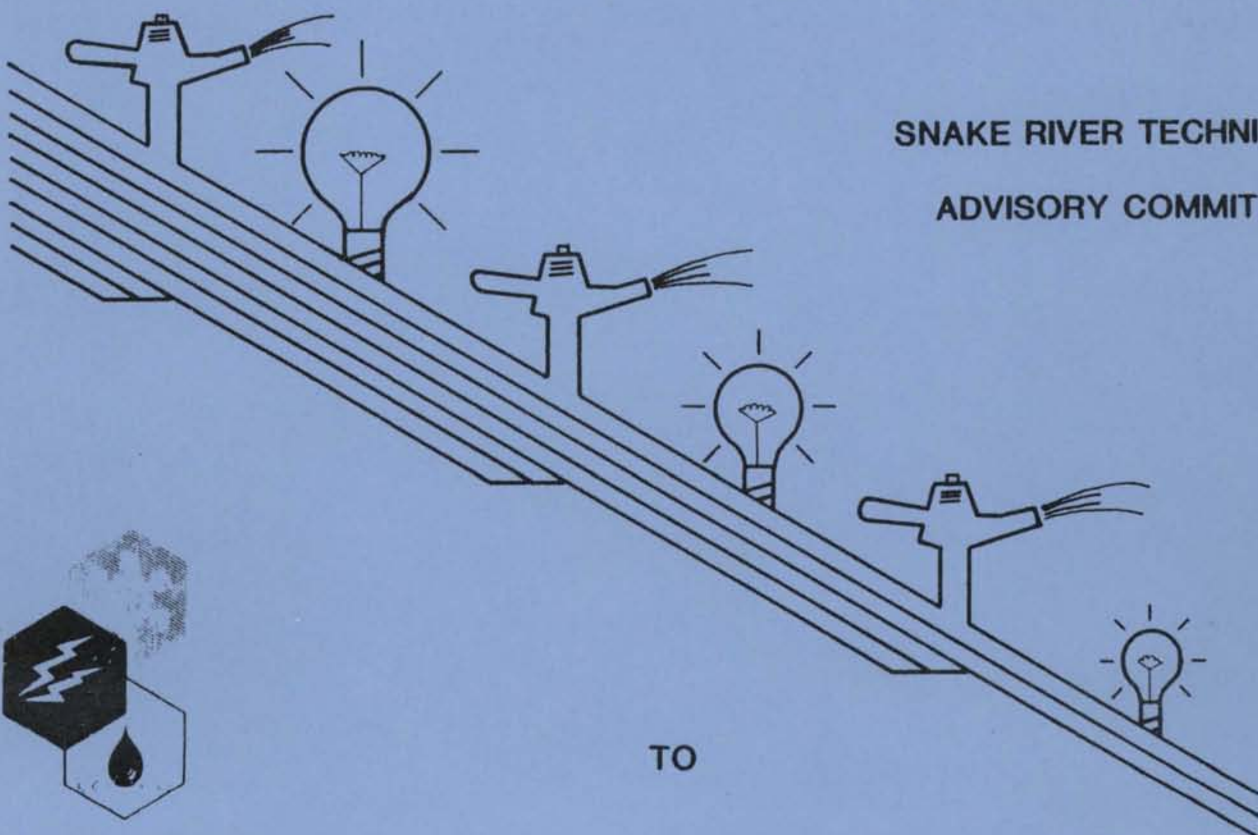
NEEDED WATER RESOURCES PROGRAMS IN THE SNAKE RIVER BASIN

by

SNAKE RIVER TECHNICAL
ADVISORY COMMITTEE



TO

SWAN FALLS STUDY COMMITTEE
OF THE
LEGISLATIVE COUNCIL
STATE OF IDAHO

IDAHO WATER AND
ENERGY RESOURCES
RESEARCH INSTITUTE

NOVEMBER 1983

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INTRODUCTION

In April, 1983, Idaho Power Company prepared to enter into a unilateral program to provide hydrologic information on the Snake River and Snake Plain Aquifer. This effort was to be in support of litigation on the Swan Falls power right dispute. Recognizing that a unilateral approach by any entity would be less credible and more costly than a unified effort by recognized water resources organizations, the company agreed to fund a Technical Advisory Committee as Phase I of a broad technical study. A proposal was made to the Swan Falls Committee of the Legislative Council in May, 1983 and accepted. A grant was made by Idaho Power Company to the Idaho Water and Energy Resources Research Institute to coordinate the committee effort under the auspices of the Swan Falls Study Committee.

Purpose and Objectives

The purpose of the Technical Advisory Committee was to determine the scope and priority of needed hydrologic studies required to assist in planning, management, water rights administration, regulation and litigation of the Snake River system in Idaho above Swan Falls. The effort was precipitated by the recognized need for a common data base and agreement among user groups and the technical community on additional knowledge and understanding of the various hydrologic and economic relationships that policy makers require to make informed decisions on water resources alternatives for the State of Idaho. Evaluations were directed both to Swan Falls water rights problems and to providing long-term capability for water resources planning and management. This committee effort is Phase I of a study to be performed by a technical study team.

Specific tasks outlined for the Technical Advisory Committee were:

1. To evaluate the current base of hydrologic and planning data available to all water resource planners, administrators, managers or users, including river and canal flows, ground-water levels and discharges, water use and water rights.
2. To determine insufficiencies in both the data base and in knowledge of hydrologic and hydrogeologic relationships necessary to fulfill and evaluate each user's purpose.
3. To determine additional data requirements and/or analytical

procedures necessary to develop common data bases and relationships usable by all entities.

4. To determine needs and scope technical studies adequate to develop common data bases, projections, and relationships usable by all entities.
5. To develop a final report.

Procedure

The committee consisted of fifteen members representing state and federal water resource agencies, the Idaho Public Utilities Commission, consulting hydrologists, Idaho Power Company, the Idaho Water and Energy Resources Research Institute, and the Swan Falls Water Rights subcommittee of the Legislative Council.

Committee membership included the following individuals or designated representatives:

Charles Brockway, Chairman	Prof. of Civil and Agr. Engineering	University of Idaho
Richard Allen, Sec.	Research Associate Engineering	University of Idaho
Kenneth Dunn	Director	Idaho Department of Water Resources
Alan Robertson	Chief, Hydrology Branch Section	Idaho Department of Water Resources
Don Reading	Director, Admin. & Policy	Idaho Public Utilities Commission
Michael Gilmore	Deputy Attorney General	Idaho Public Utilities Commission
Thomas Nelson	Attorney	Idaho Power Company
David Meyers	Manager, Environmental Affairs	Idaho Power Company
Parry Harrison	Chief, Water Resources Branch	U. S. Bureau of Reclamation
Keith Anderson	Water Resources Consultant	Private Consultants
Ernie Hubbard	Chief, Water Resources Division	U. S. Geological Survey
Gerald Lindholm	Hydrologist	U. S. Geological Survey
Sen. Laird Noh	Co. Chr., Swan Falls Water Rights Comm.	Idaho State Senate
Rep. Vard Chatburn	Co. Chr., Swan Falls Water Rights Comm.	Idaho State House
Michael Nugent	Staff Coordinator	Idaho Legislative Council

Names, addresses, and telephone numbers of Committee members are listed in Appendix A.

The Committee met eight times during the period June 29 through November 28, 1983. In addition to performing assigned tasks, the Committee provided data and advice to the economic study group commissioned by the Legislative Council.

While the Committee attempted to arrive at a concensus in making its recommendations, this report is not a statement of position or opinion by any of the Committee members or their employers.

Historical Setting

Hydrology and Water Use

Historically, the Snake River Basin in Idaho has been the mainstay of irrigated agriculture within the state. Irrigation began in the late 1860's on the eastern Snake River Plain and expanded into the Boise Valley and Magic Valley areas. Primary development was by gravity diversion from the main stem of the Snake River, however, irrigated areas in tributary valleys were quick to develop. Figure 1 shows the general setting and location of The Snake River Basin in Idaho. In the early 1950's, development of ground water for irrigation increased rapidly. Increases in ground-water irrigated acreage on the eastern Snake River Plain reached 34,000 acres per year in the period 1959 to 1966 and averaged 23,000 acres per year in the period 1966 to 1979. Diversion from the Snake River below Thousand Springs by high-lift pumping began in the 1960's and currently supplies water to irrigate 115,000 acres.

Ground water development for irrigation has occurred primarily by pumping from the Snake Plain Aquifer which underlies the Snake River Plain north of the Snake River from Hagerman east to Rigby and St. Anthony. The Snake Plain Aquifer consists primarily of very permeable layered basalts, which underlie approximately 6 million acres including about 1.2 million acres of irrigated land. Approximately 7 million acre-feet of water enters the aquifer each year from irrigation, tributary valley underflow, precipitation, and seepage from the Snake River and tributaries. Primary discharges from the aquifer occur at Thousand Springs and from springs in the Blackfoot-American Falls reach of the river. Pumping for irrigation also removes water from the aquifer. The Snake River and Snake Plain Aquifer are hydraulically connected at various places throughout approximately 270 river miles from Heise to Thousand Springs. Along some reaches river flows are highly dependent on aquifer discharge and conversely, along some reaches the river loses water and recharges the aquifer. At Milner near Twin

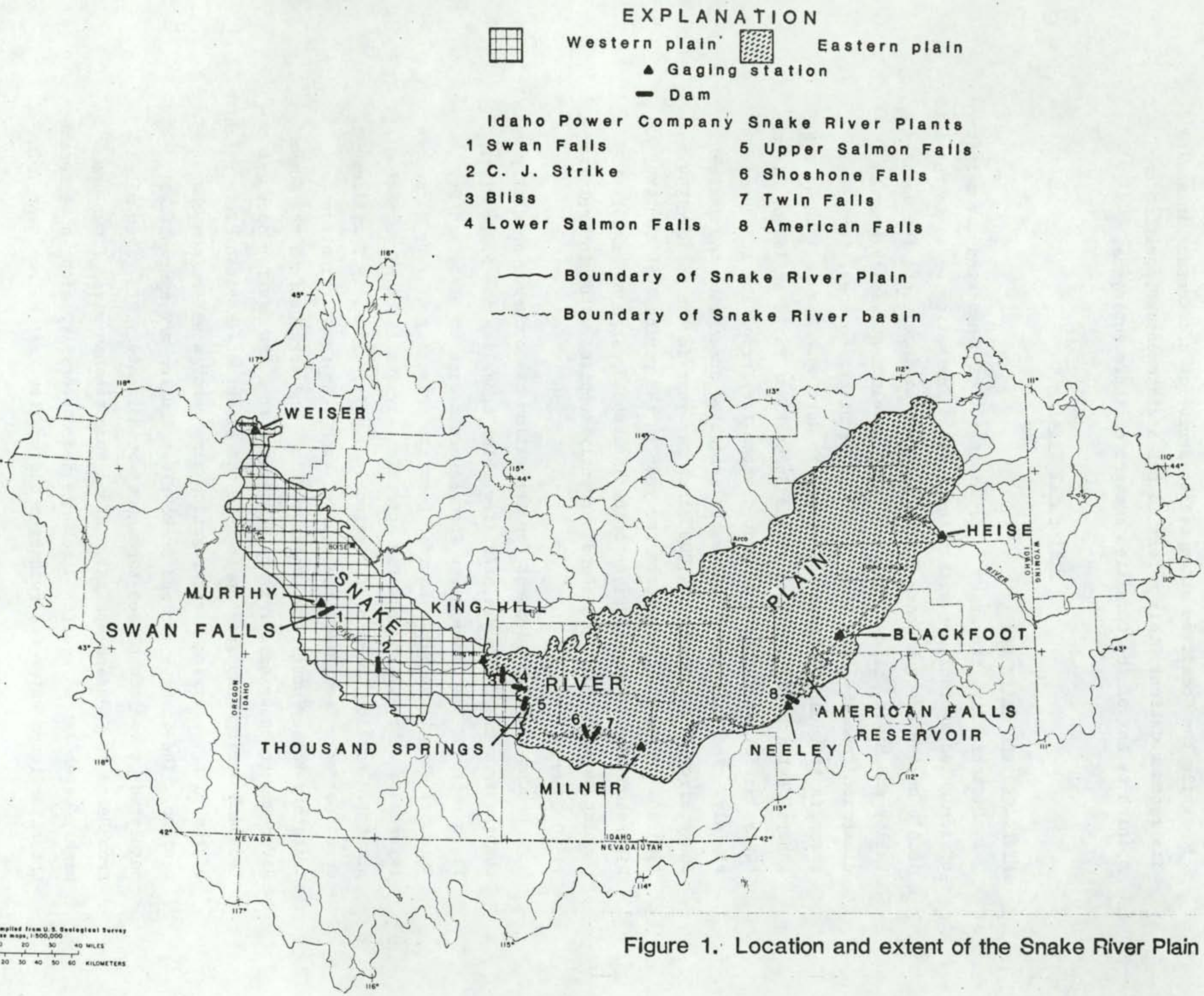

Figure 1. Location and extent of the Snake River Plain

Falls, the Snake River is normally dried up by irrigation diversions during the summer months. However, springs between Milner and King Hill discharge over 6000 cubic feet per second (cfs) to the river. The river flow at King Hill below Thousand Springs has averaged approximately 8100 cfs during the low-flow month of July.

River-aquifer flow interactions within the eastern Snake River Plain have been constantly changing since the beginning of irrigation development. Trends in diversions from the Snake River and tributaries are reflected by recorded diversions above Milner Dam (Water District 1) as shown in Figure 2. Because a major source of recharge to the Snake Plain Aquifer is deep percolation from surface water used for irrigation, spring flow which is the major aquifer discharge reflects transient or changing patterns in irrigation development. Figure 3 is a plot of estimated annual ground-water discharge of springs along the north side of the Snake River from Milner to King Hill. This figure shows the increase in flow from about 4200 cfs in early irrigation times to a peak of about 6850 cfs in 1952 with subsequent decreases due to new ground-water development and changes in water use on the eastern plain.

Because the Snake Plain Aquifer is hydraulically connected with the Snake River at various points throughout the reach from Heise to Thousand Springs, ground-water discharge to the river is important to users of the resource. In the Blackfoot-Neeley reach of the Snake River which includes American Falls Reservoir, an average of 2700 cfs (approximately 2 million acre-feet per year) enter the river from the aquifer and are subsequently used by downstream users and power plants. Surface return flows from irrigation diversions are also a major source for downstream users and must be included in river operations. With recent trends in conversion from surface water to ground water as a source for irrigation and conversions from gravity irrigation to sprinkler with increased efficiencies, changes in both surface return flows and ground water recharge and discharge are taking place.

Conflicts Among Water Uses

Five hydroelectric projects operated by Idaho Power Company are located on the Snake River between Thousand Springs and Murphy. These dams, Upper Salmon, Lower Salmon, Bliss, C.J. Strike, and Swan Falls, are "run-of-river" plants with little storage (Figure 4). In this same

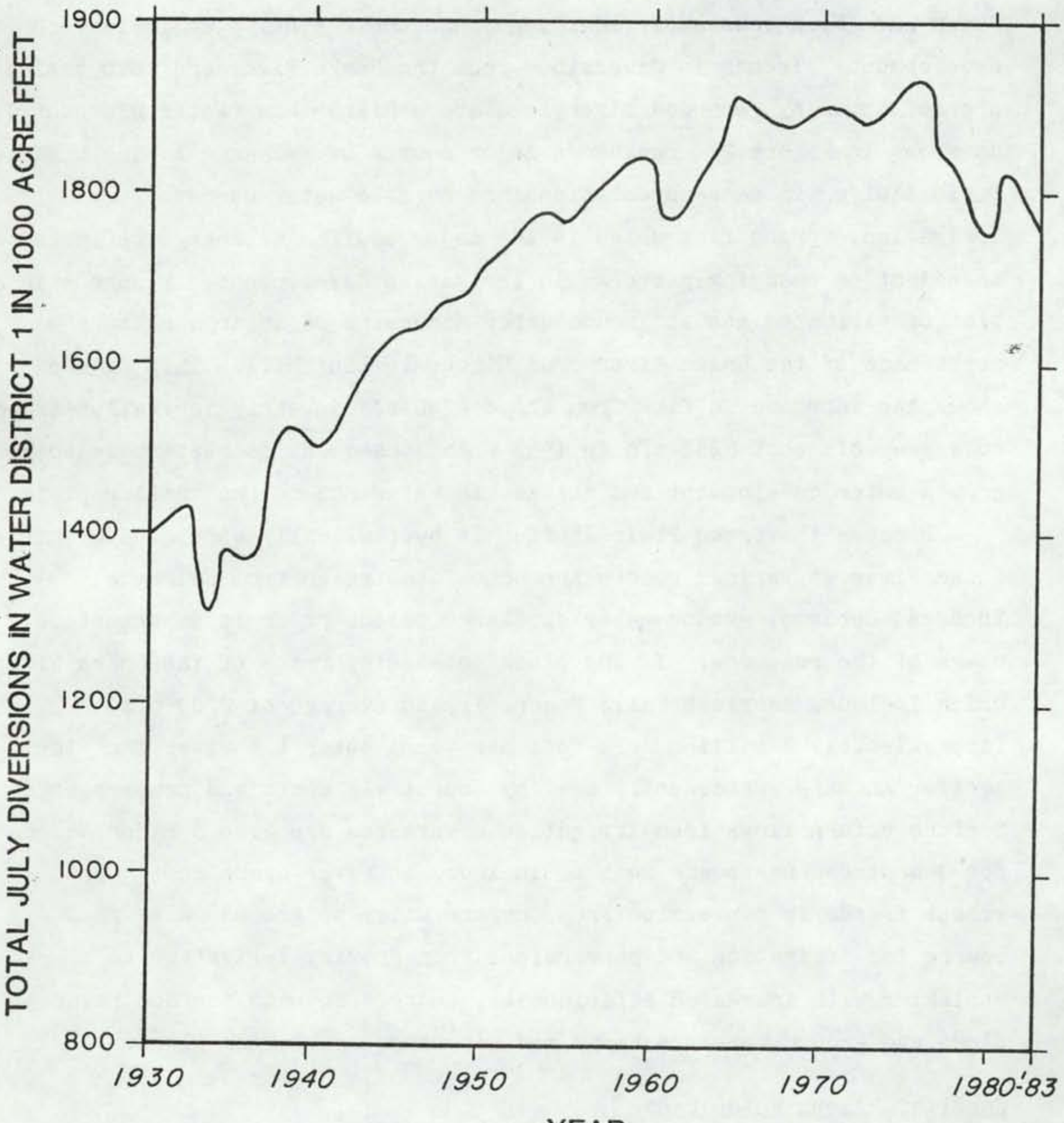

Figure 2. Trends in summertime diversions in Water District 1, as illustrated by a four year moving average of July diversions.

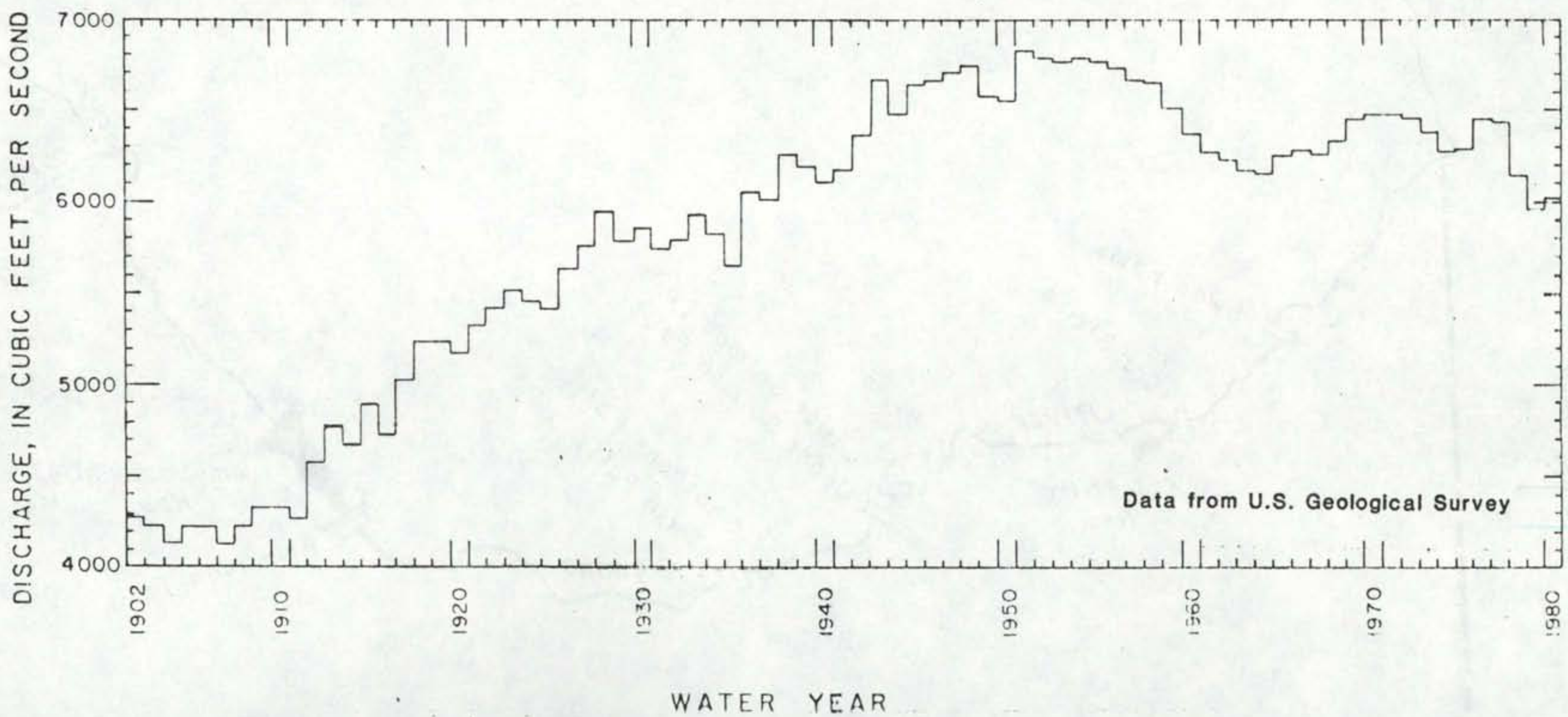

Figure 3. Average annual ground-water discharge from the north side of the Snake River from Milner to King Hill.

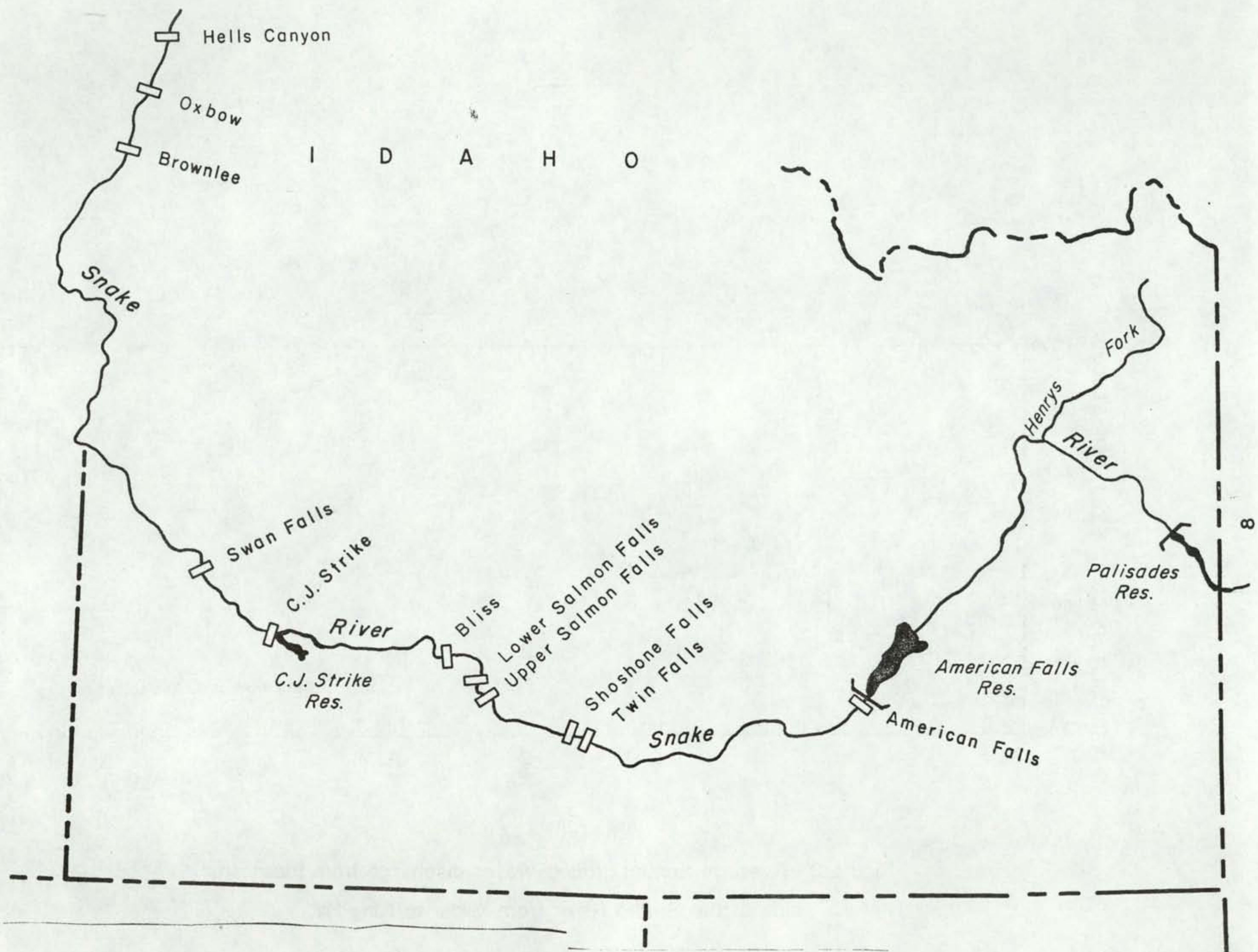

Figure 4. Idaho Power Company Snake River power plants.

reach, irrigation projects pump an estimated 2200 cfs from the Snake River during peak summer irrigation periods.

A U.S. Geological survey stream gaging station called Snake River near Murphy is located on the Snake River below Swan Falls (Figure 1). During formulation of the State Water Plan by the Idaho Water Resources Board, a minimum stream flow of 3300 cfs was set at this gage. The minimum daily flow at Murphy in July of 1981 was 4650 cfs.

Idaho Power Company which generates approximately 70 percent of its system energy from hydroelectric installations, depends on Snake River flows to meet summer energy requirements due primarily to irrigation pumping demands and winter energy requirements due to domestic heating and industrial demands. However, Idaho Power has historically operated all power plants subject to upstream depletions by irrigation, and industrial and municipal users.

During construction of the Swan Falls Dam and power plant in the early 1900's, Idaho Power obtained water rights totalling 8400 cfs. In the 1950's and 1960's construction of three Hell's Canyon dams occurred (Figure 4). Included in the federal licensing provisions of these dams was the so-called "subordination clause" which held flows unprotectable from depletions caused by future upstream development.

In 1977 a group of Idaho Power ratepayers filed a complaint with the Idaho Public Utilities Commission (PUC) to force Idaho Power to stop further diverions that decreased the amount of water available for hydropower generation at Swan Falls and to reimburse rate payers for increased costs resulting from the company's failure to protect the flows at Swan Falls. A suit was subsequently filed in district court by Idaho Power, naming as defendants all of the complainants before the PUC, the PUC itself, the Idaho Department of Water Resources, and numerous other users. The case has generally been called <u>Idaho Power v. The State of Idaho</u>. On November 19, 1982, the Idaho Supreme Court issued a ruling that essentially confirmed the subordination of the Hell's Canyon dams, but affirmed an unsubordinated right at Swan Falls. The question of whether Idaho Power had forfeited or abandoned any part of the 8400 cfs water right at Swan Falls was remanded to the District Court.

Essentially all surface and ground water in the Snake River Basin and tributaries above Swan Falls contributes to the flow of the river at

Swan Falls (Figure 1). Thus, current and future upstream depletions can conflict with any minimum flow or water right for hydropower at Swan Falls.

CURRENT STATUS OF HYDROLOGIC DATA AND WATER RIGHTS INFORMATION

Hydrologic and Land-Use Data

Stream Flow and Reservoir Contents

Data on reservoir contents and stream flow within the Snake River Basin are collected primarily by the U.S. Geological Survey (USGS) in cooperation with state, federal and private entities. In addition to the USGS, the Bureau of Reclamation (USBR) operates a few stream and reservoir gaging stations. A minor amount of information is collected by other government agencies or private companies. The Idaho Department of Water Resources (IDWR) has no regular data collection program of its own, cooperating instead in effort and funding with the USGS data program.

A history of stream and reservoir gaging effort in Idaho is illustrated in Figure 5. Consistent with early development and increased use of water, the number of gaging stations steadily increased until about 1950, then leveled off. Following an increase in data-gathering activities in the late 1960's related to federally supported planning efforts, the trend in recent years has been a steady decline. This decline in data-collection activities has occurred at the same time that increasing and often conflicting water uses have developed. Adequacy of the present data collection program for streams and reservoirs varies. Data collected at the main stem Snake River stations above Swan Falls are generally adequate as are data for the federal reservoirs. To assist with operation of the Minidoka project, the Bureau of Reclamation has installed an automated data collection system known as HYDROMET. This system, installed on a number of main-stem, tributary and reservoir gaging stations, makes data available to water managers instantaneously and allows river operations personnel to make decisions on regulation on an hourly basis if necessary.

Major Snake River tributaries such as the Henry's Fork, Blackfoot, Portneuf, Big Wood, and Bruneau Rivers are adequately gaged. However, stream flow data are lacking for smaller tributary streams and reservoir content measurements are lacking for many private reservoirs within the basin. Spring discharge in the Milner to King Hill reach, an important

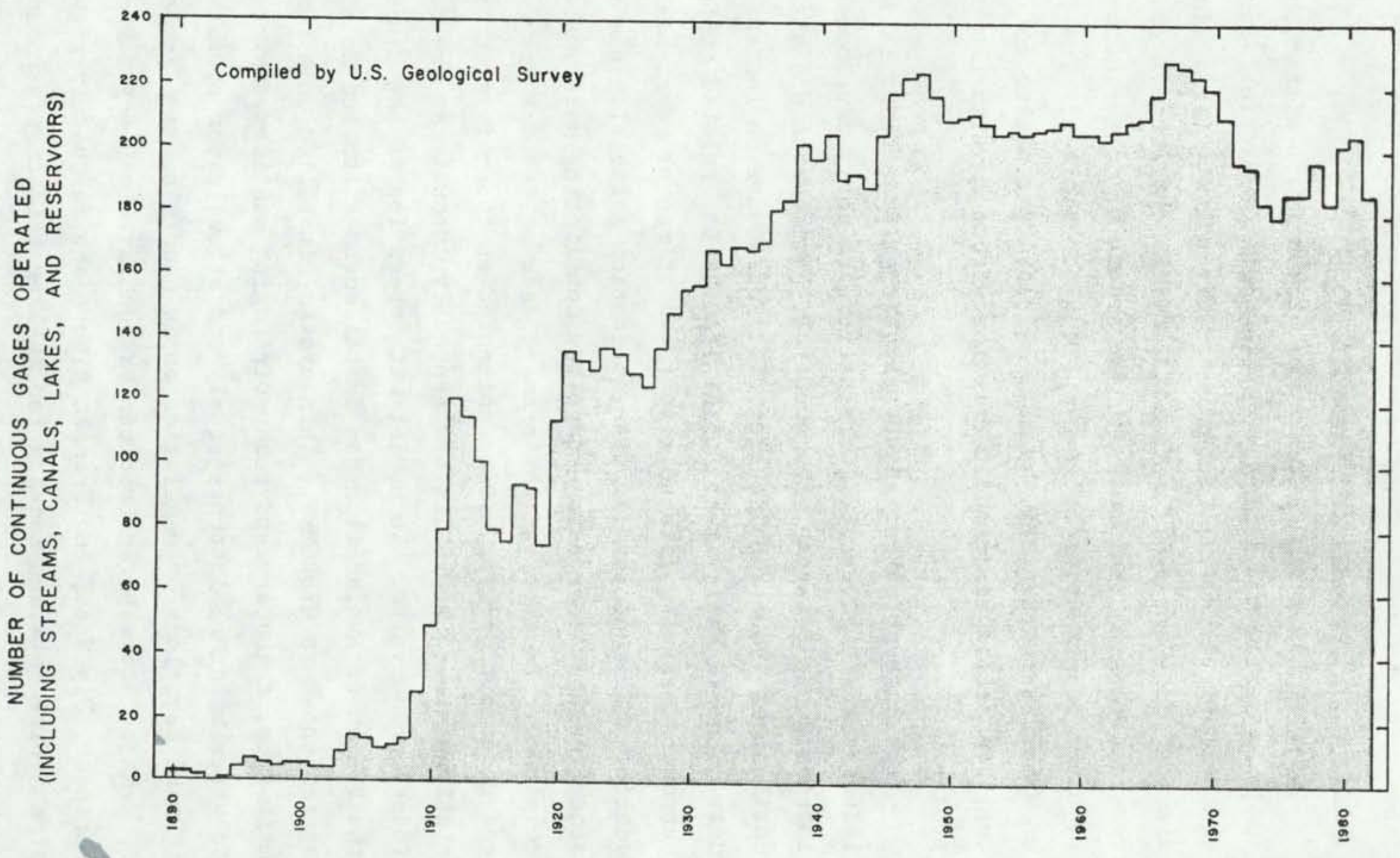

Figure 5. History of continuous stream gaging in Idaho.

component of the flow at Swan Falls, is now estimated by comparing once-per-year discharge measurements at all accessible spring sites to continuous measurement of two benchmark springs.

Irrigation Diversions

Availability of irrigation diversion data varies greatly within the basin. Good diversion records exist for that part of the basin within Water District 1, which includes the Snake River main stem and most tributaries above Milner Dam. Good records are also available for diversions in the Big and Little Wood River drainages. Elsewhere, measurements are poor or non-existent. In particular, dozens of irrigation pumping plants ranging in size from one hundred to several thousand horsepower withdraw water from the river in the Thousand Springs to Swan Falls reach. None of these diversions are now measured.

Irrigation Return Flows

No systematic or organized data collection program exists for quantifying irrigation return flows in the Snake River Basin. In 1979 and 1980 the USBR measured 19 drains and streams carrying irrigation return flow to the Snake River between Heise and American Falls Reservoir. In 1980, the USGS made numerous measurements of return flows to the Snake River downstream from Heise. Data on return flows are otherwise lacking. The lack of a systematic irrigation return flow measurement program prevents determination of aquifer recharge from irrigation and efficient management of Snake River flows.

Ground-water levels

An observation well program is maintained in the state to monitor ground-water level changes resulting from climatic fluctuations, development of new land for irrigation, and changes in irrigation practices. Funded jointly by IDWR and USGS (and operated by the latter), the network of 335 observation wells utilizes production wells (irrigation, stock, domestic) and wells specifically drilled for water-level measurement. About 65 percent of these wells are located in the Snake River drainage upstream from Swan Falls, with most of them on the eastern Snake River Plain. Frequency of measurement varies from continuous (using a mechanical recorder on the well) to an annual visit. Others are measured monthly, bimonthly, quarterly, or semiannually.

During the past few years, due to funding cutbacks, the number of observation wells and the frequencies of measurement have been reduced. A notable consequence is the decrease in the effectiveness of the network as a means for identifying areas where long-term water-level changes are occurring.

A much more limited observation well network is operated by IDWR in conjunction with the administration of critical ground-water areas. A total of 52 wells are monitored in seven of the eight critical ground-water areas within the state, and nine wells are measured in one of the three ground-water management areas. Only two are equipped with continuous recorders; the rest are measured only once each spring and once each fall.

The USBR also maintains a network of ground-water observation wells. This network includes wells at 91 sites in Idaho, 86 of which are on the eastern Snake River Plain above Swan Falls. All sites are visited and data are recorded on a bimonthly basis by the USGS under contract with the USBR. Three of the observation wells are privately owned, the remainder were drilled specifically as ground-water observation wells.

The USGS also monitors 16 wells in the state in addition to those monitored in cooperation with the IDWR. Twelve of these wells lie on the eastern Snake River Plain above Swan Falls.

Land Use

The inventory and monitoring of land use is necessary for the determination of river and ground-water depletions and the confirmation of current use under the water rights system.

The IDWR, USGS, USBR, Soil Conservation Service and others are collecting land-use information of various types, scales, and detail. The Department currently develops land-use information through the use of remotely-sensed and cartographic data in both map base and digital form.

The most recent land use data available for the Snake River Plain were developed by the IDWR in cooperation with the USGS and USBR for 1980. This data set includes 28 land use categories on the Snake River Plain, the source of irrigation water and a breakdown of agricultural use by crop group (row crop, alfalfa, pasture, grain). The overall classification accuracy for irrigated agriculture is about 90 percent, but is actually much better in areas that have a high proportion of irrigated land. A detailed breakdown of accuracy is available from the Department. The 1980 survey mapped 3,065,000 irrigated acres in the Snake River Basin upstream from Swan Falls, excluding most of Birch Creek and a part of the Big Lost River Basin. Those acres also included 916,000 acres of land irrigated solely from ground water on the eastern Snake River Plain. These data are stored on the IDWR and State Auditor's computers and provide a readily accessible and reliable 1980 data base of irrigated agriculture for southern Idaho.

Water Rights and Administration

The basic water rights system of the State of Idaho dates prior to the adoption of the State Constitution in 1889. The Constitution incorporated the appropriation doctrine of water right by use, and therefore Idaho has only one method of establishing water rights.

The so-called constitutional or beneficial use method of appropriation requires only that water be diverted and applied to a beneficial use in order to acquire a water right with a priority as of the time of use. Early statutes created a permit system that has evolved into the present system administered by the Idaho Department of Water Resources. Under that system, filing of an application followed by development consistent with the statute results in a water right as of the date of filing.

The two systems (constitutional and permit) existed side-by-side until mandatory permit systems were adopted in 1963 (ground water) and 1971 (surface water). Since adoption of the mandatory permit systems, valid rights have only been acquired by the filing process, except for single-family domestic uses from ground water which are exempt from the permit requirement.

In 1978, the legislature enacted a claims system which now requires that constitutional-use rights be incorporated in a written claim to be filed with the Department no later than June 30, 1985. This system should result in a listing of all water rights, even though the problem of validating and quantifying the claims will plague the administration of the system for years to come. Water right claims are not recognized rights which may be delivered during times of shortage. There are currently an estimated 8500 claims generated by the Act which have not been adjudicated. Three thousand of these claims are within the Snake River Basin above Swan Falls.

The present system of recording water use is a mixture of applications, permits and licenses pursuant to the permit system and constitutional-use rights which may or may not now be recorded by claims. In addition, there are decrees on some streams (and aquifers) which attempt to incorporate both types of rights, but which largely ignore watersheds to which the adjudicated stream (or aquifer) may be tributary.

The Department maintains "paper" files as the official record of rights. A computer data system is used as an aid for searching the water right records and for processing new filings. Some 67,000 water rights of all types are included in IDWR's files. Information on over 90 percent of the rights in IDWR's records have been entered into the computer system, but over one half of these data have not been proofed and updated to insure their current accuracy.

One major element of water rights which is not reflected in the IDWR files is that of federal water rights, including Indian rights. Federal lands may have a water right "reserved" to them as a result of the congressional act which segregated them from the public domain. An Indian reservation, for example, has been held in a number of cases to have a water right with a date of priority as of the date of creation of the reservation. These are the "Winters Doctrine" rights associated with Indian reservations, named after the case which first recognized them (Winters vs. U.S., 207 US 564 (1908)).

Federal water rights are usually unquantified, since their existence and extent do not necessarily depend on actual use or on filing an application with a state agency. The only mechanism available to require quantification of these rights is a general adjudication of the river. Congress has extended jurisdiction to state courts to include federal rights, including Indian rights, in general adjudications (43 USCA 666).

Water Bank

A recent innovation in the water rights system in Idaho is the water bank, authorized by the legislature in 1979 (Sec 42-1761, Idaho Code). As presently constituted, the statute allows "warehousing" of rights which are not used, without risk of loss due to non-use. In theory, the water can be leased to others while it is not being used by the owner. Thus far, the only use of the water bank has involved management of the rental of stored water on a year-by-year basis. Further discussion on needs and operation of the water bank is included in the section on Hydrologic Needs and Improvements.

Hydrologic Capabilities and Limitations

Water Budgets

Before water resources within the state of Idaho can be more effectively managed within the appropriation doctrine, their magnitude of discharge or volume must be quantified with respect to both location and time. One approach to definition of volumes, flows and distribution is to prepare a water budget for a defined area such as part or all of a river basin. Idaho statutes require a determination of the reasonably anticipated rate of future natural recharge for aquifers which require management or determination of allowed pumpout rates. Water budget determinations are the best approach to determine average natural recharge.

A water budget requires accounting for all flows or uses of water into and out of the study unit. This necessitates measurement or estimation of precipitation, surface stream flow rates, ground-water flow rates, consumptive uses within the study area, storage, and diversions outside the study area.

Water-budget analyses cannot be used unless it is possible to measure or adequately estimate specific inputs and outputs to balance the budget. For example, estimates of consumptive use by irrigated crops are major components of the water budget in most basins. These estimates may be high or low, or estimated distributions of specific crops may be in error. Recent studies by the University of Idaho have shown that methods currently used for estimating crop consumptive use in Idaho are in error for some crops. Estimation of consumptive use by rangeland or dryland crops is difficult because it is often governed by precipitation amounts and patterns and is often less than the potential rate. Ground-water and surface-water interchanges may occur above or below measurement sites, making these interactions undetectable. Changes in surface or ground-water storage with time may not be uniform across the study unit or the ground-water monitoring network may be inadequate to quantify such changes. Ground-water models can be used to quantify unmeasurable components of a water budget and establish hydrologic relationships among components. This is especially true in the eastern Snake River Plain where the complex Snake Plain Aquifer covers such a large area and receives recharge from many sources.

Ground-water Models

The impact of future events on the Snake Plain Aquifer can be evaluated by simulation using a computer model. The model simulates response of the aquifer to applied hypothetical situations. In addition to predictive capabilities, the modelling process provides insight into the complex ground-water flow system and physical characteristics of the aquifer.

The ground-water model currently used by IDWR and by the Regional office of the USBR was developed by the University of Idaho in 1970. The model has been used on several aquifers including the Snake Plain Aquifer above King Hill, Boise Valley, Silver Creek, Henry's Fork, and Mud Lake. Documentation is contained in a publication prepared by the University of Idaho for the USBR.

In developing a ground-water flow model, the aquifer area (water yielding formation) is divided into sub areas or a grid. For each sub area or grid cell, water levels and all sources of recharge to and discharge from the aquifer within that sub area and for each month or time period are estimated. If there is a well in the sub area, pumping data or water extracted must be known; or if there is a spring, the spring flow must be known. The computer then uses a series of mathematical equations to analyze the data for each sub area over the entire aquifer and computes estimated water levels, direction of ground-water flow, and spring flows for the period of record (calibration period).

The model is calibrated by adjusting estimates of aquifer characteristics such as storage within the aquifer and the ease with which water will flow to create the best possible match between computer-calculated and measured ground-water levels. When calculated recharge, spring flows and water levels match historical values, then the model can be used to simulate changes in ground-water levels and spring discharge resulting from future changes in recharge or pumpage, either natural or artificial (Figure 6). The computer model can not exactly reproduce actual occurrences, but can indicate relative changes with time. The difference between simulated and real situations is dependent upon the accuracy of the calibration, which in turn is depends upon the accuracy and detail of the basic input data. Data necessary for model calibration consist of ground-water levels, weather and climatic data, irrigation and crop information, ground-water use, stream flows, underflow from tributary valleys, and estimates of aquifer characteristics. Figure 7 illustrates a breakdown of relative volumes of storage and annual recharge to and discharge from the Snake Plain Aquifer.

The ground-water model used by the IDWR was initially calibrated to the 9,600 square miles (sq.mi.) Snake Plain Aquifer in 1974 and revised in 1978. It is currently being updated by IDWR and the University with assistance by USBR. The 1978 calibration yielded an improvement in model accuracy in which the average difference bewteen simulated and measured ground-water levels was 2.7 feet. The model simulates annual ground-water discharges well, but fails to simulate the monthly variations in spring flows. Maintaining the most accurate possible model requires updating the calibration whenever substantial amounts of new hydrologic data become available. A map of the Snake Plain Aquifer indicating model boundaries and irrigated and irrigable acreages on the eastern plain is shown in Figure 8.

As part of the USGS Regional Aquifer System Analysis (RASA) study of the Snake River Plain, which began in 1979, three-dimensional ground-water flow models were developed to conduct research needed to improve understanding of regional flow systems. The eastern plain above King Hill, called the Snake Plain Aquifer, was divided into 16 sq.mi. areas for modelling; the 4800 sq.mi. western plain from King Hill to Weiser was divided into 4 sq.mi. areas. Models were calibrated from pre-irrigation to 1980 hydrologic conditions.

Because the models simulate regional flow systems and cell sizes are large, they do not permit detailed analysis of local areas such as specific large springs or areas where the water-table slopes are steep.

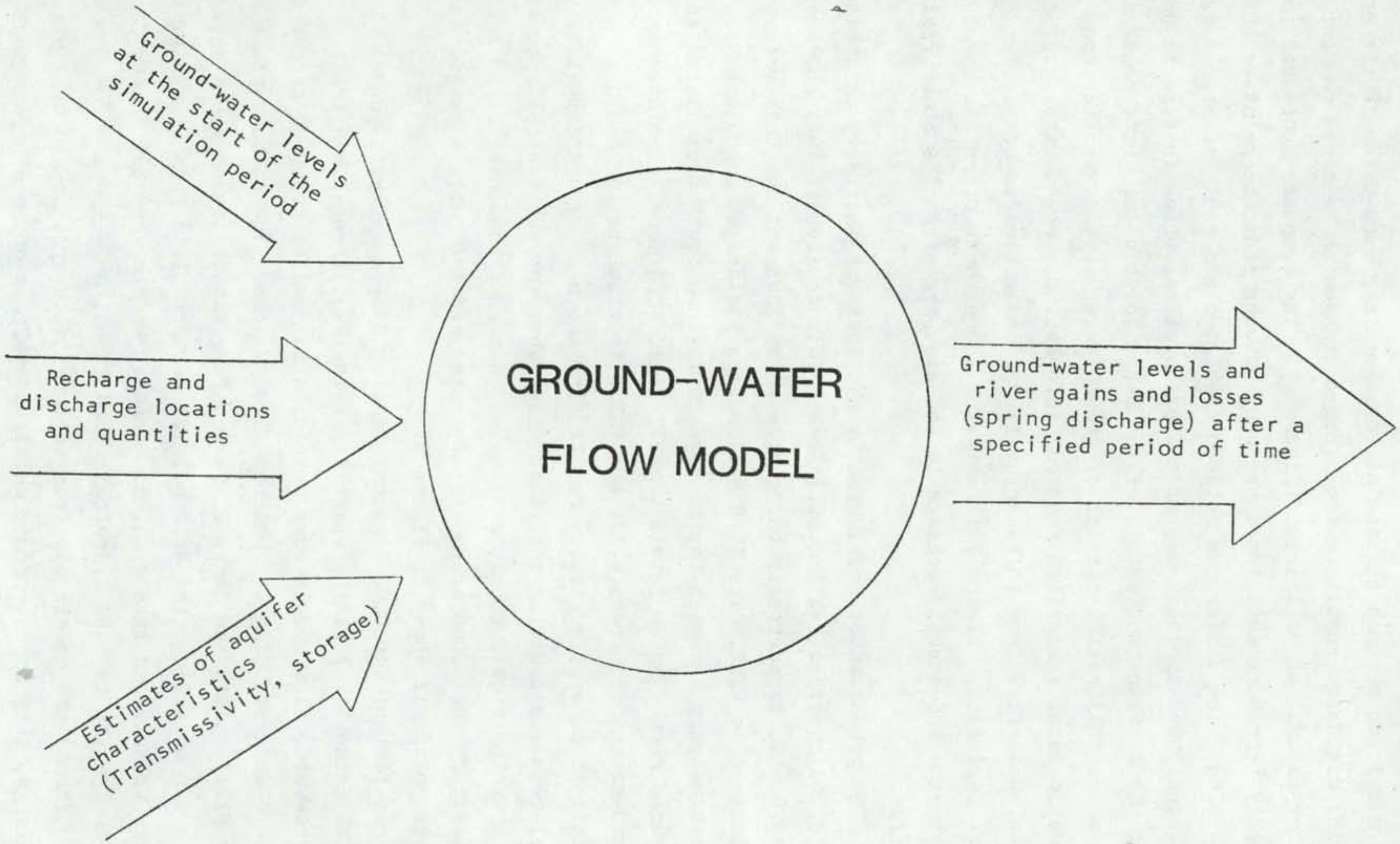

Figure 6. Schematic diagram of the ground-water flow model.

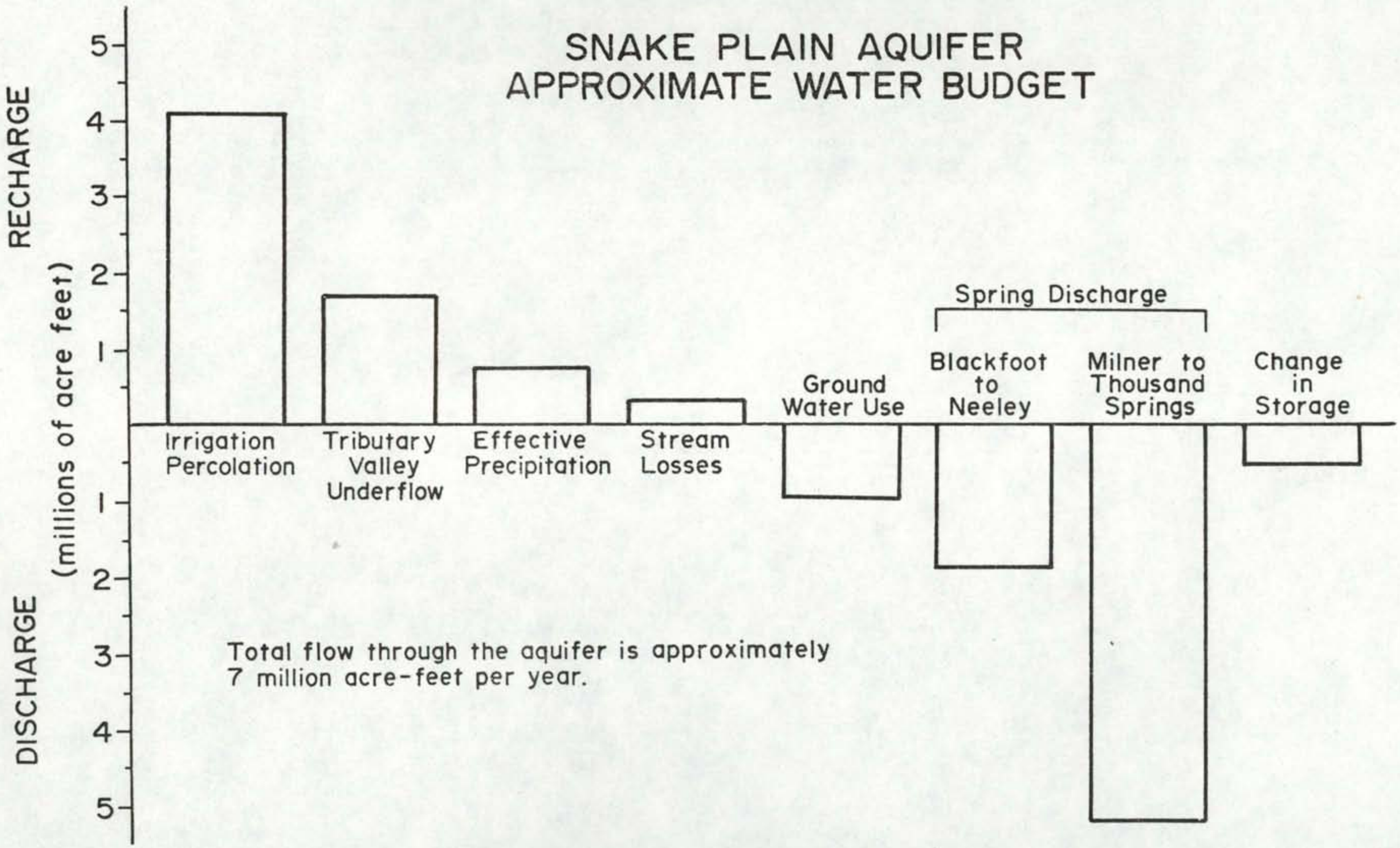

Figure 7. Estimated current annual water budget of the Snake Plain aquifer.

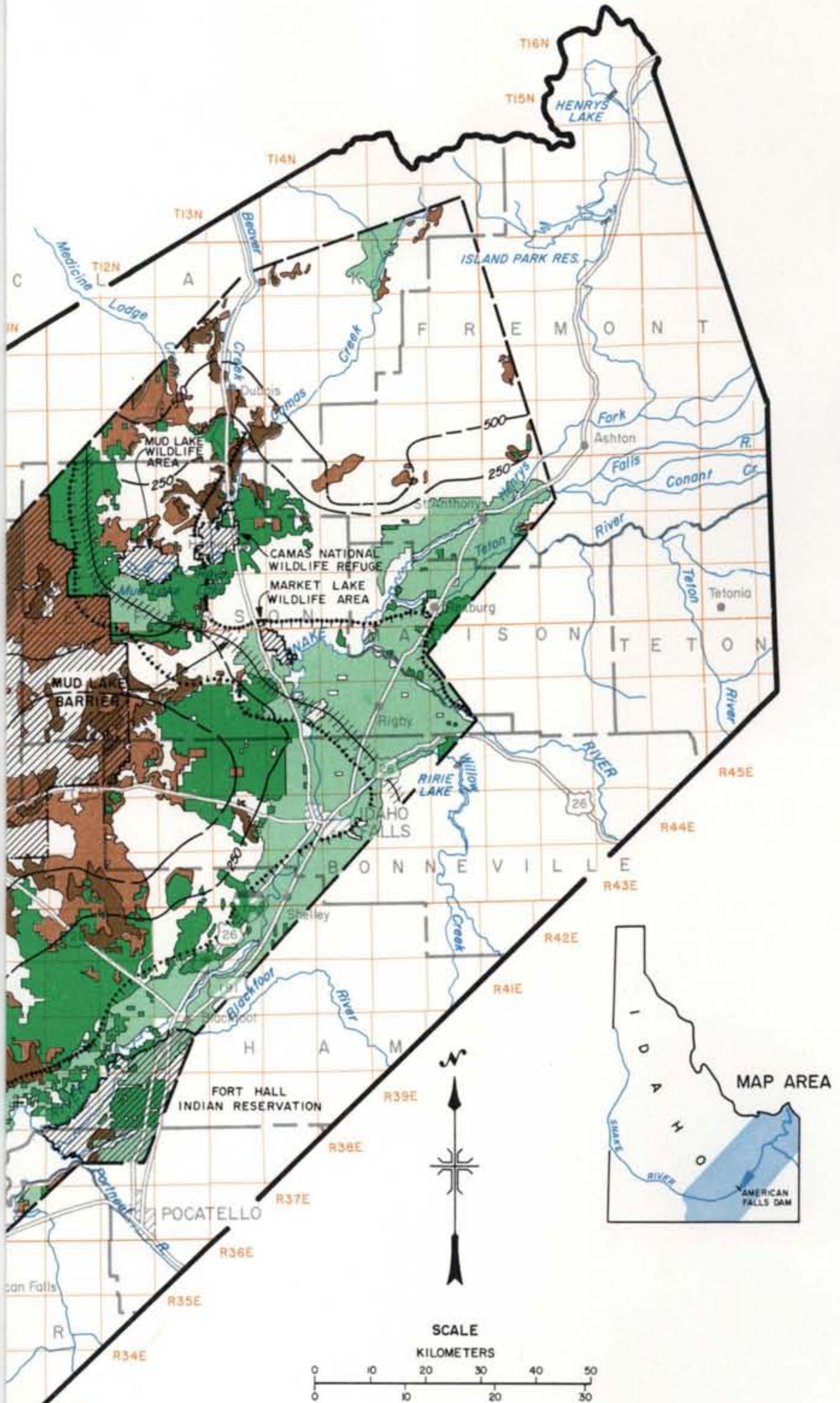

FIGURE 8.

IRRIGATED and POTENTIALLY IRRIGABLE LANDS OVERLYING THE SNAKE PLAIN AQUIFER

MAY 1979

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Properly calibrated models can improve understanding of: (1) geologic controls on ground water; (2) ground-water and surface-water relations; (3) historical cause and effect relationships with respect to development; and (4) the effects of management decisions on both ground and surface water in the future.

Both models of the Snake Plain Aquifer were developed with sparse and uncertain data. Hydrogeologic information for some areas is not adequate to accurately model the aquifer. Ground-water levels in large areas must be estimated because observation wells áre spaced far apart. Constant updating of a model is required as new and better data are obtained. Needed information, such as response times in the aquifer between recharge events and changes in spring flows has not been explored and influences on specific springs due to changes in recharge at remote areas of the aquifer have not been defined.

River Model

The IDWR has developed a computer program that, together with associated data, predicts river flows under given management assumptions. The model is a computational process which simulates the way the river system is controlled by reservoirs and diversions. Using such a model, it is possible to predict monthly flows at various locations throughout a river basin if existing river management is modified by new reservoirs, changes in operation of existing reservoirs, changes in existing diversions, minimum flows or other changes.

The IDWR Snake River model uses monthly flow data for the period 1928-78 for all reaches of the main stem and major regulated tributaries. It determines river system response to a repeat of runoff conditions that occurred during the base period if the present or changed management practices were in effect throughout the period. The period from 1930 to 1942 was very dry with correspondingly low runoff. Since 1965, precipitation and runoff have been generally high. New reservoir construction since 1928, and changes in the operation of existing reservoirs resulted in the construction of new canals and changes in diversion rates. Model input data have been adjusted to reflect these changes as though they existed throughout the period.

In some reaches of the Snake River, such as the Thousand Springs reach, ground-water discharge to the river has also changed. The river model has been adjusted to account for present conditions of ground-water discharge.

The river model is normally used to measure the effects of a change in use and management from a base condition. Although it is desirable to simulate management as accurately as possible, absolute values of items such as average flow, irrigation shortage, etc., are less important than the magnitude of hydrologic change resulting from a change in management.

Much of the data base for the model is adequate, but little is known about certain important parameters. These include irrigation return flow, Snake River diversions below Milner, and river gain from ground water in several important reaches. Because variation in diversions above Milner affect return flow and ground-water discharge, and these relationships are only partially understood, river management simulations may be inadequate to respond to the type of questions which are now being posed. Recommendations in subsequent sections are intended to correct these deficiencies.

Water District 1 Accounting Program

Water District 1 supervises the distribution of natural stream flow and stored water to more than 300 canals and pumps representing over 650 water rights in the basin above Milner Dam. Present levels of diversion averaged approximately 1.7 million acre-feet in July (Figure 2). Southern tributaries to the Snake River from Blackfoot to Milner, principally the Blackfoot, Portneuf, and Raft Rivers, are not included in or administered by Water District 1. Because of the great variation in flow throughout the basin, the determination of natural flow and its allocation by priorities is a complex process. HYDROMET data from the USBR are utilized. In order to accomplish the process of daily flow allocation, the Water District 1 watermaster and IDWR have developed a data collection system and water accounting procedure. Input data include remotely read stream flows reported through the USBR HYDROMET system a diversion data furnished by district personnel. Daily output from this program provides the watermaster the necessary information for water distribution and diversion management. It includes, for each diversion point, daily natural flow and stored flow diversion and the status of the seasonal storage account for each canal.

Although this system is designed for distribution within Water District 1, it is also used to monitor stored water deliveries to users downstream from Milner Dam, most of which result from annual rentals by Idaho Power Company for downstream power generation. If, in the future, water right transfers are made from within Water District 1 to downstream reaches, the accounting system would have to be modified to control the use of the transferred rights to avoid injury to other parties. This is further discussed in the section on Accounting Procedures.

Water Resources References

Hydrologic investigations of the eastern Snake River Plain require a review of previously published literature. The search may be very time consuming and costly. The difficulty and cost of these efforts will be reduced by development of a complete listing of literature related to the water resources of the Snake River Basin above Swan Falls. The task has been partially accomplished and a reference list is being published by the Idaho Water and Energy Resources Research Institute.

Organizational Capabilities

Consultants

Consulting engineering organizations in Idaho have competent staffs of engineers, geologists, economists, and planners capable of performing many of the hydrologic studies and evaluations required. Utilization of consultants can be advantageous when existing personnel of public agencies are already working to capacity, when expansion of those staffs is not advisable for non-recurring assignments, or when specialized skills may be needed.

Examples of work which consultants might perform include feasibility studies of proposed water developments and impacts, conducting aquifer tests and analyzing test data, economic analyses of the cost of lost power generation, evaluation of local interaction between ground-water development and surface water systems, field examinations for judicial proceedings, and modelling of hydrologic problems in local areas.

Federal Agencies

In Idaho there are three primary Federal water resource agencies; the U.S. Bureau of Reclamation (USBR), the U.S. Geological Survey (USGS) and the Corps of Engineers (Corps).

The Bureau of Reclamation emphasizes multipurpose projects which include functions such as hydropower, irrigation, municipal and industrial supplies, fish and wildlife and recreation. Bureau expertise covers the broad areas of project planning, construction and operation. To accomplish these broad goals the Bureau has developed expertise in every field of technical hydrology including data collection; remote sensing; ground water; and sizing, design, and construction, and operation of hydrologic facilities. The Bureau is also involved in the analysis of hydrologic data, the prediction of future fluctuations in water supplies and the effect of various planning and operational alternatives on stream flows, ground water, water quality and water users.

Much of the Bureau's project-related program is directed by Congress through specific authorizations and fund appropriations. The agency does have some flexibility in accomplishing interagency coordination activities and in providing technical assistance within limits of available funds.

The U.S. Geological Survey, Water Resources Division, provides hydrologic information needed for optimum use and management of the Nation's water resources. The Survey collects hydrologic data on a systematic basis and conducts interpretive water-resource studies to describe the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water. The USGS supports basic and applied research in hydraulics, hydrology, and related fields to improve understanding of hydrologic systems and how they respond to stress. Water data and results of investigations are distributed as regularly published reports and computerized information services.

The Water Resources Division's programs are funded by (1) direct federal funding; (2) cooperative funding, where the federal government, representing national interests, and cooperating agencies, representing state and local interests, share funding 50/50; and (3) reimbursement to the USGS for work done for other federal agencies. In Idaho, the cooperative program between the IDWR and the USGS is the main source of funding.

The Corps of Engineers has considerable hydrologic analysis capability primarily related to flood control, regulation, and hydropower projects. It conducts hydrologic studies and is involved in construction and operation of large projects but frequently turns operation of smaller projects over to other agencies.

State of Idaho

The State of Idaho claims ownership of all waters, including ground water, when flowing in their natural channels. The State has the duty to supervise the appropriation and allotment of the State's water. This duty has been given by statute to the Department of Water Resources. The IDWR operates a program to accept, review and rule upon applications to appropriate public water to beneficial uses. Because the supply of public water is essentially finite, the remaining unappropriated supply decreases as appropriations occur. This situation requires an increasingly thorough review of applications if the rights of existing users are to be protected from injury by new diversions. Protection of existing user's rights is particularly relevant to applications proposing diversion of ground water because the effects of development are not as apparent as with surface supplies. More data and an understanding of the complex relationships between ground water and surface water are required to analyze the likely effects of ground-water development.

Responsible management of water resources requires adequate information on the amount, location and occurrence of the water supplies and upon the amount, timing and use of water. The IDWR has reduced the number and scope of its basin-wide resource-appraisal studies in response to budget reductions. Such studies evaluate the nature, location and amount of surface and ground water in a hydrologic basin or sub-basin, review the amount and location of water development, and assess the opportunity for additional development. The studies provide the basis for decisions on applications to appropriate and for management decisions such as declarations of critical ground-water areas. The information is also used by those proposing to make developments requiring the appropriation and use of water. Results of basin-wide appraisal studies are published in bulletin form and made available to the public. Similar studies have been completed by the USGS under the federal/state cooperative program.

Universities

Programs in water resources and hydrology conducted by Idaho's universities are directed primarily toward applied research and development of new methodologies for analysis and planning. The University of Idaho through the Colleges of Engineering, Agriculture, Mines and Forestry conducts research directed toward the full spectrum of water supply, water use, water quality and economics of allocation. The Idaho Water and Energy Resources Research Institute coordinates interdisciplinary studies among University departments for local, state and federal agencies and private industry. The Agricultural Economics department of the University of Idaho has considerable expertise in land and water resource development.

Idaho State University conducts environmental studies involving water quality aspects of water resource systems. Boise State University has conducted geologic and geophysical studies and projects related to geothermal development.

Efforts by University staff are limited in many cases by dual responsibilities of teaching and research. Teaching loads are increasing as University funding decreases and enrollments increase resulting in a reduction in research effort by many departments. Decreases in federal and state contract research funds have severely limited the level of research effort on most campuses.

HYDROLOGIC NEEDS AND RECOMMENDED IMPROVEMENTS

General

The Committee evaluated the current level of hydrologic capabilities of government agencies and entities in Idaho related to decisions regarding the Swan Falls water rights controversy and alternatives for the State of Idaho. Deficiencies in hydrologic data, hydrologic analysis, and management capabilities are not limited to the Snake River above Swan Falls, but are prevalent throughout the entire length of the Snake River system and, in many cases, throughout the state.

The needs and recommendations outlined in this report are the consensus of the members of the Committee who represent agencies concerned with and involved in data collection, research, planning, administration, and regulation of water resources of the state. These recommendations are the best estimates of the types and levels of increased data and effort required to answer the legal, hydrologic and economic questions related to the Swan Falls problem and to allow the State to adequately plan and manage the water resources so vital to the continued well-being of the people of Idaho.

Hydrologic and Land-Use Data

Stream flow and Reservoir Contents

An evaluation of the existing stream-gaging network in the Snake River drainage above Swan Falls was made during this study. The trend is toward a decreased number of gaging sites. A number of deficiencies were noted, including some gages discontinued because of lack of funding and lack of gages at key points.

> The Committee recommends the installation or reactivation of 24 additional stream flow gages and another series of spring-flow measurements each November in addition to the series currently performed in the spring.

Specific gages and installations are described in the work plan, "Surface-Water Gaging Network in the Snake River Basin above Swan Falls, Idaho" (Appendix B). Total cost is estimated at $136,500 in State fiscal year 1984. Of this sum, the USGS is willing to pay one-half. Thus, in FY 1984, the State share would be $68,250 and in subsequent years, approximately $65,000 per year.

An evaluation of the program for monitoring reservoir contents and water levels indicates a need for monthly measurements at five additional reservoirs to give adequate data for management and planning. Reservoirs requiring monitoring are Pioneer in Gooding County, Cedar Creek in Twin Falls County, Fish Creek in Blaine County, Twin Lakes (Mormon) Reservoir in Camas County, and Greys Lake in Bonneville and Caribou Counties. The rationale for additional data are described in the appended work plan, "Reservoir Monitoring in the Snake River Basin."

Instrumentation and monthly measurement of five additional reservoirs is recommended.

The total for installation, operation, and maintenance of the reservoir contents program in State FY 1984 is estimated at $15,670, of which the State would pay $7,850. The State share for operation and maintenance for FY 1985 and subsequent years would be about $3,600.

Water-Supply Risk Evaluations

Methods to evaluate long-term availability of water supplies need refining. Improved methods of evaluating long-term shifts in climate are needed. In addition, methods of estimating the relative frequency of extended drought periods would allow projects to be planned with improved economic certainty incorporating risk analysis in the planning process. The drought period of 1930-1942 is included in the base data used to evaluate water availability. If weather conditions during that period were unique and similar dry periods are unlikely to occur in the future, estimates of water availability could be substantially increased. Because of the implicators and magnitude of this task no recommendation is made for funding this work by the State. When undertaken, it should be broadly supported by affected entities throughout the Pacific Northwest.

Irrigation Diversions

About 100 pumping plants and gravity diversions withdraw approximately 450,000 acre-feet of water from the Snake River between Salmon Falls Creek and Swan Falls (1980 data). Currently, these withdrawals are not systematically measured, yet knowledge of their magnitude is essential for better management and protection of the resource.

The Committee recommends that a program be undertaken by the USGS in cooperation with the IDWR to measure diversions between Salmon Falls Creek and Swan Falls.

About 85 percent of the withdrawals can be accounted for by measuring the 39 largest-volume sites. The remainder can be estimated with reasonable accuracy using power consumption, lift, and pump efficiency data. It is essential that power consumption records for these pumps be made available. This effort is described in the appended work plan, "Monitoring Irrigation Withdrawals from the Snake River between Salmon Falls Creek and Swan Falls Dam."

The cost for this program is estimated at $142,800 in state FY 1984, of which the USGS would pay one-half. Thus, in FY 1984, the State share would be $71,400; in FY 1985, $111,200; and in FY 1986 and thereafter, about $40,800.

Irrigation diversion measurements from streams are necessary both for river operations management and for determining aquifer recharge due to deep percolation of applied irrigation water in excess of crop water requirements. Diversions by pumping from ground water are equally important since they provide water to be consumptively used by crops. However, the net depletion from an aquifer due to ground-water pumping for irrigation is equal to the consumptive use of the crops if all pumped water in excess of consumptive use returns to the aquifer. This is generally the case in ground-water irrigated areas where runoff to surface streams seldom occurs. The timing of the return of excess pumped water will depend on soil type and geology of the aquifer; relationships which need to be investigated further. To estimate net depletions for ground-water modelling and water-budget analysis, it is only necessary to determine the ground-water irrigated area overlying the aquifer, crop types, and consumptive use. For this reason, the Committee is not recommending a program for measurement of ground-water diversions.

Return Flows

Another very important but largely unquantified kind of hydrologic data are irrigation return flows to the Snake River. Surface return flows have been measured or estimated at almost 90 sites above the Murphy gaging station near Swan Falls. Miscellaneous measurements at these sites indicate return flows of nearly 1,900 cubic feet per second during the irrigation season. Numerous other small but unmeasured return flows enter the Snake River. Flows are highly variable during the irrigation season.

The Committee recommends that the 13 largest drains be measured continuously and that periodic measurements be made on an additional 60 drains.

The USGS would assist the State in this endeavor, providing one-half the required funds. Total costs for State FY 1984 are estimated at $41,000 as shown in the appended work plan "Measurement and Analysis of Irrigation-Return Flows to the Snake River between Heise and Murphy." The State share would be $20,500 in FY 1984; $38,000 in FY 1985; and about $27,600 in FY 1986.

Ground-Water Levels

Both the number of observation wells and frequency of measurement have decreased in the basin above Swan Falls. The current observation-well network operated by the USGS under cooperative programs with IDWR and the USBR was evaluated. Severe data deficiencies are present in parts of the basin above Swan Falls. Data are inadequate to evaluate Critical Ground-Water Areas, to quantify water-level trends, and to calibrate ground-water models. These findings are described and justified in more detail in the appended work plan, "Ground-Water Monitoring Network on the Snake River Plain."

The Committee recommends that funds be made available to upgrade and add to the current ground-water monitoring network.

The USGS would bear one-half the costs to meet these important data needs. Total funding requirement in state FY 1984 is estimated at $126,000. The State share would be $63,000 in FY 1984 and about $100,000 in FY 1985 and subsequent years.

Drilling Program

Although intermittently-pumped or abandoned water wells can be used to monitor ground-water levels in many parts of the Snake River Plain, they are not available everywhere. In the 1950's, several holes were drilled in parts of the plain where there were no wells suitable for monitoring. Since then, water-level data obtained from these holes have become increasingly valuable. Starting in the 1960's, the USBR drilled several holes in the Rexburg-St. Anthony area and installed several pipes in each hole; each pipe (piezometer) is open to a different depth in the aquifer and measures the water pressure at that point. Water-level data obtained verifies vertical (upward and downward) as well as horizontal ground-water flow under parts of the Snake River Plain. As part of the USGS RASA study, a 1,123-foot test hole was drilled near Wendell and five piezometers were installed. Hydraulic pressures in the hole increase with depth, indicating upward movement of water in that area.

At least five additional strategically located test holes with several piezometers in each are needed on the Snake River Plain for management purposes. To maximize information return, continuous coring of the saturated section is desired and piezometers must be installed with great care.

The Committee recommends that one 1,500-2,000 foot test hole on the Snake River Plain be drilled each year for the next five years and that three to five piezometers be installed in each hole to obtain needed geologic and hydrologic information.

Upon completion of each hole, a report would be written that would detail the geologic and hydrologic significance and provide the types of information upon which future studies must be based. Total cost for drilling, installing piezometers, and reporting results is estimated at $120,000 for each hole. Because of federal interests in the eastern Snake River Plain, the USGS could provide one-half the required funds and the State the other half (about $60,000) for each year's drilling. The Committee recommends a State appropriation of $60,000 for FY 1985.

Since the USBR is also interested in water management in the Snake River Basin, funding by the Bureau should be pursued for future drilling programs. Potential development at the Idaho National Engineering Laboratory (INEL) will require greater knowledge of the geology and flow systems in that part of the aquifer to determine directions and magnitudes of flow beneath the site. Because of the proposed use of INEL for a breeder reactor, a program to develop water-quality and pressure measurements adjacent to the site should be pursued with the federal government.

Irrigated Acreage

To determine changes in ground water and surface water depletion since 1980, and to provide quantifiable information necessary for adjudication work on the Snake River Plain above Swan Falls, it is necessary to develop and maintain current land-use data. IDWR currently uses remotely sensed data from satellite systems for acreage determinations. However, to produce the types and amounts of information necessary for the adjudication and management of the Snake River Basin requires the development and implementation of a computer-assisted mapping program. This computer-aided mapping or Geographic Information System (GIS) will be used to develop a common series of data layers. A GIS is an organized approach to the storing, retrieving, manipulating, analyzing, and displaying of spatially-referenced data.

The magnitude and complexities of an adjudication of the Snake River Basin requires the incorporation of remotely-sensed and mapped data. Remote sensing will furnish information on present land use and land cover. Computer-assisted mapping will be used to develop computer readable map information such as: points of use and diversion for water rights, irrigation district boundaries, irrigation source, canals and diversions, hydrologic unit boundaries, irrigated acreages, etc. A Geographic Information System will provide the means for incorporating these diverse data sets into compatible forms and allow the systematic analysis and organization of these data for the adjudication process. The manual techniques which are currently utilized are very detailed and time consuming. These manual techniques are quite adequate for county or sub-county adjudication work but for a regional scale approach they become unmanageable and lack flexibility for rapid update and correction when compared to computer assisted methods. A Geographic Information System is a required part of a recommended Snake River adjudication and will be included in that cost.

Conjunctive Management

"Conjunctive management" is a term describing an adminstrative system which takes into account impacts users of surface water have on ground water users, and vice versa. Effective conjunctive management has not been achieved in Idaho.

Several provisions in Idaho's water law recognize the relationships that exist between ground water and surface water. However, information concerning these relationships is not adequate to allow effective conjunctive management. The close relationships that exist between the Snake River and the Snake Plain Aquifer require that water be managed conjunctively. This will require the collection of additional data, extensive analysis to improve understanding of the relationships and development of statutory and administrative procedures to fully implement conjunctive management.

Snake River Adjudication

If water resources in the Snake River Basin are to be managed for maximum beneficial use within the constraints of the Constitution, laws of the State and new directives of the legislature, the priority of those rights must be established. There are presently a number of decrees affecting surface and ground water tributary to the Snake River Plain. These decrees were created and operate in a vacuum. They do not acknowledge the existence of other tributaries they may affect or rights listed in the decrees are or may be subordinate to other rights not listed. These decrees are not effective vehicles for management of the entire system.

The procedure to quantify all rights to use waters of the Snake River system within Idaho is a general adjudication pursuant to I.C. Section 42-1406, et seq. This statute permits the State to require the federal government to quantify its reserved rights, in addition to permitting the quantification of statutory claims. Delay could cause piecemeal adjudication of federal claims in federal court.

Considerations of due process of law require that reasonable notice be given to all persons who claim a right, or reasonably can be expected to claim a right, to the use of water in the Snake River system. Assembling this information will be a monumental undertaking; however, it can be spread over a number of years prior to actual institution of the case in court.

The Committee recommends an appropriation to IDWR limited to an adjudication of water rights in the Snake River Basin in the amount of $796,100 for FY 1985.

It is estimated that the adjudication will require over 300 person-years of effort and 1 million dollars per year for the subsequent 10 year period.

Department of Water Resources Water Rights Records

Better data, accounting procedures, and a study of statutory and institutional changes and provisions necessary to implement conjunctive management is recommended as well as an adjudication of the Snake River Basin as discussed in the previous section.

Accurate information concerning water rights and the effect of one user's rights on another user is of critical importance in making policy decisions. The Swan Falls decision highlights the importance of the ability to quantify these effects. What rights have been applied for, licensed, or allowed to lapse in a given area in a certain time period? What applications remain outstanding in a given area? These and similar questions must be answered to analyze the impacts of changes in water use or policy. To replace the present method of physically searching "paper" records in the Department to answer these questions, the paper records must be organized and entered into a verified computer data base for efficient access and retrieval.

IDWR is obtaining a new computer system which will be useable as a management tool as well as an archival tool. However, the information now on the computer tapes should not be transferred into the new computer system without being verified.

<u>The Committee recommends that a one-time effort should be made to resolve deficiencies in the IDWR data base related to the area above Swan Falls.</u>

It is estimated that proofing, correcting and updating IDWR computer files relating to water rights and claims above Swan Falls will take seven person-years. An appropriation to IDWR solely for this purpose is recommended in the amount of $105,000 in FY 1985 and FY 1986 budgets.

<u>Accounting Procedures</u>

Changes in point of diversion and place, period and nature of use of established water rights are permitted in Idaho if injuries to rights of third parties do not occur and the right is not enlarged by the change. Regulation of such changes occurs in two separate phases: (1) review before the change is authorized by Department staff and (2) administration of diversions after the change is authorized. Neither mechanism in Idaho is operable to the extent necessary to insure that the rights of other water users are not adversely affected if such changes become more prevalent because of the Swan Falls decision. Extensive changes to existing rights could occur with the allocation of Idaho Power's Swan Falls right, after compensation, to upstream consumptive uses. Changes and transfers of existing irrigation rights may become prevalent as a source of water for new development if purchase of existing irrigation rights or water bank utilization is found to be less expensive than compensating Idaho Power for the lost hydropower.

Improved methods of determining the physical effects of a proposed transfer are needed, including development and utilization of the mathematical models discussed elsewhere.

The administrative procedure must be improved to assure that the transferred right is used only within its original bounds. In whole or part, this may result from the adjudication previously mentioned. However, the completion of the adjudication is probably so far in the future that an interim program is required.

The committee recommends that $69,000 be appropriated to IDWR in FY 1985 and FY 1986 to form and fund a study of the technical and institutional resources needed to permit transfers of water rights without injury to others.

It is estimated that this study would require 3 person-years of effort.

Accounting for Impacts of New Development

One of the problems raised by the Swan Falls controversy is the impact of new irrigation developments above Swan Falls on power generation. There are two facets to the problem:

(1) What is the effect on hydropower generation of new irrigation development?

(2) What is the economic cost of replacing lost hydropower generation?

The aquifer model, when reviewed and improved as proposed elsewhere in this report, will be able to analyze the effects of proposed development on the aquifer and on the river. This information, coupled with Idaho Power Company's generation models and IDWR's river model may then be used to predict power losses.

In addition, there will be economic costs associated with loss of hydropower generation. Although policy decisions will control the question of where those costs are allocated, development of a useable data bank and analytical procedures to permit predictions of those costs in a variety of settings would be invaluable to policy makers. This effort is estimated at 2.2 person-years.

The committee recommends appropriation of $90,000 included in the subsequent section on aquifer model applications in FY 1986 to fund a study to develop techniques to be used in predicting the effect of new development on power generation and the cost of those losses.

Water Bank

A potentially useful tool for permitting maximum development of the State's water resources is the water bank. As presently constituted, the water bank is of only limited utility in such an endeavor. The current structure does not require adequate notice nor analysis of benefits and costs to other users prior to rental of stored water. Effects on other users are not fully evaluated. The water bank has not been integrated with improved reservoir regulation for optimal use of water resources.

Existing federal reclamation projects are built upon a formulation of contracts and policies which, in conjunction with state water law, may not result in the most beneficial use of the water resource. Present methods of operation are probably lawful in the context of state and federal law, but may not result in full utilization of the water resources.

The water bank statutes need to be critically examined to permit the bank's use as an integral part of a program of better utilization of existing resources. The study will require information and expertise from a wide range of water users, hydrologists, lawyers, legislators and government officials. Possibilities for long-term commitments for leased storage and implementation of some form of water-supply insurance programs to reduce risk should be evaluated.

> The committee recommends that a multi-disciplinary committee be formed to evaluate and advise the State on the structure and utilization of the water bank and that $39,000 be appropriated for FY 1985 to fund a study of the water bank as a mechanism for assisting in better utilization of the water resources of the State.

This study, estimated at one person-year, should include an evaluation of the alternative structures and mechanisms for a water bank within hydrologic and statutory constraints. Also, the current and possible federal posture toward contracted storage and the role of reserved rights must be determined.

Conversion to Sprinkler Irrigation

As the Snake River traverses southern Idaho from the Wyoming border to the Oregon border, its waters are diverted, used and re-used. One user's return flow water becomes another's source of water for diversion. All water users in the basin have an interest in the way the water is used by others.

One important result of applying water for irrigation is recharge of the Snake Plain Aquifer. Of the approximately 7 million acre-feet of water which annually recharge the aquifer, 4 million acre-feet percolate through the soil to the aquifer.

Changes in irrigation practices can obviously affect recharge to the aquifer. For example, subirrigation practices in the Henrys Fork Basin contribute large amounts of water to ground water. In 1980, an estimated 1,143,000 acre-feet of water were applied to approximately 114,000 acres in that area. If two acre-feet per acre were consumed by crops, then 915,000 acre-feet were available for surface return flow and ground-water recharge. The water available for aquifer recharge could represent almost 20 percent of the total recharge from irrigation in a typical year.

There is a pattern of conversion to sprinkler irrigation using ground water in the Egin Bench area of the Henrys Fork Basin. IDWR Water Information Bulletin No. 36 documented a pattern of conversion in the Aberdeen-Springfield area in 1974. The Rockford area of the Aberdeen-Springfield Canal Company has already converted from surface water to ground water and small amounts of conversion have occurred within the North Side Canal Company (10,000 acres are estimated by the Company's staff.)

Annual surface water diversions in Water District 1 have declined by about one million acre-feet a year. Figure 2 represents the trend to decreasing July diversions which can be attributed in part to improvements in delivery system management and climatological differences. However, it may also reflect in part the effects of conversions to ground-water sources from surface-water sources. The complex water-use system makes it difficult to generalize about the effects of conversions. However, a lessening of demand for surface water diversion increases the supply available to junior rights. It also results in a reduction in demands on reservoir storage.

Conversion from a surface water source to ground water has a two fold effect: it may reduce recharge to ground water, depending on location of the diversion, and withdraw additional water from an already depleted supply. The Henrys Fork Basin, for example, if completely converted to sprinkler systems and ground-water diversions, could represent a one million acre-foot decrease in net ground-water recharge, due to the removal of surface water applications and increased ground-water pumping.

The committee believes that the magnitude of existing conversions needs to be determined, and that an analysis of the factors that lead to conversions should be made, to allow prediction of the impact of present and future conversions. It believes the potential changes which could result from unrestricted conversion should be determined, so that current policy can be reviewed in light of those changes.

The committee recommends an appropriation of $30,000 for FY 1985 to study the extent and possible effects of conversion from surface water sources to ground-water sources.

Needed Technical Hydrologic Capabilities

Ground-Water Model Improvements

Future decisions regarding water resources of the Snake River Basin in southern Idaho will be significantly effected by predictions based on the ground-water models. A calibrated model must be able to predict aquifer response from projected water use changes for many years into the future with reasonable accuracy to be a useful tool for aquifer management. The current model has been calibrate to detailed water-use data for a one-year period. The validity of extrapolating the calibration to longer periods has not been demonstrated. The average error obtained during calibration has unknown significance when applied in a longer term simulation. Credibility of the model will be enhanced by simulation of the 100-year period of irrigation development on the eastern Snake River Plain. Pre-irrigation water levels within the aquifer can be generated by the model and compared to historic values.

The accuracy of predicted ground-water levels and spring discharges is a function of the accuracy and detail of data used in model calibration. Changing data within reasonable ranges of values, and observing the consequent changes in results, provides an idea of the sensitivity of the model to possible errors. Future research can then be directed at the most sensitive factors. Model sensitivity to recharge and discharge, both on the eastern Snake River Plain and at the boundaries, must be evaluated. The sensitivity of the model results to errors in estimates of aquifer characteristics should also be examined.

The time lag between initiating aquifer recharge or discharge at a specific point and the aquifer response at any other point is becoming increasingly important as competition for water increases. The aquifer exhibits the tendency to dampen or decrease the effects of changes in recharge to or discharge from points distant from the recharge area. For example, summer irrigation withdrawals from the aquifer may cause depletions in aquifer discharge to the river of a lesser magnitude than the withdrawls, but distributed over the entire year. The time of year, or even which year effects of withdrawls or recharges become evident, affects most downstream uses. Model output is currently designed to provide information primarily on ground-water levels and river gains and losses. Numerous simulations aimed at determining lag times between changes in aquifer recharge or discharge and response warrant changes in the model to provide convenient output.

Several technical aspects of the model should be evaluated to determine their effects on accuracy. The aquifer is represented in the model by a grid of about 1100 sub areas at a spacing of about 3 miles. In some areas, where water levels or aquifer characteristics change dramatically, a reduced spacing may prove advantageous. Spacing may either be reduced for the entire grid or may be made variable in the computer program. Model calibration is performed by minimizing the differences between predicted and measured or estimated water levels at every grid point. The effectiveness of various methods of calibration should be evaluated.

The basis for an accurate model calibration is formed by detailed and accurate data on ground-water levels, geology, and aquifer recharge and discharge. Much of this information was gathered during 1980 and 1981 as part of the USGS RASA project and is currently being incorporated by IDWR, the University of Idaho, and the USBR into a new calibration of the model. Additional improvements should be made to the data in several areas.

Determinations of aquifer recharge and discharge are based on large quantities of irrigation, crop, weather, and stream-flow data. Improved satellite imagery techniques and changes in irrigated areas and irrigation practices warrant periodic updating of crop and irrigation distributions. An updating would include identification of new irrigated areas; improved techniques will permit more accurate determination of acreages and crop types. These updated values should be incorporated in model input prior to recalibration of the model.

Ground-water underflow from mountain valleys is a major component of total recharge to the Snake Plain Aquifer and is one of the most difficult to estimate. Estimates of the relative magnitudes of the recharge and discharge elements are illustrated in Figure 6. Underflow estimates made by the USGS during the RASA program are probably the best available information; however, these estimates should be reviewed to determine if additional work is required.

Most recharge to the Snake Plain Aquifer originates from surface and underground flow from tributary valleys and from irrigation percolation (see Figure 7). A much lesser amount of the recharge occurs from precipitation directly on the plain. The model is currently operated under the assumption that no recharge results from precipitation on non-irrigated parts of the plain. Recharge from precipitation on rangeland can be determined as the difference between precipitation and the consumptive use of range vegetation. Rangeland consumptive use estimating procedures should be reviewed and new methods such as the regional aridity approach should be evaluated. Consumptive use of crops is calculated in the ground-water model by a routine utilizing meterological inputs such as temperature, wind speed, humidity and solar radiation or by using previously published data for average consumptive use.

Recharge to aquifers tributary to the Snake River Plain is often determined from average rainfall distribution maps based on scattered precipitation reporting stations. The maps currently used were developed in the 1950's. Additional years of precipitation data have become available and revision of the rainfall distribution maps to reflect the longer period will improve the accuracy of recharge estimates. Agreement among agencies in updated rainfall distributions would facilitate modelling and water-budget analysis use.

Aquifer recharge from irrigation occurs as percolation through the unsaturated soil profile to the water table. In most areas of the eastern Snake River Plain ground water is unconfined and a free water table is present. However, in some areas such as the Minidoka tract, Henrys Fork Valley and near Mud Lake, percolation recharges a local shallow aquifer which in turn leaks downward to the regional Snake Plain

Aquifer or discharges laterally to surface water. The shallow aquifer in the Henrys Fork and Mud Lake areas has been extensively studied and estimates of leakage to the Snake Plain Aquifer have been made.

The magnitude of leakage and lateral movement of shallow ground water in the Minidoka area is unkown. Current model calibration assumes that irrigation percolation occurs immediately and directly recharges the Snake Plain Aquifer. Because a shallow ground-water system prevents direct recharge to the regional aquifer, a model which neglects the shallow system may not accurately reflect the actual response of the regional aquifer. Modifying the model to portray more accurately the real system would improve the accuracy and credibility of the model in this area. Modification requires study of local flow systems and model calibration must be updated to assure the most accurate possible results.

Updating the ground-water model should include the following tasks which are estimated to require 5.5 person-years of effort:

1) Test the model's capability to simulate long-term conditions.
2) Test model sensitivity to errors in recharge and estimates of aquifer characteristics.
3) Modify the computer model to provide lag times between changes in diversions or recharge and changes in aquifer water levels and discharge.
4) Evaluate model sensitivity to grid spacing.
5) Evaluate calibration criteria (least-squares fit of water levels).
6) Review methods for calculation of rangeland consumptive use.
7) Review and, if necessary, update published precipitation data.
8) Evaluate the modelling significance of the elevated water table in the Minidoka area.
9) Evaluate the feasibility of modifying the model to accept irrigation return flows as a percentage of diversions.
10) Include new data from satellite observation in a recalibration of the model.

The committee recommends state funding of $20,000 in FY 1984, $120,000 in FY 1985, and $80,000 in FY 1986 for improvement in ground-water modelling capabilities.

River Model

The river model was last used to estimate flows for 1980 conditions of development and management. To assess changes which have occured in diversions and land use since 1980, all adjustments to present-conditions should be reviewed. Diversions in Water District 1 have been declining since 1976 and these declines are only partially reflected in the 1980 study. Reduced diversions affect river flows as well as ground-water recharge. Changes in ground-water recharge, in turn, affect river flows.

Proposed measurements of Snake River diversions below Milner and return flow sites throughout the basin will permit a more realistic assessment of flows available at Swan Falls and other power sites below Milner.

The Committee recommends that the river model be updated when the new data become available, as part of IDWR's regular program of model maintenance.

Consumptive Use Bulletin

Irrigated, dryland and rangeland crops are by far the largest consumptive uses of water in Idaho. It is the consumptive use part of irrigation diversions which deplete the resource. Therefore, it is necessary to have accurate estimates of past and future volumes of consumptive use across Idaho to effectively manage surface and ground-water discharge within the state and to evaluate all economic and physical effects of future developments and uses.

The University of Idaho has completed a study to select and calibrate a consumptive use equation for application to Idaho crops. The FAO-Blaney-Criddle equation, developed by the United Nations Food and Agricultural Organization in 1977, has been thoroughly tested, calibrated and applied to over 90 temperature and precipitation measuring sites in Idaho to estimate average monthly consumptive use and consumptive irrigation requirements of irrigated crops. Additional work is needed to furnish Idaho water users sufficient information for economic design and management of irrigation and water-resource systems.

Procedures, which relate consumptive use by crops for periods less than 30 days duration to consumptive use over monthly periods, need to be reviewed or developed for application in Idaho. These procedures are necessary in the design of irrigation systems to meet peak-use requirements which are often less than 30 days duration. Decreased water diversions within Idaho can result if irrigation system designers are furnished adequate consumptive use information to prevent over design and excess operation of systems. Procedures should be tested using daily and monthly estimates and measurements of consumptive use at Kimberly, Idaho.

Procedures are needed to estimate yearly and monthly variation in consumptive use necessary for good economic design. Developed procedures should allow adjustment of statistics generated from estimated monthly consumptive use by the FAO method to describe accurately the probabilities of real occurrences. A simple method of presenting averages, ranges and variabilities of consumptive use requirements and consumptive irrigation requirements is needed to allow easy dissemination and understanding.

University of Idaho researchers at the Kimberly Research and Extension Center have completed the basic data analysis for preparation of a consumptive use bulletin for Idaho. The bulletin, which would include estimates and statistics for monthly consumptive use and irrigation requirements for agricultural locations throughout Idaho, should be prepared and published for general distribution.

<u>The Committee recommends funding for consumptive use studies and publication of a consumptive use bulletin by the University of Idaho in the amount of $18,000 for FY 1985.</u>

Organizational Needs

Consultants

Consulting organizations require information and data similar to planning or regulatory agencies. Water-supply determinations and analysis of impacts require stream flow and aquifer water level data which are lacking in many areas. In many cases, consulting firms are retained for assistance in evaluation of smaller stream-aquifer systems for which data are extremely lacking or non-existent. Collection of hydrologic data on smaller basins or watersheds is more difficult to justify by state agencies since the number of beneficiaries is usually small. Infrequent or one-time stream flow measurements on small watersheds may be more beneficial to consultants than continuous long-term records of major streams.

In general however, updating of hydrologic and land-use data bases as proposed in this report will assist the consulting community.

Federal Agencies

The role of the USBR in project evaluation and Snake River operations is hampered, as is IDWR, by data deficiencies. Lack of adequate surface and ground-water return flow measurements makes determination of optimum reservoir operation difficult and evaluation of future potential project water supplies tenuous. Water supplies for the Bureau's projects in the Upper Snake River Basin depend on Snake River flows and ground-water return flows. It is therefore very important that hydrologic relationships between the aquifers and the main river be understood and predictable.

State

The multifaceted role of water administration, planning, and research places a heavy burden on the IDWR in these times of changing needs and policies in water resources development and management. The number of water rights filings and the increased complexity of application review have been increasing since 1980 (Figure 9); however, the IDWR's capabilities to operate the program have been steadily decreasing (Figure 10). In an effort to maintain timely review and prompt decisions, and because several new regulatory programs have been added to the Department's responsibilities during recent years, staff responsible for the procedural processing of applications (designated as Resource Administration Division, Figure 10), have been maintained at the expense of reducing staff available for technical review of applications, resource studies, and resource planning (designated as Resource Analysis Division, Figure 10). Backlogs in processing still exist in the water administration process (Figure 11) and the technical competence applied to decisions on individual applications and overall resource management has suffered accordingly. The programs are ongoing responsibilities which are required for efficient service to water users and for adequate administration of the water resources of the state.

The importance of adequate management of allocation of the public

Figure 9. Trends in water rights transactions, applications, claims, amendments and transfers.

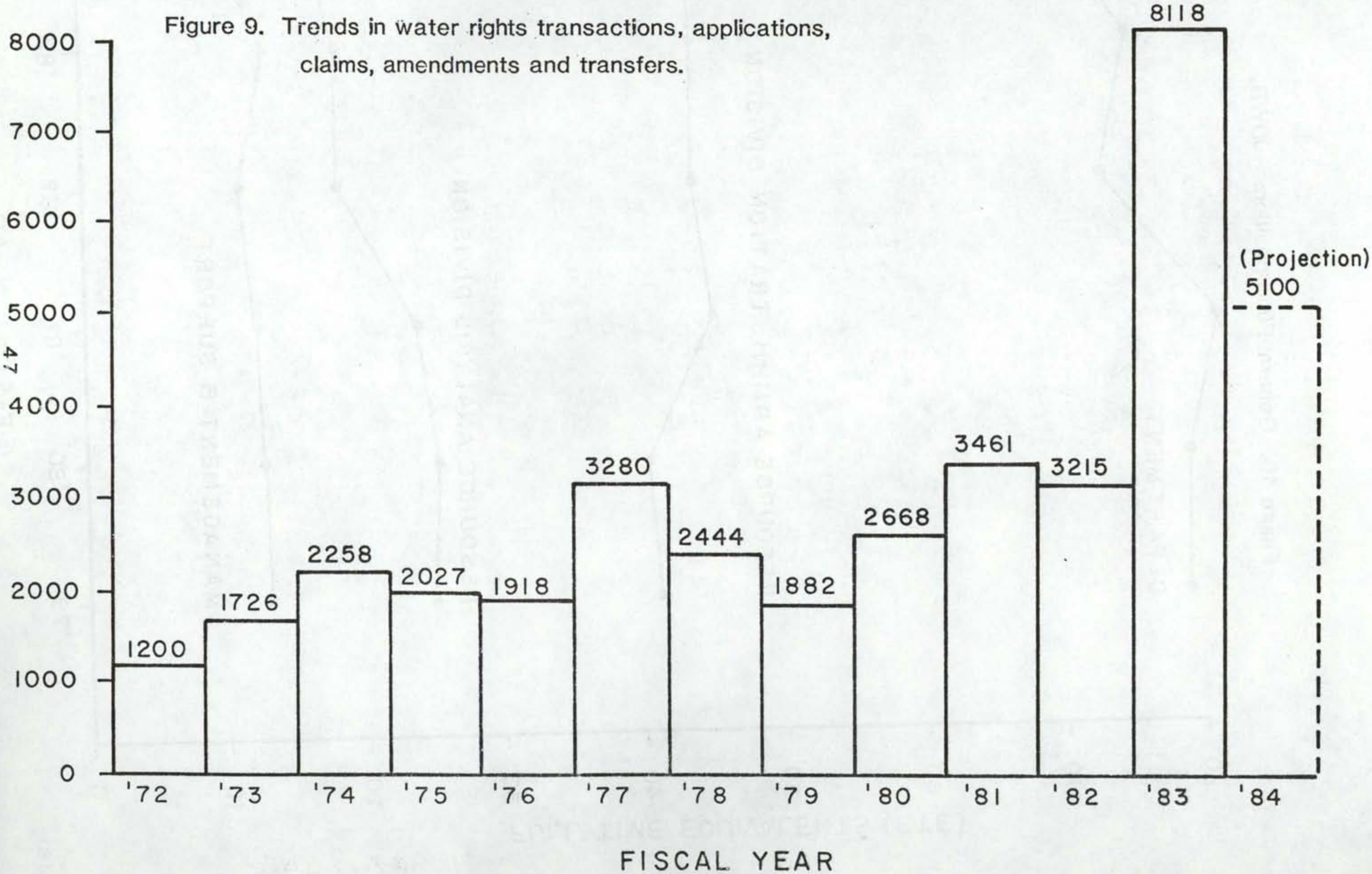


Figure 10. General Fund positions - IDWR.

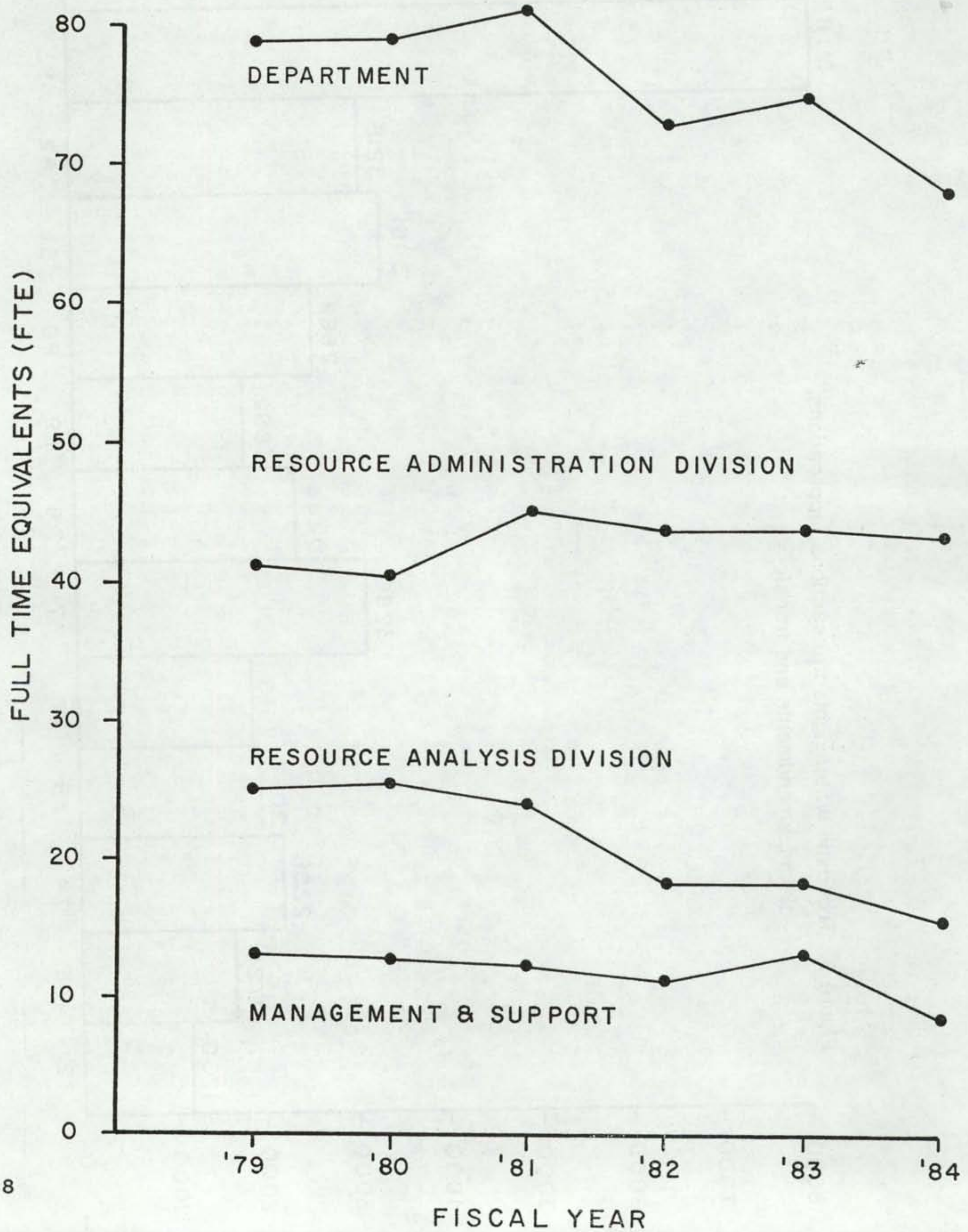
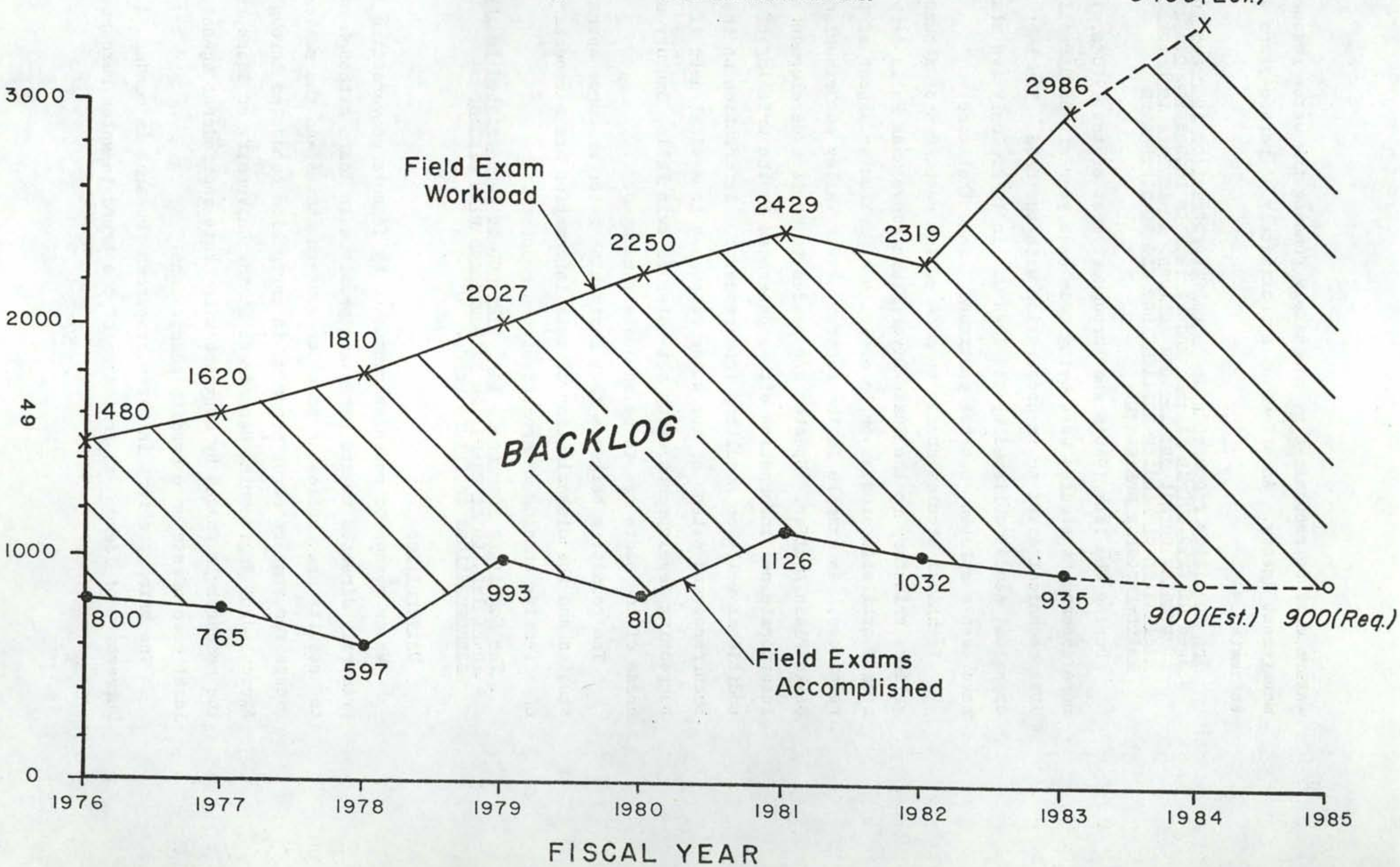


Figure 11. Water rights field examination status.



waters must be recognized by adequately funding the water resource management agency. An effort of approximately 16 person-years is estimated.

The committee recommends an annual appropriation increase to IDWR of $250,600 in FY 1985 and FY 1986 to reduce the backlog of pending permit and license actions, to improve technical evaluation of pending applications and to strengthen water-resource management.

During the late 1960's and throughout most of the 1970's, three or more assessment studies were being made each year either directly by IDWR technical staff or in cooperation with the USGS. The last resource appraisal study published by the IDWR was in 1978. Only two studies have been completed, but not published, since that time.

Technical studies should be made of the resources of a number of valleys tributary to the Snake River Plain above Swan Falls either to update available studies or to evaluate a particular aspect of the water resources. An example is the Portneuf River Valley contribution to the Snake Plain Aquifer. Updates are needed to monitor development and to incorporate new information either generated by the drilling of additional wells or resulting from research. Information on the occurrence and extent of hot water resources is a vital need if burgeoning developments using hot water in Twin Falls, Banbury and other areas of the state are to be adequately managed.

The committee believes that basin-wide water resource appraisal studies and the dissemination of this information are a necessary part of effective ongoing management of the resource.

The Committee recommends that $121,600 be appropriated to IDWR in FY 1985 to re-establish this program with similar appropriations in future years.

Universities

Water resources research conducted by Idaho's universities is primarily directed toward needs and problems in Idaho although many of the results are applicable to other western states and the nation. Except for some research programs in irrigation conducted through the Agricultural Engineering Department at the University of Idaho, most of the research is funded by contract with state and federal agencies and local governments or commodity commissions.

The primary effort in water resources research is conducted at the University of Idaho. An indicator of the trend in water resources effort is the funding for research through the Idaho Water and Energy Resources Research Institute, Table 1.

Table 1. Approximate Funding of the Idaho Water and Energy Resources Research Institute, 1978 to 1984.

Fiscal Year	Funding
1978	885,000
1979	730,000
1980	706,000
1981	1,000,000
1982	410,000
1983	100,000
1984	250,000

This trend is influenced by decreases in federal funding through the now defunct Office of Water Resoures Research and decreases in state funding through the Departments of Water Resources and Health and Welfare. Water resources and irrigation-related research through the University of Idaho Departments of Agricultural and Civil Engineering has likewise decreased in the same period. The mission of all institutions of higher education is teaching, research, and service. Maintenance and retention of competent teaching staff in the water resources field require an opportunity for staff to pursue research in their area of expertise to maintain competence in this era of rapidly changing technology. Lack of funding from state and federal agencies is hindering Universities in fulfilling research responsibilities and in attracting and retaining competent staff.

It is recommended that the expertise and facilities of Idaho's universities be utilized wherever possible to perform research to enhance capabilities in water resources and supplement state and federal efforts.

RECOMMENDED APPLICATIONS OF IMPROVED TECHNOLOGY

Application of the Snake Plain Aquifer Model To Forecast Effects of Current or Proposed Changes in Water Uses or Policies

Effects of current and proposed irrigation development on the Snake Plain Aquifer and aquifer discharge in the near future and over the next fifty to one hundred years can be determined only if the changing state of the aquifer is known. Discharges from the aquifer at Thousand Springs and other locations have increased and decreased since the early 1900's (Figure 3). Amounts and locations of recharge in the eastern part of the plain have changed significantly within the past ten years and the effect of these changes will be experienced for several years. If future spring discharges in the absence of any proposed development can be determined, then the added effects of proposed new development can be evaluated.

Effects of proposed development on the eastern Snake River Plain on aquifer discharge will vary depending upon the location and magnitude of development. Reductions in discharge from springs due to development also vary seasonally and a change in timing of spring flow reduction may, in many cases, have a greater effect upon water and power rights downstream of Thousand Springs than the total depletion. Therefore, it is necessary to determine lag times and magnitudes of changes in river flows caused by changes in ground-water pumping or recharge at specific locations in the aquifer system.

In addition, new ground-water developments may affect current pumpers by lowering local ground-water levels and increasing pumping lifts. Therefore, the ground-water flow model should be used to determine potential ground-water elevation changes owing to changes in recharge or pumpage at specific locations or changes in irrigation management or increased irrigated acreage.

Application of the ground-water model to the aquifer system in the described manner will aid in developing an understanding of the aquifer-river interactions and flow systems so that effects of future proposed water developments may be determined more readily.

Estimated effects of proposed and present irrigation development on the eastern Snake River Plain can be used with certainty only if the ground-water model adequately displays the changing state of the aquifer as previously discussed. One way of determining the adequacy of the ground-water model would be to apply it assuming recharge to the aquifer is different from the norm. One application would be to evaluate impacts on the Snake Plain Aquifer for worst case (1934-35) climatic conditions. This type of application would also provide information concerning changes in aquifer discharge and water levels under current and proposed development if climatic conditions similar to the 1930's reoccurred.

The Committee recommends funding of these necessary applications of the State ground-water model at $90,000 in FY 1986, contingent on funding of research to recalibrate and improve the model during FY 85 as recommended in the previous section of this report.

Evaluation of Development Options and Projects

Development of Ground-water and River Systems Base Conditions

Both the river and ground-water system are in a state of change. Evaluation of future changes in water management, water rights, new development, aquifer recharge, etc. requires determination of river and aquifer flows under present conditions of management. The river and ground-water models need to be used with a new data base to simulate flow conditions which would result from continuation of present management conditions and policy.

Changes in River System Facilities and Management

Needed hydrologic evaluations will be identified as legislative and judicial processes proceed on the Swan Falls issue and various policies and management options are defined. The following are examples of possible studies which could be needed:

Future development: The proposed SB1180 contract or some agreement or additional legislation could permit more development from the aquifer and river than the present level. Application of both models will be required to determine effects on river flows, hydropower generation, and aquifer levels caused by potential development. Other options for further development would require similar studies.

Alternate system management: There are possible methods of operation and management of the existing river-aquifer system to reduce the effects of additional depletions.

Some of these include alternate reservoir management, better distribution system management, and enhanced irrigation efficiency. Models can be used to simulate alternative management options.

New facilities: New facilities could also minimize impacts of depletion. New reservoirs, aquifer recharge projects, ground-water exchange facilities, and rehabilitation of irrigation systems are possible alternatives to reduce depletions. Effects of any new facility or combination of facilities should be evaluated.

Non-technical evaluations: Hydrologic evaluation of options in isolation is not sufficient. Each new management proposal or system change must be evaluated with regard to economic, environmental, political and institutional constraints and public-opinion concerns.

Because of the time requirements for data collection and model updates, these types of evaluations would be performed after FY 1985. Costs for such studies cannot be determined at this time.

RECOMMENDATIONS FOR PROGRAM IMPLEMENTATION

Performance of the projects and programs recommended by this Committee should be carried out primarily under the auspices of the Idaho Department of Water Resources as the designated water resources agency for Idaho. It is recognized that other state and federal agencies and Idaho Power Company have legitimate concerns regarding the conduct and results of such studies. Any or all of the proposed programs could be undertaken unilaterally by any of the above parties providing adequate funds were available. It is not in the best interests of the State, Idaho Power Company or any federal agency for any one entity to pursue such studies independently.

It is therefore recommended that these proposed studies and programs be performed by a technical study team coordinated and funded by IDWR, comprised of Department and University staff, utilizing the expertise of all federal agencies and the cost-sharing opportunities available under the USGS cooperative program. Consultants and other agency staff would be included within the study team as needed. It is further recommended that a technical advisory committee, similar to the Technical Advisory Committee currently constituted, be funded through IDWR to advise and assure agreement among concerned groups on conduct of programs.

Program Costs and Timing

The efforts recommended by the Committee are generally divided into five categories: 1) Data-collection program; 2) Analytical capability improvement; 3) Applications and evaluations; 4) Water rights records and accounting updating; and 5) General adjudication of the Snake River. The data collection program is an ongoing function necessary to bring the State to a level of knowledge of the resource for sustained management and planning. Likewise, the water rights records program will require continued funding after the initial effort to place all files in a computerized data base. Improvements in analytical capabilities are required before many of the other recommended projects and studies can be performed. It is estimated that the general adjudication of water rights in the Snake River above Swan Falls will require an intensive effort and funding for at least 10 years.

Table 2 shows the estimated state funding requirements for the recommended programs for fiscal years 1984, 1985 and 1986. It is the opinion of the Committee that commencing the data collection programs and model improvement in FY84 is imperative if results of other efforts are to be obtained in sufficient time for useful decision making.

Table 2.--Estimated state costs for required water resources programs and studies. FY 84-86

	Costs			
	FY 84	FY 85	FY 86	Total
Data Collection Program[1]				
Surface Water Gaging	68,250	64,800	67,850	200,900
Reservoir Monitoring	7,850	3,550	3,775	15,175
Pumped Diversions	71,400	111,200	40,800	223,400
Irrigation Return Flows	20,500	38,000	27,600	86,100
Ground Water Monitoring	63,000	97,500	102,450	262,950
Observation Well Drilling		60,000	60,000	120,000
Irrigation Water Source Conversion		30,000		30,000
	231,000	405,050	302,475	938,525
Analytical Capability Improvement				
Ground-Water Model Improvement	20,000	120,000	80,000	220,000
River Model Improvement	0[2]	0[2]	0[2]	0[2]
Consumptive Use		18,000		18,000
	20,000	138,000	80,000	238,000
Applications and Evaluations				
Water Bank Evaluations		39,400		39,400
Ground-Water Model Applications			90,000	90,000
Development Options Analysis			N/A[3]	N/A[3]
		39,400	90,000	129,400
Water Rights Records and Accounting				
Water Rights Records		105,000	105,000	210,000
Accounting Procedures Development		69,000	69,000	138,000
General IDWR Program Improvement		250,600	250,600	501,200
Water Resources Bulletins		121,600	121,600	243,200
		546,200	546,200	1,092,400
Adjudication				
General Snake River Adjudication[2]		796,100	1,000,000	1,796,100
TOTAL	251,000	1,924,750	2,018,675	4,194,425

1/ Listed costs represent the State share under the USGS cooperative program or one-half of the total program cost. See Appendix B.

2/ Included in the IDWR general operating request.

3/ Cost estimates cannot be determined pending definition of required projects.

APPENDIX A

TECHNICAL ADVISORY COMMITTEE

SNAKE RIVER WATER RESOURCES

NAME	REPRESENTING	ADDRESS	PHONE
Charles Brockway	University of Idaho	Route #1 Kimberly, ID 83341	423-4691
Richard G. Allen	University of Idaho	Route #1 Kimberly, ID 83341	423-4691
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Alan Robertson	Idaho Department of Water Resources	450 W. State Boise, ID 83720	334-4485
Don Reading	Idaho Public Utilities Commission	472 W. Washington Statehouse Mail Boise, ID 83720	334-3423
Michael Gilmore	Idaho Public Utilities Commission	472 W. Washington Statehouse Mail Boise, ID 83720	334-2267
David Meyers	Idaho Power Company	P.O. Box 70 Boise, ID 83707	383-2728
Thomas Nelson	Idaho Power Company	P.O. Box 1906 Twin Falls, ID 83301	734-0700
Ernie Hubbard	U. S. Geological Survey	230 Collins Road Boise, ID 83702	334-1701
Gerald Lindholm	U. S. Geological Survey	230 Collins Road Boise, ID 83702	334-1701
Parry Harrison	U. S. Bureau of Reclamation	Federal Building 550 W. Fort Boise, ID 83701	334-1296
Keith Anderson	Water Resources Consultant	Anderson and Kelly 6700 Emerald Boise, ID 83705	375-9220
Laird Noh State Senator	Swan Falls Water Rights Committee	Route #1, Box 65 Kimberly, ID 83341	733-3617
Vard Chatburn State Rep.	Swan Falls Water Rights Committee	Box 97 Albion, ID 83311	673-6661
Mike Nugent Staff Coordinator	Legislative Council	Statehouse Boise, ID 83720	334-2475

APPENDIX B

10/28/83

SURFACE-WATER GAGING STATION NETWORK IN THE SNAKE RIVER BASIN ABOVE SWAN FALLS, IDAHO

Work Plan

U.S. Geological Survey
Boise, Idaho
October 1983

Background and Need for Study

The U.S. Geological Survey has been collecting streamflow data in Idaho since 1889. Because the Snake River is the lifeline for agricultural production on the Snake River Plain and the source of low-cost electrical energy for much of southern Idaho, it has long been the focus for data collection.

The streamflow measurement program, conducted by the U.S. Geological Survey in cooperation with various Federal and State agencies, needs periodic evaluation for adequacy and relevance. The existing network of stream gages has evolved through the years as Federal and State interests in water resources have increased. It has resulted more from the need for information at specific sites than from a planned, all-purpose data-collection system (Thomas and Harenberg, 1970).

In addition to the basic stream-gaging program, the U.S. Geological Survey, in cooperation with other Federal and State agencies, has collected streamflow data for small basin hydrologic studies and low-flow investigations. Water samples were collected at many sites to determine variations in water quality with changes in discharge.

The need for good and timely hydrologic data is now more apparent than ever because of the recent Swan Falls decision. It has brought into focus the conflict of interest concerning water use for irrigated agriculture and power development. Answers to questions concerning hydrologic effects of various management alternatives must be based on sound hydrologic data.

Problem

The problem is that additional streamflow data are needed at a number of sites to satisfy a variety of data needs. In recent years, nearly all funds have been used to collect water-management type data on major streams at the expense of (1) the small basin hydrology program, (2) the low-flow program, and (3) related surface-water quality studies. The specific need at this time is for additional streamflow data to help answer questions that might arise owing to the Swan Falls issue.

Objective

The objective is to evaluate and upgrade the current surface-water monitoring network. Changes are needed to provide more detailed hydrologic data than are currently being collected, particularly in areas that affect Snake River flow at Swan Falls. An expanded streamflow measurement program will provide data needed for future hydrologic analysis, including mathematical modeling of the complex stream-aquifer system.

Approach

Referring to areas above Swan Falls in figure 1, the approach would be to add new and reestablish or reactivate discontinued gaging stations and increase measuring frequency as outlined below. If, after discontinuing a gage, the measurement structures were removed, the station must be reestablished. If, after discontinuing a gage, the old measurement structures can be reused, the station will be reactivated.

Snake River: Blackfoot-Neeley (includes American Falls Reservoir).--Ground-water discharge to the Snake River from Blackfoot to Neeley is about 1.8 million acre-feet annually. When stage of American Falls Reservoir is high, about half of the total is measured directly, most as spring flow. The percentage directly measurable decreases as reservoir stage rises. To better understand ground-water and surface-water relations in the American Falls area, the following changes in the surface-water network are needed:

1. Reestablish the gage on Bannock Creek near Pocatello (13076000).

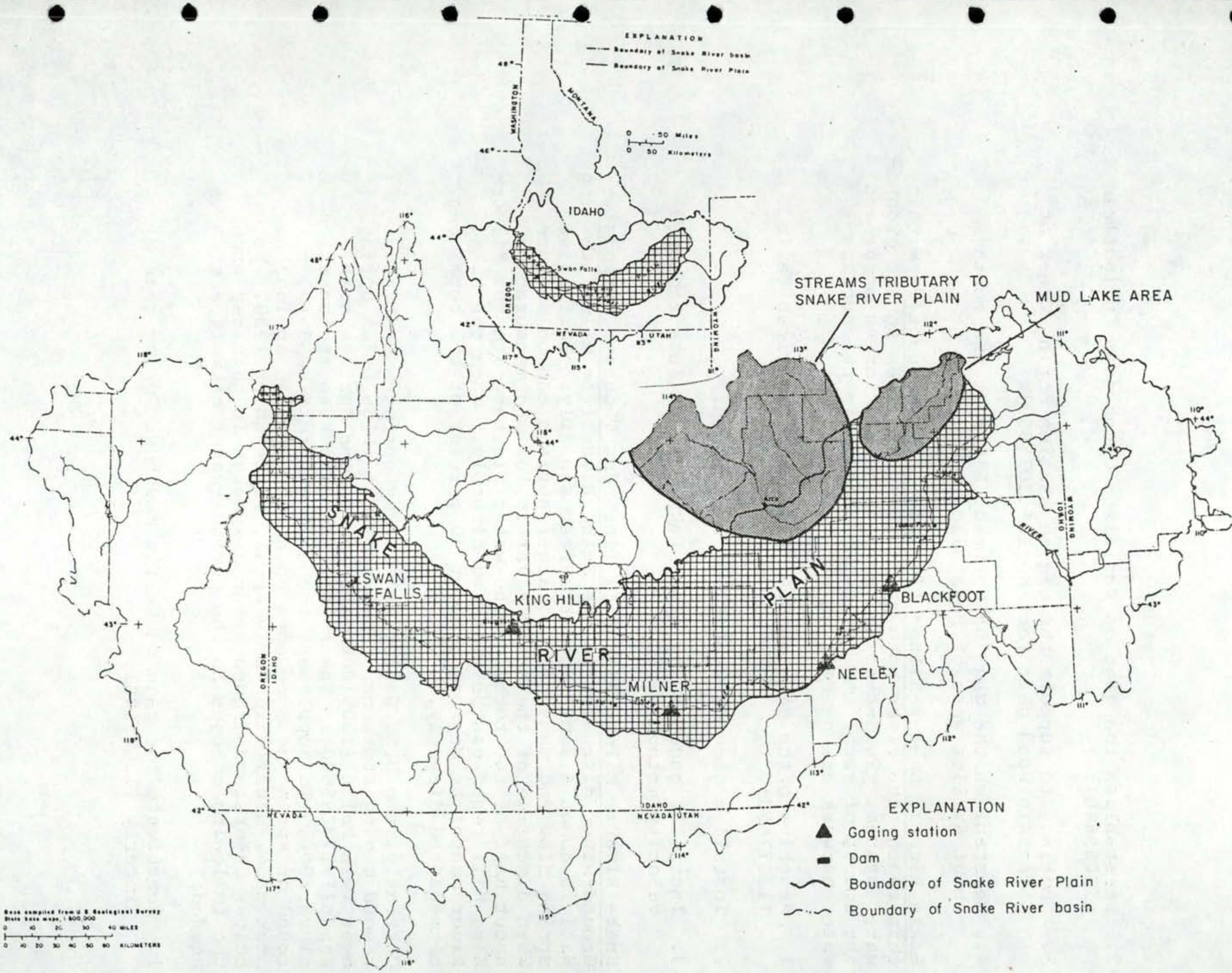


Figure 1.-- Index for proposed revisions to surface-water gaging-station network

2. Reestablish the gage on Danielson Creek near Springfield (13069540).

3. Continue to support the gaging station Spring Creek at Sheepskin Road near Fort Hall (13075983).

4. Reestablish the gage on Portneuf River at the mouth about 6 miles west of Pocatello.

Snake River: Neeley-Milner (includes Lake Walcott).--Within this reach, the river both gains from and loses to the ground-water system. To determine where gains and losses occur and the amount of each, the following changes in the surface-water network are needed:

1. Reactivate the gage on Rock Creek near American Falls (13077650).

2. Install a gage on Raft River near mouth.

3. Install a gage midway along Lake Walcott (use acoustic velocity method).

Snake River: Milner-King Hill (includes Thousand Springs).--Ground-water discharge to the Snake River from Milner to King Hill is about 4.3 million acre-feet annually. Most is as spring flow and many of the larger springs can be measured. When discharge of the Malad River is low and measurable, about half of the total ground-water discharge to the Milner-King Hill reach can be measured directly. When the Malad River cannot be measured, about 30 percent of the total can be measured directly.

Currently, the U.S. Geological Survey operates continuous-record gaging stations on two springs: Blue Lakes Spring near Twin Falls (13091000) and Box Canyon Springs near Wendell (13095500). These stations have been in operation since 1950. To supplement these long-term flow data, a round of spring measurements on all accessible springs has been made, usually in early April, since about 1950. To better understand ground-water discharge in this key area, the following changes in the surface-water network are needed:

1. Reactivate the gage on Devils Washbowl Spring near Kimberly (13089500).

2. Reestablish the gage on Malad River near Bliss (13153500).

3. Install a gage on power flume at Idaho Power Company's lower Malad plant.

4. Reestablish the gage on Clover Creek at mouth (13154200).

5. Add a round of spring measurements in November.

Snake River: King Hill-Swan Falls (includes C. J. Strike Reservoir).--Ground-water discharge to the Snake River from King Hill to Swan Falls is difficult to determine. Although probably small with respect to flow in the Snake River, preliminary indications are that the amount has increased with time. To aid in determining source, reach of river in which most ground water is discharged, and amount of discharge, the following changes in the surface-water network are needed:

1. Reestablish the gage on King Hill Creek near King Hill (13155000).

2. Reestablish the gage on Little Canyon Creek at Glenns Ferry (13155500).

3. Reestablish the gage on Cold Springs Creek near Hammett (13156000).

4. Reestablish the gage on Bennett Creek near Hammett (13157000).

5. Install a gage on the Snake River immediately below C. J. Strike Reservoir.

6. Install gages on two gravity diversions below the Bruneau River gage near Hot Springs.

Mud Lake area.--The Mud Lake area receives runoff from several streams, but the only continuous-record gage is on Camas Creek at Camas (13112000). To improve hydrologic understanding in this area where ground water and surface water are used conjunctively for irrigation, the following changes in the surface-water network are needed:

1. Reactivate the gage Camas Creek at Eighteen-Mile Shearing Corral (13108500).

2. Reactivate the gage Beaver Creek at Spencer (13113000).

3. Upgrade the nonrecording gage on Beaver Creek at Dubois (13113500) to a continuous-record gage. The gage is now operated for water management only during the irrigation season.

4. Reactivate the gage on Medicine Lodge Creek near Argora (13116500).

<u>Streams tributary to the Snake River Plain</u>.--A large part of inflow to the Snake River Plain from tributary streams is now being gaged; however, additional data are needed. To obtain data needed for future hydrologic analysis and management of the hydrologic system above Swan Falls, the following changes in the surface-water network are needed:

1. Reactivate the gage on Birch Creek near Reno (13117000).

2. Reactivate the gage on Little Lost River near Howe (13119000).

3. Reactivate the gage on Big Lost River near Arco (13132500).

Report Plans

Data collected will be included in the U.S. Geological Survey's annual Water Resources Data for Idaho publication and stored in WATSTORE.

References

Thomas, C. A., and Harenberg, W. A., 1970, A proposed streamflow-data program for Idaho: U.S. Geological Survey Open-File Report, 71 p.

Costs

Subject to the availability of funds, the U.S. Geological Survey can enter into a cooperative agreement with any legal entity in the State, such as a municipality, county, or water district, to provide up to 50 percent of the economic support for qualifying hydrologic projects or studies.

Costs are estimated for C and I, Construction and Instrumentation; O and M, Operation and Maintenance.

Estimated costs for Federal fiscal years (Oct.-Sept.) are:

Reach or Area	1984 C and I	1984 O and M (6 mos.)	1985 O and M	1986 O and M
Snake River: Blackfoot-Neeley (includes American Falls Reservoir)	$12,000	$10,000	$21,000	$22,000
Snake River: Neeley-Milner (includes Lake Walcott)	36,000	7,500	15,800	16,600
Snake River: Milner-King Hill (includes Thousand Springs)	17,000	8,500	17,900	18,800
November springs run	—	—	7,000	7,000
Snake River: King Hill-Swan Falls (includes C. J. Strike Reservoir)	27,000	15,500	32,600	34,200
Mud Lake area	10,000	10,000	21,000	22,100
Streams tributary to the Snake River Plain	5,000	7,500	15,800	16,600
TOTALS	$107,000	$59,000	$131,100	$137,300
FY TOTALS	$166,000		$131,100	$137,300

Estimated costs for State fiscal years (July-June) are:

	1984 C and I	1984 O and M (3 mos.)	1985 O and M	1986 O and M	1987 O and M (3 mos.)
TOTALS	$107,000	$29,500	$131,100	$135,700	$32,600
FY TOTALS	$136,500		$131,100	$135,700	$32,600
Federal Share	$68,250		$64,800	$67,850	$16,300
State Share	$68,250		$64,800	$67,850	$16,300

RESERVOIR MONITORING IN THE SNAKE RIVER BASIN

Work Plan

U.S. Geological Survey
Boise, Idaho
October 1983

Background and Need for Study

Records of stage and storage content have been routinely collected on large lakes and reservoirs. The information is used for water management and is needed for hydrologic studies. Although the main purpose for constructing most reservoirs is storage for irrigation and/or power generation, flood control is also important. Water-related recreation activities have become an important use of many reservoirs. Hydrologic studies, whether regional or local in scope, rely on information of changes in storage, inflow to and releases from reservoirs, and the timing of such occurrences.

Problem

Several reservoirs in or near the Snake River Plain are not gaged. Although not large, each reservoir can store more than 10,000 acre-feet of water. The amount of water stored at any time is unknown because reservoir stage is not presently gaged.

Objective

The objective of the project is to expand the available information about water stored on or near the Snake River Plain.

Approach

Either a wire weight, vertical staff, or sloping gage would be installed at four of the five reservoirs shown in figure 1. The type of gage required will depend upon conditions at each site. Greys Lake is equipped with a gage operated by the Bureau of Sport Fisheries and Wildlife. An observer

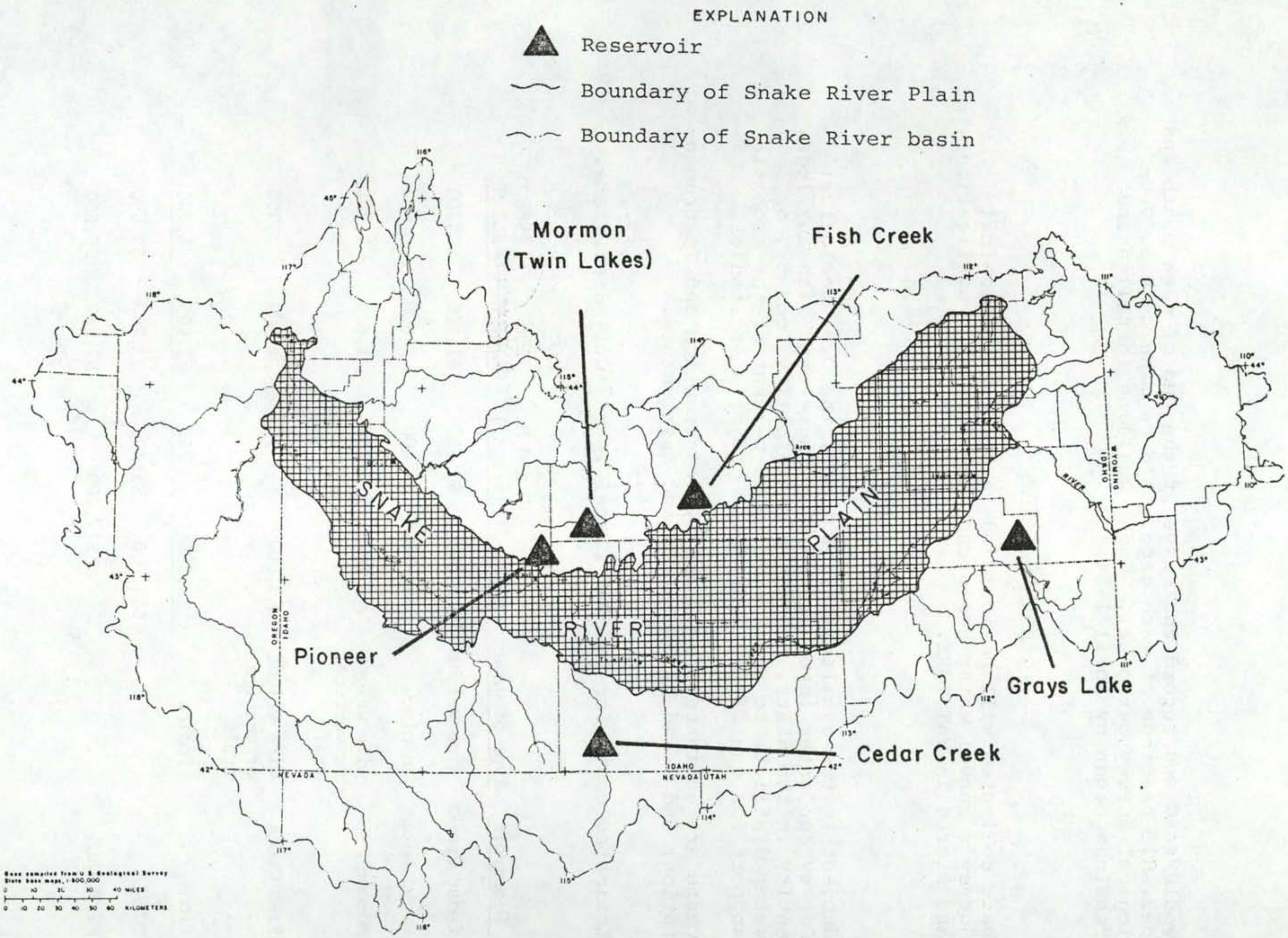


Figure 1.--Location of reservoirs to be gaged.

would read and record the stage at the end of each month and periodic readings of each gage would be made by U.S. Geological Survey personnel. Gages would be installed and readings begun by April 1984.

Report Plans

Data collected will be included in the U.S. Geological Survey's annual Water Resources Data for Idaho publication and stored in WATSTORE.

Costs

Subject to the availability of funds, the U.S. Geological Survey can enter into a cooperative agreement with any legal entity in the State, such as a municipality, county, or water district, to provide up to 50 percent of the economic support for qualifying hydrologic projects or studies.

Costs are estimated for C and I, Construction and Instrumentation; and O and M, Operation and Maintenance.

Estimated costs for Federal fiscal years (Oct.-Sept.) are:

Reservoir	Type of gage	1984 C and I	1984 O and M (6 mos.)	1985 O and M	1986 O and M
Cedar Creek	wire weight	$ 3,000	$ 750	$1,600	$1,700
Greys Lake	in place	------	400	800	850
Mormon	wire weight or vertical staff	3,000	750	1,600	1,700
Fish Creek	wire weight or vertical staff	3,000	750	1,600	1,700
Pioneer	sloping	5,000	750	1,600	1,700
TOTALS		$14,000	$3,400	$7,200	$7,650
FY TOTALS		$17,400		$7,200	$7,650

Estimated costs for State fiscal year (July-June) are:

	1984 C and I	1984 O and M (3 mos.)	1985 O and M	1986 O and M	1987 O and M (3 mos.)
TOTALS	$14,000	$1,700	$7,100	$7,550	$1,900
FY TOTALS	$15,700		$7,100	$7,550	$1,900
Federal Share	$7,850		$3,550	$3,775	$950
State Share	$7,850		$3,550	$3,775	$950

MONITORING IRRIGATION WITHDRAWALS FROM THE SNAKE RIVER BETWEEN SALMON FALLS CREEK AND SWAN FALLS DAM

Work Plan

U.S. Geological Survey
Boise, Idaho
October 1983

Problem

Demand for Snake River water for both instream and offstream uses has increased steadily since the initiation of irrigated agriculture in Idaho. In recent years, direct withdrawals for irrigation have become a concern to water managers. In the reach from Salmon Falls Creek to Swan Falls Dam, withdrawals have increased to a point where in some years, flow in the Snake River may drop below established minimums. Most water is withdrawn by large pumping plants that lift water out of the Snake River Canyon onto adjacent uplands (fig. 1).

Recent conflict among water users indicates a need for more effective management of Snake River water in this reach. The problem is that some of the basic data needed for improved management are not available. Specifically, withdrawals for irrigation are largely unmonitored and their effects can only be approximated at best.

Objective

The objective is to set up a monitoring system to measure or estimate daily withdrawals from the Snake River by irrigation pumps and gravity diversions in the reach from Salmon Falls Creek to Swan Falls Dam.

Approach

Withdrawals by river pumping plants and gravity diversions from the Snake River in 1980 were estimated by the U.S. Geological Survey during their current study of the Snake River Plain. Data from this study indicate that about 100 irrigation diversions withdraw about 450,000 acre-feet of water from the reach from Salmon Falls Creek to Swan Falls Dam. About 85 percent of the volume withdrawn will be accounted for by measuring discharge at 39 sites (fig. 2). Withdrawals at the remaining sites will be estimated.

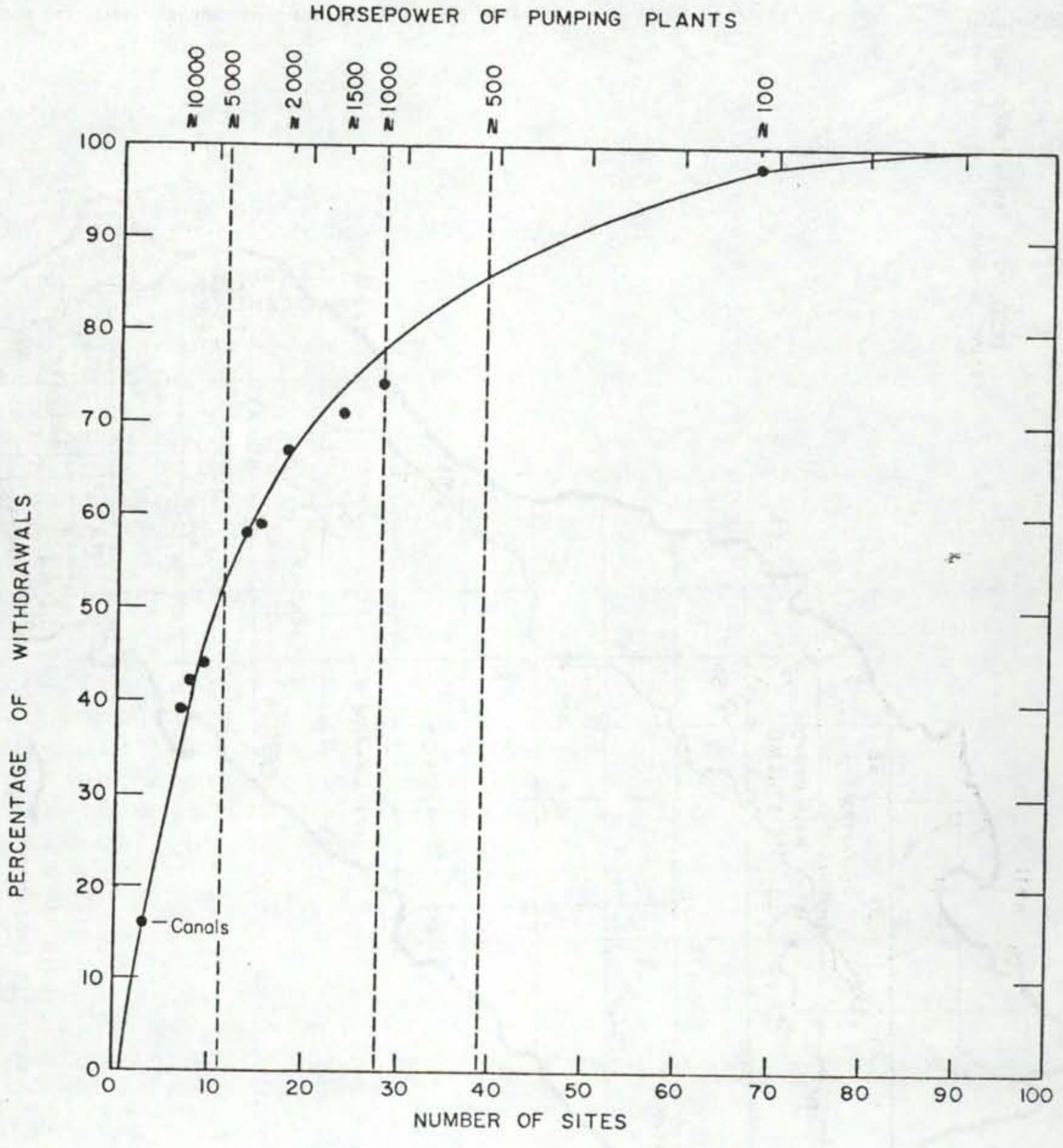


Figure 2.--Irrigation diversions on the Snake River between Salmon Falls and Swan Falls Dam.

Base from U. S. Geological Survey
State base maps, 1: 500,000

10 0 10 20 MILES
10 0 10 20 30 KILOMETERS

Figure 1.--Locations of river pumps on the Snake River between Salmon Falls Creek and Swan Falls Dam.

Choice of measurement method depends on site-specific conditions and will require a reconnaissance of all sites in the first year of the project. Sites suitable for open-channel measurement will be equipped with stage recorders in California-type or 48-inch metal shelters. Where discharge is through pipes, measurements will be made with permanent inline flowmeters. Daily withdrawal data will be stored at each site with continuous recorders.

Sites will be instrumented over a 2-year time period. About 15 sites will be instrumented by April 1984 so they can operate during the 1984 irrigation season. The remaining measurement sites will be instrumented in fiscal year 1985.

Daily withdrawals at unmeasured sites will be estimated from power consumption records. During the 1984 and 1985 irrigation seasons, each pumping plant will be visited to measure kWh/acre-ft (kilowatt hour consumption per acre-foot of water withdrawn). Monthly kilowatt-hour consumption divided by kWh/acre-ft will be used as an estimate of withdrawals at each site. Estimated monthly withdrawals can be divided into daily withdrawals using owner-supplied or estimated records of operation. In subsequent years, 25 percent of the sites will be remeasured to update the kWh/acre-ft estimates.

Report Plans

The project will result in two types of reports:

1. A journal article or similar widely distributed publication describing instrumentation and operation experiences at sites equipped with inline flowmeters. Documentation of use of these flowmeters in field situations is generally unavailable and will be beneficial to an audience considering closed-system fluid measurements. Publication target date: October 1, 1986.

2. Annual open-file data reports containing site descriptions and withdrawal data. Publication target date: June 1 of the year following each irrigation season.

In addition, data collected will be used in interpretive studies of the hydrologic system operating in the Snake River Plain.

Costs

Subject to the availability of funds, the U.S. Geological Survey can enter into a cooperative agreement with any legal entity in the State, such as a municipality, county, or water district, to provide up to 50 percent of the economic support for qualifying hydrologic projects or studies. Costs are estimated for C and I, Construction and Instrumentation; and O and M, Operation and Maintenance.

Estimated costs for Federal fiscal years (Oct.-Sept.) are:

	1984			1985			1986	
	C and I	O and M	Other	C and I	O and M	Other	O and M	Other
Data collection:	$107,000			$108,900				
Measured sites		$26,100*			$38,900**		$40,800**	
Estimated sites		8,300***			8,700***		8,400***	
Data analysis and report preparation			$47,000		$40,000	$51,900		$27,900
FY TOTALS		$188,400			$208,400		$77,100	

Estimated costs for State fiscal years (July-June) are:

	1984			1985			1986		1987	
	C and I	O and M	Other	C and I	O and M	Other	O and M	Other	O and M	Other
Data collection:	$107,000			$108,900						
Measured sites		$13,000*			$41,500**		$38,500**		$12,800**	
Estimated sites		2,800***			12,000***		8,000***		2,600***	
Data analysis and report preparation			$20,000			$60,000		$35,100		$11,700
FY TOTALS		$142,800			$222,400		$81,600		$27,100	
Federal Share		$71,400			$111,200		$40,800		$13,550	
State Share		$71,400			$111,200		$40,800		$13,550	

* 15 sites
** 39 sites
*** 60 sites

MEASUREMENT AND ANALYSIS OF IRRIGATION RETURN FLOWS TO THE SNAKE RIVER BETWEEN HEISE AND MURPHY

Work Plan

U.S. GEOLOGICAL SURVEY
Boise, Idaho
October 1983

Problem

The Snake River is the lifeline for agricultural production on the Snake River Plain and the source of low-cost electrical energy for much of southern Idaho. The competition between these two uses becomes critical during the latter part of the irrigation season and during low water years. Effective management of the Snake River is therefore essential to best serve the interests of the State. Accounting for irrigation return flow to the Snake River is a necessary part of any water-budget analysis. A systematic effort to collect and analyze return-flow data has not been made.

Objective

Measurements or estimates of irrigation return flow will be made at all currently ungaged drains and streams discharging to the Snake River between Heise and Murphy. Sources of return flow will be identified and variations in amount of flow determined. This information along with other measured and estimated data will be used in water-budget analyses of the Snake River system and for subreaches of the river between gaging stations.

Approach

In 1979 and 1980 the U.S. Bureau of Reclamation operated 19 gages on drains and streams carrying irrigation return flow to the Snake River between Heise and American Falls Reservoir. In 1980 the U.S. Geological Survey made numerous return-flow measurements from Heise to Weiser as part of their regional aquifer study. Figure 1 shows the location of currently (1983) ungaged return-flow sites. The number of return-flow sites from Heise to Murphy, their relative magnitudes of flow, and total quantity of flow are summarized below. For many of the sites, only a few instantaneous discharge measurements have been made previously.

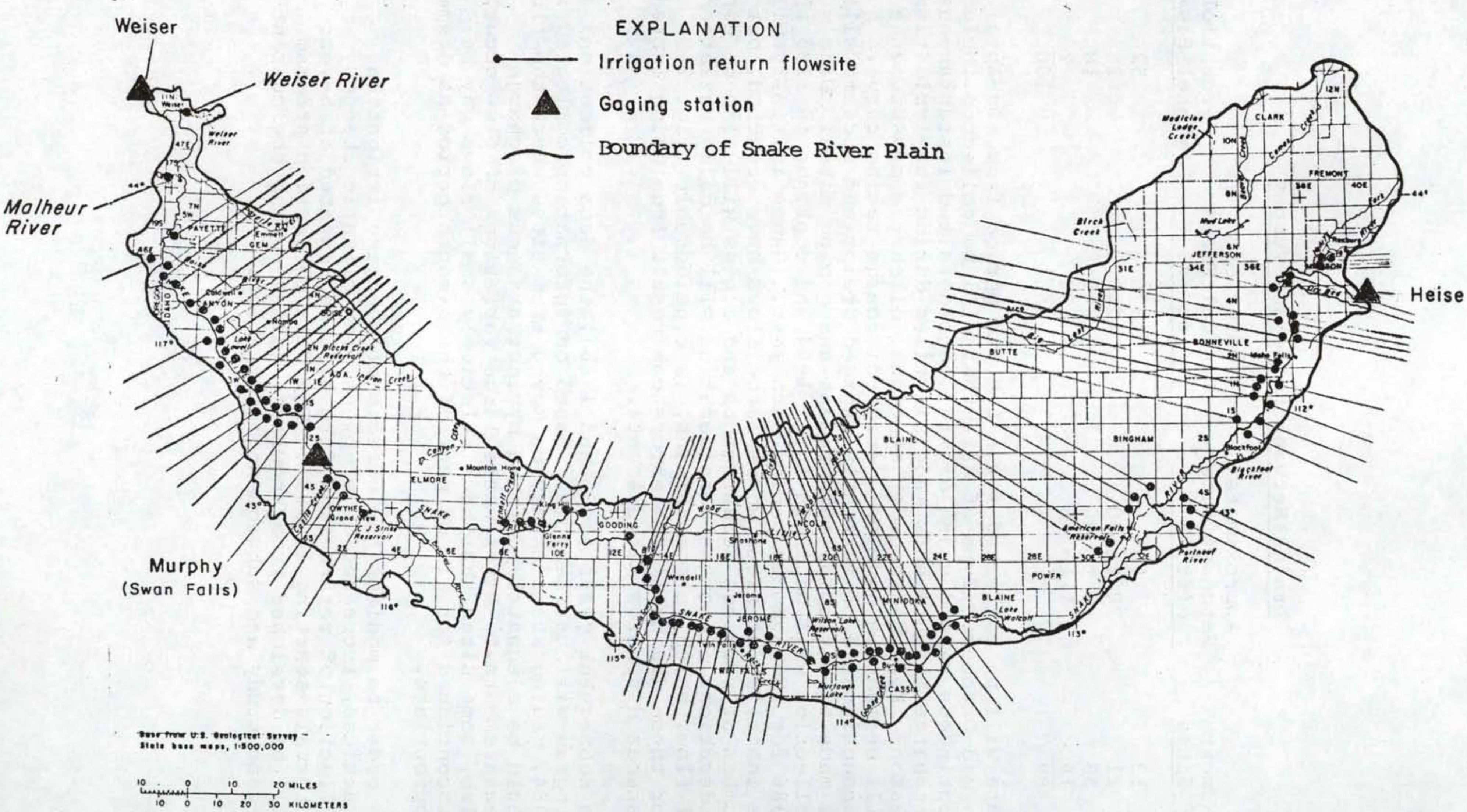


Figure 1.--Sites of currently ungaged irrigation return flow to the Snake River.

Drains Between Heise and Murphy

Number of Sites	Approximate Range of Flow (ft^3/s)	Total of Typical Flows (ft^3/s)	Percent of Total Flow
13	50+	970	52
21	20 to 50	520	28
39	5 to 20	340	18
16	1 to 5	30	2
89		1,860	100

Data will be collected for a 6-month period from mid-April to mid-October. Type of data that will be collected includes continuous record using digital recorders and instantaneous discharge measurements made six times during the irrigation season. For the recorder stations, discharge measurements will be made to develop a stage-discharge rating curve. A reconnaissance of currently ungaged drains and streams will be made to determine measurement and gaging sites. Data collection will begin in April 1984 and continue in 1985 and 1986 for the 6-month period each year. Gages initially will be installed at sites where large flows have occurred, but number of previous measurements and access will also be considerations. Another consideration will be daily variation of flow, which in some drains, is considerable (fig. 2). For these drains, large errors can result from using instantaneous discharge measurements.

In subsequent years (1985 and 1986), the data collection program will be flexible. Based on information collected in 1984, gaging stations may be moved from sites where the flow could be adequately defined by instantaneous discharge measurements to sites where large variations of flow occur. Also, some sites that have relatively small flows may be discontinued for all or part of the 6-month period as deemed appropriate.

In order to monitor the effects of changing irrigation practices, increased development, and climatic changes, collection of return-flow data will be repeated at 5-year intervals starting in 1991. The data collection program will be developed from knowledge gained during the current 3-year study and subsequent information.

Report Plans

The return-flow data collection program will be described and first year results will be presented in an Open-File Report. Measurement sites will be located on a map, hydrographs of daily mean discharge for gaged sites will be shown, and miscellaneous discharge measurements will be listed. Water budgets for select reaches of the Snake River will be determined by using Snake River and tributary gaging-station data, return flow, and diversion data collected in 1984. A first draft of the report will be completed by March 1985. Data collected in 1985, 1986, and subsequent years will be published in the annual report of the U.S. Geological Survey entitled "Water Resources Data for Idaho."

Costs

Subject to the availability of funds, the U.S. Geological Survey can enter into a cooperative agreement with any legal entity in the State, such as a municipality, county, or water district, to provide up to 50 percent of the economic support for qualifying hydrologic projects or studies. Costs are estimated for C and I, Construction and Instrumentation; and O and M, Operation and Maintenance.

Estimated costs for Federal fiscal years (Oct.-Sept.) are:

	1984			1985		1986
	C and I	O and M	Other	O and M	Other	O and M
Data collection: 13 recorder stations and 60 miscellaneous measurement sites	$13,000	$42,000		$44,100		$46,300
Planning and initial analyses			$10,000			
Final analyses and report preparation					$40,000	
FY TOTALS		$65,000		$84,100		$46,300

Estimated costs for State fiscal years (July-June) are:

	1984			1985		1986		1987
	C and I	O and M (3 mos.)	Other	O and M	Other	O and M	Other	O and M (3 mos.)
Data collection	$13,000	$21,000		$43,000		$45,200		$23,200
Planning and initial analyses			$7,000		$ 3,000			
Final analyses and report preparation					$30,000		$10,000	
FY TOTALS		$41,000		$76,000		$55,200		$23,200
Federal Share		$20,500		$38,000		$27,600		$11,600
State Share		$20,500		$38,000		$27,600		$11,600

GROUND-WATER MONITORING NETWORK ON THE SNAKE RIVER PLAIN

Work Plan

U.S. Geological Survey
Boise, Idaho
October 1983

Background and Need for the Study

The statewide ground-water monitoring network, operated by the U.S. Geological Survey in cooperation with the Idaho Department of Water Resources, began in 1946. Currently, about 160 observation wells on the Snake River Plain are included in this network. In some areas of the Snake River Plain, development of surface-water resources for irrigation has increased ground-water recharge, and the rising water table has caused waterlogging. In other areas of the plain, more efficient use of and changes in methods of applying surface water for irrigation since the mid-1970's have resulted in reduced amounts of water available for recharge to ground-water systems. Subsequent downward water-level trends have occurred. In 1980, ground-water discharge to the Snake River between Heise and King Hill was about 6,500,000 acre-feet. Lowered ground-water levels will reduce the hydraulic gradient and eventually reduce the amount of ground water discharged to the Snake River. Generalized areas where aquifers are being impacted by development are shown on the attached map.

Problem

The nearly completed Snake River Plain regional aquifer study has pointed out significant gaps in our current ground-water monitoring network. The current network was not designed to monitor changes that result from more efficient use of surface water, conversion from surface-water irrigation to ground-water irrigation, or increased use of geothermal water, and has not kept pace with new ground-water development. In the wake of the recent Swan Falls Decision, the need to review and upgrade our present ground-water monitoring network for better understanding of ground-water/surface-water relations on the Snake River Plain is even more imperative.

Objective

The objectives are to evaluate and upgrade the current ground-water monitoring network, and in 15 impacted areas, add more wells to the network to obtain a more complete data base for a better understanding of the hydrology of the Snake River Plain. The revised and expanded network will more adequately reflect ground-water changes in the Snake River Plain regional aquifer system owing to increased agricultural development and changes in irrigation practices. An expanded water-level data base will be invaluable for calibration of mathematical models and for use in future hydrologic analysis of the Snake River-Snake River Plain aquifer system.

Approach

Referring to river reaches and areas above Swan Falls Dam on the attached map, the approach would be to: (1) Examine each observation well in the Snake River Plain network above Swan Falls to insure that data needs for the particular area are being met; and (2) add new observation wells in each referenced area and change measuring frequency in current network wells to determine effect on the Snake River system owing to changes in irrigation practices and new ground-water development, including geothermal water. Some wells will be equipped with continuous recorders, others measured at frequencies suggested in the attached table. The program must be flexible to allow changing wells being measured as well as frequency of measurement in both the current and revised networks. In some nonreferenced or blank areas on the map, there are presently an adequate number of observation wells, but for several wells in those areas, increased frequency of measurement is proposed. In other nonreferenced areas, it is highly unlikely that wells suitable for monitoring are available. Although not a part of this proposal, it must be recognized that in some areas, new holes should be drilled and piezometers installed for the sole purpose of monitoring.

Report Plans

Data collected will be included in the U.S. Geological Survey's annual Water Resources Data for Idaho publication and stored in WATSTORE.

AREA	CURRENT MONITORING STATUS	SUGGESTIONS FOR ADDITIONAL MONITORING	JUSTIFICATION
Castle Creek-Little Valley	1 well, r 6 wells, s	5 wells, m	Large ground-water withdrawals, declining water levels (25 ft, 1971-80).
South Mountain Home	2 wells, m 1 well, q 1 well, s	4 wells, m	Large ground-water withdrawals, declining water levels (1-2 ft/yr).
Deadman Gulch-Sailor Creek	1 well, b 1 well, s	4 wells, m	Current observation wells declining at rate of 1.75-3.00 ft/yr. Area has new development.
Blue Gulch Critical Ground-Water Area	1 well, r 2 wells, b 3 wells, s	5 wells, m	Critical Ground-Water Area. Better areal coverage needed. Local thermal artesian aquifer not monitored. Development of thermal water for irrigation may affect both systems.
Banbury Ground-Water Management Area	None	2 wells, r 4 wells, m	Ground-water withdrawals in 1979 were 10,000 acre-ft. Declines in artesian pressures and flow are reported. Anticipated new development could increase withdrawals by 4-5 times.

AREA	CURRENT MONITORING STATUS	SUGGESTIONS FOR ADDITIONAL MONITORING	JUSTIFICATION
Twin Falls-Hollister	2 wells, b 2 wells, s	1 well, r 11 wells, m	Area bounded on east and west by Critical Ground-Water or Ground-Water Management Areas. New development of extensive(?) warm-water system.
Artesian to Kenyon Critical Ground-Water Areas	1 well, r 5 wells, b 2 wells, s 1 well, a	6 wells, m	Critical Ground-Water Areas. More areal coverage needed.
Lake Walcott-Bliss	3 wells, r 3 wells, m 2 wells, b 10 wells, s	4 wells, r 16 wells, m	Declining water levels will reduce gradient which could affect spring flows. Additional areal coverage needed.
Burley to mouth of Raft River	3 wells, m (piezometer nest) 3 wells, s	5 wells, m	Water levels currently declining. More areal coverage needed to monitor ground-water development.
Lake Walcott-American Falls	7 wells, b 3 wells, s	6 wells, m	More areal coverage needed to monitor new ground-water development.
American Falls-Idaho Falls	3 wells, m 1 well, s	10 wells, m	Several areas of ground-water development not adequately monitored. More areal coverage needed in surface-water irrigated areas to monitor changes in irrigation methods on ground-water recharge and spring inflow to American Falls Reservoir.

AREA	CURRENT MONITORING STATUS	SUGGESTIONS FOR ADDITIONAL MONITORING	JUSTIFICATION
Rexburg Bench-Teton River	1 well, m 1 well, b 1 well, a	6 wells, m	Additional wells needed to monitor effects of ground-water exchange pumpage on Teton River.
St. Anthony-Ashton	1 well, b 2 wells, s 1 well, a	4 wells, m	Additional wells needed to monitor effects of more efficient use of surface water on ground-water recharge.
Dubois-Camas	1 well, r	4 wells, m	Observation well in area declining. Additional areal coverage needed to monitor ground-water development.
Big Lost River Valley	2 wells, m	4 wells, m	Big Lost River Valley is major north-side tributary to Snake River Plain aquifer. Need additional areal coverage of new ground-water development, which could affect amount of recharge to the plain.

r - recorder
m - monthly measurement
b - bimonthly measurement
q - quarterly measurement
s - semiannual measurement
a - annual measurement

Costs

Subject to the availability of funds, the U.S. Geological Survey can enter into a cooperative agreement with any legal entity in the State, such as a municipality, county, or water district, to provide up to 50 percent of the economic support for qualifying hydrologic projects or studies.

In FY 1983, the cooperative program between the U.S. Geological Survey and the Idaho Department of Water Resources for monitoring ground-water levels on the Snake River Plain above Swan Falls was funded at $118,200. Additional funding is needed to increase measuring frequency in about 50-60 percent of the wells. Two man-months of office work are needed for analyzing individual wells to determine desired frequency. Proposed additions to the current ground-water network would include about 8 man-months of office and field inventory before the plan could be fully implemented.

Cost estimates for upgrading the current ground-water network are summarized below. Costs are estimated for annual O and M (operation and maintenance) of 101 new observation wells and include salaries, travel, and technical and administrative support.

Estimated costs for Federal fiscal years (Oct.-Sept.) are:

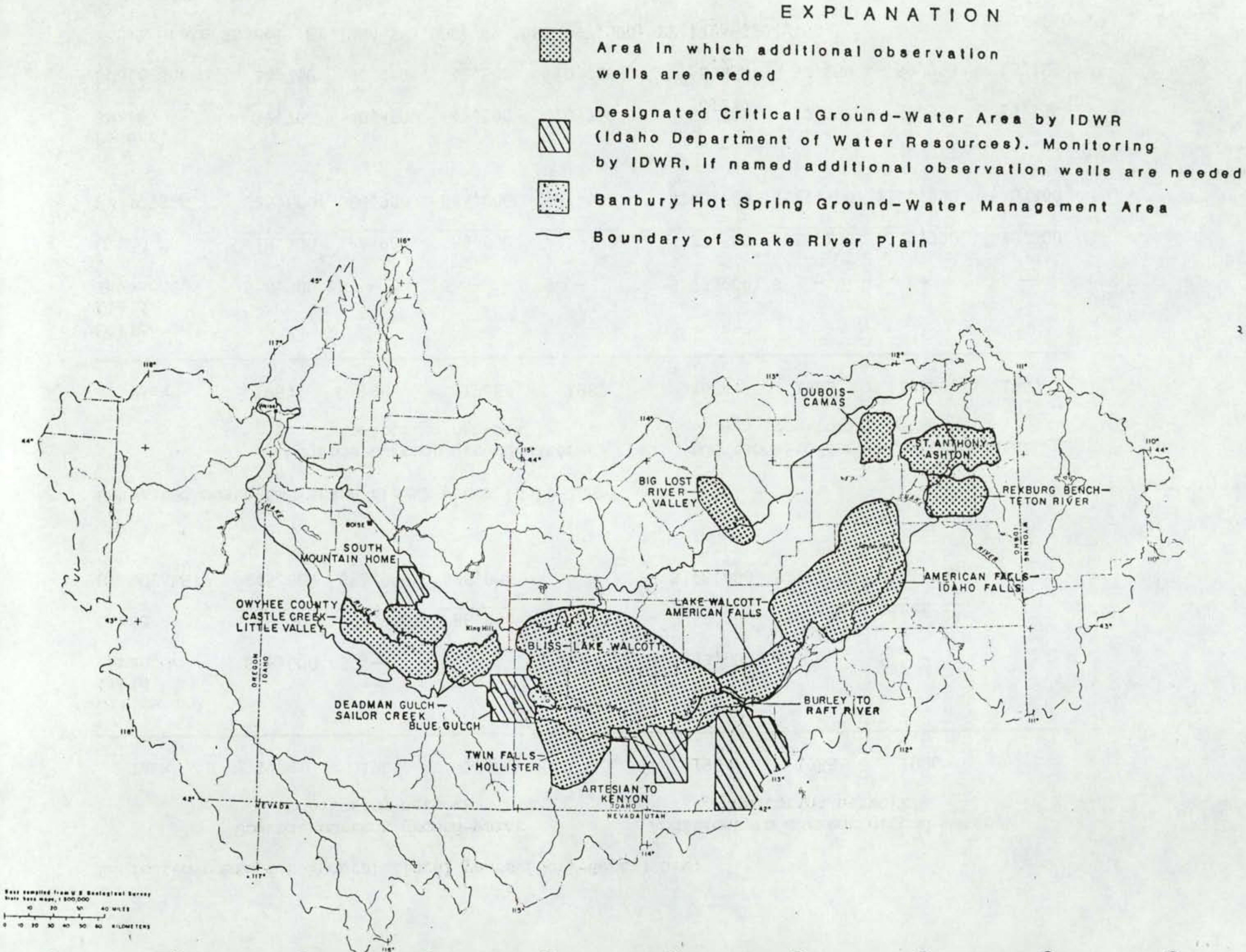
Task	Upgrade current ground-water monitoring network			Additions to current ground-water monitoring network		
	1984	1985	1986	1984	1985	1986
Office and field inventory	$ 6,000	$ -	$ -	$ 73,000	$ -	$ -
O and M	39,000*	81,900	86,000	55,000*	115,500	121,300
FY TOTALS	$45,000	$81,900	$86,000	$128,000	$115,500	$121,300

Estimated costs for State fiscal years (July-June) are:

Task	Upgrade current ground-water monitoring network				Additions to current ground-water monitoring network			
	1984	1985	1986	1987	1984	1985	1986	1987
Office and field inventory	$ 6,000	$ -	$ -	$ -	$ 73,000	$ -	$ -	$ -
O and M	19,500**	80,900	85,000	21,500	27,500**	114,100	119,900	30,300
FY TOTALS	$25,500	$80,900	$85,000	$21,500	$100,500	$114,100	$119,900	$30,300
Federal Share	12,750	40,450	42,500	10,750	50,250	57,050	59,950	15,150
State Share	12,750	40,450	42,500	10,750	50,250	57,050	59,950	15,150

Total State Share: FY 1984-$63,000; FY 1985-$97,500; FY 1986-$102,450

* 6 months
** 3 months


EXPLANATION
Area in which additional observation wells are needed
Designated Critical Ground-Water Area by IDWR (Idaho Department of Water Resources). Monitoring by IDWR, if named additional observation wells are needed
Banbury Hot Spring Ground-Water Management Area
Boundary of Snake River Plain
DUBOIS-CAMAS
ST. ANTHONY-ASHTON
REXBURG BENCH-TETON RIVER
BIG LOST RIVER VALLEY
AMERICAN FALLS-IDAHO FALLS
LAKE WALCOTT-AMERICAN FALLS
SOUTH MOUNTAIN HOME
OWYHEE COUNTY CASTLE CREEK-LITTLE VALLEY
BLISS-LAKE WALCOTT
DEADMAN GULCH-SAILOR CREEK
BLUE GULCH
TWIN FALLS-HOLLISTER
ARTESIAN TO KENYON
BURLEY TO RAFT RIVER
BOISE
King Hill
OREGON
IDAHO
NEVADA
UTAH
WYOMING
SNAKE
RIVER