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0093 Water Problems in Colorado

Colorado Legislative Council

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WATER PROBLEMS IN COLORADO

Colorado Legislative Council

Report To The

Colorado General Assembly

Research Publication No. 93
November, 1964

COLORADO GENERAL ASSEMBLY

LEGISLATIVE COUNCIL

ROOM 341, STATE CAPITOL
DENVER 2, COLORADO
222-9911—EXTENSION 2285

November 24, 1964

To Members of the Forty-fifth Colorado General Assembly:

In accordance with the provisions of House Joint Resolution No. 1030, 1964 regular session, the Legislative Council submits the accompanying report and recommendations relating to water problems in Colorado.

This report and recommendations were approved by the Council at its meeting on November 23, 1964, for transmission to the members of the Forty-fifth General Assembly.

Respectfully Submitted,

C. P. (Doc) Lamb,
Chairman

COLORADO GENERAL ASSEMBLY

LEGISLATIVE COUNCIL

ROOM 341, STATE CAPITOL
DENVER 2, COLORADO
222-9911—EXTENSION 2285

November 10, 1964

Representative C. P. Lamb, Chairman
Colorado Legislative Council
Room 341, State Capitol
Denver, Colorado

Dear Mr. Chairman:

Your committee appointed to review the surface and underground water supplies of the state has completed its assignment and submits the accompanying final report and recommendations thereon.

The committee's study of our water problems clearly demonstrated the need for corrective action, and the committee has therefore adopted the accompanying recommendations as measures to meet this need. The complexities of these problems are so great, however, that consideration may want to be given to additional study and recommendations concerning our water problems.

Respectfully Submitted,

Frank L. Gill, Chairman
Committee on Water

FLG/mp

FOREWORD

The Legislative Council's Committee on Water was created under the provisions of House Joint Resolution No. 1030, 1964 regular session, to study the surface and underground water supplies of the state. Recognizing the complexities of our water problems and the varying conditions which exist in different areas within Colorado, the Council appointed the following 23-member committee to carry out this assignment:

Senator Frank L. Gill, Chairman
Representative Frank A. Kemp, Jr., Vice Chairman
Senator Raymond W. Braiden
Senator Fay DeBerard
Senator Wilkie Ham
Senator Harry M. Locke
Senator Carl J. Magnuson
Senator Floyd Oliver
Senator Wilson Rockwell
Senator Ranger Rogers
Senator Dale P. Tursi
Representative Arthur L. Andersen
Representative H. George Autry
Representative Robert S. Eberhardt
Representative William M. Griffith
Representative Ted E. Lewis
Representative Harold L. McCormick
Representative Hiram A. McNeil
Representative Clarence H. Quinlan
Representative R. D. Saunders
Representative Robert Schafer
Representative Oakley Wade
Representative Arthur M. Wyatt

Representative C. P. Lamb, chairman of the Legislative Council, also served as an ex officio member of the committee.

The bulk of the committee's activities consisted of conducting meetings in various areas of the state to discuss water problems with users, administering officials, engineers, lawyers, and other interested persons. The exchange of ideas and information concerning water supplies and problems in Colorado which took place at these meetings resulted in the accompanying report and recommendations of this committee.

The committee and staff were aided in their endeavors by numerous state, local, and federal officials, as well as by several private individuals concerned about the state's water problems. Mr. Morton W. Bittinger, associate research engineer at Colorado State University, served as the committee's consultant on water supplies and problems. Miss Clair T. Sippel, secretary of the Legislative Reference Office, and Mr. Phillip E. Jones, senior research analyst from the Legislative Council's staff, also assisted the committee.

November 10, 1964

Lyle C. Kyle
Director

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COMMITTEE FINDINGS AND RECOMMENDATIONS

In accordance with the provisions of House Joint Resolution No. 1030, 1964 regular session, the Legislative Council's Committee on Water has completed its study of the surface and underground water supplies of the state. On the basis of this study, a general summary of which is contained in its accompanying report entitled "Water Problems in Colorado," the committee submits the following recommendations:

1. That legislation be adopted to permit the organization of local ground water districts. Such districts should be under local control and direction and should be authorized to regulate and manage the ground water supplies within their areas. The committee believes that any legislation concerning ground water should protect the rights of existing wells. Further, the committee believes that a recharge or pumping system is needed in Colorado to sustain underground water storage and to effectuate a solution to the problem of salt deposits resulting from the continuing use and re-use of water, and local ground water districts could be utilized to carry out this program along with their other activities.

2. That the General Assembly direct the State Engineer to deny calls on surface supplies used to irrigate mountain meadows on a three-year trial basis, including a provision that there be no increase in existing priorities in the mountain valleys at the time this becomes effective, and that an amendment be submitted to provide for this procedure in our constitution. Similarly, consideration may want to be given to providing that a senior decree be limited to a number of miles of river over which a call could be made, or through application of an efficiency rating system.

3. That the loss of water from evaporation in on-stream reservoirs be charged against the reservoir, and that the State Engineer be authorized to require on-stream reservoirs to pass or release the amount of natural in-flows.

4. That legislation be adopted similar to the outline in Appendix C in the accompanying report to provide a stronger well drilling law and to require better well construction in order to prevent the problem of leaks and possible contamination of aquifers.

The committee also believes that the wasting of water by phreatophytes is a problem and that it would be beneficial if there could be a state program to reduce this waste. In regard to the comprehensive study recommended by the Colorado Water Congress and others at the committee's meeting in Denver (page 23 of the accompanying report), the committee decided that this was a decision to be made after seeing how much water legislation was offered in the 1965 session in order to determine the necessity of such a comprehensive study. However, the committee agrees that more study is needed in regard to changing the constitutional order of priority for use of water and allowing a change in use from agricultural to industrial following the purchase of agricultural land and accompanying water rights.

WATER PROBLEMS IN COLORADO

Water is the most important single resource in Colorado today, and its availability and proper use is essential to the state's economic future. With water of sufficient quantity and quality, the state can continue to grow and prosper; without water, at best there can only be economic stagnation and eventual depression.

There would be little concern about the availability of water if the people in this state were allowed to use the water produced in the major river basins of Colorado -- an annual average total of 16,030,000 acre feet -- but Colorado shares its water with its downstream sister states, largely to the south and west, through interstate agreements. Consequently, the amount of water available for use in Colorado is limited, and questions continually arise as to the better usage of that water which is available.

In 1964, the Colorado General Assembly directed the Legislative Council to appoint a committee "to make a comprehensive study of the surface and underground water supplies of the state." In carrying out this assignment, the 23-member committee held a series of meetings in various areas of the state to discuss problems of water with water users, administering officials, engineers, lawyers, and other interested persons. This report is based on the activities of the committee and the testimony and materials submitted to the committee during the course of its meetings.

Sources of Water in Colorado

The state's water supplies originate in the atmosphere, but once it reaches the ground it may either become part of a stream's surface flow or it may find its way beneath the earth's surface where it may be stored as ground or underground water.

Surface Water

Surface water in Colorado is located in five major river basins -- the North Platte River basin; the South Platte River basin; the Arkansas River basin; the Rio Grande River basin; and the Colorado River system including the Yampa River, the White River, the Gunnison River, the San Juan and Dolores Rivers, and the Colorado River.

These five basins provide an annual average virgin production of 16,030,000 acre feet of water. Of this total, as of January 1, 1963, an estimated 5,243,000 acre feet is consumed in Colorado and the remainder, or approximately 11,000,000 acre feet, flows out of the state each year.[1]

1. Taken from data contained in Information Bulletin No. 22, August 28, 1964, Colorado Water Conservation Board.

Ground Water

Water found beneath the surface of the earth is known as ground or underground water. This water is found in aquifers, or underground reservoirs, in varying quantities and qualities. In Colorado, there are four major aquifers -- (1) the alluvium and terrace deposits of the South Platte Valley and its major tributaries; (2) the alluvium terrace deposits of the Arkansas Valley and its major tributaries; (3) the valley fill in the San Luis Valley; and (4) the Ogallala formation in the high plains area of Eastern Colorado. There is little ground water in the western part of the state.

Much of the discussion concerning ground water centers on the importance of recognizing the type of aquifer in which the ground water is found. In general, two types of aquifers may be described -- (1) the shallow alluvial aquifers with a free ground water table in hydraulic connection with surface water flow, and (2) "confined" or "artesian" aquifers which are recharged primarily from outcrop areas usually some distance from the part of the aquifer being pumped. The first type of aquifer, with its hydraulic connection with surface flows, must be considered a part of the total water system of the basin, but the second type of "confined" aquifer may often be treated separately from surface water. On the whole, the confined-type aquifers receive negligible recharge in comparison to normal withdrawal so that the use of this water involves a type of mining operation.

Aquifers do not fall neatly into one type or the other and, consequently, the physical situations within each basin and each aquifer must be considered in each area.

Some Basic Differences Between Surface and Ground Water[2]

Surface and ground water have widely different characteristics. Many states govern both by a single theory of law and commonly by a single set of statutory regulations. These laws rarely recognize the difference and, thus, pose many problems to water users and to those concerned with the optimum beneficial development of the resource.

Some of the differences in the two types of water are shown in the following comparative statements that are generally applicable to surface and ground water:

2. Colorado Ground Water Circular No. 6, "Legal and Management Problems Related to the Development of an Artesian Ground-Water Reservoir," by Edward A. Moulder, United States Geological Survey and Colorado Water Conservation Board, 1962, p. 2.

Surface Water	Ground Water
1. Availability in terms of time is widely variable depending largely on variations in climatic conditions.	1. Availability in terms of time is influenced only slightly by variations in climatic conditions.
2. Withdrawals are limited largely by the perennial supply owing to relatively small amount of storage.	2. Withdrawals may exceed the perennial supply substantially for extended periods of time according to the amount of water in storage.
3. Most, if not all, of the perennial supply can be withdrawn from a single point within the system.	3. Only a small part of the perennial supply can be withdrawn from a single point.
4. The rate of transmission of water from place to place within the system is rapid.	4. The rate of transmission of water from place to place is comparatively very slow.

Another difference perhaps worth noting here is that there is much less loss from evaporation in underground storage than there is in surface storage.

The Appropriation of Water Doctrine in Colorado

Water use in the United States is largely based on two different doctrines -- the riparian doctrine whereby the right of use resides in the ownership of riparian lands, or lands adjoining the water, and the appropriation doctrine which generally grants to an individual a perpetual right to use a specified quantity of water for a specified beneficial use. Under the appropriation doctrine, the first person to be awarded a right or decree is superior to all subsequent rights or decrees for the same beneficial use of water, i.e., "the first in time is first in right," and, in time of short supplies of water, may shut down all junior decrees until he has received his appropriated amount of water.

Colorado, along with most of the other western states with arid or semi-arid climates, follows the appropriation of water doctrine. The basic provisions covering this doctrine are contained in Sections 5 and 6 of Article XVI in Colorado's Constitution:

> Section 5. Water, public property. The water of every natural stream, not heretofore appropriated, within the state of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation as hereinafter provided.
>
> Section 6. Diverting unappropriated water -- priority. The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation

> shall give the better right as between those using the water for the same purpose; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall have the preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes.

As may be noted, no mention is made of ground water in these two sections, nor is such mention made in any other sections of the state's constitution. This omission, coupled with the lack of an effective law governing ground water, has led to the statement that "there is virtual anarchy in water administration in this state today."[3]

The use of water in Colorado is governed by three types of law -- constitutional law, statutory law, and case law. Because of inadequate constitutional and statutory provisions, case law is quite prevalent and has been used often by water users in order to obtain answers or solutions to their problems.

Summary of Water Committee Meetings

At its organizational meeting on April 28, 1964, the Legislative Council Committee on Water agreed that area meetings should be held in various watersheds in the state. This would not only provide local people with a chance to present their comments and problems to the committee but it would also allow the members of the committee to become acquainted with water problems different than those in their own areas. With this in mind, the committee held two meetings in the Arkansas River Valley, one meeting on the Western Slope, one meeting in the San Luis Valley, one meeting in the High Plains, and one meeting in the South Platte River Basin. These area hearings were followed with a meeting with technical staff personnel at Colorado State University in Fort Collins, and with a final day of hearings in Denver which was largely devoted to discussions with water law attorneys and engineers.

Arkansas River Valley

The Arkansas River begins in the mountains of central Colorado and flows in a south and easterly direction through Salida, Canon City, Pueblo, and across the plains in the southeastern part of the state where it enters Kansas east of Lamar. The average annual consumptive use of water in the Arkansas River Basin totals 968,000 acre feet, leaving a remaining flow at the state line of some 200,000 acre feet. Demands by Kansas under the Arkansas River Compact have averaged 50,000 acre feet annually since the compact went into effect in 1949.

3. Statement by Felix L. Sparks, Director, Colorado Water Conservation Board, Minutes of Committee's Meeting, October 8, 1964, page 11.

Kansas is entitled only to a portion of the winter flows, plus a percentage of the storage in John Martin Reservoir.[1]

The alluvium and terrace deposits of the Arkansas River Valley and its principal tributaries constitute an important aquifer in Colorado. Water in this aquifer is in hydraulic connection with the surface flow of the river, with heavy pumping activities underway in the lower part of the basin. In fact, local overdevelopment, owing largely to inadequate spacing of wells, was reported for some places in the valley as far back as 1956.[4]

Because of the difference in water conditions and usage, the committee held two meetings in the Arkansas River Valley -- one in Lamar on June 3rd for the lower end of the basin and one in Pueblo on June 4th for the upper end of the basin.

Lower River Basin. Water users in the lower reaches of the Arkansas River expressed substantial concern with the effects of pumping on the surface flow of the river, transportation losses in the river between the upper and the lower basins, illegal diversions of surface flow, and problems connected with abandoned wells.

Much of the discussion at the committee's meeting in Lamar revolved around the effects of pumping on the Arkansas River's stream flow. One of the complaints was that the pumping of wells is in effect changing the priorities on the river, not by law but by practice. Mr. M. W. Bittinger, committee consultant, reported that on the basis of average stream flow in August, surface decrees filed later than 1885 or 1888 would not be getting much water from the river as the older decrees would be using all of the available stream flow. In this connection, Mr. John E. Moore, on the staff of the Groundwater Branch of the United States Geological Survey, stated that an unplanned development of the ground-water reservoir will result in a drastic decrease in stream flow and will therefore work a hardship on those surface decrees downstream from the wells. (See Appendix A for text of Mr. Moore's report: "Water Management Study of Lower Arkansas River Basin.")

The loss of water on the way downstream was discussed as a problem affecting both lower and upper basin water users. It was reported by one water user that some of the priorities upstream have to release 400 to 500 acre feet of water in order that a senior decree in the lower area will receive 67 acre feet of water. The loss in transportation was attributed to pumping and to phreatophytes -- water-using or "junk" vegetation along the river such as trees, brush, weeds, etc.

1. Taken from data contained in Information Bulletin No. 22, August 28, 1964, Colorado Water Conservation Board.

4. Ground-Water Series -- Circular 4, "Ground Water in Colorado and the Status of Investigations," by Thad G. McLaughlin, United States Geological Survey and Colorado Water Conservation Board, January 1956, p. 8.

Illegal diversions of surface water, or water being taken out of its order of priority, was another problem mentioned. Later, at the committee's meeting in Denver on October 8th, the committee was informed that a suit is to be brought against the Oxford and Highline Ditch Companies, and the plaintiffs will be the Fort Lyon and Catlin Ditch Companies. Reportedly, the defendants are pumping directly from the river to supplement their surface appropriations and are introducing the pumped water into their ditches below their headgates so that it is not charged against their surface decrees; the plaintiffs will attempt to have this practice stopped.

Area residents also expressed concern with the problem of abandoned wells which can contaminate or pollute ground water supplies of others. It was reported that some of these wells were improperly drilled to begin with, while others are breaking down because no one plugged them after they were no longer being used.

The water users were distressed because of the lack of state assistance and state action in regard to their water problems, and several recommendations for legislative consideration were made to the committee. Perhaps of greatest importance is the need for the state to enact specific statutory provisions dealing with water so that the individual water users will not have to go to the courts for relief and answers to their problems.

In this connection, various -- and at times conflicting -- recommendations were made to the committee. One recommendation was that because each watershed has different problems, each drainage area should be under a separate law. A similar suggestion was that the legislature should provide the machinery for areas to form water districts and to authorize local administration of these districts. Another was that the state have one authoritative law flexible enough to meet the different problems in the different areas. It was suggested by one person that wells need to be put under a system of priorities, while another felt that such priorities were not needed in the control of ground water use.

In order to meet some of the other problems connected with wells, a stronger well drilling law was urged. Also, a spacing provision on the location of wells is needed, such as New Mexico has in its law; for example, no well could be drilled within one-fourth mile of an existing well in the same aquifer.

One conclusion of Mr. Moore's study of the Lower Arkansas River Basin was that in order to achieve the maximum use of the available water supply, ground and surface water must be developed and managed as a single supply.

Upper River Basin. Water users in the Upper River Basin reported a number of the same problems as those reported by downstream users. Similar to comments made in Lamar, the Division Engineer stated that surface water rights junior to 1887 are becoming quite marginal along the upper part of the river, but this situation is compounded by the fact that ground water is not so easily obtained as it is in the lower valley areas because of geological conditions.

Charges were made at the Pueblo meeting that the use of pumps in the lower basin is depleting the river's surface flow. Transportation loss of surface supplies because of the growth of junk vegetation along the river was also mentioned, and it was estimated that there could be 50 per cent salvage of this loss if corrective measures were taken.

In addition, a major problem was reported to be evaporation losses in surface reservoirs. The extent of this problem was indicated by the report that over a period of 28 years, including some years when no water was available, only 16 per cent of the amount of water put in the Great Plains Reservoir came out in direct flow. The state's water laws make no provision concerning evaporation losses in reservoirs, but a district court decision was rendered that an off-stream reservoir must stand its seepage and evaporation losses but not an on-stream reservoir. In actual practice, however, it was reported at the Pueblo meeting and again at the Denver meeting on October 8th, as a general rule no reservoir sustains this loss but makes it up through diversions from surface flow.

Similarly, the complaint was made that large stock and other water ponds are taking water belonging to surface appropriators. Another problem mentioned was that there are too many state agencies dealing with water -- the State Engineer, the Colorado Water Conservation Board, and the Ground Water Commission -- and there is a need for accurate measurements concerning surface and ground water in the Arkansas Valley.

In terms of recommendations at the Pueblo meeting, it was suggested that all water needs to be regulated, the same as surface water is regulated now, but the important point is that there must be some controls on the drilling of wells. Along this line, another suggestion was that the state change from the use of decrees to another method -- volumetric measurement rather than rate measurement, i.e., water could come from surface or ground supplies, or both, under a quantitative measurement.

The prevention of the growth of junk vegetation along the river was also a recommendation, with the additional suggestion that diversion ditches and dams be made responsible to assist in this prevention.

The question was raised as to whether now is the time to adopt a new law regarding water instead of waiting until the United States Geological Survey completes its surveys of the river, i.e., a better law could be drafted on the basis of this information which is as yet unavailable.

Western Slope

For all practical purposes, the Western Slope of Colorado is dependent on surface flow to supply its water needs, and at this time, at least, there is very little ground water development in this area. The Colorado River System produces some 11,460,000 acre feet of water each year, and there is a consumptive use of 1,640,000 acre feet

of this total in Colorado, leaving 9,820,000 flowing out of state. Under the terms of the Colorado River and Upper Colorado River Basin Compacts, Colorado is allocated the consumptive use of 3,855,000 acre feet annually.[1]

One of the major questions involving the future of water use on the Western Slope is directly connected with oil shale production. The principal deposits of oil shale in the United States are located in Western Colorado, and their importance to the future economy of the state cannot be minimized. The development of this industry, however, is expected to require rather substantial amounts of water, as follows: 1965 -- 5,000 acre feet per year; 1970 -- 40,000 acre feet per year; and by 1975 -- 250,000 acre feet per year.[5] Moreover, depending on the production process utilized, much of this water will be totally consumed so that there will be relatively little return flow.

The committee met in Glenwood Springs on July 18, 1964, to review water supplies and problems on the Western Slope. It was pointed out that the oil shale industry is in such an experimental stage that no one really knows exactly how much water will be required, but the need will be substantial. One possible problem involves the constitutional priorities regarding the use of water -- (1) domestic, (2) agricultural, and (3) industrial -- because in this area it might be more important to the region's economy to use water for industrial rather than for agricultural purposes.

In this connection, some companies have been buying ranches in this area in order to obtain their water rights and not the land. There is a question that if they try to change the use of this water to industrial purposes, a court suit may be filed and these companies could lose their investments. That is, when there is a change in use from perhaps 25 per cent consumptive use for perhaps three months a year to 100 per cent consumptive use for 365 days a year, the other water users with decrees on the same surface supply may object. A somewhat comparable situation was reported for the Eastern Slope where water is injected in the secondary recovery of oil -- there is 100 per cent consumptive use of the water but this use returns more money to the area than if the water were used for farming.

The appropriation doctrine is working very well on the Western Slope, and the committee was cautioned that any change to meet problems on the Eastern Slope should not upset the system on the Western Slope. Apparently, water users on the Western Slope do not encounter the problem of transportation losses of water which was mentioned so frequently at Lamar and Pueblo and at subsequent meetings of the committee on the Eastern Slope. However, it was reported to the committee that brush and timber on the Western Slope use water which could otherwise

1. Taken from data contained in Information Bulletin No. 22, August 28, 1964, Colorado Water Conservation Board.

5. Water Requirements for Oil Shale, 1960-1975; A Study for the Colorado Water Conservation Board by Cameron and Jones, Inc., July, 1959; p. 1.

be put to better or more beneficial use with better land and water management practices. This misuse occurs not only as a result of moisture being absorbed by the brush and timber, but also because of evaporation into the air when the snow falls on the branches and not on the ground where it can be absorbed into the soil.

This misuse of water on the higher lands restricts the benefits to the lands below due to the loss in run-off and underground water storage. The first step in correcting this problem would be to compel ditch owners to keep their ditches clear of the growth of timber, brush, etc.

One attorney at the meeting stated that it is almost impossible in this state to say what a given water right is today since, unlike other states such as Utah and Wyoming, our State Engineer merely files decrees and does not maintain an up-to-date record of water rights. Consequently, the law should establish some central place or agency having the responsibility of not only adjudicating water rights but also of maintaining a record of the water rights, and this record should be kept current. It was suggested that this procedure should include wells and that it would also be advisable to have each change or transfer of ownership noted.

Another suggestion made to the committee was that any water code must make it essential for the claimant to prove that there would be no adverse effect on existing water rights if his application for a water right were approved.

San Luis Valley

The water-bearing materials beneath the floor of the San Luis Valley constitute one of the most unusual aquifers in the country. The aquifer consists of a series of beds of sand and gravel interbedded with clay and extending to a depth of many thousand feet. The layers of clay serve as confining beds and create artesian pressures in the underlying beds of sand and gravel. One well drilled to a depth of 1,000 feet encountered more than 50 separate flows of water.

Recharge to the upper zones of the aquifer is supplied largely by the use of surface water for irrigation. For many years the crops have been subirrigated by a shallow water table maintained by the infiltration of surface water through ditches. During the drought of the 1930's, when the supply of surface water was not adequate, wells were drilled to supply supplemental water. The two methods of irrigation are at cross purposes -- one trying to hold the water table at the root zone and the other pulling the water table down.[6]

The San Luis Valley is located in the Rio Grande River Basin in south-central Colorado. The Rio Grande River has an estimated average annual virgin production of 1,130,000 acre feet of water; of this total, 870,000 acre feet of water is consumed in Colorado, leaving 260,000 acre feet flowing out of the state. The waters of the Rio Grande River

6. Ground-Water Series -- Circular 4, previously cited, pp. 8-9.

are subject to the terms of the Rio Grande River Compact. In recent years Colorado has not been able to meet its commitment under the terms of this compact, and as of December 31, 1963, was in debt to the extent of 734,400 acre feet of water.[1]

In addition to the river basin production, there is a so-called closed basin north and east of the Rio Grande. The Colorado Water Conservation Board estimates an average annual water production for this area of 270,000 acre feet from precipitation, all of which is applied to consumptive use. The water in this closed basin does not reach the river system, and since it cannot escape, the water evaporates, leaving only the salt and other mineral deposits in the ground.

Water users appearing at the committee's meeting in Alamosa on July 20th pointed out that there is nothing the General Assembly can do about the terms of the Rio Grande River Compact, although there is a possibility that the Colorado Water Conservation Board would renegotiate the compact if a regulatory clause on water delivery could be included. The water users from the closed basin area seemed most concerned about wells being drilled by persons not having surface rights and who do not therefore add water diverted from the river to the ground water storage. These new wells also are damaging the wells of older, established users in the valley and restrictions are needed somewhere along the line. The Colorado Ground Water Commission has received a petition to declare an area north of the Rio Grande River as a critical district, or where the drilling of new wells could be restricted. This situation is under study and a report thereon is scheduled to be submitted to the commission in December.

Similar to other areas, problems of improperly drilled wells and losses of water in transportation were reported to the committee. Because of the various layers of underground water in the area, some poorly-drilled wells have combined or co-mingled different waters, and regulation is needed to prevent this.

A major problem facing the valley is the increasing collection of salt which is retained in the closed basin. An average of 600,000 acre feet of good water is brought into the basin each year. As this water is used and reused, however, the mineral content increases in parts per million of dissolved solids and eventually results in a high saline situation in the sump area or eastern part of the valley where the water evaporates. Moreover, while this problem is localized in the eastern part of the valley at this time, the situation is spreading west and could evenutally destroy the productivity of the entire closed basin area.

One solution proposed is to install drainage pumps to remove the salt along with the mineralized water from the basin instead of allowing the rather highly mineralized water to collect in the lower eastern part where the moisture is lost through transpiration and evaporation, leaving only the minerals in the ground. These pumps

1. Taken from data contained in Information Bulletin No. 22, August 28, 1964, Colorado Water Conservation Board.

would have to be located properly to be an effective solution, and there would have to be a sufficient amount of water to dilute the water with the flow in the Rio Grande River so that its addition would not pollute the river's water for downstream users in other states.

Ogallala Formation

Of the four major ground-water provinces in Colorado, the Ogallala formation is the largest. It covers about 12,000 square miles, including all or parts of the following counties: Lincoln, Elbert, El Paso, Pueblo, Crowley, Baca, Prowers, Cheyenne, Kiowa, Kit Carson, Washington, Yuma, Phillips, Logan, and Sedgwick. This province has been separated into three major parts by Big Sandy Creek and the Arkansas River. The largest part is northeast of Big Sandy Creek and centers around Yuma County. The part southwest of Big Sandy Creek is irregularly shaped, being eroded, in part, by tributaries to the Big Sandy and the Arkansas. The third part lies south of the Arkansas River in the southeast corner of the state.[7]

The Ogallala formation contains ground water generally non-tributary to surface flow. The aquifer is recharged only by precipitation, and it is estimated that probably not more than one inch of the normal annual rainfall (15 to 18 inches) reaches the aquifer. Unless this condition changes, the ground water supplies could eventually be depleted. Thus, the aquifer could be developed in one of two ways: (1) It could be developed only to the extent of the salvageable recharge so that the supply, although comparatively small, will last indefinitely; or, (2) its water can be considered an expendable resource similar to oil, gas, lead, or zinc and can be "mined" over a period of several generations, after which it will be depleted to the point where it can no longer be used for large-scale irrigation.[8]

The committee's meeting at Burlington on August 31st was largely devoted to the use of wells in Cheyenne, Kiowa, Kit Carson, Yuma, Phillips, Sedgwick, and Washington counties which are experiencing substantial ground water development. For example, in Kit Carson County alone the number of wells has increased from eight in 1936 to some 370 producing wells at the present time.

A Northeast Colorado Area Development Committee has been organized for the purpose of studying problems in the high plains area which transcend county lines -- problems that are important for the social and economic development of this area. The committee's number one project in this respect is the study of underground water development in this area, and the status of this undertaking was reported to

7. Colorado Ground Water Circular No. 5, "Ground Water in the Ogallala and Several Consolidated Formations in Colorado," by Edward A. Moulder, United States Geological Survey and Colorado Water Conservation Board, December 1960; p. 1.

8. Ground-Water Series -- Circular 4, previously cited, p. 13.

the water committee at Burlington. First of all, the more important facts pertaining to the underground water situation were outlined as follows:

1. Our principal water-bearing information, the Ogallala, underlies some 9,000 square miles in Eastern Colorado, (see Figure 1). The Ogallala formation also underlies portions of Nebraska, Kansas, Oklahoma, Texas, and New Mexico -- being one of the major ground water basins of the United States.

2. Underlying the Ogallala in Colorado is an impermeable shale base, sloping in general to the east and northeast. The surface of the shale, however, is not a plane surface but contains channels and ridges carved by erosion before the Ogallala was deposited.

3. The saturated thickness of the Ogallala (the depth of water in a well penetrating the entire formation) varies from zero to over 300 feet, (see Figure 1). In general, the thickness increases as one goes from west to east, but the thickness also depends upon one's location in repect to the bedrock ridges or channels.

4. The large volume of underground water within the Ogallala formation has accumulated slowly over many thousands of years. Contrary to some popular belief, this ground water basin is <u>not</u> fed from the Rocky Mountains, or from streams originating in the mountains, but only from the small percentage of natural precipitation which finds its way down to the ground water. This natural replenishment probably averages less than one-inch per year. Because of the slope of the base of the Ogallala the underground water is continually flowing out of Colorado being approximately balanced by the average annual recharge from precipitation.

5. Simple arithmetic tells us that limiting the use of underground water to an amount equal to the natural recharge would allow irrigation of only a few acres per section of land. Even then, water table levels would lower because the underground flow out of the State would be diminished only slightly. Therefore, it is inevitable that the resource must be depleted to be of economic value to our area and the State.

6. Although ground water use for irrigation in the region started many years ago, intensive development has occurred only in recent years. This trend is shown in Figure 2, from information obtained from the State Engineer's Office. These figures indicate the number of irrigation wells have doubled in the last 6 years.

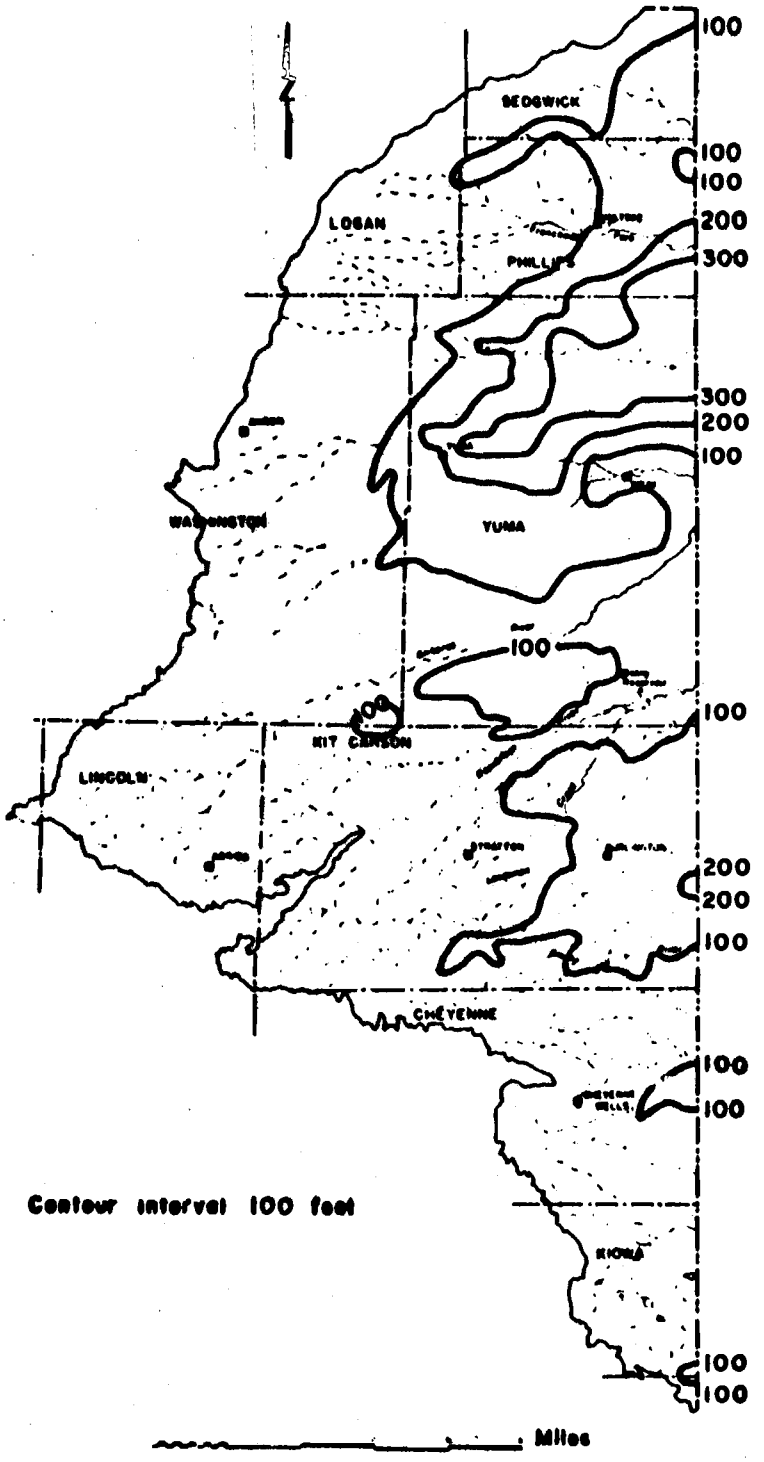

FIG. 1. APPROXIMATE BOUNDARY AND SATURATED THICKNESS OF OGALLALA FORMATION, NORTHERN PORTION OF COLORADO HIGH PLAINS. (Adapted from Colorado Ground Water Circular No. 8).

In view of these facts and figures, the Northeast Colorado Area Development Committee reported that it was very much concerned with the need for planned development, conservation, and management of the underground water supplies in the area.

This committee suggested that there are many important decisions to be made which will require much study, but "the point that is important to us here and now is that the Northern High Plains should be set aside as a special area so that management decisions for the development of this valuable resource may be in the hands of the people of the region. We have a common water resource that is peculiar to this area, and our people would like to have the opportunity to develop this resource to its fullest. We feel that the people want local voice in the development and management of this resource and that their desires would not be inconsistent with the social and economic development of the High Plains area and the State."

The area development committee did not have specific recommendations to submit at the Burlington meeting. Subsequently, however, the following recommendations were submitted to the water committee on October 8th:

"The people in the Ogallala formation request the help and source knowledge of the state in administering its ground water. The state engineer should act as arbitrator in any disputes within the area, with appeals to the court being provided, but the governing of the district should be in the hands of the local people and local discretion should be authorized. Fees should be levied on wells over 100 gallons and the proceeds split between the state engineer and the local governing body.

"There should be two different types of state laws -- one involving ground water tributary to surface flow and another dealing with closed basins such as the Ogallala, with the latter law being based on local control.

"A local basin district should be self-supporting. There should be a tax levied on the amount of water withdrawn per well except on domestic and livestock wells, or on the basis of the acreage under irrigation. There is a question yet as to whether cities are to be included in the district and assessed costs.

"The tax is to provide sufficient revenues to pay all necessary expenses including the cost of recharge projects, the hiring of technical experts, expenses for board members, etc.

"Provisions on the use of water should include a prohibition against the taking of water for use outside the closed basin except with permission from the district governing board. The law should be patterned after the soil conservation law as to districts."

South Platte River Basin

The South Platte River has its headwaters in the South Park area. This river constitutes the major surface supply for the South Platte River Basin, or roughly the northeastern quarter of the state.

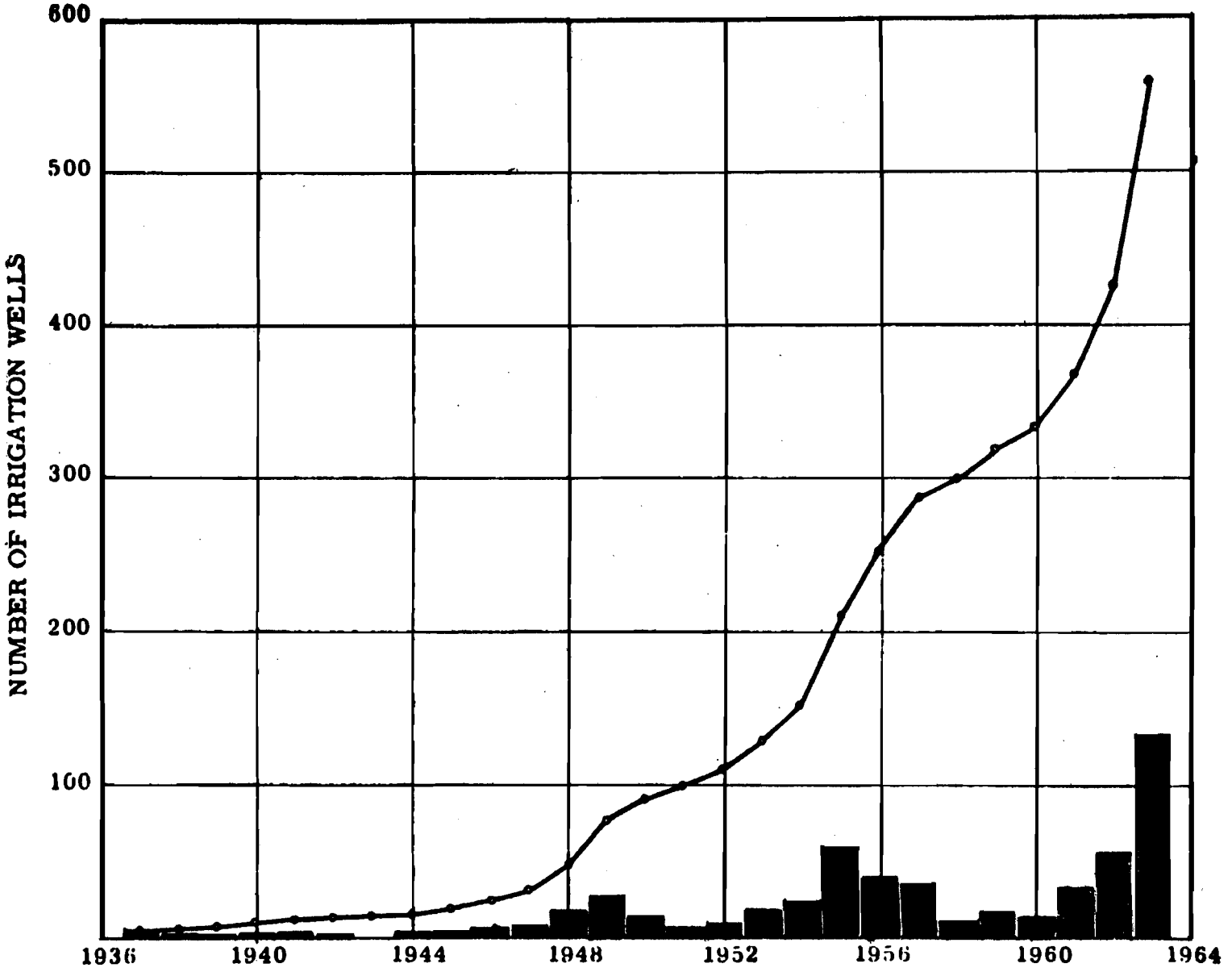

FIG. 2. NUMBER OF IRRIGATION WELLS DRILLED EACH YEAR (BAR GRAPH) AND ACCUMULATED TOTAL IRRIGATION WELLS (LINE GRAPH), NORTHERN PORTION OF COLORADO HIGH PLAINS. DATA FROM RECORDS OF COLORADO STATE ENGINEER.

This basin imports some 380,000 acre feet of water each year from the Western Slope to supplement its estimated average annual virgin production of water of 1,600,000 acre feet. The consumptive use of water in the basin averages 1,640,000 acre feet annually, with flow out of the state amounting to about 340,000 acre feet of water. Delivery requirements under the South Platte River Compact do not exceed 100,000 acre feet per year, so the state line flow has been more than adequate to comply with the compact provisions.[1]

The South Platte Valley is the most highly developed aquifer in Colorado. Most of the wells are in the main stem of the South Platte Valley where they are used for supplemental irrigation. In tributary valleys, such as Beaver, Badger, Bijou, and Kiowa, no surface water is used for irrigation and the only sources of recharge are local precipitation and infiltration through the stream beds during periods of flood runoff -- plus the fraction of the ground water that returns to the water table from irrigated fields. As a consequence, the amount of water being pumped annually probably exceeds the annual replenishment in these places, the water levels are declining at a serious rate (as much as four or five feet a year), and the aquifer is locally approaching exhaustion.

Studies of the occurrence of ground water has shown that there is about 11,000,000 acre feet of ground water in storage in the South Platte Valley and tributaries between Hardin, Colorado, and the Colorado-Nebraska state line. On this basis it can be estimated conservatively that there is at least 25,000,000 acre feet of ground water in storage in all the South Platte Valley in Colorado and in all of its tributaries. This large body of ground water is a valuable adjunct to the irrigation economy of the South Platte Basin in that the ground water may be used at any time to supplement the surface water supply or it may be drawn upon heavily during periods of low stream flow.[9]

The importance of pumping ground water for irrigation purposes in the South Platte Valley was stressed to the committee when it met in Fort Morgan on September 1st. The demand for water takes place in a short season -- 120 days -- and if pumping were eliminated, the committee was told, it would substantially injure the economy of this area. Where the users get their water is immaterial; the important thing is that water is available when the users need it.

On the other hand, the use of wells along the river was drying up the stream flow, it was reported, and a participant at the meeting cautioned that the well users "were cutting their own throats," and that he believed there would have to be some give and take on this situation.

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1. Taken from data contained in Information Bulletin No. 22, August 28, 1964, Colorado Water Conservation Board.

9. Ground-Water Series -- Circular 4, previously cited, p. 5-6.

Mr. A. Ralph Owens, Deputy State Engineer, estimated that there were more than 6,000 wells along the South Platte River, as compared to from 1,200 to 1,500 in the Arkansas Valley. He reported that, on advice of the Attorney General, the State Engineer would not try to shut down a well on complaint of a surface user. Mr. Owens suggested that if the people of Colorado are to get the maximum use of the state's greatest natural resource, then agreement will have to be reached on the reasonable use of surface and ground water.

In contrast to the aquifer in the Arkansas Valley, which is narrow with most of the wells being within two miles of the river, the aquifer in the South Platte Valley is broad with some wells being located as much as 20 miles from the river. Because of a change in the use of water, an increase in the growth along the river, and a change in irrigation practices, the committee was informed, residents in the valley can never go back to the way the South Platte River use to be.

Mr. Bittinger, the committee's consultant, reported that there could be a happy medium between surface and ground water users. For example, approximately 25 million acre feet of water is in storage under the South Platte River Valley. If only a fraction of this underground storage were used in a planned way, similar to a surface water reservoir with heavy withdrawals during dry periods and planned-for recharge in more favorable runoff years, the conjunctive use of the two supplies could be managed to the benefit of all water users. Studies are currently being made for such conjunctive-use programs, but final results, as well as public acceptance, are still a few years away.

The advantages of underground water storage as contrasted to surface storage were discussed, and one example given was the artificial recharge project in Prospect Valley where it is estimated that the users could wait ten years without pumping and still recover at least 90 per cent of the water stored underground. In comparison, of 23 acre feet of water stored in Jackson Reservoir, 12 acre feet would be delivered at the headgate, or a loss of almost half, although some of this loss would be sustained during transportation of the water.

The loss of surface water in transportation was another problem which received considerable attention, as it had in previous committee meetings. One recommendation was that senior water users be limited as to the number of miles of surface flow over which they could place a call for water, or that an efficiency rating system be applied. Another suggestion was that junior surface water users in the South Park Area, where there are no wells, be allowed to divert surface water out of priority since the return flow from their diversions would eventually reach the stream and, shortly thereafter, the downstream users.

In order to alleviate conditions in South Park, it was also recommended to the committee that on-stream reservoirs be required by law to sustain their losses from evaporation and that the water commissioner's job be up-graded so that the calibre of man needed for this position can be obtained.

Colorado State University

On October 7th, the committee met with various technical and professional personnel at Colorado State University to discuss various aspects of ground water, surface water, and weather modification.

Review of Ground Water Problems. Mr. Bittinger reviewed the problems of ground water in this state. Two of the most formidable problems are (1) disputes between surface water users and ground water users, and (2) disputes among ground water users.

Some ground water basins in Colorado are only beginning to be developed, such as the Ogallala formation. Others, such as the Bijou Valley, are nearing depletion. The problems in all basins in which current or potential development will exceed natural replenishment are how to extend the water supply sufficiently to obtain economic stability, and then how to equitably allocate the depleting supply of water. Official or artificial ground water recharge provides one solution, but the potential of this solution is limited in Colorado due to a lack of available water for recharge. A partial solution to problems which develop in a depletion-type of situation is the spacing of wells so as to minimize interference between pumped wells, but to be efficient this must be initiated in the early stages of a basin's development.

Another major problem, which is found mainly along the South Platte and Arkansas rivers, is where the aquifer and the stream flow are directly connected. The problem is how to integrate the two operations as part of a basin-wide ground and surface water management program. Mr. Bittinger said that implementing this concept is something that will have to be worked out over a period of time, and he doubted if this could be done completely in the 1965 session.

Use of Public Districts. Dr. Stephen C. Smith, CSU Department of Economics, reported that the public district form of organization can be useful in adjusting ground water management to meet local conditions and desires and to relate the state's responsibilities to the local situation. The success of public districts has been demonstrated in California and other states authorizing their use.

There are several factors which should be given serious consideration in the creation of public districts. These include defining the duties and powers of a district; specifying those conditions of state interest in the management of a district; providing for a local election to determine the formation of a district; authorizing the methods and limits of district financing, including bond issues; and utilizing technical assistance in the integrated management of ground and surface water.

Ground Water Legislation. Mr. Willis Ellis, of the University of Denver's School of Law, informed the committee of a study project he was conducting concerning ground water legislation in the western states, including Colorado. The objective of this study is not to devise proposed legislation to solve problems for all time, but to try to discover what would be best from the point of view of hydrologists, economists, and lawyers, i.e., an "ideal" situation.

There is considerable contrast between Colorado's present surface and ground water laws -- rigid property rights are given with surface water rights but not in the case of ground water. Because there are no firm property rights so far as ground water is concerned, the state is losing new additions to its economy since farmers and industries need assurance of available water supplies for 50 to 100 years in the future or they will not make large investments in Colorado.

The Colorado Supreme Court has ruled that if ground water is tributary to a stream, it must be considered as part of the surface flow, but this is only theory. That is, in actual practice, the State Engineer has refused to administer priorities on ground water, on advice of the Attorney General, even if it is tributary to a stream. Consequently, in this state ground water belongs to the man who pumps it to the surface, and there is concern that a surface user may go to court and enjoin a well from being pumped, thereby jeopardizing the investments which have already been made in developing ground water supplies.

Controls om pumping should be provided by the administering agency but not on the basis of a "call" as in the case of surface decrees. The General Assembly will have to decide which aquifer will be mined and which will be maintained. This decision could be given to the local districts, but Mr. Ellis said that he thought this should be a matter for state decision, not local. Once this decision has been made as to mining or maintaining the ground water resource, the state still must control its usage. That is, the state should have the power to say how much ground water can be pumped.

Transfer of Water Rights. Mr. Don Seastone, an economist at CSU, reviewed a study-in-progress of ways to maximize the efficiency, in an economic sense, of the use of surface water. In comparing the transfer process in Colorado with that in New Mexico, he noted that Colorado has many elements to impede the transfer from a lower value use to a higher value use. The fact that courts in Colorado are called upon to make too many decisions that they are not qualified to answer is one impediment. To illustrate, two sets of hydrologists appear before a district court in Colorado with opposing "facts" to support opposing points of view, whereas in New Mexico the transfer process is initiated with the State Engineer and he conducts the studies necessary to arrive at a decision. It was suggested that some attention be given by the General Assembly to expanding the duties of the State Engineer in Colorado so that he would decide initially questions now going to district court.

Domestic Water Districts. Mr. Raymond L. Anderson, of the Economic Research Service, reported on the growth of rural domestic water districts in Boulder, Larimer, and Weld counties since 1960. The first such district was formed by a group of farmers near Longmont who wanted better quality drinking water. There are now nine of these districts in formation and all but one obtains its water from the Colorado-Big Thompson system, and the one exception gets its water from a well. These districts essentially represent a transfer of water from agricultural use to domestic use and while thus far no great amount of

water is involved -- about 6,000 acre feet at present -- this amount is increasing.

Water Quality Legislation. Mr. Jerrell F. Fair, a Public Health Service Fellow in the Department of Microbiology at CSU, reviewed the scientific validity and technical language of certain areas of Colorado's water pollution laws. The newly-recognized problem of water quality presents a totally different challenge than the problems of supply, rights, and distribution. These latter problems deal to a great extent with tangible objects perceivable by the four senses. However, today many of the most feared chemical pollutants can neither be seen, tasted, smelled, nor felt.

The methodology involved in the detection of chemical and biological agents is not perfect and therefore is in a constant process of improvement and revision. Colorado's statutory law concerning specific polluting materials does provide for a specific methodology but, unfortunately, in many cases the specified methodology is outdated. Mr. Fair suggested that there are several points in Colorado's water pollution laws which could be corrected without a great deal of difficulty and, further, similar errors in future statutes could be avoided by review prior to enactment by competent laboratory scientists.

In regard to the future, Mr. Fair pointed out that the only two real solutions to pollution are abatement after it has begun and the more desirable alternative of preventing its initiation. To accomplish this latter alternative, there should be established a vigorous diversified agency composed of chemists, biologist, engineers, and water law experts, which has as its primary concern the maintenance of our water resources in a condition consistent with the use to be made of them.

In addition, Mr. Fair stated that consideration must be given soon to the steps necessary to maintain the quality of the state's ground water resources. The role of currently existing water pollution laws in protecting ground water is ill defined and ambiguous, and because of the difficulties in abating ground water pollution, it is imperative to concentrate upon preventing the initiation of contamination of ground water supplies rather than abatement after the pollution has occurred.

To sum up, Mr. Fair presented the following four points for committee consideration:

(1) The complexity of water quality problems necessitates a unified approach by legislative, legal, and scientific personnel.

(2) Statutory law covering water pollution must accurately provide for the best available means of detecting pollution and should by the quality of its structure reflect a real determination on the part of this state to use all available means to combat this great problem.

(3) Although pollution of many of our surface streams has proceeded to such an extent that we will have to live with the problem indefinitely, there is an opportunity to prevent similar deterioration of our ground water resources by prompt and prudent action.

Weather Modification. Mr. Lewis Grand, of the Atmospheric Science Department at CSU, reported on the results of cloud seeding and other experimental work in connection with weather modification. Despite this work, the basic questions still remain: Are there really additional substantial amounts of rainfall to be obtained and, if so, how are we to change our methodology to obtain it? It is going to take a period of extensive research to answer these questions and, in general, this research cannot be done in the laboratory but must be carried out in the atmosphere.

Mr. Grand suggested that the law be amended to include a meaningful licensing system of weather modifiers. The present law merely requires that financial responsibility and enough knowledge be shown so that violent damage would not result from the applicant's activities, and Mr. Grand questioned the value of these provisions because they do not exclude the unqualified weather modifier. The law should be amended so that an applicant must meet certain qualification and experience requirements.

Watershed Management. Mr. Kendal Johnson, of the Watershed Management Department at CSU, reported on his study of an attempt to join the physical and legal aspects of ground water. He agreed that the current period of water law is coming to an end and that water management is the next step that this state should take. The missing part is access to technical knowledge, and this could be done through the court reference procedure with the State Engineer or some other state agency acting as a friend of the court. This is one of the specifics that needs to be provided by the General Assembly -- just exactly what form of technical information will be developed and by whom.

Denver Meeting

The committee met in Denver on October 8th with water attorneys and engineers and with representatives of the Colorado Water Conservation Board and the Colorado Ground Water Commission to discuss changes in the state's water laws.

Mr. Felix L. Sparks, director of the Colorado Water Conservation Board, suggested that the problem of ground water should be solved before this subject gets involved with an over-all revision of the state's water laws. The main problem is how to integrate ground water with surface water administration. The two represent a total water resource, but reference is made only to natural streams in the state's constitution and original statutes as if ground water did not exist. But it does exist and it is basic to the use of water in Colorado. One result of this condition is that there is virtual anarchy in water administration in this state today.

A system needs to be worked out combining pumps and surface use to protect existing senior surface rights, and senior decrees on the lower basins would first have to be satisfied. To increase the effective use of water, wells must be first converted to priorities so every user would know what water rights he had. The key is that there is only a limited amount of advice the state can give unless the local people agree on the job which needs to be done, and unless they feel they are getting a better water supply under the new system. Local

districts can provide the answer and the present water conservancy districts can be used for this purpose.

Mr. John H. Cuykendall, of the Colorado Ground Water Commission, pointed out that there is a permit system for wells in Colorado now, and the same information is required as for a surface water right. When a man secures a well permit from the State Engineer, he has spent his money, put water to beneficial use, and he has acquired a vested right. He personally felt that there was no chance for a law to be passed in 1965 because too many people feel that water under their ground belongs to them and no one is going to take it away. A great deal of education is needed before a law can be passed which will control the use of ground water.

In this connection, there are other problems in the state in addition to those associated with the use of ground water along rivers. The Ogallala formation is seeing the development of wells snowballing and, at the present rate, by 1967 there will be more than 1,500 wells in Kit Carson County alone. This area is entirely different from areas along the rivers, and their problem is to conserve what ground water resources they have. At the same time, wells in Nebraska and Kansas could be used to pump the water now lying in the Ogallala formation in Colorado unless this water is pumped in Colorado first.

The Colorado Ground water Commission believes that it is easier to amend the present law than it is to write a new act, and the commission consequently submitted proposed amendments to the committee which would take care of such situations as those in the Ogallala area. Also, after some seven years of experience with the present (1957) law, Mr. Cuykendall said, there are some things which are almost impossible to administer. It is an error to flatly prohibit any more wells in a "critical" district, and it is an error to allow local residents to immediately throw out decisions of the ground water commission. The proposed amendment will allow the commission to determine when an area needs something done and, after a series of hearings in an area, the commission could or could not designate an area as "critical." He also questioned provisions in the present law on the amount of use exceeding the amount of recharge because this is a difficult thing to determine despite what the engineers say.

Mr. David J. Miller, an attorney, stated that the 1960 report of the Ground Water Codification and Research Studies Committee represented his thoughts on water law changes which are needed. To summarize, he said, a little bit of something is always better than a lot of nothing. From a practical standpoint, the wasting of water is at the head of the list where change is needed, and a statute should be enacted to give power to some state agency in this respect. Changes at the point of diversion ought not to be permitted, and a change in use should be limited both to time and volume, i.e., if the prior use was for six months, the new use should be only for six months.

Some means should be provided to permit the performing of conservation functions so that if water can be used better, even if not in the strict order of priority, this use should be allowed -- in other words, the management of water should be authorized. Also, Colorado is one of the few states where non-use is not made a presumption of abandonment of a water right, and this should be changed.

One recommendation made by the 1960 committee which could be effected was that the irrigation district acts and water conservancy district act should be amended to permit ground water development, storage, and recharge. Mr. Miller emphasized that unless the people understand any proposed legislation, the General Assembly will not be able to sell it.

Mr. Duane L. Barnard, an attorney, presented the following resolution on behalf of the Colorado Water Congress:

"BE IT RESOLVED that the Colorado Water Congress hereby requests the Governor to implement the improvement of the water laws of Colorado by assigning specific areas of study and action rather than attempting the 'complete code revision' approach which has proven ineffective to date; that the Governor seek such implementation by requesting the Attorney General of Colorado, the Colorado State Engineer and the Director of the Colorado Water Conservation Board to act as a committee to guide the water law improvements; that this committee of State officers work in harmony with the Colorado Legislative Water Study Committee, the Water Section of the Colorado Bar Association and the Colorado Engineers Water Law Committee; that work already done by these groups not be discarded but be utilized to the greatest practicable extent as background for appropriate improvements in the water code; and that the specifics to be studied and acted upon include the following:

1. Colorado Ground Water rights including their relation to surface water rights.

2. Adjustment of conditional decree procedures in relation to the new judicial code.

3. Create a simplified method of establishing private titles to water rights.

4. Removal of changes of point of diversion from the adjudication system to the permit system, with the right of appeal to the courts.

5. Clarification of procedures before the State Engineer and his subordinates and the securing of adequate jurisdiction for their actions based thereon."

Mr. Barnard also reported that the General Assembly must consider the surface water right owners on the Western Slope in preparing any new laws. Because of the water diverted from the Western to the Eastern Slope, adverse effects as a result of the use of wells in Eastern Colorado directly affect the users in Western Colorado. In other words, it is a state-wide problem and not one limited to any particular area. The legislature should provide a mandatory method of cooperation between districts, with guidelines being included in the law on this point.

Mr. Tom Campbell, who served as co-chairman of an engineers' committee on water law, reported that this committee, after holding weekly meetings for a year, concluded that nothing very effective could be done on recodification without adequate ground water law and control.

The committee came to the general conclusion that there are three types of underground aquifers and any law adopted should take these three types into account: (1) strictly alluvial aquifers directly tributary to surface flow; (2) non-tributary aquifers which can replenish themselves; and (3) closed aquifers which cannot replenish themselves and must therefore be considered as mining operations. (See Appendix B for "Excerpts from April 1963 Report of Engineers' Water Law Committee... on Ground Water Law.")

Mr. George Vranesh, counsel for the Oxford and Highline Ditch Companies in the Lower Arkansas River Basin, reviewed the law suit which will be filed against these two ditches by the Fort Lyon and Catlin Ditch Companies. This suit, which is designed to prohibit the Oxford and Highline companies from pumping directly from the Arkansas River to supplement their surface appropriations, will not resolve all of the basic questions and it will probably result in bad law. He added that the suit will cost about $25,000 on each side and this money could be better spent in studies to draw better laws.

Mr. Vranesh suggested an inventory of Colorado's surface and ground waters to determine the ground water which is tributary and that which is non-tributary to surface flow. These two types have to be regulated differently, and a study should determine the basic rules governing them. The result would be more advantageous to well users as they at least would know what rights they had, and he urged the adoption of a ground water control law for Colorado.

Mr. Glen Saunders, attorney for a group of Arkansas Valley water users who want a determination on water rights, said that this suit means that after some 35 years the problems are so great that the users have decided it is time to try to get some decisions on their water problems. The Arkansas Valley is one of those renewal alluvial aquifers which needs management. It is the wish of both sides in this suit for the legislature to realize that to settle problems by litigation is more of a financial burden than the people can bear. The only solution is for the General Assembly to reverse itself and to adopt a permit system for ground water, especially in renewable aquifers.

Mr. Saunders said that he wanted to impress upon the committee the urgency of this problem and that direct property rights are being destroyed by the inaction of the legislature. While this committee is probably not ready to write a comprehensive law for the 1965 session, the General Assembly probably will be asked to provide the funds to finance the detailed work needed before this job can be done. The time to make this study and to circulate proposed drafts for area approval is before the bill is presented to the General Assembly.

Until now, Mr. Saunders said, the engineers and lawyers have been at cross purposes -- the engineers are interested in the best use of water and the lawyers are interested in preserving property rights. The compromise for the legislature is to provide for the form of regulatory districts which will guarantee to the senior decrees their historic or customary amounts of water. A system is being worked out at the present time along the Purgatorie River with the Bureau of Reclamation whereby all water rights will be pooled in order to obtain better supplies and the people will also be getting flood control out of the program. This is a practical approach and, if it could be worked

out, one which could be used as a basis for districts in Colorado under the Colorado Water Conservation Board where the Bureau of Reclamation is not involved. This would mean a new and more economical application of water in Colorado involving a new system of water law for this state. Each district need not operate the same, but each district should function under the same state law in respect to users of surface and ground water.

Mr. Charles Fisk, consulting engineer for the Upper South Platte Water Conservancy District, reported that most of the users in this district (the South Park area) are junior appropriators who do not have wells. It is beneficial for these users to put water back into the alluvial and then into the streams through return flow, and this benefits the users downstream. There should be an over-all district encompassing the entire South Platte Valley for administrative purposes, including a limit on the distance that a call for water can be made on the river. The people in South Park also have a problem with evaporation loss from reservoirs, and the law should contain a specific provision on this problem.

Mr. Charles J. Beise, attorney for the Southeastern Colorado Water Conservancy District, observed that the proposal for forming a special type of district would create some possibly needless entity and, as an alternative, he suggested the state utilize the approximately 30 water conservancy districts existing now in Colorado for this purpose as a means of reducing the costs of administration. Mr. Duane Barnard also agreed that water conservancy powers could be expanded to take care of specific problems.

Mr. Gene Waggoner stated that the knowledge of geological problems is essential in dealing with ground water, and that one important control of ground water problems comes first through having qualified well drillers. The quality of well drillers in Colorado now varies, and much damage can result from the unqualified driller. (In this connection, Appendix C contains an outline for a water well contractor licensing code which was prepared by the Colorado Water Well Contractors Association and submitted to the committee.) Mr. Waggoner also agreed that it is tremendously important to have information about tributary and non-tributary water, and he therefore recommended that a comprehensive study be made before a law is adopted.

Mr. John Barnard, Jr., an attorney, strongly suggested that the committee recommend the General Assembly approve the program recommended by the Colorado Water Congress -- a two-year study at $50,000 per year with representatives from various agencies and the General Assembly participating in the study. No one individual on a part-time basis can write this law, and the solutions in detail to the problems involved will take a great deal of work, i.e., identifying the problems and drawing up the detailed solutions. He also agreed that the law should provide administrative procedures instead of judicial determinations in regard to water disputes.

He added that a law on water control districts should provide state-wide standards, with areas being treated differently for purposes of administration. These districts can perform two major functions: (1) determine compensation for injured senior rights, assessed on an acre-foot basis on junior users, and (2) in areas where physically

possible, carry out a program to artifically recharge the aquifer. There are two kinds of existing districts which could be used for this program, if the statutes were amended, but it would be preferable to establish a new type of district to carry out these functions.

Mr. Marvin B. Woolf, Boulder City Attorney, raised the problem of ground water in relation to the building of subdivisions where water is taken from senior decrees. If the state would enforce its present laws and the people were not allowed to take water which did not belong to them, they would soon insist that the state have a good water law. He therefore suggested extensive enforcement of the present laws.

Mr. Cecile Osborne, an engineer, stated that because of past irrigation developments along the South Platte River, surface and ground water users are now working side by side and the date of their surface decrees makes no particular difference as all are using wells if they can find the ground water. The point has been reached, consequently, where ground water is more important than surface water, although it is still necessary to have surface supplies. Management of surface and ground water is needed so that, for example, wells could be shut off in wet years and used in dry years. The problem is that senior appropriators have been taking a free ride on the junior appropriators to a certain extent, and some way the equity of costs should be borne by all and both supplies should be managed together. If this were done, there would be more water available for all users.

Concluding Comments

On the basis of the testimony and reports submitted to the committee during the course of its meetings, substantial agreement exists on the need for solutions to the many water problems now encountered in Colorado. Disagreement arises, however, on the specific details involved in drafting solutions to these problems.

The committee was informed by the director of the Colorado Water Conservation Board that "more than one million dollars in state and federal funds have been spent in gathering information on water in Colorado, and in a few years the entire state should be mapped in regard to water supplies."[10] Yet some persons informed the committee that not enough information is available and the state should wait until it is available before writing any new water laws. On the other hand, other persons stressed the urgency of the state taking action now, even suggesting that the General Assembly has too long evaded its responsibilities in this area. That is, specific provisions are needed now on water rights -- what they are and who has them.

A number of those appearing before the committee recommended an over-all management of surface and ground water supplies where they are related, and, where the ground water is non-tributary, the management of ground water alone. Local control through local districts is needed under state-wide standards, with flexible provisions being

10. Minutes of Committee's Meeting, Alamosa, Colorado, July 20, 1964, p. 1.

included in order to meet varying local conditions and problems. Other suggestions which received rather general support included adopting a stronger well drillers' law, adding specific provisions on evaporation losses in surface reservoirs, and reducing water loss resulting from junk vegetation along ditches and streams.

The details of these and other recommended solutions, however, remain to be spelled out, and as yet undiscovered questions and problems may also arise when such specific provisions are written. Consequently, before final action can be taken by the General Assembly, it would seem necessary that specific proposed changes must be prepared in bill form in order to obtain the most complete public reaction and discussion.

APPENDIX A

WATER MANAGEMENT STUDY OF LOWER ARKANSAS RIVER BASIN

Remarks of John E. Moore, Groundwater Branch of the United States Geological Survey, Presented to the Committee on Water at Lamar, Colorado, June 3, 1964.

Introduction

In 1963 the Geological Survey, in cooperation with the Colorado Water Conservation Board, began a 3-year study of the water resources of the Arkansas River Valley between Canon City and the State line. The study will enable the Board to assist the Legislature in formulating a comprehensive plan for the optimum development and management of the ground-water and surface-water supply for the maximum benefit of all water users.

In order to achieve the maximum use of the available water supply, ground water and surface water must be developed and managed as a single supply. In the Arkansas Valley the ground water in unconsolidated sand and gravel valley-fill deposits is intimately associated with the Arkansas River. The river is hydrauically connected with the valley fill, controls the water level in these deposits, and during much of the year drainage from these deposits sustains the flow of the river. In fact, the ground-water body is there largely because of diversion for irrigation from the river. Thus irrigation has increased the recharge and amount of water stored in the valley-fill deposits, thereby permitting the development of irrigation wells. The development of irrigation wells in the Arkansas Valley has been beneficial in that they provide water to crops during periods of deficient surface-water supply. However, an unplanned development of the ground-water reservoir will result in a drastic decrease in streamflow and will therefore work a hardship on those with surface-water rights downstream from the wells. Unplanned development will therefore have adverse effects; planned development will minimize or eliminate these effects.

A planned development and management of the ground-water supply can only be made after a thorough study has been made of the physical environment. The efforts of the Ground Water, Surface Water, and Quality of Water branches of the Geological Survey are combined in this study of the physical environment of the Arkansas Valley.

Previous Studies

Previous county studies of the Arkansas Valley provide much of the basic data for this investigation. Preliminary geologic and ground-water field studies of the valley from Canon City to the State line have been completed. Hydrogeologic basic data, such as records of wells and chemical analyses of ground water and surface water, have been published for Prowers, Bent, and Otero-Crowley Counties (Colorado Ground Water Basic Data Reports 1, 11, and 14). Geologic and ground-water county reports have been prepared for Prowers and Otero-Crowley

Counties, and the reports for Bent and Pueblo-Fremont Counties are in preparation. Additional field data will be collected during this study to supplement these records and to bring them up to date.

A pilot management study of a short reach of the Arkansas River between La Junta and Las Animas was completed in 1963. We were assisted in this study by Colorado State University who studied the use of water by phreatophytes. A preliminary report of this investigation entitled "Effects of water management on a reach of the Arkansas River" (Published as Colorado Ground Water Circular 10) has shown that the ground-water reservoir can provide additional supplemental water for irrigation and that substantial amounts of water now consumed wastefully by phreatophytes can be salvaged. The records of ground water and surface water for the period 1940 to 1960 were analyzed to study the effects of changing management practices. The analysis showed that the consumptive use of water increased by about 20,000 acre-feet but that the irrigated acreage in the study reach remained practically the same. The major factor causing increased consumptive use is the increased use of ground water to supplement the surface-water supply.

Objectives

In general the objectives of the present investigation are as follows:

1. Determine the nature, extent, and chemical quality of the ground-water and surface-water resources of the Arkansas Valley.

2. Define the interrelation of ground water and surface water.

3. Define water-management problems that exist or that are likely to occur in the future.

4. Evaluate the effects of possible changes in management that could increase or improve the supply. The State of Colorado will use the basic facts to prepare an equitable ground-water law.

Field Investigations

Field investigations are being made to provide additional data to evaluate the water resources of the valley.

1. The ground-water field investigations consists of augering test holes, installation of permanent observation wells, pumping tests, mass measurement of ground-water levels, and inventory of all new irrigation wells.

The augering and observation-well installation program was recently completed. 83 test holes were augered (total footage about 3,200) and 58 permanent observation wells were installed between Pueblo and the State line. The test holes provided additional information on the physical character and extent of the valley-fill aquifer, and the observation wells improved the observation-well network.

Several pumping tests were begun this spring, and more are planned to determine the aquifer's ability to transmit and store water and the relation of ground water to surface water. Mass measurements of ground-water level were made in 500 wells in November 1963 and in 1000 wells in April 1964 between Canon City and the State line. Two similar measurements are scheduled for July and September. Data from these measurements will be used to determine the effect of pumping on the amount of water stored in the aquifer and its relationship to the flow of the Arkansas River.

We are now inventorying about 220 large-capacity irrigation wells that have been drilled in the Arkansas Valley since our county studies were completed. Most of these wells (139 or 63%) were drilled in Prowers County. The data from this inventory along with the data collected in the county studies will be used to compute the amount of ground water that is pumped for irrigation.

2. The surface-water field investigations consist of measurements of the flow of the Arkansas River and its principal tributaries. In addition, we are making seepage-run studies in selected reaches of the Arkansas River to measure loss or gain. Data from these studies will be used to evaluate the effects of pumping and evapotranspiration on the flow of the river.

3. A chemical-quality monitoring network was recently established in the Arkansas Valley to study changes in quality of surface water and ground water in time and space. Three continuous instruments that record the quality of surface water were installed early in 1964 at Nepesta, at the Fort Lyon diversion near La Junta, and at Las Animas. Daily samples of chemical quality (dissolved-solids content) are being obtained at Pueblo, John Martin, and Coolidge (Kansas). In addition to these, monthly samples of the Arkansas, its tributaries, and canals are being collected for complete chemical analysis at 12 locations and for determination of dissolved-solids content at 18 locations. A network of 100 irrigation wells also has been selected for sampling. These wells will be sampled in the spring and at the close of the pumping season in the fall. These data will be supplemented with mass measurements of dissolved solids of ground water and surface water. This chemical-quality program will form a basis for evaluating the effects of present or future agricultural practices on water quality, for suggesting changes in these practices that will improve the quality, and will provide a useful tool in studying the interrelations between ground water and surface water.

Conclusion

All available geologic, hydrologic, chemical, and climatologic data will be evaluated and compiled on maps, graphs, and tables. Once these data have been organized, we will construct an analog model of the Arkansas Valley in cooperation with the CWCB and the Southeastern Conservancy District. The model will simulate the hydrologic system in miniature. An analog model is based on the fact that the flow of water in the hydrologic system is similar to the flow of electricity in an electrical system. The physical properties of the aquifer, the flow of water in irrigation canals and in the river, and recharge are

represented by the electrical properties of the model components and the flow of electricity through them. For example, a decline in the water table or decrease in streamflow as a result of pumping by irrigation wells can be represented by changing the voltage in the model. With the analog model it will be possible to predict the effect of pumping 3, 10, or 50 years from now in a matter of a few minutes. We will first program past and present ground and surface-water data in order to determine if the model is a true analog of the system. Then the analog model will be used to predict and measure the effects of future changes in water management. For example, the effect of increased pumpage of ground water on the flow of the stream can be predicted, and evaluations can be made of proposed improvements in water management.

APPENDIX B

Excerpts from April 1963

REPORT OF ENGINEERS' WATER LAW COMMITTEE FOR COLORADO WATER LAW RECODIFICATION ON GROUND WATER LAW*

The ground water sub-committee has spent several months in meeting and studying the various problems associated with recodification of the ground water portion of our water laws. In this report we have attempted only to point out the basic problems for which the new laws must provide, and our thinking concerning solutions. No attempt has been made to specifically write sentences or paragraphs which should go into the law.

BASIC PRINCIPLES

We have decided upon certain basic principles and have tried to apply them throughout our thinking. These principles are:

(1) The ground water code should strive for equity to all, and make the maximum possible beneficial use of the total water resources of each area without material interference with existing rights, uses and investments.

(2) The ground water code should be written recognizing the important physical differences in the occurrence, natural recharge, movement and uses, of ground water not only as between separate aquifers but also within a single aquifer. For instance, in addition to general provisions or regulations applying to all phases of ground water from confined (artesian) aquifers as compared to ground water from unconfined aquifers. The geologic and hydrologic factors governing the occurrence and flow of water in these two types of aquifers are so different that one set of provisions or regulations cannot properly serve both.

(3) The ground water code should allow for administrative discretion in establishing or changing operational details, recognizing that new physical information and technology may be developed in the future making operation and administrative changes necessary.

(4) The ground water code must provide for ample administrative and policing funds along with enforceable penalties. The lack of such funds and penalties is a great weakness of our present laws on ground water.

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* Prepared by ground water subcommittee of Engineers' Water Law Committee composed of Eugene B. Waggoner, W. W. Wheeler and Morton W. Bittinger, Chairman.

GROUND WATER PROBLEMS IN NEED OF LEGISLATION

A number of general problems pertaining to ground water, its development and use, are in need of legislative attention. These include:

(1) Definition of rights to use ground water, which should be subdivided into at least three categories,

a. Relative rights to use of water as between surface water diverters and ground water users where the two supplies are hydraulically interrelated. Differentiation between aquifers having material connection with streams and those which do not (principally confined or artesian) is needed here.

b. Relative rights to use ground water as between well owners drawing from an aquifer that is being depleted.

c. Relative rights to use ground water between neighboring wells interferring with each others efficiency.

(2) Protection of ground water quality through control of contamination, pollution and poor well construction. Police powers are required and penalties provided so as to be able to accomplish this objective. Contaminated ground water is lost, safeguards are needed to prevent and control its potential contamination.

(3) Protection of the public against unscrupulous well drilling activities and inferior wells. The present law requires well drillers' in commercial business to be licensed and bonded. Attempts are being made to strengthen this provision with penalties. At present the only method the State Engineer has is through the use of court injunctions. Currently, bonding regulations are so weak and loose that the well owner has little protection against unscrupulous contractors.

(4) Definition of the role of the State in ground water matters. At present, a Ground Water Commission sits at the State level on ground water matters. The commission is not effective principally because of the lack of powers given by statute. Because of the many specialized problems involved with ground water, we advocate the retention of the Ground Water Commission with additional powers and authority. The relationship and relative obligations of the Ground Water Commission, the State Engineer and the Colorado Water Conservation Board need to be spelled out.

(5) Provision for local organization for management of ground water supplies. We believe that enabling statutes should be passed providing for the establishment and operation of public districts empowered to finance and operate facilities for the benefit of the ground water users (for instance, ground water recharge). Such enabling statutes provide for adequate safeguards against infringement upon vested rights within or outside of the district.

OUTLINE OF PROPOSED GROUND WATER PORTION OF WATER CODE

The following outline embodies the Committee's views on the contents of a ground water code for Colorado. As stated earlier, no attempt has been made to actually write a law, but only provide our ideas of what should be concluded.

I. DEFINITIONS - The following should be carefully defined for purposes of this law:

- A. User
- B. Underground water and ground water
- C. Aquifer
  - 1. Confined
  - 2. Unconfined
- D. State Engineer
- E. Ground Water Commission
- F. Colorado Water Conservation Board
- G. Well
- H. Artesian well
- I. Well driller
- J. Private driller
- K. Permit
- L. Adjudication
- M. Referee
- N. Aquifer or well interference
- O. Ground water - surface water hydraulic connection
- P. Recharge
- Q. Depletion
- R. Drawdown
- S. Static water level

II. OWNERSHIP OF GROUND WATER - We believe that all ground water should be declared the property of the public, dedicated to the beneficial use of the people under the laws of the State.

III. PERMITS TO USE GROUND WATER - The provisions and requirements for obtaining permits to use ground water need little change from that in the current statute (Section 5) except for:

- A. Elimination of reference to "Tentatively Critical Ground Water Districts."
- B. Provision for authority of State Engineer upon concurrence by a majority vote of the Ground Water Commission to deny applications for permits to use ground water in specific areas found to be troubled with well interference or in danger of depletion.
- C. Penalty provision for not complying with requirements of this section.
- D. Provision (at the master decree) for adjudication of wells already registered with the State Engineer, and for future adjudications on succeeding adjudication days.

IV. RELATIVE RIGHTS TO USE GROUND WATER - Because of different geologic and hydrologic conditions, relative rights under several classifications should be defined.

A. Surface Water User vs. Ground Water User. Relative rights between surface water and ground water users in Colorado needs clarification. The problem occurs principally in the unconfined aquifers of the South Platte and Arkansas River basins. Here, for all practical purposes, we are talking about large capacity wells located between the highest irrigation ditches and the stream. These wells derive their annual supply from irrigation losses and, in general, depletion of the aquifer is not a problem.

The following sections set forth the physical facts, conclusions and some ideas toward a solution of this problem:

1. Physical Facts

a. Ground water in aquifers under and adjacent to effluent streams is hydraulically related to the stream flow. Pumping and consumptive use of this water causes a depletion of stream flow by (1) reversing the gradient sufficiently to cause water to flow from the river to the wells and/or (2) intercepting ground water that would otherwise augment stream flow.

b. Practically all of the large capacity wells drawing water from the alluvium of Colorado's natural streams are junior in time to the surface water rights on these streams.

c. The principal problem of rights occurs when wells cause sufficient draft on the river--or reduce ground water inflow sufficiently--to cause downstream diverters with senior rights to call on upstream users with junior rights to pass water to them.

d. Strict administration of the prior appropriation doctrine, i.e. shutting down of wells in reverse order of construction date, would probably not give the desired relief to a surface diverter until all wells are shut down and/or the need is over. That is, the time lag due to the slow movement of ground water makes it impractical to use the same rules as in an "immediate response" surface water system.

e. Ground water use has added considerably to the economic stability of the areas in question. Considerable wealth has been produced through its use and can continue to do so because of the annual recharge received from the overlying surface water system.

2. Conclusions

a. Maximum beneficial use of the total water supply can only be achieved through coordinated use of both surface and ground water.

b. Users of ground water from an alluvial aquifer underlying and adjacent to an effluent stream hold some obligation to surface water diverters, In that:

(1) Their supply is derived from annual losses from ditches, reservoirs, and irrigated fields and their pumping lift is kept low because of this.
(2) They are using water which would otherwise be available to surface water diverters who developed their systems on the basis of ground water "return flows."

3. Possible Solution - Since it appears shutting down of wells to afford relief to senior surface rights is not practical or reasonable, the possibility of compensation should be explored thoroughly. If, for instance, the obligation of ground water users could be recognized in terms of a pumping assessment or tax, the funds raised could be used to:

a. Retire surface or ground water rights serving marginal lands, thus reducing the demand on the total water supply.

b. Where feasible from geologic and water supply standpoints, provide immediate relief to affected ditches by replacement water from ground water sources during drought periods--with provision for artificial recharge during surplus years.

To accomplish these programs, sufficient authority would have to be given to the State Engineer to require such action.

B. Ground Water User vs. Ground Water User. Users of ground water from a common aquifer are in competition with one another for the supply. The relative rights of these competing ground water users becomes critical when wells are too closely spaced and/or the supply nears depletion. All the confined aquifers and certain unconfined aquifers fall into this category.

1. Physical Facts

a. Certain aquifers within Colorado do not have sufficient natural recharge to withstand development on an economic scale without eventual depletion of the resource. These include (but are not limited to):

(1) Ogallala formation, High Plains.
(2) Dakota and Cheyenne sandstones, SE Colorado.

(3) Alluvium of Box Elder, Kiowa, Bijou, Badger and Beaver Creeks above irrigation ditches.
(4) Alluvium of Lone Tree and Crow Creeks above irrigation ditches.

b. Certain aquifers have "pipeline" problems, i.e., the transmissibility is so low that water cannot be supplied fast enough to wells even though the aquifer remains full of water. These include:

(1) Denver Basin artesian aquifers.
(2) Grand Junction artesian basin.
(3) San Luis Valley artesian aquifers.

c. In general, changes in water levels, pumping, etc., in the aquifers described in a and b have insignificant influence on flowing surface water and surface rights.

2. Conclusions

a. Strict application of the prior appropriation doctrine to aquifers being depleted or mined is not realistic. Under this scheme a senior well near the edge of the aquifer where the saturated thickness is a minimum could require that the aquifer be held full for him.

b. Strict administration of the prior appropriation doctrine in aquifers with "pipeline" problems would often prevent a full beneficial use of the water. For instance, consider the hypothetical situation of 50 wells drilled in an aquifer of this type in which the first well was drilled near one side of the aquifer with each succeeding well being drilled 1/2 mile further distant from the previous well (thus the 50th well is approximately 25 miles from the first well, etc.). When the most senior well begins to experience difficulty due to lowered water levels, the prior appropriation doctrine would call for the wells to be shut off in reverse order of their construction dates, i.e. the 50th well, the 49th, etc., in order for the senior appropriator to obtain relief. These most junior wells have had some effect on the first well, but not as much as numbers 2 and 3 have had. If the administrator follows the doctrine strictly, he will be unnecessarily reducing the use of water. However, if he should attempt to shut down those wells nearest to the senior, they would object because there would still be junior wells in operation.

3. Possible Solutions

The ground water systems described above are principally of the "mining" type. That is, development on a practical scale will require an eventual depletion of the resources. The time required is a function of many variables, including (a) rate of development, (b) volume of water in storage, (c) changes in uses, (d) natural recharge, (e)

possibilities of artificial recharge, etc. Some of our aquifers are well on their way towards depletion. In others, particularly the Ogallala and the San Luis Valley formations, we have the rare opportunity to help guide the development systematically and scientifically.

We believe considerable authority must be vested in the State Engineer to regulate well drilling in aquifers under this category. Many of the problems of interference between neighboring wells can be avoided by controlling the spacing of wells. We believe the State Engineer should have the authority (after majority affirmative vote of the Ground Water Commission) to deny applications for permits for use of ground water if interference with existing wells is likely, or if depletion of the aquifer is imminent.

A partial solution which passes management responsibilities to the ground water users in these types of aquifers may be desirable. This can probably be best accomplished through the formation of special public districts set up by the Legislature for each aquifer or group of aquifers. The boundaries should correspond with aquifer boundaries and could be established by direction of the State Engineer as deemed needed. Each district should be charged with the management of the ground water supplies underlying it. Operational procedures and regulations should require the approval of the State Engineer, but the district should be given the power to:

a. Raise money through assessments on property or tolls on water pumped;

b. Acquire surface water rights and construct and operate artificial recharge facilities;

c. Control waste;

d. Set regulations on spacing of wells;

e. Restrict drilling of additional wells in areas of high concentration of pumping--such restrictions always to be subject to the approval of the State Engineer;

f. Conduct education programs; and

g. Hire professional staff and/or consultants.

Considerable care should be given to provide safeguards to vested rights both within and outside of the district boundaries.

V. RELATIONSHIP OF STATE ENGINEER, GROUND WATER COMMISSION AND COLORADO WATER CONSERVATION BOARD

The relative duties and obligations of the State Engineer, Ground Water Commission and the Colorado Water Conservation Board should

be spelled out insofar as possible. Provision should be made for a referee (possibly the Director of Natural Resources, or equivalent) to determine areas of authority and obligations if disputes arise.

We believe the State Engineer should have authority to regulate well drilling, both as to location and type of well construction. All regulations established by the State Engineer should be subject to the approval of the Ground Water Commission. The State Engineer should also have authority to stop waste or contamination of ground water supplies.

VI. PROTECTION OF GROUND WATER QUALITY - Specifications and enforcement provisions are needed to:

A. Prevent entrance of surface waters into wells, by proper surface completion.

B. Seal between aquifers of different qualities and heads.

C. Seal abandoned wells.

D. Require sterilization of wells and equipment.

E. Control distance of wells from sources of contamination.

F. Prevent contamination from waste discharges (liquid or solid) into pits, channels, etc. (such as improper location of sanitary fills where ground water contamination would be a hazard).

VII. WELL DRILLER LICENSING AND BONDING

The basic provisions for licensing and bonding in Section 10 of the present ground water law should be retained, with a tightening up of bonding requirements and the addition of a penalty clause.

VIII. GROUND WATER DISTRICTS

There is a need for public districts specially designed to handle ground water problems. Financing and facilities are needed to properly manage a ground water reservoir. The suggested powers and relationship to the State Engineer are briefly discussed under "Relative Rights to Use Ground Water," part B-3.

APPENDIX C

OUTLINE FOR A WATER WELL CONTRACTOR LICENSING CODE

Prepared in cooperation by the Colorado Water Well Contractors Association, Colorado State Engineer, Colorado State Engineer's Office - Ground Water Section, E. B. Waggoner of Woodward-Clyde-Sherard and Associates.

Definitions

(1) "WELL" as used herein means any structure or device used for the purpose of or with the effect of obtaining water, from an underground water aquifer.

(2) "WATER WELL CONTRACTOR" means any individual, corporation, partnership, association, political subdivision or public agency in immediate supervision of and responsible for construction or development of an individual well or wells, either by contract or for hire or for any consideration whatsoever.

(3) "PRIVATE DRILLER" as used herein means any individual, corporation, partnership, association, political subdivision or public agency which shall construct a well or wells entirely for their own use on property owned or controlled by them with equipment owned and operated by them.

(4) "BOARD OF EXAMINERS" as used herein refers to the Board of Examiners created and provided for herein to facilitate the functioning of this Code.

License Requirements For Water Well Contractors

A. Written application for examination and license, showing qualifications and experience.

(1) Qualifications: Age-21 years, Citizenship - U.S. experience - Minimum of five years. Resident-qualified State elector.

(2) Resident license: Non transferable and unassignable, nor can this be construed or subverted as to sub-contracting or relinquishing responsibility under this Code.

(3) Fee: $10.00 to accompany application, (not refundable) balance upon successful completion of examination before issuance of license. Resident license fee - $25.00 annually.

(4) Performance and compliance bond in the amount of five thousand dollars with a corporate surety authorized to do business in the State of Colorado, conditioned to require such water well contractor to comply with the laws of the State of Colorado and the regulations of the Board of Examiners promulgated in compliance with this Code.

(5) Non-resident license: Non transferable and unassignable, nor can this be construed or subverted as to sub-contracting or relinquishing responsibility under this Code.

(6) Fee: $25.00 to accompany application (not refundable) balance upon successful completion of examination before issuance of license. Non-resident license fee - $200.00 annually.

(7) Performance and compliance bond in the amount of fifty thousand dollars with a corporate surety authorized to do business in the State of Colorado conditioned to require such water well contractor to comply with the laws of the State of Colorado and the regulations of the Board of Examiners promulgated in compliance with this Code.

(8) Private driller; is exempt from all license requirements except resident stipulation and minimum construction standards.

Examination

A. Oral: To be given by the Board of Examiners.

(1) Basics of drilling methods

(2) Basics of construction

B. Written: Examination to be compiled by the Board of Examiners

(1) State and local laws, Rules and Regulations regarding Water Well Contractors licensing laws.

C. Re-examination: Upon failure to pass an examination applicant may be reexamined within ninety days.

Minimum Water Well Construction Standards

A. Shall be made as may be required by the existing geological conditions.

(1) Such minimum standards shall be drafted and established by a joint committee composed of the Board of Examiners, Colorado State Engineer's Representative, Colorado State Engineer's Office-Ground Water Represenative, Colorado State Public Health Service Representative, United States Geological Survey-Ground Water Section Representative, and the Attorney for the Colorado Water Conservation Board. The Governor and the Attorney General shall be ex-officio members of this Board.

(2) Deviations from these standards for a particular well may be made upon the approval of the Board of Examiners and the State Engineer and the Attorney General.

Board of Examiners -- To be Appointed by the Governor

A. (1) Four years - staggered terms

(2) Maximum of two four-year terms

(3) Three of first five members appointed for two year terms and then all subsequent terms for four years.

(4) Board members shall be non salaried, but shall be reimbursed for actual travel and subsistence expenses incurred by them in the performance of their duties.

(5) Examining board shall meet as necessary, but not less than once every three months. Time and place to be determined by the Board provided that at least one meeting be held in Denver within three months after the appointment of the membership, at which time a Chairman, Vice-chairman and Secretary will be selected.

(6) A special meeting may be called at any time on order of the Chairman and/or Vice-chairman and/or any three members of the Board.

B. Board to be composed of:

(1) Two Water Well Contractors-minimum experience-ten years in Colorado -- Terms not to be concurrent.

(2) State Engineer or his representative.

(3) Representative of the Colorado State Public Health Service.

(4) Engineer or geologist with minimum of ten years experience in water supply and water well construction.

C. Meetings:

(1) Quarterly meetings and others as may be necessary to give examinations after notification of all members of the Board.

(2) Three members constitute a quorum.

(3) Three members or voting proxies required to pass any action.

D. The Board of Examiners shall be familiar with the State Ground Water Code and maintain liaison with official agencies.

Board of Examiners Hearing

A. If at any time the Board of Examiners deems a possible violation of this act, they are empowered to require the complaintant and/or complaintee to appear for a hearing before the Board on this section.

B. After such action the Board may revoke the license of any Water Well Contractor who shall be found by the Board to have violated the terms of this Code. No license shall thereafter be issued to

such Water Well Contractor until he shall have given reasonable assurance of an ability and intention to perform his duties as a Water Well Contractor in compliance with this Code.

Scope of This Code

A. Any water well which shall be dug, drilled, cased, recased, deepened or excavated either by contract or for hire or for any consideration whatsoever.

B. Each well will require a permit, log and history and a fee under penalty of misdemeanor.

C. All unrevoked and unexpired licenses or other evidence of such licenses are hereby expressly approved, ratified and confirmed.

Jurisdiction

Enforcement by the Board of Examiners of the provisions of this act must be commenced within a period of twelve months from the date of completion of any water well drilled.

Violation

A. Misdemeanor for violation of this act may be: (1) $300 or, (2) 30 days, or (3) both.

B. Revocation of license may be instituted by the Board of Examiners upon the action instituted by a hearing.

Disposition of Fees

A. All monies collected as license fees in compliance with this Code shall be paid into the State Treasury and placed in a separate account known as: the State Board of Water Well Contractor Examiners. The General Assembly shall appropriate therefrom to the Board of examiners the expenses of administrating this Code. Expenditures shall be made by voucher, signed by the Chairman of the Board and counter-signed by the Secretary of the Board.