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LEMHI RIVER BASIN

Geology and Hydrology
Irrigation Efficiency

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The bound copy we had we sent to Nathan Higer per Foster request of 4-22-76

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January 29, 1976

Mr. Jim Herndon
Lemhi Water Users
P.O. Box 789
Salmon, Idaho 83467

Dear Mr. Herndon:

This firm in conjunction with Wiser Irrigation Service of Burley, Idaho, began an intensive investigation of irrigation practices and hydrology in the Lemhi Valley about March 1975. The attached report is the result of that study.

Several questions were raised upon review of the proposed findings of water rights in the Lemhi River Basin submitted to the 7th Judicial District by the Idaho Department of Water Resources. Item four under "Findings of Fact" states that the irrigation water requirement at the field head gate is found to be 3.0 acre feet per acre per calendar year. That subject will be addressed in another portion of this report. Additionally, under item five, "The Normal Irrigation Season", was found to be from April 1st to November 1st of each year. If flood water applications were to be accepted as beneficial uses and subsequently water rights, this irrigation season is far too short and should be extended, especially during the spring months.

Item fourteen admits by inference that the application of "high or flood waters" during the months of May and June is a beneficial use and also admits to the fact that the practice has been common on a historical basis. The Conclusions of Law, item six, refers specifically to the practice of diverting flood waters but limits that practice under two conditions: (a) The waters to be diverted are applied to a beneficial use, and (b) The existing quantified rights--including future appropriations of water--are first satisfied. To me, this is merely lip service to the prior statements of the Department that this diversion of high water or flood water will be recognized as a historical practice and that water rights will be granted for such practices. Item six, subsection A limits such diversion to beneficial uses. Unfortunately, this type of diversion is unique and has never been specifically accounted as being a beneficial use. Subsection B, to me, totally eliminated the establishment of a vested water right because of the phrase, "including future appropriations of water". This is to say that any subsequent private, state or federal appropriation of water for any purpose, including minimum stream flow, recreation or inter-basin transfer would take precedent over the diversion of flood waters.

The items enumerated above are those questions that I feel are pertinent to the problem and that have a significant bearing on the future of water use in the Lemhi Basin. The report following will address the geologic make-up of the valley, the hydrologic setting and what happens to water either when it is applied to benches or to crop land adjacent to the Lemhi River. Information included within the report will show that even though water may be applied to crops in excess of the consumptive irrigation requirement there is no actual diminishment of water since the excess percolates downward, enters the ground water system and moves into the Lemhi River at a later date, augmenting low summer time flows. I think the only logical decision the court can make is to allow whatever figure we feel is adequate for irrigation of crops and that the application of high water or flood water to benches and spot land in the early part of the year would be recognized as a beneficial use. It is essentially the same as artificial recharge to the ground water system.

I will look forward to hearing from you with regard to the next actions we need to take prior to the hearing.

Very truly yours,

Sherl Chapman

Sherl L. Chapman
Consultant

SLC/lh

Attachments

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LEMHI RIVER BASIN

Introduction

The Lemhi River Basin, located in north-east central Idaho, is formed by the confluence of 18-mile Creek and Texas Creek near the town of Leadore. The river flows northwestward at a meandering channel which lies in a flood plain ranging from 1 to 1 1/2 miles in width. It is bounded for most of its length by flat, low-lying terraces ranging from 50 to over 200 feet in height above the valley floor. Numerous alluvial fans formed by tributary streams intrude into the valley at several locations. The upper valley, which ranges in width from 4 to 8 miles, is floored by coarse alluvial and glacial outwash material. The primary use of water in the basin is for irrigation of agricultural lands. There exists approximately 50 to 55 thousand acres of land in the valley which is irrigated at the present time. Domestic and stock usage ranks second in the magnitude of water diverted.

The purposes for this investigation and report are:

(1) to determine the geologic make-up of the river basin

(2) to determine the hydrologic setting of the valley

(3) to determine the relationship between the surface water and ground water systems in the Lemhi River Basin.

Vegetation

The Lemhi Valley is scantily covered with sagebrush, a few cacti and various weeds and grasses. This vegetative cover does not reflect so much the condition of aridity as the inability of the soil to retain water in sufficient amounts to support more abundant vegetation. In places the valley has a decidedly "desert" appearance. Along the better watered valley bottom and watercourses, brush and trees grow in profusion.

The mountain slopes are covered to a greater extent with sagebrush and grasses and evergreen trees appear on shielded north slopes. Areas underlain by the older rocks support trees while the younger better drained volcanics support little vegetation.

Geology

The Lemhi River Basin is bounded on the northeast by the Bitteroot Range and on the southwest on the Lemhi Range, both of which approach altitudes of nearly 11,000 feet above sea level. An elongate ridge of sediments protrude into the valley at its head near Leadore which has the name Middle Ridge. The Ridge separates the two creeks that form the main stem of the Lemhi River. Middle Ridge and the mountain ranges bordering the valley all have a northwest-southeast trend which is parallel with the regional trend in north central Idaho. The upper end of the valley lies at about 7200 feet above sea level of the river and slopes northward to about 3900 feet above sea level at the mouth of the river.

The rocks in both mountain ranges consist chiefly of dolomite, quartzite, limestone and phyllite of Precambrian and Paeleozoic age. Although joints and fractures penetrate, the rocks they are generally of low permeability and have historically provided low to very low yields to wells penetrating them. Tuffaceous sedimentary deposits of Tertiary age overlie some of the older rocks at some places in the mountains and underlie all of the Lemhi Valley. These deposits are exposed on both sides of the Lemhi River in a narrow intermittent band parallel to the river nearly all of the way to the town of Salmon on the north. Detailed geologic mapping, (Anderson 1957), geologic cross sections, (Anderson 1961), and an investigation conducted by E. G. Crosthwaite of the U.S. Geological Survey (open file report, 1965) demonstrate beyond a reasonable doubt that these Tertiary sediments underlie nearly all of the Lemhi River Basin at a shallow depth. Typically, these sediments consist of shales with sandy lenses, silty shales and some conglomerates, all containing bentonitic clays. Such rocks are typically quite impermeable and yield very little water to wells or allow only minor amounts of ground water to flow through them.

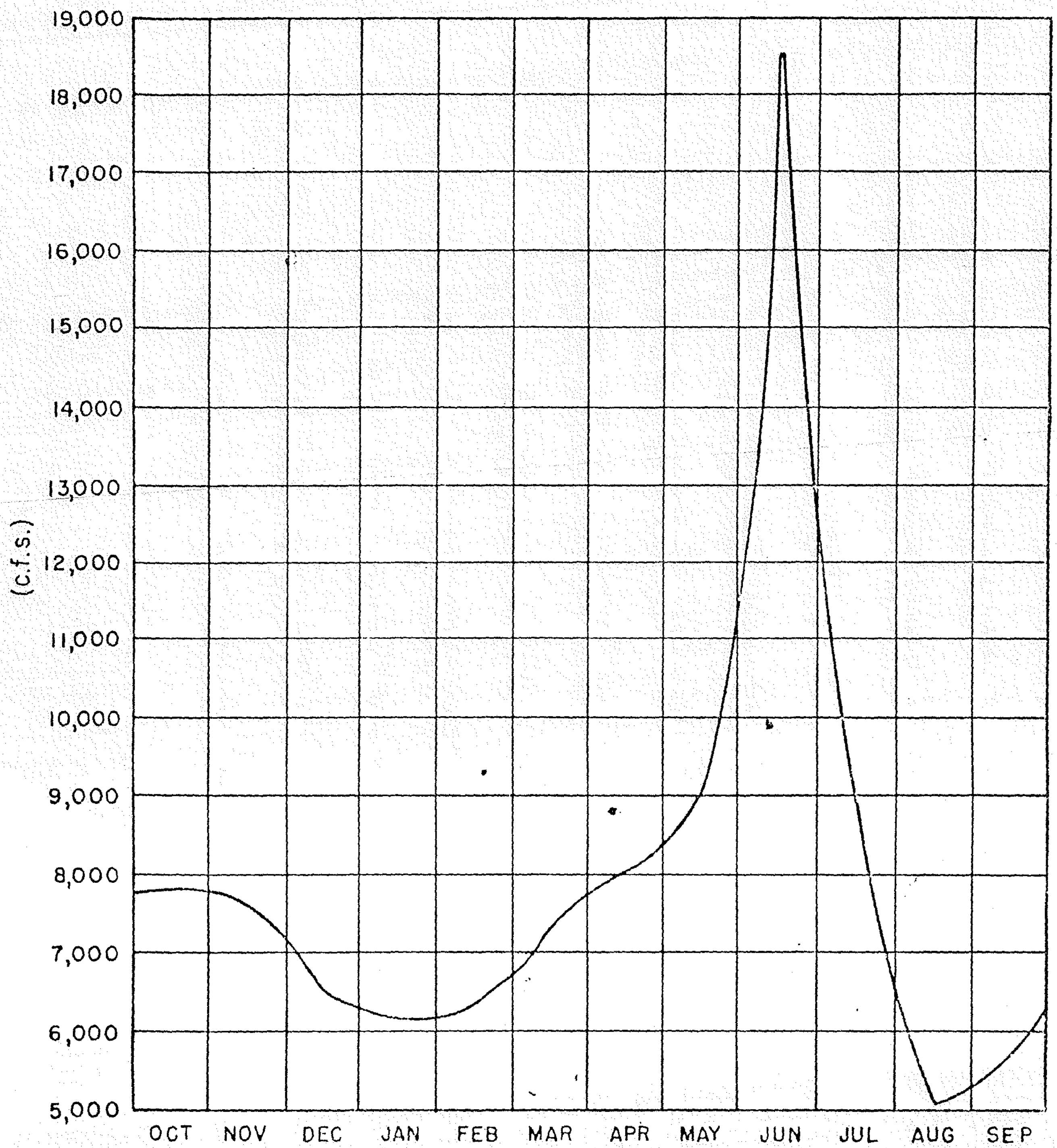
The valley floor is composed of coarse to fine sand and gravels and overlie the Tertiary sediments discussed previously. These deposits are believed to be relatively thin although no data has been discovered to give a definitive thickness at any particular location in the valley. The terraces adjacent to the valley floor are composed of coarse gravels, sand and silt. These deposits were emplaced when the Lemhi River was at a higher elevation than at present and are essentially remnants of the old flood plain or reworked alluvial deposits from tributary streams. The rock material present is that in the mountains that has been eroded and deposited through the various tributary streams. The generally coarse nature of these deposits provides great permeability and they yield water freely to properly constructed wells. The maximum thickness of these deposits is not been quantified but at no location in the valley were they observed as being more than 200 or 300 feet thick.

Hydrology

Surface Water

The Lemhi River is the primary drainage from the Basin with Hayden Creek next in size. The U.S. Geological Survey has gaged the Lemhi River for a number of years both near the town of Salmon and near Lemhi. These gages allow interpretation of the flow characteristics of the Lemhi River and also an assessment of the total quantity of outflow from the Basin for any given period. That data is available and on file in several publications from the U.S. Geological Survey. Based on the period of record at both gaging stations the highest flow occurs during the first part of June primarily because of snow melt of the bordering mountains. Voluminous discharge continues from mid June to July but generally does not extend more than a few weeks. However, high flows, those above 9000 cubic feet per second may last from 10 to 12 weeks. Low flow in the river, those less than 5000 cubic feet per second usually occurs during the month of August and the first part of September. These peak flows and their duration patterns are shown on figure 1.

Figures 2 and 3 show the percentage of time a given discharge is equalled or exceeded for Lemhi and Salmon respectively. Using a reference discharge of 300 c.f.s., figure 3 shows that the discharge will be equalled or exceeded 19% of the year. These figures are based on the mean monthly flow for the period of record shown. By comparing the percentage of time to a given flow, the amount in the river to satisfy existing water rights and new appropriations can be estimated. It is obvious from both figure 2 and figure 3 that even with existing irrigation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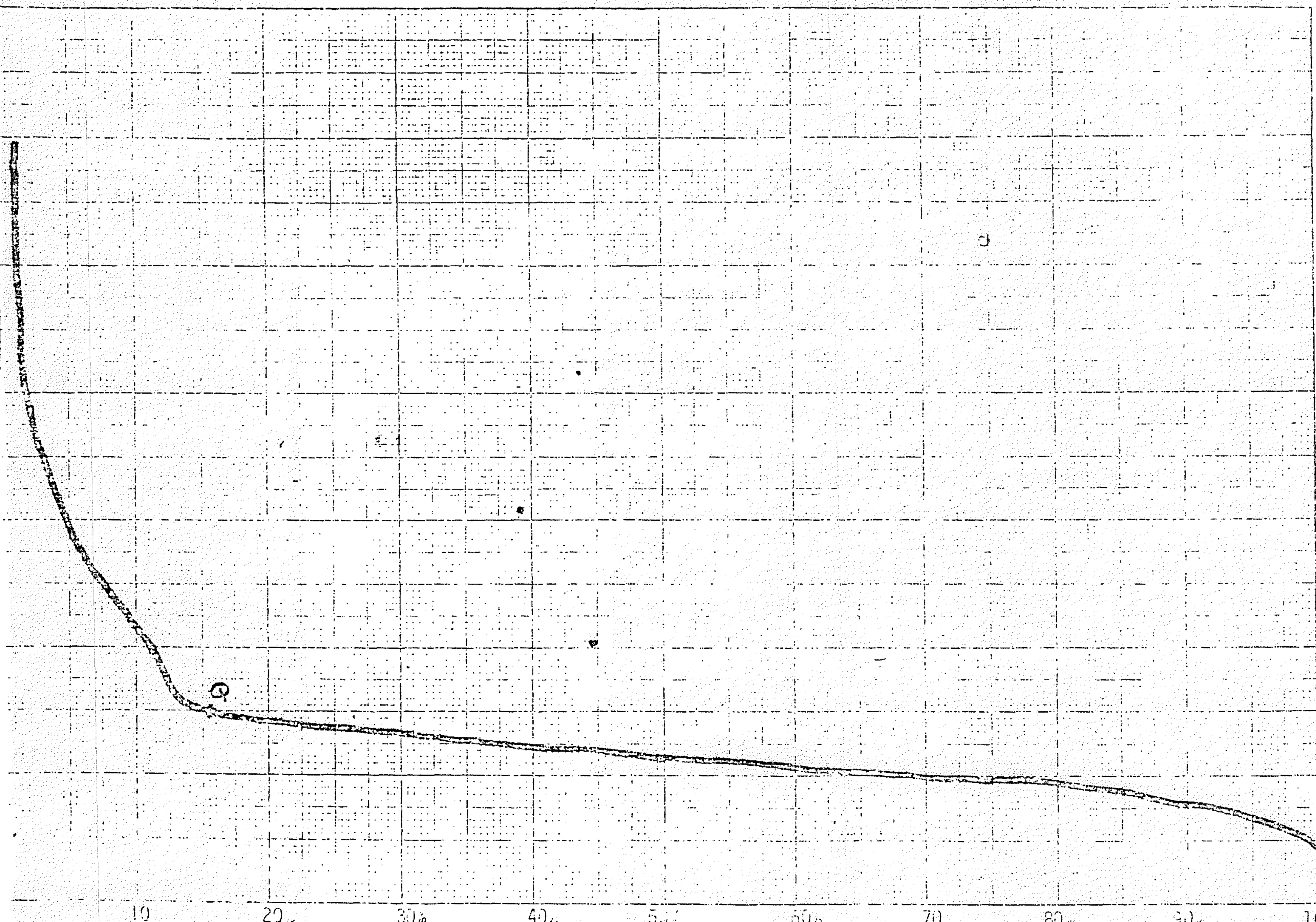

Figure 2 - Flow duration curve Lemhi River at Lemhi 1956-1953

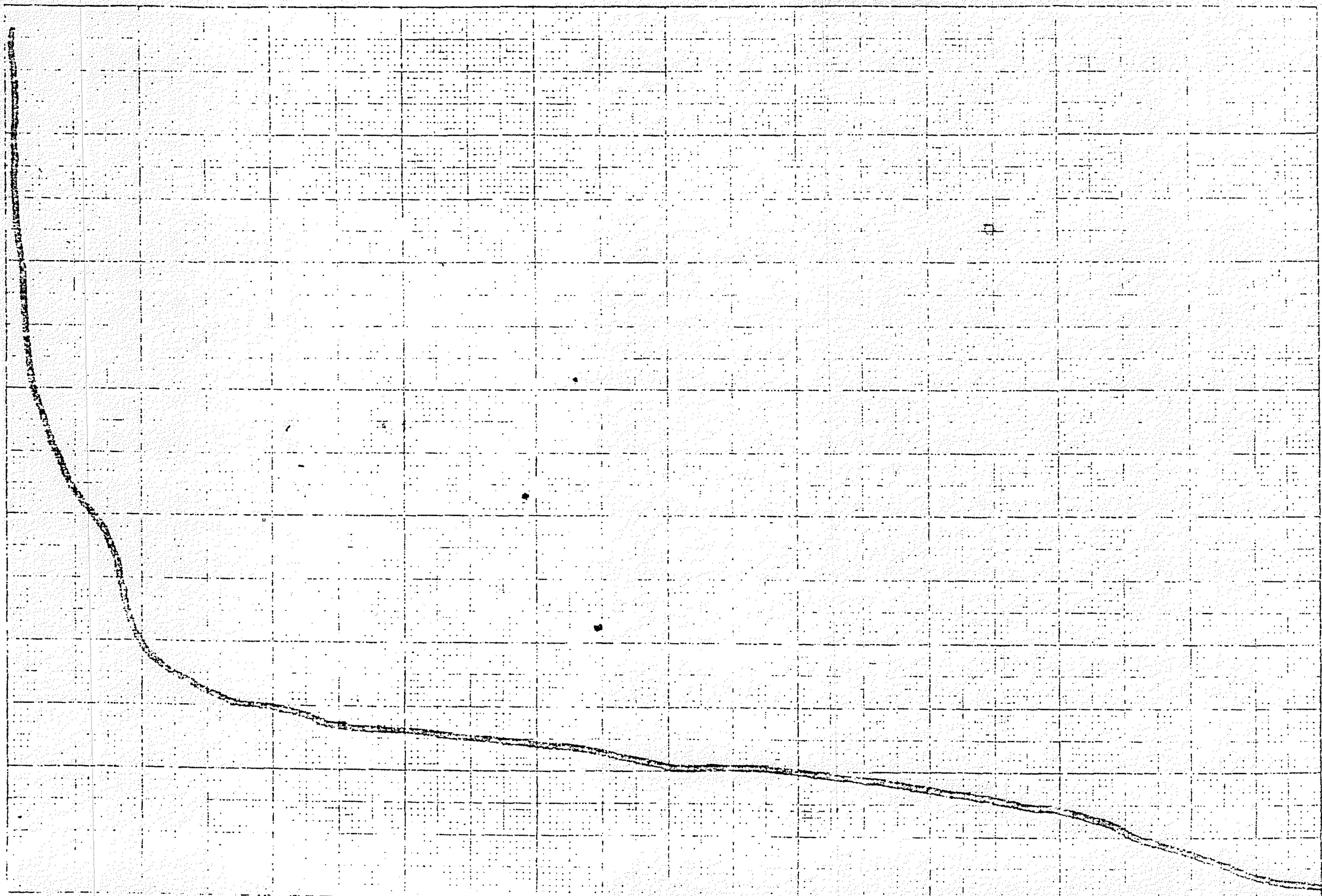

Figure 3 - Flow duration curve Lemhi River at Salmon 1929-1943

diversions using historical practices the river has not gone dry either at Lemhi in the period 1956-63 or at Salmon during the period 1929-43. In fact, the discharge at Salmon during the period 1929-43 did not fall below 120 cubic feet per second over 85% of the time. This further demonstrates the actuality of return flow both from a ground water system and from overland runoff from irrigated fields since existing water rights on the River Basin far exceed the natural flow of the river during low flow periods.

Tributary inflow during the peak runoff period is relatively minor. Most sink into the coarse alluvium on the valley floor and reach the river only as underflow and others are diverted by residents of the valley onto the River terraces adjacent to the valley floor. Hayden Creek is the only major tributary that contributes significantly to the flow of the Lemhi River on a year round basis. During peak runoff it may contribute as much as 50% of the total flow of the river and as much as 20% during the rest of the year.

Ground Water

Data from 44 wells in the Lemhi River Basin were utilized for this report. Well head and water surface elevations are utilized in order to determine the general ground water flow pattern and direction. Forty-three of the wells are located on or near the valley floor and are developed in alluvial materials. Depth of the wells range from 14 feet to 180 feet and the depth-to-water from 4 to 57 feet. One well, drilled into the Paleozoic rocks along the mountain front is approximately 900 feet deep. Depth to water is 56 feet below land surface and the yield is very low. There appears to be no significant correlation between the depth of the well and the depth of water. All of the wells except the very deep one are utilized for domestic or stock watering purposes, therefore no yield data were available for this report.

Ground water flow in the Lemhi River Basin is generally from the bounding mountains toward the center of the valley and then northward sub-parallel to the Lemhi River. A large percentage of the ground water enters the river as sub-surface flow and spring discharge. The rest of the ground water that is not captured by wells moves out of the valley at the mouth and into the Salmon River Basin, presumably to enter the Salmon River as sub-surface flow.

Ground water levels in the Lemhi River Basin are generally highest in August and September. Typically, ground water levels in most basins are highest in February and March and decline through the summer months. The reason that the reverse situation exists in the Lemhi River Basin is that irrigation water applied to lands in the upper valley reach the ground water systems in these months causing the level to rise. Ground water levels slowly decline after this period to their spring level with fluctuations from spring to fall commonly in the range of 4 to 10 feet. This reaction to recharge from the application of irrigation water is significant in that it demonstrates the sensitivity of the aquifer, its limit as to water holding capacity and demonstrates the contention that over application or irrigation water does not deprive downstream water users of their right to divert, but merely increases the lag time between runoff and the usability of water at any particular downstream point.

Ground Water-Surface Water Relationship

The ground water and surface water systems in the Lemhi River Basin can not be treated as two separate entities because they are directly connected. This can be most easily demonstrated by observing the effect of diversion of peak flows of tributaries onto the river terraces during the spring months. The flow of

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Ground Water-Surface Water Relationship

The ground water and surface water systems in the Lemhi River Basin can not be treated as two separate entities because they are directly connected. This can be most easily demonstrated by observing the effect of diversion of peak flows of tributaries onto the river terraces during the spring months. The flow of these tributaries sink into the coarse terrace gravels and move downward through the terrace gravels and valley floor alluvium to enter the Lemhi River as underflow or as spring discharge during the summer months. This and the application of irrigation water in excess of the consumptive irrigation requirements is believed to be the primary reason for the rise in ground water levels in August and September. The Lemhi River gains water from the ground water system throughout most of its length. Measurements taken for the Department of Water Administration during an investigation in 1972 demonstrate that the only reach that loses water to the ground water system is between Hayden Creek and Baker during the late summer and fall months. During the rest of the year, it either gains slightly or remains in equilibrium. Additionally, E.G. Crosthwaite in his open file report on the water resources of the upper Lemhi Valley states on page 9 that "practically all the water which percolates into the ground moves toward the river and reappears in numerous seeps and springs in the flood plain of the Lemhi River". It becomes very apparent that the water entering the alluvial fans and terraces adjacent to the valley floor and the water entering through application of irrigation water recharges the ground water system and the two are inseparably related.

Irrigation Efficiency

Introduction

Mr. Sherl Chapman and the Lemhi Irrigation District approached Wiser Irrigation, Burley, Idaho, with a request to investigate the following statement from the PROPOSED FINDING OF WATER RIGHTS IN THE LEMHI RIVER BASIN, "Findings of Fact", Item 4, Page 4.

The irrigation water requirement at the field headgate is found to be 3.0 acre feet per acre per calendar year regardless of the source or sources of supply, The loss in acre-feet from the point of diversion at the source to the field headgate varies dependent on length, slope and capacity of ditch together with the type of soil through which it passes.

Consumptive use or evapotranspiration of water from the land and crops is a total of 1.8 AF/acre to be applied from some water source. The balance of 1.55 AF/acre (3.0 acre feet per acre minus 1.45 acre feet per acre) reflects application losses that under present physical and economical conditions may be liberal, but are not unreasonable for the present methods of water application in the Lemhi River Basin.

To accomplish the task assigned a meeting was held with the Lemhi Irrigation District Board of Directors and three sites were selected at different locations within the valley where adequate measuring stations could be established to determine the amount of water diverted onto the three acreages. Measuring stations were also established at several locations so that any surface runoff from the three acreages could be measured.

The three sites selected are outlined on the attached maps with the measuring sites also indicated. The sites are typical of the entire valley with bottom land and bench land represented. The irrigation practices on the sites are typical as are the diversions on the distribution systems.

Comments will first be presented on the paragraph from the adjudication report above and then the findings that will verify or disclaim the statement.

Irrigation Water Requirement

The irrigation water requirement is that amount of water required to be diverted from a source, either ground water or surface water, which is distributed upon the land in such a manner that the crops receive the required amount of water for their development and growth.

The irrigation water requirement consists of two major components. The first is known as crop consumptive use, (C.U.). This is the amount of water that is taken from the soil and used by the plant to sustain life. The crop consumptive use is affected by temperature, climate, type of plant, amount of water readily available, type of soil, solar radiation, etc. Because of the many variables involved, exact measurement of C.U. is extremely difficult. Several empirical or experimental methods have been developed by scientists. This report uses the consumptive use requirements shown in Bulletin 516, Consumptive Irrigation Requirements for Crops in Idaho. The 1.8 acre foot/acre figure for C.U. in the Lemhi Valley is realistic. It may be low according to more recent methods of determining C.U. but it is not an unrealistic figure.

The second major component of the irrigation water requirement is the losses--seepage in laterals, deep percolation, distribution losses, evaporation, use by non-crop plants, and excess water required to allow uniform distribution over rough, steep and uneven terrain. This component is regulated by management. This report assumes that management and irrigating methods will remain as they are presently.

Item 4 of "Findings of Fact" states that 3.0 acre feet per acre is the maximum amount of water required to be diverted at the head of the field or field headgate. Of the 3.0 acre feet diverted, 1.8 acre feet is consumptive use, or used by the crop. The report also claims that .35 acre feet per acre is provided by precipitation. Normal precipitation for the area does provide that amount of water, except that precipitation cannot be relied upon to provide the same amount of water every year, nor can it be guaranteed that the precipitation can be used by the crops when it comes. This being the case, precipitation should be ignored when determining the irrigation water requirement of the area.

Irrigation Efficiency

Irrigation efficiency is a term defined by the industry as the ratio of the total amount of water diverted divided by the amount of water used by the crop expressed in percent. As an example, if 3.0 acre feet are diverted and 1.8 acre feet is used by the crop, the irrigation efficiency is 1.8/3.0 or 60 percent.

The irrigation industry recognizes and acknowledges certain irrigation efficiencies with regard to the various irrigation methods. Sprinkler irrigation with all of the water enclosed in pipes, etc., is designed on the basis of 65 to 75 percent irrigation efficiency. Land that is leveled and corrugated or border diked can be surface irrigated with efficiencies in the range of 40 to 65 percent depending primarily upon type of soil, condition of the distribution system and the quantity or volume of water available. Land that is surface irrigated and is steep, rough, coarse and relatively uncultivated and is irrigated from earthen ditches with little or no artificial means of control as is the case in the majority of the Lemhi River Basin has an irrigation efficiency of less than 30 percent.

Irrigation practices, terrain, and conditions in the Lemhi Basin are such that irrigation efficiencies are not likely to be greater than 30 percent and are likely to be much less.

Investigations

Three areas were located where measurements were taken to determine the quantity of water diverted onto the three areas. The measurements were made by use of a current meter or weirs where the sites allowed. Measurements were recorded for approximately 50 days beginning June 26, 1975, and ending August 15, 1975. The actual irrigation season varies, but is recognized to extend at least from April 1 to November 1 or for 190 to 210 days.

Site No. 1 contained 1209 acres near Baker. Three and one tenths (3.1) acre feet per acre were diverted onto the land during the 50 day period for an irrigation efficiency of 28 percent. Irrigation efficiencies are typically lower than this during early and late season applications.

Site No. 2 consisted of 413 acres near Lemhi. Seven and three tenths (7.3) acre feet per acre were diverted during the 50 day period of measurement for an irrigation efficiency of 12 percent.

Site No. 3 contained 66 acres of coarse steep benchland near Leadore. Eight and three tenths (8.3) acre feet per acre were diverted for an irrigation efficiency of 10 percent.

Conclusions and Recommendations

Based on the data generated by these authors, other researchers and the Department of Water Resources, several conclusions and recommendations can be made regarding the Lemhi River Basin. These are as follows:

(1) The normal irrigation season of April 1 to November 1 of each year should be extended because of the possibility of flood runoff occurring prior to the April 1st date which would allow the diversion of those flood flows onto crop land on the terraces.

(2) That the diversion of high waters or flood waters onto the benches and the application of irrigation water to the crop land provides recharge to the aquifers in the Lemhi River Basin and subsequently contributes to the stream flow during the late summer and fall months.

(3) That the court should declare diversion of such high waters or flood waters as a beneficial use. Since that diversion tends to provide water diverted by wells for domestic and stock usage, as well as augmenting summertime flows that are in turn diverted in the lower basin for irrigation.

(4) The investigations showed that actual irrigation efficiencies in the Lemhi River Basin range from 10 to 28 percent. This correlates very well with the industry's general assumption of less than 30 percent for the type of terrain and methods used in the Lemhi Basin.

(5) The consumptive use should not be reduced by the amount of precipitation. Reducing the C.U. assumes that all precipitation is used by the crop. This is erroneous because the precipitation very often comes at a time when the crop cannot utilize it.

(6) In light of the evidence presented and the practices existent in the Lemhi Basin, 9.0 acre feet per acre is a much more reasonable figure for the annual irrigation water requirement in the Lemhi River Basin. The poor irrigation efficiency is not unusual nor adverse since nearly 80 percent of the 9.0 acre feet diverted is returned to the river at some future time.

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