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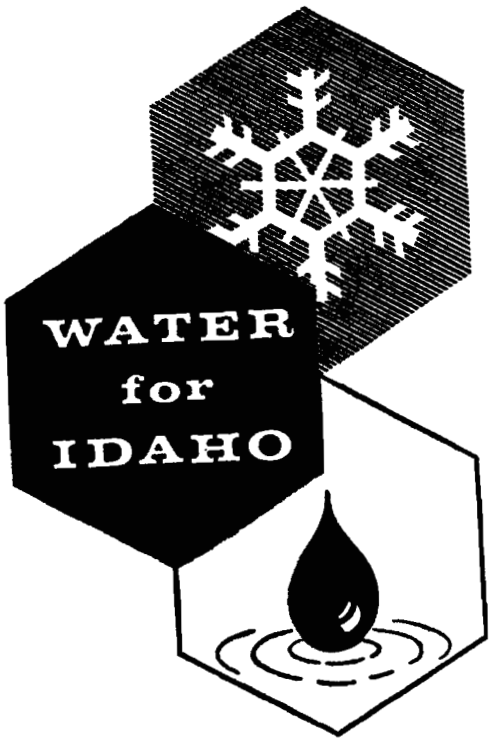

Advisability of Establishing A Groundwater Research Center in Idaho

by KEITH E. ANDERSON
ROBERT E. GLOVER

Consultants' Report To
Water Resources Research Institute
University of Idaho
Moscow, Idaho
July, 1969

ADVISABILITY OF ESTABLISHING

A

GROUNDWATER RESEARCH CENTER

IN IDAHO

An Evaluation Report

By

Keith E. Anderson

Robert E. Glover

The work upon which this Project is based was supported in part by funds provided by the United States Department of the Interior, Office of Water Resources Research as authorized under the Water Resources Act of 1964.

July 1969

Boise, Idaho
May 1, 1969

Mr. C. C. Warnick, Director
Water Resources Research Institute
University of Idaho
Moscow, Idaho

Dear Mr. Warnick:

We are pleased to transmit herewith our Board of Consultants' report on the need and advisability of a proposed groundwater research center for the State of Idaho.

We have endeavored to evaluate and include in our study not only the need and advisability of such a research center but also the type of center that we feel would be desirable, its scope of activity and relationship with other institutions or organizations, the costs and means of financing such an undertaking, and some suggested research problems which might be undertaken at such a center.

We appreciate the opportunity of preparing such a report and recommendations for you and if you have questions concerning the report we would be pleased to answer them.

Very truly yours,

Keith E. Anderson

Keith E. Anderson

Robert E. Glover

Robert E. Glover

Attachment

C O N T E N T S

INTRODUCTION

Authorization

The Board of Consultants was authorized to proceed with the investigation and report on the feasibility and desirability of establishing a groundwater research center in Idaho in early February 1968 by Mr. C. C. Warnick, Director, Water Resources Research Institute, University of Idaho.

Nature of Assignment

The assignment was outlined for the consultants in general terms with wide latitude given in the matter of the method of investigation and preparation of report and conclusions.

Primary consideration has been given to the two questions:

Is there a need for such a groundwater research center in Idaho?

If so, is the establishment of such a center feasible?

If such a center was deemed feasible, additional questions were then to be investigated and evaluated such as the type of center, the purpose of such a facility, cooperation with surrounding states, the relationship to the educational system in Idaho and to other agencies involved in water research or investigation, the types of investigation to be carried on and potential research problems for study, and specific recommendations concerning such a facility including its location, staffing, physical plant and equipment, costs, and possible means of financing.

Scope of Study

Although each consultant has drawn upon his own particular background and experience in the field of groundwater investigations and development, particular efforts have been made to become familiar with the problems and needs relating to groundwater investigations or research in the State of Idaho.

Discussions and interviews have been held with representatives of state and federal agencies within Idaho that are currently involved in the groundwater picture or who could benefit from additional knowledge and

research on groundwater in Idaho. Similar discussions have been held with persons from neighboring states to learn of existing or planned programs of a similar nature in the surrounding states as well as the possible interest or participation that such other states might have in a groundwater research center for Idaho.

Members of the Board have met on two occasions in Boise to confer on joint findings and evaluations.

SUMMARY AND RECOMMENDATIONS

(1) Groundwater is now an important source for water supply in the State of Idaho and its importance will increase as time goes on.

(2) Groundwater and surface water are parts of a common supply and conflicts will develop between surface diverters and groundwater users as the use of water increases to the point where the supply approaches complete utilization.

(3) Development of compatible working arrangements between surface diverters and groundwater users will require a better understanding of Idaho groundwater, including transient groundwater behavior.

(4) The many highly specialized technical skills adequate for a quantitative assessment of groundwater are not generally available at the present time. A thorough grounding in analytical procedures for dealing with transient groundwater flows is essential to serve as a basis for development of the needed technical skills.

(5) To develop the needed analytical skills it is recommended that additional courses be organized and offered within the state's higher education system. It would facilitate further developments if these courses could be offered in the immediate future.

(6) Analog studies could be profitably applied to a study of the combined use of surface reservoirs and groundwater storage in the Snake River Plain aquifer for interception and storage of flood flows.

(7) Digital computer possibilities for processing data from analytical or analog sources should be investigated.

(8) Initial work of these types could be carried out at the University of Idaho, as an interim measure pending later establishment of a developing Groundwater Research Center.

(9) Groundwater problems in the neighboring states are not believed to be of such nature as would develop an outside interest in contributing financially toward the development of a Groundwater Research Center in Idaho.

(10) It is recommended that a Groundwater Research Center be established at Twin Falls, Idaho, as a unit within the Idaho Water Resources Institute, maintaining a close liaison with the entire higher education system of the State.

(11) Areas of study at the Research Center should be directed toward problems of immediate and practical benefit to the water users and citizens of Idaho.

(12) The initial cost of establishing such a Center is estimated at $90,000 with annual operating costs of $85,000.

(13) Initial financing will probably have to come from State sources with a possibility of cooperative Federal funds being available. The Research Center should not be undertaken until adequate financing for the continued operation seems assured.

(14) A well-planned, aggressive approach to the groundwater problems of Idaho is desirable and justifiable on the basis of experience in other areas where such a policy has not been allowed.

NEED AND VALUE

Value of Water

Idaho, as other arid western states, is dependent upon an adequate supply of water and its proper development management and administration for the growth and economy of its people. Famed for its agricultural developments, such development would be almost non-existent within the state if it were not for irrigation. If the state is to continue to grow and prosper it will require additional information on the sources and availability of water and sufficient information to plan for the wise and sound development and management of this resource.

Groundwater - Surface Water Relationship

Most of the attention to Idaho's water resource over the past decades has been given to the streams, lakes, and other surface water resources. The inter-relationship between groundwater and surface water is well known but not generally understood by the public. Groundwater constitutes a major source of supply for the municipalities within the state and for the industry and agriculture in the southern part of the state. Proper development and utilization of the state's water resource cannot be made without considering both surface water and groundwater as a single entity. As the surface water supplies have become more fully utilized, and as attention has turned toward development of groundwater, the inter-relationship between the two becomes apparent and the problems of future interference and proper co-ordinated management become very real and immediate. One has but to look at other states in the west, whose population growth has exceeded Idaho, to see the types of problems and difficulties that can result if over-all development of water is allowed to proceed without adequate information or planning.

With surface reservoir sites largely developed, the groundwater aquifers constitute the largest reserve of water available to the state--and particularly in the Snake River plain of southern Idaho which is unique in the world in its size and capacity to store and transmit water.

Growth in Groundwater Use

The growth and development in use of groundwater in Idaho within the past ten to twenty years has been phenomenal. Where at one time groundwater was used primarily as a source of municipal supply to towns and villages, it has now reached a point where about one-third of the irrigated land within the state is supplied totally or in part from groundwater. Present new developments for irrigation as well as industry and municipal growth, are largely coming from groundwater sources. In 1968 alone, 474 new applications to appropriate over 1,700 cubic feet per second of groundwater (nearly 800,000 gallons a minute) were submitted to the State Department of Reclamation.

Need For Information

The rapid expansion in the development of groundwater within the state has already begun to create problems in planning for the management and administration of groundwater or its expliotation on a sound and feasible basis and has provided problems or conflicts between interests that have resulted in extensive litigation and the potential need for future legislation.

In order that adequate planning may now be made for the future, additional information on the occurrence of groundwater and its behavior, is needed.

New developments proposing groundwater-surface water exchanges will be of increasing future importance. Sound technical decisions for such projects cannot be obtained by makeshift procedures particularly where complexities such as those in the Snake River Plain aquifer are present. Those directly concerned would include irrigators dependent on groundwater, domestic, municipal and industrial users, recreation interests and power producers. All have an interest in any changes proposed and need to know: where and when and in what manner any artificially stored groundwater would return to the river before the ability of existing surface reservoirs to handle the returning flows could be evaluated; the effect on water-table levels of proposed storage or withdrawal of groundwater; the effects on groundwater quality; and the feasibility of various alternatives to exchange proposals. With trained personnel and facilities available, problems such as these could be attacked with excellent prospects for success, the questions of all interested or affected parties could be answered, and the way would be opened for progress toward solutions acceptable to everyone.

TYPE AND PURPOSE OF FACILITY

Training

An important function of the proposed research center would be to provide training of graduate students and professional people in the techniques of groundwater investigation and research. Some of the personnel assigned to various research projects, under the direction of staff members of other project leaders, would have the opportunity to receive excellent training in both field and laboratory or analytical techniques associated with groundwater studies.

Research

The primary objective of the center would be to carry on research studies of problems relating to groundwater in Idaho--its occurrence, development and utilization, and management.

Research problems investigated at the center should be selected so that they are of immediate and practical benefit to the citizens of the state rather than being oriented primarily toward theoretical or generalized studies. Some suggested research problems of this type which might be undertaken in the early years of operation at the center are listed later in our report.

Scope of Activity

Consideration has been given as to whether the proposed center should serve as an Idaho facility or whether it should be of a regional nature. Although all of the states bordering Idaho have groundwater problems peculiar to their own geological and geographical setting, and although none of these states has a research center established primarily for groundwater investigations, it is believed that it would be more feasible and desirable--at least in the initial years--to establish and maintain the proposed facility solely for the State of Idaho. Of necessity in certain investigations it would involve field studies that might extend a short distance beyond the state border since some of the groundwater basin problems and the inter-relation with surface water would encompass areas outside of Idaho.

Provision should be made in the establishment of the center, however, for cooperative studies of problems which may have importance to Idaho and also be of a regional nature in which outside interests would wish to participate. Provision should also be made for cooperation with private interests, such as industry or agriculture, for research studies which would be of benefit to such private interest. In these instances, however, it is essential that it be understood that the results of such research financed by private interests be made available on a public basis.

Relation to Other Agencies

With proper direction and guidance there should be no conflict between the activities of the proposed groundwater research center and related activities of other agencies or of private consultants. The function of the research center should be to supplement or compliment the activities of other agencies and to carry on investigations of problems which would not otherwise be done by an existing agency or firm under their present program.

There are a number of Federal and State agencies that are currently involved to some degree with groundwater problems. Some of these principal organizations are as follows:

State of Idaho
- Department of Reclamation
- Water Resources Board
- Department of Health
- Fish and Game Commission
- Highway Department
- University of Idaho
- Idaho State University
- Boise State College

United States Government
- Bureau of Reclamation
- Geological Survey
- Corps of Engineers
- Agricultural Research Service
- Soil Conservation Service

Environmental Services - Weather Bureau
Forest Service
Atomic Energy Commission
Public Health Service
Bureau of Land Management
Bureau of Sports Fisheries
Bureau of Outdoor Recreation
Bureau of Indian Affairs

It is expected that the director of the research center would maintain a close liason with representatives in Idaho from all such agencies to insure that the program of the center was properly coordinated with the activities and needs of these agencies.

Communication

It is essential that the public and the agencies concerned be kept informed of progress made not only with specific research projects but also in the development of skills for evaluating the occurrence and movement of groundwater. These are highly specialized skills and unless their availability is made known the public will not know where to turn to get answers to their particular problems.

Such special skills are entirely outside the everyday experiences of the general public and a good deal of skepticism can be expected concerning their effectiveness unless their competency is demonstrated. Studies correlating historic data will be useful for providing such demonstrations.

COOPERATION WITH OTHER STATES

Although other states surrounding Idaho do not have a similar research facility for groundwater investigations, each has expressed an interest in the results of groundwater research that might be obtained at the proposed center and in the availability of such results to assist them in problems which may be of a comparable nature.

Provision should be made for cooperative or joint investigations between states or for agencies in other states, subject to the availability of time and personnel to carry on such work.

It is conceivable at some future date the activities of the center might expand to a point where it could be properly designated as a regional research center rather than one established primarily for Idaho.

At the present time, however, there does not appear to be sufficient interest on the part of neighboring states, nor does there appear to be means of financing or contributing to financing from such states, to establish the proposed center on a regional basis.

RELATION TO EDUCATION SYSTEM

It is recommended that the proposed center be established as a unit within the Idaho Water Resources Research Institute, maintaining a close liason with the entire higher education system of the state.

Graduate Study Program

It is anticipated that the activities at the center would utilize the services of graduate students in carrying on research investigations and at the same time either offer graduate level courses in groundwater subjects or provide an opportunity for field or laboratory investigations to compliment such courses that might be given elsewhere.

Credit for courses taken through the center or for research study carried on at the center should be given toward advanced degrees at any of the state universities or colleges.

Necessary Skills and Development

It is recommended that undergraduate level instruction be started at the state colleges and universities in elementary courses on groundwater. These courses, to be offered through the appropriate engineering or geology departments, would not be a function of the center although the center could assist in setting up the curriculum for the courses or in providing materials for use in such courses.

The establishment of such courses in basic groundwater geology and hydrology would train students who would then be in a position at the graduate level to participate in the activities of the center at a more advanced level. The undergraduate courses could include such items as:

- Origin and occurrence of groundwater
- The hydrologic cycle
- Descriptions of important aquifers stressing geologic characteristics, origin, constituents and nature such as the following:
  - Extrusive volcanic rocks
  - Limestones
  - Sandstones
  - Lacustrine deposits
  - Wind blown sands
  - Stream laid deposits and alluvial fans
  - Deltaic deposits
  - Glacial drift and outwash
  - Igneous rocks
  - Coastal aquifers and salt water problems
- Occurrence of groundwater
  - Water table conditions
  - Artesian conditions
  - Ghyben-Herzberg principal for coastal aquifers
- Management of groundwater
  - Effects of overdraft
  - Methods of recharge
  - Water quality

History of development of concepts

Work of Darcy, Dupuit, Forchheimer, Ghyben, Herzberg, Boussinesq, Meinzer, Theis, and others.

Terminology

Aquifer, permeability, tranmissibility, specific yield or effective voids ration, steady state, transient state, mathematical formulations, simple solutions, initial conditions, boundary conditions.

In order to carry on advanced research in groundwater problems it will be necessary to draw upon many outside related skills that have a bearing on such problems, including such fields as civil engineering, geology, chemistry, mechanical engineering, electronics, economics, law, and agriculture. Many research projects undertaken will involve participation by persons skilled in one or more of these areas.

The first requirement for a laboratory to deal with groundwater problems would be personnel with a background of engineering, a knowledge of advanced mathematics including work in the subjects of ordinary and partial differential equations, and special training in the field of transient groundwater hydraulics.

It is recommended that prior to (or at least concurrent with) the establishment of the center graduate level instruction in groundwater be initiated, particularly in the field of transient phenomena, to train investigators in the advanced techniques of groundwater research and investigation who could then participate in the investigation of individual research problems.

Such graduate instruction should initially be started at the University of Idaho at Moscow because of the availability at that location of personnel and facilities in these other skills related to groundwater.

A graduate course in transient groundwater hydraulics should include the following developments:

Pumped or flowing well cases

Unconfined aquifers-development of charts, tables, aquifer constant.
Confined aquifers-charts, derivations, tabulations, aquifer constant.

Flowing artesian well-pressure pattern as a function of radius and time, flow as a function of time.

The "leaky roof aquifer case. Well drawing water from an aquifer separated from an upper water bearing formation by a semi-permeable bed.

Parallel flow cases

The bank storage case

The line source (canal leakage) case

Drainage by parallel drains

Special cases

Stream depletion due to a well

Effect of distributed pumping

Return flow due to deep percolation from irrigation

A key skill, which may not be available unless positive action is taken, can be contributed by the applied mathematician familiar with the treatment of transient groundwater phenomena. It will be his task to provide means of quantitatively evaluating the effect of proposed water regime changes. Planning cannot proceed without his help because such quantitative evaluations must provide a basis for planning efforts. Experience indicates that groundwaters and surface waters are generally considered as separate entities until something happens to bring their interrelation to attention. This is often a controversy between users who find that they are competing for the same water supply. Demands for an immediate solution can be expected and pleas for time to find and to apply the information and skills needed to obtain a solution are likely to be met with impatience and exasperation. The absence of groundwater skills at such a time can leave certain questions unresolved or even lead to decisions which further experience may show to have been unwise, crippling or destructive.

AREAS OF INVESTIGATION

There are a number of general areas of investigation or study which could properly be carried on at the proposed center, some of the major such areas are described in the following paragraphs.

Analytical Studies

Investigation of many complicated groundwater problems, particularly those involving transient conditions, can be carried on by mathematical analytical methods, by the use of electrical analogs such as those constructed recently by both the Bureau of Reclamation and the Geological Survey, and through the use of digital computers.

A knowledge of analog design, construction and operation procedures would be an important requirement. This devise permits the handling of cases in which complex boundary conditions or variations of aquifer characteristics and perching layers may be present. It also opens the way to obtaining solutions for cases so complex that formal methods become unwieldy. To foster the early acquirement of analog skills it would be effective to make enough money available so that a simple demonstration analog could be designed, constructed and operated by students taking the advanced groundwater course. Opportunities to apply analog methods to important field cases should be investigated, such as correlation of stream flow records with return flows and the effects of groundwater pumping.

A survey should be made to locate already available equipment which could be used for analog work such as a direct-writing oscillograph and associated amplifiers.

Progress could be made along these lines while the possibilities of organizing, equipping and staffing a Groundwater Research Center are being explored. They would be desirable skills to possess in any case. It is suggested that courses of this type be arranged and offered for study as soon as possible. Whether a Groundwater Research Center is established soon or not, these skills could be diligently cultivated with profit.

The cost for constructing and instrumenting an analog of the Snake Plain area for example, may be estimated as follows:

Analog panel including panel board, maps, resistors, capacitors, bushings, connectors and wiring	$2,500.
One two-channel direct writing oscillograph with event markers and associated amplifier equipment	$2,000.
Constant current input units	$3,000.
Servo-units to interpose between the network and the oscillograph	$ 800.
Supplies, wire, tools, incidentals	$1,700.
Total for materials	$10,000.

There would be additional costs for shop work for mounting the panel with about two man-months allowed for assembly.

Water Quality

Water quality investigations, which would involve both field and laboratory work, would deal with both the physical, chemical and bacteriological quality aspects of groundwater problems. The results of studies in this area could have considerable value in improving the quality of water supply presently available to municipalities and industries throughout the state as well as providing protection against future pollution or deterioration in groundwater quality.

Geology - Hydrology

Basic investigations of the geologic and hydrologic factors relating to the occurrence of groundwater in Idaho would be important. This is particularly true in areas that have been lacking in previous study such as the deeper aquifers in the Snake River plain and the detailed hydrologic characteristics in small basins or water sheds.

Geophysics

The application of recent geophysical techniques and their value in studying Idaho groundwater could be another area for study. The introduction of well-logging techniques in many areas of the state could doubtless provide valuable data on the occurrence of groundwater which would be useful in formulating plans for optimum development, exploitation and management of this resource.

Drilling and Development

Studies on improved well design and construction, rehabilitation, and drilling would be another important area for study at the center.

The economics of rotary and air drilling equipment in basalts, evaluation of well screen and filter designs, and chemical treatment for development or rehabilitation of wells are examples of possible study areas.

RECOMMENDED FACILITY

Location

The first step in the organization of the proposed center could be the establishment of graduate level instruction in groundwater at the University of Idaho at Moscow. Concurrent with this, or as soon as financing became available, a center should be established at a location in the field where the necessary research could be carried on most feasibly. We would recommend that such a location for the center would be in Twin Falls, Idaho, adjacent to the present Snake River water research center of the U. S. Department of Agriculture--and located on land presently owned by the state. The Twin Falls location appears to be ideal geographically from the standpoint of the major area of groundwater development in Idaho and particularly the lava aquifers of the Snake River plain. It also has the distinct advantage of being adjacent to other research facilities, which, although not working directly with groundwater, have physical facilities which could be used by the two organizations on a shared or cooperative basis.

Staffing

The initial offering of graduate level instruction at the University could possibly be carried on with existing personnel. Ultimately such graduate instruction would be transferred to the Twin Falls location where some of the personnel assigned permanently to the center could participate both in instruction and research problems.

The staffing of the field center at Twin Falls should ultimately provide specialists in the principal areas of investigation such as electrical analogs and electronics, digital computers, geology and hydrology, mechanical engineering-drilling-well development, and chemistry.

The center would require a director to coordinate and administer the activities of the facility. This person should have administrative and management skills and be competent in the field of public relations, and yet might properly be the principal specialist in one of the areas of investigation listed above. A minimum of three such highly trained specialists should be available for the initial permanent staffing

at the proposed Twin Falls location. One would have particular skill in the analog, computer, or analytical techniques. Another would be skilled in the basic fields of geology and groundwater hydrology. The third specialist should have background in well drilling, development, and logging techniques.

Plant and Equipment

It is recommended that the initial physical facility at Twin Falls, to be located on state owned land, would comprise an office-laboratory building of approximately 1600 square feet and a garage of 400 square feet with provision for future expansion.

The initial equipment would include purchase or construction of an electrical analog suitable for detailed investigation of the Snake River plain or another major groundwater province within the state, well logging equipment capable of investigating many of the physical characteristics in drilled wells, and the necessary supporting office equipment such as calculators, drafting equipment, and vehicles for field transportation.

Cost

The principal cost associated with operation of this facility would be the salaries of the permanent staff and the cost of associated field travel. In addition to this annual cost would be the initial capital investment required to construct and equip the facility.

It is estimated that competent and skilled personnel would be available for the permanent staff at an average salary of $12,500. per year with the director receiving possibly $15,000.

A summary of the estimated initial cost to construct and equip the facility as well as the estimated annual costs for salaries and operation, are shown on the attached tabulation.

CONSTRUCTION

Item	Estimated Cost
Building and physical plant	$ 40,000.
Analog(s) and equipment	17,500.
Office and drafting equipment	7,500.
Vehicles	10,000.
Well logging equipment	10,000.
Miscellaneous supplies and equipment	5,000.
Total	$ 90,000.

ANNUAL OPERATION

Salaries	
Director and 3 professional persons	$ 52,500.
Secretarial, drafting, clerical	12,500.
Advisory board	2,000.
Travel expenses	12,000.
Physical plant	6,000.
Total	$ 85,000.

Additional capital expenditures, as well as operating funds, would be required in later years as the center became established and its scope of activities would expand.

FINANCING

Essentially all of the initial financing, and probably all or most of the financing for at least the first five years of operation of this center, would have to come from state appropriations.

Some assistance could very likely be obtained from sources of federal financing with a portion of the operational costs possibly being available from the office of Water Resources Research. Other federal agencies that might participate in the cost of operating the center would be the National Science Foundation, National Institute of Health, and Federal Water Pollution Control Administration.

In many of the individual research problems that would be undertaken, some cooperative or matching funds might be available from other agencies--either state or federal. In addition, the cost of personnel who would be participating on specific problems could be paid by the agency lending or assigning such personnel temporarily to the center would remain under the administrative direction of their own agency but would have the facilities of the center for use during the course of their studies.

The costs of investigations carried on for industry, consultants, or other private entities would also be paid in full or in large part by the group requesting such study.

A portion of the cost of some equipment, such as well logging equipment, could possibly be recovered by making such equipment available on a lease or rental basis for individual assignments to private consultants--either with or without an operation.

Establishment of the center should not be undertaken, however, unless construction, equipment, and operating costs for at least the first five years could probably be guaranteed in financing from only state sources.

POSSIBLE RESEARCH PROBLEMS

Possible research for consideration by the research center staff could include such problems as:

1. Flood storage in aquifers in conjunction with surface reservoirs.
2. Analysis of return flows in valleys such as those of the Payette and Boise rivers.
3. Economics of groundwater development for various uses.
4. Basic geologic data as related to groundwater occurrence and development.
5. Determination of aquifer coefficients, particularly volcanic rock.
6. Evaluation of minimum well construction standards presently in effect, as relating to conservation as well as public health.
7. Application of new drilling techniques and materials to Idaho groundwater development.
8. Hydrology of small basins and related aquifer systems.
9. Geophysical methods as related to exploration for, or development of, Idaho groundwater.
10. Legal or legislative requirements for groundwater management.
11. Studies of groundwater recharge, natural and artificial.
12. Studies of groundwater pollution and corrective measures.
13. Groundwater movement studies through use of tracers, remote sensing, etc.
14. Management and optimum utilization of groundwater storage.