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A Perspective of Contemporary Water Planning and Management Problems in Utah

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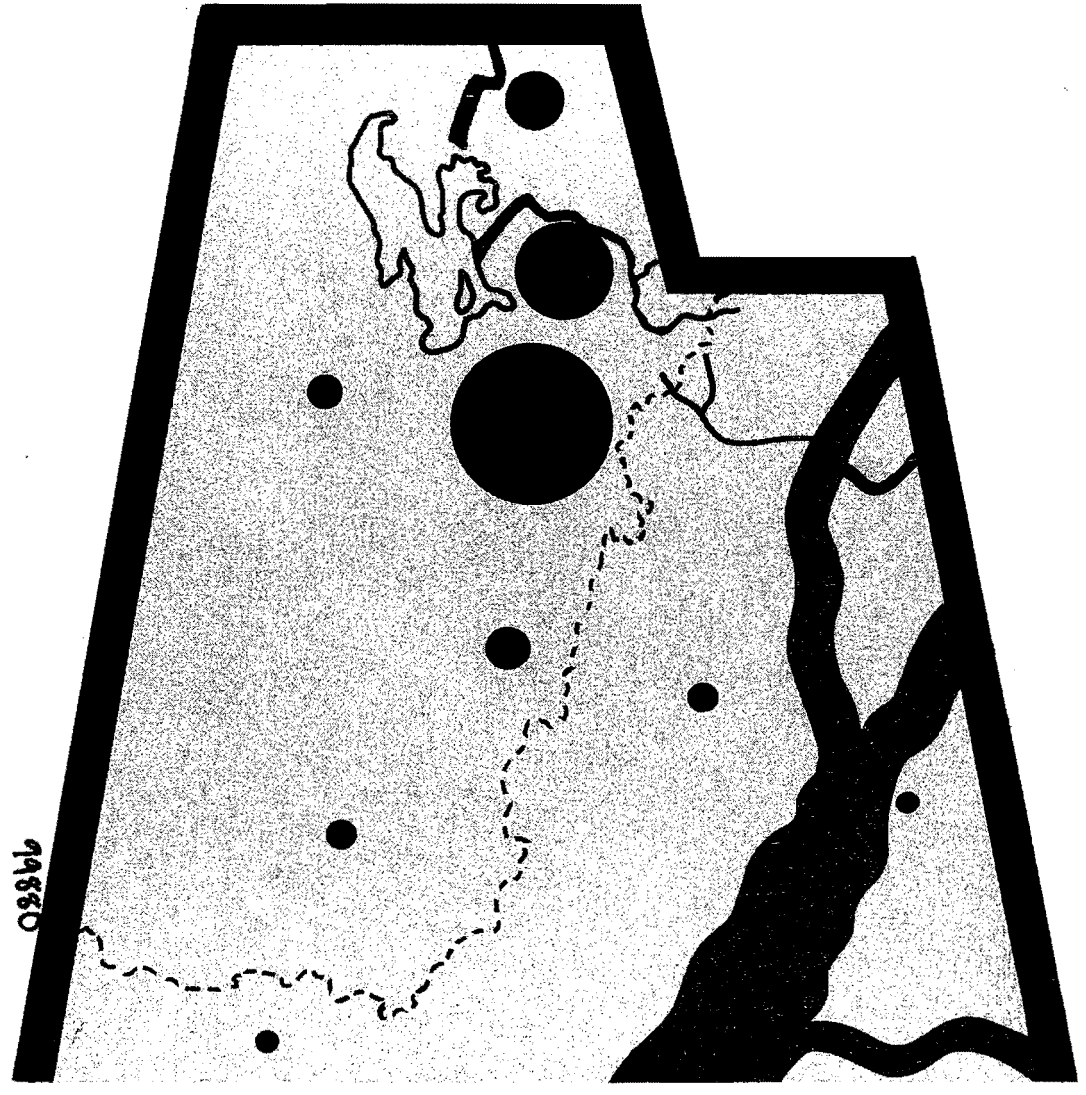

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A PERSPECTIVE OF CONTEMPORARY WATER PLANNING AND MANAGEMENT PROBLEMS IN UTAH

By
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He has had consulting experience in the United States, Africa, and Vietnam, and has had two years' industrial experience in design, development, and testing of new sprinkler irrigation systems and pumping plants.

Dr. Bagley is a member of eight scientific and professional societies and is the author of 26 technical publications.

This paper was originally presented at the Seventh Annual Engineering Symposium at Brigham Young University, April 16, 1966, and appeared in the proceedings of that symposium. Continued request for copies of the paper led to a decision to make it more broadly available. No attempt has been made to update or revise the material included. While perspectives may have changed somewhat, the problems presented generally remain salient and timely.

A PERSPECTIVE OF CONTEMPORARY WATER PLANNING AND MANAGEMENT PROBLEMS IN UTAH

By Jay M. Bagley

I should like to discuss what I consider to be a few major problems Utah faces in connection with water and its development. Time will not permit great detail or breadth of discussion. The points I should like to discuss best can be made by first setting some hydrologic scenery. Actually, although hydrologic considerations provide the central melody to planning for water resources development, there are many socio-politico-legal-economic variations on the theme. My approach will be to remark briefly on the environment in which today's planning must take place, provide some broad hydrologic guideposts, and with this backdrop select a few problems for comment and discussion.

The Planning Millieu

Each successive stage in the evolution of man's material progress has expanded the use of resources and in a parallel way enlarged and improved his technological capability. Thus, through the years there has been a continuous upward and outward spiraling of resources use and technological capability. The net effect of technological advance is to broaden the horizons of resource development while shrinking or eliminating the geographic separations which once served to minimize and lessen the interference between users and the impact of one resource use upon another. Today we are only a few hours away from every man on earth. Expanding technology, expanding population, and expanding uses of natural resources have had the effect of forcing an increased interdependency of social interests. Or, stated another way, the ripple caused by resource development today has an ever-broadening direct and indirect influence on a variety of human activity.

As water development has proceeded over the years, many different institutions, agencies, and organizations with peculiar concern for development, administration, and use of water have been established. Some 25 units in five departments and at least three independent agencies of the federal government have significant responsibility for various aspects of water resource management. In Utah there are 11 state agencies engaged directly or indirectly in water activity. In addition, there are 13 water conservancy districts, three water improvement districts, six metropolitan water districts, and more than 1,000 mutual irrigation companies in Utah (to say nothing of the many individual communities engaged in developing and supplying water). Thus, we find great horizontal and vertical overlap between governmental units involved with water resources. It is little wonder that the distinction between responsibilities and functions is not always clear.

Over time, also, a substantial body of law has accumulated which sets bounds to the way water can be used. The influence of political boundaries, statutes, decrees, administrative rules and regulations, court decisions, ordinances, etc., greatly affects the flexibility of planning and development.

Physical Aspects of Planning Environment

Fundamentally, water resource development entails the modification of a natural hydrologic system so that its flow characteristics better conform to specific needs. The construction of physical works to store and convey water alters the existing flow pattern and brings about a new hydrologic equilibrium better suited to man's needs. Without such modification, social and economic potentials may be suppressed. Regardless of the kind of use made of water, since the natural flow system is "unidirectional," the effects of manipulation, regulation, or alteration of the flow pattern at a particular location (within the system) will affect the subsequent flow pattern at downstream locations.

Consequently, the paramount question in any water development scheme is: What will be the effect of each new use on those already existing? The answer can only be found in the concept of a dynamic hydrologic flow system; an understanding of the intercon-

nection of all surface and subsurface waters; an appreciation of the interlinking of the flow subsystems which make up the total hydrologic entity; and a knowledge of the physical characteristics of water quantity, quality, availability, and regimen. Such an understanding provides the under-pinning and is the very heart of any orderly and unified approach to water development for any and all purposes. Without this we cannot predict the consequences of the developments we plan with any degree of reliability.

This then is the planning and development "mix." Superposed on this dynamic natural hydrologic flow system characterized by constant change and complex interrelations of the phenomena and processes in operation are the many man-made social, institutional, legal, and economic systems which are all interlinked to form a complex dynamic hydro-socio-politico-legal-economic system. Such a system (or perhaps more correctly, nested and superposed sets of natural and social systems) obviously involves considerable interdependency and interrelation among the components of which it is comprised. A change in the water components through water development is reflected to varying degrees in all other components of the composite system. It is under this conceptual basis and under this complex set of circumstances that today's planners must seek for an understanding of the interconnecting links so that they can distinguish the pattern which is, and can formulate guidelines for action to achieve the pattern which is to be.

The planner must achieve an awareness of the consequences flowing from each new decision and be equally aware of the penalties of indecision. In his book *The Great Ascent,* Heilbrone has said that a true development plan would entail ". . .a pervasive social transformation;. . .a wholesale metamorphosis of habits, a wrenching reorientation of values;. . .an unweaving and reweaving of the fabric of daily existence itself;. . .in any society such transformation is a profoundly dislocating experience."

Obviously, planning for the best long-term use of water today is a truly Herculean task. Methodology has not yet been devised which can consider the numerous parameters involved, describe their interaction in space and time, and arrive at a simultaneous solution of the whole matrix. Even if we had the methodology and hardware

to test alternatives for *optimality* we must remember that choices will seldom be made on the basis of optimum utilization of resources alone, but tempered significantly in the political arena. This delicate political aspect often creates a somewhat uneasy situation for planners. Politicians generally tend to view things in the short run and are not generally so sympathetic to long-term measures regardless of what "pure" planning may show to be best. The fact that planning and development imply the sacrifice of possible benefits today for the sake of the expected benefits of tomorrow may be a factor here.

Utah's Water Planning Program

These forces of change alluded to above have been responsible for a great resurgence of activity with respect to water planning and development at all levels of government. Impending problems of meeting rapidly increasing water demands have been widely proclaimed nationally. Quality is recognized as a vital dimension of water as never before. This resurgence of national concern with water has been reflected in a number of very recent congressional enactments which have triggered truly massive efforts in research, planning, and development of water resources. Congress has provided for water research centers in every state; established several regional pollution control field laboratories and is establishing additional laboratories; has enacted legislation to unify and coordinate federal planning and to assist the states in their planning activities; and has established a separate administration to cope with pollution and given it broad powers to control water quality. It has instituted a 200 million dollar, five-year program in research and test plants for desalting water and is becoming heavily involved with weather modification experimentation and research. These and other examples could be cited to illustrate the national concern with water and the intent to do something about the problems. In parallel, many states have decided that planning must be more than the preparation of the budget for the next biennium and have inaugurated new or accelerated existing water planning and development programs.

In 1963 the Utah Legislature authorized a water planning program for the state to be accomplished under the direction of the Utah Water and Power Board (now Division of Water Resources). The Utah Water and Power Board accepted the responsibility handed

them by S. B. 93 and are proceeding toward the development of an overall state water plan. Their approach has indicated a dedication to the principle of active participation by all who have a contribution to make. They have developed formal and informal cooperation with state and federal agencies to accomplish certain elements of the planning program. Utah State University at Logan has attempted to fill its supporting role by furnishing information, assisting in certain evaluations, and offering constructive comment.

In the past the initiative in planning has rested with the federal agencies. State and local governments have been in the position of merely approving or disapproving plans for specific projects without making comprehensive background studies or clearly considering objectives to be met. Federal agencies have their own operational objectives and where state direction and leadership are absent, federal agencies adhere to broad national policies which vary among agencies and in their relative applicability from state to state. A viable and vigorous planning program which directly involves state agencies and institutions in the specification of its own long-range objectives and in the implementation of them is a vital necessity. The mandate given the Utah Water and Power Board to proceed with such a program with respect to water may prove to be one of the wisest pieces of legislation passed in a long time. The alternative would be a minor state role in reviewing project plans and serving as a local administrator of the growing federal water programs.

Utah's Hydrologic Setting

I have attempted to outline in general the conceptual basis for present resource planning and management and have only briefly remarked about Utah's planning effort. Against this backdrop I should like now to examine Utah's hydrologic characteristics which in turn will provide the setting to make a few comments regarding some major water problems and the challenges we face in overcoming them.

Utah receives an average of some 59,000,000 acre-feet of water in precipitation each year (13.2 inches). This would apportion to each of our one million residents about 59 acre-feet per year, or about one-sixth of an acre-foot every day. One-sixth of an acre-foot

amounts to about 54,000 gallons per day which is enough to fill the volume of an average house. Of course, most of this precipitation is consumed by evaporation and transpiration at the location it falls. Approximately 9,000,000 acre-feet is yielded to the streams and tributaries of the state and is subject to regulation and management. So long as water is not actually converted to a vapor in use it can be reused again and again. Consequently, we may divert more than 9,000,000 acre-feet but this is all the consumption we have to manage. This water yield amounts to about nine acre-feet per person each year or about 8,000 gallons per day. This undeveloped manageable supply of water would be enough to fill a good sized room every day. This seems like a lot of water, yet we know we live in an area considered to be chronically water short. A general consideration of water receipts and disbursements will show how our portion is utilized.

The 9,000,000 acre-feet of water, which emerge from the water yielding areas into the streams and tributaries of Utah, represents less than 15 percent of the precipitation that falls on the state. In terms of the regional distribution of this yield, about 54,000 acre-feet (less than one percent) comes from the Columbia River Basin portion of the state, about 4,880,000 acre-feet (57 percent) from the Great Basin portion, and about 3,617,000 acre-feet (42 percent) from that portion within the Colorado River Basin. The relative proportions of water yield are shown in Fig. 1.

Water consumption of Utah's manageable supply is illustrated in Fig. 2. Only about one-third of our water yield is consumed by irrigated agriculture while two-thirds is being consumed by evaporation from water surfaces, phreatophytic vegetation, mud flats, etc. Only about two percent of total consumption is in municipal and industrial uses. This is not a record of which a state with a rich water-use heritage can be proud. It suggests that our water management leaves something to be desired.

Although more detailed water budgets have been prepared for the major hydrologic regions of the state, perhaps a comparison of water utilization in the two major basins--the Great Basin and the Colorado River Basin--would serve to illustrate another interesting hydrologic fact.

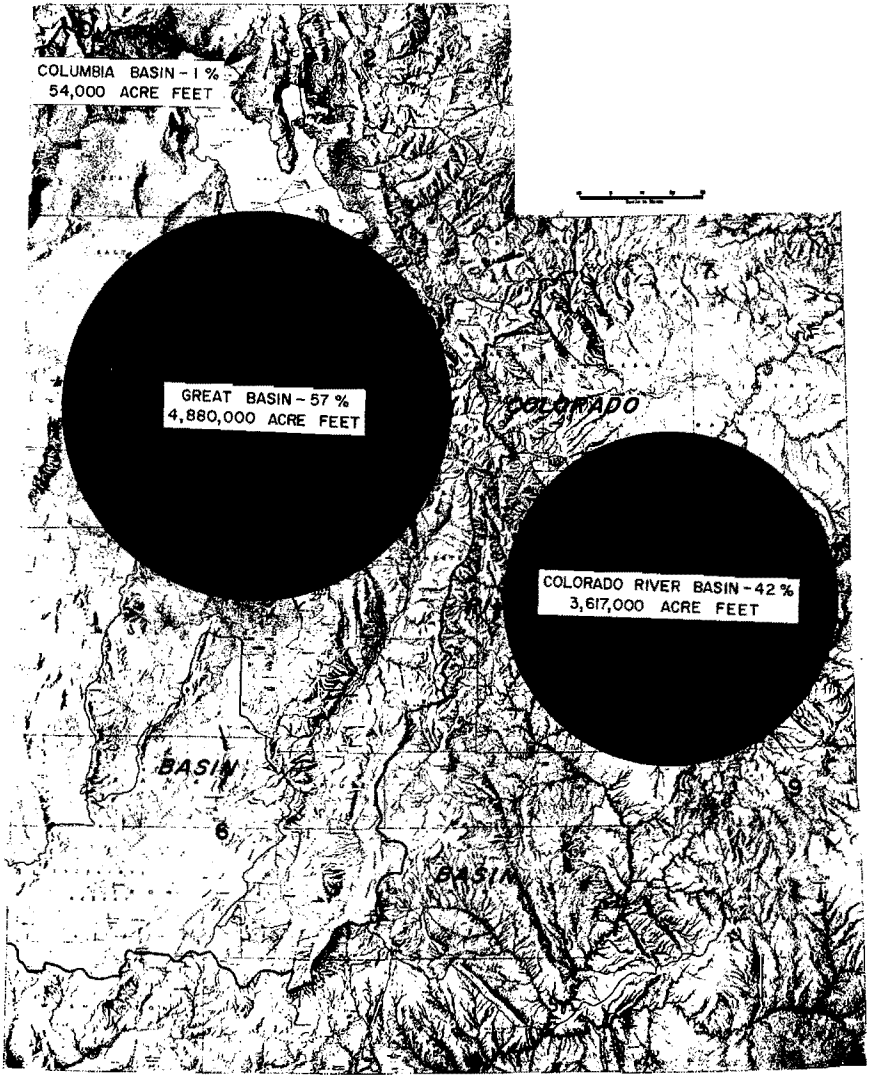

Fig. 1. Utah's manageable water supply.

PRESENT CONSUMPTION OF UTAH'S WATER SUPPLY

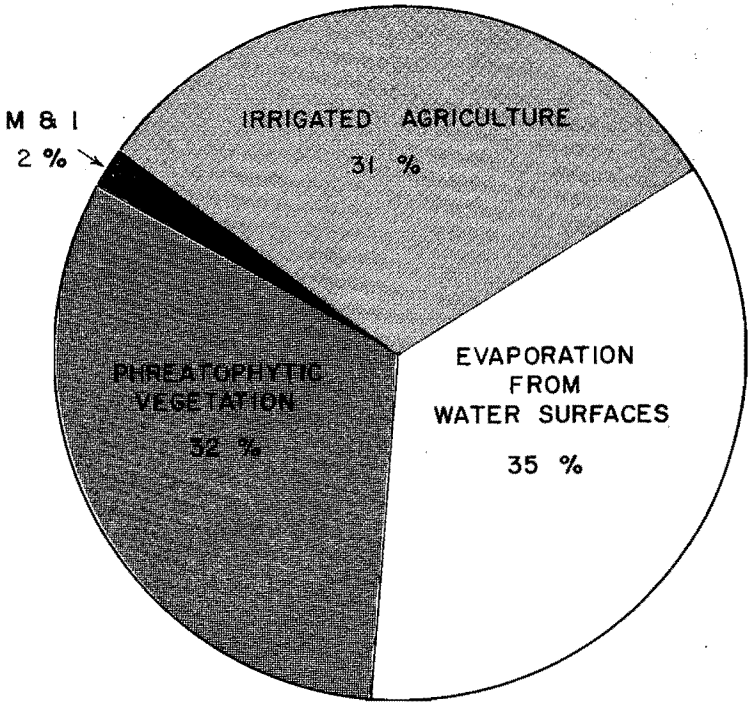

Fig. 2. Present consumption of Utah's water supply.

Recall from Fig. 1 that 57 percent of Utah's water yield came from Great Basin drainage and 42 percent from Colorado River drainage. Yet Fig. 3 indicates that about 85 percent of the state's water consumption takes place in the Great Basin while only about 15 percent occurs in the Colorado River drainage. You will immediately see that the consumption in the Great Basin portion of Utah exceeds the yield which was indicated in Fig. 1 while the opposite is true of the Colorado River Basin. This is explained by the fact that in addition to the water yielded from Utah's Great Basin watersheds there is considerable inflow to the Great Basin from the Bear River at the Idaho line. There is also import from the Colorado River Basin. Since the Great Basin is a closed drainage, everything that comes into it is eventually consumed. On the other hand, a good part of Utah's water yield in the Colorado River Basin flows out of the state in the Colorado River and a part is exported to the Great Basin.

Of the total water consumed in the Great Basin only 29 percent is for the beneficial purposes of agriculture, municipal, and industrial use. Seventy-one percent is lost by water surface evaporation and generally noneconomic riparian vegetation. (About 30 percent of total Great Basin consumption is by evaporation from the Great Salt Lake alone.) In the Colorado River Basin of Utah 54 percent of total manageable consumption is by irrigated crops and domestic use. (A considerably better record than that of the Great Basin.) About 46 percent is being consumed by evaporation and phreatophytic vegetation. Thus, it would appear that the volumes of water escaping from water surfaces, along with the tremendous volumes of water being wasted by phreatophytes which occupy large areas along stream and river channels as well as the broad valley bottoms, represent a heavy toll levied against those supplies yielded and potentially subject to management. I should qualify this statement somewhat. Certainly, there is economic value from the water consumption taking place on the wet lands which I have placed in the phreatophyte category. These wet lands, marshes, and water surfaces have considerable value as waterfowl habitat, water based recreation, and other uses. In fact, judging from the present consumption it would appear that our people place rather high values on the latter kind of water uses. In many instances, however, users really don't know the water cost involved in particular uses. Although it is often difficult to place a value on water, we are going

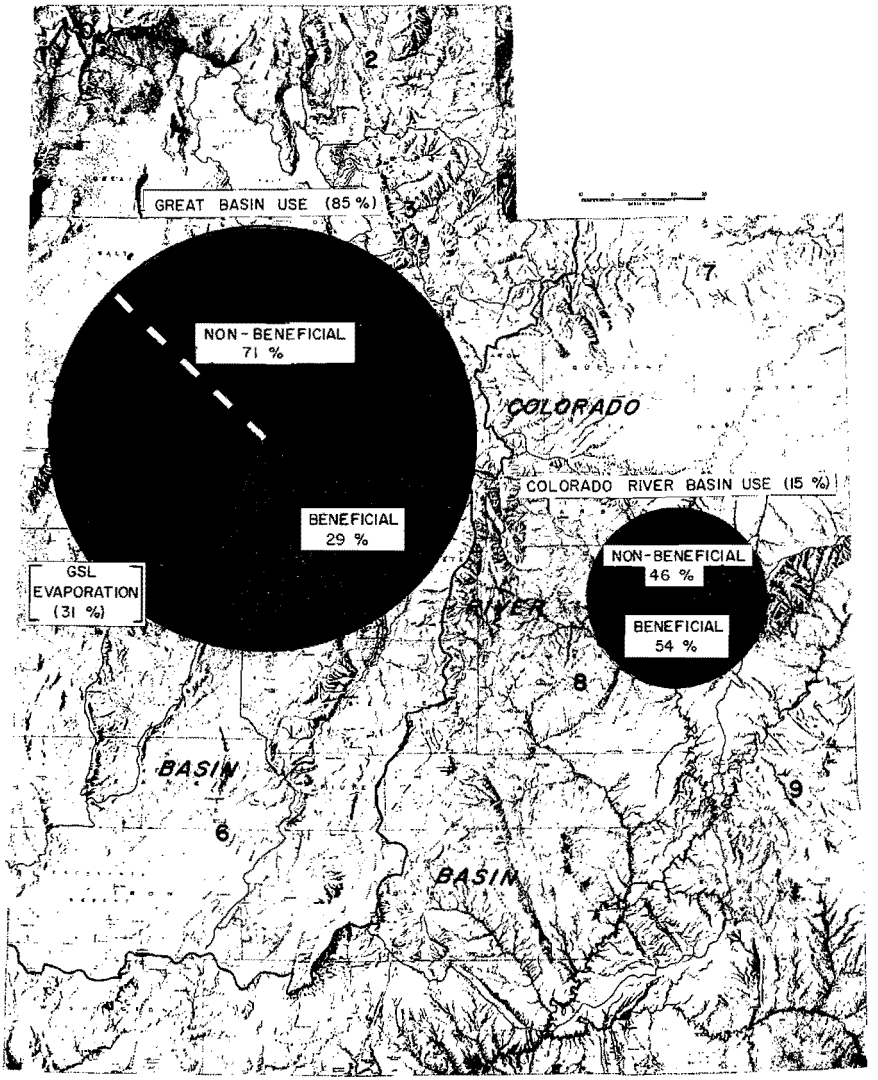

Fig. 3. Water use in major basins.

to have to do this in order to adequately consider each use in planning and development. True, value cannot always be easily quantified in monetary terms. Nevertheless, if all potential uses are to be properly evaluated in the planning mix, we need to know the requirements and their value. A recent article in the local newspaper stated that in the case of wildlife ". . .monetary benefits are secondary. Americans demand, questions of 'impracticability' notwithstanding, that their outdoor heritage be preserved." Time will not permit a dissertation on the value of water in alternative uses. I will just leave this matter by stating some equivalents assembled by Ethan Axtmann of the Utah Water and Power Board for Utah conditions. The implications for those making planning decisions are quite apparent.

7 1/2 acre-feet of water = 1 duck
= 190 pounds of trout
= 1 cow
= 10 tons of alfalfa
= 6 average families
= 3,000,000 kwh electricity (thermo-steam)
= 30 tons of steel
= 90 tons of copper

Interstate Waters

A major planning and development task that has long been recognized is to provide for the use of our entitlement to interstate waters. Utah is basically a state of numerous small rivers and the amount of water flowing in the two major interstate rivers, the Colorado and the Bear, dwarfs the amounts occurring in most other streams throughout the state. The Bear River continues to empty some 900,000 acre-feet per year into the Great Salt Lake, and over 1,000,000 acre-feet of Utah's share to the Colorado River continues to flow out of the state unused; hence, the long-felt need to utilize our entitlements from these streams.

Best estimates of current, committed, and projected possible Colorado River depletions are shown in Table 1. Note that we are currently using 579,000 acre-feet, which is approximately 34 percent

STATE OF UTAH

COLORADO RIVER SYSTEM WATER
Compact Allocations
Present, Committed, and Project Depletions
(Units 1,000 acre-feet)

Allocation: (Upper Colorado River Basin Compact) 100%
(7,500 - 50) x 23% = 1,714

Probable Water Supply: (Tipton Report) 83.9%
(6,300* - 50) x 23% = 1,438 74.5%
(5,600** - 50) x 23% = 1,277

*7,500 annual delivery at Lee Ferry
**8,250 annual delivery at Lee Ferry

	Consum. Use.	Evap.	At Site Depletion	Salvage	Depletion at Lee Ferry	Accum. Total	Percentage
Present Depletion:							
Inbasin	449	6	455				
Export	108	16	124				
Totals			579	-23	556		
Mainstem Evap.		23			23	579	33.8
Committed Depletion:							
Bonneville	148	18	166				
Upalco	18	2	20				
Jensen	9	1	10				
Uintah	18	2	20				
Emery County	14	3	17				
Kaiparowits	102	0	102				
Totals			335	-13	322		
Mainstem Evap.		129			129	1030	60.1
Projected Depletion:							
Ute Indian			243	- 8	235	1265	73.8
San Juan & Grande Co.			30		30	1295	75.6
Price River			20		20	1315	76.7
Ute Indian Ext.			197	- 7	190	1505	87.8
Gray Canyon			220	- 8	212	1717	100.2
Juniper			160	- 5	155	1872	109.2

of our Upper Colorado River Compact allocation and based on approximately 7,500,000 per year available to the Upper Colorado Basin as provided in the Colorado River Compact. Committed depletions with accompanying proportion of mainstem evaporation losses which will accrue are estimated at another 451,000 acre-feet per year which would bring the accumulated total depletion up to about 60 percent. Colorado River flows subsequent to the Colorado River Compact have indicated considerably less flow than was estimated at that time. There is also a commitment to supply Mexico with a certain amount of water to be met from Colorado River supplies. These factors may ultimately force a reduction in the amount of water we can realistically obtain as our share of the Colorado River. A recent report by Tipton and Kalmbach, Inc., has suggested that based on more recent hydrologic conditions, and assuming an annual delivery at Lee Ferry of 7,500,000 acre-feet, the Upper Basin states would get about 6,300,000 acre-feet per year or about 84 percent of their compact entitlement. If this is the case, our current and committed depletion jumps to about 72 percent of our portion. This leaves from 30 to 40 percent of our Colorado River water not yet committed or in a serious stage of planning.

Some potential projects and estimates of depletion not yet committed are shown in Table 1. They are typical of many possibilities which have been proposed. This list and the accompanying depletion estimates vary almost daily. This is indicative of the highly exploratory and reconnaissance nature of many of the projects. The so-called "ultimate" phase of Central Utah Project would import into the Bonneville Basin the total amount of water that could reasonably be physically intercepted from the south slopes of the Uinta and transported across the mountains. Much of this water now used in the Uinta Basin would be replaced from the Green River. Some estimates of transmountain exports from the Colorado River Basin are in the neighborhood of another 400,000 acre-feet. One can see from Table 1 that depletions expected from such projects as the Ute Indian Extension, Gray Canyon, and Juniper would approach 6,000,000 acre-feet.

An inventory of long-range use of water for industrial purposes is difficult to compile. However, the number of applicants for water for mining and industrial purposes in the Colorado River Basin of

Utah has increased greatly in recent years. Eight applications were filed for mining and industrial purposes between 1956 and 1964 in the Colorado River Basin (average one per year). In the next two years, 34 filings were made. These filings for such stated uses as oil shale processing, thermal electric power generation, coal mining and processing, and extraction of oil from bituminous sands represent a potential depletion to the Colorado River system of more than 700,000 acre-feet. This does not include the Resources Company's Kaiparowits Thermal Electric Plant listed as a committed depletion in Table 1.

In short, the potential demands for water, without regard to comparative merits, will greatly exceed Utah's available supplies from the Colorado River. These demands will come from agriculture, industries of all kinds, municipalities, recreationists, and other segments of society. They will come from federal, state, and local agencies, and from private groups. These potential demands will vary widely in terms of relative technical feasibility, economic justification, and social implication. They will not be confined to particular regions of the state. This implies then that in achieving a coordinated, comprehensive state-wide plan of water development, Colorado River supplies and uses must be coordinated with supplies and uses elsewhere. This would further imply that if the state is to develop a totally integrated state-wide plan of water development it should avoid being trapped by a 30-year-old definition of "ultimate Central Utah." Ultimate development of Colorado River water must consider potential water projects in *any part of the state* and for *any legitimate purpose which best suits the state's long-term objectives.*

This same implication applies to the Bear River as well as the Colorado River. These two great sources of water should certainly not be viewed in the context of two separate and distinct projects. The Bear River has been studied for many years. Thus far a project capable of meeting the repayment costs without exceeding the mill levy limitations of the Utah Conservation District Act has not been formulated. Idaho has no district law which can provide a source of revenue for their repayment obligations. Even if Utah were willing to alter the District Act to meet its repayment deficiency, the division of the water between Utah and Idaho may still present a problem. (Idaho is so uncertain about its own needs that it tends to oppose or delay development out of a fear that the future may reveal some short-sightedness.)

Coordinated Use

There is one rather obvious aspect of coordinated and integrated water use which could be mentioned. Some of the water development now contemplated would involve large transbasin diversions from the Colorado River Basin to the Bonneville Basin. This would be intended, in large measure, to meet the demands of highly populated areas along the Wasatch Front in the Great Salt Lake drainage. Fig. 4 shows population according to major hydrologic regions of the state. The tremendous concentration of political and economic influence in a relatively small geographic portion of our state is obvious. Reapportionment of the legislature will intensify the political concentration. Metropolitan areas can pay relatively high prices for water and project planning tends to pivot around this capability. In fact, considerably more than one-half of the water being imported on the initial phase of Central Utah Project is for municipal purposes, and, of course, the ultimate phase would bring in a good deal more. Such projects will tend to concentrate greater supplies in the areas adjacent to the Utah Lake and Great Salt Lake.

It is an interesting coincidence that present inflow to Great Salt Lake from its major tributaries is practically the same as Utah's entitlement to the water of the Colorado River. The relative magnitudes are shown in Fig. 5. The Bear River contributes about 910,000 acre-feet annually; the Weber 480,000; the Jordan about 270,000; and other miscellaneous sources 30,000 for a total estimated inflow of 1,690,000 acre-feet to the Great Salt Lake. This is about equal to the 1,714,000 acre-feet allocated to Utah from the Colorado River. Water once discharged into the Great Salt Lake becomes of such quality that it is never rediverted except in the extraction of its brine. Millions of dollars have been and are being spent in planning and investigation to import water to areas which (from a hydrologic viewpoint) are already in surplus. Yet the equivalent of Utah's Colorado River is making its way right past these areas and entering the Great Salt Lake where it is ultimately consumed through evaporation. Would not this seemingly profligate waste justify some study and investigation to see to what extent these inflows could be intercepted and put to beneficial use? Of course we could expect obstacles of various kinds, and a variety of technical, legal, and political problems associated with the inter-

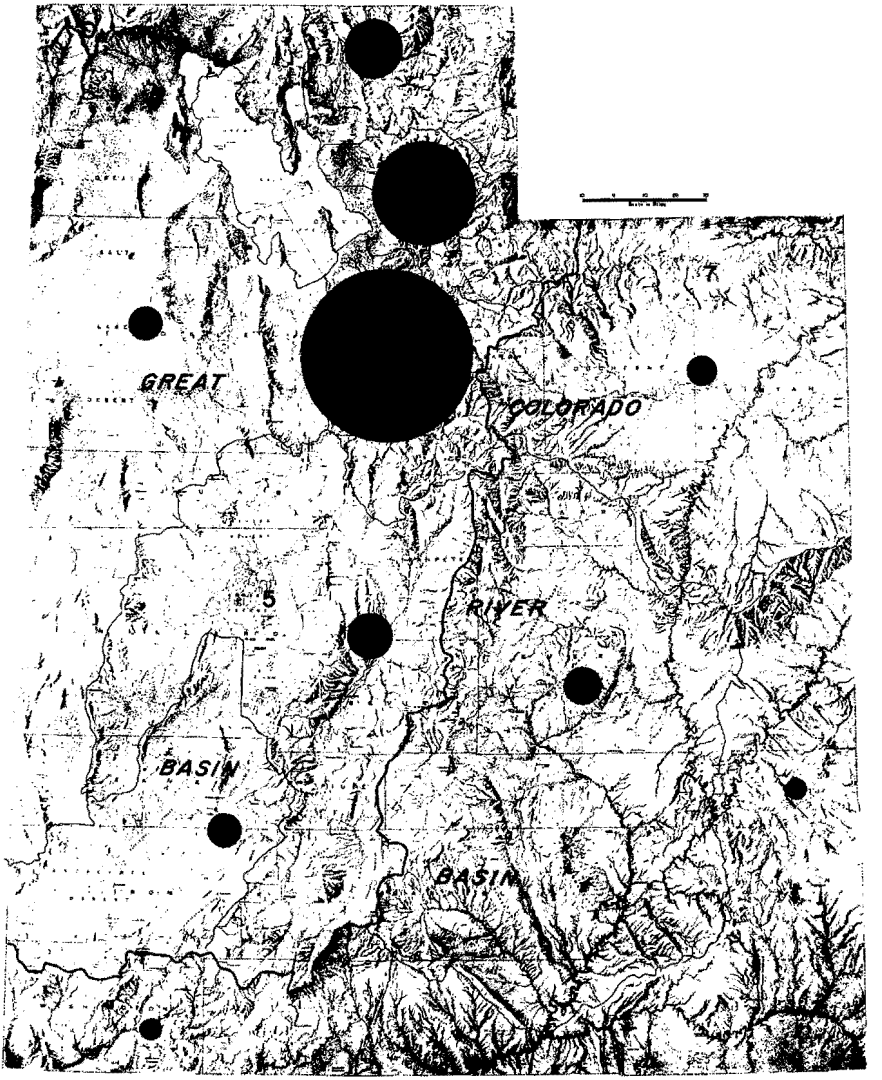

Fig. 4. Population distribution by principle hydrologic regions.

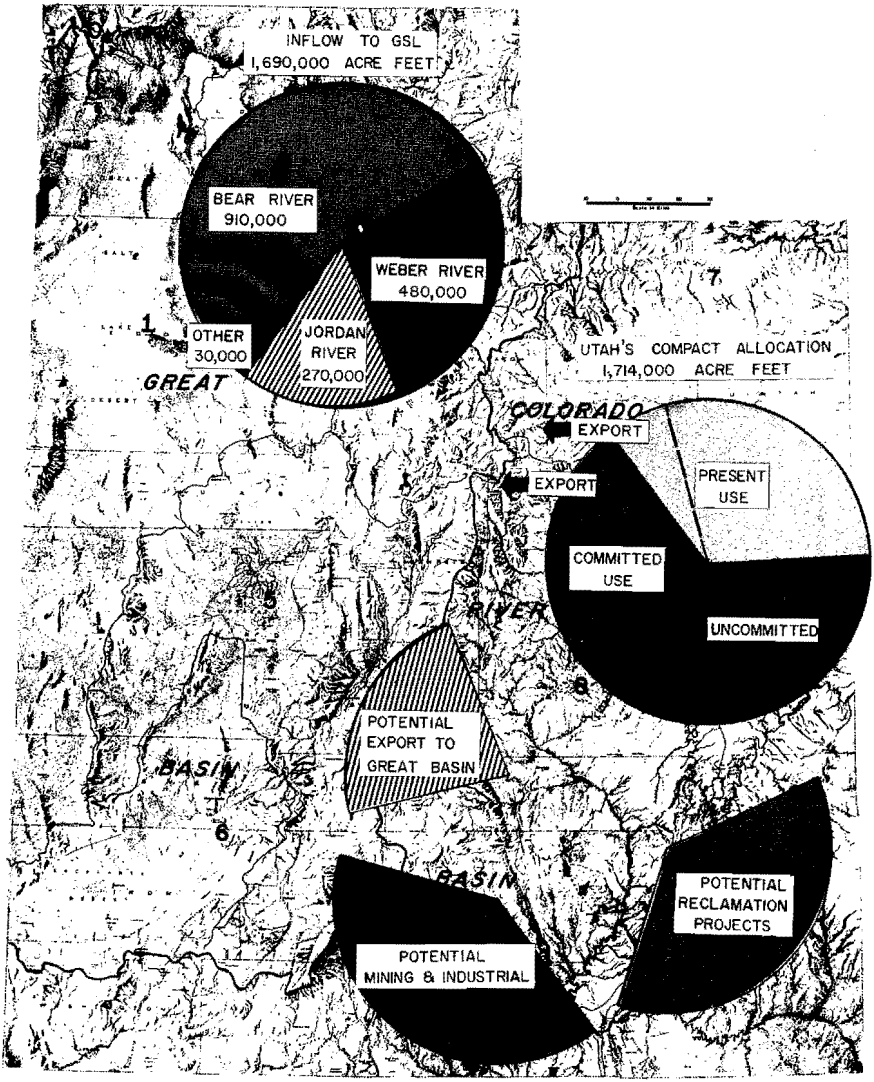

Fig. 5. Utah's Colorado River allocation and disposition compared to inflow to Great Salt Lake.

ception of some of these surpluses. Nonetheless, there are certainly ways of retrieving *some* of this loss by better management practices. Salvaging only eight percent of the water now entering Great Salt Lake from surface and underground tributaries would provide a supply equal to that being imported in the initial phase of the Central Utah Project. In fact, if we could reduce the evaporation from Utah Lake by about one-third, we would gain a like amount. It is not unlikely that when the hydrologic characteristics of the Bonneville Basin become more completely understood, plans can be made to meet some of the increasing demands from local rather than imported sources, thus releasing more Colorado River water to be used elsewhere. Note from Fig. 5 that the potential uses under current consideration exceed the uncommitted portion of Colorado River water by two to three times.

From the foregoing it would appear that from a hydrologic viewpoint Central Utah Project thinking applied to the Wasatch Range might make a lot of sense. Should we be intercepting Wasatch Front waters and moving them south? The difference between the concept of moving surplus water west from the Uintas and moving it south from the Wasatch is that we have no magnet of economic and political power in the southern part of our state to match the concentration of the north. Population distribution would suggest an almost insurmountable political problem in transferring these "hydrologic surpluses" to areas of "hydrologic deficiency." Be that as it may, development alternatives which *spread* water rather than *concentrate* it (if that concentration greatly exceeds possible consumption) may provide a broader and more viable economic base for the entire state in the long run. The propensity for growth induced by water development in an already water rich area may not be nearly so great as in a water deficient area. Latent growth nuclei existing outside the Wasatch Front might be energized by water projects and bloom into self-sustaining growth processes. Certainly we should not overlook such potentials for triggering growth on as broad a regional base as possible.

Central Arizona Project Implications

Much is being heard these days about the so-called "Colorado River Basin Project Bill." This bill, centered around the Central

Arizona Project, has been enlarged and broadened to include many other projects and provide for investigations conerning water imports to the Colorado River system. Utah has a vital stake in this because the Arizona Project would necessarily utilize waters to which we are entitled and hope to develop and use ourselves in time. Our concern would be with whether or not we could get this water back when we need it some years hence. Provisions of the Colorado River Compact are specifically protected in the proposed bill so our rights supposedly would not be jeopardized. However, if our development must depend on governmental authorization, it is highly doubtful that Congress would approve additional projects if water supplies were questionable for existing and proposed works, regardless of *legal* rights to use. On the other hand the bill places considerable emphasis on seeking water for import into the Colorado River Basin. Utah would stand to benefit from this in the same proportion as her present upper Colorado River entitlement. This is an allotment that would be difficult to negotiate outside this bill if Utah were to oppose it.

Our ace-in-the-hole here might be the potential mining and industrial development which, as has been indicated earlier, is filing applications for Colorado River water at an unprecedented rate. Our State Engineer has every legal right to approve such applications up to the extent of our Compact entitlements, regardless of what projects are approved in the Lower Basin. We are not at the mercy of the political power of the Lower Basin in this regard. The tremendous storehouse of mineral and fuel resources in the Colorado River Basin will require large quantities of water for its development. Resources Company, in its Kaiparowits scheme, for example, will consume 102,000 acre-feet per year and risk an amount of capital nearly double the cost of the initial phase of Central Utah Project. A few industries of this kind financed by private capital and not at the mercy of congressional appropriations might utilize large blocks of Colorado River water at considerable economic advantage to Utah.

Great Salt Lake

There has been considerable concern recently regarding development of recreational and industrial resources of the Great Salt Lake. This lake certainly does have some very unique features which could

and should be exploited for tourist and recreational attractions. It also has tremendous mineral wealth which ought to be obtained. The significant point to be noted again, however, is that the resource potential of the Great Salt Lake is not separate from the resource combinations existing within the entire drainage area tributary to the lake and of the entire state for that matter.

The fact that the Great Salt Lake is at the very end of the hydrologic ditch makes utilization of its resources a critical consideration. A too-restrictive consideration of resources of Great Salt Lake itself because of its "bottom" position in the water resource system, could have a very detrimental and long-range effect on the entire region. Without a careful assessment of the hydrologic characteristics of the Great Salt Lake and its tributaries, economic development and management of resources which depend on certain lake levels being maintained or quantities of water supplied, are on highly uncertain ground. Premature clamor for roads and dikes or the press for national monument or park status with utter disregard for the hydrologic aspects may result in great long-term disservice to the people of Utah. We must be able to predict what would happen to lake levels and flow characteristics under a variety of planning alternatives, some of which result in less inflow to the lake. The Great Salt Lake provides a great opportunity to have our cake and eat it too if we plan it that way. An understanding of the hydrology and limnology of the lake is vital to the optimum utilization of the tremendous recreational and industrial potentials while at the same time not committing ourselves to the perpetual waste of as much water as our entitlement from the Colorado River (1,700,000 acre-feet per year).

Water Laws

One final problem which may be more potential than real might be mentioned. This is the matter of water rights. It is well recognized that one of the important aspects of water resource planning is the legal or institutional phases which establish the ground rules within which development takes place. Development which meets physical, economic, and social feasibility tests may still be defeated if legal aspects are ignored. Since planning is for the future, it entails many projections with various degrees of uncertainty. The added uncer-

tainty of insecure water rights and entitlement leaves the planner in an extremely precarious position. In water development of any scale, the assurance of a water supply well in advance of heavy expenditures is needed. Thus, in the early evolvement of water rights law, protection of rights while permitting orderly and equitable development of water supplies has been paramount. Western water users learned very early that water interests on a stream system must be weighted in common. This must be accomplished while achieving certainty in water rights and an assurance that they could not be lost without due process. The appropriation doctrine which recognized priorities and treats water rights as a property right has served rather effectively in this regard.

Since we have had a century of experience with water law and water rights, the question might be posed: Aren't such problems pretty well settled? It is true that we have come a long way, but there are still many problems. Without going into a lengthy explanation let me just touch on this state-federal problem which arises from time to time.

Cause for concern has developed around what level of government water right conflicts are resolved. There have been a number of assertions by the Department of Justice and some court cases in recent years which have introduced a good deal of uncertainty in the pattern of established water rights. In simple terms these conflicts have been generated around the philosophy that the United States owns all unappropriated water which is appurtenant to federal lands. This appurtenant right attaches to lands which have been reserved. This would mean that water rights initiated in conformance to state law and dated after the initiation of a federal reserve would be subordinate to any uses which may be made by the government. The Department of Justice has indicated that submitting to the jurisdiction of states with respect to water rights would make the federal government subordinate to the state. There is much reference to the commerce clause and the defense clause of the Constitution which also establish federal rights to use. Distinction is made between navigable and nonnavigable also. This kind of division again points up the gross ignorance of the hydrologic unity of a river basin which would indicate that navigable and nonnavigable sections are parts of the same overall flow system and the flow in the navigable part is certainly affected by what happens in the nonnavigable.

Through interpretations placed on some of the above legal documents, it has also been suggested that the federal government can exercise these rights without regard to current use patterns and water rights patterns at all. In other words, the salient feature of current water rights which insists that a water right cannot be changed or taken away without due process does not hold with the federal government. These two features, (1) holding that water which is in association with the land is a property right of the landowner, and (2) the arbitrary manipulation, allocation, and use of this water without regard to the consequences to existing users, have some extremely disconcerting implications.

Although the federal-state conflict has developed much heat around the matter of who owns the water, it seems to me that the basic fallacy is the effect of these interpretations on the carefully evolved doctrine which now provides some order and equity in acquiring and utilizing waters beneficially. In a sense, the federal position means going back more than a hundred years in water law. It means that federal government is adopting the *riparian doctrine* which was found ill-suited hydrologically and legally many years ago. If this body of water law evolved over a hundred years of development is discarded, it means that the federal government is without law because they have nothing to take its place. Certainly some level of government must assume responsibility for making fair apportionments, enforcing regulations, protecting existing rights, and specifying how rights may be forfeited, etc.

At the present, one cannot point to many state or private developments which have actually been hurt by the federal exercise of power. If the present chaotic situation with respect to water rights is not resolved, however, it appears that lower levels of government and private entities will be forced right out of the development field. This is because they simply must have reasonable assurance that water will continue to be available if they are to invest in its use.

Water Quality

One of the most important water problems Utah now faces is that of maintaining water quality. Quality problems bid fair to become the No. 1 water problem in the years ahead.

In conformance with the Water Quality Act of 1965, conferees of the Colorado River Basin states are now attempting to hammer out water quality standards to be applied throughout the basin. Failure to accomplish this by July 1, 1967 would invite the FWPCA to propose its own standards on such interstate waters. There is considerable uneasiness about such an eventuality because the "guidelines" originally set down by the Secretary of Interior are rather unrealistic in some respects. They suggest that no further degradation in existing water quality will be permitted. Non-degradable materials (salinity or TDS) of course is included as a pollutant.

When the Colorado River Compact was consummated and the allowable depletions allocated, certainly it was recognized that such eventual depletion would result in a greater concentration of salts in the main stem, even though total salts may remain fairly constant. If no increase in ratio of dissolved solids to volume of water (ppm) is permitted (and this seems to be the interpretation some FWPCA officials [and our sister states to the south] would make) then the entire burden of water quality maintenance rests on the "late developing" states. Those states already using their complete entitlement of depletion could allege that any upstream development would adversely affect resulting water quality and thereby thwart development. In other words, new water quality standards could conceivably result in the abrogation of the 1922 or 1948 compacts. The water quality standards adopted could be used as a device to delay and prevent development of water entitled to by compact.

Finale

I have given an extremely broad-brush treatment to a few aspects of Utah's water development which will take on more and more significance with time. I tried to make the point at the outset that in today's planning mix there are no simple clear-cut solutions to water problems. Yet, from a hydrologic standpoint, there is yet great opportunity to extend and augment our water supplies by more intelligent use, reuse, and salvage of manageable supplies at hand. Utah's water problems may not be nearly so much a matter of nature's niggardliness as of our ability to manage what we have.

To accomplish complete and integrated management, a guiding criterion should envision an almost complete interlinking of projects in a highly flexible system that can be made responsive to varying needs at any location and for any purpose. This would suggest reclamation of all waste water and considerable attention to the maintenance of quality. It would mean regulation sufficient to capture and utilize flood flows; it would mean complete diversion of our share of interstate waters; and it would mean the conjunctive use of surface and subsurface storage and conveyance. An inkling of this concept might be indicated by the possibility of Willard Bay Reservoir providing a connecting terminal for the Bear and Weber rivers. A link to Utah Lake could join these river systems with the Jordan. This kind of interlinking might continue right down to Sevier Bridge Reservoir. By the device of water exchange made possible through such an intertie, effects could be felt in almost every corner of the state. This particular example may be an engineering pipe dream but it does serve to illustrate the point that considerations of a "water grid" would have the same advantages as a "power grid" in its responsiveness and flexibility in meeting user needs.

Utah lies on the threshold of its greatest era of water development. Let us hope that we can marshall our talents and our statesmanship to achieve social and economic benefits as a result.