating the soil to improve water run-off rates. Even with the present knowledge, costs for doing this are not particularly great. There are, of course, other problems associated with the reduction of the type of losses just referred to that would have to be solved. The main ones involve soil stabilization to prevent erosion, and the cost-benefit economics of individual situations.

There is little doubt in my mind that research could find better and more economical ways than are now known to save water that is presently being lost. I wanted to bring this particular problem into focus because I believe herein lies a tremendous source of potential fresh water which is now being lost not only in the State of Arizona but to all the Southwest and in many arid areas of the world. One does not have to do much calculating to determine that even in the 4- to 5-inch rainfall belt if one could save the water, say from two-thirds of the area and put it onto the one-third remaining, there would be sufficient water remaining for crop production, particularly of the dry-land type of crop. In higher rainfall belts there would even be water available for irrigated crop production.

Solutions to these problems and the many others listed by your committee are not just going to happen. Solution is going to come about only by research and through the applications of science and technology, requiring the many disciplines of science. To be sure, these solutions can be brought about only if sufficient research effort is put forth.

Having worked with the Federal Government for nearly 19 years, where a good share of activity was concerned with water research, I am aware of the problems of coordination of water research activities at the Federal level. As your committee found when you were preparing background information, there was not available at any one place within the Federal Government a single source which could supply the nature and extent of water resources research activities conducted by the Federal Government. To an outsider it seems incredible that such a situation could exist, but it does.

This bill would do much to correct this situation in that it would provide for one agency to accumulate and categorize Federal research activities in water

resources. It would do the same, if my information is correct, with respect to other research activities in water such as conducted by the States and other research organizations. There is a great need for this type of activity. It not only makes it possible for the scientists throughout the Nation to have a knowledge of what is going on, on an up-to-date basis, but it also makes it possible for a committee such as yours and other interested groups to have the same knowledge and to evaluate programs in light of the total research effort. I believe this will do much to make for a more complete attack on the various research problems. As indicated earlier, there are a number of problems which do not now receive attention and I am equally certain that there are a number of activities in which there is a duplication of effort. To me, the latter is less serious than the former. To categorize on a current basis all water research by the various research agencies will indeed be a great help.

The amount of money as suggested by this bill for the initial water research program is quite modest. I would like to dispel any fears that anyone might have that there is not now available an adequate amount of trained manpower to utilize this amount of money to a very good advantage. There are at the present time, in various States and private research institutions throughout these United States, tremendous amounts of the scientific resources. This is true not only with respect to the human resource but with respect to facilities, both of which are available to make good use of the amount of money that is mentioned in this bill.

To be sure, as progress is made, more facilities and new equipment will be needed to make maximum progress in water research. Likewise, additional trained men will be needed, and the bill provides for assisting along these lines. The point I am trying to make here is that the initial amount of money to be made available through this bill can be put to immediate, effective, and efficient use. I am confident that these programs of research can be undertaken in the immediate future without having to raid existing present Federal and State research teams.

In many ways we are fortunate with respect to water problems. They do not involve single disciplines, but a multitude of disciplines. For instance, most any problem one would think of with respect to water would involve a group of disciplines, such as physicists, chemists, mathematicians, geologists, engineers, agriculturalists, economists, sociologists, and so forth. When one thinks of solution to these problems, the input of scientific knowledge comes from a group of people. The carrying out of the actual research in many cases can be done by less well-trained people under the supervision and guidance of a few chief scientists. It is because of the nature of this research and the kind of studies laid out that the needed research can be done by scientists that are already available and facilities that already exist.

I should like to make one further comment which has to do with our present concept of water and water problems. The committee has considered the water problem from several aspects, such as use for recreation and human consumption, in addition to the agricultural, industrial, and sociological-economic aspects. Research must also include all of these aspects. Each phase must be included according to its importance. The program envisioned in Senate bill 2 is one that has long been needed and certainly is headed in the right direction insofar as helping the American people solve the problem of water resources.

Senator Moss. We have remaining four witnesses to be heard and—maybe we don't. There is one that is to be filed only, so perhaps we have time. I was beginning to worry about the clock.

Dr. Milton E. Muelder and Dr. L. L. Quill, of research development, Michigan State University, will be our next witnesses. We appreciate hearing from you gentlemen.

**STATEMENT OF DR. MILTON E. MUELDER, INSTITUTES OF WATER RESEARCH DEVELOPMENT, MICHIGAN STATE UNIVERSITY, ACCOMPANIED BY DR. L. L. QUILL**

Mr. MUELDER. Senator Moss, members of the committee, we appreciate very much the invitation to testify on Senate bill 2. President

Hannah is out of the country on an important mission, therefore is unable to respond affirmatively to the request that he appear. His views, however, in support of this bill as well as the previous bill that was introduced last year I think are well known and he has asked us to represent him. We are also coming in our own behalf in response to the invitation.

We endorse warmly the creation of water resource research centers at the land-grant institutions. As many have indicated and emphasized, interdisciplinary approaches which are so important for water research are well established at these universities. These institutions have extensive experience in how to relate effectively research, teaching, and extension. Indeed, the continuous exchange among land-grant institutions of knowledge, ideas, and research results on water resource problems will undoubtedly bring to this critical area the same successful endeavor which these institutions have brought and continue to bring to the question of food and agriculture. Experiences at Michigan State University are possible of duplication elsewhere.

Within its limited and restricted resources, the Michigan State University's Institute of Water Research, of which Dr. Quill here is the director, serves to coordinate and stimulate concern on this important national, natural resource among a wide spectrum of university disciplines.

The institute of water research is assisted by an all-university advisory committee whose members come from the respective disciplines having important water research interest. Limited funds, however, allow for only a small expression of the university's great potential in making substantial contribution to the water problem.

Research can be supplemented in an important way by teaching programs in a large number of disciplines. Career opportunities in water management for personnel having the benefits of discreet training and research experiences could be developed rapidly if adequate support were available. Water management cuts across a variety of fields and problems: engineering, agriculture, disposal of waste materials, the location and production of a water supply, recreation, water rights, to mention only a few. Courses at Michigan State University make a good beginning to provide excellent training in water problems: for example, hydraulics and fluid flow, the design of supply and sewage disposal systems, geophysics, structural geology and hydrology, water resource development and conservation, watershed management, public health sanitation, water and sewage and wildlife management, et cetera.

At many institutions such as at Michigan State University a large number of departments are engaged in water research. We noted at Michigan State University in a survey 2 years ago, that 73 projects related to water research were being pursued by 80 faculty and 21 departments. But a central office such as a water research institute is needed to coordinate these efforts, to relate them more effectively to the national water problems, to fill wide gaps in research efforts, to relate university efforts and interests to State, regional, and national requirements, and to assist in the establishment of appropriate training and extension programs.

The institute, however, can only operate to its maximum effectiveness with resources. Thus, at Michigan State University, the water research institute currently is able to support, out of very limited funds, only six research projects from the many submitted to it. This is an important start, but it is an extremely small step. These projects, incidentally, involve six different departments and three colleges. One of these projects has been integrated with a study requested by the U.S. Forest Service which is contributing funds on a matching basis.

Water problems are national, they are regional, they are State, and they are local in character. Land-grant institutions are long accustomed to working effectively and cooperatively in all four of these dimensions. They have a long history in relating university resources to the solution of complex problems involving many disciplines. We are sufficiently conversant in our interdisciplinary studies at Michigan State University to appreciate the proportions of the problem; we also appreciate the benefits which would accrue if we were able to properly mobilize the resources, scientific knowledge and skills of the entire university. Like other land-grant institutions we are dedicated not only to new knowledge in its own right, but also in behalf of society.

We reemphasize very strongly the deep concern of Michigan State University over the complex water problem faced by our Nation and believe that the general principles of the proposed bill are sound and workable.

This much for our statement, members of the committee. We will be very happy to respond to any specific questions which you would like to put to us.

Senator Moss. Thank you, Dr. Muelder. We appreciate that very much and I was glad to note that early in your statement you emphasized the point that this effort would not only give us advance in the field of research but it is a good teaching device for preparing more technicians in the field.

I think we are limited somewhat by the number who are qualified now to do advanced research in many of these water disciplines. By this method we would have many more in a short period of time at our teaching institutions. I appreciate it. We appreciate your being here, Dr. Quill.

Did you wish to add any comment at this point?

Dr. QUILL. I think he covered it very well.

Senator Moss. Thanks. Maybe Senator Metcalf has a question.

Senator METCALF. We appreciate your appearance.

Senator Moss. Thank you so much. We do appreciate it.

Mrs. Haskell Rosenblum, the director of the League of Women Voters of the United States, is here and will testify. The League of Women Voters has taken such a great interest in the field of water resource development, has appeared before this committee and before other committees on which I serve whenever we are taking up the subject of water resources, and always has made a great contribution. I feel gratified that you are prepared to testify today on this bill that is before us.

Mrs. Rosenblum.

**STATEMENT OF MRS. HASKELL ROSENBLUM, DIRECTOR, LEAGUE OF WOMEN VOTERS OF THE UNITED STATES**

Mrs. ROSENBLUM. Thank you, Senator Moss.

As Senator Moss and Senator Burdick both will remember, members of the League of Women Voters appeared at 21 out of the 22 field hearings of the Senate Select Committee on Water Resources. Leagues watched for the committee report and took its recommendations seriously. It is with pleasure therefore that I now appear as their representative to speak in upport of legislation to further the Senate committee's recommendations for expanded research.

From study of their own river basins and regions, league members spoke to the committee about the unsolved water problems of their home areas. Different as were the water needs described from Idaho and Indiana, from South Carolina and South Dakota, there was one need that appeared again and again as leagues carried on their studies. There was one problem basic to the polluted Potomac, the flooding Mississippi, the water-short lower Colorado, the salmon-rich Columbia. A quote from the California league will illustrate:

Research is an integral part of intelligent planning. There is need for more funds for basic data, more continuity in research and coordination of the data collected. \* \* \*

Every area had the problem of insufficient knowledge, every basin needed more information and better data. Leagues found that irrevocable decisions had to be made based at best on educated guesses. There were no answers to many of the questions league members asked. From our own experience we learned of the need for basic and applied research in the water field.

Efficient utilization and protection of our water supply is so important to national well-being that we think the Federal Government has a responsibility to encourage research in this field, research the need for which has been supported by many eminent scientists and politicians.

Members of the League of Women Voters have agreed that Federal, State, and local governments and private interests each has a responsibility for and should share in the cost of water resource planning and development. We are glad to see that title I, section 100(b) of this proposed legislation provides for Federal funds matched by funds from State or local government or private sources on a dollar-for-dollar basis.

League experience has given our members a belief in the efficacy of the grant-in-aid to increase investment of funds from other sources. We see no reason to doubt that Federal funds will lead other sources to increase investment in water research, particularly if the water research institutes which this bill will establish become centers attracting capable men and women and producing high-caliber work.

As mentioned in earlier testimony before this committee, the league is aware that specialists in the water field, especially competent research scientists, are in short supply. Federal financial aid to encourage the development of water research centers in a college or university of each State will indeed be seed money. Undergraduates today are searching for fields of specialization. Frequently the exposure to the interest and research of a professor is the stimulant the

student needs. Therefore the centers to be established by this legislation may well give many students the opportunity of seeing the possibilities of future careers in the water field.

We in the league are pleased to see that this bill suggests that social and political scientists may have a valuable contribution to make in water research. We do not wish to propose any changes in the legislation as it stands, but we hope that the committee report will put emphasis on this point. You gentlemen of this Senate committee will hear many eminent physical scientists and engineers stress the importance of expanding basic research and technology in these specialized fields. And important it is indeed.

But as the spokesman for the League of Women Voters, I would like to say that what bothers most citizens is not how to contain, purify, control, impound, or generate power from our water but what choice to make and whether there are suitable alternatives; not whether to make a choice between one large dam or several smaller ones, but possibly between a dam and something else—a better method of waste treatment or a natural recreation area; between the development of recreation or more irrigation or more industry. What are the economic effects? What combination of multipurpose installations will be best? Nowhere has there been consideration of a number of possible plans offering choice between real alternatives. For the research on which better water choices can be made, we need the economist, the statistician, the political scientist, as well as the engineers, the biologist, botanist, and geologist.

Senator Anderson, in his remarks introducing S. 2, mentioned his intention that the university centers should be established along these lines. I repeat, we hope the committee report will emphasize this intention.

The League of Women Voters is particularly aware of the importance of communication between specialists and citizens so that the discoveries of the one can be put into use through the interest and understanding of the other. One advantage of a water research institute eventually in every State will be the close association of laymen and specialists which is made possible when the professionals are close by and intimately acquainted with local conditions. These circumstances encourage communication.

A further encouragement would be the inclusion of communication experts and political scientists with other experts at these water institutions. Then methods may be developed to establish close rapport between the water consumers and the research experts in water resource development.

We hope too that the committee report may help to establish criteria for the projects to be undertaken. It would not be wise to make the bill too explicit but the report of the committee, we understand, has a binding effect on the executive agency responsible for administration. League members like to be sure that their tax money is used wisely. We would like to see in the committee report safeguards which will help insure that the financial aid goes to good projects, those which offer promise of greatest advance.

The suggestion that—

the service should use consultants and advisory boards to the fullest extent practical in identifying the research problems of most importance to be financed—

proposed by the Water Resources Committee of the Association of State Universities and Land-Grant Colleges merits attention. May I add support for spelling out that such advisory or selection committees also should be broad in composition and their members of recognized repute? Such a procedure would help to maintain citizen confidence in the quality of the sponsored projects and in the independence of the educational institutions.

The League of Women Voters is grateful for the opportunity to present its views to this committee. We hope that this proposed legislation will have a successful course through the Congress because we know that the need for water research is very great.

Senator Moss. Thank you very much, Mrs. Rosenblum, for that very fine statement and presentation of the position taken by the League of Women Voters. As always, you have some very constructive suggestions and we appreciate them very much.

Do you have any questions?

Senator METCALF. No questions.

Senator Moss. No questions. So thank you very much, Mrs. Rosenblum.

Mrs. ROSENBLUM. Thank you.

Senator Moss. Also a statement has been presented by Kenneth B. Pomeroy, chief forester of the American Forestry Association, and his statement will be made part of the record.

(The statement referred to follows:)

STATEMENT OF KENNETH B. POMEROY, CHIEF FORESTER, THE AMERICAN FORESTRY ASSOCIATION

The American Forestry Association wishes to submit the following statement in support of S. 2, the water resources research bill:

In October 1962 the American Forestry Association called together 40 of the Nation's leading conservationists. These men were assigned the task of drafting a comprehensive program for the intelligent use and management of natural resources on forests and related lands. These men represented every major segment of the entire conservation field. On the subject of water, they recommended:

"1. A continuing and more active program for the development and conservation of water supplies, including structures for the impoundment and transportation of water, and institution of forest and other vegetative management practices, where it has been demonstrated that greater and better timed water yields result and risks from erosion are minimal. To this end, research should be continued and intensified to determine the physical and economic consequences of programs of forest and other vegetative cover management.

"2. Research should be continued and intensified in the fields of weather modification, evaporation suppression and control of unnecessary losses from unproductive, water-wasting vegetation.

"3. Research designed to establish the relationship between land use practices and stream sedimentation should be carried forward to the point that the economic and conservation values of such practices can be appraised with reasonable accuracy.

"4. There should be active programs of physical science and economic research to establish practices and policies which will most effectively provide for pollution control and abatement."

The directors of the American Forestry Association endorsed the above recommendations at their regular board meeting on February 15, 1963. At the same time the directors endorsed the proposals contained in S. 2, the water resource research bill.

Senator Moss. This completes the list of witnesses who were scheduled to appear before this committee, and if there are no further matters to be heard, we will now stand adjourned.

(Whereupon, at 12:02 o'clock p.m., the hearing was adjourned.)

## ADDITIONAL STATEMENTS AND COMMUNICATIONS

In accordance with permission previously granted, the following communications and statements received subsequent to the hearings on S. 2 are included in the hearing record :

U.S. SENATE,

Washington, D.C., February 25, 1963.

HON. CLINTON P. ANDERSON,  
*Chairman, Senate Committee on Interior and Insular Affairs,*  
Washington, D.C.

DEAR CLINT: As you know, a Senate assignment overseas made it impossible for me to testify in support of S. 2 when hearings were held earlier this month. I am therefore pleased as a cosponsor of the bill to have this opportunity to submit a written statement endorsing this legislation which will further stimulate our national water research program.

Cordially yours,

ERNEST GRUENING, *U.S. Senator.*

STATEMENT OF HON. ERNEST GRUENING, A U.S. SENATOR FROM THE STATE OF ALASKA

Every available statistic indicates the severity of the water shortage which faces the Nation. Already some States have experienced the fears and frustrations arising from inadequate water reserves. I am pleased as one of the cosponsors of S. 2 to have the opportunity to endorse this legislation which will further stimulate our national water research program.

President Kennedy's task force on water resources has reported that water is being mined at an alarming rate throughout the Nation. Obviously such "mining" must be judicious. Waste must be eliminated. Water reuse methods must be found. Less expensive ways to desalinize ocean waters must be perfected. And water pollution must be ended.

These are major goals which the States cannot accomplish alone.

As a nation, we have come to realize that we are no longer blessed with the never-ending abundance which our forefathers found and too often wasted.

We have the opportunity to conserve our water resources. The tools of S. 2 would supplement rather than supplant the existing programs of the Federal agencies.

I approve of legislation which would make available to the State universities and colleges moneys which would establish within each State a water resources research institute, center, or equivalent agency. I support the use of matching funds available on a dollar-for-dollar basis to State water resources research institutes or centers "to meet the necessary expense of water resources research projects which could not otherwise be undertaken \* \* \*."

In Alaska where a water pollution research laboratory is being located at the University of Alaska, in College, water research as it relates to the Far North is vital. The environmental studies planned at the State university will have far-reaching effects and will be of national and international interest.

The support envisioned in S. 2 will be helpful to the 49th State. Casual observers, I find, are likely to conclude that Alaska's water resources are unlimited. It is true that our coastline extends 34,000 miles, that we have thousands of lakes and streams and that the fifth largest river in North America, the Yukon flows across the top portion of the State.

It is also true that Alaska's usable water supply is limited. When U.S. Public Health Service employees examined the State's water they found that many of the streams were "fouled with glacial flour." They reported, too, that "extremely wide fluctuations in flow impose drastic limits on the usability of many other streams."

The extent of Alaska's ground water resources is unknown. It seems probable that the State will have to depend upon its surface waters for the majority of its water requirements. But research is necessary to determine the validity of such a probability.

Alaska will have, in future years, the industry it desires. Alaska also will have the problems which industry brings—such as stream pollution from pulp and paper mills. Alaska can better meet such challenges if it is armed properly.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS,  
*Washington, D.C., March 1, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Senate Interior and Insular Affairs Committee,  
 U.S. Senate, Washington, D.C.*

DEAR SENATOR ANDERSON: There are several items upon which the National Society of Professional Engineers wishes to comment in connection with your Water Resources Research Planning Act (S. 2). The national society is a non-profit, membership organization composed of professional engineers in virtually every specialized branch of engineering practice and type of employment. All of the society's approximately 60,000 members are licensed under applicable State engineering registration laws, and are affiliated through 53 State and territorial societies and about 450 local community chapters. It is respectfully requested that the views and recommendations contained in this letter be made a part of the record of the hearings on your bill.

Following introduction of your bill, a report was sent out to all of the society's local chapters and State societies. Many of these chapters and State societies have continuing committees on water resources problems and proposals, composed of individuals highly knowledgeable in this most important, complex field. These State societies and local chapters were asked to submit their comments and recommendations to the headquarters of the national society so that they might be made available to you and your committee in considering recommendations and changes in the measure.

The National Society of Professional Engineers is keenly cognizant of the importance of the Nation's water resources. In order that these resources may properly be developed, utilized, and conserved within the national interest, the society approves the objectives of S. 2, but does have some reservations about the measure in its present form.

One of the principal concerns voiced by our State and local chapters is that the programs on the State level be closely coordinated with ongoing programs under the jurisdiction of many other Federal, State, and local agencies. While it is recognized that every State has problems in connection with water resources which are peculiar to that State or region, there is still, in many instances, a considerable degree of common problems with other jurisdictions. In addition, there is keen concern that programs developed and carried on in the State or regional institutes be of the highest possible quality, leading to the most efficient use of expenditures. An additional concern is that the program on the State level not be dominated by one particular discipline or segment of a State university or college to the detriment of the overall purposes of the program.

We believe that these principal concerns which were expressed by our constituent State and local societies may be resolved by the implementation of the following legislative amendment to the present bill:

NATIONAL ADVISORY COMMITTEE ON WATER RESOURCES

It is recommended that the enabling legislation provide for a National Advisory Committee on Water Resources composed of engineers, scientists, and members of other disciplines concerned with water resources research which would advise the Secretary of Interior on the types, coordination, and management of programs to be conducted. This Committee would also be charged with advising the Secretary on necessary administrative guidelines, directives, and other matters of policy in connection with the overall objectives and purposes of the act. Language should be so drafted as to permit the establishment of additional committees to be charged with specific studies and projects.

While Secretary Udall has indicated his intention to administratively provide for such an advisory council and to consult with various experts, there appears to be little reason for objection to the establishment of a legislative mandate to effect this result. As we all are aware, administrators come and go, but if a sound long-range Federal program is to be developed, the enabling legislation should be equally sound and provide for unanticipated eventualities. The Department of Interior has advised (informally) that they would have no objection to the legislative requirement herein recommended.

It is respectfully submitted that the adoption of this recommendation will be in accord with the overall objectives of the proposed act and strengthen its administration. We have taken the liberty of drafting an amendment regarding the establishment of an Advisory Committee, which is attached to this letter.

If we may be of further assistance to you in any manner, please do not hesitate to contact us.

Very truly yours,

PAUL H. ROBBINS, *P.E., Executive Director.*

PROPOSED AMENDMENT OF THE NATIONAL ADVISORY COMMITTEE ON WATER RESOURCES

SEC. —. (a) There is hereby established in the Department of Interior a National Advisory Committee on Water Resources (hereinafter referred to as the "Committee"). The Committee shall consist of the Secretary, who shall be Chairman, and twelve persons appointed without regard to the civil service laws by the Secretary. The membership of the council shall contain representation from engineering, scientific, and other interested professions concerned with the development of water resources.

(b) Appointed members of the Committee, while attending meetings of the Committee or while otherwise serving at the request of the Secretary, shall be entitled to receive compensation at a rate to be fixed by the Secretary, but not exceeding \$75 per diem, and shall also be entitled to receive an allowance for actual and necessary traveling and subsistence expenses while so serving away from their places of residence.

(c) The Secretary may appoint such special advisory and technical committees as may be useful in carrying out his and the Committee's functions under this title.

(d) The Committee shall—

(1) Advise, consult with, and make recommendations to the Secretary on matters of basic policy arising out of the administration of this Act;

(2) Consult with the Commissioner in the formulation of all regulations, standards, and criteria promulgated by him in carrying out this Act; and

(3) Perform such services as the Secretary may delegate to it.

(e) The Secretary may utilize the services of any member or members of the Committee in connection with matters relating to this Act, for such periods, in addition to conference periods, as he may deem appropriate.

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WESTERN WASHINGTON STATE COLLEGE,  
DEPARTMENT OF BIOLOGY,  
*Bellingham, Wash., February 27, 1963.*

Re Lake Whatcom study project.

HON. CLINTON P. ANDERSON,  
*U.S. Senate, Washington, D.C.*

DEAR SIR: We were most pleased to read recently of your bill for Federal support of basic water research. We would certainly rise to second the statements of Mr. Jerome B. Wiesner quoted in the enclosed newspaper clipping. This bill is not only timely from the standpoint of national well-being but would also serve to complement some of the work which is being done here in Washington on both local and State levels. On April 1, 1962, the city of Bellingham entered into an agreement with the undersigned of the Biology Department of Western Washington State College to make a complete limnological investigation of Lake Whatcom, our city reservoir. Several factors prompted us to undertake this investigation. In the first place this lake is large, approximately 12 miles long, averaging a mile in width, and has a mean depth of about 150 feet. It has been used for many years as a center of recreation, as well as for the reservoir of industrial and domestic water supply. In the past it has been used quite extensively in the lumbering industry with at one time 11 sawmills located on the lake. With the increase in demands for water for both industrial and domestic needs, the Water Board of the City of Bellingham took the very bold step of providing for the diversion of water from the Middle Fork of the Nooksack River some 20 miles distant through a pipeline into Lake Whatcom. With this, the lake level can be maintained, and adequacy of water supply is insured. The introduction of this water from a new source coincided with the unique granting by the city of money for basic limnological research on Lake Whatcom. Probably the most unique feature in this agreement between the city and Western Washington State College was that there was no serious pollution problem in the lake at the time. It was the desire of the members of the water board simply to find out all that they could about their reservoir.

Lake Whatcom is divided into three distinct depressions; that is, there are three regions to the lake which are quite distinct from one another in a number of ways. The differences between the various parts of the lake are so great, in fact, that under some systems of classification these various regions would fall into different lake categories. Some of our findings concerning the amount of dissolved oxygen at various depths and various regions of the lake have already been used in support of measures to move the water supply source for one of the State fish hatcheries. Our work on coliform analysis has shown that much of the lake is quite free from human fecal pollution but that there are certain regions that bear close watching. Since the new source of water—the Nooksack River—was from an area of glacial melt, we were prompted to undertake investigations of the microchemical variations in water quality and the effects these might have on plants and animals in the lake. We are conducting a qualitative and quantitative study of the radioisotopes present both in the water from the Nooksack River and from the bulk of the lake.

The initial grant from the city was for \$3,700. With this and with whatever other resources—volunteer help, equipment loans, etc.—we could tap, we were able to complete the first year of our study. Recently, the city water board allocated \$8,000 to continue support for our project for an additional year. The second year's grant was given with the firm understanding that after April 1, 1964, our project would rely on support from other sources. It should be pointed out here that we have obtained assistance gratis in the nature of laboratory analyses from the University of Washington and from the Washington State University.

We have submitted one report thus far to the city of Bellingham giving findings of our first half year of study and are in the process now of preparing our first annual report. The Washington State Pollution Control Commission has agreed to publish the results of the first year of our study and has expressed a very strong interest in our project. The assistant director of the Washington State Pollution Control Commission has approached us casually in regard to the possibility of our doing contract work for limnological investigations for other lakes in the region. We are not in a position to undertake such endeavors at the present time, but this request certainly fits in with our long-term plans. It is our intent to establish here at Western Washington State College a center for limnological studies.

We anticipate that when a center for the study of water is established in Washington—as indeed a center must be established, hopefully, through the mechanics of your bill—we may be competing with other State institutions of higher education for its location. Our interest in establishing the center here at Western does not stem from idle dreams, however. Western Washington State College is the fastest growing of the State colleges, and our department has for many years emphasized the ecological approach to the study of biology. Our campus is ideally situated for such an approach, of course—only a few minutes from salt water, and we can travel to the foot of a glacier within an hour and a half. Fresh water and estuarine situations of all sorts abound within a 50-mile radius of the campus. We are strategically located also, about halfway between the Universities of Washington and British Columbia.

The foregoing comments, we hope, will serve to emphasize our strong support for your measure. We would appreciate receiving a copy of the bill as soon as it is available. If there is any way in which we might assist you in support of passage of this bill, please do not hesitate to call upon us.

Sincerely,

GERALD F. KRAFT,  
*Instructor of Zoology.*

CHARLES J. FLORA,  
*Associate Professor of Zoology.*

[From the Bellingham Herald, Feb. 22, 1963]

#### JFK'S SCIENCE ADVISER URGES CONGRESS TO PROVIDE MONEY FOR BASIC WATER RESEARCH

WASHINGTON (UPI).—President Kennedy's Science Adviser went to Capitol Hill today to urge Congress to provide money for basic water research in special centers throughout the Nation.

Jerome B. Wiesner appeared before the Senate Interior Committee in behalf of a bill written by Senator Clinton P. Anderson, Democrat, of New Mexico.

"The water resources problems facing the Nation are of such scope and complexity as to justify immediate steps to broaden and strengthen research on those problems," Wiesner said. He added there was a "need to enlist and increase combined efforts of scientists, engineers, economists, and other scholars for research and graduate education in the several disciplines underlying water resources."

Wiesner said nature blessed the country with an abundance of water. But he added that variations in geographical distribution and rapid population growth and industry expansion "have combined to pose mounting problems of availability of water of adequate quality."

"Consequently, the development of water resources has become one of the largest single activities in the United States," he said. "Water resource development, encompassing all sectors of society, presently involves an expenditure of about \$10 billion every year, and the rate is rapidly increasing."

But too small a fraction of this yearly investment is devoted to research. Wiesner said research needs ranged from basic research on the nature of water to studies in the social sciences with respect to management of water resources.

"If we are to make headway in anticipating and ameliorating water shortages, it is necessary to develop and mobilize the scientific and technical capabilities of our research institutions, Federal and State, public and private," Wiesner said.

Anderson's bill seeks to provide up to \$100,000 for each State to set up a water research center. It also would authorize \$5 million annually in matching funds for the States to use in water research, and \$10 million a year in grants-in-aid to universities, colleges, and research centers.

Aims of the Anderson bill, introduced shortly after Congress convened, anticipated recommendations in a special water message the President sent to Capitol Hill Monday.

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SOUTH DAKOTA STATE GEOLOGICAL SURVEY,  
*Vermillion, February 26, 1963.*

Hon. GEORGE MCGOVERN,  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR MCGOVERN: I certainly appreciate the opportunity to have been able to discuss with you on February 19 the Anderson bill (S. 2) which would establish water resources research centers. I also appreciate your taking such an interest in this type of legislation, which will be of such great importance to us in South Dakota as well as in other parts of the Nation.

Although agreeing with the principle of S. 2, I should like to repeat my concern about certain parts of the bill.

We all agree that water problems are going to loom as an increasingly important part of our life in the future, and will govern in large measure the growth and development of all parts of the Nation. We will also agree that research on water problems is badly needed—Secretary Udall stressed this point in the hearings when he stated that only 0.75 percent of the total being spent on water projects is earmarked for research, as opposed to the 3 to 5 percent which "industries" spend. I have seen elsewhere that the figures are 0.5 percent compared with 2 percent; although the numbers differ, the ratio tells the sad story: We are spending for water research at the rate of only one-fourth as much as is being spent on research in all other fields.

(1) Now that the need for research is established, who is going to do it? This, I feel, is one of the major modifications that I would suggest for bill S. 2. It should give greater emphasis to the training of personnel. This would result in more men being available to do the research—thus, more research and better research accomplished. In emphasizing the training aspect, research could be initially related to the teaching field—research for theses in conjunction with their attaining the academic degrees. Then, when more manpower becomes available in the water field, increased emphasis on research would be a more fruitful expenditure of money. You will recall that Secretary Udall agreed with your views when you expressed this sentiment at the hearing.

(2) Another major flaw in the bill, it seems to me, is that it does not make adequate provision for existing water research that is being carried out by existing Federal and State agencies, such as the U.S. Geological Survey or the South Dakota Geological Survey. Thus I feel that the language should be strengthened in title III, sec. 300 (line 25 on p. 8 and lines 1-2 on p. 9) and sec. 301 (line 3 on p. 10) to provide not only for lack of duplication, or diminishing

existing authorities on responsibilities, but to go further and stress that such Federal and State agency activities should be increased.

(3) Another great fear that I have is that the program will be so fragmented, with one institute being established per State, plus at least an equivalent amount of money available for research at other schools in that State, that not as significant results will be accomplished as if only a relatively few (say 10 to 15) institutes were thus supported initially. This would permit better coordination of research activity, would result in awards going to institutes or institutions which have a significant number of trained personnel, and would permit guidelines to be established for the possible later expansion of this activity into every State. Actually, after the first few trial years of the program, it may be concluded that it would be less economic to have such institutes in every State but rather that regional institutes such as those mentioned in the bill would function best in some parts of the Nation.

(4) I feel that it is of great importance to insure that the collection of basic data be continued as a major effort of the Federal agencies so doing. (U.S. Geological Survey is the major one.)

(5) I think it important that research be carried on in two different areas—basic (or fundamental) research and applied research. The latter usually has an immediate application to administration and regulation, although it depends for its efficiency and success on the former. Thus, I would suggest an added section under title III to stress this need.

Now, I should like to comment on the testimony given by the representatives of the State land-grant universities and colleges on the afternoon of February 19.

President Elkins, of the University of Maryland, stressed the need for manpower for research and teaching, and I obviously agree wholeheartedly with him.

However, I must disagree vociferously with the comments of President Aldrich, of California, on this same subject. His argument was most persuasive and beautifully expressed; in fact, it has been a long time since I have heard as eloquent a statement as the testimony of Dr. Aldrich. Nevertheless, despite what Dr. Aldrich said, adequately trained personnel for a water research program as provided for in bill S. 2 are not available presently at the State land-grant universities and colleges, or anywhere else on the scale called for by S. 2. A few are present at universities and colleges, and many more exist in the Federal and State water research agencies, but they must not be pirated.

Furthermore, if Dr. Aldrich would provide these research personnel from positions they are currently occupying at the schools, what is to become of the work that they formerly did? Is it so insignificant that it can be relegated to a state of suspended animation?

And last, I do agree with Dr. Aldrich on his reply to Senator Moss' query as to why not concentrate the expanded research activity in the existing Federal agencies rather than the States. Dr. Aldrich's reply, as you recall, was that "genius is where you find it," and he expanded his answer to say that the scientists in the Federal scientific groups are not reproducing their kind, as is a teacher at a university. And that the fresh, untrammled young minds are more venturesome at questioning established principles and scientific authority, and that this exchange of student and professor has greater chance of uncovering new principles, new ideas. I am sure that, as a former professor at Dakota Wesleyan, that you will agree, as do I.

In summary then, bill S. 2 is a move in the right direction, but I urge that it be modified in at least five major ways:

(1) Training of research workers in water resources is of primary importance, not secondary.

(2) The importance of existing research in water resources by existing Federal and State agencies should be stressed.

(3) Institutes should be established initially at only selected schools, rather than by using the scattergun approach.

(4) Increased effort in the collection of basic data (especially by Federal and State agencies already active in this process), as a basis for research ideas and experimentation, should be specified.

(5) The difference between basic and applied research should be recognized, and adequate provision should be made for the former, lest the more striking and newsworthy results of the latter cause basic research to be overlooked.

(6) An adequate supply of trained personnel is not available (despite President Aldrich's statement to the contrary), and must be provided for. (See par. (1), above.)

(7) Research work should not be concentrated in the Federal or State agencies, but must be carried out in increasing amounts at selected schools more adequately equipped and staffed than others. Certainly, this should not need to include at least one school in each State, and it even more emphatically should not be confined to land-grant institutions. I would remind President Aldrich that his statement "genius is where you find it" is true, and that such genius also exists in State or private universities or colleges that are not land-grant ones.

Again, I appreciate the opportunity to have been able to discuss some of my views with you at the time of the initial hearings on bill S. 2, and the opportunity to elaborate on them herein.

If there is further information that you wish regarding this matter, I shall be glad to try to supply it.

Sincerely yours,

ALLEN F. AGNEW, *State Geologist.*

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STATE OF ILLINOIS,  
STATE WATER SURVEY DIVISION,  
*Urbana, February 28, 1963.*

HON. CLINTON P. ANDERSON,  
*Chairman, Committee on Interior and Insular Affairs,  
U.S. Senate, Washington, D.C.*

DEAR SENATOR ANDERSON: This letter relates to Senate bill 2, 88th Congress, 1st session, known as the Water Resources Research Act. I am writing as president of the section of hydrology and chairman of the committee on status and needs in hydrology of the section of hydrology of the American Geophysical Union. This committee is composed of the leading hydrologists in this country. Meeting in Chicago on February 13-15, 1963, this committee adopted a position in opposition to S. 2 which is incorporated in this letter. Appended to this letter are statements of position on other mechanisms related to the advancement of the science of hydrology which are currently also under active discussion in this country, and in the committee membership.

The committee on status and needs in hydrology concurs in the great need to accelerate both research and education in the water sciences. It believes that only through this fundamental approach will we ultimately achieve the new body of knowledge and the competence to meet the challenge facing this Nation and the world in making efficient and maximum beneficial use of its water resources.

Therefore, the committee concurs in the need and the urgency regarding water sciences which you have so well expressed. It also agrees with the necessity of looking to our universities as the principal mechanism through which these needs can be met, and to the necessity of increased Federal support.

The committee also wishes to congratulate you in your great interest in this matter and also the manner in which the earlier version of S. 2 was introduced last July. This action certainly has promoted widespread interest and discussion which has been wholesome. It is therefore with some regret that we oppose S. 2 in its present form. I shall try to convey some of our thinking as developed in extensive discussion.

Although the success of the land-grant college approach in agriculture cannot be denied, it does not necessarily follow that this approach—100 years later and in a different area—is right for water resources research. For one thing the establishment of 50 water resources centers does not mean that only 50 would exist. A number of universities, not in the land-grant or even the State university systems, presently are prominent in water research and should be encouraged to so continue. We might name Stanford University, Johns Hopkins, Harvard, MIT, and the California Institute of Technology to mention but a few of more than a dozen such universities. There are other State or independent institutions such as the Desert Research Institute, the Illinois State Water Survey, Battelle Institute, and others which are widely recognized as centers of hydrologic research. Of course, there are literally dozens of research centers and laboratories carrying on hydrologic research in such Federal agencies as the Agricultural Research Service, the Forest Service, the Public Health Service, and the U.S. Geological Survey. With the additions consequent to S. 2, therefore, there would be more than a hundred centers of hydrologic research which we believe is more than we require or can afford. By "afford" is meant not only dollars but competent talent to staff.

Discussions indicate that in many instances it will be very difficult for the State Governors or legislatures to determine which university should be the center. As a matter of fact, it can be safely predicted that despite your very best intentions there will be much controversy over who receives these funds—both because of the money involved as well as the prestige.

As you will note from the appended material, the committee on status and needs in hydrology has a great deal of confidence in existing granting agencies of the Federal Government; for example, the National Science Foundation. We believe the NSF is well aware of the needs for greatly expanded research in hydrology, and if adequately funded, will support worthy proposals which will lead to expanded education and research in this field. The system of project justifications, review, and reports which they employ, as does the National Institutes of Health and other organizations, are very wholesome. These prevent the deadwood and inactive projects which exist only on paper when an assured annual appropriation is available.

The complete statement of the committee on status and needs in hydrology follows. Other actions and the committee membership are appended.

"This committee strongly favors increased Federal support of education and research in hydrology and water resources.

"The committee desires action that will emphasize increased Federal support for training and education of water resources personnel and for water resources research. This support may well be administered by the National Science Foundation and other appropriate Federal agencies. We believe that institutions with established or immediately potential programs and capabilities should be the initial recipients of such support.

"The committee opposes enactment of Senate bill 2 and its companion bill in the House (88th Cong., 1st sess.) in their present form because the provisions of this bill do not allow adequate measures of economy and efficiency. With this in mind, the committee urges the president of the Hydrology Section, American Geophysical Union, or his designate to convey these views to the appropriate congressional committees."

Very truly yours,

WILLIAM C. ACKERMANN, *Chairman.*

STATEMENT OF AMERICAN GEOPHYSICAL UNION, SECTION OF HYDROLOGY,  
COMMITTEE ON STATUS AND NEEDS IN HYDROLOGY, REGARDING INSTITUTIONS AND  
MECHANISMS, ADOPTED FEBRUARY 15, 1963

The Committee on Status and Needs in Hydrology of the Section of Hydrology, American Geophysical Union, meeting in Chicago on February 13-15, 1963, has considered alternative institutions and mechanisms to advance national and international programs of education, research, planning, and operations relating to hydrology.

The committee has studied and discussed the background and problems related to a number of subject areas and concurs on each as stated below. The committee recommends that immediate steps be taken to place in operation the specific actions herein included:

(A) JOURNAL DEVOTED EXCLUSIVELY TO HYDROLOGY

The committee believes that there is a need for a new journal dealing exclusively with hydrology.

We propose that the new journal be entitled "Hydrology," a name that has the elegance of simplicity and completeness. We believe that words such as "journal" or "sciences" are unnecessary, and that terms such as "research" may be unnecessarily limiting or restrictive, as there is considerable desire for an outlet for papers of an applied and descriptive nature.

We propose also that high standards of scientific quality be maintained, and that the subject matter deal with hydrology as a geophysical science including the applied phases.

We propose that action on this journal be contingent on the recommendation of the subcommittee established to consider the "American Hydrological Society."

The American Geophysical Union serves hydrology as a meeting ground for scientists who have their backgrounds in diverse fields and who carry out their research in different parts of the hydrologic cycle.

We believe that the present Journal of Geophysical Research does not adequately fulfill the needs. Hydrological papers are lost in its title and lost in its

bulk. This situation has tended to discourage the publication of hydrologic papers in the Journal of Geophysical Research so most hydrological papers now appear in several other journals. Hence the American Geophysical Union is rapidly losing its effectiveness as a cohesive force in hydrology.

We believe that the new journal would provide needed visibility and focus for hydrology. We are convinced that the proposed journal would elicit a renewed flow of significant papers toward the AGU and lead toward increased membership among the many hydrologists engaged in vast programs of water resources development. Moreover, the identification afforded by a new journal would help attract competent talent to this growing field and would enable the AGU to keep pace with the resurgence in hydrologic research.

Further, we believe that the Journal of Geophysical Research should continue as the place of publication of broad interdisciplinary papers, and that it is essential to retain our association with and interest in geophysics both to provide the proper development of hydrology and to maintain our comprehensive understanding of the earth.

#### (B) AMERICAN HYDROLOGICAL SOCIETY

The committee considered the advisability of organizing a professional and scientific society as a means of advancing and gaining recognition for hydrology.

Although there is much to be gained through establishment of a society dedicated to a specific field, there are adverse aspects which cannot be overlooked. Therefore, the president of the section of hydrology is urged to appoint a subcommittee to give the matter full consideration. It is requested that this subcommittee render a report at the next meeting of the committee on—

(1) The feasibility of achieving greater autonomy and recognition for hydrology within the structure of the American Geophysical Union and the extent to which the needs for a professional-scientific society could be met within the union; and

(2) The feasibility and desirability of creating a separate society for hydrology at an appropriate time in the future.

#### (C) UNIVERSITIES COUNCIL ON HYDROLOGY

The committee unanimously endorses the universities council on hydrology in its objective of fostering and furthering education and research in the field of hydrology.

The growing importance of water resources both nationally and internationally requires that education and research programs be augmented and strengthened in the immediate future. We believe that the UCOH should be responsive to the needs of public agencies and private organizations concerned with the broad field of hydrology. Further, we believe that the activities and programs of UCOH should be coordinated with those of the Section of Hydrology, American Geophysical Union.

#### (D) ORGANIZATION FOR ADMINISTRATION AND HYDROLOGICAL PROPOSALS IN THE NATIONAL SCIENCE FOUNDATION

The committee believes that—

(1) The present organization of the National Science Foundation is adequate to process the hydrological research proposals submitted at the present time.

(2) The number of proposals at present is too low in relation to the hydrological research needs. A clear, forceful statement of research needs and opportunities should be prepared to promote the hydrological program of the National Science Foundation.

(3) The National Science Foundation should facilitate and stimulate the development of basic hydrological research by (a) supporting on an expanding basis the development of faculties, students, and facilities in educational institutions concerned with research and education in hydrology; and (b) the recognition of hydrology as an identifiable entity within the National Science Foundation.

#### (E) HYDROLOGY COMMITTEE IN NATIONAL ACADEMY OF SCIENCES

The committee recognizes the important need for a committee on hydrology and recommends that the president, Section of Hydrology, American Geophysi-

cal Union, contact the Chairman, Earth Sciences Division, National Research Council, with a view to formation of a Committee on Hydrology within the framework of the National Academy of Sciences-National Research Council.

## (F) WATER RESOURCES RESEARCH INSTITUTES

This committee strongly favors increased Federal support of education and research in hydrology and water resources.

The committee desires action that will emphasize increased Federal support for training and education of water resources personnel and for water resources research. This support may well be administered by the National Science Foundation and other appropriate Federal agencies. We believe that institutions with established or immediately potential programs and capabilities should be the initial recipients of such support.

The committee opposes enactment of Senate bill 2 and its companion bill in the House (88th Cong., 1st sess.) in their present form because the provisions of this bill do not allow adequate measures of economy and efficiency. With this in mind, the committee urges the president of the Hydrology Section, American Geophysical Union, or his designate to convey these views to the appropriate congressional committees.

## (G) INTERNATIONAL MECHANISMS FOR FORMULATING AND CARRYING OUT THE PROGRAM OF THE INTERNATIONAL HYDROLOGICAL DECADE

The committee expresses its deep and active interest in the concept of an international program in scientific hydrology. In furtherance of this program it is resolved that the President appoint a subcommittee to represent our interests on a continuing basis between assembled meetings.

We further request this subcommittee to convene at the earliest possible opportunity and as may be needed in the future to represent and convey the interests and views of the committee. It shall also be the responsibility of the subcommittee to inform the committee of activities, actions, and mechanisms related to the international hydrological decade.

## (H) COMMITTEE ON STATUS AND NEEDS IN HYDROLOGY

The committee recommends that its chairman seek financial support from appropriate sources to permit the committee to meet again to address itself to an overall evaluation of the status and needs of hydrology.

## AMERICAN GEOPHYSICAL UNION, SECTION OF HYDROLOGY, COMMITTEE ON STATUS AND NEED IN HYDROLOGY, IN ATTENDANCE AT SECOND CONFERENCE OF AMERICAN HYDROLOGISTS

William C. Ackermann, chairman, Illinois State Water Survey, Urbana, Ill.

Henry W. Anderson, California Forest and Range Experiment Station, Berkeley, Calif.

James A. Bender, Chief, Research Division, U.S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, Hanover, N.H.

Dr. W. E. Benson,<sup>1</sup> National Science Foundation, Washington, D.C.

Prof. George S. Benton, Department of Mechanics, Johns Hopkins University, Baltimore, Md.

Dr. Paul Bock, Hydrology and Water Resources Division, Travelers Research Center, Hartford, Conn.

Dr. Norman H. Brooks, Hydrodynamics Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Dr. Ven Te Chow, University of Illinois, Urbana, Ill.

Dr. N. A. Christensen, College of Engineering, Cornell University, Ithaca, N.Y.

Robert H. Clark, Hydraulics Division, Department of Northern Affairs and National Resources, Ottawa, Ontario, Canada.

Dr. Robert E. Dils, College of Forestry and Range Management, Colorado State University, Fort Collins, Colo.

Leonard B. Dworsky, U.S. Public Health Service, Washington, D.C.

<sup>1</sup> Consultant to the 2d Conference of American Hydrologists.

- William O. Field, American Geographical Society, New York, N.Y.  
 Lloyd L. Harrold, research project supervisor, Agricultural Research Service, Coshocton, Ohio.  
 John W. Harshbarger, Department of Geology, University of Arizona, Tucson, Ariz.  
 William E. Hiatt, Hydrologic Services Division, U.S. Weather Bureau, Washington, D.C.  
 Edward A. Johnson, Central States Forest Experiment Station, U.S. Forest Service, Columbus, Ohio.  
 Dr. Don Kirkham, Department of Agronomy, Iowa State University, Ames, Iowa.  
 Victor A. Koelzer,<sup>2</sup> Harza Engineering Co., Chicago, Ill.  
 Max A. Kohler, Division of Hydrologic Services, U.S. Weather Bureau, Washington, D.C.  
 Walter B. Langbein, U.S. Geological Survey, Department of Interior, Washington, D.C.  
 Dr. Luna B. Leopold, U.S. Geological Survey, Department of Interior, Washington, D.C.  
 Ray K. Linsley, Department of Civil Engineering, Stanford University, Stanford, Calif.  
 Dr. George B. Maxey, Desert Research Institute, University of Nevada, Reno, Nev.  
 Dr. Mark F. Meier, U.S. Geological Survey, Tacoma, Wash.  
 Dr. Raymond L. Nace, U.S. Geological Survey, Department of Interior, Washington, D.C.  
 H. O. Ogrosky, Chief, Hydrology Branch, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.  
 Dr. Sverre Petterssen,<sup>1</sup> Department of Geophysical Sciences, University of Chicago, Chicago, Ill.  
 Harman F. Smith, Illinois State Water Survey, Urbana, Ill.  
 Franklin F. Snyder, Office of Chief Engineer, Corps of Engineers, U.S. Army, Washington, D.C.  
 Waldo E. Smith, ex officio, American Geophysical Union, Washington, D.C.  
 Kenneth C. Spengler,<sup>1</sup> American Meteorological Society, Boston, Mass.  
 Dr. David K. Todd, Department of Civil Engineering, University of California, Berkeley, Calif.  
 Dr. Harold E. Thomas, U.S. Geological Survey, Menlo Park, Calif.  
 Dr. C. H. M. van Bavel, chief soil scientist, U.S. Water Conservation Laboratory, Tempe, Ariz.  
 Dr. Cecil H. Wadleigh, Director, Soil and Water Conservation Research Branch, Agricultural Research Service, Beltsville, Md.  
 Dr. H. G. Wilm,<sup>2</sup> commissioner, Department of Conservation, State of New York, Albany, N.Y.  
 Ralph N. Wilson,<sup>2</sup> Office, Chief of Engineers, Corps of Engineers, Civil Works, Washington, D.C.  
 Walter T. Wilson, Hydrologic Services Division, U.S. Weather Bureau, Washington, D.C.  
 Dr. M. Gordon Wolman, Department of Geography, Johns Hopkins University, Baltimore, Md.

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SOUTH DAKOTA STATE COLLEGE,  
 DIVISION OF AGRICULTURE,  
*Brookings, S. Dak., February 15, 1963.*

HON. GEORGE MCGOVERN,  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR MCGOVERN: The legislation proposed in Senate bill 2 could have far-reaching implications on the development of the Nation's water resources. The bill patterns a program comparable to two time-tested acts, the Hatch Act and the Smith-Lever Act, which have so effectively complemented the program envisioned by the Land Grant College Act of 1862.

The principle of decentralizing research among the several States is a basic tenet of S. 2 and of the Hatch Act. I believe in this philosophy because it provides a means whereby research in the field of water resource development can be done under a wide range of problem areas. Furthermore, such a program

<sup>1</sup> Consultant to the 2d Conference of American Hydrologists.

<sup>2</sup> Unable to be present at 2d Conference of American Hydrologists.

will stimulate the training of scientists as a byproduct of the research programs in the several land-grant colleges. The bill makes provision for overall coordination of the research program between the States and departments of the Federal and State governments—a precedent successfully established by the land-grant colleges and the Department of Agriculture. More research undertakings require an interdisciplinary approach which is available on college and university campuses. It would seem that this kind of an approach would have a salutary effect on research progress in a field so complex as that of water resource development and conservation. I am particularly pleased that specific provisions have been made in section 104 of the proposed act that direct coordination of the research with State water resource research agencies. This is most important if we are to develop a research program in a given State geared to the needs and opportunities within a State.

South Dakota State College is actively concerned with the development of our water resources. Our problems are characteristic of those indigenous to the Great Plains area and include the variability of rainfall as it threatens the economic stability of the region's major industry—agriculture. Besides an inadequate supply of water, the quality of water available to municipalities is poor and frequently hampers urban and industrial growth. Fluctuating water supplies interfere with the State's future development of recreational areas and profitability of converting land from agriculture to other uses such as recreation. We look at water resource development as one of the tools for increasing the employment opportunities for young people within the State.

For these reasons South Dakota State College has committed resources to research, teaching, and extension programs that are related to water resource development. We are limited in funds and personnel but, given additional support, we could expand our research into such areas as evaporation reduction, desalination of water, the development of small-scale water treatment facilities, and expanding studies on the improved utilization of water in agriculture. We now have work in process at several locations with the experiment station. These include Newell, Redfield, and Centerville, in addition to field and laboratory studies here at Brookings.

The resources of the extension service have been and will continue to be committed to educational programs aimed at assisting people organize sub-conservancy irrigation districts and watershed development projects. The interest of people of our State in water resource development is indicated by the overwhelming vote to organize and tax themselves for these developments. We heartily commend you for cosponsoring S. 2. If the legislation and the bill are enacted, it will enable South Dakota State College to expand and carry on greatly needed research programs from which will come results of importance to the future of our State and Nation.

Sincerely yours,

ORVILLE G. BENTLEY,

*Dean, Division of Agriculture, and Director of Experiment Station.*

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STATEMENT OF THE AMERICAN FARM BUREAU FEDERATION, JOHN I. TAYLOR,  
ASSISTANT LEGISLATIVE DIRECTOR, FEBRUARY 26, 1963

Water—one of the vital elements necessary to sustain life—is the general subject of the legislation proposed in S. 2. Farmers and Farm Bureau are very interested in water and in its future capabilities. Research in this field, compared to the extent this bill proposes, has been quite limited. The exploration of the many phases of water should have a great influence on its future use—its attainment—its disposition.

While much work has been done on its handling and conservation, even these factors need further research.

This bill S. 2 proposes to establish water research centers at land-grant colleges and State universities, to stimulate water research at other colleges, universities, and centers of competence, and to promote a more adequate national program of water research.

At our latest annual meeting, held in Atlanta, Ga., on December 12-14, 1962, we said:

“We favor a continued and expanded research program on conversion of saline water, air pollution, water and soil conservation, drainage, forestry manage-

ment, restoration of strip mining areas, and other natural resource problems, within the present framework of Federal-State-private cooperation."

We further said: "The Government must exercise strict economy, eliminate duplication, and promote efficient operations."

In view of these policies, the American Farm Bureau Federation is in general support of the ideas and principles contained in S. 2. However, we wish to suggest some thoughts for amendments to improve the measure.

1. We feel this bill, as drawn, would make funds available to every college in every State. This would lead to such a diffusion of funds as to prohibit any real, effective research to be done by any college or university. We believe these funds should be allocated to the States on a matching basis for the purpose of establishing one water research center at the land-grant college or where there is no land-grant college—at one college or university, designated by the State.

The land-grant colleges, through their experiment stations, are eminently prepared and qualified to undertake this work.

2. We believe further there is too much opportunity for duplication of effort in water research in this bill. We suggest a committee composed of people from the designated colleges and universities to screen and allocate the various phases of proposed research work to assure no duplicated effort.

3. The report of the Senate Select Committee on National Water Resources recommended as follows: "Third. The Federal Government should undertake a coordinated scientific research program on water." While the information and facts contained in this report are excellent and complete, we do not agree with this recommendation. The Federal Government is not a research agency and should not be made into one. There should be, of course, provision for loans or grants to private institutions and individuals to pursue water research, but this work also should be coordinated with the work done by colleges and universities.

The committee and the Congress should make certain that the program contemplated under titles II and III of the bill are fully in accord and not duplicated by that contemplated under title I.

4. Funds are always a problem, and we consider research in the field of water a very high priority. We cannot, however, recommend this or any other program except within the framework of a balanced budget. We therefore respectfully urge the committee and the Congress to cut other proposed expenditures to make possible this important work.

We shall make specific recommendations for budget adjustments when we appear before the Appropriations Committees of the Congress.

This is indeed a world of reality—it is real to those who do not have enough water or good water now. It will become more real to those whose water is diminishing and polluting to a marked degree. But, it is also very real to all our citizens as they consider the stability of our currency, the value of our money, and the respect of the free world. These can only be maintained within the purview of a balanced economy.

We support the passage of S. 2 and urge the committee to give credence and action to these suggestions.

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STATEMENT OF J. W. CORNWALL, FAIRFIELD, WASH., CHAIRMAN, RESEARCH COMMITTEE, NATIONAL ASSOCIATION OF SOIL AND WATER CONSERVATION DISTRICTS

There is virtually unanimous agreement by all the responsible agencies and authorities in the field of water that the water supply needs of the United States are going to increase sharply and continuously in the years ahead. Conservation and wise management of the available supplies are imperative if we are to have enough water for our essential uses during the remainder of this century and in the period thereafter. Potential additions to the available supply need to be developed, waste must be materially reduced, and capabilities for reuse substantially increased.

The attainment of these vital objectives will require improved knowledge in many fields—economic as well as physical, social as well as political. The need for research in all of these fields bearing on the water problem has been amply justified by extended analysis and hearings by competent authorities. The investigations of the Nation's water problems have also made clear the oncoming need for a larger body of well-qualified personnel in the various key areas of water resources conservation, development, and use.

The enactment of S. 2 would contribute in an important way to the accomplishment of these necessary water knowledge, research and personnel objectives.

The National Association of Soil and Water Conservation Districts (NACD) is vitally concerned with the conservation, development, and use of water supplies—and with those disciplines which can contribute to the quality, quantity, and availability of supplies. This association, jointly with the National Reclamation Association, sponsored a National Water Research Symposium in Washington, D.C., March 28–30, 1961, for the specific purpose of acquainting the general public with the seriousness of the problem and to help focus attention upon the need for a more adequate research program.

At that time we pointed out that “research is the key to the solution of the water problem, but it is generally agreed that our present water research program is entirely inadequate to meet the many and diverse water situations which are developing so rapidly.”

The symposium, participated in by many of the Nation's most distinguished water authorities, underscored again the increasing dimensions of the total water problem, and the critical need for moving ahead with an enlarged and comprehensive program of water research.

At the recent annual convention of the National Association of Soil and Water Conservation Districts in Denver, February 3–7, 1963, our council endorsed in total the five basic recommendations of the Senate Select Committee on National Water Resources. This, of course, included the third recommendation, which is most pertinent to S. 2.

“Third, a greatly expanded and comprehensive Federal program of scientific research on water, probing ways both to increase our supplies and to increase the efficiency of our use of available supplies.”

The 2,930 soil and water conservation districts of the country—in all 50 States, Puerto Rico, and the Virgin Islands—represent the first custodians of the Nation's annual replenishment of water. These districts with their co-operators—now numbering in excess of 1,800,000 farmers, ranchers, and other landowners and operators—are in a position to make a major contribution to the conservation, development, and improved management of water supplies. Indeed, they are now doing so. In the years ahead they will do even more, for water is a critical element in their operations. All of them are water users. At one time or another each year, most districts face too much or too little water. They engage in drainage, irrigation, water storage, flood prevention, and other forms of water management and control.

Across the landscape of America, districts are uniting in common cause the largest body of conservation-minded citizens owning and operating land—the first catchment for most of the annual replenishment of our water supply.

We in the NACD are impressed by the merits of S. 2. It constitutes an important improvement, in its language and provisions, over S. 3579 (of the 87th Congress), which was widely circulated for the purpose of review and comment.

It is plain in S. 2, for example, that the work to be undertaken would be a part of a comprehensive, expanded program of water research. It is intended to supplement existing and future water research efforts—including those by appropriate Federal agencies and private institutions—and is not intended to serve as a complete program.

The dimensions of water research needs in the United States are so large and diverse, it would have been a serious mistake to centralize administration, or to limit the opportunities for Federal participation in water research, through narrowly drafted or interpreted legislative provisions.

We believe S. 2 has beneficially clarified questions raised last year about the relationships of the various Federal agencies and programs involved in water research. Nothing could be plainer than section 301, which declares that “Nothing in the foregoing section nor in this act is intended nor shall be construed as giving its Secretary or the Department of the Interior any authority or surveillance over water resources research conducted by any other agency of the Federal Government, nor shall it be construed as repealing, superseding, or diminishing existing authorities or responsibilities of any agency of the Federal Government to plan and conduct, contract for, or assist in research in its areas of responsibility and concern with water resources.”

We are pleased to note the provisions in S. 2 which call for an annual review of the various water resource research and investigations projects underway—and the protections against low priority or duplicating research.

One might readily argue for the authorization of larger or smaller sums of money in support of the research work contemplated by this bill. Our position, however, is that the initiation of the cooperative research program—with the presently indicated breadth of institutions, foundations, firms, and individuals—is much more important than the precise number of dollars allocated for the work.

As Senator Anderson has pointed out, a program of this character and size cannot be launched immediately. After the authorization, there must be appropriations. Even after these steps, further time must elapse before the intent can be translated into the fact of research underway.

We could comment on many other provisions of S. 2. Our purpose is probably best served in this instance, however, by observing that the soil and water conservation districts of America need and will be able to do a better job in connection with the water supplies coming under their management if they have the benefit of added research. As district supervisors, as district cooperators, and as citizens, we in the NACD believe the prospective water requirements of the United States demand the kind of water research efforts proposed in S. 2—in addition to existing and other efforts which may also be undertaken in this field.

The danger in the water resources situation is not that we will do too much, but that our attention to it will be too small and come too late.

FARGO, N. DAK., *March 11, 1963.*

Hon. MILTON R. YOUNG,  
U.S. Senator,  
State of North Dakota,  
Senate Office Building,  
Washington, D.C.

DEAR SENATOR YOUNG: Senate bill 2 relating to the proposed establishment of water resources research centers has been considered by the Fargo City Commission at its last regular meeting. I am pleased to inform you that the bill was endorsed unanimously pursuant to the enclosed certified copy of a resolution adopted by the board of city commissioners.

This appears to be good legislation and definitely in the public interest. We also are hopeful that Fargo, N. Dak., and North Dakota State University will be considered as a site for a water resources research center.

Your efforts in connection with this matter will be appreciated and we would also appreciate being advised as to the progress of this legislation. If there is anything further that we can do, please let us know.

Respectfully yours,

HERSCHEL LASHKOWITZ, *Mayor.*

Enclosures.

CITY OF FARGO, N. DAK.

BOARD OF CITY COMMISSIONERS

\* \* \* \* \*

BOARD ENDORSES LEGISLATION FOR ESTABLISHMENT OF WATER RESOURCES RESEARCH CENTERS

\* \* \* \* \*

Commissioner Oakey moved that the board go on record endorsing U.S. Senate bill S. 2 and that the president of the board be requested to forward a copy of this motion to the congressional delegation from the State of North Dakota, and, if such legislation is enacted, that the board take such steps as it deems appropriate to set up a water resources research center at North Dakota State University in the city of Fargo.

Second by Hagen. On call of the roll Commissioners Hagen, Markey, McCannel, Oakey, and Lashkowitz all voted "aye."

No commissioner being absent and none voting "nay," the motion was declared carried.

\* \* \* \* \*

## CERTIFICATE OF CITY AUDITOR

STATE OF NORTH DAKOTA,  
*County of Cass, ss:*

I, Wm. G. Johnson, do hereby certify that I am the duly appointed, qualified and acting city auditor of the city of Fargo, N. Dak.; and

That the foregoing is a full, true, and correct copy of a motion adopted by the board of city commissioners of the city of Fargo at the regular meeting of the board held on Tuesday, March 5, 1963; and

That such motion is now part of the permanent records of the city of Fargo, N. Dak., as such records are filed in the office of the city auditor.

[SEAL]

WM. G. JOHNSON,  
*City Auditor of the City of Fargo, Fargo, N. Dak.*

APPENDIX

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EXHIBIT 1

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LIST OF  
CURRENT RESEARCH

in

W A T E R    R E S O U R C E S

at

THE UNIVERSITY OF ARIZONA

Tucson

January 1963

## CURRENT RESEARCH IN WATER RESOURCES

The University of Arizona has long been engaged in research and instruction in water resource development and management and has achieved a recognized position among institutions of higher learning in these fields. Yet, there is the general opinion of the campus community that much more needs to be done and in this spirit the University is now increasing its endeavors in all areas concerned with water resources. The study of the distribution and movement of water on the earth accounts for a disproportionately small percentage of the total scientific research being done in the United States. The burden placed upon our water resources, by the current population explosion, the ever-increasing per capita consumption of water and the insidious destruction of our surface and ground waters by pollution, result in complex problems against which present day knowledge is inadequate.

The development and management of water resources involve the sciences, and their applications that relate the physical environment, biological processes, engineering systems, agricultural and industrial uses, and economic, political and social conditions to the development and management of water resources for maximum welfare. Under this broad framework, research at the University of Arizona is being carried on by the departments of Agricultural Chemistry and Soils, Agricultural Economics, Agricultural Engineering, Agronomy, Civil Engineering, Geology, Horticulture, Watershed Management, the Geochronology Laboratories, the Institute of Atmospheric Physics, the Institute of Water Utilization, and the Laboratory of Tree-Ring Research. The departments of the University are staffed with faculty members whose specialized interests cover the diverse facets of water resources. Laboratory facilities are rapidly being expanded to meet the increasing need for the water resource research programs.

The current research in water resources at The University of Arizona clearly reflects the national trend of expansion of effort upon the many facets of water supply and its relation to life. Indeed, the world-wide recognition of the importance of water to every nation's economy is bringing into focus an awareness that the training of future hydrologists must be broadened to cope with the future complex problems in water. The varied interests of the cooperating departments at The University of Arizona in teaching and research in hydrology are indicated in the diversity of activities shown in the following projects.

## DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

## TITLE AND NUMBER OF PROJECT:

Arizona - Water and Ion Movement in Soil and Plants. 472.

## SUPPORT:

Agricultural Experiment Station, in cooperation with Southwest Branch, SWC, ARS, USDA.

## PERSONNEL:

C. O. Stanberry, L. R. Cooper, W. H. Fuller, H. A. Schreiber.

## NATURE OF RESEARCH:

Combination laboratory and field investigation

## DESCRIPTION OF PROJECT:

Soil water movement and the movement of ions and dissolved substances in soils and plants are interrelated and comprise the area of investigation. Attention has been given recently to unsaturated flow of water in connection with the movement of various phosphate ions in soils.

## PRESENT STATUS:

Active

## RESULTS:

The movement of phosphorus from four phosphate sources in sandy, silty, and clay soils was determined by means of radioactive-tagged sources of phosphorus. After application of the phosphorus source, plots were irrigated one to four times. The water soluble phosphates moved only about 1/2 inch deeper after irrigation than the insoluble phosphates.

## PUBLICATIONS:

"Vertical Movement of P in Calcareous Soils," C. O. Stanberry, H. A. Schreiber, W. H. Fuller, L. R. Cooper, was presented before the Soil Chemistry Section of the Soil Sci. Soc. Amer. at Ithaca, N. Y. Aug. 20-23, 1962 by senior author. It is in press at the Proc. of the Soil Sci. Soc. Amer.

## DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

## TITLE AND NUMBER OF PROJECT:

A Study of the Mechanics of Unsaturated Flow of Water in Soils. Hatch 488.  
(W-68)

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

D. M. Anderson, R. C. Jones, G. Pender.

## NATURE OF RESEARCH:

Laboratory investigation

## DESCRIPTION OF PROJECT:

An effort is being made to discover all the physical processes occurring during soil water movement.

## PRESENT STATUS:

Active

## RESULTS:

The movement of a liquid water flow through soils has been shown to consist of no less than five distinct processes: viscous flow of the liquid phase, evaporation of water at the liquid flow, combined diffusion and viscous flow of water vapor ahead of the advancing liquid, sorption of water vapor by the medium, and cyclic heat flow due to thermal gradients and evaporation. A method of distinguishing liquid from vapor movement of water in soils was developed.

## PUBLICATIONS:

"Temperature Fluctuations At a Wetting Front": I. Characteristic Temperature-Time Curves. Duwayne M. Anderson and A. Linville. Soil Sci. Soc. Amer. Proc. 26:14-18 (1962).

"Temperature Fluctuations At a Wetting Front": II. The Effect of Initial Water Content of the Medium on the Magnitude of the Temperature Fluctuations. Duwayne M. Anderson, Garrison Sposito, and A. Linville. Soil Sci. Soc. Amer. Proc. (in press).

"Temperature Fluctuations At a Wetting Front": III. Apparent Activation Energies for Water Movement in the Liquid and Vapor Phases. Duwayne M. Anderson, A. Linville, and Garrison Sposito. Soil Sci. Soc. Amer. Proc. (in press).

## DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

## TITLE AND NUMBER OF PROJECT:

Interrelationships of Soil Moisture and Temperature on Plant Growth and Physiological Fractions. Hatch 489. (W-67).

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

R. H. Maier, X. Kawchack, Ray A. Cattani

## NATURE OF RESEARCH:

Laboratory investigation.

## DESCRIPTION OF PROJECT:

The physiological aspects of plant growth are known to depend upon soil moisture and temperature. The interrelationship of these two factors has been relatively unstudied because of experimental difficulties. The influence of soil moisture on the chemical forms of iron translocated within plants was selected as a good avenue in approaching the difficult objective suggested by the title of this project.

## PRESENT STATUS:

Active

## DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

## TITLE AND NUMBER OF PROJECT:

Soil, Water, and Plant Testing as a Means of Improving Crop Production.  
State 455.

## SUPPORT:

Agricultural Experiment Station

## PERSONNEL:

H. V. Smith, W. H. Fuller, G. E. Draper.

## NATURE OF RESEARCH:

Laboratory "service" project - chiefly analytical work in the laboratory.

## DESCRIPTION OF PROJECT:

This is a service project that assists individuals, departments, and agencies with soil, water, and plant analysis problems. Among the services given are analyses for suitability of water for use as irrigation water; analyses of soils for the major plant nutrients, presence of salts, and for purposes of classification; analyses of plant petioles used chiefly to determine the fertility level of soils.

Constituents commonly found in waters are determined and are used as a basis of determining the quality of water for domestic use or use as irrigation waters.

## PRESENT STATUS:

Active (continuing).

## RESULTS:

Waters of similar quality are frequently found to be associated with each other in separate parts of the state; thus the areas of "hard waters," "boron waters," "fluoride waters," etc., are becoming better defined.

## PUBLICATIONS:

"The Chemical Composition of Representative Arizona Waters." H. V. Smith, A. B. Caster, W. H. Fuller, E. C. Breazeale, and G. E. Draper. Ag. Ext. Sta. Bul. 225. 1949.

"Reclamation of Saline and Alkali Soils," Wallace H. Fuller. Plant Food Review, Fall 1962.

"Gypsum and Other Sulfur Bearing Amendments for Arid and Semi-Arid Soils." W. H. Fuller, and H. Ray. Ag. Ext. A-1 Bul. (in press).

"The Quality of Arizona's Domestic Waters." H. V. Smith, T. F. Buehrer, W. H. Fuller, G. E. Draper. Ag. Ext. Sta. Bul. (in press).

## DEPARTMENT OF AGRICULTURAL ECONOMICS

## TITLE AND NUMBER OF PROJECT:

Water in relation to social and economic growth in an arid environment.  
2RC-220-489.

## SUPPORT:

Rockefeller Foundation grant, and Agricultural Experiment Station.

## PERSONNEL:

M. M. Kelso, W. E. Martin.

## NATURE OF RESEARCH:

The research is analytical; its empirical data will be obtained from secondary sources. It will advance theory and understanding of the relations between natural resources and the human community. It will provide data for several Master's and Doctor's theses.

## DESCRIPTION OF PROJECT:

Questions which the research will seek to answer are:

1. What has been and what will be the relation between a limited, falling water supply and the levels of incomes and capital absorption generated (a) in agriculture and (b) in the handling, processing, and supplying industries tributary to it?
2. What will be the income generating and capital absorbing power of Arizona's water in industry sectors other than agriculture and its tributary industries?
3. What rationing of the limited and decreasing supply of water in Arizona among potential uses will produce the greatest long-run economic product?
4. What will be the value of additional water imported from outside or generated inside the area and in what uses will its economic value be greatest?
5. What population characteristics (number, age, health, source and level of income, welfare status, school demands, etc.) accompany the economic changes that have occurred and that may be expected to occur as the water stock diminishes and the society grows?
6. What modifications in present institutional parameters (primarily government, property) will permit attainment of a higher maximum of economic product from the limiting water supply?

## PRESENT STATUS:

Active

## DEPARTMENT OF AGRICULTURAL ECONOMICS

## TITLE AND PROJECT NUMBER:

The Value of Water from Forested Watersheds in Central Arizona. 2RC-220-394.

## SUPPORT:

Southwest Forest and Range Experiment Station, U. S. Forest Service, and Agricultural Experiment Station.

## PERSONNEL:

M. M. Kelso, Lawrence Mack, David Worley, U.S. Forest Service.

## NATURE OF RESEARCH:

Analytical and field investigation for advancement of theory; for the operation and development of watershed management for increased value of its products; and for a Master's thesis.

## DESCRIPTION OF THE PROJECT:

The goal of this research is to determine the value of additional surface flow water produced on the Beaver Creek watershed by treatments imposed by the Forest Service when such increased water is used for agricultural production in Maricopa County and when it is used in such manner as to prolong the useful ground-water reserve and reduce costs of pumping.

## PRESENT STATUS:

Active

## PUBLICATIONS:

"The Stock Resource Value of Water," by M. M. Kelso, Journal of Farm Economics, XLIII(5): 1112-1129, Dec. 1961. (Copies available from the author on request.)

## DEPARTMENT OF AGRICULTURAL ECONOMICS

## TITLE AND NUMBER OF PROJECT:

Determining and Sharing Costs and Benefits from Development of the Central Arizona Watershed. State 495.

## SUPPORT:

Agricultural Experiment Station in cooperation with Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, and Arizona Water Resources Committee.

## PERSONNEL:

M. M. Kelso.

## NATURE OF RESEARCH:

Analytical and field investigation for advancement of theory; for the operation and development of watershed management to increase the value of its products.

## DESCRIPTION OF THE RESEARCH:

The ultimate objective of this project is to develop recommendations and procedures that can be used by the Arizona Watershed Committee to determine economic-feasibility of any program of watershed management it may propose and to suggest a feasible plan for financial sharing of costs and benefits among affected parties.

To attain this ultimate objective, the following interim objectives will be pursued:

1. To recommend procedures for evaluating and economic-feasibility of alternative plans of watershed management as the basis for selecting the "most favorable" alternative.
2. To recommend procedures for determining the incidence of benefits and costs of any selected program as among affected groups and individuals insofar as such benefits and costs are identifiable and assignable.
3. To recommend possible schemes of organization and procedure whereby the watershed management program may be administered, the costs and benefits prorated, the charges assessed and collected, and the reimbursements determined and paid out.

## PRESENT STATUS:

Active

## PUBLICATIONS:

"The Stock Resource Value of Water" by M. M. Kelso, Journal of Farm Economics XLIII (5): 1112-1129, December 1961. (Copies available from the author).

## DEPARTMENT OF AGRICULTURAL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Effect of Crop Cover on Efficiency of Sprinkler Irrigation Under Varying Climatic and Operating Conditions. Hatch 547. (W-65).

## SUPPORT:

Agricultural Experiment Station

## PERSONNEL:

K. R. Frost.

## NATURE OF RESEARCH:

Laboratory research for theory and design.

## DESCRIPTION OF PROJECT:

Precise water balance of growing crops under sprinkler application of irrigation water. Crops are grown in a tank of soil 12 feet in diameter and 2 feet deep. Instrumentation permits measurement of loss or gain of 0.005 inches of water on the area of the tank. Measurements permit evaluation of loss or gain of water from dew, rain, irrigation, evaporation, and transpiration on crops at any stage of growth and as functions of ambient atmospheric conditions.

## PRESENT STATUS:

Active

## RESULTS:

Evapotranspiration during sprinkling is approximately equal to that during non-sprinkling periods since evaporation from wet foliage replaces normal transpiration. Daily evapotranspiration ranges from 6-8 times the one-hour evapotranspiration at the period of peak rates. Cloud cover reduces evapotranspiration by one-third from that at full-run under the same vapor pressure deficit.

## PUBLICATIONS:

"A Weighing Evapotranspirometer." K. R. Frost. Agricultural Engineering. 43(3):160, March 1962.

"Factors Affecting Evapotranspiration Losses During Sprinkling." K. R. Frost. A.S.A.E. Paper No. 62701 (Mimeo) Presented at 1962 Winter Meeting A.S.A.E.

## DEPARTMENT OF AGRICULTURAL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Sprinkler Irrigation Studies Under Arid Southwestern Conditions. Hatch 303.

## SUPPORT:

Agricultural Experiment Station

## PERSONNEL:

K. R. Frost

## NATURE OF RESEARCH:

Field investigation for design data.

## DESCRIPTION OF PROJECT:

Investigation of the use of sprinkler application of irrigation water in production of Arizona crops. Irrigation efficiencies under sprinkling as compared to efficiencies under surface applications. Irrigation scheduling and system design for sprinkler application of water. Crop yields per unit of land and per unit of water as functions of method of water application, soil type, irrigation schedules, and crop species and variety.

## PRESENT STATUS:

Active

## RESULTS:

Field tests on citrus, cotton, grains, and legumes indicate increased crop production per unit of water applied when water is applied by sprinklers rather than by surface methods. Results vary with crop and soil texture. On coarse textured soils water savings of 50% have been achieved by sprinkling.

## PUBLICATIONS:

"Sprinkler Evaporation Losses", H. C. Schwalen and K. R. Frost, Progressive Agriculture in Arizona. 4(4): 10-11. 1953.

"Sprinkler Irrigation", H. C. Schwalen, K. R. Frost, W. W. Hinz. Ariz. Agr. Exp. Sta. Bull. #250. 1954.

"Sprinkler Evaporation Losses", K. R. Frost and H. C. Schwalen, Agricultural Engineering 36(8) 526-527. Aug. 1955.

"Sprinkler Irrigation of Citrus", K. R. Frost. Progressive Agriculture in Arizona. 6(3): 4. 1955.

"Evapo-transpiration During Sprinkler Irrigation". K. R. Frost and H. C. Schwalen. Trans. of A.S.A.E. 3(1): 18-20, 24. 1960.

"Citrus Irrigation Experiments on the Yuma Mesa", K. R. Frost and R. Rodney. Progressive Agriculture in Arizona. 14(4): 14-15. 1962.

"Twelve Years of Sprinkler Irrigation Research", K. R. Frost. Progressive Agriculture in Arizona 15(1): (in press) 1963.

## DEPARTMENT OF AGRICULTURAL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Ground Water Supplies. 436.

## SUPPORT:

Agricultural Experiment Station, City of Tucson, and Pima County.

## PERSONNEL:

H. C. Schwalen, R. J. Shaw, W. G. Matlock.

## NATURE OF RESEARCH:

Field, laboratory and analytical for development.

## DESCRIPTION OF PROJECT:

Detailed continuing groundwater inventory of selected basins in Arizona including at present the Santa Cruz from Nogales to Red Rock, Avra, Altar, Little Chino, Redington Area of the San Pedro. Groundwater contour maps are prepared annually. Specific yields, storage coefficients and transmissibilities are determined from well tests. An electric analog of the Tucson groundwater basin is being developed.

## PRESENT STATUS:

Active

## RESULTS:

Groundwater elevation data has been developed for all areas studied. Volumetric unwatering estimates have been prepared. Water balance estimates have been prepared for the Tucson Metropolitan, Sahuarita Districts, and Cortaro Districts. Open files are maintained from which current ground water level data is available for any location in the area studied.

## PUBLICATIONS:

"Water in the Santa Cruz Valley", H. C. Schwalen and R. J. Shaw. Agr. Exp. Sta. Bull. #288. Oct. 1957.

"Suspended Sediment and Chemical Analyses of the San Pedro River at Charleston, Arizona", H. C. Schwalen. Agr. Exp. Sta. Report #202. June 1961.

"Progress Report on Study of Water in the Santa Cruz Valley, Arizona", H. C. Schwalen and R. J. Shaw. Agr. Exp. Sta. Report #205. November 1961.

"Upper Santa Cruz Valley", H. C. Schwalen. Water Resources Report #11, Annual Report on Ground Water in Arizona. Spring 1961 to Spring 1962. pp. 61-66, Arizona State Land Department 1962.

"Avra-Marana Area", H. C. Schwalen, *Ibid.* pp. 66-71.

"Chino Valley", H. C. Schwalen, *Ibid.* pp. 106-109.

## DEPARTMENT OF AGRONOMY

## TITLE AND NUMBER OF PROJECT:

Water Use Efficiency of Forage Crops. Hatch 552.

## SUPPORT:

Agricultural Experiment Station

## PERSONNEL:

A. A. Baltensperger.

## NATURE OF RESEARCH:

Field study.

## DESCRIPTION OF PROJECT:

Several thousand genotypes in a species planted nursery will be screened for water use efficiency. Variation within two species of Cynodon will be measured for ability to use water efficiently. Less than optimum water for maximum forage production will be applied in order to separate genotypes for their ability to produce forage under these limited moisture conditions. Mature plants will be measured for total forage production, recovery after harvest and survival.

## PRESENT STATUS:

Active

## DEPARTMENT OF AGRONOMY

## TITLE AND NUMBER OF PROJECT:

Revegetation of Cleared Floodways. 502.

## SUPPORT:

Agricultural Experiment Station, U.S. Bureau of Reclamation, Corps of Engineers.

## PERSONNEL:

A. A. Baltensperger, J. M. Tromble, K. C. Hamilton and Neal Wright.

## NATURE OF RESEARCH:

Field Phase, and laboratory and field phase. Involves both development and theory. Master's thesis is near completion on laboratory phase.

## DESCRIPTION OF PROJECT:

Practical field phase deals with discerning which forage species and strains are best adapted to lower Gila River floodway. Both warm and cool season forage species have been established using different quality water for irrigation. Water table and salt content of water and soil were noted.

Laboratory-field phase is concerned with studying germination salt tolerance within and among species of Panicum and Cynodon. Seed lots accessions from various sources of these two genera were studied for their ability to germinate in different concentrations of NaCl, CaCl<sub>2</sub>, MgCl<sub>2</sub> and all possible combinations of these three salts.

## PRESENT STATUS:

Active

## RESULTS:

Field studies showed bermuda grass, Cynodon dactylon, and blue panic grass, Panicum antidotale, to be the most promising warm season forage grasses. Harding grass, Phalaris tuberosa, tall fescue, Festuca arundinacea, and alfalfa, Medicago sativa, were promising as cool season species. It is felt that these adapted species would offer severe competition for invading phreatophytes.

The laboratory salt tolerance study indicated large differences in germination salt tolerance among seed lots of both species. It should be possible to successfully select within Cynodon and Panicum for increased salt tolerance. However, seed accessions exhibited tolerance to one specific salt and not another which indicated selection should be practical for all salts of interest.

## PUBLICATIONS:

"Revegetation of a Cleared Section of a Floodway", Bruce Powers, and K. C. Hamilton. Ariz. Agr. Exp. Sta. Report # 198. 23 pp. 1961.

## DEPARTMENT OF ANTHROPOLOGY

## TITLE AND NUMBER OF PROJECT:

Comparative Analysis of Pre-Industrial Systems of Water Management in Arid Regions. 2RC-NSF530. (359).

## SUPPORT:

National Science Foundation.

## PERSONNEL:

Richard B. Woodbury.

## NATURE OF RESEARCH:

Field work, analysis and synthesis of published and unpublished data.

## DESCRIPTION OF PROJECT:

Since the development of Old and New World cultures in arid areas, both civilizations and simpler societies, has been strongly conditioned by the need for water & by the means for its management; and since hypothesis and conclusions as to the nature of this conditioning have rested on scanty factual bases, pre-industrial systems of several areas are under study: (1) southwestern U.S. and northwestern Mexico, (2) central Mexico, (3) coastal Peru, (4) Iraq; (5) Egypt, and (6) the Negev. The purpose is to provide a sounder basis for inferences as to the levels of technologic and social complexity associated with particular types of water control and of the role of water problems in culture growth.

## PRESENT STATUS:

Active

## INSTITUTE OF ATMOSPHERIC PHYSICS

## TITLE AND NUMBER OF PROJECT:

Vegetation Changes in the Sonoran Desert. G11. 2RC-ONR-950-384.

## SUPPORT:

Office of Naval Research, and Department jointly with United States Geological Survey.

## PERSONNEL:

James Rodney Hastings, Raymond M. Turner.

## NATURE OF RESEARCH:

Field, laboratory and analytical.

## DESCRIPTION OF PROJECT:

A general investigation into the reasons for arroyo-cutting and vegetation change in the Sonoran desert, and into the mechanics of change.

## PRESENT STATUS:

Active

## RESULTS:

Recent evidence, to be published shortly, points to climatic change as a dominant factor in Arizona's changing vegetation. Increasing aridity seems to be indicated.

## PUBLICATIONS:

"Vegetation Change and Arroyo Cutting in Southeastern Arizona", James Rodney Hastings. Journal Arizona Academy of Science. 1:60-67.1959.

"Precipitation and Saguaro Growth", James Rodney Hastings. University of Arizona Arid Lands Colloquia. 1959-60, 1960-1961.

"Physical Determination of Growth and Age in the Giant Cactus", James Rodney Hastings and Stanley M. Alcorn. Journal Arizona Academy of Science 2:32-39. 1961.

"The Changing Mile--A Photographic Study of Vegetation Change with Time in the Lower Life Zones of a Semi-Arid Region", James Rodney Hastings and Raymond M. Turner. (In preparation for The University of Arizona Press.)

## INSTITUTE OF ATMOSPHERIC PHYSICS

## TITLE AND NUMBER OF PROJECT:

Climatology of Arizona. G-11.

## SUPPORT:

Departmental project.

## PERSONNEL:

William D. Sellers, Christine R. Green.

## NATURE OF RESEARCH:

Analytical evaluation of Arizona climatic data.

## DESCRIPTION OF PROJECT:

Project is to provide a complete description of the past and present climate of Arizona.

## PRESENT STATUS:

Active

## PUBLICATIONS:

"Arizona Climate", William D. Sellers, editor, 500 pp., Sept. 1960; revised and published by University Press in 1963.

"Arizona Climate, supplement No. 1", Christine R. Green, 400 pp., Feb. 1962.

A list of available technical reports may be obtained from the Institute of Atmospheric Physics.

## INSTITUTE OF ATMOSPHERIC PHYSICS

## TITLE AND NUMBER OF PROJECT:

Saline Water Demineralization. 2RC-OSW 950. (340).

## SUPPORT:

Office of Saline Water, U. S. Department of the Interior.

## PERSONNEL:

Carl N. Hodges, John E. Groh, T. Lewis Thompson.

## NATURE OF RESEARCH:

Analytical evaluation, laboratory testing and developmental work.

## DESCRIPTION OF PROJECT:

The project is the development and evaluation of a solar powered demineralization system.

## PRESENT STATUS:

Active

## RESULTS:

A small experimental demineralization plant has been developed and is presently operating. Preliminary results indicate that the process may be economically attractive in sunny areas.

## PUBLICATIONS:

Interim Report I. "Separate Component Multiple-Effect Solar Distillation", Carl N. Hodges, T. Lewis Thompson, John E. Groh, Institute of Atmospheric Physics, The University of Arizona. 1962.

## INSTITUTE OF ATMOSPHERIC PHYSICS

## TITLE AND NUMBER OF PROJECT:

Energy Balance of Desert Regions. G11

## SUPPORT:

Departmental project.

## PERSONNEL:

William D. Sellers, Carl N. Hodges

## NATURE OF RESEARCH:

Field investigation for testing of new equipment.

## DESCRIPTION OF PROJECT:

Project is to accurately measure all components of the energy balance over various types of desert surfaces. Emphasis is placed on measuring the heat used for evaporation.

## PRESENT STATUS:

Active

## RESULTS:

Evaporation rates measured in the dry stream channel of Walnut Gulch in southeastern Arizona over an 18-day period in October 1961 were high enough to indicate that natural recharge of the water table is negligible when the water table is 48 to 90 cm below the surface. For dry soils evaporation rates appear to decrease with increasing wind speed; the reverse is true for wet soils. Practically all the radiative energy incident on short grass is used for evaporation.

## PUBLICATIONS:

"The Energy Balance of Non-Uniform Soil Surfaces", William D. Sellers and Carl N. Hodges. Journal of the Atmospheric Sciences, 19:6:482-491, November 1962. May be obtained from the Institute of Atmospheric Physics.

## INSTITUTE OF ATMOSPHERIC PHYSICS

## TITLE AND NUMBER OF PROJECT:

Physics of Convective Clouds and Cloud Modification, 2RC-NSF-950(552).

## SUPPORT:

National Science Foundation, U. S. Weather Bureau, and U. S. Forest Service.

## PERSONNEL:

L. J. Battan and A. R. Kassander, Jr.

## NATURE OF RESEARCH:

Field investigations of the physics of convective clouds and the effects of cloud seeding with silver iodide.

## DESCRIPTION OF PROJECT:

The program involves detailed observations of convective clouds during the summer by means of radar, a pair of high resolution cameras. A network of recording rain gages is employed to measure rainfall. Cloud seeding is conducted with airborne silver-iodide generators. A carefully-controlled randomization scheme is employed to decide on which days to seed. The results are analyzed statistically. In addition a physical evaluation is made to uncover information about the fundamental nature of cloud and precipitation formation.

## PRESENT STATUS:

Active

## RESULTS:

To date the experiments have failed to show that cloud seeding with silver iodide can increase rainfall from the convective clouds commonly observed in the summer in the vicinity of Tucson. The analyses suggest that the quantity of rainfall does not depend on the ice nuclei properties of the air. This result leads to the inference that seeding with ice nuclei (such as silver iodide particles) is not likely to be successful in increasing rainfall.

## PUBLICATIONS:

"Design of a Program of Randomized Seeding of Orographic Cumuli," L. J. Battan and A. R. Kassander, Jr., J. Meteor., 17, No. 6, 583-590 (1960).

"Some Properties of Convective Clouds," L. J. Battan, Nubila, Verona, Italy, IV, No. 1, 1-12 (1961).

"Evaluation of Effects of Airborne Silver-Iodide Seeding of Convective Clouds," L. J. Battan and A. R. Kassander, Jr., Sci. Rep. No. 18, Inst. of Atmos. Physics, Univ. of Ariz., Tucson, 59 pp. (1962).

"Relationship between Cloud Base and Initial Radar Echo," L. J. Battan, J. Applied Meteor., 2 (1963) (Accepted for publication).

## DEPARTMENT OF CHEMICAL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Solar Evaporation of Saline Waters Under Vacuum.

## SUPPORT:

Departmental funds for initial phases of research.

## PERSONNEL:

D. H. White, and I. Shaheen.

## NATURE OF RESEARCH:

For master's degree thesis in Chemical Engineering.

## DESCRIPTION OF PROJECT:

Solar evaporation of saline or brackish waters in systems, either mechanical or desert sands as process facilities, with pressures below atmospheric and corresponding operating temperatures of evaporation and condensing in the range of 60 to 120 F.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Hydrologic Characteristics of a Groundwater Basin. (part of AES436).

## SUPPORT:

City of Tucson and Pima County through a cooperative agreement with the Agricultural Engineering Department, Arizona Agricultural Experiment Station.

## PERSONNEL:

John Ferris, W. G. Matlock.

## NATURE OF RESEARCH:

Analytical, laboratory, and field investigations for development, operation, design and theory, for Doctoral dissertation.

## DESCRIPTION OF PROJECT:

Attempts are being made to determine the hydrologic characteristics (specific yield and/or storage coefficient and transmissibility) of the groundwater basin in the Santa Cruz Valley near Tucson, Arizona. Well tests are being made at sites where observation wells are available. Water budget analyses are being used in connection with mathematical models. A passive element electric analog model is being developed.

## PRESENT STATUS:

Active

## RESULTS:

Well tests made during the past two years indicate that realistic values of specific yield and/or storage coefficient are not obtained from such tests in the Santa Cruz Valley. Values of transmissibility are more consistent and reasonable.

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Scour at Relief Bridges.

## SUPPORT:

Departmental

## PERSONNEL:

Emmett M. Laursen; Robert B. Conklin

## NATURE OF RESEARCH:

Laboratory investigation related to theory and design, for Master's thesis.

## DESCRIPTION OF PROJECT:

To find the effect of sediment size and velocity of flow on the limiting depths of clear-water scour in simple relief-bridge geometries. First, the case of the long contraction will be studied, then the case of the long gradually-contracting channel. The last case to be studied will involve various simple abrupt contractions. Throughout the experiments, examination of the assumptions of the analysis of Dr. E. M. Laursen will be made and also of the time dependency of depth of scour insofar as feasible.

## PRESENT STATUS:

Active

## RESULTS:

Based on the assumptions that the depth of scour at the obstruction is a multiple of the depth of scour in a comparable long contraction, that the particle shear upstream can be evaluated by Manning's formula and Strickler's relation, and that the shear in the scoured area is the critical tractive force, analytical relationships for the depth of scour have been obtained.

## PUBLICATIONS:

"An Analysis of Relief Bridge Scour," by E. M. Laursen, submitted to Journal of the Hydraulics Division, American Society of Civil Engineers.

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Critical Tractive Force of Uniform Sands.

## SUPPORT:

Departmental project

## PERSONNEL:

Emmett M. Laursen; Jimmy F. Harp

## NATURE OF RESEARCH:

Analytical and laboratory investigation related to theory, for Doctoral dissertation.

## DESCRIPTION OF PROJECT:

Analytic and experimental attempts to relate the average boundary shear to the incipient movement of sediment particles composing the boundary. In the laminar regime, the analysis will proceed by approximating the forces on sediment particles in various possible positions among other sediment particles. The turbulent flow regime analysis will also consider the statistical nature of the variations in the flow.

The experimental results will be used to determine any needed constants or functions and to verify the approximate analyses.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Characteristics of Segmental Orifices.

## SUPPORT:

Departmental project

## PERSONNEL:

Emmett M. Laursen, Norman H. Perry

## NATURE OF RESEARCH:

Laboratory investigation for development, for Master's thesis.

## DESCRIPTION OF PROJECT:

A partial orifice plate, such as a segment of a circle, may have advantages in some situations as a metering device. The discharge and loss characteristics of such a constriction will be studied.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

The Biochemical Oxygen Demand of Algal Suspensions. ERL 6200.

## SUPPORT:

Department and National Institutes of Health of the U.S. Department of Health, Education and Welfare

## PERSONNEL:

Quentin M. Mees; Stanley J. Dea

## NATURE OF RESEARCH:

Laboratory investigation related to theory for Master's thesis.

## DESCRIPTION OF PROJECT:

The biochemical oxygen demand test is of major importance in the examination of polluted waters, because it is an important indication of its organic stability. The presence of algae in these waters exerts an oxygen demand when the BOD test is determined, therefore giving a misleading value. The purpose of this thesis is to determine the difference in BOD exerted by suspended algae using a reliable and relatively straightforward laboratory determination.

The chlorophyll test and the volatile filtered solids test will be used in attempting to find a consistent technique for evaluating the oxygen demand exerted by the presence of algae in samples used for routine BOD determinations involving incubation in the dark.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Alkyl Benzene Sulphenate Removal in Raw Sewage Stabilization Lagoons.  
ERL 6200.

## SUPPORT:

Department in cooperation with the National Institutes of Health of U. S. Department of Health, Education, and Welfare; and Sanitary District No. 1 of Pima County.

## PERSONNEL:

Quentin M. Mees; Bill B. Dendy

## NATURE OF RESEARCH:

Field and laboratory investigation related to theory and operation for Master's thesis.

## DESCRIPTION OF PROJECT:

A study of the effect of raw sewage stabilization lagoons on the concentrations of ABS which are imposed upon them.

## PRESENT STATUS:

Completed

## RESULTS:

It was established that in all probability no reduction in ABS concentration was affected by the process. For the particular installation under observation, an increase in concentration in the lagoon over that in the raw sewage was observed. Probable reasons given for the observed increase included excessive evaporation rates, during initial phases of operation, which drastically reduced the effluent flow during the period of study. Following substantial increases in effluent flow, recent observations of ABS concentrations seem to substantiate this hypothesis.

## PUBLICATIONS:

"Alkyl Benzene Sulphenate Removal in Raw Sewage Stabilization Lagoons,"  
Master's thesis, Bill B. Dendy, The University of Arizona, 1962.

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Natural Sealing Potential of Raw Sewage Stabilization Lagoons. ERL 6200.

## SUPPORT:

Department in cooperation with the National Institutes of Health of the U.S. Department of Health, Education, and Welfare; and Sanitary District No. 1 of Pima County.

## PERSONNEL:

Quentin M. Mees; Stephen A. Deming.

## NATURE OF RESEARCH:

Field and laboratory investigation related to theory and design, for Master's thesis.

## DESCRIPTION OF PROJECT:

To determine and correlate the probable losses of water from a raw sewage stabilization lagoon located 14 miles northwest of Tucson, Arizona, in the Santa Cruz River Valley being administered and operated by Sanitary District No. 1 of Pima County. The evaporation from the liquid surface will be determined by an evaporation pan at the site, and the accumulated data correlated with permanent weather installations in the valley. Seepage will be investigated by auger and tube assemblies with such auxiliary structures and facilities needed to accomplish the work. Representative sampling of the lagoon bottom material and material adjacent to the lagoon site will be accomplished. Soil samples will be classified and tested for permeability, moisture content, and all other factors deemed necessary to evaluate the problem. Seepage and evaporation data will be combined with inflow and outflow data in an effort to establish a hydrologic balance.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Oxidation Ponds for the Treatment of Raw Sewage in the Southwest. ERL 6200.

## SUPPORT:

Department and National Institutes of Health of the U. S. Department of Health, Education, and Welfare

## PERSONNEL:

Quentin M. Mees; Eugene W. Dooley

## NATURE OF RESEARCH:

Field and laboratory investigation related to theory and design, for Master's thesis.

## DESCRIPTION OF PROJECT:

Oxidation ponds for the treatment of raw sewage are an economical and efficient method of treatment applicable to domestic sewage flows. Their efficiency is probably increased in the arid southwest by virtue of the ample supply of sunshine, and thus design criteria may be different. The design criteria of states with similar climatic conditions will also be examined but must be weighted by consideration of the attitude that these states take toward such installations.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Survival of Pathogens in Sewage Stabilization Ponds. ERL 6200.

## SUPPORT:

Department in cooperation with the National Institutes of Health of the U. S. Department of Health, Education, and Welfare, Arizona State Department of Health, and Sanitary District No. 1 of Pima County.

## PERSONNEL:

Quentin M. Mees; Jack R. Hensley

## NATURE OF RESEARCH:

Field and laboratory investigation for operation, development, theory, and design.

## DESCRIPTION OF PROJECT:

A study of the ability of amoeba, intestinal flagellates, and ova of helminths to survive the stabilization processes in a raw sewage stabilization pond. Chemical analyses aimed at evaluating various environmental parameters include acidity, alkalinity, biochemical oxygen demand, chlorides, dissolved oxygen, nitrogen, pH, phosphates, suspended solids, temperature, turbidity, and Coleform concentrations.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

Flow Patterns in a Stabilization Lagoon.

## SUPPORT:

Department in cooperation with Sanitary District No. 1 of Pima County.

## PERSONNEL:

Quentin M. Mees; William C. Pisano

## NATURE OF RESEARCH:

Field investigation for design and development for Master's thesis.

## DESCRIPTION OF PROJECT:

The flow pattern in a stabilization lagoon is affected by the thermal structure in the lagoon, the surface winds, and the diffusion of the jet inflow so that serious short circuiting can result. The true patterns obtained will be measured and means of controlling these factors will be investigated.

## PRESENT STATUS:

Active

## DEPARTMENT OF CIVIL ENGINEERING

## TITLE AND NUMBER OF PROJECT:

A Study of Partially Saturated Flow in Sand-Epoxy Resin Columns.

## SUPPORT:

Departmental project

## PERSONNEL:

Richard L. Sloane; John B. Carney

## NATURE OF RESEARCH:

Laboratory investigation related to theory, for Doctoral dissertation.

## DESCRIPTION OF PROJECT:

The flow of water through soils often takes place under conditions of partially saturated flow. The prediction of fluid distribution and pressure under conditions of partially saturated flow is important to those interested in the problem of recharge to the ground water table from water applied to the surface of the earth.

This study of partially saturated flow will make use of vertical columns made of sand grains cemented together with epoxy resin. The use of this type of sand column will result in a model for which properties such as void ratio and particle arrangement will remain constant during a series of tests.

## PRESENT STATUS:

Active

## GEOCHRONOLOGY LABORATORIES

## TITLE AND NUMBER OF PROJECT:

Radiocarbon as a Tracer in Water Supply Problems

## SUPPORT:

Departmental and Research Corporation.

## PERSONNEL:

Paul E. Damon, J. W. Harshbarger, J. Sigalove, A. Long, Fred Cagle.

## NATURE OF RESEARCH:

Laboratory and field; basic research; thesis and dissertation work.

## DESCRIPTION OF PROJECT:

The study of ground water movement through aquifers has been limited by the slow rate of movement of the subsurface waters. Thus, if a tracer is introduced, only limited information is obtainable between the times of spiking and observation. However, radiocarbon (C-14) has been naturally introduced into ground water reservoirs continuously throughout geologic time and, consequently, movement which has taken place during the last 45,000 years may be studied. In addition, nuclear technology is now producing radiocarbon at a greater rate than nature and so this artificially produced radiocarbon may also be used to trace recent water movements. Furthermore, it represents a potential hazard to health and therefore it is essential to monitor the increment for the safety of the community.

We propose to monitor the present carbon-14 content of surface water and organic matter in the Southwest and to measure the radiocarbon content of subsurface waters. The source of the carbon in water will be determined by  $C^{12}/C^{13}$  measurements. This data will be related to ground water hydrologic problems such as the rate of laminar flow through aquifers, their permeability, the source and rate of recharge, paleoclimatology, radioactive contamination in water supplies, and the waste disposal problem.

## PRESENT STATUS:

Active

## RESULTS:

The C-14 age of a number of water samples has been determined. The results are quite reasonable. For example, flow rates of approximately 10 feet per year have been deduced in the Safford region. The uptake of bomb C-14 in vegetation is also being monitored.

## PUBLICATIONS:

"Arizona Radiocarbon Dates IV," P. E. Damon, Austin Long, and J. J. Sigalove, American Journal of Science, Radiocarbon, Vol. 5, 1963, in press.

## GEOCHRONOLOGY LABORATORIES

## TITLE AND NUMBER OF PROJECT:

Pollen Analysis and Statistical Correlations of Pluvial Lakes. NSF-337.

## SUPPORT:

National Science Foundation

## PERSONNEL:

Paul S. Martin, James E. Mosimann, P. J. Mehringer, R. Hevly

## NATURE OF RESEARCH:

Pollen stratigraphic study of dry lake beds in various playas of western North America; multivariate statistical analysis and IBM computing of the results as a method of detecting significant relationships between fossil pollen types. Both laboratory and field studies are involved. Part of the results may be used in a Ph.D. thesis by Mehringer.

## DESCRIPTION OF PROJECT:

We are collecting and counting mud samples from drill cores taken in the Willcox Playa, Arizona; China Lake, California; Great Salt Lake, Utah, Montezuma Well and Laguna Salada, central Arizona. Pollen counts of the core samples are used to correlate between playa lakes, and to determine the nature of Pleistocene environmental changes. The history of wind-pollinated (and allergy-producing) plants can be followed in detail. The geologic and hydrologic history of the basins is also revealed through the pollen record.

## PRESENT STATUS:

Active

## RESULTS:

In each core studied to date, the Wisconsin pluvial period is marked by major changes in vegetation - pinon-juniper woodland into the Mojave Desert, pine woodland into the Great Salt Lake Desert, and pine-spruce forest into central Arizona north of the Mogollon Rim. Statistical correlations show that in the Willcox Playa, pine and spruce are positively correlated while the correlations between other types change with time. There is no clear cut evidence of a pre-Wisconsin pluvial episode.

## PUBLICATIONS:

"Geochronology of Pluvial Lake Cochise II. Pollen analysis of a 42 m. core," Paul S. Martin. To appear in Ecology, 1963, summer issue.

"Geochronology of Pluvial Lake Cochise I. Pollen analysis of shore deposits," Paul S. Martin with R. H. Hevly, Jour. Ariz. Acad. Sci., 2:24-31, 1961.

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

Geologic Framework and Hydrology of Alluvial Basins in Arizona.

## SUPPORT:

Departmental, Rockefeller Foundation

## PERSONNEL:

John W. Harshbarger, Jerry Harbour, James Marlowe, Charles L. Fair

## NATURE OF RESEARCH:

Field and laboratory studies relating the pertinent geological factors to development of water supplies.

## DESCRIPTION OF PROJECT:

To translate complex subsurface geometric parameters into permeability, transmissibility, storage capacity, and specific parameters. Appraise suitable geologic environments for potential areas of artificial recharge. Field studies included detailed stratigraphic mapping and subsurface mapping with the aid of water well logs, gravimetric geophysical data. Safford basin served as principal study area.

## PRESENT STATUS:

Active

## RESULTS:

The geometric and geological boundaries of Safford basin depart from the classical concept of alluvial basin framework. The establishment of the occurrence of several ground water systems (artesian and non-artesian) provides facts for guidelines to management of water supply. The occurrence of previously unknown gravel aquifers was established.

## PUBLICATIONS:

"Geohydrology of the Safford Inner Valley," Charles L. Fair, Arizona Geological Society Digest, 4th annual vol., 1962.

"Geologic Framework and Hydrology of Intermountain Valleys of the Great Basin (abstract)," John W. Harshbarger, Geol. Soc. America Bull., v. 71, 1961.

"Geohydrology of Arid Lands - Arizona - a case study." John W. Harshbarger. Proceedings of Arid Lands Colloquium, Univ. of Ariz. Press, 1961

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

Capturing Additional Water for Increasing Supplies.

## SUPPORT:

Interdepartmental in cooperation with U. S. Geological Survey

## PERSONNEL:

John W. Harshbarger, Robert Streitz, Geo. Maddox, John F. Lance

## NATURE OF RESEARCH:

Field and laboratory studies for development design.

## DESCRIPTION OF PROJECT:

Subsurface lithologic mapping of the Tucson basin sediments from drill cutting samples and well logs to determine geologic skeleton of the ground water reservoir. Preliminary flow-net determinations to ascertain the transmissibility and storage coefficient parameters. Ascertainment of geologic environment for potential artificial recharge of surface water.

## PRESENT STATUS:

Active

## RESULTS:

The complex lithologic character of the basin sediments are not amenable to simple quantitative determination techniques. Digital number system devised for describing lithology. The spatial distribution of relative permeable and impermeable currents, subsurface faults and the reflections on the water table.

The known geometric configuration of the permeable zones indicate specific areas where artificial recharge could be achieved and wells could be developed for maximum water yield.

## PUBLICATIONS:

Master's Thesis, George Maddox, The University of Arizona, 1961.

Master's Thesis, Robert Streitz, The University of Arizona, 1962.

"Capturing Water for Increasing Supplies in Land and Water Use." J. W. Harshbarger, A.A.A.S. special volume (in press).

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

Mining Geohydrology.

## SUPPORT:

Departmental project.

## PERSONNEL:

Estes F. Hollyday, John G. Ferris

## NATURE OF RESEARCH:

Field and analytical; theory and development; Master's thesis

## DESCRIPTION OF PROJECT:

A geohydrologic analysis of mine dewatering and water development with special reference to Tombstone mining district, Cochise County, Arizona. The project investigates the interrelationships between geology and hydrology, in fractured crystalline rocks, through field investigation, analysis of nine years of pumping records, and geologic reports. The ultimate purpose is to develop new concepts of hydrologic behavior of fractured crystalline rocks with special reference to mining areas.

## PRESENT STATUS:

Active

## RESULTS:

The reported vast quantities of water pumped from the Tombstone mines during the period 1903 to 1911 have been supplied to the hornfels-marble aquifer complex of the mines from storage in the valley alluvium north of the mining district. Storage in the mine rocks is less than 1% by volume. Transmissibility is found to decrease logarithmically with time and higher rates of pumping, apparently varying between 20,000 and 5,000 gallons per day per foot of aquifer. Within the mines, movement is entirely through fractures, fissures and solution openings.

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

Ground Subsidence Due to Groundwater Withdrawal in the Tucson Basin and Tempe, Arizona.

## SUPPORT:

Departmental project.

## PERSONNEL:

W. C. Lacy, W. S. Platt, Neal Nollau.

## NATURE OF RESEARCH:

Laboratory and field investigation; Master's thesis

## DESCRIPTION OF PROJECT:

Observation of structural damage to buildings in Tucson as a guide to zones of differential ground movement. Correlation of the pattern of building fracturing intensity with soil types, depression of ground water level, and subsidence of bench marks in the Tucson Basin area and Tempe, Arizona.

## PRESENT STATUS:

Active

## RESULTS:

Close correlation with water withdrawal and ground subsidence effects exist.

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

The Relationships of the Confined and Unconfined Water Tables Above and Below the Tres Alamos Dam Site of the San Pedro River, Cochise County, Arizona.

## SUPPORT:

Departmental project.

## PERSONNEL:

E. L. Montgomery, John W. Harshbarger.

## NATURE OF RESEARCH:

Field investigation for development; Master's thesis.

## DESCRIPTION OF PROJECT:

Geologic mapping at a scale of 3 inches to the mile of Townships 14 and 15 south, Range 20 east. Gravity survey information derived from converting gravity values to varying thicknesses of valley fill will be used in conjunction with well logs to determine thickness and water characteristics of the underlying strata. The preceding information and data from water levels in well records will be used to determine the relationships of the confined and unconfined water tables above and below the Tres Alamos Dam site of the San Pedro River.

## PRESENT STATUS:

Active

## RESULTS:

The confined water above and below the Tres Alamos Dam site seems to be hydraulically connected through a ground water pass, west of the granitic outcrop forming the Dam site. The unconfined water tables seem to be connected or continuous through the present stream channel of the San Pedro River.

## DEPARTMENT OF GEOLOGY

## TITLE AND NUMBER OF PROJECT:

The Occurrence of Thermal Ground Water in the Basin and Range Province of Arizona.

## SUPPORT:

Water Resources Division of the U. W. Geological Survey

## PERSONNEL:

Jerome J. Wright.

## NATURE OF RESEARCH:

Analytical and field investigation; operation and development; research with possibility of doctoral dissertation.

## DESCRIPTION OF PROJECT:

The principal object of the report was to examine on a regional basis the occurrence of ground-water having temperature considered to be higher than normal. The occurrence of thermal water is closely allied to the structural elements of the Basin and Range Province. Geothermal gradients computed for a number of occurrences display a wide range of values. Chemical analyses of hot spring water taken from a representative group of springs in the province indicate diverse origins and environments.

## PRESENT STATUS:

Completed.

## RESULTS:

Results indicate that a great amount of data concerning ground water may be obtained by detailed thermal studies using electronic instruments. Work of this nature has not been done to date. A considerable amount of experimentation on methodology must be performed.

## PUBLICATIONS:

Report, Jerome J. Wright, in press in the U.S. Geological Survey Circular, U.S. Geological Survey, Washington, D.C.

## HYDROLOGY PROGRAM

## TITLE AND NUMBER OF PROJECT:

Current Meter Development.

## SUPPORT:

Departmental and the Ground Water Branch of the U.S. Geological Survey.

## PERSONNEL:

E. H. Cordes, John G. Ferris

## NATURE OF RESEARCH:

Design and Development for Field Use, Master's Thesis.

## DESCRIPTION OF PROJECT:

This project will entail the design and operation of a current meter to measure the vertical velocity component in a pumping well. The velocity profile can then be applied to study transmissibility of ground water aquifers.

## PRESENT STATUS:

Active well.

## HYDROLOGY PROGRAM

## TITLE AND NUMBER OF PROJECT:

Development of Hydraulic Models Analogous to Subsurface Geologic Conditions for Studying and Demonstrating the Characteristics of Ground Water Movement, NSF-G17703.

## SUPPORT:

National Science Foundation.

## PERSONNEL:

Jay H. Lehr, Jerome J. Wright.

## NATURE OF RESEARCH:

Laboratory Investigation, Design, development and operation.

## DESCRIPTION OF PROJECT:

The purpose of the project is to clarify the characteristics of laminar flow in groundwater movement in a manner which will enable a visual flow net analysis. Hydraulic models are being developed which consist of consolidated media simulating sedimentary rock, enclosed in a water-tight case with a transparent side. Basic geologic structures and lithologies can be synthesized, and colored inks can be inserted into the flow system of the model, forming visible flow lines. These flow lines can then be observed and analyzed in order to better understand the pattern of laminar groundwater flow as controlled by geologic factors. A few of the empirical model experiments which are being carried out include: 1) Refraction of flow bands across lithologic interfaces, 2) Continuity of flow around and through highly permeable and impermeable lenses of different lithologies, 3) Flow net systems caused by a single pumping well, 4) Flow-net system of mutual interference of depression cones caused by pumping multiple wells, 5) Artesian aquifer systems, 6) Infiltration phenomenon.

Models are being developed for use in education in science and hydrology at the college and university level.

## PRESENT STATUS:

Active.

## RESULTS:

Models consisting of plexiglass cases containing artificially consolidated porous media which can be arranged in a nearly infinite variety of geologic structures and hydrologic situations have been developed. A wide variety of these models have been constructed and through their use it has become possible for the college student to obtain a clear description and understanding of previously conceived groundwater theories.

## PUBLICATIONS:

"Empirical Studies of Laminar Flow in Porous Consolidated Media" (Abstract), Jay H. Lehr, Geological Society of America Bulletin, Special Paper 68, p. 217, 1961.

"Empirical Studies of Laminar Flow in Porous Consolidated Media," Jay H. Lehr. Doctoral Dissertation in Hydrology; The University of Arizona, June 1962.

## HYDROLOGY PROGRAM

## NUMBER AND TITLE OF PROJECT:

The Mechanics of Earth Fissuring in Alluvial Basins.

## SUPPORT:

Department of Geology in cooperation with the U.S. Geological Survey.

## PERSONNEL:

Dennis E. Peterson, H. E. Skibitzke

## NATURE OF RESEARCH:

Analytical and Field Investigation for Theory and Doctoral Dissertation.

## DESCRIPTION OF PROJECT:

## Field studies:

- Mapping fissure locations
- Mapping surface elevation changes
- Mapping changes in water levels
- Gravity surveys for analysis of basin structures

Synthesis of field data into a working hypothesis for the origin of the fissures.

Formulation of a model describing the development of fissures by means of theoretical mechanics.

## PRESENT STATUS:

Active.

## RESULTS:

Fissure locations are associated with differential subsidence.

## PUBLICATIONS:

"Notes on Earth Fissures in Southern Arizona," G. M. Robinson and D.E. Peterson, U.S. Geological Survey Circular 466, 1962, U. S. G. P. O., Washington 25, D. C.

"Earth Fissuring in Pinal County, Arizona," D. E. Peterson, M.S. Thesis, 1962; The University of Arizona, Tucson.

## HYDROLOGY PROGRAM

## TITLE AND NUMBER OF PROJECT:

Groundwater Hydrology of the Western Desert, U.A.R.

## SUPPORT:

Department of Geology in cooperation with the General Desert Development Authority, Cairo, U.A.R.

## PERSONNEL:

Moh. H. I. Salem, John W. Harshbarger, J. G. Ferris.

## NATURE OF RESEARCH:

Analytical study of field data; operation and development; Doctoral dissertation.

## DESCRIPTION OF PROJECT:

An electric analog model of the subsurface geologic and hydrologic conditions of the western desert of the U.A.R., Libya, Sudan and Tchad is being constructed. Presently the area of recharge is in the high regions of Tchad and of Darfur in the Sudan. Groundwater is discharged into the Nile and into the Qattara Depression. The distribution of the fundamental differential equations in the system will be determined taking into consideration the boundary conditions. It is hoped that the equations can be solved with the use of the electric analog model. The effects on the Ground Water system due to changed boundary conditions such as the completion of the Aswan High Dam (The Nile is expected to recharge water to the aquifer after the dam is completed) or the initiation of the Qattara Depression project, will be included in the general analysis of the western desert.

## PRESENT STATUS:

Active

## DEPARTMENT OF HORTICULTURE

## TITLE AND NUMBER OF PROJECT:

Response of Citrus Trees to Soil Moisture; Movement of Soil Moisture in the Root Zone. Hatch 371.

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

R. H. Hilgeman, J. A. Dunlap.

## NATURE OF RESEARCH:

Combination field and laboratory research for operation and theory.

## DESCRIPTION OF PROJECT:

The conservation of water is of vital importance in Arizona because of the overdevelopment of the underground supply and recurring droughts. Present experiments now in progress at the Citrus Experiment Station show that the application of different amounts of water had marked effects upon tree growth and fruiting. Preliminary experiments on the movement of water in the upper six feet of bare soil suggest that relatively large quantities of water are lost through evaporation and downward percolation from the root zone of the plants. These experiments will be coordinated under this project. Further information is required to determine methods of maintaining water in the root zone while reducing evaporational and percolation losses. Such data has wide application throughout all desert areas similar to Arizona. Valencia orange trees have been found to closely respond in vegetative growth, fruit quality and sizes to the amount of water currently applied. Fruiting responses have been slow and do not become evident for several years. Information acquired from this work will contribute to a program of developing methods of water application which will supply the needs of the tree with a minimum loss from evaporation and percolation.

## PRESENT STATUS:

Active.

## RESULTS:

Present field tests show clearly that keeping the soil in the root zone constantly above the wilting point induces poor tree condition after several years. A program of alternate periods of high soil moisture followed by periods of low soil moisture with moderate stress on the trees has prevented this condition and increased yields. Exploratory data indicates that the amount of water depletion from the soil does not fit the root distribution pattern. Water loss from noncropped cultivated plots, covered plots and crop plots, shows that as much as 55% of the water applied may be lost by downward drainage and evaporation conditions. This program coordinates within one experiment, all present research on water responses of citrus trees and studies of movement of soil moisture.

## PUBLICATIONS:

"The Effect of Temperature, Precipitation, Blossom Date and Yield upon the Enlargement of Valencia Oranges," R. H. Hilgeman, H. Tucker, and T. A. Hales; Proceedings of the American Society for Horticulture Science, Volume 74, 1959, pages 266 - 279.

"Commercial Citrus Production in Arizona," R. H. Hilgeman and D. R. Rodney; Special Report No. 7, Agricultural Experiment Station and Cooperative Extension Service, The University of Arizona.

## LABORATORY OF TREE-RING RESEARCH

## TITLE AND NUMBER OF PROJECT:

A Study of Tree Growth and Environment as a Basis for Interpretation of Dendroclimatic Series, 960-138 and 960-458.

## SUPPORT:

Largely from the National Park Service; National Geographic Society; U.S. Weather Bureau, and the Research Corporation.

## PERSONNEL:

Harold C. Fritts.

## NATURE OF RESEARCH:

A combined field, laboratory and analytical study.

## DESCRIPTION OF PROJECT:

Field studies at Mesa Verde National Park, Colorado, and on Mount Bigelow near Tucson are aimed toward providing a biological basis for the correlation of ring width with climate.

## PRESENT STATUS:

Active.

## RESULTS:

Several measures have been made of tree-ring variability and the similarity between species and among individuals. The growth period has been determined and tentative model constructed for the tree growth-environmental relationships.

## PUBLICATIONS:

"The Relevance of Dendrographic Studies to Tree-Ring Research," Harold C. Fritts, Tree-Ring Bull. 24(1-2): 9-11, 1962.

"Analysis and Evaluation of the Sources of Variation in Tree-Rings from Mesa Verde National Park," Harold C. Fritts and D. G. Smith. Mimeographed paper presented at Annual Meeting of the Am. Inst. of Biol. Sciences, Corvallis, Oregon, 13 pp, August 30, 1962.

## LABORATORY OF TREE-RING RESEARCH

## TITLE AND NUMBER OF PROJECT:

Dendrochronology of Bristlecone Pine (*Pinus aristata* Engelm.) as a Basis for the Extension of Dendroclimatic Indices. 960-292.

## SUPPORT:

National Science Foundation.

## PERSONNEL:

W. G. McGinnies, C. W. Ferguson, H. C. Fritts, Marvin A. Stokes.

## NATURE OF RESEARCH:

Includes field and laboratory investigations.

## DESCRIPTION OF PROJECT:

The project includes field and laboratory studies of bristlecone pine to provide exact date each growth ring was produced as far back as available material allows. The oldest rings on living trees were formed more than 4500 years ago. Simultaneous field studies are aimed toward determining the relation between various climatic parameters and tree ring growth. Experimental data and climatic records will be used to determine the value of bristlecone tree rings for long time climatic and streamflow interpretations. A tree-ring chronology has been established to 800 B.C. and it is expected this will be extended to 2000 B.C. by June 1963. Dated material has been furnished to radio carbon laboratories for check dating. Environmental studies were set up in the White Mountains of California in the summer of 1962.

## PRESENT STATUS:

Active.

## LABORATORY OF TREE-RING RESEARCH

## TITLE AND NUMBER OF PROJECT:

Dendroclimatic Research.

## SUPPORT:

Laboratory project.

## PERSONNEL:

W. G. McGinnies, Harold C. Fritts, Wesley C. Ferguson, Marvin A. Stokes.

## NATURE OF RESEARCH:

Project is a combination of analytical laboratory and field investigations. It represents about half the total research program of the tree-ring laboratory and is closely integrated with dendrochronological research.

## DESCRIPTION OF PROJECT:

The project is aimed toward determining the relationship between climate and the radial growth of trees as expressed by annual rings. It includes a study of the effects of yearly variations as well as long time trends. In the western United States precipitation has an important influence on tree growth and it is hoped that the cause and effect relationships, can be identified to the point where specific climatic factors can be estimated from tree-ring information.

## PRESENT STATUS:

A continuing program.

## RESULTS:

Very preliminary results emphasize the importance of winter precipitation as the primary control of ring growth though in pine the precipitation regime for a 12 month period is important. A portion of the growth response is exhibited by a lag so that a small portion of climatic variation may be reflected in ring widths of the two or three following years.

## PUBLICATIONS:

"An Approach to Dendroclimatology: Screening by Means of Multiple Regression Techniques," H. C. Fritts, *Jour. Geophysical Res.* 67(4): 1413-1420. 1962.

"The Relation of Growth Ring Widths in American Beech and White Oak to Variations in Climate," H. C. Fritts, *Tree-Ring Bull.* 25(1 and 2): In press. 1962.

"Dendrochronology," W. G. McGinnies, *Journal of Forestry.* 61(1): 5-11. 1963.

## INSTITUTE OF WATER UTILIZATION

## TITLE AND NUMBER OF PROJECT:

Reduction of Evaporation Losses by Using Monomolecular Films. State 507.

## SUPPORT:

Agricultural Experiment Station and the U. S. Bureau of Reclamation.

## PERSONNEL:

C. Brent Cluff, Sol D. Resnick, Howard Goldstein.

## NATURE OF RESEARCH:

Laboratory and Field investigation, operation, development, and theory.

## DESCRIPTION OF PROJECT:

- (1) To develop and verify techniques for determining the effectiveness of various monomolecular films considering film, water and climatic characteristics typical of semi-arid regions.
- (2) To develop a simple, effective, inexpensive apparatus for applying and maintaining a monomolecular film at maximum film pressure on ponds and reservoirs.
- (3) To screen physical conditioning and spreading agents to be used with the chemicals forming monomolecular films selected under Objective 1.
- (4) To develop methods for detecting the presence, extent, and pressure of a monomolecular film.

## PRESENT STATUS:

Active.

## RESULTS:

Initial selection and chemical testing where necessary, of the commercial fatty alcohols to be used, were accomplished. Calibration of field and laboratory equipment was completed. The laboratory phase of the program is almost completed especially with regard to the determination under controlled conditions of spreading and healing rates with time for varying temperatures and humidities. The evaporation pan testing phase is also providing useful data for application in the pond testing program. Testing in the field ponds is well under way using chemical in the following physical forms; Solid, flakes, powders, emulsions, and solutions. Considerable attention is being given to the development of dispensers for alcohols in the various physical forms.

## PUBLICATIONS:

Quarterly progress reports prepared for U. S. Bureau of Reclamation. Available from Institute of Water Utilization.

## INSTITUTE OF WATER UTILIZATION

## TITLE AND NUMBER OF PROJECT:

Selection and Testing of Materials for Surfacing Watershed Areas. State 508.

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

Sol D. Resnick, C. Brent Cluff, Ervin Schmutz, Richard Shaw

## NATURE OF RESEARCH:

Laboratory and field investigation; operation and development.

## DESCRIPTION OF PROJECT:

To test plastics, butyl rubber, bitumens, cement, and other chemicals as water-proofing materials. The materials selected should have the following properties:

- a. Prevent infiltration of most of the precipitation.
- b. Bind soil sufficiently to prevent erosion.
- c. Be easy to apply, preferably by spraying on the surface of the ground.
- d. Be fairly inexpensive.

## PRESENT STATUS:

Active.

## RESULTS:

Analysis was completed of recording rainfall and runoff data collected for the tenth and eleventh years of operation of the Page Ranch asphalt-paved runoff area.

Twelve plots with concrete borders and volumetric measuring tanks are nearing completion. Besides conventional paving materials as plastics, chemicals selected through a screening program by the U. S. Water Conservation Laboratory will be tested.

## INSTITUTE OF WATER UTILIZATION

## TITLE AND NUMBER OF PROJECT:

The Effects of Algae and Molds Upon Some Hydrologic Processes of Moisture Exchange. Hatch 523, (W-73).

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

Sol D. Resnick, William F. Faust.

## NATURE OF RESEARCH:

Laboratory and Field Investigation; operation and theory; Master's thesis.

## DESCRIPTION OF PROJECT:

To determine the effects of algae and molds upon the vertical transfer of moisture across the soil-air interface and to evaluate the influence of these effects upon water yield.

## PRESENT STATUS:

Active.

## RESULTS:

One phase of the past year's work was a study of the algal-mold crusts as they occur in wild land areas with special emphasis on molds present. A second phase of the past year's work was the construction of suitable equipment for investigating the effects of algae and molds upon the hydrologic processes of runoff, infiltration, and evaporation and erosion at soil surfaces.

## PUBLICATIONS:

Yearly progress reports prepared for CSESS. Available from Institute of Water Utilization.

## INSTITUTE OF WATER UTILIZATION

## TITLE AND NUMBER OF PROJECT:

Climatic Patterns and Their Effect on Arizona Agriculture. Hatch 541. (W-48)

## SUPPORT:

Agricultural Experiment Station, Institute of Atmospheric Physics.

## PERSONNEL:

Sol D. Resnick, P. C. Kangieser, W. D. Sellers, Christine Green.

## NATURE OF RESEARCH:

Analytical; operation and theory.

## DESCRIPTION OF PROJECT:

(1) To record and tabulate weather data for Arizona from selected locations such as experiment stations, experiment farms and other locations of importance to agriculture and forestry, on coded machine cards so as to make them available for research.

(2) For a network of stations, analyze the precipitation data for determination of probabilities for weekly periods and combination of weekly periods.

## PRESENT STATUS:

Active.

## RESULTS:

Weekly summaries of precipitation, maximum temperature, and minimum temperature data for the selected network of 19 climatological stations for the period, March 1, 1931 through February 28, 1961 were tabulated on cards for machine analysis. The Weather Bureau's procedure was used for estimating missing data.

## PUBLICATIONS:

Yearly progress reports prepared for CSESS. Available from Institute of Water Utilization.

## INSTITUTE OF WATER UTILIZATION

## TITLE AND NUMBER OF PROJECT:

Investigation of Sites, Methods, Aquifer Deterioration Control, and Effects of Artificial Ground Water Recharge of Alluvial Basins Typical of the Arid Southwest United States. State 505.

## SUPPORT:

Agricultural Experiment Station.

## PERSONNEL:

L. G. Wilson, Sol D. Resnick,

## NATURE OF RESEARCH:

Laboratory and Field Investigation; operation and development.

## DESCRIPTION OF PROJECT:

(1) To test the various methods of ground water recharge and determine the ones best suited to arid lands. (2) To test in laboratory and field and evaluate, also considering costs, various types of flocculants and filters for removal of suspended and colloidal material from recharge water. (3) To determine the effect on the aquifer and groundwater of recharging sediment laden flood water. (4) To study the effect on groundwater and the aquifer of any bacteria which may be introduced with recharge water; identify and find methods for controlling the growth and spread of these bacteria.

## PRESENT STATUS:

Active.

## RESULTS:

- A. Artificial recharge experiments were conducted on a test pit at Beardsley, Arizona. Constant head and falling head infiltration experiments were performed. Seepage meter tests indicated that water below the pit surface occurred in the unsaturated state.
- B. Additional experiments were conducted to determine the effectiveness of grass filters in reducing sediment load in flood water. Coastal Bermuda was the most efficient grass of six grass varieties and one alfalfa variety tested.
- C. The investigation conducted to determine the nature of the process of sediment removal by pea gravel filters indicated that removal occurred as a result of adsorption of sediment to an organic film (schmutzdecke).

## PUBLICATIONS:

"To Save Precious Water - Bury It!" - C. E. Maddox and S. D. Resnick, Progressive Agriculture in Arizona, Vol. XIV, No. 5, p. 4, Sept.-Oct., 1962.  
"Letting Grass Take the Mud Out of Water," L. G. Wilson and C. B. Cluff, Progressive Agriculture in Arizona, Vol. XIV, No. 6, p. 12, Nov.-Dec., 1962.

## DEPARTMENT OF WATERSHED MANAGEMENT

## TITLE AND NUMBER OF PROJECT:

Evaporation, Transpiration and Evapotranspiration from Soils Under Varying Soil Moisture and Solar Radiation Levels. 509-D.

## SUPPORT:

Agricultural Experiment Station in cooperation with the Soil Conservation Service of the U. S. Department of Agriculture.

## PERSONNEL:

A. L. McComb, P. B. Rowe, Howard G. Halverson.

## NATURE OF RESEARCH:

Analytical, laboratory, theory, Master's thesis.

## DESCRIPTION OF PROJECT:

Effects of different levels of soil moisture and solar radiation on evaporation, transpiration and evapotranspiration were measured by use of 8 groups of fifteen, 10-inch plastic pots. Each pot contained a forest soil collected from a mixed stand of ponderosa pine (Pinus ponderosa) and Douglas fir (Pseudotsuga taxifolia). Evaporation was studied by using pots containing soil only, transpiration by using pots containing two-year-old Aleppo pine (Pinus halepensis) seedlings with the soil sealed to prevent evaporation, and evapotranspiration by using pots containing tree seedlings with the surface soil exposed.

## PRESENT STATUS:

Completed.

## RESULTS:

Water losses (transpiration and evapotranspiration) from the potted seedlings were closely correlated with a soil moisture and to a lesser degree with solar radiation. Evaporation from a bare soil surface, on the other hand, was significantly related only to soil moisture. In all cases, the greater the soil moisture, the greater the rate of water loss. This indicates that in the management of vegetation to reduce water loss, emphasis should be placed on methods of reducing the availability of soil water to direct evaporation.

## PUBLICATIONS:

"Transpiration and Evapotranspiration with Aleppo Pine (Pinus halepensis Mill.) Seedlings Under Varying Soil Moisture and Solar Radiation Levels". Howard G. Halverson, Thesis, The University of Arizona: 50 pp. (typed), illus. May 15, 1962.

## DEPARTMENT OF WATERSHED MANAGEMENT

## TITLE AND NUMBER OF PROJECT:

The Development and Testing of Methods for Determining Evaporation, Transpiration and Evapotranspiration in Pine Stands by Soil Moisture Sampling. 509-D.

## SUPPORT:

Department of Watershed Management in cooperation with U. S. Bureau of Indian Affairs, White Mt. Apache Tribe & Southwest Forest Industries, McNary, Arizona.

## PERSONNEL:

A. L. McComb, P. B. Rowe, Hilton Lee Silvey.

## NATURE OF RESEARCH:

Analytical and field investigation, development and operation; Master's thesis.

## DESCRIPTION OF PROJECT:

Study designed to develop and test a method for measuring the evaporation and transpiration components of evapotranspiration in mature ponderosa pine stands in central Arizona. Installation consisted of twelve, 14 x 18 foot trenched plots - 3 with bare soil, 3 with a mature ponderosa pine cover, 3 with a vegetation free soil covered with plastic sheeting, and 3 with mature ponderosa pine and ground covered with plastic sheeting. Soil moisture supplied by natural rainfall, supplemented by irrigation. Soil moisture storage, percolation through the soil, and evaporative losses were determined for each treatment by periodic soil moisture sampling and allied meteorological observations.

## PRESENT STATUS:

Completed.

## RESULTS:

The individual processes involved in the disposition of precipitation (evaporation, transpiration, soil moisture storage, and percolation through the root zone), and the effects of vegetation on these processes can be evaluated through the use of plastic sheeting, soil moisture sampling and allied climatic measurements. Such information is basic to predicting potential effects of vegetation manipulation on both on-site and off-site water yields.

## PUBLICATIONS:

"A Method for Determining Evaporation, Transpiration and Evapotranspiration in Pine Stands by Soil Moisture Sampling." Hilton Lee Silvey, Thesis; The University of Arizona, 84 pp. (typed), illus. May 25, 1962.

## DEPARTMENT OF WATERSHED MANAGEMENT

## TITLE AND NUMBER OF PROJECT:

A Comparison of the Structure, Bulk Density, Infiltration Capacity and Permeability of a Soil Under Grazed and Ungrazed Grass, and Grazed and Ungrazed Grass-Juniper Vegetation. 509-D.

## SUPPORT:

Department in cooperation with the Forest Service of the U. S. Department of Agriculture.

## PERSONNEL:

P. B. Rowe, A. L. McComb, Almer D. Zander

## NATURE OF RESEARCH:

Analytical, field investigation, theory, Master's thesis.

## DESCRIPTION OF PROJECT:

Inventories and measurements of pertinent site characteristics were made for each of the vegetation conditions studied. These included both qualitative and quantitative descriptions of past and present land use, litter cover, and surface soil conditions. Infiltration capacity (for dry and wet soil condition) bulk density, and penetrability tests were made of the surface soil. Pits were then dug to the depth of the weathered bed rock, soil horizons differentiated, and bulk density, permeability, texture, organic matter and pH determinations made for each horizon.

## PRESENT STATUS:

Field work and analyses completed, thesis in preparation.

## RESULTS:

Preliminary results indicate important differences in the physical properties of the soil between the vegetation conditions studied. In the heavily grazed areas the infiltration capacities and penetrabilities were generally less and bulk densities greater than in the comparative ungrazed area. To a lesser degree, this also appears to be true for the juniper-grass as compared to the grass areas.

## DEPARTMENT OF WATERSHED MANAGEMENT

## TITLE AND NUMBER OF PROJECT:

Effect of Fire and Residual Ash on the Vegetation, Soil, Water Relations  
in Selected Ponderosa Pine Stands. 509D.

## SUPPORT:

Department in cooperation with U.S. Bureau of Indian Affairs, White Mt.  
Apache Tribe.

## PERSONNEL:

P. B. Rowe, A. L. McComb, Malcolm J. Zwolinski.

## NATURE OF RESEARCH:

Analytical, laboratory and field investigations, theory, doctoral  
dissertations.

## DESCRIPTION OF PROJECT:

The study will include a series of laboratory and field experiments to  
evaluate the influences of wild fire and controlled burning on the chemical  
and physical properties of a forest soil as these may affect the basic  
processes of surface and soil water movements. Laboratory studies will be  
carried on to determine changes in the structure, pore space, and chemical  
characteristics of the soil due to burning of the ground cover. Field  
studies employing North Fork type infiltrometers, soil and soil moisture  
sampling will be carried on to supplement and extend the results of the  
laboratory studies.

## PRESENT STATUS:

Active

## RESULTS:

Preliminary studies and literature review indicate conflicting and inclusive  
evidence of the effects of ash residue on water-soil relations.

## EXHIBIT 2

**OKLAHOMA STATE UNIVERSITY • STILLWATER**

Office of the President  
FRontier 2-6211, Ext. 201

January 29, 1963

Senator Clinton P. Anderson  
Committee on Interior and Insular Affairs  
Senate Office Building  
Washington, D. C.

Dear Senator Anderson:

My letter of June 12, 1962, indicating research activity in the field of Water Resources, I find was incomplete. Accordingly I would appreciate having that report amended by the attached information. Oklahoma State University has been concerned with the water resources problem of Oklahoma during most of the years of the University's operation. A continuing program in the Sanitary Engineering field began in 1922 which has provided information and services for municipal and industrial users of water throughout the intervening years.

We recognize the primary importance of water resources which were, for many years, so eloquently described by the late Senator Kerr. We support the investment in acquiring a more complete and accurate understanding of water conservation and utilization.

Sincerely,

*Oliver S. Willham*  
Oliver S. Willham  
P r e s i d e n t

Attachments

WATER RESOURCES RESEARCH  
OKLAHOMA STATE UNIVERSITY  
STILLWATER, OKLAHOMA

School of Civil Engineering and  
Office of Engineering Research  
College of Engineering

The research program in water resources within the School of Civil Engineering involves a wide range of subject material. Research is in progress in subject material related to water quality, reduction of water pollution, and water conditioning. Graduate students are utilized in the various research projects such that while accomplishing the end results of the research, professional personnel are educated in modern research methods and procedures in the area of water resources engineering. A continuing program in cooperation with the Oklahoma Water and Pollution Control Association of adult education has been conducted by this school since 1922. Research papers and discussions have been presented at the Oklahoma Industrial Wastes Conference and at the Water and Pollution Control Short Courses.

- (1) Project: Kinetics and Mechanism in Activated Sludge Processes

Director: Anthony F. Gaudy, Jr.

Sponsor: Department of Health, Education and Welfare

Purpose and Objectives: A study of various physical and chemical factors which affect system kinetic behavior, substrate partition and substrate removal in continuous-flow activated sludge units.

- (2) Project: Response of Activated Sludge to Organic Shock Loads

Director: Anthony F. Gaudy, Jr.

Sponsor: Department of Health, Education and Welfare

Purpose and Objectives: An integrated investigation using both batch and continuous flow conditions of various changes in environment, or shock loads, to which an activated sludge is subjected during the course of waste purification.

- (3) Project: Bio-Engineering

Director: Anthony F. Gaudy, Jr.

Sponsor: Department of Health, Education and Welfare

Purpose and Objectives: A graduate training program at the Ph.D. level with special emphasis on education for research in water supply and pollution control.

- (4) Project: Cryostatic Collection of Organic Materials from Aqueous Media

Director: Louis Hemphill

Sponsor: An institutionally supported project

Purpose and Objectives: Development of a method and apparatus, based on using an inert carrier gas for the mass transfer and low temperature "cold trap" condensers, for collecting organic material from natural water.

- (5) Project: Differential Thermal Analysis

Director: Louis Hemphill

Sponsor: An institutionally supported project

Purpose and Objectives: Development of a differential thermal analyzer which will permit investigation of energy distribution in samples of environmental interest.

- (6) Project: Sorption of Organic Materials on Clay Minerals in Solution

Director: Louis Hemphill

Sponsor: An institutionally supported project

Purpose and Objectives: Determination of the affinity of clay minerals in aqueous solution for sorbing organic materials having relatively high toxicity.

- (7) Project: Controlled Temperature Synthetic Feed Aerobic Sludge Digestion

Director: Quintin B. Graves

Sponsor: An institutionally supported project

Purpose and Objectives: A determination of the value of aerobic sludge digestion. A synthetic sludge is used to eliminate variable strength and composition of the sludge. The temperature is controlled to determine the effects of temperature on aerobic digestion. The effectiveness of the process is measured by the drainability of the sludge, by the reduction in solids and by the presence or absence of odors.

- (8) Project: Industrial Hygiene, Radiological Health, Water Pollution Control and Air Pollution Control

Director: Quintin B. Graves

Sponsor: Department of Health, Education and Welfare

Purpose and Objectives: A graduate training program in sanitary and public health engineering including water resources as affected by wastes.

School of Electrical Engineering and  
Office of Engineering Research  
College of Engineering

The research program related to water resources within the School of Electrical Engineering involves the storing of energy as shown in the following project:

- (1) Project: Energy Storage Project

Director: William L. Hughes and C. M. Summers

Sponsor: University

Purpose and Objectives: Basic work is being done in developing means of storing energy. This has direct application in making better use of the energy developed at hydroelectric plants since water can be used for both irrigation and power, the energy being stored for later use.

School of Agricultural Engineering  
College of Engineering  
College of Agriculture and  
Oklahoma Agricultural Experiment Station

The program of research in water resources within the School of Agricultural Engineering involves research on reduction of evaporation from reservoirs, effective use of limited irrigation of water supplies, the hydraulics of overland flow, hydrologic studies on small grass-covered watersheds and farm water supply development.

- (1) Project: The Effectiveness of Monomolecular Films for Reducing Evaporation From Reservoirs

Director: F. R. Crow

Sponsor: Oklahoma Agricultural Experiment Station cooperative with U. S. Bureau of Reclamation

Purpose and Objectives: Two paired plastic lined ponds, designed for evaporation research, are being used to study various aspects of evaporation reduction by monomolecular films. Apparatus has been developed for automatic application of hexaocadecanol slurry. Present research is on the effects of wind on monolayers and development and testing of methods of alleviating adverse effects of wind.

Evaporation reductions of 25 to 40% have been obtained in long duration tests using slurry method of applying films. Curves have been developed relating wind speed and required film application rate. In current research a system of floating barriers is used to confine the monolayer to reduce frequency of application. Various height/spacing ratios have been tested. The effect of the barriers, with and without monolayer, on evaporation is being studied.

Publications: "Reducing Reservoir Evaporation" by F. R. Crow, Agricultural Engineering, Vol. 42, No. 5, May 1961.

- (2) Project: Irrigation Engineering Studies on the Effective Use of Limited Irrigation Water Supplies

Director: James E. Garton

Sponsor: Oklahoma Agricultural Experiment Station

Purpose and Objectives: These studies are being conducted at a 240 acre irrigation research farm. In general, the research has been concerned with how a farmer can make the most effective use of a limited water supply. Experiments have been conducted on the more common irrigated crops of the area, cotton, grain sorghum, and wheat.

The research has been directed toward the following questions: What is the average seasonal use of water by various crops? How frequently should they be irrigated for maximum returns? What is the best method of determining when to irrigate?

Some work has been done on the uniformity of application with various methods of furrow irrigation. This work will be expanded with the objective being to improve the uniformity and efficiency of irrigation while at the same time reducing the labor requirement.

- (3) Project: The Hydraulics of Overland Flow

Director: F. R. Crow

Sponsor: Oklahoma Agricultural Experiment Station cooperative with Agricultural Research Service, U.S. Department of Agriculture

Purpose and Objectives: A study of the basic relationships involved in the hydraulics of overland flow. Now in its initial phase, the research is being done at the Stillwater Outdoor Hydraulic Laboratory. Test channels, 96 ft. long will be subjected to simulated rainfall of various intensities and droplet sizes. The water surface profile will be studied for transient and equilibrium states for channels surfaced with cement mortar and also for earth channels vegetated with wheat.

- (4) Project: Hydrologic Studies on Small Grass-Covered Watersheds

Director: F. R. Crow

Sponsor: Agricultural Experiment Station cooperative with Agricultural Research Service, U. S. Department of Agriculture

Purpose and Objectives: Measurements are being made to provide hydrologic data on total watershed runoff and peak rates of runoff from three small grass-covered watersheds in north central Oklahoma. Highway culverts, modified by the addition of weir sills, are being used as runoff measuring devices. Intensive model tests of culverts equipped with weir sills completed. Ten years data on precipitation and runoff completed.

- (5) Project: Farm Water Supply Development

Director: Elmer R. Daniel

Sponsor: Oklahoma Agricultural Experiment Station

Purpose and Objectives: A study of the basic relationships involved in the design of a municipal gravity sand filtration water plant as applied to an individual surface water supply system for the farmstead.

Purification of individual water supply using ultra violet energy.

A study now in progress of pressure filtration of surface water to provide design data for a packaged treating unit. Study consists of rapid flocculation, detention, filtration, taste and odor removal, and chlorination.

- Publications: "A Household Water Supply from Your Farm Pond", Cir. E-580, available through mailing room Agriculture Extension Service, Oklahoma State University.
- "Ultra Violet Bacterial Disinfection of Domestic Water Supply" Elmer R. Daniel, Agricultural Engineering, Vol. 43, No. 6, pp. 344-345, 350, June 1962.
- "A Packaged System for Rapid Treatment of Pond Water" by Elmer R. Daniel. Paper given at Oklahoma Section ASAE, November 30, 1962.

Aquatic Biology Laboratory  
Zoology Department  
Research Foundation  
College of Arts and Sciences

The program of research in water resources at the Aquatic Biology Laboratory is concerned mainly with graduate thesis research. More than thirty Ph.D. degrees, and about as many M.S. degrees, have been earned in various aspects of aquatic biology. Thesis research topics have been concerned with biological effects of oil refinery and paper mill effluents; productivity of ponds and reservoirs; reaction of fishes to toxicity of oil refinery effluents, to oxygen deficiency, to temperature, and to certain chemicals; and life histories of fishes of economic importance.

Support for research at the Aquatic Biology Laboratory has come from a variety of sources.

- (1) The Oklahoma Oil Refiner's Waste Control Council has supported studies of the biological effects of oil refinery effluents since 1957. Principal investigator, Troy C. Dorris, Ph.D.
- (2) The U. S. Public Health Service, National Institutes of Health, has supported two research projects on the biological effects of oil refinery effluents.

Continuous-flow toxicity bioassay of oil refinery effluents. Principal investigator, Troy C. Dorris, Ph.D.

Relative resistance of fish species to toxicity of oil refinery effluents. Principal investigator, W. H. Irwin, Ph.D.

- (3) The U. S. Public Health Service, Division of Water Supply and Pollution Control, supports a training program for Aquatic Biologist Specialists in Water Pollution. Director, Troy C. Dorris, Ph.D.

- (4) The National Science Foundation has supported three college teacher research participation programs. Director, Troy C. Dorris, Ph.D.
- (5) Ten research fellowship and stipend grants have been received from various sources, including: National Defense Education Act, National Institutes of Health, National Science Foundation, Cooperative Wildlife Unit, and Oklahoma Game and Fish Council.

Representative selection of thesis topics since 1957.

Interaction of toxic components of oil refinery effluents.

Activities of insect populations in oil refinery effluent-holding ponds in waste improvement.

Toxicity of oil refinery effluents under conditions of continuous renewal.

Reaction of fish species to oxygen deficiency.

Relative resistance of selected species of fish to toxicity of oil refinery effluents.

Algal photosynthesis in oil refinery effluent-holding ponds.

Effect of water exchange rates on photosynthesis in farm ponds.

Plankton populations in oil refinery effluent-holding ponds.

Algal populations in kraft-mill effluent-holding ponds.

Reaction of fish species to temperature.

Life-history of the fat-head minnow.

Life-history of the thread-fin shad.

