Information Circular No. 1

WATER
for
IDAHO

Problems in Preparing a State Water Inventory

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May, 1969

PROBLEMS IN PREPARING A STATE WATER INVENTORY

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Like other western states, Idaho has been concerned with water resources almost from the time that it became a territory in 1863. Much of the past, present, and future prosperity in the Snake River Basin is inseparably linked with water supply.

Current nation-wide interest in regional water-resource planning and development, involving the possibility of interbasin transfer of water has resulted in the creation of the Idaho Water Resource Board by the Idaho Legislature. This is a relatively new agency charged with planning for the conservation and development of water resources in the State of Idaho. Through contracts with various agencies, the Board is now engaged in a series of studies that will be used as a basis for supporting Idaho's position in regional and interstate basin investigations, in the development of a State Water Plan, and for informational reports for any private or public use (Idaho Water Resource Board, 1968, p. 1).

Before plans for the development of water resources can be formulated intelligently, there is a need to inventory the water supply and related land resources of the State. Among the first studies contracted by the Idaho Water Resource Board was a "Soil Surveys and Land Classification" project and a "Water Inventory," the latter being the subject of this report.

The need for a knowledge of water quantities generated within Idaho and for knowledge of the present uses of water in the State resulted in the award of a contract by the Board to the Water Resources Research Institute at the University of Idaho for the preparation of a water inventory of the State. The resulting report involved the present utilization of water; future water requirements will be covered by other reports.

The preparation of a comprehensive water inventory for the entire State had never before been undertaken in Idaho. Special problems were encountered in the preparation of this inventory which may be of interest

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to those who have participated in the preparation of water inventories in other states or to those charged with preparing similar reports for states which have as yet to inventory their water supplies. While the remarks that follow refer specifically to the problems faced in preparing Idaho's water inventory, these same problems very likely have been or will be faced by other states.

The preparation of a water inventory for Idaho amounted almost entirely to a job of data gathering. Because the Water Resources Research Institute and the University of Idaho are not data-gathering organizations, as such, most of the basic information that appears in the report was acquired from numerous sources, including Federal and State agencies, as well as private utilities and individuals.

Because of the urgent need for this information, the contract provided for a 15-month study terminating September 30, 1968. In consideration of the magnitude of the task and the limited time available, the resulting report is only preliminary in nature. No attempt was made to report in depth on any of the subjects covered in the inventory. Summaries were used where possible and graphical presentations of data were used extensively. Emphasis was placed on illustrating any trends as shown by historical records, as well as on presenting current conditions.

The inventory is divided essentially into two parts; water supply and water uses. In addition there are short sections on water quality, flood potential, and water rights. The report consists of a 598-page text and an atlas containing 50 maps, each 16 inches by 21 inches in size. The text contains 181 pages of descriptive written material and 417 pages of illustrations. The main subdivisions include an introductory chapter, and chapters on climatology, surface water, groundwater, water use and water control, water rights, and recommendations. In addition, there is a large appendix consisting of five parts, the last of which is a comprehensive bibliography of water resources literature pertaining to Idaho.

The general objectives in preparing the inventory were to discuss and evaluate:

1. The climatology within the boundaries of the State.
2. The magnitude of surface water yields and flows within the State.
3. The magnitude of surface water flows entering the State and leaving the State.
4. The location and extent of groundwater.

5. The dependability of the water supply and the character of the water.

6. The present uses of water in the State.

One of the principal overall objectives was to prepare a water balance sheet for the State, that is, an account of all water entering the State, water used within the State, and water leaving the State.

Idaho is a mountainous, arid to semi-arid State, containing seven large river systems: the Bear, the Kootenai, the Clark Fork-Pend Oreille, the Coeur d'Alene-Spokane, the Snake, the Salmon, and the Clearwater, the latter two systems being branches of the Snake (Figure 1). The largest river system in the State in terms of drainage area is the Snake River. For water resources studies, the State has been divided into six major subdivisions: Bear River, Panhandle, Upper Snake River, Southwest Idaho, Salmon, and Clearwater Basins. (See Figure 2.)

In preparing the water inventory, it soon became evident that one of the biggest problems was the lack of accurate information. In some subject areas this problem was particularly acute. In the case of climatology, even the most recent isohyetal map of Idaho was deficient, especially in the mountainous central portion where there are a limited number of weather stations to use for control. In order to accurately measure total precipitation on an area, a dependable isohyetal map is required. Evaporation data for Idaho are extremely meager. At present, there are only nine stations reporting evaporation measurements and, of these, only five stations have records of more than ten years. The map of annual lake evaporation in Idaho, at best, is only a broad generalization of the true conditions. A knowledge of evaporation is particularly important in its relationship to the consumptive use of water by plants. In preparing a water balance, the amount of runoff intercepted and stored in the soil is extremely important. Except for a few measuring stations in farming areas, data on soil moisture in Idaho are practically non-existent.

In Idaho, stream flow measurements by the U. S. Geological Survey apparently were begun in the southern part of the State in 1889. Since that time, approximately 1100 stations have been established in the State and adjacent to the borders of the State, some of which subsequently were abandoned. Currently there are about 500 active stations. These stations cover fairly adequately the major streams in the State; however, there are hundreds of small perennial streams that have few if any streamflow

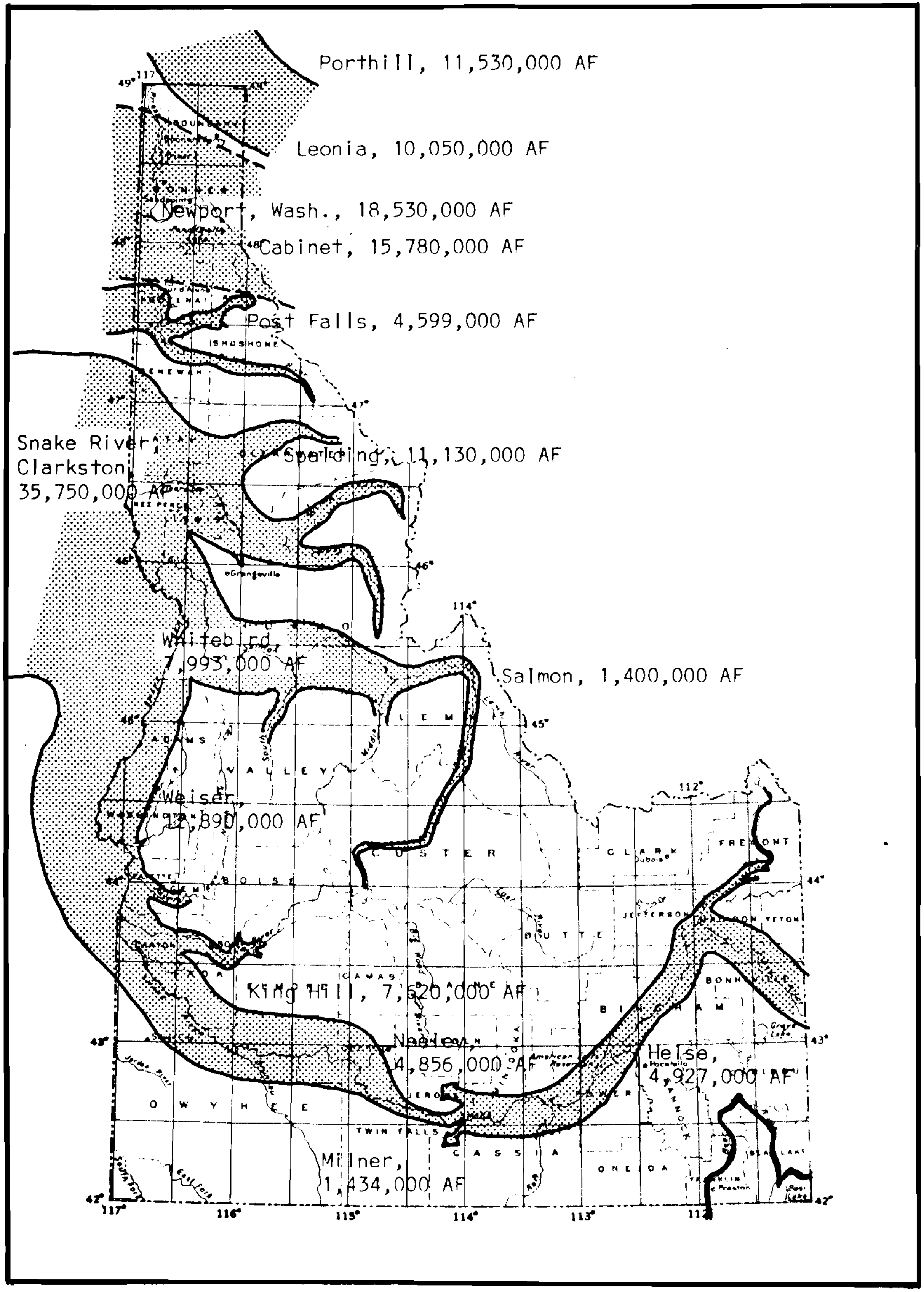


Figure 1. Mean annual runoff of principal streams in Idaho based on all records through the 1965 water year. Width of shaded portions of diagram are proportional to runoff. Data from U. S. Geological Survey.

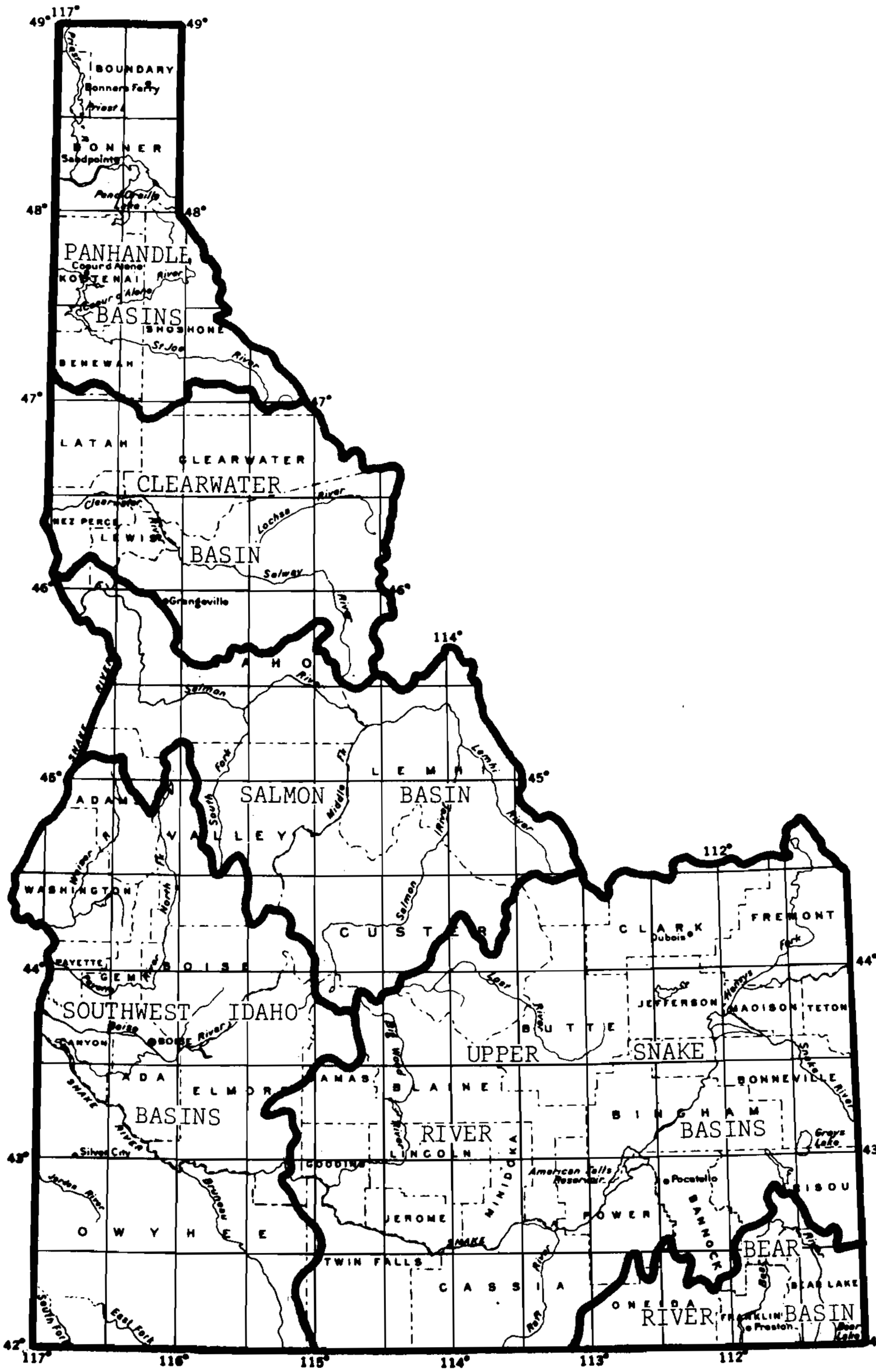


Figure 2. Major drainage basins of Idaho.

measurements. The preparation of water budgets for these small drainage basins is at present difficult if not impossible because of the lack of streamflow data.

More and more importance is being attached to the quality of both surface water and groundwater. The use or non-use of water for some purposes is influenced by the quality of the water; therefore, an attempt was made in the inventory to evaluate water quality. A large number of water quality measuring stations have been installed in Idaho in recent years. Additional stations are needed and it will be several years before the lengths of records at existing stations are adequate for obtaining averages and trends. With regard to the establishment of water quality stations, we are about at the same point that we were in the 1890's with regard to the establishment of stations for measuring water quantity.

Groundwater is one of the principal water resources of Idaho. Since World War II the development of groundwater supplies for irrigation purposes has been increasing at such a rate that serious overpumping has occurred in some areas (Figure 3). In spite of the fact that mining of groundwater is occurring at localized areas in the State, the groundwater potential has barely been tapped. A reliable estimate of the groundwater resources of Idaho for management purposes is long overdue, but many problems are encountered in attempting to prepare such an estimate. So far, there has been no attempt to accurately determine the total volume of water in storage in the numerous aquifer units in the State for several reasons. First, the aquifer thicknesses, except very locally, are unknown; second, the specific yield, which at best is a rough estimate, generally decreases with depth and for most aquifers is even more of an unknown; and lastly, there seems little possibility in the forseeable future, of drawing the water table down excessively, except perhaps locally, anywhere in Idaho.

In connection with the management of groundwater resources, the recharge, both natural and artificial, of the aquifers is important. Very little information is available in Idaho on either natural or artificial recharge. The determination of natural recharge often is very difficult because of the possibility of counting the same water two or more times. For example, it is extimated that some water cycles in and out of aquifers at least three times as it moves from the upper end of the Snake River Plain to the lower end. Data are lacking to evaluate the economic benefits of artificial recharge as well as the numerous problems associated with it. Figure 4

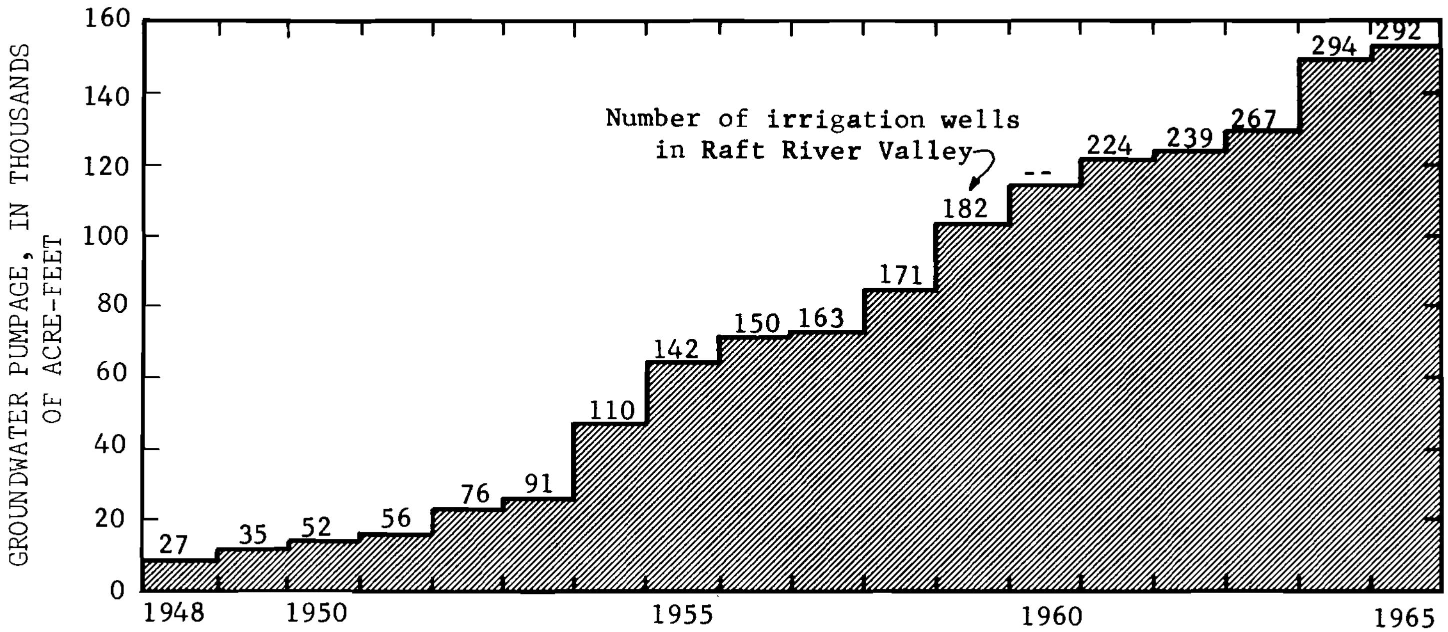


Figure 3. Groundwater pumpage and number of irrigation wells in Raft River Valley, 1948-1965 (Burnham and others, 1966, p. 46).

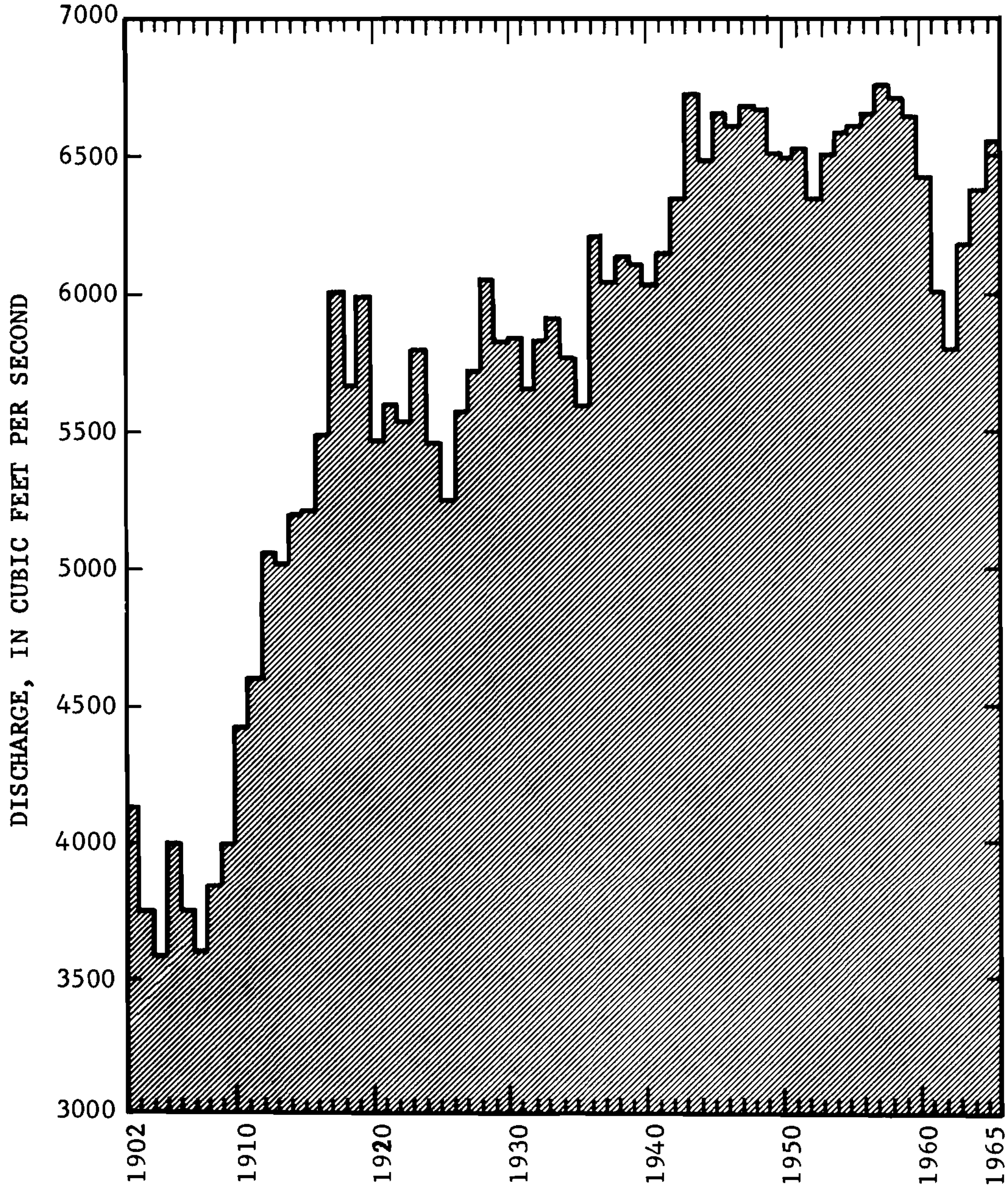


Figure 4. Estimated spring flow along Snake River from Milner to King Hill (Burnham and others, 1966, p. 27).

shows the increases in estimated spring flow along the Snake River from Milner to King Hill resulting from the growth of irrigation on the Snake River Plain since the early 1900's.

In southern Idaho, by far the principal use of water is for irrigation. The distribution of water to the users is managed by several hundred canal companies and water user organizations. Very few of these companies and organizations maintain accurate records of diversions into their canal systems; consequently, it is difficult to obtain the actual quantities of water diverted from the streams for irrigation purposes. Although the industrial uses of water in Idaho are relatively minor, reliable data on these uses are difficult to acquire and often do not exist.

Recreation, including the establishment and maintenance of fisheries and wildlife sanctuaries is becoming more and more important in its relationship to water resources. Use of our lakes and streams for recreational purposes has increased at an astronomical rate in recent years and there are more and more outcries by the public to leave certain streams in their "wild" or free-flowing state. Unlike demands that use water consumptively, the use of water for recreation and related activities tends to be largely intangible and difficult to measure. Some organizations, such as the Bureau of Outdoor Recreation, have devised criteria for evaluating recreation activities, but often, as in Idaho, the necessary basic data needed to utilize the criteria are not available. Also, information needed to compare the recreational "use" of a stream in its natural or free-flowing state with the conventional uses of the stream is not available at present.

One of the important objectives of the inventory was to obtain sufficient information to prepare a hydrologic balance sheet for the State. This was to consist of an evaluation of the various factors involved in the hydrologic cycle; that is, the amounts of evaporation from water surfaces and soil and through transpiration by plants; precipitation in the form of snow, hail, rain, etc.; surface runoff; groundwater flow; soil moisture; and water consumed in the growing of plant tissues. The hydrologic cycle is complex and even if it were possible to evaluate each of the above factors, there is much yet to be learned about the interaction of these factors. Because of the sparsity of measuring stations and the rugged terrain in Idaho, it is difficult to obtain total average amounts for the State of the prime factors, precipitation and evaporation. There is practically no basis for estimating the total water involved in soil moisture and that comsumed in the growth of plant tissue. Neither is there an adequate means of determining the flow of groundwater into and out of the State. Surface runoff is perhaps the factor for which the most reliable measurements can be obtained. Even then, where State boundaries cross water courses, only the larger streams have gauging stations and not many of these are located exactly at the borders of the State. Considering the present state of the art, and our inability to evaluate many of the factors involved in the hydrologic cycle, a hydrologic balance sheet for a state such as Idaho will at best be rather crude.

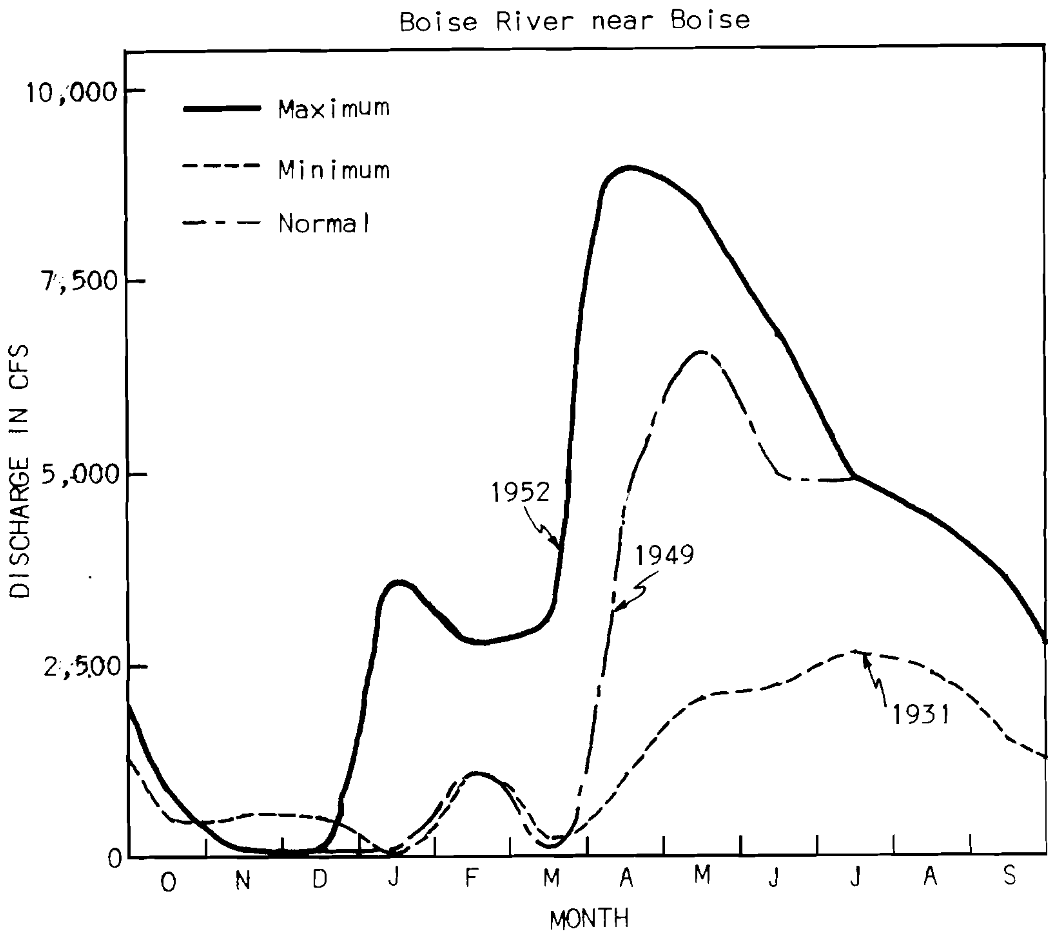
The presentation of historical records of climatological data such as precipitation and of surface runoff data for the major streams presented no special problems. In order to show the historical development of irrigation in the State and to show changes in streamflow depletions over the years, it was necessary to establish historical values for irrigated acreages above many stream-gauging stations throughout the State. This was a formidable task and required perhaps more time and effort to complete than any other part of the report. Not the least of the problems was that of a definition for the term "irrigated area". There are numerous definitions for this term, and, even if it were possible to arrive at a single, precise, definition, it is likely that in using the definition there would be as many values of irrigated acreage as people gathering the information. Information for the historical acreages was obtained from numerous sources and conflicting data were not unusual. The Census of Agriculture was an important source of many acreage figures, but these figures, as well as those from several other sources, usually were on a county basis which required adjustment of the figures to apply to the stream-gauging stations. It was fully recognized that the various sources of irrigated acreage values involved slight differences in definition of the term "irrigated area". Considering the errors inherent in collecting data on irrigated acreage, it seems unlikely that these differences are significant.

Little is known of the effect of large irrigated tracts on the pattern of precipitation in an area. At present it can only be concluded that the average pattern of precipitation has not been changed significantly by the works of man. This is not true in the case of runoff, especially in areas representing a high level of development such as southern Idaho. Here the natural flow of the Snake River and many of its tributary streams are modified greatly by storage facilities, irrigation diversions, and return flow from irrigation, and to a lesser extent by the consumptive use of water by plants. In some parts of this area, the entire surface water supply is now put to beneficial use. In large areas such as this, involving many reservoirs, numerous points of diversion, and varied uses of water, the computation of modified flows becomes fantastically complex. A knowledge of these flows is important, however, because modified flows resulting from extensive uses of water upstream may influence or prohibit the future use of a stream for other purposes downstream (Figure 5).

In irrigation, water is actually consumed by the crops or is lost to the atmosphere by transpiration. Therefore, the use of water to irrigate land and to produce crops reduces, or depletes, the amount of water available for other purposes. Usually, the total amount of water diverted is considerably greater than the net loss to the basin, which is the amount dissipated through transpiration by crops and through evaporation from the land surfaces that have been artificially wetted. Most of the remaining water returns ultimately to the streams, largely by underground percolation at a time and a rate unlike natural runoff. Thus, the use of water for irrigation diminishes streamflow and changes the regimen of the stream by altering the runoff patterns.

For purposes of preparing a water balance, it would be ideal if accurate records were available for total water diverted from the streams for irrigation, the amount of water available at the farmer's headgate, the amount of water consumed by the plants, and the amount of return flows. Because such records rarely exist, some of these quantities must be combined and others must be obtained by taking differences between known quantities.

For the Idaho water inventory, values for consumptive use at gauging stations throughout the State were derived from basic data computed for use in the Agricultural Water Needs Study being conducted by the University of Idaho for the Idaho Water Resource Board. These data are based on the Modified Blaney-Criddle Method which correlates consumptive use with temperature, length of day, crop, and stage of growth. Actually, the "consumptive irrigation requirement" was used which is determined by deducting the estimated contribution of rainfall toward the production of irrigated crops from the annual consumptive use. From the Agricultural Water Needs Study, values of consumptive irrigation requirement were available for 12 crops at 42 weather stations in Idaho. These data were accompanied by a map of Idaho showing areas under the influence of each



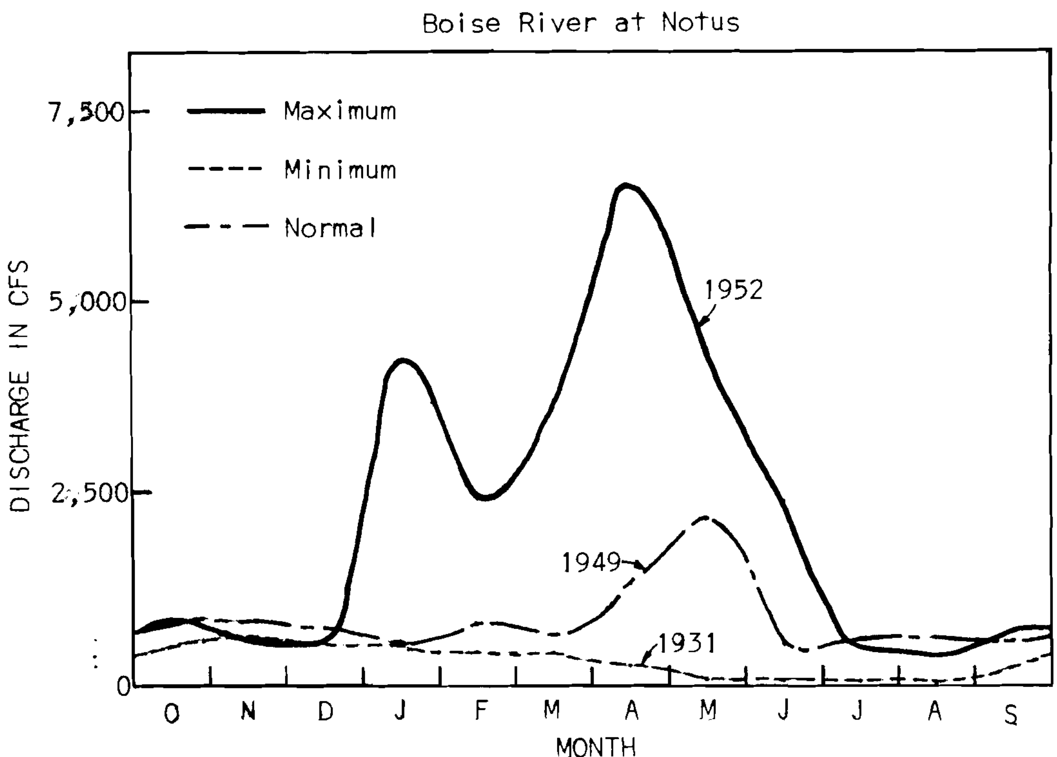


Figure 5. Monthly maximum, minimum, and average discharge modified to reflect 1970 level of development for period 1928-1957 for Boise River near Boise and at Notus. Data from Columbia-North Pacific Region Comprehensive Framework Study, Hydrology Work Group (1967).

station. Present irrigated acreage figures for each county in the State were based on information from the Soil Conservation Service. A percentage breakdown of crops grown in each county was available from the Census of Agriculture.

Based on the map showing estimated areas of influence covered by each of the 42 weather stations, certain of these stations were chosen as being representative of each of the 44 counties in the State relative to consumptive irrigation requirements. In general, where a county was represented by more than one weather station, the consumptive irrigation requirements for each crop were averaged.

The acreage of each crop in each county was obtained by multiplying the total irrigated acreage in the county by the percentage of the total acreage for each crop. Then the weighted consumptive irrigation requirement for each county was obtained by adding the products of these acreages and the consumptive irrigation requirements for the respective crops and dividing the sum by the total irrigated acreage in the county. Finally, the weighted consumptive irrigation requirements for watersheds above the various gauging stations were computed by first estimating the irrigated acreage in each county involved in each watershed. The consumptive irrigation requirement was then determined by adding the products of weighted consumptive irrigation requirements for each county and the irrigated acreage involved in the respective counties and dividing the sum by the total irrigated acreage in the watershed.

The annual depletion of the water supply for a watershed is simply the product of the consumptive irrigation requirement for the watershed and the total irrigated acreage in the watershed (Figure 6). The procedure outlined above is rather roundabout, but it is one method of solving the problem of obtaining depletions on a watershed basis from information on a weather station and county basis.

While there were numerous problems in preparing the Water Inventory of Idaho, some of which I have discussed above, one problem we did not have was that of obtaining available data. Requests were made to many organizations for information and in almost all cases this information was given freely and promptly. Only with cooperation like this were we able to complete the inventory in the limited time available.

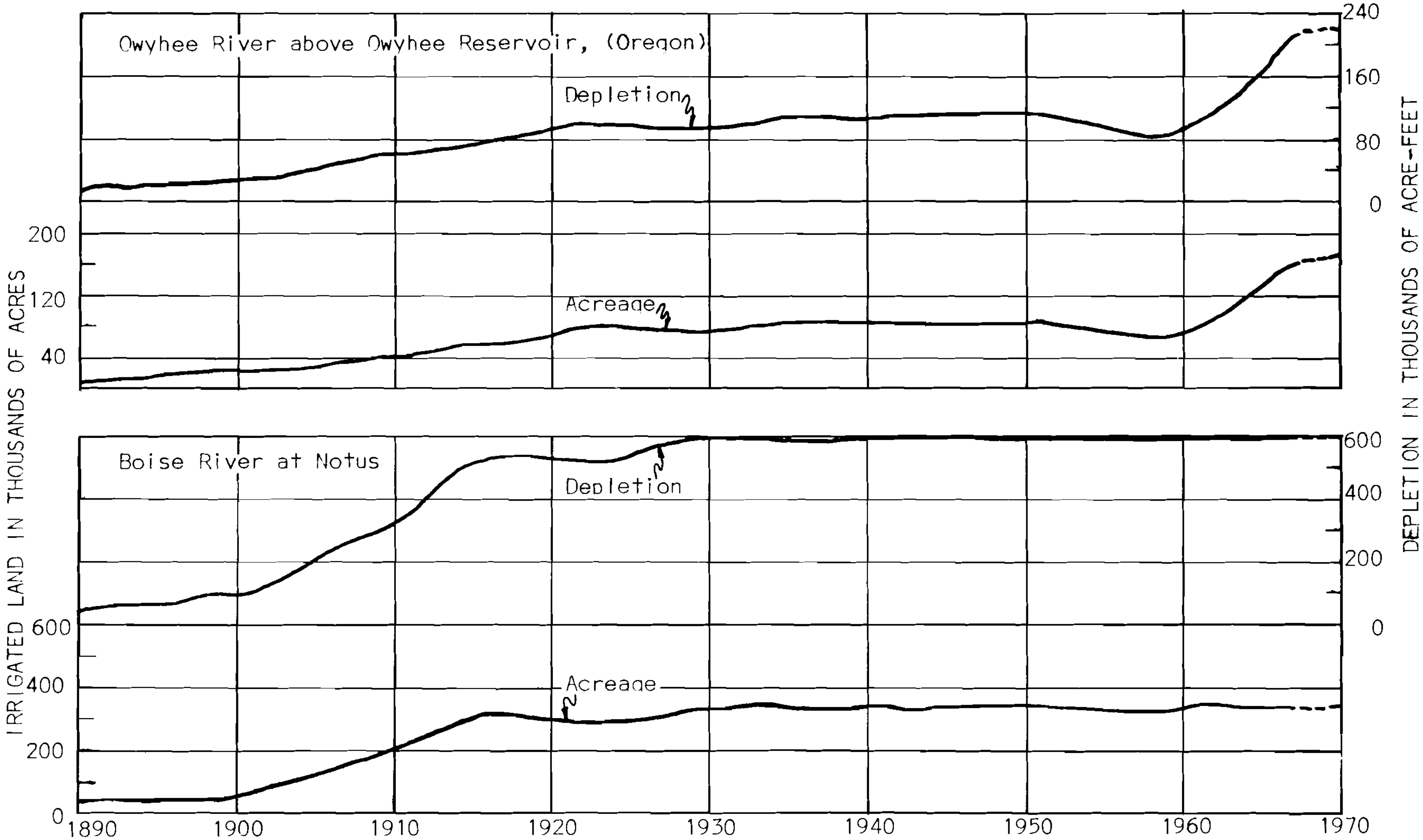


Figure 6. Irrigated acreage and estimated annual depletion for Owyhee River above Owyhee Reservoir, (Oreg.) and Boise River Basin.

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