The economics of water transfer : an institutional appraisal (with special reference to Montana)
by Chennat Gopalakrishnan

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Agricultural Economics
Montana State University
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Abstract:
The dramatic increase in the demand for and use of water in the United States in recent years has thrust the problem of water transfer into prominence. Numerous studies have revealed that the existing pattern of water use is seriously defective and that these defects could be corrected, at least partially, by a process of water transfer between uses (say, from agricultural to industrial) and users (say, from individuals to public districts). The basic objective of this study is to analyze the economic implications of water transfer, to identify the institutional handicaps which impede the optimum transfer of water, and finally to suggest measures to remove these institutional barriers, all in terms' of Montana's current water situation.

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The current pattern of water-use in Montana is far from optimal.

From an economic standpoint, the use of a larger quantity of water for recreation purposes is much more profitable than its use for irrigation. There is also a strong case for increase of industrial uses of water.

There is a pressing need for institutional reforms. The water laws currently existing in Montana impede ideal water transfer, and hence need drastic revamping. The creation of conservancy districts in the State is another measure to be implemented. Other institutional factors hampering Montana's water development are the antipathy and/or apathy toward federal involvement in the state's water resource development, and the long-standing controversy between conservationists and "dam-builders".

There is considerable scope for extensive research on a number of problems relating to Montana's water resource development. Some possible areas of research could include the preparation of a complete inventory, of the water supply and demand data for the state, detailed projections of future water needs for the different water-using sectors, extensive studies of Montana's vast, untapped water-based recreation potential, and an inquiry into specific-measures to restructure Montana's legal-institutional complex, Montana's university-based Joint Water Resources Council, in cooperation with a number of Departments and the Agricultural Experiment Station at Montana State University (Bozeman), the University of Montana Law Center (Missoula), and other agencies could undertake a number of fruitful investigations of an inter-disciplinary nature.

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of

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in

Agricultural Economics

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ABSTRACT

The dramatic increase in the demand for and use of water in the United States in recent years has thrust the problem of water transfer into prominence. Numerous studies have revealed that the existing pattern of water use is seriously defective and that these defects could be corrected, at least partially, by a process of water transfer between uses (say, from agricultural to industrial) and users (say, from individuals to public districts). The basic objective of this study is to analyze the economic implications of water transfer, to identify the institutional handicaps which impede the optimum transfer of water, and finally to suggest measures to remove these institutional barriers, all in terms of Montana's current water situation.

Montana is currently using less than half of its water. The competition for this unused water, from downstream users on both the Missouri and Columbia, is steadily rising. There is also the threat posed by the possibility for inter-basin transfer.

The current pattern of water-use in Montana is far from optimal. From an economic standpoint, the use of a larger quantity of water for recreation purposes is much more profitable than its use for irrigation. There is also a strong case for increase of industrial uses of water.

There is a pressing need for institutional reforms. The water laws currently existing in Montana impede ideal water transfer, and hence need drastic revamping. The creation of conservancy districts in the State is another measure to be implemented. Other institutional factors hampering Montana's water development are the antipathy and/or apathy toward federal involvement in the state's water resource development, and the long-standing controversy between conservationists and "dam-builders".

There is considerable scope for extensive research on a number of problems relating to Montana's water resource development. Some possible areas of research could include the preparation of a complete inventory of the water supply and demand data for the state, detailed projections of future water needs for the different water-using sectors, extensive studies of Montana's vast, untapped water-based recreation potential, and an inquiry into specific measures to restructure Montana's legal-institutional complex. Montana's university-based Joint Water Resources Council, in cooperation with a number of Departments and the Agricultural Experiment Station at Montana State University (Bozeman), the University of Montana Law Center (Missoula), and other agencies could undertake a number of fruitful investigations of an inter-disciplinary nature.

PART I

WATER TRANSFER: A THEORETICAL APPRAISAL

CHAPTER I

NATURE AND SCOPE OF THE STUDY

Introduction

The ever-increasing demand for water, coupled with its comparatively limited supply, has made water an "ocean-sized" problem in the United States in recent years. The situation is acute, especially in the chronically water-short Western states. The enormity of the problem will become all the more clear when we examine closely the sharp increase in the demand for and use of water in the past few years and relate it to the potential for increasing water supply. The discussion that follows demonstrates that the demand for water for different uses has been increasing at a much faster pace than the increase in supply, particularly in the Western United States. This imbalance in the supply-demand situation has precipitated a "water crisis" necessitating the adoption of a series of measures, an important one being the transfer of water between uses and users. The basic purpose of this measure is to correct the present situation and to insure a more efficient use of the limited water resources. Before the implications of this policy are analyzed in detail, the background of the water problem should be examined in terms of the trends in supply and demand over the past several years.

Background

A. Trends in Demand

The total water use in the United States increased from 40 billion gallons per day in 1900 to about 300 billion gallons per day in 1960.

According to one estimate, Americans who use 355 billion gallons of water a day at present, will increase their requirements to more than 600 billion gallons a day by 1985. 1/ By the year 2000, the total water use is expected to reach a trillion gallons a day.

The most authentic estimates are those published by the Senate Select Committee on National Water Resources (1961). 2/ According to these estimates (based on medium projections of population increase), by 1980 demand on the nation's water resources will almost double, and it will triple by the year 2000. Thus, demand is projected to increase to 559 billion gallons a day or 51 percent of streamflow by 1980 and to 81 percent of streamflow by the year 2000.

By 1954, the average remaining streamflow in the United States exclusive of Alaska and Hawaii, was about 1,100 billion gallons a day. Demand for withdrawal of 300 billion gallons a day was thus about equal to 27 percent of streamflow in 1954. It must, however, be remembered that these figures represent withdrawals, and that most of this water is returned to the stream, and can be reused many times, provided measures are taken to preserve its quality.

The withdrawal of water has to be distinguished clearly from consumptive uses, or losses, for the different purposes. These range from about 60 percent of the water withdrawn for irrigation down to a fraction of one percent of water diverted for steam-electric power cooling, which under

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1/ Time, (Chicago: October 1, 1965).

2/ Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961), p. 4.

present methods of use, would require the largest withdrawal of water before 1980. The supply-demand studies project an increase in consumptive uses from 109.5 billion gallons daily in 1954, to 119.3 billion gallons daily by 1980, and 156.3 billion gallons daily by the year 2000. This is shown in Table I. Thus, projected consumptive uses of water diverted from streams or underground sources range from an amount less than 10 percent of streamflow in 1954, to 11 percent in 1980, and about 14 per cent in the year 2000. In addition to this, conservation practices for watershed improvement may lead to increases in evaporation, primarily from the surfaces of small reservoirs. Also, maintenance of additional swamps and wetlands for production of wildlife would increase evaporation and transpiration losses. Projected increase in depletion from streamflow resulting from these onsite uses are shown in Table I. No figures are given for 1954 depletions, since natural depletion for these purposes is already reflected in the 1,100 billion gallons per day estimate of remaining streamflow.

The total of consumptive uses and depletions is estimated to be 190 billion gallons daily, or about 17 percent of available streamflow in 1980, and 253.2 billion gallons daily, or nearly 23 percent, in the year 2000. The relationship of withdrawals and consumptive uses and depletions for the different purposes is represented in Figure I.

Further, enormous quantities of water are required in the flowing streams for the generation of hydroelectric power, navigation, recreation, fish habitat, and pollution abatement. Table II gives the projections of the streamflow uses.

TABLE I. TOTAL REQUIREMENTS IN THE UNITED STATES FOR WITHDRAWAL AND CONSUMPTIVE USES OR DEPLETIONS FROM STREAMFLOW. (Billions of Gallons Daily.)

Purpose	1954 a/		1980		2000	
	Gross withdrawals	Net consumptive uses or depletions from streamflow	Gross withdrawals	Net consumptive uses or depletions from streamflow	Gross withdrawals	Net consumptive uses or depletions from streamflow
Diversion:						
Irrigation	176.1	103.9	167.0	104.5	184.5	126.3
Municipal	16.7	2.1	28.6	3.7	42.2	5.5
Manufacturing	31.9	2.8	101.6	8.7	229.2	20.8
Mining	1.5	.3	2.7	.6	3.4	.7
Stream electric power cooling	74.1	.4	258.9	1.7	429.4	2.9
Subtotal, withdrawals and consumptive uses	300.3	109.5	558.9	119.3	888.4	156.3
Onsite Uses:						
Watershed improvement programs	--	--	--	4.0 b/	--	7.0 b/
Swamps and wetlands for wildlife c/	--	--	--	66.7 b/	--	89.9 b/
Subtotal onsite depletions	--	--	--	70.7	--	96.0
Total of consumptive and depletions	--	--	--	190.0	--	253.2

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961).

a/ The year 1954 was used as the base year for the supply demand studies because it was the last for which statistics on water use has been compiled.

b/ Increase over 1954 depletions for these purposes.

c/ Includes also other depletions for fish and wildlife, such as consumptive use of water by fish hatcheries.

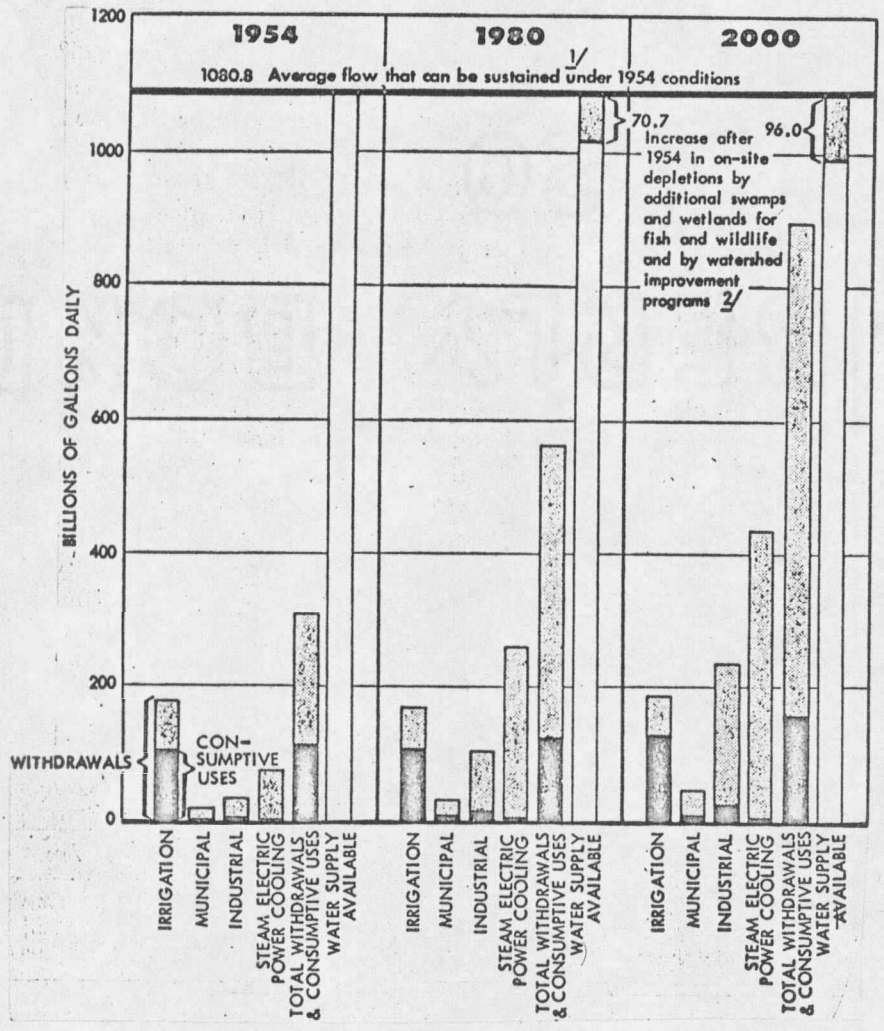


Figure 1. Water Withdrawals and Consumptive Uses in the United States for Various Purposes.

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961), p. 7.

NOTE: Except for the quantities consumed, the same water can be withdrawn and re-used many times, provided its quality is maintained.

1/ Maximum low flow before depletions from use but after estimated evaporation losses from added reservoir capacity.

2/ Onsite depletions not shown for 1954 because they have already been subtracted from average flow.

TABLE II. STREAMFLOW IN THE UNITED STATES

(Billions of Gallons Daily)

	1954	1980	2000
Hydroelectric Power	374.0	616.0	636.5
Navigation	281.0	238.4	221.4
Sport Fish Habitat	78.0	171.0	241.4
Dilution for Pollution Abatement	NA*	332.2	446.5

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961) p. 8.

* No figure is given for dilution requirement for pollution abatement in 1954 since no such specification existed at that time.

Figure 2 gives a diagrammatic representation of streamflow uses enumerated in Table II.

The current pattern of demand will reveal that agriculture is by far the most important single use of water. 3/ Thus, agriculture now uses 107 to 119 million acre feet per year, or 40 percent of all withdrawals. Agricultural uses include, in addition to irrigation, withdrawals for livestock and household purposes. The significance of agricultural uses stems from it being the most consumptive of all water uses. Table III shows some salient characteristics of the agricultural uses and sources of water.

3/ United States Department of Agriculture, Land and Water Resources (A Policy Guide), (Washington, D. C.: May 1962), pp. 28-29.

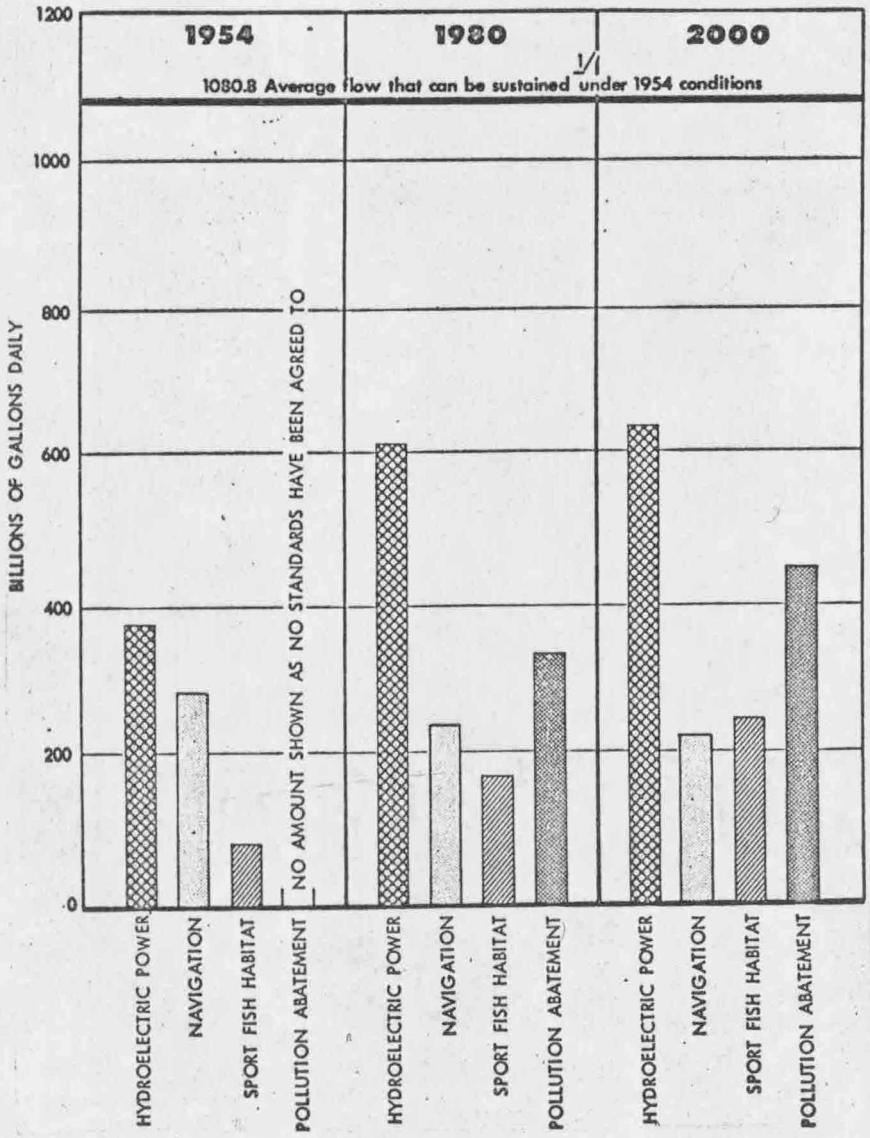


Figure 2. Streamflow Uses.

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961), p. 10.

1/ Maximum low flow before depletions from use but after estimated evaporation losses from added reservoir capacity.

TABLE III. AGRICULTURAL USES AND SOURCES OF WATER IN 1960 FOR THE UNITED STATES, EXCLUDING ALASKA AND HAWAII. a/

Use and Primary Source of Supply	Annual Use				
	Livestock	Other Rural Domestic	Irrigation	Total Agricultural	Percent of Total
	Million acre-feet	Million acre-feet	Million acre-feet	Million acre-feet	
Withdrawal:					
Surface	0.78	0.11	75.14	76.03	70
Ground	1.01	2.13	27.79	30.93	30
Total	1.79	2.24	102.94 b/	106.96	100
Consumption:					
All	1.68	1.34	49.32 c/	52.34	100
	Percent	Percent	Percent	Percent	
Percentage of withdrawal	93	60	48 d/	49	--

Source: United States Department of Agriculture, Land and Water Resources (A Policy Guide), (Washington, D. C.: May 1962), p. 30.

a/ Unless otherwise indicated these estimates are from Kenneth A. MacKichan and J. C. Kammerer. Estimated Use of Water in the United States, 1960, United States Department of the Interior, Geological Survey Circular 456, Washington, D. C., 1961.

b/ Per-acre requirements as indicated by MacKichan and Kammerer in a/ above applied to 33.75 million acres irrigated in 1960, with the estimate of acreage irrigated based on trends reported by the Bureau of the Census since 1939.

c/ Excludes an unknown portion of reservoir evaporation attributable to storage for irrigation purposes.

d/ If based on direct farm application rather than total withdrawals, consumptive use in irrigation ranges near 60 percent.

The Table indicates that irrigation accounts for a major share of the total agricultural demand for water. Thus, in 1960 out of a total agricultural demand for water of 106.96 million acre-feet, irrigation alone accounted for 102.94 million acre-feet. What is more, irrigation represents a highly consumptive use of water--48 percent of the withdrawal in 1960. Figure 3 depicts the major sources of water for irrigation in the United States and also the steady increase in the amount of land brought under irrigation.

Trends over the 20-year period under consideration show average annual increases of about 2 million acre-feet in water withdrawals for irrigation and 0.9 million acre-feet in consumptive use. Studies have also revealed that irrigation from groundwater in relation to surface water has registered a steady and significant increase since 1939 (see Figure 3). Thus, in 1939 only 17 percent of the irrigated acreage in the United States was served by ground water as against 44 percent in 1960.

The above pattern of water use is, however, undergoing rapid change. Wollman has estimated the supply and demand requirements for water in the United States for the years 1980 and 2000. These projections are included in a report on the prospective supply of and demand for water prepared for the Senate Select Committee on National Water Resources. 4/ The report draws attention to a steady and sharp growth of manufacturing industries

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4/ Wollman, Nathaniel, A Preliminary Report on the Supply of and Demand for Water in the United States as Estimated for 1980 and 2000, (Washington, D. C.: Resources for the Future, 1961).

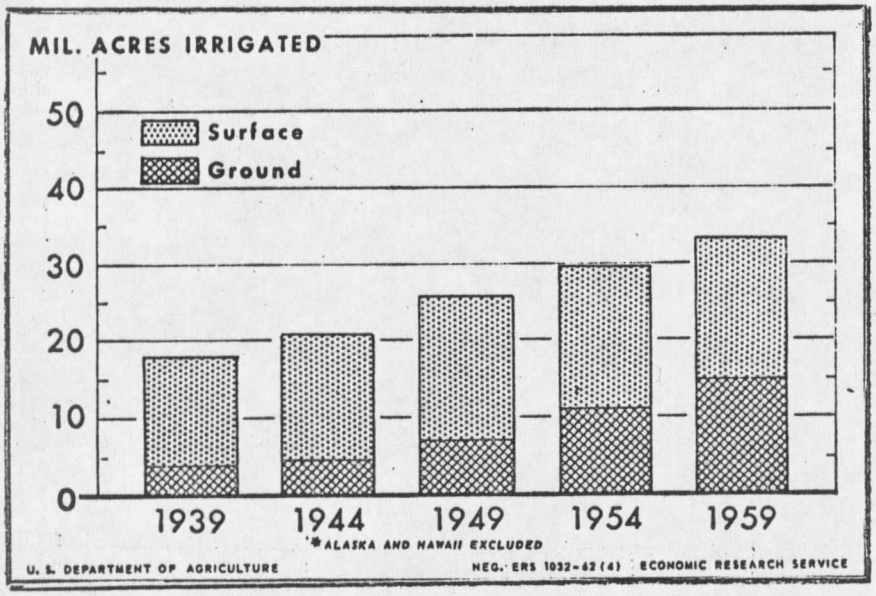


Figure 3. Sources of Water for Irrigation in the United States*

Source: United States Department of Agriculture, Land and Water Resources, (Washington, D. C.: May 1962), p. 30.

using large quantities of water. Thus, between 1947 and 1954, the major water-using manufacturing industries grew as shown in Table IV.

TABLE IV. GROWTH OF MANUFACTURING INDUSTRIES IN THE UNITED STATES, 1947-1954.

(Index of Production: 1947 = 100)

	1954
Pulp and Paper	133
Chemicals	153
Petroleum Refining	140
Primary Aluminum	247
All Manufacturing	127
Food	105
Pig Iron and Steel	107

Source: Wollman, Nathaniel, A Preliminary Report on the Supply of and Demand for Water in the United States as Estimated for 1980 and 2000, (Washington, D. C.: Resources for the Future, 1961).

The study by Wollman also reveals that household use of water has been growing at a rate far in excess of population growth. Per capita urban use exceeds per capita rural use; and because a larger proportion of the United States population is becoming urban, urban per capita use of water has been consistently increasing.

According to Wollman the major water-depleting uses in the years ahead would be irrigated agriculture and the provision of swamp and wetlands for wildlife, primarily water fowl. Major quantities of water

will be required for dilution of effluent from sewage treatment plants handling household and industrial wastes. On account of the fantastic increase in the volume of wastes disposed of in rivers, an improvement in the degree of treatment will be required in order to meet the estimated water quality requirements for the preservation of aquatic life. By 1980 only nine regions would have enough water supply to maintain the minimum stipulated levels of waste treatment; i.e., 70 percent for municipal and 50 percent for industrial wastes, with maximum sustained flows. In the remaining 13 regions, minimum levels of treatment would range between 70 and 97 1/2 percent.

These facts show that the problem of water pollution has at present assumed alarming proportions. 5/ The Hudson is today, in the words of the New York City Board, "an open, running sewer". As one report describes it:

> United States rivers and streams, like the muddy Missouri, used to be contaminated with nothing worse than silt, some salt, and the acids from mines. Now they are garbage dumps. Raw sewage, scrap paper, ammonia compounds, toxic chemicals, pesticides, oils and grease balls as big as a human fist--these are the unsavory contents of thousands of miles of United States waterways. 6/

As a result, far too large a percentage of withdrawn water returns to the source in a condition that makes it less than fully usable by others. And this poses a serious challenge.

5/ Water, a Power Special Report, (New York: June 1966), pp. 22-26.

6/ Time, (Chicago: October 1, 1965).

Another significant factor that will lead to a pronounced increase in the demand for water in the future is water-based recreation. 7/ Taking into account estimates of future increases in travel, personal income, and leisure time, and future population growth, the Park Service estimates that visits to national parks will increase from 63 million in 1950 to 240 million by 1980, and to well over 400 million by the year 2000. It is further estimated that visits to national parks, national forests, state parks and county and municipal parks will reach 8 billion per year by 1980 and 13.4 billion by the year 2000. Domestic water needs will require an estimated withdrawal of 63.7 billion gallons of water in national, state, and county parks by 1980, and 101.8 billion in the year 2000. Water-based recreational activities like swimming and boating will involve further use of water, quantitative estimates of which are not available.

The foregoing analysis demonstrates that the demand for water for non-irrigation uses has been increasing at a steady rate in the recent past and that this trend will continue at an accelerated pace in the years ahead. It also points up the significant fact that a number of non-irrigation demands for water have been emerging in recent years. All evidence leads to the conclusion that these non-irrigation demands for water will continue to register a rapid increase in the future.

7/ Outdoor Recreation Resources Review Commission, Outdoor Recreation for America, (Washington, D. C.: January 1962).

B. Trends in Supply

It is against the background of steadily soaring demand for water that the other facet of the problem, supply, is to be examined. The basic problem, the "crisis in water", stems from the inexorable fact that the supply of water, in an absolute sense, is limited.

> The earth has exactly as much water now as it ever had: no less, but no more. Unlike any other resource, the 326 million cubic miles of water are not used up. In nature's familiar, never ending cycle, water falls to earth as precipitation, seeps underground, flows into lakes and streams, and rushes toward the oceans. Sooner or later, it evaporates back into the air or is given up by plants in the process of transpiration. An acre of corn gives off to the air about 4,000 gallons of water each day. In time the water returns to the earth again in the form of rain and snow. 8/

The entire process is graphically illustrated by Figure 4 on the world water cycle.

The gravity of the situation is revealed when the projected withdrawal depletions, together with a rough idea of flow and on-site requirements, are compared with the total availability of water. Irrigation, as we have already seen, is the nation's heaviest single withdrawer and consumer of water. The figures released by the United States Geological Survey reveal that the 17 western states use about 77 bgd (billion gallons per day) for irrigation.

The distribution of the nation's average runoff of 1,250 bgd between West and East is represented by Figure 5 (the runoff is the water left after evaporation and plant transpiration have taken their toll of the

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8/ Time, op. cit., p. 79.

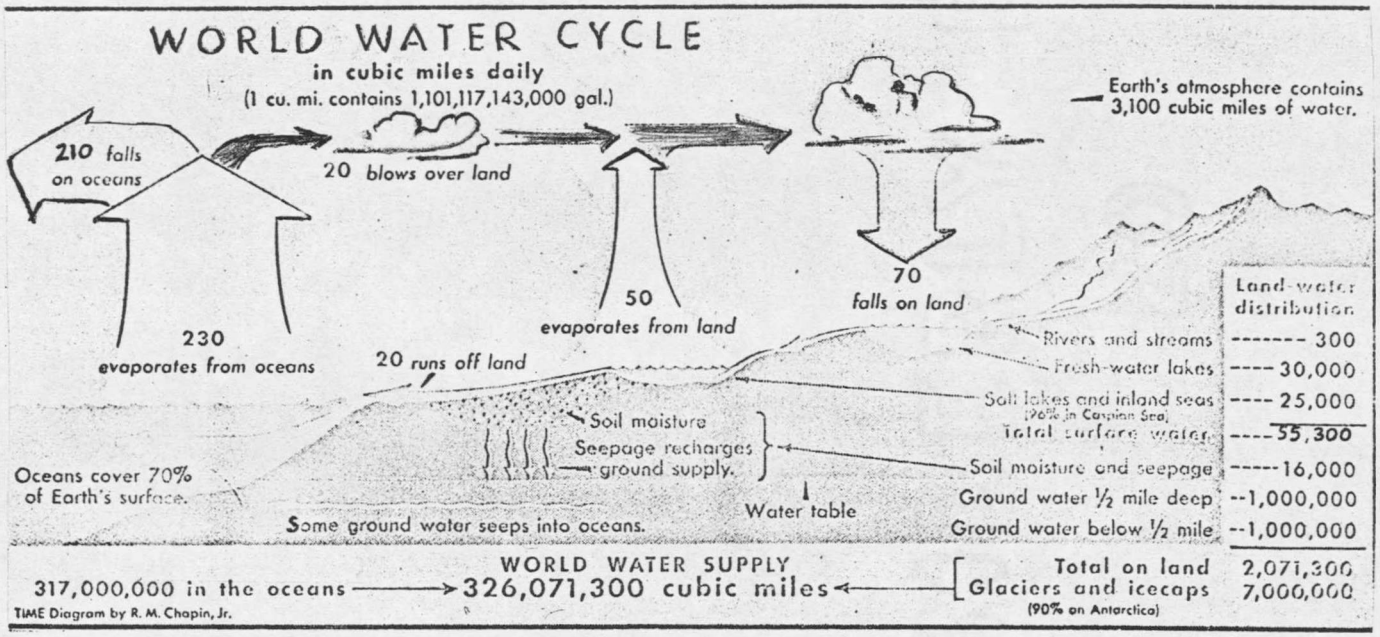


Figure 4. World Water Cycle.

Source: Time, October 1, 1965, p. 79.

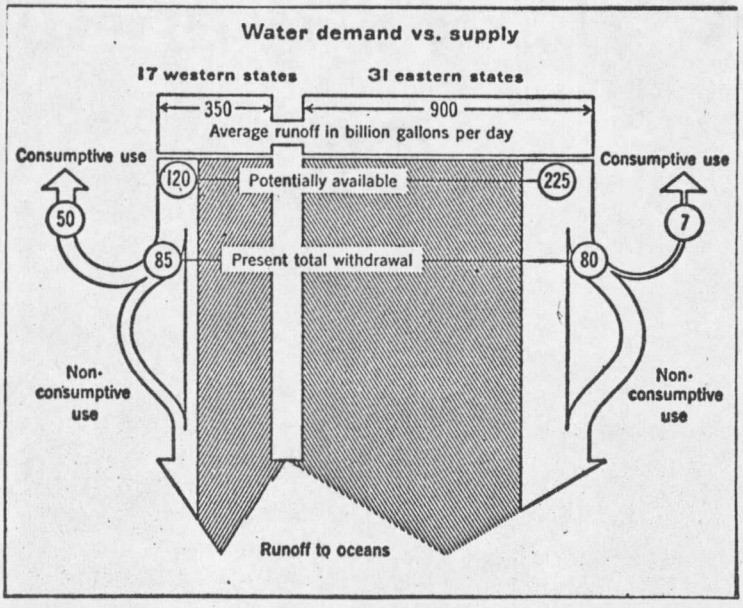


Figure 5. Water Demand vs. Supply.

Source: McGraw Hill Book Company, Inc., The Mighty Force of Research (New York: 1956), p. 107.

average precipitation of 4,300 bgd). On account of irrigation losses, which probably cannot be reduced markedly, the West's consumptive use of 50 bgd is over seven times that of the East. This, again reveals that irrigation is the major single element in the nation's consumptive use of water. And the fact that irrigation constitutes the most important water demand in the West has drawn the West much closer to the estimated limits of its potentially (i.e., economically) available supply than is the East. 9/

The case for the transfer of water between uses and users stems from the assumption that the pattern of water demand in the future will be distinctly different from what it is today, especially in the arid and semi-arid regions of the Western states. At present, as stated earlier, a very significant proportion of the water supply of the Western states, is used for irrigation. This resulted in an estimated total withdrawal depletion in 1960 in the West more than four times what it was in the East. Another factor which adds to the complexity of water supply in the West is the unequal distribution throughout the sub-regions. The West, especially in its Rocky Mountain and Southwest regions, faces a very difficult water situation.

One method for improving this situation is diversion of supplies from water-surplus to water-deficient areas. Another method is the

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9/ Bello, Francis, "How Are We Fixed for Water", The Mighty Force of Research, (New York: McGraw-Hill Book Company, Inc., 1956), pp. 106-107.

adoption of new techniques to increase the supplies of fresh water. These include weather modification, desalinization techniques to reduce losses due to evapo-transpiration and, of course, the use of water with greater efficiency.

More important than these technological problems, however, are the institutional and economic problems. Thus, it has been pointed out that the Western water law and the existing water-pricing policies fail to encourage efficient water use, and may actually militate against it. 10/

> Major adjustments in the pattern of water use--particularly in the Southwest--will be essential if the arid West is to share fully in the nation's economic growth. In the driest parts of the region, municipal and industrial use can support a far larger amount of economic activity per unit of water depletion than does agriculture--perhaps at a ratio of 50 or 60 to 1. A transfer to municipal and industrial use of 10 percent of the irrigation depletion projected for the year 2000 would support nearly double the projected level of depletion from municipal and industrial activity. 11/

Consequently, the effects upon economic growth could be very substantial. In light of the above discussion we can conclude that knowing more about the economic issues involved should lead to a much better understanding of the costs of the many alternatives and of their impact upon the different sectors of the economy.

The Problem Defined

The limited supply of water in relation to the fast-expanding demand for it makes the optimum utilization of the water resources imperative.

10/ Landsberg, Hans H., Natural Resources for U. S. Growth, (Baltimore: The Johns Hopkins Press, April, 1964), p. 145.

11/ Ibid, p. 145.

Investigations, economic and technological, dealing with the value of water in alternative uses have proved conclusively that the existing pattern of water use in the United States is far from ideal. And it is in this context that the strategic importance of transferring water between uses and users emerges. In effect, then, the process of water transfer is designed to revamp the current pattern of water use with a view to increase the value and productivity of water in alternative uses.

As noted above in the background, a distinct shift in the demand for water from conventional uses (mainly agricultural) to a number of newly-emerging uses (e.g., industrial, pollution abatement, and recreational) has occurred in recent years. This shift necessitates a transfer of water between uses (agricultural, industrial, pollution abatement, recreational, municipal, etc.) and users (individuals, firms, public districts, government agencies, etc.) with the objective of enhancing the value and productivity of water. This, in turn, calls for an ideal pattern of water use which would increase the overall welfare and efficiency of the economy. The basic problem, then, is one of analyzing the economic implications of transferring water between alternate uses and users, identifying the institutional handicaps which impede the optimum transfer of water and finally, suggesting ways and means to reduce or remove these institutional barriers.

Basic Objectives

The basic objectives of this investigation are:

1. An inquiry into the factors which necessitate a transfer of water between uses and users.

2. An analytical survey and critical evaluation of the economic problems involved in a process of water transfer.

3. A detailed investigation of the legal, administrative and institutional barriers which impede an ideal transfer of water between uses and users, and

4. Recommendation of specific measures to remove these barriers.

An attempt has been made to relate each one of the above objectives to the situation existing in Montana. Thus, the study focuses special attention on the case for water transfer in Montana, examines the legal-institutional factors standing in the way of ideal water transfer, and makes specific recommendations to remedy these handicaps.

Justification

The spectacular increase in the overall demand for water, the emergence of new water needs, the changing pattern of prospective water demand and use--all these have begun to make their impact felt on the various institutions concerned with the allocation of water. With increasing economic development and the continued growth of population, the role of water as a vital resource will steadily assume greater and greater importance. The relatively limited supply of water in relation to the ever-growing demand for it will inevitably lead to competition. This, in turn, would necessitiate the adoption of measures designed to increase efficiency in water use. And one of the crucial measures to accomplish this is to bring about a change in the existing pattern of water use by suitable modifications in the institutional structure

through which water is transferred between competing uses and users. Thus, the present study has a bearing on the whole process of economic growth and is of importance to the enhancement of overall economic efficiency and welfare.

Major Sources of Information

This study, which is essentially theoretical in nature, has gathered the basic data and information from a variety of sources. These can be divided into the following categories:

1. Government Reports and Publications: This includes the Report of the President's Water Resources Policy Commission (Vols. 1 and 2, 1950) and virtually all the reports of the Senate Select Committee on National Water Resources (1961).

2. Bulletins published by the various Agricultural Experiment Stations and unpublished dissertations related to the economic and institutional aspects of water resource development.

3. The law journals put out by the Law Departments of various universities for information concerning the legal-institutional aspects.

4. Books and anthologies, proceedings of the different conferences on water resources, and reprints published by the Resources for the Future. Among books, special mention has to be made of the extremely valuable compilations by Wells Hutchins of the water laws of the different states.

5. Articles pertaining to the problem under investigation that have appeared in professional journals, e.g., Journal of Farm Economics,

Land Economics, Natural Resources, American Economic Review, Water Resources Research, and Soil and Water Conservation.

6. Articles that have been published from time to time in the various popular magazines and newspapers. A good deal of information about Montana's water resources and the various programs that are currently underway to tap Montana's water potential has been gathered from news items and articles published in the various Montana newspapers.

7. Information made available by the various government and non-government agencies regarding the water resource development of Montana.

The information and data gathered from the above sources have been supplemented and verified in several ways. Discussions with economists, legal experts, engineers, geologists, and others who are conversant with the national water situation in general, and Montana's water problems in particular, have proved to be of considerable value in the conduct of this inquiry.

Plan of the Dissertation

This dissertation is divided into two principal parts and seven chapters: Part I deals with the theoretical issues ivolved in the economic and institutional aspects of water transfer; Part II examines in depth the economic factors and the legal and institutional facets of water transfer as they relate to Montana.

The first chapter outlines briefly the nature and scope of the inquiry. The second chapter examines in detail the complex economic

problems involved in the allocation of water between competing uses. This is followed by a comprehensive analysis and evaluation of the institutional aspects of water transfer (Chapter 3). Chapter 4 studies the varied economic aspects pertaining to the transfer of water within Montana. The next chapter (Chapter 5) deals with the ramifications of Montana's water laws as they affect water transfer. Chapter 6 discusses a few other institutional factors which have a pronounced bearing on the use and development of Montana's water. The final chapter (Chapter 7) gives a summary of the principal problems presented and outlines specific recommendations to solve them.

CHAPTER II

THE ECONOMICS OF WATER TRANSFER

Introduction

This chapter is primarily an attempt to examine the theoretical principles which govern the allocation of water among competing uses. The first section disucsses the theoretical basis for resource allocation. The second section examines in some detail the impact of transferring water from low-productive to high-productive uses on the pace and pattern of economic development. Part three deals with the economic implications of water transfer. First, the allocation of water in terms of the market for water rights is studied. This is followed by a comprehensive survey of the various ramifications involved in water-pricing. Special attention is paid in this connection to a discussion of the role of marginal cost pricing in the valuation of water. The final section views the problem of water transfer and its consequences from the standpoints of both efficiency and equity and highlights some of the relevant issues.

Theoretical Basis for Resource Allocation

In order to understand the nature of the "market" for water and the allocation of water among multiple uses, a discussion of the theoretical principles underlying resource allocation would be useful.

The problem of resource allocation stems from the scarcity of resources in relation to the demand for them and the consequent need for "choice". The theoretical basis of resource allocation has been explained by economists in terms of two concepts: (a) the concept of proportionality

embodied in the law of variable proportions, and (b) the equi-marginal principle. Each of these concepts is examined in turn and then the applicability of the general theory of resource allocation to the allocation of water is examined against this broader milieu.

The Concept of Proportionality

The concept of proportionality plays a crucial role in the allocation of resources. It exerts a significant bearing on the decision of the producer regarding an optimum combination of his factors of production.

The basic law governing the allocation of resources in the productive process is the Law of Variable Proportions or the Law of Diminishing Returns. Boulding states this law as follows:

> As we increase the quantity of any one input which is combined with a fixed quantity of the other inputs, the marginal physical productivity of the variable input must eventually decline. 1/

Given a functional relationship as defined by Boulding, the production function would be of the general form $Y = f(x_1 | x_2 \ldots x_n)$, where Y is the output, x_1 the input that is varied, and $x_2 \ldots x_n$ the inputs that are held constant. With such a function, the quantity of Y produced depends upon the amount of the variable input x_1 used, with the rate of production influenced by the proportionality between input x_1 and the fixed inputs.

1/ Boulding, Kenneth, E., Economic Analysis, Third Edition (New York: Harper and Brothers, 1955), p. 589.

The operation of the physical law of diminishing returns in relation to the production function is shown in Figure 6.

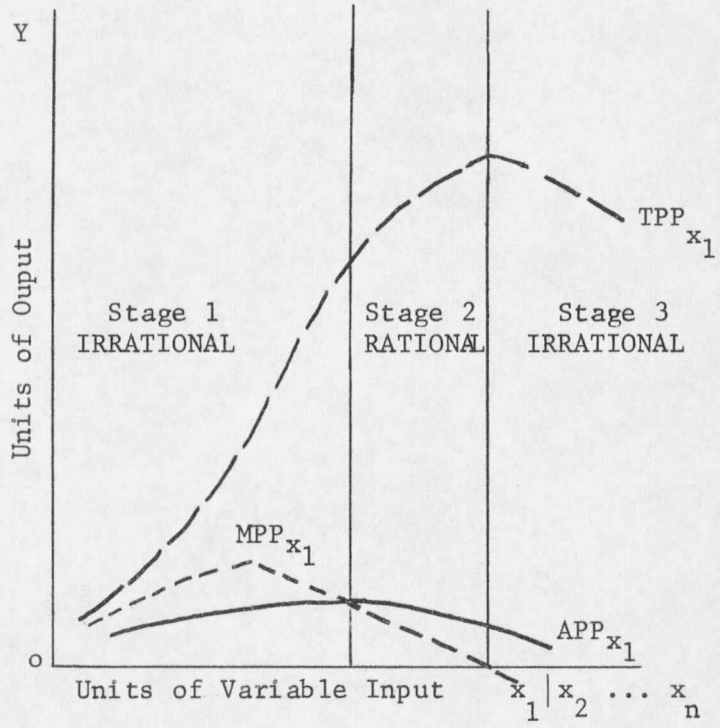


Figure 6. The Law of Diminishing Returns and Stages of Production.

This figure shows the relationships between the variable input x_1 and total physical product (TPP_{x_1}), marginal physical product (MPP_{x_1}), and average physical product (APP_{x_1}). At the maximum point on TPP_{x_1}, MPP_{x_1} touches the horizontal axis and is zero. Beyond this point, MPP_{x_1} is negative and total product declines. When MPP_{x_1} is above APP_{x_1}, average physical product is increasing. When APP_{x_1} is equal to MPP_{x_1}, average physical product is at a maximum. When MPP_{x_1} is below APP_{x_1}, average physical product is decreasing.

The production function depicted by Figure 6 is divided into three stages of production. Stage 1 is an irrational stage of production. In

this area, MPP_{x_1} is always greater than APP_{x_1}. If it pays to produce any output at all in this stage, it pays to produce at least the maximum total output for this stage, because when MPP_{x_1} is greater than APP_{x_1}, Stage 3 is also an irrational area of production. This is the area in which MPP_{x_1} is negative and additional input reduces TPP_{x_1}. In Stage 2, MPP_{x_1} decreases continuously and is always less than APP_{x_1}. The firm demand for the input is represented by that part of the MPP_{x_1} curve lying in Stage 2 multiplied by the price of the input. Somewhere in Stage 2 is located the optimum rate of production. 2;3/

Thus far the discussion has been related to the physical law of diminishing returns. However, most producers in our economic society would be interested to know the input-output problems in monetary terms. The change from the physical to the economic concept of diminishing returns can be accomplished simply by assigning a cost to each of the input factors and a market value or price to each unit produced.

The Economic Sense of Proportionality

Figure 7 gives a typical example of the value product diagram used in economic analysis. This figure assumes a single (or composite) fixed factor and a single (or composite) homogeneous input used in varying amounts. As such, all of the net returns above the cost of the variable input can be

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2/ Stigler, George J., The Theory of Price, Revised Edition (New York: The Macmillan Company, 1952), Ch. 7.

3/ Heady, Earl O., Economics of Agricultural Production and Resource Use, (Englewood Cliffs, New Jersey: Prentice Hall, 1965), Chs. 2 and 3.

considered as an economic return to the fixed factor. The calculation of this return is illustrated by Figure 7.

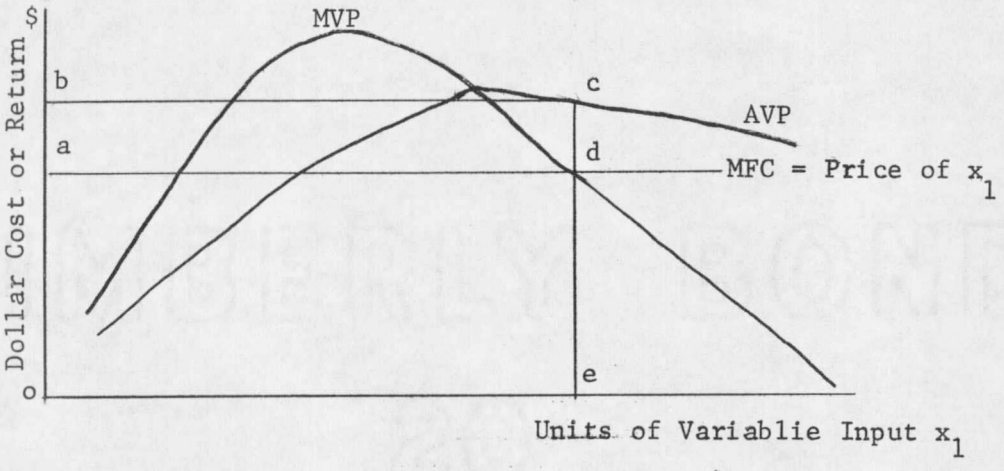


Figure 7. Cost and Returns Relationship and Profit Maximization.

This example assumes a given production function, with prices assigned to the variable input and the product. With this combination of factors, the producer finds it most profitable to stop where the last unit of the input uses just pays for itself. This is shown in the figure as that point where the two curves, MVP and MFC, intersect, and therefore are equal. At this point, the total value of output is the rectangle obce. The net return to the fixed factor is the difference between the total value product (obce) and total factor cost (oade) - a difference represented by the rectangle abcd.

The Equi-Marginal Principle

This analysis assumes unlimited resources at the disposal of the operator. Under practical conditions, however, the supply of production factors for the average producer is limited and he usually has several

different uses to which these resources can be put. In such a situation, the producer with a fixed supply (or limited resources) bases his resource allocation on what is called the "equi-marginal principle".

In theoretical terms, this simply means that when a resource used in any one use (or enterprise) produces an MVP at least equal to that which it could secure from its best alternative use, profit from its use is maximized. Thus, the transfer of resources from one use to another will take place until the rate of gain from the transfer just equals the rate of loss from the withdrawal. Profits thus are at a maximum. As Boulding puts it, "the ideal apportionment is clearly that in which there is nothing to be gained by transferring marginal units of resources from one use or occupation to another." 4/

Application to Water-pricing

A close look at the market for water and the prices of water in different uses, however, suggests that the operation of the equi-marginal principle in the allocation of water among multiple uses is seriously hampered. Thus, we notice pronounced price differentials in the case of water, depending on the use to which it is put. For instance, the amount that has to be paid per acre-foot of water used for industrial purposes is much higher than the same amount of water used for, say, irrigation or domestic use. Put in a different way, this implies that the marginal returns of the same quantity of water vary considerably in different uses.

4/ Boulding, Kenneth E., op. cit., p. 689.

A situation like this cannot exist in a purely competitive set up. There is always a tendency for the marginal returns received from the different uses of a commodity to tend toward quality. If the MVP in one use is greater than in another use, there will occur a drift or transfer of resources from the low-yielding to the high-yielding use until the MVP's from both the uses are equalized. This type of transfer automatically takes place in a competitive set up where the market forces are left unhampered.

However, the free transfer of water from one use to another, as dictated by the equi-marginal principle, does not occur in the case of water. And it is in this context that the problem of institutional factors emerges. These institutional barriers encompass a very wide range--legal, administrative, political, psychological and socio-cultural. These institutional handicaps prevent the unhindered operation of free market forces in the allocation of water among competing uses and users. Thus, the basic theoretical principles governing optimal resource allocation have a limited applicability in the case of water at the present time.

Two other factors have also to be taken into account in considering the applicability of the theoretical principles discussed above to the allocation and pricing of water. The first one relates to the multiple use of water. Water can be put to a number of uses, which are non-competitive in nature. Thus, water used for recreation purposes can also be used for the generation of electricity, and following that, too, for irrigation. In other words, water is not a "one-shot" resource, and hence can be used over and over again in a sequence of uses.

Further, very large investment aggregates are involved in the construction of multi-purpose projects, especially those for power generation and irrigation development. This is untenable with the assumption made in the general discussion that resources can be divided into any number of smaller units. Consequently, the traditional theory of resource allocation predicated on divisibility of resources to very small units has only a limited validity in the case of water pricing.

Economic Development and Water Transfer

The use of water in the United States has been growing in recent years at a much faster pace than the growth in population. Consequently, in the historically water-scarce regions of the United States, the future pattern of water allocation over the next several years is likely to set definite limitations on the nature of the region's economic growth, and hence, upon the economic growth of the nation as a whole.

> Planning and action to meet current and future needs for water and its services are primarily matters of public decision. And in the West there is a further element of public participation. Here, under appropriation law, shares of the water supply are allocated to specific uses on a property right basis, and these rigidities are, in turn, written into interstate compacts on water use. Thus, the "free market" is a limited instrument for determining the relative desirability of water's alternative use--more so than it is in the case of most other resource products. 5/

In certain states, however, subject to administrative controls, water rights can be bought and sold. Hence, the market forces can help allocate water among competing uses.

5/ Wollman, Nathaniel, The Value of Water in Alternative Uses (Albuquerque: The University of New Mexico Press, 1962), p. xii.

It is necessary, therefore, to study the effects on the economy of the different patterns of water use, in light of the estimated increase in the growth of population and economic activity. An inter-disciplinary approach involving economists, geologists, engineers, biologists and lawyers can be of much value in this connection. A pioneering effort in this direction is Wollman's study on the "Value of Water in Alternative Uses" (1962). This study describes eight possible patterns for the use of unappropriated water in two river basin areas (San Juan and Rio Grande) in New Mexico. The eight possible patterns of water use described in this book represent different combinations of water according to three major uses: Municipal and industrial, recreational, and agricultural. The results of the study indicated that the contribution of the Rio Grande basin to gross national product (GNP) would be about $50 for each acre-foot of water used in irrigation, as against between $200 and $300 for each acre-foot used as fish and wildlife habitat, and between $3,000 and $4,000 for each acre-foot used in industry. This result, however, does not warrant the assumption that since industry yielded the highest value-added per acre-foot of water, and hence constituted the highest productivity, all available water should be allotted to industry.

The same results were obtained by analyzing the basic data on municipal and industrial, agricultural, and recreational uses of water in terms of variations in profit rates and in benefit-cost ratios. Thus, high-industry models yielded benefit-cost ratios of 6.0 and 4.7, whereas high irrigation models gave ratios of 2.1 and 2.0. 6/

6/ Ibid, p. xix.

The principal indicators used in the Wollman study to estimate the value of water in alternative uses were: (1) gross product, (2) primary value-added, (3) value added by purchase, (4) secondary value-added, (5) water costs, (6) employment and population, (7) capital requirements and capital supply. (For a detailed explanation of each of the above indicators, see Appendix A.)

Economic development can continue at an undiminished pace only through a process that will allow complete or full use of available supplies of water and also enable easy and advantageous transfers to "high valued" or more productive uses as these emerge. Optimum economic growth can be accomplished only by making necessary adjustments to meet the ever-growing demands. In order for this to become a reality, the engineering and economic elements of a water resource program should provide maximum flexibility of water use to satisfy the rapidly changing optimum patterns of water demand.

Thus it has been shown that reallocation of water from agricultural to industrial, municipal and recreational uses is capable of markedly expanding the development potential of water-deficient regions. This fact makes clear the importance of efficient mechanisms for the transfer of water from lower to higher value uses in these regions. Water has to be smoothly transferred to support industrial and urban growth in the Western areas if they are to continue to grow. In addition, as water supplies become more stringent, it becomes highly important that water uses in agriculture is applied to the most productive lands and crops by the most efficient methods.

Renshaw 7/ has made the following estimates of the mean-value of water per acre-foot for different uses:

Use	Value Per Acre-Foot
Domestic	$100.19
Industrial	40.73
Irrigation	1.67
Power	0.71
Waste Disposal	0.63
Inland Navigation	0.05
Commercial Fisheries	0.025

These figures, though not applicable to all situations, still give us an idea of the comparative range of values.

The following two specific examples indicate how a reallocation of water from one use to another could bring about a substantial change in the contribution of water to economic development. Criddle 8/ cites as an example the transfer of water from agricultural to industrial purposes by referring to a development of the Price River in Carbon County, Utah. It is pointed out that the direct and indirect returns stemming from the agricultural use of water in this area would represent only a small fraction of the returns likely to be generated by the creation of an electric plant. He, further, states that the estimates of the total returns from industry in Carbon County amount to over $28 million per annum compared with the total agricultural returns of about $1.25 million a year. Despite this, however, in this area about three-acre feet of water is used for irrigation for every acre-foot used for industrial and other uses.

7/ Renshaw, E. F., "Value of Acre-Foot of Water", Journal of Water Works Association, March 1958, pp. 303-309.

8/ Criddle, Wayne D., "Problems of Transferring Currently Developed Water Among Uses and Users", Water Transfer Problems, (Report No. 10), Conference Proceedings of the Committee on the Economics of Water Resource Development of the WAERC, (Portland, Oregon: December 1961), pp. 21-24.

Another example relates to a somewhat similar development in Kemmerer, Wyoming--a storage reservoir with 28,000 acre-feet capacity under construction on Ham's Fork River to supply water for a 300,000 kilowatt thermal plant. It is estimated that the same amount of water used for agricultural purposes in this area would have a much smaller impact on the local economy as compared to the effect of the industrial use of water.

The above two examples, however, have some serious limitations. For one thing, the comparison is between a consumptive use of water (irrigation) on the one hand, and a nonconsumptive use (industry) on the other. Second, the possibility for the creation of a multi-purpose project which can use water for a number of purposes, including irrigation, is not explored in those examples. The possible total returns from the creation of a multi-purpose project in each case could have been much higher than the returns from industrial use of water alone. Third, the figures employed by Criddle to estimate the possible returns from the industrial use of water are averages (or means) only. Thus, they are unable to indicate the marginal productivity of water in either industrial or agricultural use. Finally, a complete transfer of the available water from agriculture to industry in communities which are basically agricultural would tend to upset the familiar pattern of life and could result in a number of "social costs". Viewed in this perspective, any agrument for a wholesale transfer of water from agriculture to industry loses much of its weight.

An important aspect of water transfer relates to the transfer of newly developed water between uses and users. Newly developed water, of course,

includes developments in surface and ground waters. There are, however, a number of other developments which are not so clear-cut but nonetheless could be regarded as "new" waters. Holje 9/ considers the following categories as representing "new" water:

1. Storage of surface and ground water;
2. Industrial recycling and reuse;
3. Water budgeting in irrigation;
4. Reduction of evaporation losses in reservoirs;
5. Demineralization of saline and brackish waters;
6. Industrial use of saline water;
7. Multiple-use management;
8. Watershed management;
9. Weather modification.

Holje states that a classification of the above nature is of considerable importance in transferring newly developed water. Thus, he notes that the problems of water transfer are significantly different in the contrast between "new" water resulting from ground water development and, say, from weather modification, particularly in a physical sense.

Another problem of significance in water transfer is the rural-urban transfer of water. 10/ There has been a steadily growing competition for

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9/ Holje, Helmer, "The Transfer of Newly Developed Water", op. cit., pp. 21-24.

10/ Smith, Stephen C., "Organization and Water Rights in the Rural-Urban Transfer of Water", Economics and Public Policy in Water Resource Development, (Ames: Iowa State University Press, 1965), pp. 251-272.

water between these two categories of uses in recent years. Legal and administrative institutions currently existing in the different areas play a very dominant role in effecting the allocation of water between rural and urban areas. And this makes rural-urban water-transfer a problem of extreme complexity.

The transfer of water from less-productive to more-productive uses contributes to economic growth indirectly. The concept of "externalities" or "spill-over effects" refers to these economic effects which lie outside the decision making process of micro units of water uses. 11/ In the case of water transfer, these effects are generated by water supply interdependencies and income interdependencies of a more general character in the water-using community. In the context of externalities, a water transfer is considered desirable if the new use after the transfer creates an increase in income. This is regarded as the major welfare criterion for analysis of the allocation problem and the role played by institutions in effecting such transfer. Externalities from changing water use have distinct welfare implications resulting from major changes in the pattern and pace of overall economic development.

There is a close relationship between water-transfer and economic development. Consequently, it has become increasingly clear that the basic policy in the field of water resource development is to achieve the

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11/ Hartman, L. M., and D. A. Seastone, "Welfare Goals and Organization of Decision Making for the Allocation of Water Resources", Land Economics, (February 1965), pp. 21-30.

most economic allocation of water with a view to maximize the net benefits to society. How exactly could this optimal allocation of the limited water resources between competing uses be accomplished? It is here that the market mechanism and pricing policies assume a strategic role.

Allocation of Water Among Competing Uses

In order to understand the nature of the transfer of water among alternative uses, we have to examine rather closely two separate aspects of the problem: (a) the market for water rights, and (b) the problem of pricing water. These two aspects are closely interwoven and they exert a significant influence on the allocation of water among a variety of competing uses.

A. The Market for Water Rights

The market mechanism plays an important role in the transfer of rights to water supplies. This is specifically so, since owing to a number of reasons (some historical and others stemming from the basic nature of water supplies) the transfer of water rights is impeded by legal and administrative procedures and precedents. Hence, it is believed that greater reliance upon the market process of purchase and sale would lead to more productive use of water and greater economic returns.

> This is a particularly important problem in much of the West where efficient use of limited water supplies is important to regional economic advancement and where water law tends to inhibit transfer out of low-value irrigation uses to high-value municipal and industrial uses. 12/

12/ Fox, Irving, K., "New Horizons in Water Resources Administration", Public Administration Review, (March 1965), p. 67.

The term "market" is conventionally defined with respect to the interaction among buyers and sellers.

> It identifies the process of tenure transactions from producer to consumer, the institutions facilitating this process, and the conditions of exchange--or the exchange ratios--prevailing at each stage. 13/

According to Kelso 14/ if market forces are to be employed to allocate water among uses and users, water rights must be permitted to be bought and sold. But little is known about the market for water rights. How effective are such markets in allocating water to its "highest and best" use? Both Kelso and Brewer are of the view that the market for water rights deviates considerably from the textbook definition of a "free market". Thus, as Brewer has shown, instead of a large number of buyers and sellers, there may be a small number or even a single buyer or seller.

Brewer points out that in the context of a market, water transfer is often equated with a sales transaction. The parties to the transfer may be individuals or agencies, and the process may occur at a wholesale level, a retail level or it may exist between different levels. Transfer between entities at the same marketing level may be termed "horizontal" transfers, as distinct from "vertical" transfers, which involve several market levels. Examples of the latter include transfers of water from a district to its members or from a federal or state agency to a local district.

13/ Brewer, Michael, "Economics of Public Water Pricing: The California Case", Economics and Public Policy in Water Resource Development, op. cit., p. 224.

14/ Kelso, M. M., Regional Project Outline on "The Economics of Water Transfer: An Appraisal of Institutions", January 1964, p. 7.

Thus, producers and sellers of water are not numerically equivalent in the water market. Some producers sell water entirely on a wholesale basis. An instance in point is the sale of water by the Bureau of Reclamation through the Central Valley Project in California. Others are both wholesalers and retailers; local irrigation districts belong to this category. These examples clearly indicate the need to modify the conventional market approach in the case of water transfer.

The market mechanism has also other ramifications. There is, for example, the crucial question of how effectively the market exchange of property rights in water (the mechanism implied by the prior appropriation doctrine in the Western United States) can result in economically optimal water allocation, especially, on a large scale. For one thing, the impact of water allocation on third parties (i.e., non-participants in the market-determined decision to transfer) has to be reckoned with. These third parties include the service community of an irrigation project, downstream users who depend upon return flows, and downstream users affected by changes in the quality of flow attendant to changes in use. Second, it is not yet evident that the best method for water transfer in the arid west is the exchange of water rights in markets on account of the difficulty

> in arriving at reasonably certain definitions of rights when major third party effects, resulting from water quality deterioration and return flow dependency, are involved. Perhaps, the most satisfactory solution will be some mixture of market transfers of rights and administrative allocations. 15/

15/ Kneese, Allen V., "Economic and Related Problems in Contemporary Water Resources Management", Natural Resources Journal, Oct. 1965, p. 5.

"The real value of the concept of water market is thus, primarily, expository." In any case, an appraisal of the historical effectiveness of the market system to cope with past allocation problems would be of marked value in gathering information about the necessary modifications to be introduced in the future.

B. The Problem of Pricing

A vital problem in the transfer of water between uses and users is the formulation of a system or method of water-pricing that adequately reflects the costs of supplying the water and the value of alternative uses forgone. In any account of the existing competition for water, consideration should be accorded to making much greater use of prices and charges in the allocation of water supplies among competing demands. However, as the previous section has revealed, the very nature of water management and water values precludes complete or exclusive reliance upon market forces. This, of course, does not mean that traditional policies and concepts should be allowed to unduly inhibit the use of fees and charges in cases where market forces can operate effectively in the optimization of economic values. However, economists and policy-makers do agree that the price mechanism has serious limitations as a value indicator.

A significant problem in the transfer of water, when both public and private agencies are involved, relates to the determination of the value of public goods. If water is priced, the marginal value of the last unit of water to consumers is being measured if the pricing is competitive. On the other hand, if water is freely distributed, the factor cost of water production measures the value of resources employed in water development

in their highest alternative uses. The results obtained in both cases will be different.

In the first instance, it is reasonable to assume that as a result of its market pricing, fewer resources would be devoted to the production of water in case of reduced demand and more to the generation of other items of output than in the second case. The composition of output in the two situations, therefore, differs. Consequently, judgments concerning appropriate weights have to be made to achieve an index number comparison.

Three factors stand out as dominant variables in public water pricing policies. These are: location of delivery (in relation to the head of a surface distribution system), the type of use to which water is put, and time. Price may be systematically related to any or all of these variables or may be functionally unrelated.

The price aspect of water transfer potentially performs two economic functions, efficiency of which may be evaluated. The first is allocating the involved resource; the second relates to investments in water "production", or more simply, the water producing projects. Criteria for economic efficiency of the latter function include least-cost production and correct supply response. Marginal cost pricing may satisfy all these criteria. 16/

16/ Brewer, Michael, "Water Transfer and Economic Growth", Water Transfer Problems, Conference Proceedings of the Committee on the Economics of Water Resource Development of the WAERC, Report No. 10, op. cit., p. 82.

The role of marginal cost pricing in fixing water rates has been examined in detail by Milliman. 17/ According to Milliman pricing of water resources in terms of marginal cost represents by far the best and most efficient method of pricing. He illustrates with the aid of two figures the superiority of marginal cost pricing over average cost pricing in the case of an industry. Milliman contrasts the conventional public utility pricing solution, based on average costs, which includes a "fair return", with a marginal cost pricing policy in these two figures.

Figure 8 represents marginal cost and average cost pricing for a case of decreasing average cost. The figure reveals that average costs are decreasing for the relevant range of output, although the possibility of their eventual rising if production is continued beyond some point cannot be ruled out. The figure indicates that average cost pricing would establish a general rate level of OS and set the level of ouput at OA. Thus, total system revenues would just equal total costs of OSUA. Milliman points out that this result, while "financially sound", is by no means an optimal situation in terms of efficient use of the facilities already existing, since water users are more than willing to cover all of the extra costs of extra output until an output of OB is reached. Beyond OB, the marginal cost of output rises above the demand curve, which is assumed to measure the extra value consumers attach to additional output.

17/ Milliman, J. W., Policy Horizons for Future Urban Water Supply, (Washington, D. C.: Resources for the Future, July 1963).

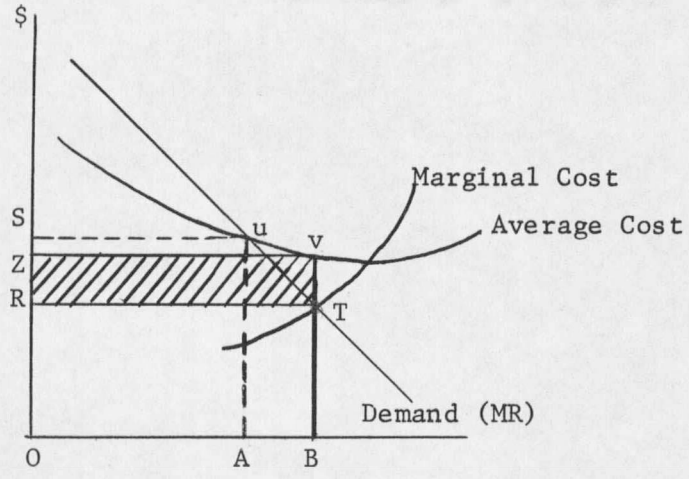


Figure 8. Marginal Cost and Average Cost Pricing for Case of Decreasing Average Cost.

Furthermore, the area under the demand curve (value of water service as seen by users) for the output AB exceeds the area under the marginal cost curve (value of alternatives sacrificed by this particular use of resources). Therefore, it would be socially desirable to continue to expand service up to the point where the prices that consumers are prepared to pay equal the extra cost of the extra output. In this case the optimal output is OB. This proves the general proposition that average cost pricing in a decreasing average cost case will result in under-utilization of plant capacity.

Now, let us examine the marginal cost pricing solution in the same case. Here the rule would be to produce an output of OB and set the general level of rates at OR. Marginal costs would be less than average costs by RZ (also TV) and a deficit RZVT would result. This deficit would be reflected, in conventional accounting terms, as an inadequate return on

financial costs of capital facilities already in place. Milliman states in this connection:

> Although this problem is a very real possibility, it is not nearly as serious as is often claimed. There are a whole range of solutions or compromises which could achieve most of the gains of marginal cost pricing in terms of efficient use of the utility plant and yet cover total cost requirements. 18/

According to Milliman, it is, however, more likely that the future provision for urban water supply would often result in increasing, not decreasing, average costs for services. He substantiates this view by citing the example of urban water supply facilities in rapidly growing urban areas in southern California and the southwest. As is revealed by Figure 9, marginal cost of service will then be above average costs and that marginal cost pricing will produce "surpluses" and not deficits.

The marginal cost price solution in this case would achieve a general level of rates of OR at the optimal output of OB. Total revenues would exceed total costs and a surplus of RTZV would result.

Figure 9 further indicates the inefficiency introduced by average cost pricing principles in the case of rising average costs. Thus, equating demand prices with average costs (AU) would create an output of OA. No surplus would be generated since total revenues would equal total costs. Yet the marginal cost of service is AJ and this cost exceeds the demand price by UJ. Consumers are not covering the extra costs of extra use and this obviously implies that water supplies are being inefficiently used.

18/ Ibid., p. 129.

In other words, the amount of social loss is measured by the area TJU. This is the quantity by which the extra costs of producing output BA (the area under the marginal cost curve) exceeds the value in use (the area under the demand curve for output BA). Thus, average cost pricing in cases of increasing average costs often results in "underpricing of scarce resources and over-utilization of scarce facilities". Here is thus a case for the adoption of marginal cost pricing in preference to average cost pricing.

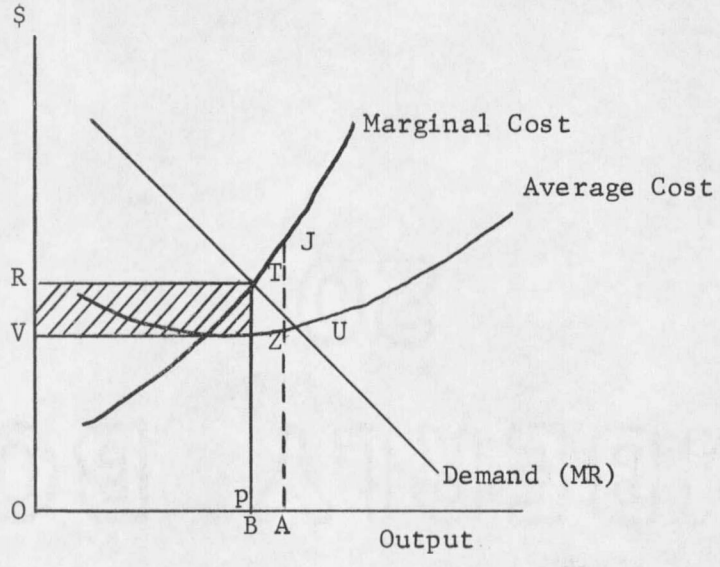


Figure 9. Marginal Cost and Average Cost Pricing for Case of Increasing Average Cost.

If there are "externalities", marginal cost pricing, however, will not suffice. One argument maintains that under such circumstances marginal cost pricing coupled with a subsidization program financed by tax receipts is the most desirable way out. This position assumes that higher-cost firms will tend to be eliminated through market competition. In the case of water transfer, there is little opportunity for competition among producers.

Rather, competition exists between agencies with regard to their scale of operation, with resulting internal pressures and, in the extreme, free water. Even with subsidization, the quantity demanded will not proceed to the point of zero marginal value productivity of water so long as any user price is charged. 19/

Kelso 20/ points out that when water is developed by the government and sold to individuals, the price is usually determined by a mixture of ability to pay and the repayment necessary to cover the cost that has been allocated to this particular water use. For example, the price of irrigation water to farmers on a Bureau of Reclamation project has little resemblance to the price that would exist in a free market situation. Thus, water prices need not necessarily reflect the differing productivities of water in different uses.

Water Transfer: Efficiency vs. Equity

Various efforts have been made from time to time to formulate a water resources policy designed to maximize the returns from the allocation of water among competing uses. Economists have developed a body of theory to apply to situations in which the competitive market is not able to accomplish an efficient result. This body of theory, referred to as welfare economics, is directly applicable to water resources on account of several

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19/ Brewer, Michael, "Water Transfer and Economic Growth", op. cit., p. 82.

20/ Kelso, M. M., op. cit., p. 1.

characteristics of water development. Three of the principal characteristics are:

> (1) Many resource commodities can be produced and/or distributed at minimum cost only through natural monopolies because the conditions of production involve major economies of scale. Thus, the unregulated market does not function or functions only imperfectly in these instances.
>
> (2) Many products of water resources, or water resource connected services are not subject to division into units for sale and purchase. Flood control, for example, usually cannot be limited to a single price of property and a scenic area may be viewed by many.
>
> (3) Many uses of water resources have unusually significant spillover or external effects. Storage of water at one location on a river influences power output at another location downstream. Use of a stream for waste disposal may be distinctly advantageous to a city or plant, but such use may impose costs or damages upon others downstream. 21/

The theory of economic welfare can be systematically applied to spell out the conditions essential to achieve efficiency of activities possessing these characteristics.

A transfer process designed to allocate a limited or scarce resource to the highest competing or the most productive use may be regarded as efficient. In order to assess the efficiency of the transfer process, the duration of the rate of growth has also to be taken into account. For instance, a very rapid short-run growth may be socially less desirable than a somewhat lower rate of growth over a longer time period.

21/ Fox, Irving, K., op. cit., p. 63.

A more difficult problem relates to the impact of water transfer on the question of equity. The effect of specific types of water transfer on income distribution, either directly or indirectly, through changes in real output is one of the principal aspects to be considered. Equitable economic growth, for the purposes of this analysis, is regarded as representing a positive rate of change of the real output of an economy with a smaller aggregate variation from the mean on a per capita basis. A per capital definition of equitable growth may not, however, be adequate. For example, regional income differences may be increased, although on a per capita basis it may appear that equity criteria are fulfilled. In studying the growth process from a long-run perspective, therefore, economic implications of such regional inequities which appear over time through the political processes are considerable and they have to be taken into account.

A final problem to be resolved relates to the manner in which public water is priced. If it is valued at market prices (and this assumes that the method of water transfer involved uses prices determined on some sort of a market), perfection in the product market assumes greater importance. If, on the other hand, water is valued at factor cost (as is done by the Department of Commerce), then the interests of equity dictate perfection of the factor markets. 22/ The purpose behind these requirements is to guard against the accrual of large amounts of quasi-rents on either of these two markets.

22/ Brewer, Michael, "Water Transfer and Economic Growth", op. cit., p. 81.

These are some of the major economic problems involved in a process of water transfer. And they set an appropriate background for an analysis of the institutional factors affecting the reallocation of water among alternative uses.

CHAPTER III

THE LEGAL FRAMEWORK: A CRITICAL APPRAISAL

Introduction

The strategic role of water in the development of the semi-arid and arid regions is nowhere more manifest than in the legal doctrines governing its control and use.

This chapter is an attempt to study critically the many facets of the legal framework encompassing water-resource development in the West. Section 1 examines in detail the implications of the two basic water laws in the United States--the riparian and appropriation doctrines--and evaluates their merits and demerits. This serves as a background to the next section which attempts to illustrate the general theory discussed above with specific examples from a number of Western states. The analysis deals with surface water laws and ground water laws separately. The final part ties in the whole discussion with the crucial problem of water transfer. This section analyzes the close inter-relationship between water-rights and the problems of water transfer, points out how the existing legal doctrines act as a deterrent to the transfer of water between uses and users, and brings out the necessity for overhauling the prevailing legal framework.

Water Laws: Theory

The rights of individuals to the ownership and use of water from different sources are determined in the United States on the basis of two principal legal doctrines: (1) the Doctrine of Riparian Rights and (2) the Doctrine of Prior Appropriation. In general, the Riparian Doctrine

prevails in virtually all the states (with the sole exception of Mississippi) east of the Mississippi River. The 17 states west of the Mississippi employ the Doctrine of Prior Appropriation in one form or another. Before proceeding to an analysis of the two systems of water laws, it would be well to explain the legal implications of the term "water-rights".

Water Rights

Legally recognized rights to the use of water are considered as water-rights. These rights, whether held under the Riparian or Appropriation Doctrine, are rights in real property. Consequently, they are as much entitled to the same protection of the law as are other classes of property rights. 1/

Water rights are acquired and exercised in accordance with state laws, both under the Riparian and Appropriation Doctrines. Federal laws establishing a general procedure for the requisition of rights to the use of water are non-existent. It is significant to note that the United States Supreme Court has time and again recognized the power of each state to adopt its own system of water laws.*

The Riparian Doctrine

The Riparian Doctrine is generally considered to have evolved from the English common law. The Doctrine was first recognized in the English

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1/ Timmons, John F., et al., Iowa's Water Resources - Sources, Uses and Laws, (Ames: The Iowa State College Press, 1956), p. 99.

*See, Wantrup, Ciriacy, "Concepts Used as Economic Criteria for a System of Water Rights", Economics and Public Policy in Water Resource Development, (Ames: Iowa State University Press, 1965) for an excellent analysis of the economic dimensions of water rights.

law in 1833. Since it became a part of the common law of England, the states and territories of the United States that adopted the English Common law thereby adopted the Doctrine of Riparian Rights.

The basic principles underlying this Doctrine are stated by Wells A. Hutchins:

> Under the Riparian Doctrine in its strict sense, the owner of land contiguous to a water course is entitled to have the stream flow by or through his land, undiminished in quantity and unpolluted in quality, except that any Riparian proprietor may make whatever use of the water he requires for domestic and household purposes and the watering of farm animals. In its modified sense, the Doctrine allows each proprietor to make such use of the water for the irrigation of his Riparian land as is reasonable in relation to the similar requirements of other proprietors of land riparian to the same stream; and under the more recent developments the riparian owner's use of water must be reasonable with respect to the needs of appropriators of the water for use on non-riparian land. 2/

The salient features of the Riparian Doctrine are:

1. The right of a riparian owner extends only to the use of the riparian water, and carries with it no ownership of the water itself. This means that riparian owners have usufructuary, but not proprietary rights in the water that flows by their land.

2. Rights to use stream water depends upon location, the primary requirement being that the user owns lands contiguous to the stream. Riparian rights are limited to riparian land.

3. Riparian rights do not depend upon an owner's use of water and in normal circumstances cannot be lost through non-use or dis-use.

2/ Hutchins, Wells A., Selected Problems in the Law of Water Rights in the West, U. S. D. A., Miscellaneous Publications 418, (Washington, D. C., 1942), p. 39.

4. There is no requirement that the water be put to beneficial use.

5. Although the riparian owners can use the water for a variety of purposes, except for domestic or stockwatering purposes, they have no right to divert or take more water from a stream or lake than they expect to return to it.

The Riparian Doctrine, as noted earlier, prevails throughout the east (barring Mississippi). The system of Riparian Rights, no doubt, has undergone a number of minor changes in details from state to state, especially in recent years.* However, the basic characteristics of the Doctrine still remain more or less the same.

> Its advantages . . . are principally those which stem from its flexibility; its major disadvantage is the companion characteristic of uncertainty, together with the limitations inherent in a system of administration by the courts. 3/

The foregoing discussion indicates that a law of this nature is extremely inadequate to meet the conditions and needs of the semi-arid and arid Western states. For one thing, rights to the use of stream waters are restricted to Riparian owners; secondly, this water law which provides for equality of use discourages investment and the development of a stable agriculture. Further, the provision that the stream must

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3/ Martin, Roscoe C., Water for New York, (Syracuse University Press, 1960), p. 108. (Chapter IV of this book contains a lucid discussion of water resource law.)

*An instance in point is the emergence of the concept of "reasonable use" in Riparian Law. Under this "reasonable use" theory, the interest of the riparian that received protection is not in the natural state of the stream but in the use of water actually enjoyed.

remain where it is accustomed to flow, undiminished in quality and unimpaired in quality, renders this law unsuited to agriculture. 4/

The Appropriation Doctrine

As people began to settle in the arid lands of the Western states, it became increasingly clear that the Riparian Doctrine was basically unsuited to the conditions obtaining in these states. And thus began the search for a new water-rights law which would recognize the strategic role of water in the development of these water-short areas.

> This system originated in the west in the mid-nineteenth century, where water was scarce and laws were rudimentary or often times non-existent. It grew from the practice of the early settlers of taking water where they found it and using it where they needed it. In the course of time, and by common agreement, a crude system of notice was adopted to indicate the amount taken by and the nature of the use by each appropriator. 5/

The principal features of the Appropriation Doctrine are:

1. It gives an exclusive right to the first appropriator; and, in accordance with the Doctrine of Priority, the rights of later appropriations are conditional upon the prior rights of those who have preceded.

2. It makes all rights conditional upon beneficial use--as the Doctrine of Priority was adopted for the protection of the first settlers in time of scarcity, so the Doctrine of Beneficial Use became a protection to later appropriators against wasteful use by those with earlier rights.

4/ Dunbar, Robert G., The Search for a Stable Water Right in Montana, Agricultural History, vol. 28, (October 1954), pp. 138-149.

5/ Martin, Roscoe C., op. cit., p. 109.

3. It permits water to be used on non-riparian lands as well as on riparian lands.

4. It permits diversion of water regardless of the diminution of the stream.

5. Continuation of the right depends upon beneficial use. The right may be lost by abandonment, statutory forfeiture, adverse use and estoppel. 6/

The basic principle underlying the Appropriation Doctrine is summed up by the catch phrase "first in time, first in right". This suggests that the key feature of the Appropriation Doctrine is its recognition of priorities in appropriative rights. Raleigh Barlowe illustrates the operation of these priorities with the aid of a diagram depicting a stream upon which several claims for water have been filed (Figure 10).

It is assumed

> that the first and sixth claims involve riparian users who take water to irrigate relatively small acreages, that the second and fifth priorities are held by irrigation projects along the stream, that the fourth priority involves a large irrigation project located several miles away from the stream, and that the third priority is held by a downstream hydroelectric plant which claims a definite minimum flow of the stream at all times.
>
> Regardless of their location along the stream, each of these claimants enjoys water rights only in accordance with the priority of his (or its) claim. The first and second claimants may expect to take water up to the full amount of their claims at any time. After them, the power company can

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6/ Huffman, Roy., Irrigation Development and Public Water Policy, (New York: The Ronald Press Company, 1953), p. 43.

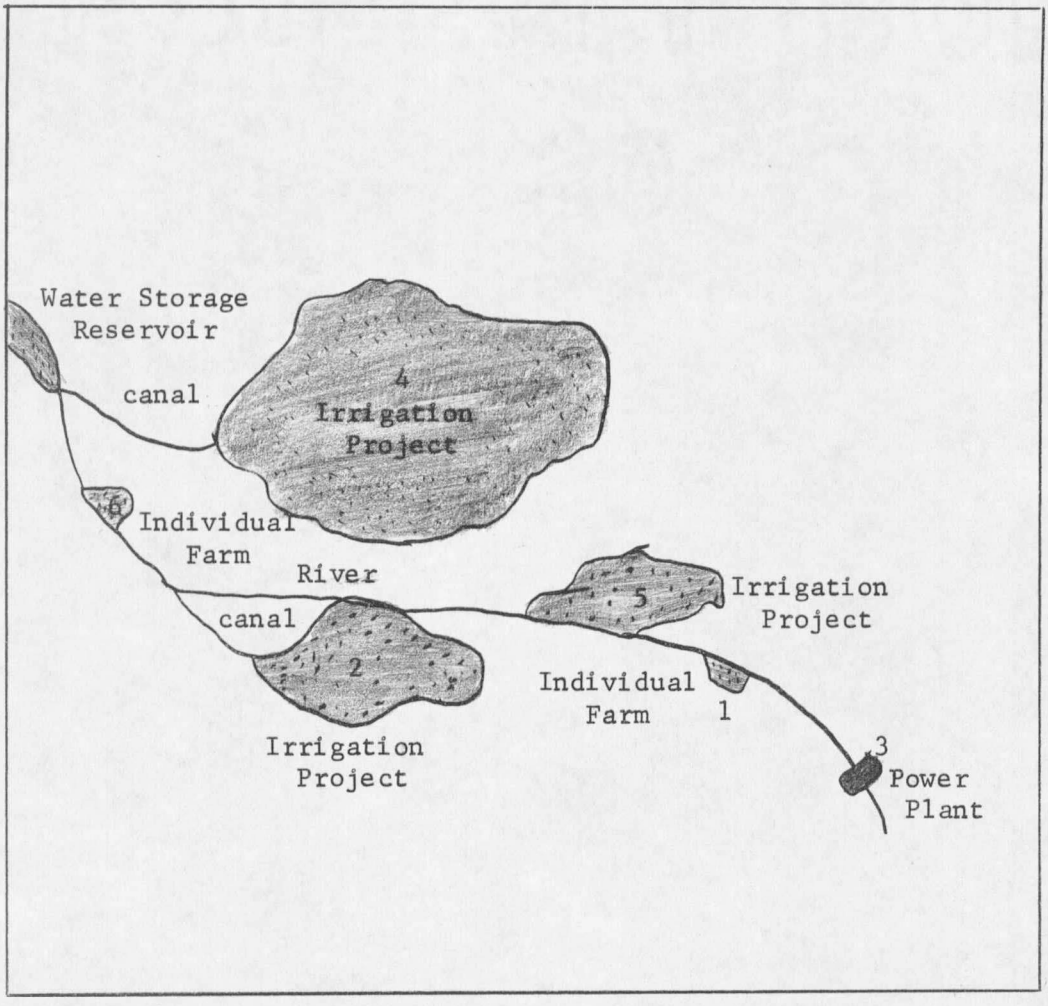


Figure 10. Example Showing Priorities in Appropriative Rights Under the Appropriation Doctrine.

Source: Barlowe, Raleigh, Land Resource Economics, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1961), p. 358.

> insist upon a minimum natural flow of the stream which may take all of the flow during drouth periods. Since the priorities of the first three claimants may entitle them to the full flow of the stream during the drier months of the year, the remaining claimants can find their rights cut off at the very time they feel the greatest need for irrigation water. They can remedy this situation by building an upstream storage reservoir which will hold seasonal flood water for later use. 7/

The appropriation system has been gaining increasing importance in recent years, even in the eastern states because of the advantages of this system over the traditional Riparian Doctrine. Roscoe Martin gives an account of these advantages:

> Among these, the principle of full utilization of the water resources deserves to be ranked first. Second, the appropriation system permits the use of water where needed without tying use to riparian ownership. Third, it restricts the appropriator to beneficial use, both as to purpose and as to amount and makes possible the reappropriation of excess amounts not beneficially used. Fourth, the amount, purpose and place of use of appropriated water are definitely indicated and this adds an element of certainty which is unknown under the riparian system. Fifth, management of water resources by the courts through individual case rulings gives way under appropriation to management by a full-time administrative agency staffed by experts. 8/

> The concept of beneficial use in appropriation law is of fundamental importance in western water law. . . . The application of water to useful and beneficial purposes is the sine aua non of a water right expressed under the Doctrine of Prior Appropriation. This concept is frequently expressed in the maxim that benficial use is the basis, the measure and the limit of the right to use water, and the concept has been enacted into the statutory law of many Western states and incorporated into the federal reclamation law. 9/

7/ Barlowe, Raleigh, Land Resource Economics, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1958), p. 358.

8/ Martin, Roscoe C., op. cit., p. 111.

9/ Trelease, Frank J., "The Concept of Reasonable Beneficial Use in the Law of Surface Streams", Economics and Public Policy in Water-Resource Development, (Ames: Iowa State University Press, 1965), p. 277.

The appropriation doctrine has been designed from the start to deal with a short-supply situation. However, it has not succeeded fully in accomplishing this task in the various Western states which face an almost perennial water shortage.

Water Laws in the Western States: Practice

The purpose of this section is to study the actual operation of the doctrine of prior appropriation in a number of Western states. For the sake of analytical clarity, the application of the law with reference to surface water and ground water is considered separately. The discussion that follows brings out some significant points:

1. The doctrine of prior appropriation has undergone a number of changes in the course of the last several years.

2. The actual changes vary from state to state and have been mostly in the nature of specific modifications suited to special conditions obtaining in the various states.

General Survey

It is generally regarded that the doctrine of prior appropriation governs the control and use of water in the 17 states west of the Mississippi.* Almost all of these states are either arid or semi-arid in nature.

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*These states are: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming and constitute the Western of two hydrologic environments. However, actually only eight inter-mountain states--Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming--employ prior appropriation to the exclusion of the riparian doctrine. Oregon is also listed with these states since it has given up the riparian doctrine except for its application in a few early cases in which riparian rights were established for beneficial uses. The remaining eight Western states employ a blend which recognizes some features of both systems. In other words, the appropriation principle is used in combination with the riparian doctrine. (See: Barlowe, Raleigh, Land Economics, Ch. 12 and Martin, Roscoe C., Water for New York, Ch. 4).

In other words, the overall water supply in these states is always sufficient to grow crops on all the land available. There are, however, scattered areas of perennial water surplus within the region, chiefly along the north Pacific Coast and high in the mountain ranges. Except for these "purple patches", most of the area encompassed by these Western states is basically water-short.

Viewed in this perspective, the critical importance of water for agriculture in the West becomes self-evident.

> The quantity of water available is far short of the quantity that would be required for the farming of all agricultural lands. The need for irrigation varies widely, the primary consideration in a given area being the deficiency of precipitation during the growing season with regard to the quantity of water required for crop growth. In some portions of the West, then, irrigation is seldom required; in other areas, it contributes to a wider range of crop production than would be possible with complete dependence on precipitation; and in still others, it is necessary to practically every form of dependable agricultural development. 10/

Much of the problem, thus, stems from the simple fact that there is more land than water in the West. 11/ Prescott Webb brings the whole situation into bold relief in his revealing chapter on "The Search for Water in the Great Plains", with the following observation:

> An examination of the rainfall map of the United States reveals clearly that the Great Plains environment has a far lower water supply than is found in the region east

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10/ Hutchins, Wells A., op. cit., pp. 64-65

11/ Hodge, Carl, (Ed.), Aridity and Man, American Association for the Advancement of Science, Publication No. 74, (Washington, D. C., 1963). (Gives a searching analysis of the challenge of the arid lands in the United States with special reference to the strategic role of water.)

> of the 98th Meridian. From the time that men first crossed the line as explorers down to the present, there has been in this region a constant and persistent search for water. 12/

It is pointed out that if "every drop of water which falls on the mountains of the West could be made available, there would not be enough to supply one-half of the land suited to irrigation." 13/ The situation has not changed significantly even today and the search for water still continues.

Wells Hutchins has pointed out that the state procedures apply to appropriations in the different states, whether made on private lands or on the public domain. The relation of the United States Government to the appropriation doctrine is essentially a matter of recognizing state customs and laws upon the subject. All of the 17 Western states have statutes providing for the appropriation of water. The early enactments were, as a rule, brief and gave the sanction of law to customs then in effect. It is interesting to note that in various states the earliest statutes were enacted long after the beginning of irrigation development. An instance in point is California. Although the appropriation doctrine in its generally accepted form originated in California, the first legislative authorization to appropriate water was made as late as 1872.

12/ Webb, Walter Prescott, The Great Plains, (New York: Grosset & Dunlap, 1931), p. 319.

13/ Ibid., p. 319.

Similarly, irrigation in Nevada began as far back as 1849; but the first general legislation on the subject did not appear until 1866.

A review of the actual implementation of the appropriation doctrine in the several Western states points up some salient features: 14/

1. Administrative procedure governing the acquisition, determination and administration of rights, in contrast with its early stages, has become highly developed throughout the West. The present procedures are based largely upon those which originated in Colorado and Wyoming. The state's supervision and control are usually exercised through the state engineer or other corresponding official, and the courts. In some states a board or department of the state government exercises control.

2. The centralized system of public control over water rights has not been completely applied in all states and has been more successful in some places than in others. However, it is a workable system generally and its foundation is the state's vital interest in the orderly utilization of its resources.

3. Many of the states have specifically dedicated unappropriated waters to the public. Dedication of waters to the public, for the purpose of laying the legal foundation for their appropriation and use under state regulation, is made by Constitutional provision in some states, but by statute in most of the states in the West. Some of the provisions refer to all waters in the state, and some speak of certain classes only. Such dedication of water is subject to vested private rights, as well as to the rights of the federal government.

Surface Water Rights

The doctrine of prior appropriation, in one form or another, constitutes the basis of the water laws relating to the ownership, control and appropriation of surface waters in most of the Western states. Whatever

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14/ Hutchins, Wells A., op. cit., p. 75, p. 77, p. 78 respectively.

changes have been made are mostly alterations to suit the special conditions existing in the different states. Thus, the basic purpose behind these modifications was to enhance the operational efficiency of the original doctrine.

Arizona provides a typical example of a Western state which has repudiated the riparian doctrine in very clear terms and has based its water laws on the doctrine of appropriative rights. The courts have specifically held, time and again, that the riparian doctrine has been repudiated. However, for nearly three decades no efforts were made by the Territorial government to regulate the manner in which a valid appropriation should be made. The determination of the methods for a valid appropriation was left entirely to the courts. The State Water Code of 1919 wrote into the legal structure of the state the principles which had governed the decisions of courts for many decades. 15/

The doctrine of appropriation governs the acquisition of water rights in Colorado to the exclusion of the riparian doctrine. This was settled as far back as 1882 in Coffin V. Left Hand Ditch Company when the Court stated:

> We conclude, then, that the common law doctrine giving the riparian owner a right to the flow of water in its natural channel upon and over his lands, even though he makes no beneficial use thereof, is inapplicable to Colorado. Imperative necessity, unknown to the countries which gave it birth,

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15/ Mann, Dean E., The Politics of Water in Arizona, (Tucson: The University of Arizona Press, 1963), p. 38.

> compels the recognition of another doctrine in conflict therewith. 16/

The United States Supreme Court stated, in 1922, concerning Colorado and Wyoming: "The common law rule respecting riparian rights in flowing water never obtained in either state". On the basis of these and a number of other court decisions, Wells Hutchins concludes that Colorado had at no time recognized the riparian doctrine. 17/

California has long recognized both the riparian doctrine and the doctrine of appropriation. The California Civil Code provides that all waters within the state are the property of the people of the state, and that running water flowing in a river or stream or down a canyon or ravine is subject to appropriation. 18/ This resulted in a unique situation in as much as it attempted to combine two systems of water rights that are inherently in conflict. The inevitable result was extensive litigation. As one writer points out:

> California's recognition of riparian rights in surface streams created an unavoidable conflict with use under appropriation rights for which a basis of compromise was not found until there has been 40 years of litigation. 19/

However, the conflicts between the water systems finally began to be resolved and eventually the state has been able to evolve a workable system of water rights.

16/ Six Colorado 443 (1882).

17/ Hutchins, Wells A., op. cit., p. 85.

18/ California Civil Code (Section 1410).

19/ Harding, S. T., Water In California, (Palo Alto: N. P. Publication, 1960), p. 26.

> Out of the experience of the first hundred years of statehood, California had developed a workable water right system under which those using water could determine the security of their title to their use and those planning projects to use unappropriated water could predict, with reasonable certainty, the water which might be available for use. 20/

In 1913 the California Legislature enacted a general Water Commission Act covering all uses of water. This Act which became effective in December 1914, along with the subsequent amendments, form the basic statute governing appropriation rights in surface streams. The Water Commission Act was codified in 1943 as part of the Water Code.

Ground Water Rights

Ground water, technically, refers to all available water supplies under the surface of the earth. . . ."all water in the ground that is free to move by gravity and to enter wells, capable of being extracted from the ground and susceptible to practicable legal control". 21/ Ground water occurs due to the precipitation and absorption of surface waters, including those flowing in streams and is continually in motion from higher to lower areas on account of geological conditions and hydrostatic forces.

From a legal standpoint, ground water is usually divided into two categories: (1) water flowing in defined subterranean streams and (2) percolating, i.e., water flowing in channels reasonably ascertainable.

Ground water hydrologists have criticized the above classification of ground water into two distinct categories as having no scientific

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20/ Ibid., p. 29.

21/ Hutchins, Wells A., op. cit., p. 146.

basis or satisfactory applicability. 22/ For example, Thompson of the United States Geological Survey points out that "much of the classification of ground water adopted in many court decisions and by wirters of legal textbooks is not consistent with scientific principles of ground water hydology". 23/ Consequently, this distinction has been removed from the water rights statutes of a number of Western states, e.g., Idaho, Kansas, Nevada, Oregon, Utah, Wyoming and North and South Dakota. However, several states, including both California and Texas, "with their great developments of ground water for various purposes and their millions of acres of irrigate land" still retain this historical distinction. Even though the distinction between underground streams and percolating waters made in court decisions is not always scientific, still the distinction has gained wide recognition in almost all legal discussions of ground water.

The rights of individuals in ground water arise from two contrasting doctrines of law: (1) The Common Law or English Doctrine which emphasizes that the water is the absolute property of the owner of the overlying land in perpetuity; and (2) the Doctrine of Prior Appropriation, whose fundamental principle is that the "first in time, is the first in right". 24/

22/ Thompson and Fielder, "Some Problems Relating to Legal Control of Use of Groundwaters", 30 Journal of American Water Works Association, 1049-61.

23/ Hutchins, Wells A., op. cit., p. 25 (quoted).

24/ Piper, Arthur M., "Interpretation and Current Status of Ground Water Rights", papers delivered at the water rights conference held at the Kellogg Center, Michigan State University, East Lansing, Michigan, (March 1960), p. 68.

Water rights play a decisive role as far as the optimum use of the ground water resources is concerned. Wells Hutchins, while discussing the relations of the individual rights to the public interest, points out that protection of private rights of property is a matter of public concern, because constitutional rights are invoked in securing the individual's rights.

> Substantial private rights will be and should be protected. This is in the public interest. On the other hand, the perpetuation of unsubtantial, unused and ill-used rights in an overdrawn ground water reservoir is not in the public interest. Recent high court decisions, few though they are, indicate a growing awareness of this. 25/

The use of underground streams, in many of the Western states, is governed by the same water rights doctrine that is applied to surface waters. For instance, if a definite underground stream is found in a riparian doctrine state, its waters are normally subject to the riparian rights recognized in that state. Likewise, if the underground stream is located in an appropriation or modified riparian doctrine state, its waters in most cases are available for appropriation. 26/

The laws relating to the ownership and use of percolating ground water have been developed mainly by the courts.

> With such exceptions and exemptions, statutes invoking the doctrine of prior appropriation have been applied to all ground waters in Colorado, Idaho, Kansas, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. Arizona applies the doctrine in declared

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25/ Hutchins, Wells A., "Groundwater Legislation", Rocky Mountain Law Review, Vol. 30, No. 4, 1958, pp. 1-25.

26/ Barlowe, Raleigh, op. cit., p. 360.

> 'critical areas' for use of water on newly developed land. In California, the doctrine applies to ground water that may be surplus to the needs of overlying landowners and that are proposed to be exported beyond the basin of origin. 27/

Wells Hutchins points out in his discussion of ground water legislation, that the English rule was replaced in some states by the American rule of reasonable use.

> This rule recognizes the landowner's right to capture and use the water that exists in his land, but limits him to such quantity of water as it is necessary for some useful purpose in connection with the land from which the water is extracted. The chief limitations are that waste of the water, or export of the water for distant use, are not reasonable if the result deprives other overlying landowners of the opportunity to make reasonable use of the common supply of their own lands. 28/

How precisely does the doctrine of prior appropriation operate with respect to the control and use of ground water? Figure 11 illustrates this. 29/

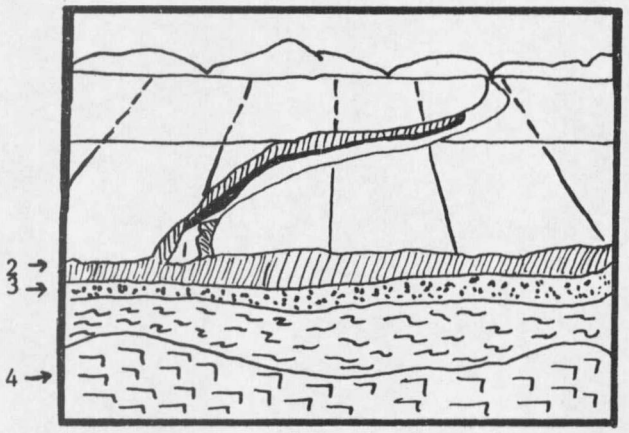
New Mexico has a highly regarded ground water code which asserts public ownership of the ground waters of the state and provides for their apportionment in the public interest. New Mexico Appropriative Groundwater Statute was the first to be put into wide administrative operation and it has established a general pattern for much of the subsequent legislation of that sort. The Statute was first enacted in 1927, was ruled invalid owing to technical defects, and was replaced by the current statute enacted

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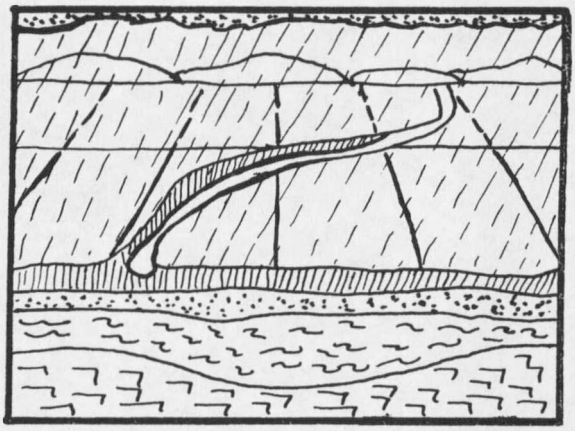
27/ Piper, Arthur M., op. cit., p. 71.

28/ Hutchins, Wells A., "Groundwater Legislation", Rocky Mountain Law Review, op. cit., pp. 1-25.

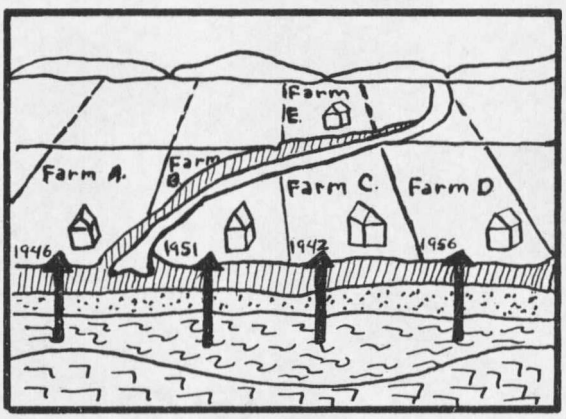
29/ Oklahoma Water Resources Board, Oklahoma's Water Resources, (Oklahoma City: 1960), p. 33.



A.--A cross section of sub-surface. (1) Stream or dry stream bed. (2) Layer of top-soil. (3) Pervious material - sand, gravel, etc. (4) Underground material - rock, shale.



B.--Recharge by rainfall and seepage downward to sub-surface area.



C.--Appropriation of water.

Farmers A, B, C, and D have appropriated ground water in the years 1946, 1951, 1942, and 1956, respectively. Farmer E decides to apply. If the state has a system for controlling appropriations of ground water, then the Administrator will decide on the application. If the state has no administrator, but still has the system of prior appropriation, then the application may be decided by a local administrator or by the courts through an adjudication.

If ground water levels are lowered to an excessive extent, the latest appropriators may be ordered, in reverse order of appropriation, to stop pumping until the situation is alleviated. The first in time is the first in right.

Figure 11. An Example of Prior Appropriation.

Source: Oklahoma Water Resources Board, Oklahoma's Water Resources, (Oklahoma City: 1960), p. 33.

in 1931 and amended by additions in 1953. Basic provisions of the statute are given below:

> 75-11-1. The water of underground streams, channels, artesian basins, reservoirs, or lakes, having reasonably ascertainable boundaries and hereby declared to be public waters and to belong to the public and to be subject to appropriation for beneficial use. (Modified by 75-11-9 and 75-11-21, below.)
>
> 75-11-2. Beneficial use is the basis, the measure, and the limit of the right to the use of the (ground) waters.
>
> 75-11-9. All underground waters of the State of New Mexico are hereby declared to be public waters and to belong to the public of the State of New Mexico and to be subject to an appropriation for beneficial use within the State of New Mexico. All existing rights to the beneficial use of such waters are hereby recognized.
>
> 75-11-20. No person shall withdraw water from any underground source in the State of New Mexico for use in any other state by drilling a well in New Mexico and transporting the water outside the state or by drilling a well outside the boundaries of the state and pumping water from under lands lying within the territorial boundaries of the State of New Mexico.
>
> 75-11-21. No permit and license to appropriate underground waters shall be required except in basins declared by the State engineer to have reasonable ascertainable boundaries.
>
> 75-11-22. The State engineer and the attorney general or the various district attorneys are authorized and directed to use any and all legal means necessary to enforce the provisions of (the act).

In 1950, the constitutionality of the New Mexico statute was challenged, but the court upheld its validity. The challengers argued that the waters at issue were their absolute property, since they were owners of the overlying land (invoking the principle of the common law doctrine). The court maintained, however, that the Desert Land Act of 1877 had set apart those waters for disposition by the state.

The appropriation doctrine is regarded as the sole basis for a right to surface water or ground water in New Mexico. But, it is interesting that the State Supreme Court in 1958 declared that the town of Las Vegas has a paramount right to all the water required for its continued growth, on the basis of a Mexican colonization (Pueblo) grant in 1835. 30/

In Texas the use of ground water is regulated by the common law doctrine. The state authorizes groups of water users to form conservancy districts for "the conservation, preservation, protection and recharging and the prevention of waste of the underground water of an underground water reservoir or subdivision thereof". 31/ In the high plains area of Texas, districts have been formed and are operating under this act. 32/

Ground water plays a dominant role in the overall water supply of Arizona. For example, as much as 70 percent of the total water used for irrigation in the state in 1952 came from ground water sources, causing a considerable lowering of the ground water level. The first serious attempt to regulate the use of ground water in Arizona found expression in the form of the Ground Water Code of 1948. This Water Code, however, suffered from serious defects and in 1951 a committee was appointed to study the ground water situation and to recommend methods of strengthening the Water Code. Recommendation of the Underground Water Commission was

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30/ Thomas, Harold E., "Essentials for Optimum Use of Ground Water Resources", Western Resources Conference 1959, (Boulder: University of Colorado Press, 1960), p. 184.

31/ Texas Laws, 1949, Underground Water-Bill, Section 3c.

32/ Duggan, "Texas Groundwater Law", Proceedings 1954, University of Texas, Water Law Conference.

that there was great need for regulatory legislation to prevent further excessive discharges in this direction. Dean Mann has very well summed up the existing situation with respect to ground water use in Arizona:

> Ground water laws have perhaps prevented the expansion of agriculture and further over-development of land dependent on ground water, but they have not redressed the serious imbalance of withdrawal and supply that existed before the laws were put on statute books. 33/

The ground water law in Nevada is based on "preferential use". 34/ This resembles closely the "highest and best use" of the modified doctrine of riparian rights. The incorporation of "preferential use" into the ground water law of Nevada is, in part, an attempt to solve the problem of ground water basin discharges. These discharges have resulted in marked reduction in the capacity of the reservoir, cracking of masonry and concrete floors, ruptures of pipelines leading from wells, damage to pumping equipment, broken water lines, and cracked curbs and streets.

> Under this authorization (Nevada State Law NRS534 . 120, Art. 2) the drilling of irrigation wells has been prohibited in the highly developed part of Las Vegas Valley, although municipal and domestic wells still may be drilled. The state also has recognized preferential use of water for domestic use in that a maximum of 1,440 gallons per day per household may be withdrawn for domestic use without regard to other water rights. 35/

The basic rule that governs the rights to the use of ground water in California is an outgrowth of the American rule of reasonable use

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33/ Mann, Dean E., op. cit., p. 66.

34/ Geological Survey, The Groundwater Situation in Nevada, 1960, (Washington, D. C.: United States Department of the Interior, 1961), p. 6.

35/ Malmberg, G. T., Land Subsidence in Las Vegas Valley, Nevada, Geological Survey, (Washington, D. C.: United States Department of the Interior, 1964), p. 6.

known as the California Correlative Doctrine, or doctrine of correlative rights. This doctrine implies that

> the rights of all landowners over a common basin, saturated strata or underground reservoir are co-equal or correlative, and that one landowner cannot extract more than his share even for use on his own lands, where the rights of others are injured thereby; nor can he claim more than this share on the ground of peculiar benefit to him from its use.

Thus, rights of use under this doctrine are based on location of the land in relation to the water supply. In other words, owners of all lands that overlie supply of percolating water have correlative or co-equal rights to the use of the water, just as have the owners of riparian lands in the waters of the stream to which their lands are contiguous. 36/

Water Rights and Water Transfer

Water rights or laws governing the ownership and use of water constitute a significant institutional factor in water resource development in the United States. A study of the problem of water transfer in relation to water rights will reveal that the two are inextricably interwoven. In other words, water laws obtaining in a particular area have a very definite bearing on the problem of water transfer. What follows is an attempt to study how precisely the two major water laws--riparian and appropriation doctrines--limit and/or obstruct the free transfer of water between uses

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36/ Hutchins, Wells A., "California Groundwater: Legal Problems", California Law Review, December 1957, p. 689.

(domestic, municipal, agricultural, industrial, recreational, etc.) and users (individuals, firms, public districts, government agencies, etc.).

The Riparian Doctrine.--Clyde O. Martz points out that the strict riparian doctrine could obstruct desirable water transfer in three distinct ways.

> First of all, the right, being part and parcel of riparian land, cannot be transferred to non-riparian domestic, industrial, or agricultural purposes over the objection of other riparian proprietors on the stream. . . . Except to the extent that particular states have given constitutional or statutory recognition to non-riparian uses on some other basis than riparian right, this aspect of the riparian doctrine severely limits water transfers. A second limiting factor in the riparian doctrine exists in the fact that riparian land is generally confined to the watershed of the source stream and to a reasonable distance from the point of any diversion. A third limitation on transfer exists in the narrow classification that has been given to privilege riparian uses in many jurisdictions. 37/

Riparian doctrine in its strict form has been modified in recent years by most of the states to a reasonable use doctrine which permits a number of consumptive and moderately polluting riparian uses. Although this is an improvement over the old one in many respects, it still continues to be a deterrent to free water transfer. Since it bases rights on land ownership, it will always obstruct transfers to non-riparian lands and uses, to lands beyond a stream watershed or more than a reasonable

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37/ Martz, Clyde O., "Legal Problems in Water Transfer", Water Transfer Problems, (Report No. 10), Conference Proceedings of the Committee on the Economics of Water Resource Development of the WAERC, (Portland, Oregon: December 1961), p. 41.

distance from the supply, "and to uses that are not compatible with the natural flow of reasonable-use variations of the doctrine in particular jurisdictions".

The Appropriation Doctrine.--One characteristic of the appropriation doctrine tends to impede the free transfer of water between uses and users.

> That is the prevailing idea that the appropriation extends not to water alone, or to beneficial use, but to the level and period of stream flow that existed at the date of appropriation. While the courts are reluctant to maintain the level of stream flow as against junior parties seeking to make a full appropriation of the source, they have been willing to give both seniors and juniors this protection against changes in the character or place of appropriation. Although this practice does not prevent the full appropriation of the stream, it most certainly obstructs the free transfer of water from original low productive uses to high productive uses that may be dictated by economic and population growth. 38/

According to Martz,

> doctrinal barriers to the transfer of water are much more inherent in the riparian system than in the appropriation system. The latter produces barriers of this kind only to the extent that it gives an appropriator a claim on the current and level of the stream beyond that needed for his present beneficial uses. 39/

Wantrup also expresses the same view when he states:

> Appropriative rights are better suited for such transfer (i.e., transfer of water rights) than riparian rights because the former are clearly defined in quantity, priority, points of diversion and other ways. 40/

38/ Ibid., p. 44.

39/ Ibid., p. 44.

40/ Wantrup, Ciriacy, "Concepts Used as Economic Criteria for a System of Water Rights", Economics and Public Policy in Water Resource Development, (Ames: Iowa State University Press, 1965), p. 261.

All this does not imply that the appropriation doctrine is the most ideal system for facilitating the desirable transfer of water between uses and users. In fact, there are several administrative, institutional, evidentiary and jurisdictional practices which render water transfer extremely difficult under the appropriation doctrine.

PART II

MONTANA'S WATER TRANSFER: ECONOMIC AND INSTITUTIONAL DIMENSIONS

CHAPTER IV

WATER TRANSFER IN MONTANA: ECONOMIC ASPECTS

Introduction

The water situation that exists in Montana at present is unique. Montana has an abundant supply of water--in fact, it is the largest headwater state in the nation and its drainage flows into two of the nation's greatest rivers: the Columbia and the Missouri. The uniqueness of the situation is that Montana is currently using less than half its water and yet has no constitutional provisions or statutes definitely recording its rights to waters originating within its boundaries. 1/ And the state cannot maintain its rights to unused water indefinitely. If additional profitable uses for the unused water are not developed without further delay, competitive uses downstream will undoubtedly establish rights to Montana water by means of prior beneficial use.

In fact, competition for Montana's water is growing swiftly and steadily. Downstream uses on the Missouri, such as barge transportation, can establish use rights. Similarly, power and other uses downstream on the Columbia can establish use rights. Further, there is the strong possibility of Montana losing its unused water through inter-basin transfers from surplus to deficit areas. 2/ Montana is one of the few states in the

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1/ Renne, Roland R., "Competition for Montana's Water Will Continue to Increase", Montana Farmer Stockman, (April 7, 1966), p. 13.

2/ From a speech given at the annual meeting of the State Rural Areas Development Committee held in Bozeman on February 17, 1966, (as reported in the Bozeman Chronicle, February 18, 1966).

nation with a water surplus. (Also included in this category are Oregon and Washington.) Although Montana does not have a real water problem now, it is edging closer to it, and without a use program, is vulnerable to losing water to other basins.

How could additional profitable uses be made of Montana's untapped water potential? This is perhaps the most important problem that merits attention in solving the situation that confronts the state. According to one estimate, Montana's water needs in the immediate future will be a minimum of an additional 5 million acre-feet a year. 3/ This estimate does not include the demand for water for industrial and recreation uses. The demand for water for recreation uses is expected to increase by leaps and bounds in the years to come in Montana. As one writer has put it, "an outdoor recreation explosion is going to hit Montana", in large measure due to an increase in the demand for water-based recreation on the part of out-of-state visitors. Also, the water demand for industrial purposes will increase, though not spectacularly. All these point to the fact that opportunities for the profitable use of water within Montana are by no means lacking. What is actually lacking is a complete, detailed and reliable inventory of the possible water uses within the state in the years to come. There is a pressing need for such comprehensive demand projections.

3/ Mooney, Thomas E., "Hungry Eyes Covet Montana Water", The Billings Gazette, (February 16, 1966), p. 12.

"Already the hungry eyes of sister western states are on Montana water and the gleam that is beginning to appear may become a firm beam within the next decade." 4/

In addition to the need for avoiding the possibility of losing Montana water to other states, there is the case for developing the State's water resources to ensure the advancement of its economy. Renne in this connection has drawn attention to the role of the new federal program in the development of Montana's water resources. "These programs provide Montana with a golden opportunity to develop sound plans and embark on water and related resource development projects that will be highly beneficial". 5/ (This aspect is discussed in detail elsewhere.)

Against this broader background we will examine and analyze in this chapter the principal economic factors that have a significant bearing on the problem of water transfer and the more efficient utilization of Montana's water resources. The section that follows outlines the current water situation in Montana in terms of the supply of and the demand for water. The third section attempts to focus attention on the need for and the problems involved in transferring water between uses and users inside Montana. Having discussed the need for water transfer, the next section proceeds to examine the important elements of the future pattern

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4/ Ibid., p. 12.

5/ Renne, Roland R., op. cit., p. 13.

of water demand in Montana. It is pointed out in this section that water-based recreation will assume a new significance in the State in the near future.

Current Water Situation In Montana

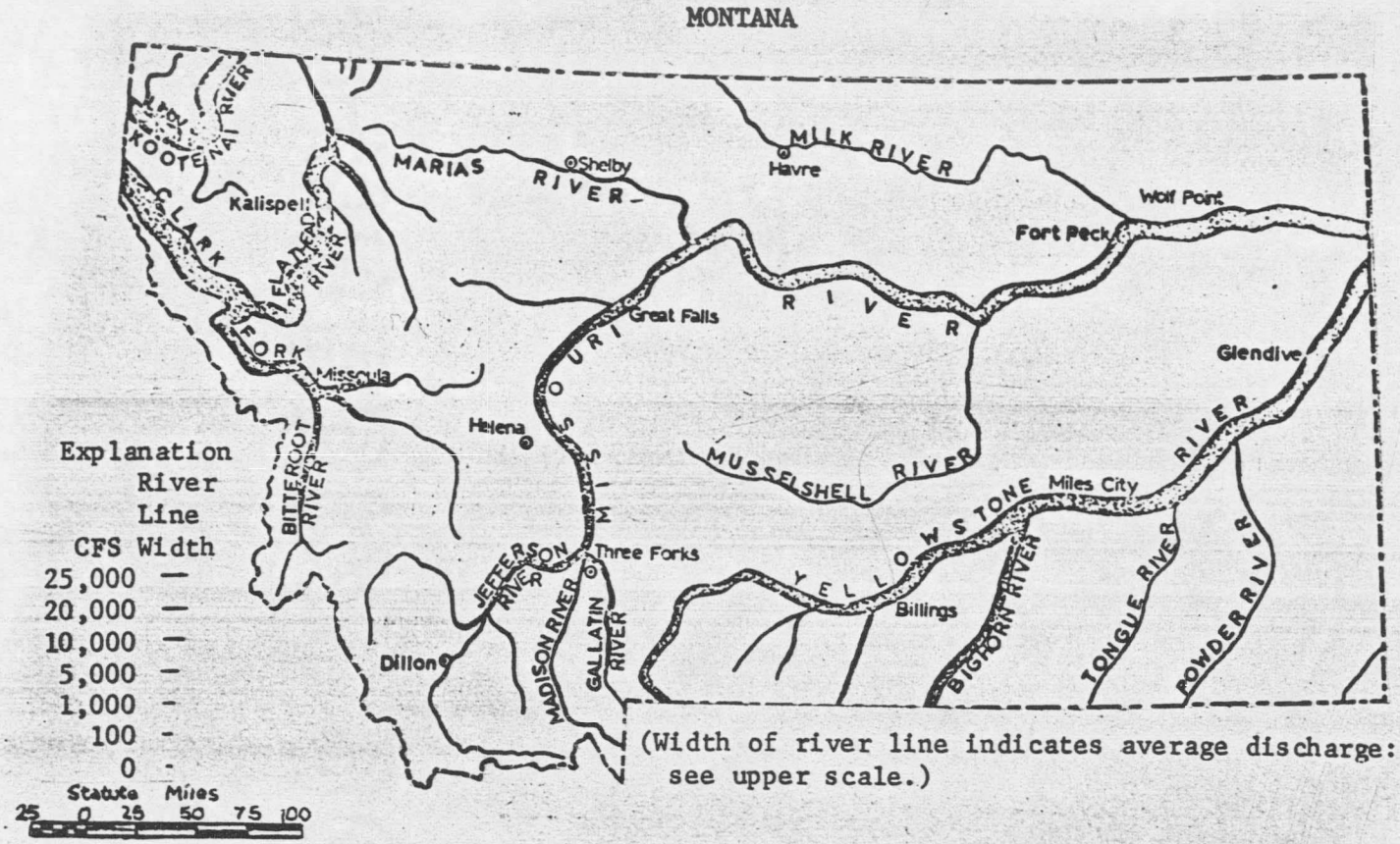
Supply of Water

Surface Water.--Surface water constitutes the major source of water supply in Montana. The surface water of Montana drains into the Pacific Ocean, the Gulf of Mexico, and the Hudson Bay. In addition, there are a few small closed basins near the northern border east of the Continental Divide and northwest of Billings. The area of Montana east of the Continental Divide lies in the Great Plains and drains into the main stem of the Missouri River or its tributary, the Yellowstone. The western part of the state abounds in mountains and valleys and is drained by tributaries of the Columbia River--the Kootenai, and the Clark Fork.

The relative discharge of the principal streams flowing through Montana is shown in the schematic map of Figure 12.* The Columbia River Basin constitutes 17 percent of the area of the state and accounts for 58 percent of the total streamflow of 63,000 cubic feet per second. Nearly 82 percent of the state lies in the Missouri River Basin and has 40 percent

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*The line width of streams represents the mean discharge. The width is varied as the square root of the discharge to enable visualization of major streams throughout their length.



(Width of river line indicates average discharge: see upper scale.)

Figure 12. Mean Discharge of Principal Streams.

Source: United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (Washington, D. C.: May 1963).

of the water supply. The Hudson Bay drainage area consists of less than half of one percent of the drainage area of the state and has almost two percent of the streamflow.

The areal distribution of the mean annual runoff as equivalent inches of depth over the land surface is shown generalized in Figure 13. The mean annual runoff varies from more than 40 inches to less than 0.25 inch and averages about 3.5 inches for the State. The generally mountainous areas west and east of the Continental Divide have a relatively high runoff. The runoff is less than one inch in about half of the State.

Groundwater.--Ground water is one of Montana's most valuable resources and there has been a steady increase in its use in recent years. The natural underground reservoirs in Montana "represent a last reserve whose intelligent and efficient use can implement and stabilize the increasing demands of population and industrial growth". 6/

Ground water studies in Montana have revealed that the distribution of ground water in the State is not at all uniform.

> The most widespread sources are beneath the plains, but many of these are too deep to be useful. The most productive aquifers are the unconsolidated valley fill in the west and the alluvium along the larger streams in the east bedrock aquifers are important as sources of domestic water, but the alluvial aquifers are those having potential for large-scale production of municipal, industrial and irrigation water. 7/

6/ Swenson, F. A., Ground Water Resources of Montana, (Talk given to Montana Reclamation Association, Billings, Montana, November 15, 1954).

7/ United States Department of the Interior, Natural Resources of Montana, (Washington, D. C.: United States Government Printing Office, 1964), p. 28.

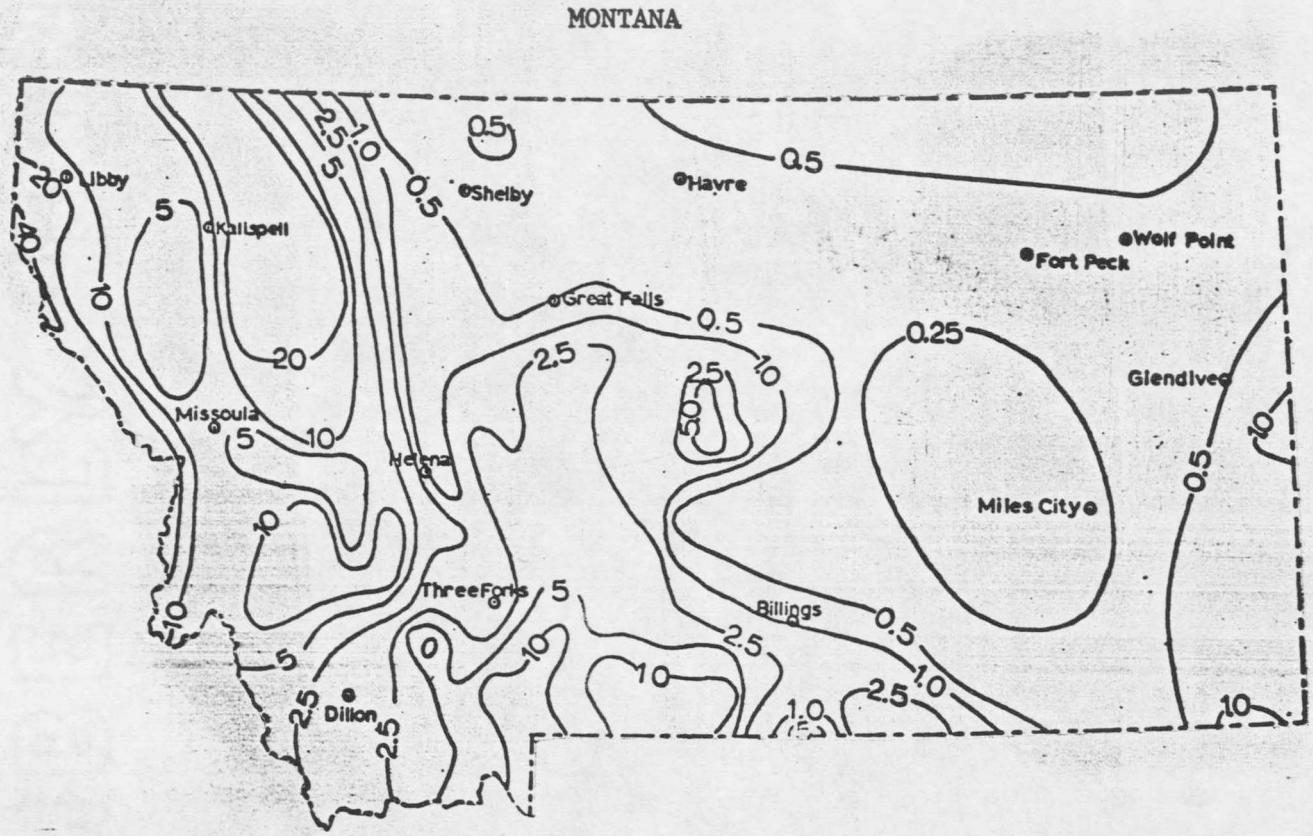


Figure 13. Mean Annual Runoff, in Inches (generalized).

Source: United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (Washington, D. C.: May 1963).

Development of groundwater in the Yellowstone River Basin has been largely for domestic and stock use and for irrigation of small gardens in the dry-land farming areas. The chief source of potable ground water is the alluvial fill found in nearly all the stream valleys and on the bordering terraces. Wells driven below bedrock encounter water-bearing strata at depths of from 100 to 4,500 feet. Deep wells are especially abundant in the central and northeastern portion of the Yellowstone Basin.

Although ground water provides at present only about one-fifth of Montana's yearly total withdrawal, there is scope for further development. Figure 14 indicates the magnitude of the ground water supplies that can be developed from wells in the unconsolidated rock deposits in various parts of Montana.

> The areas shown are those in which wells within the indicated range of yield are known to be present. The indicated well yields may not be available at all locations within the areas shown, but the potential for such well yields is favorable. Moderate to large well yields from unconsolidated rocks may be available in other parts of the State but are not yet known. 8/

Demand for Water*

Current Pattern of Water Use.--Crops and livestock constitute the principal sources of income in Montana. The intensified irrigation areas

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8/ United States Geological Survey and Montana Bureau of Mines and Geology, op. cit, p. 144.

*The data appearing in this section have been taken mainly from the following two publications: United States Department of the Interior, Natural Resources of Montana, (1964) and United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (1963).

MONTANA

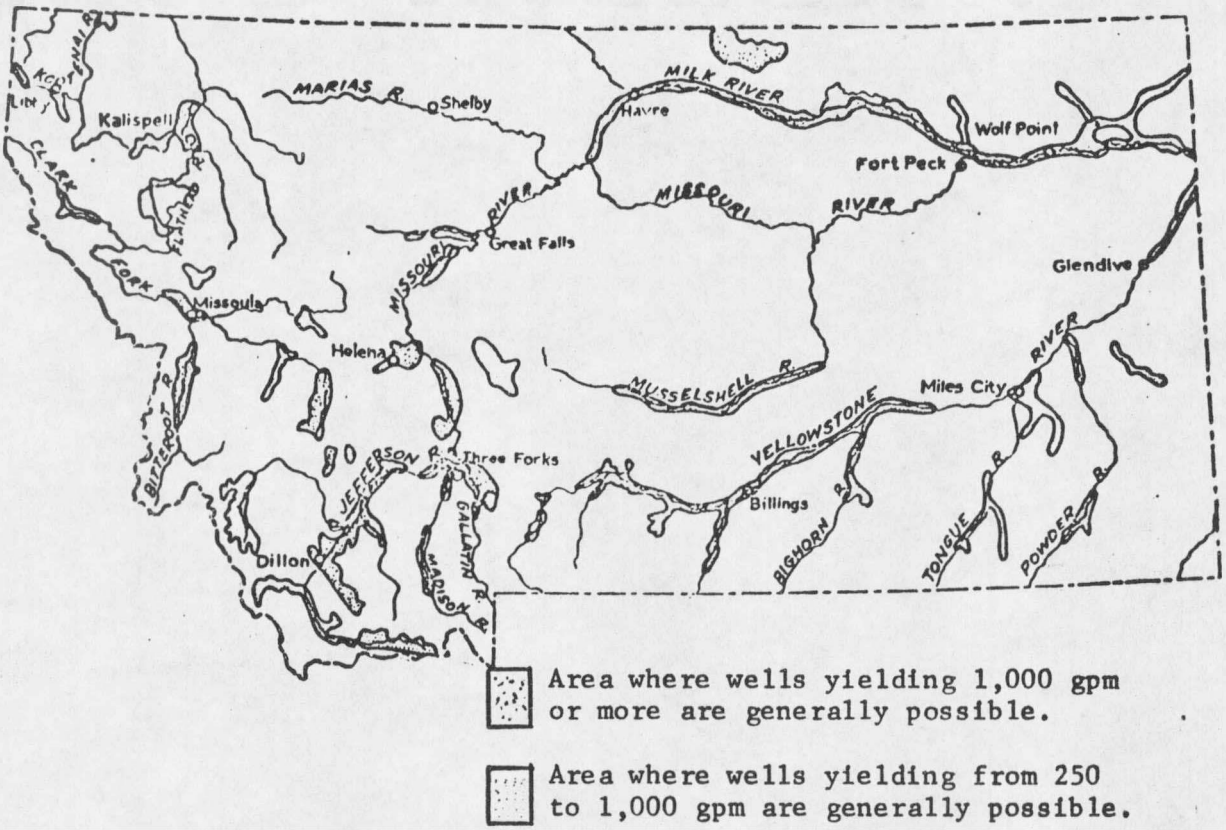


Figure 14. Map Showing Real Distribution of Water-bearing Unconsolidated Rocks and Potential Well Yields.

Source: United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (Washington, D. C.: May 1963).

in the State are among its finest agricultural resources. These irrigated lands, in addition to providing high-value crops, also form the basis for the State's important livestock-fattening industry. These facts show that irrigation contributes a good deal to the stability of Montana's agricultural economy. No wonder, therefore, that irrigation accounts for most of the consumptive use of water. It is estimated that about 2.4 million acre-feet of water are used in Montana annually to irrigate 1.8 million acres.

Although the use of surface and ground water for livestock has a high economic value, the use of the range for livestock is limited in a number of areas by the scarcity of water. This is because investigations have also proved that the evaporation loss from shallow stock ponds is much greater than the amount consumed by the livestock from this source. The quantity of water used for livestock exceeds the amount for municipal uses.

The municipal uses of water take up about 110 million gallons of water every day. Another 42 million gallons of water are used daily for rural domestic use. Total use of water by industry amounts to about 260 million gallons a day. (This excludes hydropower, a nonconsumptive use.) There has been a steady increase in the industrial use of water on account of the emergence of new industries and also greater use of water by the petroleum industry. It is significant to note that the total amount of water used for municipal and industrial purposes forms even less than one percent of the average surface-water supply.

According to one estimate: ground water is used exclusively by 92 municipalities; 40 are supplied by surface water, and 19 use combinations of surface and ground water. Ground water is the primary source of rural, domestic and stock water supplies. About 18 percent of the commercial and industrial use is supplied from surface water sources. Nearly 80 percent of the State's population is supplied by surface water of good quality. 9/

The numerous streams, lakes and reservoirs which abound the Montana landscape play a very important role in recreation. Both the residents of Montana and out-of-state tourists have been making use of these natural waterways and lakes in ever-increasing numbers in recent years. However, no reliable estimates of the water used for recreational purposes within the state are available at present.

Generation of an adequate and steady supply of power is of supreme importance in any scheme of water resource development. This requires considerable storage capacity to redistribute variable seasonal flows for less-variable power generation needs.

The installed capacity of each stream in the major river basins in Montana is given in Table V. The installed power capacity in kilowatts represents the manufacturer's rating of the maximum power output from the generating equipment. The average annual power production is given in terms of kilowatt hours as reported by the Federal Commission in 1960.

9/ United States Geological Survey and Montana Bureau of Mines and Geology, op. cit., p. 145.

TABLE V. INSTALLED CAPACITY AND AVERAGE YEARLY POWER OF EXISTING PROJECTS IN MONTANA.

Stream	Existing c/ Installed Capacity (kilowatts)	Percent of State Total	Existing d/ Average Power (kilowatts)	Percent of State Total
Columbia River Basin				
Lake Creek	4,500	0.36	2,854	0.39
Flint Creek	1,100	0.09	913	0.12
Clark Fork	315,920	25.04	186,073	25.23
South Fork, Flathead River a/	285,000	22.58	94,406	12.80
Swan River	4,150	0.33	3,539	0.48
Big Creek	360	0.03	126	0.02
Flathead River	168,300	13.31	121,005	16.41
Total Columbia River Basin	779,030	61.74	408,269	55.45
Missouri River Basin b/				
Missouri (main stem)	463,800	36.76	314,269	42.62
Madison River	9,000	0.71	8,333	1.13
Yellowstone River Basin: West Rosebud Creek	10,000	0.79	5,936	0.80
Total Missouri River Basin	482,800	38.26	328,538	44.55
Total for State	1,261,830	100.00	737,454	100.00

Source: United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (Washington, D. C.: United States Government Printing Office, May 1963), p. 148.

a/ Hungry Horse Dam.

b/ Includes Fort Peck and Canyon Ferry Dams.

c/ This represents the manufacturer's rating of the maximum power output from the generating equipment.

d/ This indicates the average annual power production of the state (59 percent of the installed capacity) as reporeted by the Federal Power Commission in 1960.

The average power generation in the State is reported to be 59 percent of the installed capacity. 10/

It is estimated that the additional water power potential of the state would be about 18 billion kilowatt hours or nearly three times the present production. Information concerning the potential development prospects is presented in Table VI. This does not include the additional power that would be available as a result of the reconstruction or improvement of the present projects. 11/

This, then, is a brief account of the current pattern of water demand in Montana. In light of this account, the next section proceeds to analyze the case for bringing about modifications in the present pattern to enhance water use efficiency and also meet more adequately the changing requirements for water.

The Case for Water Transfer in Montana

We have examined in the previous chapters the rationale behind the need to transfer water among uses and users. The basic arguments developed in this connection remain valid with respect to water transfer in Montana. The current pattern of water use in Montana (outlined in the previous section) does not represent the most efficient utilization of the state's water resources viewed in light of the criteria we have employed to

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10/ United States Geological Survey and Montana Bureau of Mines and Geology, op. cit., p. 148.

11/ Ibid., p. 149.

TABLE VI. INSTALLED CAPACITY AND AVERAGE ANNUAL POWER GENERATION OF UNDEVELOPED POWER RESOURCES IN MONTANA.

Stream	Undeveloped Installed Capacity (kilowatts)	Percent of State Total	Undeveloped Average Power (kilowatts)	Percent of State Total
Columbia River Basin				
Kootenai River (main stem)	1,180,000	24.16	374,772	18.37
Yaak River	159,200	3.26	46,233	2.27
Clark Fork (main stem)	480,000	9.38	173,402	8.50
Rock Creek	51,500	1.05	23,002	1.13
Blackfoot River Basin	146,300	3.00	48,208	2.36
Flathead River Basin	1,044,800	21.39	307,191	15.06
Thompson River	3,000	0.68	41,667	2.04
Bull River	2,200	0.04	1,005	0.05
Total Columbia River Basin	3,097,000	63.41	1,015,480	49.78
Missouri River Basin				
Missouri River (main stem)	310,500	6.36	210,160	10.31
Jefferson River Basin	147,000	3.01	73,516	3.60
Madison River	36,500	0.75	22,375	1.10
Gallatin River	20,800	0.43	12,329	0.60
Sun River	20,500	0.42	6,963	0.34
Marias River	3,600	0.07	1,027	0.05
Total Missouri River above Yellowstone River	538,900	11.04	326,370	16.00
Yellowstone River (main stem)	920,000	18.84	536,530	26.30
Mill Creek	15,000	0.31	7,991	0.39
Boulder River	10,000	0.20	6,849	0.34
Stillwater River	40,000	0.82	21,689	1.06
Big Horn River Basin*	255,000	5.22	121,918	5.97
Powder River	8,000	0.16	3,311	0.16
Total Yellowstone River Basin	1,248,000	25.55	698,288	34.22
Total Missouri River Basin	1,786,900	36.59	1,024,658	50.22
Total for State	4,883,900	100.00	2,040,138	100.00

Source: United States Geological Survey and Montana Bureau of Mines and Geology, Mineral and Water Resources of Montana, (Washington, D. C.: United States Government Printing Office, May 1963), p. 149.

*This includes Yellowtail Project.

measure efficiency of water use.* Thus, a closer look at the current pattern of water use in Montana reveals that the largest amount of water is at present used for irrigation--a highly consumptive water use which ranks far below industrial or municipal use of water in terms of its returns or its contribution to the economy. Thus, 1,000 gallons of water used in steel production result in more than $25, whereas 1,000 gallons of water will produce only 6 cents worth of alfalfa and $4.50 worth of lettuce. And we have to remember that the production of alfalfa far outweighs the production of lettuce in Montana. 12/ Studies in areas comparable with Montana have shown that the same amount of water used in industry can pay 50 times as much as agriculture, and recreation can pay 12 times. 13/

Further, in terms of precipitation, Iowa's agriculture returns 94 cents per 1,000 gallons in value of products as against Colorado's 23 cents and Montana's 13 cents. 14/ Obviously, if Montana is to increase its income productivity it must devise ways and means to improve the efficiency of its agriculture. More important, however, is the fact that the State must make profitable use of more of its unused water supplies by other, higher-valued uses.

12/ Ferguson, A. H., "Water", Now, (Vol. I, No.2, Spring 1966), p. 4. (Published every quarter by the Co-operative Extension Service of Montana State University, Bozeman.)

13/ Renne, Roland R., op. cit., p. 13.

14/ Ibid.

*Please see Chapter II and Appendix A for a detailed discussion of the criteria employed to measure the efficiency of water use.

There is good opportunity to diversify Montana's economy without having a large amount of heavy industry and extensive industrialization. Montana is endowed with a distinctive beauty. And precipitation makes possible high-demand water-based recreation throughout the year. The returns from the recreational use of water are markedly higher than the returns from the use of water for agricultural purposes. Hence, the transfer of water from agricultural to recreational uses is an area worthy of exploration.

The scope for transferring water to other high-yielding uses, without in the process impairing the quality of its waters by water pollution and its wide-open spaces by air pollution, is a research area that merits detailed investigation.

Future Pattern of Water Use in Montana

The future pattern of demand for water in Montana will depend on a number of factors which have a significant bearing on the state's economic growth. The principal factors that have to be taken into account in this connection are: (1) rate of growth of population, (2) the role of irrigated agriculture, (3) flood control, (4) power generation, (5) the pace and pattern of industrial growth, and most important of all (6) the fast expanding demand for water-based recreation. We will examine each one of the above factors. The paucity of data, especially projections of future trends, however, constitutes a serious difficulty in making detailed forecasts of future patterns of development.

Population growth.--During the period 1940-1950, Montana's population increased 5.6 percent. The subsequent decade, 1950-1960, witnessed a much higher rate of growth--14.6 percent, and in 1960 Montana's population stood at 674,767. 15/ Diehl estimates that the population of Montana in 1970 will be 771,221. This projection is based on the assumption that the population during the 1960-1970 decade will increase at the same rate as it did during the period 1950-1960. The reasons for using the same rate of growth for the period 1960-1970 are explained by Diehl as follows:

> During the 1950's we experienced neither a full-scale war nor a depression that would have radically disturbed vital rates, especially births and migration. The projections are prepared under the assumptions that we will not experience a severe depression in this decade and that the Vietnam war will not drain our population any more than did the Korean War. Therefore, the same birth rates, death rates, and migration rates will exist from 1960-1970 as for 1950-1960. 16/

According to these assumptions Montana's current (1966) population is in the neighborhood of 733,000. And during the period 1960-1970, Montana is expected to gain a net addition of 96,000 residents or 9,600 people every year.

Stanford Research Institute in its Basic Economic Projections 17/ estimates that Montana's population will be 745,200 in 1970 and 779,400 in 1975--a more modest rate of growth than anticipated by Diehl. In

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15/ United States Bureau of the Census, United States Census on Population, 1960, Number of Inhabitants: Montana, Final Report, PC I-(28A).

16/ Diehl, William D., "Human Resource Analysis", Chapter 4, Unpublished Tax Study prepared by the Task Force of the Taxation Sub-committee of the Montana Legislative Council, November 1966.

17/ Stanford Research Institute, Basic Economic Projections, (Palo Alto, California: Stanford University Press).

any event, the increase in population could be expected to produce three results on the demand for water in Montana: (a) an increase in the demand for domestic use of water, (b) an increase in the demand for water-oriented recreation, and (c) an increase, though of a smaller magnitude, in the municipal water use.

Irrigated Agriculture.--Montana is basically an agricultural state. Although the number of people engaged in agriculture has shrunk considerably during the past 30 years or so (at present only 15 percent of the population is engaged in farming), it still continues to be the most important income producer of the state--45.56 of the total state income in 1962. (See Table VII.) Irrigation has all through the years been a very important part of Montana's agriculture. Irrigated land has undoubtedly served as a stabilizing factor in Montana's agricultural production. Thus, during the 1930-1933 drought, irrigated lands accounted for 34 percent to 63 percent of the crop value in the state. The importance of irrigation in the agricultural economy of the state will become more clear from the following facts. Sugar beet cultivation is possible only on irrigated land in Montana. A large part of the beans and dry peas, potatoes and alfalfa is grown on irrigated land. These crops account for a major share of the total income from agriculture. Further, irrigated pastures contribute enormously to the rapid growth of dairy, farm flock sheep and beef cattle production.

The area under irrigation during 1963 stood at 1,584,574 acres and represented 19 percent of the total area under cultivation. (These are

TABLE VII. GROSS BASIC INCOME IN MONTANA, 1950 and 1962 (VALUE EXPRESSED IN THOUSANDS OF DOLLARS, EXCEPT PER CAPITA, WHICH IS GIVEN IN DOLLARS. PERCENTAGE FIGURES REPRESENT THE SHARE IN TOTAL GROSS BASIC INCOME).

	1950		1962	
	Dollars	Percent	Dollars	Percent
1. Cash receipts from farming	359,865	58.49	426,174	45.56
2. Value of mineral production	103,389	16.80	190,657	20.38
3. Value of lumber production	44,165	7.18	89,457	9.56
4. Value added by manufacturers	107,837	17.53	229,148	24.50
5. Gross basic income	615,256		935,436	
6. Per capita income	1,600		2,235	

Source: Montana State Planning Board, Montana Directory of Manufacturers and Buyers Guide, (Helena, Montana: 1965-66).

the latest figures available.) This is two percent higher than the area under irrigation in 1960. 18/ There is reason to believe that the area under irrigation will register further increase in the next few years. Thus, the Montana Conservation Needs Committee estimated in 1962 that the total acreage of irrigated cropland in the State will be 1,936,500 acres in 1975. 19/ Another report indicates that the long-range program of the Bureau of Reclamation would increase the area under irrigation by 1 million acres. The Bureau of Reclamation's recently completed Yellowtail Dam is expected to irrigate about 43,500 acres (this includes the area for which supplemental water is given). 20/ If the controversial Reichle Dam is allowed to be constructed, another 64,200 acres will be brought under irrigation. 21/

The Montana Water Conservation Board has also a number of proposals for irrigation development. The director of the Board, A. D. McDermott, announced recently that the 1967-Session of Montana's Legislature will

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18/ Montana Department of Agriculture, Montana Agricultural Statistics, Vol. X., (Helena, Montana: Statistical Reporting Service, December 1964).

19/ Montana Conservation Needs Committee, Montana Soil and Water Conservation Needs Inventory, (Bozeman, Montana: January 1962).

20/ Holje, Helmer, et al., The Hardin Irrigation Unit, Circular 244, (Bozeman, Montana: Department of Agricultural Economics and Rural Sociology; Montana Agricultural Experiment Station, March 1966), p. 4.

21/ Sullivan, G. T., "Water Project Seen as Gold Rush to Three Counties", Great Falls Tribune, November 2, 1965.

be asked by the Board to put up at least $3.4 million to build four irrigation projects--the largest such request. These four projects are expected to irrigate a total of 31,600 acres. 22/

Although the monetary returns of water used for irrigation are considerably lower than the returns that would result if used for other purposes, a complete transfer of water from agriculture is neither feasible nor desirable. In fact, it has been clearly pointed out that there is a strong case for bringing more land under irrigation on a national scale in order to avert a food shortage in the not-too-distant future.

> Productive farmlands are necessary to a self-sustaining nation. While it may be popular in some quarters to deny farm surpluses. . . nobody wants the reverse, food shortage. . . . An agricultural sub-committee of the Congress has forecast that within 15 years we shall need the productive equivalent of 116 million more acres than we now have under cultivation if we are merely to feed our people.

And again:

> . . . Medium range population assumptions indicate that, in order to feed our own people, total irrigated acreages in the United States--now 30 million--should be more than 36 million by 1980 and more than 55 million by the year 2000. 23/

Montana will definitely have to contribute its share to the anticipated increase in total irrigated area. And all these facts make it clear that there is going to be a steady increase in the demand for water for irrigation in Montana in the years ahead.

22/ The Bozeman Chronicle, November 2, 1966.

23/ Wright, James, The Coming Water Famine, (New York: Coward McCann, Inc., 1966), p. 78.

Flood Control.--The fact that the State continues to be plagued by floods, often resulting in extensive damages, indicates the necessity for recognizing the importance of flood control in the future programs of water development for Montana. In fact, flood control still figures prominently as one of the purposes for the construction of multipurpose projects by the Bureau of Reclamation and the Army Corps of Engineers within the state. The State Water Conservation Board has also plans for the construction of a series of small watersheds in several parts of the state to reduce flood damages. According to one report, the State had been subjected to five devastating floods since 1908, the most recent of which was in 1964. As a result of the 1964 flood, the Great Falls area alone sustained a loss of nearly $6 million. 24/ These are major floods and do not include the annual floods which result in moderate losses. In addition to the programs of the Bureau of Reclamation and the Water Conservation Board, the various Flood Control and Drainage Districts in the State also have formulated a number of flood control plans for future implementation. On balance, it can be concluded that the use of water for flood control programs will assume greater importance in the years to come.

Power Development.--Another principal water use is related to the generation of power. A look at Table VI will reveal clearly that the various multipurpose projects that are already in operation possess a vast amount of untapped power potential. Consequently, the scope for

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24/ Coon, Dick., "Cost of Flood Project Same as 1964 Damage", The Great Falls Tribune, November 15, 1966.

future construction of dams with a view to generate power is rather limited. An instance in point is the proposed Fort Benton Dam on the Missouri River. Secretary of the Department of Interior, Stewart Udall, stated that the power from the dam is marketable at rates that will return the investment. 25/ More recently, Udall has outlined a new policy for the construction of dams for power generation. The new policy requires the examination of alternative costs and alternative programs which would meet the same basic needs envisioned by the proposed hydro-power dams. If alternative methods are found to be cheaper (e.g., nuclear and coal-fired steam generating plants) and more suitable, they would be preferred to the dams for the generation of hydro power. 26/ Consequently, a great deal of increase in water demand for power generation appears to be unlikely.

Industrial Use of Water.--Although agriculture still contributes the major share of the State's income, its importance in terms of the people employed in farming has been steadily declining. In 1930 about 38 percent of Montana's people were engaged in agriculture. By 1964 the percentage of people living on farms had shrunk to a mere 15.6 percent--a decline of more than 50 percent. From the standpoint of the total number of people employed by agriculture, forestry and fisheries combined, the period 1950-1960 marked a decline of 25.7 percent. (See Table VIII.) Table VIII

25/ The Bozeman Chronicle, September 8, 1966.

26/ Science, (AAAS), October 7, 1966, p. 134.

TABLE VIII. PERSONS EMPLOYED BY MAJOR INDUSTRY, 1960.

Industry	Number Employed in 1960	Percentage Change During 1950-1960 (+)increase (-)decrease
1. Agriculture, forestry and fisheries	40,844	-25.7
2. Mining	6,782	-27.1
3. Construction	14,911	+ 0.9
4. Manufacturing	23,439	+25.5
5. Transportation, communication, and public utilities	21,013	- 6.6
6. Wholesale and retail trade	47,094	+13.1
7. Finance, insurance and real estate	8,035	+60.5
8. Services	51,451	+35.6
9. Public administration	12,530	+24.6
10. Total number employed	226,099	
11. Percent increase in labor force		+ 9.6

Source: Montana State Planning Board, Montana Directory of Manufacturers and Buyers Guide, (Helena, Montana: 1965-66).

further reveals that the employment in mining diminished by 27.1 percent during the same period.

However, construction, manufacturing, services and public administration registered increases in employment during the 1950-1960 period. Manufacturing and services showed especially significant gains in employment (Table VIII).

In terms of value of production, mineral production, lumber production and value added by manufacturers showed fairly large increases both in absolute numbers and as a percentage of gross basic income in 1960 as compared to 1950. Both the gross basic income and per capita income have also gone up during this period. (See Table VII.)

No estimates of the likely increase in industrial water use in Montana in the foreseeable future are at present available. However, there is good indication that the prospects for growth in construction, forest product industry, sports goods manufacture and processing industries are quite promising. It is pointed out in a recent report that the demand for water on the part of forest product industries consisting of pulp and paper, plywood, particle wood, etc., would increase steadily and rapidly in Montana in the very near future. 27/ The future "recreation explosion" in the state is expected to result in the rapid growth of sports-goods industries. Increased irrigation would result in an increase in the number of feed-processing industries; an increase in the livestock industry would

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27/ Ibid.

lead to a rise in the number of meat-processing industries. So it could be concluded that there should be a rise in the industrial demand for water in the next 10 years or so. But, there is hardly any reliable information to warrant a quantitative estimate of this demand.

Water-based Recreation.--The largest increase in the future demand for water in Montana may well be in the field of water-based recreation. Montana is a scenic wonderland endowed with a tremendous recreation potential. The noted writer Steinbeck observes:

> It seems to me that Montana is a great splash of grandeur. The scale is huge, but not overpowering. The land is rich with grass and color, and the mountains are the kind I would recreate if mountains were ever put on my agenda. Montana seems to me to be what a small boy would think Texas is like from hearing Texans. . . . It seemed to me that the frantic hustle of America is not in Montana. The calm of the mountains and the rolling grasslands had got into the habitants. 28/

The two principal attractions which draw people to Montana are Glacier and Yellowstone National Parks. The state has more than 20 state parks covering an area of about 10,000 acres. It has about 130 municipal and county parks. 29/ Montana has over 1,500 lakes and nearly 15,000 miles of fishing streams, including 31 major rivers. In addition, the state has several hundred man-made reservoirs. Most of these have been stocked and provide good fishing. The tributaries and connecting lakes of Montana's four major watersheds provide a variety of fishing seen in few other states. 30/

28/ Steinbeck, John, Travels with Charley, (New York: Viking Press, Inc., 1962), p. 158.

29/ United States Department of the Interior, op. cit., p. 12.

30/ Ibid., pp. 21-22.

Renne points out that

> Montana's precipitation makes possible high-demand water-based recreation in the spring, summer and early fall months--fishing, boating, swimming, camping, water-skiing, etc., in the late fall--hunting of water fowl, upland birds and big game; and in the winter--skiing and related winter sports. 31/

Another factor that attracts a large number of out-of-state visitors to Montana is its relatively clean streams, lakes and rivers. Renne states in this connection:

> Montana, not faced with extensive pollution, can devote much more of funds available to actual investment in planning and development of new enterprises such as recreation to increase her returns from water. 32/

Montana has been experimenting a steady growth in the number of out-of-state visitors and the earnings from them. Thus, the total number of out-of-state visitors increased from 2,562,515 in 1958 to 3,327,778 in 1962--an increase of over 20 percent. 33/ In 1962 tourism constituted the third largest source of income in Montana and probably it is the second largest source at present (1966). 34/

The major factors that will have a bearing on the demand for recreation are future increases in population, travel, personal income and leisure time. The population of Montana is expected to increase by 14.2

31/ Renne, Roland R., op. cit., p. 13.

32/ Ibid.

33/ Montana State Highway Commission (Planning Survey Division) and United States Department of Commerce (Bureau of Public Roads), Five Years of Tourist Studies in Montana, (October 1963).

34/ Department of Fish and Game (Recreation, Parks and Research Division), Montana Statewide Outdoor Recreation Plan, (Helena, Montana: September 1965). (Unpublished Report.)

percent during the period 1960-1970. This means an increase of over 96,000 people and a large fraction of these people would belong to the urban category. Table VIII reveals that both gross basic income and per capita income registered a fair increase during 1950-1962 and there is no reason to believe that this trend would be reversed.

The people within the state, however, account for only a small fraction of the total demand for Montana's recreation facilities. Out-of-state visitors contribute a very large percentage of the total earnings from recreation. According to the latest estimates available, out-of-state visitors in 1970 would go up to 3,770,600 and in 1975 to 4,486,700.

> These out-of-state visitors are one of the most vital reasons for recreation plans in Montana. The moment they enter the state they are potential water users of public facilities. Therefore any county that is exposed to them (and they all are) is in need of facilities to accommodate the visitor's basic recreation needs. 35/

Various measures have been taken in recent years to enhance the recreation facilities available in Montana. A proposal has been made by the Fish and Game Department for a state recreational waterway system which will increase the accessibility to and stimulate interest in certain upper Missouri Basin Rivers. These rivers are part of the most unique streams in the nation from the viewpoint of either their wild trout fishing or their historic importance. The Yellowstone from Gardiner to

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35/ Ibid., p. 210.

Pompeys Pillar was the first river section designated in this system and a recreational development plan has been prepared for it. Other Missouri Basin streams that could be considered for inclusion into this system are the blue-ribbon portions of the Missouri, Madison, Gallatin and Big Hole Rivers and the Missouri from Fort Benton to Fort Peck. The proposal for the creation of this state's recreational water system is an example of the greater importance attached to the preservation of the fish habitat. 36/

There is an increasing awareness of the importance of water-based recreation on the part of the agencies responsible for the development of the state's recreation potential. The Fish and Game Department has chalked out a program of park and recreation development involving $750,000 for the two-year period starting July 1, 1967. By the end of June 1966, the Fish and Game Department spent $444,000 for parks and recreation since taking over the State Parks Division from the Highway Department in July 1965, and since being designated the State recreation agency. 37/

The recreation planning effort in Montana has gained momentum in recent years. In the fall of 1964 a Governor's Outdoor Recreation Advisory and Planning Committee was set up to explore the possibilities for fully utilizing Montana's vast recreation potential. This Committee has prepared a comprehensive and detailed Outdoor Recreation Plan for the

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36/ United States Department of the Interior, Progress: Missouri River Basin, (Annual Report, 1966), pp. 148-149.

37/ The Great Falls Tribune, November 15, 1966.

entire state of Montana. The report which describes this plan has not yet been officially released. A preview of this Report, however, provides much interesting information. In the words of the Report, "this Plan has been developed with the broad objective of providing guidance in the development and implementation of Montana's present and future outdoor recreation programs". 38/ The Report, for the most part, provides information regarding the supply of and demand for outdoor recreation facilities on a region-wide basis. Seven distinct regions are identified for the whole state of Montana. These seven regions are shown in Figure 15. This report, however, does not make any attempt to give overall figures pertaining to the entire state. The usefulness of the report for the general public would be considerably enhanced by giving state-wide projections relating to supply-demand situation for recreation facilities.

Guidelines for Action

Several methods have to be adopted to exploit Montana's tourist potential to its fullest extent. The principal measures should aim at the provision of high quality facilities, privacy in the out-of-doors, access to the state's outdoor recreation opportunities, opportunities facilitating leisurely touring across the state and a full recognition of the rights of private landowners as hosts to visiting tourists. 39/

38/ Department of Fish and Game, op. cit., p. 3.

39/ Ibid., p. 210.

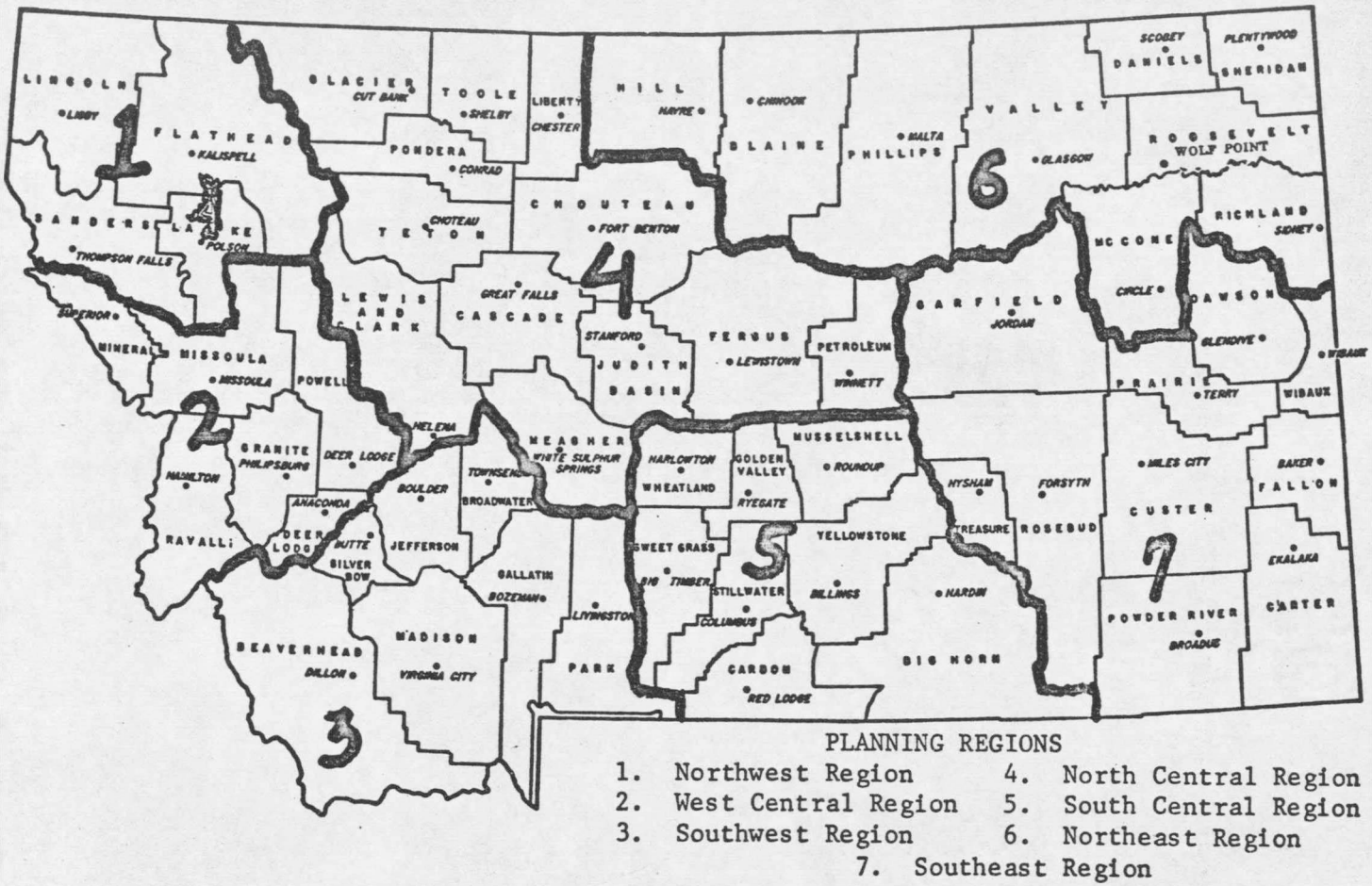


Figure 15. Proposed Recreation Regions in Montana.

Source: Department of Fish and Game (Recreation, Parks and Research Division), Montana Statewide Outdoor Recreation Plan, (Helena, Montana: September 1965). (Unpublished Report.)

Finally, a greater degree of coordination between the federal, state and local agencies responsible for the planning of recreation development is indispensible. The Federal agencies include: (1) the National Park Service, (2) the Forest Service, (3) the Fish and Wildlife Service and (4) the Corps of Engineers. The Fish and Game Commission's Recreation, Parks and Research Division is the State agency. On the local level the following agencies can play a very important role: (1) the Montana State Soil and Water Conservation Districts, (2) the Montana State Rural Area Development Committee, (3) the Montana Conservation Council, (4) the Montana Wildlife Federation, and (5) the Montana Wilderness Association. The several Montana University units can also be of considerable help in providing expert counsel and assistance to the various agencies mentioned above.

Finally, there is a problem of crucial significance which the recreation planners of Montana should take into consideration. This relates to the future establishment of industries in Montana. If industries wish to locate their plants in Montana, the state should insist on adequate measures to prevent air and water pollution. This should not create any serious problems since most of the industries have now recognized pollution control costs as an integral part of their total production costs. Allowing lakes, rivers, streams and air to get polluted would necessarily involve the spending of a large amount of funds for clean-up activities rather than for investment to develop the state's land and water resources. The state planners should, therefore, rigidly enforce anti-water-and-air

pollution laws to preserve the quality of Montana's wide-open spaces and clear waters.

The foregoing analysis indicates that there is a strong likelihood for alterations in the future pattern of water use and demand in Montana. It also suggests that much of the increased demand would be for industrial and recreational purposes, especially the latter.

CHAPTER V

MONTANA'S WATER RIGHTS

Introduction

This chapter follows up the discussion of the theory and practice of western water law given in Chapter III with special reference to Montana. The first section gives an account of the evolution of Montana's water rights. This is followed by an analytical survey of the surface water laws currently prevailing in Montana. Among other things, this section discusses the various problems related to the acquisition, protection and loss of surface water rights. The next section is devoted to a study of Montana's groundwater laws. The composition and functions of the water users' association and irrigation districts of Montana are briefly outlined in the fourth section. The final section attempts a critical evaluation of Montana's legal-institutional complex, especially from the point of view of its adequacy for effecting a desirable transfer of water between uses and users.

Evolution of Montana Water Laws

> For nearly a century Montanans have been seeking property rights in water which are as definite and defensible as those in land. They have discarded the water right which they brought with them from the humid East and adopted a new one more suited to their needs. 1/

1/ Dunbar, Robert G., "The Search for a Stable Water Right in Montana", Agricultural History, 28:138-149, (October, 1954).

What follows is a brief historical account of the search for a stable water-policy in Montana.

The first statute in Montana concerning water rights was passed by the First Territorial Legislative Assembly at Bannock on January 12, 1865. This was an act designed to protect and regulate the irrigation of land. This act provided that anyone with a possessory right or title to land on or near any stream should be entitled to use the water of the stream for irrigation. It was, further, provided in the act that if anyone carelessly managed his water, so that his waste injured someone else, commissioners might assess damages against him.

However, the power of commissioners to assess damages was soon held invalid and the act, in its entirety, was repealed immediately thereafter. The act of repeal recognized the doctrine of appropriation as applicable to all controversies regarding the right to the use of water for mining, manufacturing, agriculture and other useful purposes. This act was carried forward in the 1872 Codified Statutes as Chapter 34.

Montana's statutory water law, at the time of the Revised Statutes of 1879, contained 15 sections, relating mainly to irrigation, with no subject called "Water Rights" separately listed in the index.

> The period during which the law of water rights was governed only by custom ended in 1885, with the passage of an act providing in detail a method of appropriation of water which has remained substantially unaltered to the present date. It allowed for beneficial purposes to last until such use ceased or the right was abandoned, by posting a notice of appropriation at the point of diversion, filing a copy in the county records, and promptly completing works to carry the water away. Persons who had

> previously acquired rights were required to file the details in the county records, though noncompliance did not deprive them of their rights. Filed documents were to be prima facie evidence of their contents. Adversary proceedings with joinder of all concerned were made the method of determination of rights in a particular source of water. Finally, a device and method for the measurement of water were prescribed. These provisions were carried forward in the 1895 codes without change of substance, which process was repeated in the Revised Codes of 1907, 1921 and 1935 except for the last section. This was replaced in 1899 by the legal standard of measurement of cubic feet per second, which has since remained unchanged. 2/

In 1911 a statute containing details of appointment, duties, authority and compensation of water commissioners acting to distribute waters replaced previous similar enactments on the same subject.

In 1921 the Supreme Court declared:

> Our conclusion is that the common law doctrine of riparian rights has never prevailed in Montana since the enactment of the Bannack Statutes in 1865, and that it is unsuited to the conditions here. 3/

And this decision settled the long-standing conflict between riparian and appropriation rights and established the appropriation doctrine as the sole water law governing the use and control of water in Montana.

Surface Water Laws

Nature of Water Use

The state Constitution lays down that:

> The use of all water now appropriated, or that may hereafter be appropriated for sale, rental, distribution or other beneficial

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2/ Heman, Howard W., "Irrigation Law", Montana Law Review, (Vol. X, Spring 1949), pp. 13-34.

3/ Hutchins, Wells A., The Montana Law of Water Rights, (Bozeman, Montana: Montana Agricultural Experiment Station, August 1958), Bulletin 545, p. 2.

> use, and the right of way over the lands of others, for all ditches, drains, flumes, canals, and aqueducts, necessarily used in connection therewith, as well as the sites for reservoirs necessary for collecting and storing the same, shall be held to be a public use. 4/

The Supreme Court of Montana has recognized the crucial importance of water in furthering the prosperity of the state. Thus, the use of water in the state, even by an individual to irrigate a farm, is so much a contributing factor to the welfare of the state that the people in adopting the constitution declared it to be a public use. Since the constitution regards the use of water a public use, every citizen is ensured the right to divert and use water from a stream so long as he does not infringe the rights of others acquired by prior appropriation. Due consideration has to be accorded for the rights of public while making use of water.

Court rulings have made it clear that the ownership of the rivers and streams of Montana is vested with the state.

> The public policy of the State recognizes that a water right may be acquired by prior appropriation, that an appropriator derives his right from the State and not from the National Government, and that the use of waters flowing in natural streams in the State is subject to State regulation and control; and this policy is irreconcilable with the application of the riparian doctrine. 5/

4/ Montana Constitution, Article III., Section 15.

5/ Hutchins, Wells A., op. cit., p. 2.

Conservation of Water

The conservation of water is of supreme importance in all the western states. Consequently Montana and the rest of the western states insist on the highest and greatest possible duty from the waters of the state in the interest of agriculture and other beneficial uses.

The various court-decisions made it clear that water-right does not include the right to waste water.

> But while there is no question that waste of public water resources must be minimized in the general interest, it is equally manifest that there is a vanishing point at which the possible waste of water would be more than overcome by the waste incidental to the abandonment of reasonably efficient diversion systems and their replacement by systems at expense neither warranted nor permitted by the benefit to be derived from the water. 6/

In other words, "economy would not be insisted upon to such an extent as to imperil success."

The State Constitution, the Statutes and the various court decisions recognize the importance of water conservation through the storage and subsequent use of waters. The State Water Conservation Board was set up in 1933. The basic objectives of the Board were conservation, development, storage, distribution, and utilization of water for the welfare and benefit of the people of the State. On account of the recontinuance of adverse conditions, its powers were broadened in 1935 to permit full cooperation with the Federal government in the work of recovery. In 1939 another progressive measure was adopted when the State Engineer was authorized to

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6/ Ibid.

bring actions through the Water Conservation Board for the adjudication of rights in all the waters of the State and particularly in interstate streams. A statute enacted in 1939 states:

> It is hereby declared to be the policy of this State and necessary for the welfare of the State and its citizens, that the waters of this State and especially interstate streams arising out of the State, be investigated and adjudicated as soon as possible in order to protect the rights of water users in this State and negotiate interstate compacts in relation thereto, and that the State Water Conservation Board and State Engineer make investigations to secure necessary information and initiate and carry on actions therefor. 7/

And various measures have been taken by the State government from time to time to implement this declared policy.

Property Rights in Water

The law has specified clearly what precisely "property rights in water" imply. The law states that running water in a natural stream is public property. Thus, the person who appropriates water does not own the corpus of water while it is flowing in the stream. What the appropriator acquires is a right to the usufruct of the water, that is, a right of possession and use only.

Acquisition of Water Rights

Unadjudicated Waters.--The right to the use of the unappropriated water of any river, stream, ravine, coulee, spring, lake or other natural source

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7/ Montana Revised Codes (MRC) 1947, Section 89-847.

of supply may be acquired by appropriation, and an appropriator may impound flood, seepage and waste waters in a reservoir and thereby appropriate the same. 8/

Any person (including a corporation) is permitted to appropriate unadjudicated waters by posting a notice of appropriation at the point of intended diversion, stating the quantity of water claimed, the purpose for which it is claimed, the size of channel by which he intends to divert the water, the date and his name. Within 20 days after this he must file with the county clerk, in whose jurisdiction the point of diversion lies, a notice of appropriation containing the above data, and the name or a description of the stream and a description of the point of diversion with reference to some permanent monument. 9/

Filing the notice does not give the appropriative right, but only the right to perfect it. This is accomplished by the construction of the means of diversion, completed with reasonable diligence after having been begun within 40 days after the filing. 10/ Unless this is done, the right of the appropriator is suspended until he completes his works, at which time his right relates back to the date he posted the notice. This date governs his rights as to all other appropriations, since the first in time is first in right. 11/

8/ MRC, 1947, Section 89-801.

9/ MRC, 1947, op. cit.

10/ MRC, 1947, Section 89-811.

11/ MRC, 1947, Section 89-807.

The law recognizes that the means of conveying the water from the point of diversion to the point of use are "indispensable adjuncts" of water rights. Consequently, provision is made that the appropriator is vested with the right to build any works necessary for such purpose, such as dams, reservoirs and embankments, across intervening lands, and to take by the private form of eminent domain any land needed for this on payment of just compensation provided by law. 12/

The United States government is authorized to appropriate the water of streams or lakes within Montana through the Secretary of the Interior or his representative in the same manner and subject to the general conditions applicable to appropriations by private individuals. 13/ It is significant to note the

> waters on Indian reservations impliedly reserved by the United States government for irrigation purposes on behalf of the Indians are held by the Indians for such purposes and hence are not subject to appropriation by others. 14/

Adjudicated Waters.--Under the present procedure, a person desiring to appropriate waters of adjudicated streams must (a) employ a competent engineer to survey the proposed aqueduct, impounding dam or other work; or (b) cause to be prepared an aerial photograph with drawing thereon showing this information, with appropriate descriptions. Further, he must file a petition with the court of the county in which the water is to be appropriated, containing a declaration that the water right sought to be

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12/ MRC, 1947, Section 89-820.

13/ MRC, 1947, Section 89-808.

14/ Hutchins, Wells A., op. cit., p. 13.

acquired shall be subject to the terms of any adjudication decree theretofore rendered by a court of competent jurisdiction adjudicating the waters of such source of supply or any body of water to which the same may be tributary. Parties who may be affected are made defendents. On the conclusion of the trial the court may enter an interlocutory or permanent decree allowing the appropriation subject to the terms of all prior decrees. Failure to comply with the statutory provisions deprives the appropriator of the right to use water as against a subsequent appropriator mentioned in or bound by a decree of the court. An amendment made in 1957 qualifies this procedure with the following provision:

> . . .provided the water stored in a reservoir pursuant to an appropriation hereunder which is subsequent to an adjudication of waters in a flowing stream when so released from storage shall not be considered as a part of the natural flow of said adjudicated stream. 15/

Regarding the character of the stream flow: the Statute provides that one who seeks to use the waters of an adjudicated stream may do so without regard to whether the water he plans to use is a part of normal flow, or is flood or excess water in the stream. 16/

In 1963 the legislature passed a bill permitting the owners of at least 15 percent of the water rights affected by a decree or decrees to petition for a water commissioner to administer the water to entitled users, when they are not able to obtain the water to which they are

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15/ MRC, 1947, Section 89-829, (as amended by Laws 197, Chapter 179) to 89-844.

16/ McIntosh, Quigley V., 88 Montana 103, 107-108, 290 Pac. 266 (1930).

entitled. The owners and users of the water have to pay the commissioner's fees and compensation which are decided by the district court at the time of appointment.

Protection of Water Rights

Adversary proceedings between claimants in an action to determine the relative rights of all parties in the source of supply in question constitute the basic method of protection of water rights in Montana. 17/

> This right of action is implemented by injunctions when necessary. Most water right cases are handled in equity, with an occasional suit at law for damages resulting from temporary wrongful diversions sufficient to injure crops. In these actions, the records made by filing notices of appropriation and claims to water rights in the offices of the county clerks are prima facie evidence of all statements therein contained. . . . Since 1939 the State Engineer has had authority to bring actions to have rights in water supplies adjudicated, in accordance with the stated policy of Montana that all the waters in the state be investigated and adjudicated as soon as possible to protect the rights of water users within the state and ground negotiations for interstate water compact. 18/

Loss of Water Rights

Abandonment.--The question of abandonment of a water right is one of fact. Since the use must be for a beneficial purpose for a right to accrue in the first place, one attacking another's right must first ask whether any right ever existed, and if so, the question of abandonment may arise. Here disuse does not constitute abandonment. 19/

17/ MRC, 1947, Section 89-815.

18/ Heman, Howard W., op. cit., p. 29.

19/ Ibid., p. 30.

Prescription.--The water right of an appropriator may be lost, in general, by adverse use on the part of another, usually upstream from the appropriator, for the prescriptive period defined in the statute of limitations of actions to recover real property. This period is 10 years in Montana. To mature into prescriptive title, there must be a continuous, exclusive, uninterrupted, notorious and adverse use of the water under claim of right throughout the statutory period. 20/

Estoppel.--An appropriator may lose his right by the operation of the doctrine of estoppel if by inequitable conduct or by acts or declarations he leads others to make use of his water rights in reliance thereon. Usually some degree of turpitude on the part of the appropriator is required before he will be estopped, such as misleading statements or acts, or concealment of facts by silence, plus an intent to deceive or at least an expectation that the other party will act. 21/

Groundwater Law

Background

Montana had virtually no laws dealing specifically with groundwater until 1961.* Until that time the use of defined underground streams and percolating waters was governed by two different laws in Montana. The

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20/ Ibid.

21/ Ibid., p. 31.

*In 1947 a bill was passed dealing with drilling regulations of artesian wells, but still did not state anything specifically about groundwater.

use of underground streams was controlled by the doctrine of prior appropriation. Montana, by court decision, had ruled that water in a defined underground stream was subject to the same rules of appropriation as water in a surface stream, namely, the doctrine of prior appropriation. 22/

As a rule, under the jurisdiction of prior appropriation, when the first person in time does not use the stream for beneficial use, he loses his right. It was clearly stated in the Montana Statutes that upon abandonment and cessation of use of water by the appropriator or his successor in interest, the right ceased; but that question of abandonment shall be question of fact, to be decided as other questions of fact. Hence, these rights in Montana, are not subject to loss for non-use occurring over a set number of years.

The rule of absolute ownership, again by court decision, was applied to the use of percolating waters in Montana. It was, however, provided that the use must be without malice or negligence. This meant that the owner of the overlying land had absolute right to recover groundwater from under his land, so long as it was not in a defined channel, in any amounts and without restriction as to the manner in which it was used or where it was used.

22/ Hutchins, Wells A., Selected Problems in the Law of Water Rights in the West, United States Department of Agriculture, Miscellaneous Publication 418, (Washington, D. C.: 1942), p. 146.

1961 Groundwater Law

In 1961 the legislative assembly of Montana passed an Act relating to and providing for the appropriation and regulation of groundwater.*23/ The term groundwater is defined in this Act as "any fresh water under the surface of the land including the water under the bed of any stream, lake, reservoir, or other body of surface water". Fresh water is regarded as water fit for domestic, livestock or agricultural use.

The act provides that the rights to surface water, where the date of appropriation precedes January 1, 1962, shall take priority over all prior or subsequent groundwater rights. The application of groundwater to a beneficial use prior to January 1, 1962 is recognized in the Act as a water right. After January 1, 1962, for all appropriation of either surface or groundwater, the prior appropriation rule shall apply. The Act clearly states that the doctrine of prior appropriation or "prior rights" shall apply to the use of groundwater and that beneficial use shall be the extent and the limit of the right to groundwater. The Act recognizes other means of development for beneficial use besides wells. It also lays down the procedure to file appropriation notices with the county clerk and recorder. The Act also refers to the means of setting up boundaries of groundwater areas and also the regulation of use if it becomes necessary or desirable.

23/ Montana Session Law 1961, Chapter 237, House Substitute for Senate Bill Number 78.

*For a summary of this Act, please see Appendix B.

Montana's groundwater law has been modelled largely on the highly regarded New Mexico Statute on groundwater,* as are the groundwater laws of a number of western states. However, there are some differences between the Montana and New Mexico Statutes. A principal difference is: the New Mexico law allows for the mining of groundwater over a number of years. On the other hand, the Montana law states that a hearing shall be called when withdrawals of groundwater are in excess of recharge or it appears that it may be in the near future. According to the law, this area shall be declared a "controlled area" and that

> the administrator shall not grant a permit if the withdrawal would be beyond the capacity of the aquifer or aquifers in the groundwater area to yield groundwater within a reasonable or feasible pumping lift. 24/

In 1963, legislation was enacted concerning the licensing and examining of well drillers, which provided for the Water Well Contractors' Examining Board to administer examinations for the purpose of licensing and charging of fees for the same.

> It is the legislative intent and purpose in this enactment to reduce and minimize the waste of groundwater resources within this state by reasonable regulation and licensing of drillers and general welfare by providing a means for the development of natural resources of underground water in an orderly, sanitary and reasonable manner. 25/

24/ Revised Codes of Montana, 1947, Repl. Vol. 6, (Part I).

25/ Laws of Montana, Chapter 234, pp. 714-718.

*Please see the section on groundwater law in Chapter III.

Another law passed by the 1963 legislative session dealing with groundwater gives the State Water Conservation Board the right to appropriate groundwater. The Statute, however, makes it clear that this is so only if the construction of the project for which the water is to be used begins within four years.

Other Legal Institutions

Water Users' Associations

Montana has a number of water users' associations organized under federal law. Any water users' association having a contract with the United States government for construction of works and delivery of water, and also a contract with its shareholders is legally vested with the power to levy new assessment. The law provides that all assessments shall be equitable and be based upon benefits received or available. Further, water users' associations shall be permitted to divide the area under such irrigation project into as many districts as there are directors provided for in its articles of incorporation, and each district shall elect one director for a term not to exceed five years. 26/

Irrigation Districts

Irrigation districts are organized under state laws in order to provide the necessary water supply for the irrigation of lands. These districts are public or semi-public in character. They are political

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26/ MRC, 1947, Sections 89-1101 and 89-1105.

subdivisions of a state with clearly defined geographical boundaries. The irrigation districts have the power to issue bonds and to secure revenue from tax assessments levied upon the land. 27/

The first step in the formation of an irrigation district in Montana is to receive the approval of 60 percent of the landowners possessing not less than 60 percent of the land to be included in it. This is followed by a petition signed by the required number of landowners filed with the clerk of the district court of the county in which the lands (or most of them) are situated. The district court concerned will then hear the petition and appoint one commissioner for each division of the district. The Act resulting in the formation of irrigation districts in Montana was enacted in March 1907. This Act, like similar acts in other western states, was modelled on the Wright Act passed by the California legislature in 1887.

An Act of Congress on August 11, 1916 made public lands within irrigation districts subject to state laws. This Act provided that the approval by the Secretary of the Interior was necessary for the creation of the district if federal land was to be included in it. Public lands included in approved irrigation districts had to pay taxes like the rest of the land. However, it was made clear that nothing "shall be construed as creating any obligations against the United States to pay any of said charges, assessments, or debts incurred." Thus, the obligations become a

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27/ Huffman, Roy E., Irrigation Development and Public Water Policy, (New York: The Ronald Press Company, 1953), p. 73.

lien against the public lands, but the payments are to be made by the person who acquires the land. 28/

The board of commissioners constitutes the corporate authority of an irrigation district. Its powers include: (a) the power to manage the business and affairs of the district and execute all necessary contracts; (b) the power to appropriate water in the name of the district, to acquire water and water rights and additional waters and supplies of water; (c) the power to enter into any obligation or contract with the United States for the construction, operation and maintenance of the necessary works for the delivery and distribution of water; (d) the power to construct and maintain the necessary dams, reservoirs and works for the collection and distribution of water for the district; (e) the power to provide for the annual levy and collection of a special tax or assessment upon all the lands included in the district subject to certain regulations. 29/

Critical Evaluation

The allocation of the relatively scarce water resources among competing uses will assume crucial importance as the demand for water steadily and rapidly increases. The character of this new demand is likely to be different from the current pattern of demand for water. And this will obviously necessitate the transfer of water between uses and users in order to meet the changing and challenging requirements of the future. We

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28/ Ibid., p. 75.

29/ MRC, 1947, Sections 89-1301 and 89-1801.

have already seen in a previous chapter how the legal-institutional complex will exercise a definite and decisive influence on the transfer of water between uses and users. What follows is an attempt to evaluate the existing water rights in Montana in light of the emerging new pattern of demand.

The ownership, control and use of both surface and groundwater are governed by the doctrine of prior appropriation in Montana. Consequently, the system of water rights in Montana suffers from some of the basic weaknesses of the appropriation doctrine: (1) the system is inflexible. This stems from the freezing of rights in terms of the original appropriation. There is a certain degree of rigidity if appropriation rights cannot be severed from the land on which the water is applied and are limited to the purpose for which it was originally diverted. This rigidity may result in economically or socially unsound water use. For example, the prior appropriation of much of the available water for irrigation hampers the re-allocation of water to urban and industrial uses. (2) The heavy emphasis on priority often results in considerable waste. The conditions under which the original appropriation took place change frequently. Consequently, the water appropriated may no longer be needed in the amount, or at the place, or for the purpose specified, although the appropriator would still continue to fully enjoy his right of use. (3) In spite of the doctrine of state administration, actual management is often vested with local water commissioners appointed either by county governing

bodies or by irrigation district boards, the state official nominally responsible merely giving approval to the appointments. "This is not a particularly reliable process for bringing expertise to bear on a state program." 30/

More specifically, the following drawbacks have been pointed out in the Montana System of water rights: (1) The present system of appropriation by notice-posting and determination of rights by private suits, in which it is not necessary to join all parties concerned, is regarded as outdated. Where centralized systems exist, usually the supervision and control of the state is exercised through the state engineer or an administrative agency. The function of the courts in such cases is normally limited to deciding questions of priority of appropriation or appeals from administrative decisions. Montana has an administrative agency, the State Water Conservation Board*, and needs only to have the legislature broaden the scope of its activities.

A first step in this direction, as noted earlier, was taken in 1939 when the state engineer was empowered to sue for adjudication of streams. However, the system is still administered by water commissioners appointed by local courts and records are required to be filed in the office of the clerk or the court concerned. Montana's primary need in the field of water law, according to legal experts, is a centralized system of administration

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30/ Martin, Roscoe C., Water for New York, (Syracuse University: 1960), p. 112.

*The office of State Engineer has been abolished in Montana and its duties transferred to the Water Conservation Board.

designed to regulate the determination of existing rights, the distribution of water among those entitled to its use, and the acquisition of new rights. Such an arrangement will be of considerable help in the transfer of water from a less-productive to a more-productive use and also from one user to another. 31/

(2) Montana rules specify that to constitute abandonment in Montana there must be concurrence of relinquishment of possession, and intent not to resume it for a beneficial use. Most of the other western states have, however, provided by statute for forfeiture after a certain number of years, usually three to five. But there is no such provision in Montana law. 32/ Viewed in a context of ever-increasing demand for water, this uncertainty would only contribute to a reduction in the efficiency and expediency of water use.

(3) Montana law provides that

> to ripen into a prescriptive title, there must be a continuous, exclusive, uninterrupted, notorious and adverse use of the water under claim of right throughout the statutory period, a result difficult to attain in a state where water flows in many streambeds only in certain months of the year. The problem may be further complicated sometimes by drouth which may prevent some streams from containing any water for years. 33/

This indicates that in order to devise an efficient system of water within the state, it is essential to bring about substantial alterations in the existing provisions concerning prescription.

31/ Heman, Howard W., op. cit., p. 33.

32/ Ibid.

33/ Ibid., p. 34.

Thus, in the final analysis, it becomes clear that the legal-institutional complex currently existing in Montana, as well as in most other western states, needs revamping in order to render it capable of coping with the hard and pressing realities of today's water situation.

CHAPTER VI

OTHER INSTITUTIONAL FACTORS

Introduction

This chapter is a logical extension of the previous chapter and attempts primarily to describe the major institutional factors in addition to the water laws that impede the most productive utilization of Montana's water resources at present, and to spell out specific measures as part of an action-program to remove or countervail their effects. The chapter concludes with the thesis that the most effective method to fight institutional prejudices is to educate the "masses" through the dissemination of reliable information in easily comprehensible form. The role of the extension service in this context is emphasized.

Conservancy Districts

An important legal institution which merits special consideration is the Conservancy District. Although Montana does have a number of special districts to serve a variety of purposes, it does not have Conservancy Districts at present (See Table IX). These districts are generally formed to achieve political independence from other existing governmental agencies. Most of these districts, with few exceptions, are single-purpose administrative units.

One of the major pieces of legislation enacted by the Congress in recent years is the Watershed Protection and Flood Prevention Act, referred to as Public Law 566. The idea of "conservancy districts" gained importance after the passage of this law.

TABLE IX. KINDS AND NUMBER OF SPECIAL DISTRICTS IN THE UNITED STATES AND MONTANA, 1962.

Kinds	U. S.	Montana
Soil Conservation	2,461	57
Drainage	2,240	23
Irrigation, Water Conservation	781	50
Flood Control	500	1
Other & Composite Natural Resource Programs	176	0
Fire Protection	3,229	0
Urban Water Supply	1,502	1
Cemeteries	1,283	49
Housing and Urban Renewal	1,099	5
Sewage	937	0
School Buildings	915	0
Highways	773	0
Parks & Recreation	488	0
Hospitals	418	0
Libraries	349	0
Other Single-Function Districts	862	1
Multiple-Function Districts	310	1
Total	18,323	192

Source: United States Bureau of the Census, Census of Governments: 1962 (Washington, D. C.: United States Government Printing Office, 1963).

A conservancy district is a special-interest district created for a special purpose. It is a body corporate, with all the powers of a corporation, with perpetual existence, and power to sue and to be sued. The district is empowered with the right of eminent domain and of assessment and taxation to accomplish the purpose for which it is created. In effect, a conservancy district is a special improvement district which individuals may organize themselves for a special purpose and have the power to effect that purpose. 1/

There are a number of conservancy districts in the eastern United States. These districts have placed emphasis on flood control and pollution abatement.

In the Western States, authorization for conservancy districts varies from state to state. Thus, in North Dakota the legislature authorized one conservancy district involving specified counties. Colorado has the general enabling act type of permissive legislation. At present Colorado has as many as 32 conservancy districts. Montana is one of the few states in the western region which does not have any provision for an enabling act to create conservancy districts.

There is, however, a strong need for the creation of conservancy districts in Montana. A number of small water projects could be developed in Montana if it were possible to enlist the cooperation of all the beneficiaries involved. The easier-to-build and cheaper projects were

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1/ Sheridan, Richard., "Summary of Conservancy Act of Oklahoma", (Oklahoma City: Oklahoma Soil Conservation Board, April 1964).

first built in the state, chiefly as single-purpose projects. The justification for additional irrigation now extends beyond cultivation on the irrigated lands. Other important considerations are stabilization of the agricultural area and of the community. It was this need for multipurpose approach to the remaining projects that resulted in the emergence of the concept of conservancy districts.

It should be noted that measures are now being taken to provide legal authorization for the creation of conservancy districts. It is expected that necessary legislation will be introduced in the 1967 legislature which would lead to the establishment of conservancy districts. Since the conservancy district is primarily "a special improvement district" it could be reasonably expected to play a very vital and useful role in the context of water transfer designed to accomplish greater efficiency.

Role of Federal Government

Another institutional factor closely related to the problem of water resource development concerns the attitude of the general public toward federal participation in water projects. There is a large body of opinion which looks down upon any form of federal involvement as detrimental to the well-being of the state. It is often argued, even by knowledgeable persons, that federal participation invariably leads to a curtailment of freedom on the part of the people of the state and deprives them of some of their cherished "rights and privileges". However, this type of argument is steadily losing ground and there is a rapidly increasing awareness of the role of federal government in the areas of state resource development.

Renne has indicated the strategic role of federal activities in the water resource development of Montana. He refers in this connection to six major pieces of legislation passed by the Congress in the past two years. Six of these, which are likely to have a marked bearing on Montana's economy, are: The Water Quality Act, the Solid Waste Disposal Act, the Land and Water Conservation Fund Act, the Federal Water Project Recreation Act, the Water Resources Research Act and the Water Resources Planning Act. These six acts provide federal cooperation, technical assistance, and funds to state and local governments by which major improvements can be effected.

A brief indication of the impact of the 1965 Water Resources Planning Act on the federal government programs will make this clear. A provision in this Act forbids the study of inter-basin transfer of Columbia Basin water. This is undoubtedly to Montana's advantage. Also, the new federal law provides financial assistance to states under which Montana will receive about $100,000 a year on a matching 50-50 basis to carry on comprehensive planning of Montana's water development. 2/ The most important development in recent months is the approval by the National Water Resources Council of the establishment of a regional water planning commission for five Pacific Northwest States, of which Montana is one. 3/ And the Water Resources Council which has approved the formation of this Commission is also the result of the National Water Resources Planning Act.

2/ The Bozeman Chronicle, (from the report of a speech by Roy Huffman), February 18, 1966.

3/ The Bozeman Chronicle, November 18, 1966.

Administrative Bottlenecks

A number of reforms are possible in the case of the state administrative agencies. In the first place, these agencies are handicapped by an acute dearth of funds. The State Legislature does not appear to be in any hurry to grant appropriations in adequate amounts to enable the various state agencies to undertake water development activities within the state. Second, there is a pronounced lack of coordination in the activities of the various state and local groups engaged in water development, often resulting in avoidable waste and unnecessary duplication. Third, some of the agencies are rather sluggish in implementing water development activities. Thus, the Montana Water Conservation Board had developed 181 small water development projects in November 1966 4/, the same number as it had at the end of June 1960. 5/ In other words, over a period of more than six years the Board did not construct a single water conservation project--a six-year period of complete inactivity in the field of construction on the part of the Water Conservation Board. And it is to be remembered in this connection that by the Water Conservation Board's own admission it is primarily a "construction agency". The purpose of citing this example is not to show the Board in a bad light but to indicate that development is taking place at a slow pace, probably for reasons beyond the control of the water Conservation Board, In any case, some

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4/ Montana State Water Conservation Board, Summary of the Activities from Inception on January 22, 1934 to June 30, 1960, (Helena, Montana: March 1961).

5/ The Bozeman Chronicle, November 18, 1966.

soul-searching on the part of those responsible for this static state of affairs could be of great help in bringing about a desirable change in the situation.

The extreme reluctance on the part of the state government to allot funds for the conduct of water research has slackened the pace of urgently needed research. Adjoining states have already launched programs to estimate their future needs. Huffman pointed out recently that Montana has not contributed a single cent to the University-based Water Resources Research Center. In sharp contrast, Washington, Oregon and Idaho have appropriated large amounts to promote water resources research. For example, Washington is spending about $180,000 for an integrated study of water resources, Oregon is spending $743,000 for three different studies, and Idaho which created a Water Board as late as 1965 is providing over $125,000 for water resources research. 6/ These figures should, if anything, act as an eye-opener to the Montana planners and provision should be made in the 1967 legislature to appropriate a substantial amount for the conduct of comprehensive water planning and research. Time is running out and unless prompt measures are taken Montana may find itself deprived of a large part of its water by other downstream users who have established beneficial use of the State's waters.

Conservation Vs. Dam Building

In view of the potential importance of water-based recreation to Montana, a controversial aspect of recreation development has to be

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6/ The Billings Gazette, February 18, 1966.

examined carefully. This relates to the long-standing controversy between preservationists and the Federal agencies responsible for the construction of dams and reclamation of land (The Corps of Engineers and the Bureau of Reclamation). The feuds between these two groups have stymied water-resources development to a large measure.

The extreme view held by some conservationists that all dam construction is detrimental and potentially damaging to wilderness, wildlife, and scenic beauty is certainly untenable.

The fact of the matter is that most of the dams and reclamation projects do contribute to the development of recreation.

> Reclamation, in storing the spring runoff and regulating our streams for the public benefit is not the great destroyer, but in fact consistently improves the rivers for all purposes including recreational uses and enjoyment of natural beauty. 7/

The majestic scenery surrounding Lake Mead (Nevada) and Lake Powell (Arizona)--both Bureau of Reclamation Lakes--give support to the above view.

However, the view held by some building agencies that the enjoyment and pleasure derived from viewing beautiful scenery, wilderness areas or wild rivers are only of secondary importance if they do not contribute any tangible earnings to them is not justifiable. To quote Joan Robinson:

> The fight that has to be put up, for instance, to keep wild country from being exploited for money profit is made more difficult because its defenders can be represented as standing up for 'non-economic' values (which is considered soft-headed, foolish and unpatriotic) though the economist should have

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7/ The Bozeman Chronicle, November 17, 1966 (from the report of a speech by Floyd E. Dominy, Commissioner of the Bureau of Reclamation).

> been the first to point out that utility, not money, is economic value and that the utility of goods is not measured by their prices. 8/

Viewed in this perspective, the idea of preserving stretches of certain rivers as wild rivers can be justified in economic terms. Hence, the argument against the selection of stretches of the Flathead and upper Missouri Rivers to be included in a national system of wild rivers loses much of its validity.

These, then, are some of the institutional blocks in addition to the legal handicaps, which slow down the tempo of Montana's efforts to maximize the efficiency of its water use. A determined effort on the part of enlightened Montanans to remove these institutional bottlenecks should contribute immensely to the State's water development.

Conclusion

The success of a program of water resource development thus depends not merely on economic considerations but on a host of institutional factors also. The search for efficiency in water utilization through water transfer can be successful only if these institutional aspects are reckoned with. In order to overcome most of the major institutional blocks, in addition to removing the legal and administrative handicaps, concerted effort should be undertaken to educate people at the "grass-root level". The results of technical research have to be passed on to the common man in a form that is fully comprehensible to him. The Extension Service and the county agents can play a vital role in this matter.

8/ Robinson, Joan, Economic Philosophy, (Chicago: Aldine Publishing House, 1963), pp. 131-132.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

There has been a spectacular increase in the demand for and use of water in the United States in recent years. The demand for water has been rising at a much faster pace than the increase in available supply, especially in the Western United States. The core of the water problem, as it exists today, thus lies in the growing disparity between the supply of and demand for water. This imbalance in the supply-demand situation has precipitated a "water crisis". This has necessitated the adoption of a series of corrective measures, an important one being the transfer of water between uses and users.

The central concern of this dissertation is an analysis and evaluation of (a) the theoretical implications of the economic and institutional aspects of water transfer, and (b) a study of the economic and institutional factors which impede an optimal allocation of water among alternative uses in Montana and recommendation of specific measures to correct them.

This study reveals that the existing pattern of water use in the United States is far from ideal and points out the necessity to revamp the current water use pattern. Thus, there is a strong case for a shift in the demand for water from conventional uses (mainly agricultural) to a number of newly emerging uses (e.g., industrial, pollution abatement, recreational, municipal, etc.). This transfer of water would enhance the value and productivity of water in the different uses. And this, in

turn, should lead to an ideal pattern of water use and hence to an increase in the overall efficiency and welfare of the economy.

Economic Implications

Water plays a strategic role in economic development. Different patterns of water use have widely differing effects on the economy. Wollman undertook a study in 1962 to examine the "value of water in alternative uses". His study showed that high-industry models resulted in greater returns and yielded higher benefit-cost ratios than low-industry models.

Our study demonstrates that the reallocation of water from agricultural to industrial, municipal and recreational uses is capable of expanding the development potential of water-deficient regions. This fact makes clear the importance of efficient mechanisms for the transfer of water from lower to higher value uses in these regions. Water has to be transferred to support industrial and urban uses in the Western areas to ensure their continued growth. In addition, as water supplies become relatively more scarce, it becomes important that water used in agriculture is applied to the most productive lands and crops by the most efficient methods.

Water transfer encompasses a number of aspects. The transfer of newly-developed water between uses and users, and rural-urban transfer of water are two major facets. The transfer of water from less-productive to more-productive uses also contributes to economic growth indirectly. The concept of "externalities" or "spill-over effects" refers to these indirect economic effects.

The market mechanism plays a very important role in the transfer of rights to water supplies. However, if market forces are to be employed to allocate water among uses and users, water rights must be permitted to be bought and sold. The market exchange of water has some other limitations. First, there is the crucial question of how effectively market excahnge of property rights in water can result in economically optimal water allocation, especially, on a large-scale. Second, the impact of water allocation on third parties (i.e., non-participants in the market-determined decision to transfer) has to be considered. Third, it is not yet certain that the best method for water-transfer in the arid west is the exchange of water rights in the market.

A vital problem in the transfer of water between uses and users is the formulation of a system or method of water-pricing that adequately reflects the costs of supplying the water and the value of alternative uses foregone. The pricing of water performs two economic functions: allocation of the involved resources; investments in water producing projects.

Marginal cost pricing has a significant bearing in fixing water rates. There is a sharp contrast between public utility pricing based on marginal costs and average costs. The superiority of marginal cost pricing over average cost pricing is illustrated with the aid of diagrams in the section dealing with pricing. If there are "externalities", marginal cost pricing, however, will not suffice.

The theory of economic welfare can be applied to spell out the conditions essential to achieve efficiency in water transfer. A more difficult

problem, however, relates to the impact of water transfer on the problem of equity. The effect of specific types of water transfer on income distribution, either directly or indirectly, through changes in real output, is one of the important aspects to be considered in this context.

The Institutional Framework

The rights of individuals to the ownership and use of water from different sources are determined in the United States on the basis of two principal legal doctrines: (1) the Doctrine of Riparian Rights, and (2) the Doctrine of Prior Appropriation. In general, the Riparian Doctrine prevails in virtually all the states (with the sole exception of Mississippi) east of the Mississippi River. The 17 states west of the Mississippi employ the Doctrine of Prior Appropriation in one form or another. As people began to settle in the arid lands of the western states, it became increasingly clear that the Riparian Doctrine was basically unsuited to the conditions obtaining in these states. And this led to the adoption of the Appropriation Doctrine, the basic principle of which is "first in time, first in right".

The Appropriation Doctrine has been gaining increasing importance in recent years, even in the eastern states. The reason for this stems from the advantages of this system over the traditional Riparian Doctrine. However, this Doctrine, designed to deal with a short-supply situation, has not succeeded fully in fulfilling this task in the various Western states which face an almost perennial water-shortage.

Our study reveals that water laws in the particular areas have a definite bearing on the problem of water transfer. The analysis establishes that the Appropriation Doctrine is the more desirable of the two systems of water rights in facilitating water transfer. This system, however, is by no means, completely fault-free.

Montana's Water Situation

Economic Aspects.--The water situation that exists in Montana at present is unique. This uniqueness is the result of the fact that Montana is currently using less than half its water and yet has no constitutional provisions or statutes definitely recording its rights to water originating within its boundaries. And the state cannot maintain its rights to unused water indefinitely.

Formulating additional profitable uses for Montana's untapped water is one of the urgent problems that merits serious attention. There is thus a strong need for developing the state's water resources to ensure the advancement of its economy. A Federal program can play a very crucial role in the development of Montana's abundant water resources.

Surface water constitutes the major source of water supply in Montana. Ground water is also one of Montana's valuable resources and there has been a steady increase in its use in recent years. Although groundwater provides at present only a small fraction of Montana's yearly total withdrawal, there is much potential for further expansion.

An objective look at Montana's current methods of water use reveals that it does not represent an optimal pattern of water use. The need for transferring water to higher-yielding uses, without in the process impairing the quality of Montana's waters by pollution, has to be explored fully.

Future Pattern of Demand.--The future pattern of demand for water in Montana will depend on a number of factors. The dominant economic factors, in this connection, are: (1) the rate of growth of population, (2) the role of irrigated agriculture, (3) the pace and pattern of industrial growth, (4) the problem of flood control, (5) power generation, and the most significant of all (5) the fast-expanding demand for water-based recreation. The future role of each of the above factors has been examined in the text. The overall conclusion is, that in terms of growth, demand for water-based recreation will exceed demand for other uses.

Legals Aspects.--The first statute in Montana concerning water rights was passed in 1865. In 1921 the Supreme Court of Montana concluded that since 1865 the Doctrine of Riparian Rights has never prevailed in Montana and that it was unsuited to the conditions of the state. This decision settled a long-standing conflict between Riparian and Appropriation rights and established the Appropriation Doctrine as the sole waterlaw governing the use and control of water in Montana.

Montana had virtually no laws dealing specifically with ground water until 1961. In 1961 the legislative assembly of Montana passed an act providing for the appropriation and regulation of ground water. The act specified that the rights to surface water, where the date of appropriation precedes January 1, 1962, shall take priority over all prior or subsequent rights. After January 1, 1962, between the appropriation of either surface or ground water, the prior appropriation was made applicable.

Since the ownership, control and use of both surface and ground water are governed by the Doctrines of Prior Appropriation, the system of water rights in Montana suffers from some of the basic weaknesses of this Doctrine. These include a certain degree of inflexibility and considerable waste.

Other Insitutional Factors

In addition to the water laws, there are a few other institutional factors which have a significant bearing on the water resources development of Montana. The creation of conservancy districts is one such problem. The attitude of the people toward the role of federal government participation in the State's water resource development, administrative bottlenecks at a state level, and the controversy between the conservationists and the "dam-builders" are other principal institutional handicaps.

Major Conclusions

1. Water rights or laws governing the ownership and use of water have assumed a new significance in recent years as a major factor affecting water transfer and water resource development in the United States, especially in the western regions.

2. In most cases, the Appropriation Doctrine is a more ideal system for facilitating the transfer of water between uses and users than the Riparian Doctrine.

3. The competition for Montana's water is growing very rapidly from two major sources: downstream uses on the Missouri, such as barge transportation and downstream uses on Columbia for power generation. In addition, there is the possibility of Montana losing its unused water through inter-basin transfer.

4. The present pattern of water use in Montana is far from optimal and there is considerable scope for water transfer within the state.

5. The projected increase of 96,000 residents in Montana during 1960-1970 is expected to produce two major changes in water demand: (a) an increase in domestic and municipal water uses, and (b) an upswing in the demand of water for recreation.

6. A steady increase in the irrigation use for water in Montana is anticipated.

7. Flood control will assume greater importance in Montana in the years ahead. However, evidence indicates that a rise in water use for power generation is unlikely.

8. Sharp increase in the industrial use of water in forest-product, sports-goods, and feed-and-meat processing industries of Montana is expected during 1960-1970.

9. The most dramatic increase in the future demand for water in Montana is likely to occur in the field of water-based recreation.

10. The principal methods to increase Montana's tourist earnings should include the provision of high-quality recreational facilities, privacy in the out-of-doors, easy access to the State's outdoor recreation opportunities, and recognition of private landowners as hosts to visiting tourists.

11. The future location of industries in Montana should be made contingent on a guarantee by the prospective industrialists that they would adopt fully satisfactory measures for pollution abatement.

12. In order to bring about an efficient system of water transfer within Montana, revamping of Montana's current water rights system is essential.

13. There is a strong need for the creation of conservancy districts within Montana. A number of small water projects could be developed in Montana if it were possible to enlist the cooperation of all the prospective beneficiaries.

14. There is a large body of opinion in Montana which looks down upon any form of federal involvement in state developmental activities as necessarily detrimental. However, this group is steadily decreasing in number and their arguments are rapidly losing ground.

15. The idea of preserving scenic stretches of certain rivers as wild rivers can be justified in economic terms. And hence the arguments against the selection of stretches of Flathead and upper Missouri Rivers for inclusion in a national system of wild rivers lose much of their validity.

16. The importance of the Montana Joint Water Resources Council and the Montana State Agricultural Experiment Station as water-resources research agencies will increase considerably in the years to come.

17. The Extension Service and the county agents can play a strategic role in disseminating at the grass-roots level information gathered as a result of water-resources research.

Some Areas of Possible Research

The principal agency in the State that is carrying out water-resource research of any consequence at present is the university-based Joint Water Resources Research Center of Montana located at Bozeman. The funds of the center are derived from an initial grant of $87,500 contributed by the Federal government. More federal funds are expected to be received by the center in the coming years.

Currently, the Center is conducting

resource research in the fields of hydrology, economic and legal aspects of the state water plan, on ground water, soil-plant relationships and on water quality. Other work is being done on infra-red photography of groundwater flow, possible

re-organization of state water agencies and snow cornices in mountain regions. 1/

The purpose of this section is to outline briefly a few other areas which merit detailed investigation in any scheme for Montana's water resource development:

1. Supply Demand Data for the State.--One of the primary fields in which comprehensive research should be undertaken relates to detailed inventory of the existing water supply-demand situation, the future trends in the demand for water and the measures that could be taken to increase the supply of the State's water. The State does not face any immediate water crisis steming from supply-demand imbalance at present; but planning for the future should take this possibility into account.

2. Projections of Water Demand.--Hardly any quantitative estimates of the future use of water for industrial purposes, mining, flood control and, above all, recreation are currently available. Whatever estimates of irrigation needs are available are highly tentative. A well-planned, comprehensive study to estimate the future water use by the sectors mentioned above should prove very useful in planning for the future. This may involve two distinct phases: (1) an effort to determine the future pace, pattern and magnitude of growth of the different sectors of the economy, and (2) an effort to estimate wherever possible, in quantitative terms, the future demand for water by these sectors.

3. Recreation Benefits.--Recreation is going to rank very high among the water uses of Montana in the future. Some specific studies, choosing specific projects for depth-study, could be undertaken to estimate the recreation benefits stemming from the development of specif recreation projects. Studies of this nature, using different methodologies for estimating recreation benefits, could be made and the results compared.

4. Reduction of Water Losses.--A final area which needs attention pertains to the loss of water from evapo-transpiration. A large amount of water is "lost" by evaporation from the shallow

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1/ The Bozeman Chronicle, (from the report of a speech by Roy E. Huffman), February 18, 1966.

stock ponds for livestock; similarly, some of the crops consume a tremendous amount of water and yet result in very insignificant returns (e.g., Alfalfa vs. Lettuce). Studies on low-water-consuming, high-yielding crops should be undertaken. Also specific measures to reduce the extent of water transpiration from plants and crops should be formulated by means of extensive and thorough research.

This is by no means a complete cataloging of all future areas of research; rather, it is meant to point up some of the crucial water problems which have to be researched in the future.

APPENDICES

APPENDIX A*

A detailed explanation of each of the seven economic indicators referred to in Chapter II in connection with the measurement of the value of water in alternative uses follows:

1. Gross Product.--A state figure corresponding to gross national product. The sum of values added by all elements of each model was equal to the addition made by each model to gross state product. Gross product per unit of water (or value-added per acre-foot of water) has meaning only as an index of the efficiency with which water is being used within the region as the scarcity of water makes itself felt. Under conditions where water is the limiting factor of economic growth, if a free market in water should prevail, there would be a rise in the price of water relative to the prices of other factors of production. Assuming that the unemployment of other factors of production is minimized, there would also be a gradual transfer of water away from activities that use water in large amounts relative to other factors of production toward activities that use water in small amounts relative to other factors of prodution. 1/ The effect of such a shift would be to raise the value-added per acre-foot of water. By comparing value-added per acre-foot of water in alternative uses, it is possible to see the direction in which an economy will

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1/ If factors of production are just as mobile inter-regionally as intra-regionally, it is possible that domination of extra-regional forces will be such as to compel all adjustment to take place through an out-migration of factors of production from the region in which water is becoming scarce. An analysis of resource combinations in the in-migrating regions would then be necessary in order to know the effects of water shortage in the two classes of regions combined.

*Wollman, Nathaniel, The Value of Water in Alternative Uses, (Albuquerque: The University of New Mexico Press, 1962), pp. xv and xvii.

move in order to make the fullest use of all its resources as the scarcity of water increases. What limits there are to the rise in value-added per acre-foot of water cannot be readily ascertained. The greater the mobility of other factors of production, the sooner the limit would be reached. 2/

2. Primary Value-added.--Based on a method of measuring the contributions of a business or industry to the total product of the national economy, i.e., the amount by which the market value of the output of a firm or industry exceeds the value of the goods and services that have been obtained during the process from other firms or industries. In the present case, since water is a limiting factor for industry, urban growth, and agriculture in the two basins, the full measure of value-added per acre-foot of water could safely be used as an index of efficiency with which the region's resources would be used under conditions of water scarcity. Since fishing, camping, and picnicking are not for sale as commodities in themselves the primary value-added of water for recreation was considered to be zero.

3. Value-added by Purchases.--The second round of value-added resulting from purchases within the state by the businesses themselves. In the case of recreation, this is produced by purchases made by the participants in camping, picnicking, and fishing activities.

2/ But note the statement below regarding prospective water shortage throughout most of the West. This prospect reduces the possibility of offsetting the shortage of water by transfer of complementary resources elsewhere.

The sum of primary value-added and value-added by purchase provided a measure that was uniform for recreation, agriculture and industry.

4. Secondary Value-added.--The sum of primary value-added, and the first round of business purchases, plus subsequent rounds of business purchases and all rounds of household purchases from income paid out by these businesses. Because of the economic interplay between agriculture, industry and recreation, a complete accounting of this nature would have resulted in a degree of double counting when estimating the separate and independent effects of each activity upon the economic growth of the two basins. For this reason, comparisons among models were based on the sum of primary value-added and the first round of business purchases. Where further analyses of the region's development required the use of primary plus secondary value-added, adjustments were made in an effort to minimize the possibility of double counting.

5. Water Costs.--The effects of project engineering costs in each of the models upon primary value-added plus value-added by purchases and upon other economic measures.

6. Employment and Population.--An analysis of the labor force needed for each of the models, estimated from the level of physical production or from value-added, as compared with the expected size of the population and available labor force between now and 1975. From this it was possible to arrive at the per capita incomes yielded by each model.

7. Capital Requirements and Capital Supply.--Based on the assumption that all capital requirements were to be met out of the gross product produced within the two basins, the investments beginning in 1954 and ending in 1975. From estimates of capital requirements as well as savings generated by each model, it was possible to find out whether capital requirements were beyond the resources of the basins.

APPENDIX B

A SUMMARY OF MONTANA'S GROUND WATER LAW

The new Montana law dealing with ground water consists of 26 sections and repeals previous laws on the subject, passed in 1947. Since there were few previous laws on record concerning ground water, the 1961 legislation is practically the sole legal mention of Montana's ground water, other than court decisions.

A summary of the law follows.*

Section 89-2911 Definitions

Various definitions are explained. Of particular importance is the one defining the "Administrator" as the State Engineer of Montana. Section 89-2912 and 89-2913 Rights to Use and Filing--notice of appropriation--notice of completion.

The application of ground water to a beneficial use is the criterion to water rights. 'The first in time is the first in right' principle will be used in determining precedence of ground water rights.

Two notices are required in order to claim ground water rights. These are the "Notice of Appropriation of Groundwater" and the "Notice of Completion of Ground-Water Appropriation by Means of Well", or the "Notice of Completion of Ground Water Appropriation by Means other than a Well". Both are required to be filled out and filed with the County Clerk.

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*Sections 89-2911 through 89-2936, Rep. Vol. 6 (Part I), Revised Codes of Montana, 1947.

Construction must begin within 90 days after filing the "Notice of Appropriation", of the well or excavation. The driller must fill out the "Notice of Completion of Ground Water Appropriation by Means of a Well", and the appropriator then files it with the County Clerk. However, nothing is said about how long a time one has to complete construction after it is begun.

Copies of these notices are filed with the County Clerk, the State Administrator, and the Montana Bureau of Mines and Geology.

A provision is also made for "declaration of vested ground water rights" filing, which is similar to the procedure for initial appropriation. This provision protects users of ground water prior to the enactment of this law.

Section 89-2914 Designation or modification of controlled groundwater areas--notices of hearings

The Administrator can call a hearing or it may be petitioned for by 20, or one-fourth of the users of ground water in a ground water area, if factual data can be brought to bear showing: (1) the withdrawals are in excess of recharge, or (2) that they may be in excess of recharge in the near future, or (3) that there are significant disputes regarding priority of rights, amounts of ground water in use by appropriators, or types of use.

The remainder of the section deals with the contents of a petition for a hearing, and the requirements of time and place of the meeting, and the filing and publishing of the petition.

Section 89-2915 Limiting withdrawals--hearing and order.

Disputes to be heard will be decided by the Administrator, who will make written findings and an order. The Administrator has the authority to enforce the order, to require a person to cease excessive withdrawals in reverse order of their priority of rights, and to bring action for an injunction in district court. The Administrator has the right to lift the order if the adverse conditions have ceased, and the situation has returned to normal.

If the petitioner(s) disagree with the Administrator's decision, the only recourse is to go to court.

Section 89-2916 Administrative finding of priorities

Any person claiming a right to withdraw ground water, or the Administrator, may initiate a hearing for the ascertainment of all existing rights to the use of ground water in the ground water are or sub-area involved. Oil and gas well waters come under the Montana Oil and Gas Conservation Commission, but they shall also be notified of any hearings.

Section 89-2917 Scope of administrative hearing

The law states:

> In any hearing for the ascertainment and finding of priorities to the use of ground water, the administrator in his finding and order shall confirm, modify, alter or amend any prior order designating and modifying the boundaries of the ground water area, or sub-area involved, as the evidence justifies, shall determine the priority of rights and the quantity of ground water to which each appropriator, who is a party to the proceedings, shall be entitled in such particular ground water area or sub-area, and shall find and determine any other matter necessary to

> the ascertainment of ground water. He may also determine the level below which the ground water shall not be drawn by appropriators.

Section 89-2918 Permit required to appropriate in controlled area

When the State Administrator designates an area as controlled, the appropriator must file a notice of appropriation stamped "Permit Required" and cannot drill or excavate until the State Administrator has decided either that the permit is to be granted or that it will be denied.

> The Administrator shall not grant a permit if the withdrawal would be beyond the capacity of the aquifer or aquifers in the ground water area to yield ground water within a reasonable or feasible pumping lift. . .

Section 89-2919 thru 89-2923 Hearing. Appeals. How appeal taken--notice--record--trial. Appearance--setting aside conclusions, orders, etc., of admistrator--judgment and finding. Appeals to supreme court.

These sections deal with the methods of hearings and appeals. As might be expected, the courts have the power to set aside orders or conclusions of the Administrator.

Section 89-2924 Change of Location

> An appropriator of ground water may change the location of his well or other works for obtaining water without loss of priority to a point within the same area or sub-area if others are not thereby injured. He must notify the administrator of any such change.

Section 89-2925 Appropriation must be for a useful purpose--abandonment

> The appropriation must be for some beneficial purposes and when the appropriator or his successor in interest abandons

and ceases to use the water for such purpose, the right ceases; but questions of abandonment shall be questions of fact and shall be determined as other questions of fact.

Section 89-2926 Waste and contamination of ground water prohibited--exception--duties of administrator

All wells which contaminate other wells are required to be plugged. Flowing wells are to be equipped with caps or valves to prevent flow when not for a beneficial use, and wells are to be constructed in such a fashion that there will be no leaky casings, pipes, fittings, valves or pumps either above or below the land surface. Certain exceptions are noted, namely, (1) withdrawing water for testing wells, (2) inadvertent loss, not due to negligence, (3) water which must be removed for drainage purposes of either land or mines, and (4) disposal of ground water for mining purposes.

Section 89-2927 Inspection--entry on premises

This section gives the state the right to investigate matters in connection with the act.

Section 89-2928 and 89-2929 Information available to public. Reports to be in addition to other reports required.

All information concerned with this act is to be available to the public. Well drillers are still required to file all other required reports.

Section 89-2930 thru 89-2936 Duty of county attorneys and attorney general. Rules and regulations. Groundwater administrator--duties. Groundwater supervisors--duties. Investigation. Power to administer oaths and subpoena witnesses. Fees. Penalties.

These sections deal with the subjects indicated by their above titles. Of note is the fact that the Administrator has the power to prescribe and enforce additional reasonable rules as he may see fit. He also has the power to appoint ground water supervisors for controlled areas.

APPENDIX TABLE C-1. MAJOR DESIGNATED RECREATION AREAS IN MONTANA, 1964.*

Name	Location (counties)	Administering Agencies	Acreage	Attractions and Activities
Absaroka Primitive Area	Park	Forest Service	64,000	Forests, lakes, mountains, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, photography, sightseeing.
Anaconda-Pintlar Wilderness Area	Ravalli, Deer Lodge, Granite, Beaverhead	Forest Service	157,803	Forests, lakes, mountains, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, photography, sightseeing.
Beartooth Primitive Area	Park, Stillwater Carbon	Forest Service	230,000	Forests, glaciers, Granite Peaks, lakes, mountains, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, mountain climbing, photography, rock and fossil study, sightseeing.
Big Hole National Battlefield	Beaverhead	National Park Service	200	Historical site. Photography, sightseeing.
Bob Marshall Wilderness	Lewis & Clark, Powell Missoula, Flathead	Forest Service	950,000	Forests, lakes, mountains, rivers, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, photography, sightseeing, wild-river boating.
Bowdoin National Wildlife Refuge	Phillips	Bureau of Sport Fisheries and Wildlife	15,500	Wildlife, picnicking, photography, sightseeing.
Bowdoin Reservoir	Phillips	Bureau of Reclamation	21,340	Reservoir. Boating, camping, fishing, photography, picnicking, swimming, water skiing.
Cabinet Mt. Primitive Area	Lincoln and Sanders	Forest Service	90,000	Forests, lakes, mountains, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, mountain climbing, photography, rock study, sightseeing.
Canyon Ferry Reservoir	Lewis & Clark, Broadwater	Bureau of Reclamation State of Montana	75,671	Reservoir, state parks. Boating, camping, fishing, picnicking, sightseeing, photography, swimming, water skiing.
Charles M. Russell Game Range	Fergus, McCone, Phillips, Garfield, Petroleum, Valley	Bureau of Sport Fisheries and Wildlife	250,000	Wildlife, Ft. Peck Reservoir. Boating, camping, fishing, photography, picnicking, sightseeing, swimming, water skiing.

* Merriam, L. C. and M. B. Price, "Some Considerations in Planning for Outdoor Recreation in Montana", Montana Business Quarterly, (Spring 1965), pp. 20-23.

APPENDIX TABLE C-1. (cont'd) MAJOR DESIGNATED RECREATION AREAS IN MONTANA, 1964.

Name	Location (counties)	Administering Agencies	Acreage	Attractions and Activities
Custer Battlefield National Monument	Big Horn	National Park Service	765	Historical site, national cemetary. Photography, sightseeing.
Fresno Reservoir	Hill	Bureau of Reclamation	38,770	Reservoir. Boating, camping, fisheries, photography, picnicking, sightseeing, swimming, water skiing.
Ft. Peck Reservoir	Fergus, McCone, Phillips, Garfield, Petroleum, Valley	National Park Service Corps of Engineers - State	245,000	Reservoir, wildlife. Boating, camping, fishing, photography, picnicking, sightseeing, swimming, water skiing.
Gates of the Mountains Wild Area	Lewis & Clark	Forest Service	28,562	Forests, mountains, wildlife. Camping, hiking, horseback riding, hunting, photography, sightseeing.
Glacier National Park	Flathead and Glacier	National Park Service	1,009,159	Forests, glaciers, mountains, lakes, streams, wildlife. Boating, camping, fishing, hiking, horseback riding, mountain climbing, photography, picnicking, sightseeing, swimming, water skiing.
Hungry Horse Reservoir	Flathead	Bureau of Reclamation Forest Service		Forests, mountains, reservoir, wildriver, headquarters. Boating, camping, fishing, hunting, photography, picnikcing, sightseeing, water skiing.
Lewis and Clark Caverns	Jefferson	State of Montana	2,770	Spectacular caves, state park. Camping, photography, picnicking, sightseeing.
Makoshika State Park	Dawson	State of Montana	784	Scenic badlands, state park. Camping, photography, picnicking, sightseeing.
Medicine Lake National Wildlife Refuge	Sheridan	Bureau of Sport Fisheries and Wildlife	1,500	Lake, wildlife. Photography, picnicking, sightseeing.
Medicine Rocks State Park	Carter	State of Montana	320	Unique rock formations, state park. Photography, picnicking, sightseeing.
Mission Mt. Rimitive Area	Lake and Missoula	Forest Service	75,000	Forests, glaciers, mountains, lakes, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, mountain climbing, photography, sightseeing.
National Bison Range	Lake and Sanders	Bureau of Sport Fisheries	19,000	Big game herds. Guided tours, photography, picnicking, sightseeing.

APPENDIX TABLE C-1. (cont'd) MAJOR DESIGNATED RECREATION AREAS IN MONTANA, 1964.

Name	Location (counties)	Administering Agencies		Attractions and Activities
Nelson Reservoir	Phillips	Bureau of Reclamation State of Montana	16,183	Reservoir, state park. Boating, camping, fishing, photography, picnicking, sightseeing, swimming, water skiing.
Pishkun National Wildlife Refuge	Teton	Bureau of Sport Fisheries and Wildlife	1,500	Reservoir, wildlife. Boating, fishing, photography, picnicking, sightseeing, swimming, water skiing.
Red Rock Lakes National Wildlife Refuge.	Beaverhead	Bureau of Sport Fisheries and Wildlife	40,000	Waterfowl Conservation are, rare trumpeter swans. Photography, picnicking, sightseeing.
Selway-Bitterroot Wilderness Area (Montana & Idaho)	Ravalli	Forest Service	244,470 (in Montana)	Forests, lakes, rivers, streams, mountains, wildlife. Camping, fishing, hiking, horseback riding, hunting, photography, sightseeing, wild-river boating.
Spanish Peaks Primitive Area	Gallatin	Forest Service	50,000	Forests, lakes, mountains, streams, wildlife. Camping, fishing, hiking, horseback riding, hunting, photography, rock and fossil study, sightseeing.
Tiber Reservoir	Liberty	Bureau of Reclamation State of Montana	59,263	Reservoir, state park. Boating, camping, fishing, photography, picnicking, sightseeing, swimming, water skiing.
Yellowstone National Park (Montana, Idaho, Wyoming)	Park and Gallatin	National Park Service	142,502 (in Montana)	Forests, lakes, mountains, nearby world-famed geo-thermal area, rivers, streams, wildlife. Boating (Wyoming), camping, fishing, hiking, horseback riding, mountain climbing, photography, picnicking, sightseeing.

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